# JOURNAL OF ATHLETIC TRAINING

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# Take this Supplement to St. Louis and use it as a guide to the Free Communications Sessions

Dear NATA Members and Friends:

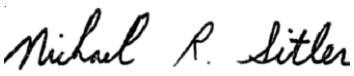
We are pleased to present the annual *Supplement* to the *Journal of Athletic Training*. This Supplement contains abstracts presented at the 2008 NATA Annual Meeting & Clinical Symposia as part of the NATA Foundation Free Communications Program.

The Free Communications Program provides certified athletic trainers, students and other healthcare providers an opportunity to present and learn about the latest in athletic training research. Research is presented in oral and poster formats and includes general research, Foundation-funded research, thematic posters, and clinical case reports. Abstracts of the research are printed here in the order of presentation at the NATA Annual Meeting in St Louis for your convenience. Free Communications presentations represent a wide range of research and clinical interests. In addition, the Clinical Case Reports sessions allow you to test your clinical assessment skills. We encourage you to attend these sessions.

We also urge you to attend the sessions featuring research funded by the Foundation. The Foundation funds research and a variety of educational programs, which include summits on issues critical to athletic training. Additionally, the Foundation funds annual scholarships to undergraduate and graduate students of athletic training.

Support from NATA members, corporations, and other affiliated groups make this supplement and all of the Foundation's programs possible. Please note projects funded by the NATA Foundation and by the generous contributions of our donors are specified in this Supplement. To make an investment in the future of the profession, please contact the Foundation today at 800-TRY-NATA, extension 142. NATA and its Foundation are pleased to offer this supplement as a service to NATA members. We hope that it provides theoretical and practical information you can use to improve your effectiveness as a certified athletic trainer. Thank you for your support!

Sincerely,



Michael R. Sitler, EdD, ATC
President, NATA Research & Education Foundation

Charles (Chuck) Kimmel, ATC
President, NATA

Dear Colleagues:

This has been a year of transition. We have moved to an online abstract submission process and added the Student Exchange Track to our Peer Review Track. As with anything new, there are a few issues along the way. But overall it went very well. I want to acknowledge a special thank you to the NATA Foundation staff of Patsy Brown, Velma Meza, and John Oliver, CAE, CFRE, whose attention to detail and dedication made this year go so well. They did a fantastic job of making this transition one of the smoothest I have experienced, especially considering all the double checking of cataloging submission and communications with authors, reviewers, and moderators to confirm everything runs smoothly at our convention. We hope you find something new in this year's Free Communications Program and *Supplement*. We again had another great year of submissions, providing the latest in athletic training research and case studies that address many of the challenges of clinical practice. To all who participate, thank you.

Several individuals have worked very hard to review submissions, schedule presentations, and produce this *Supplement*. I would like to take this opportunity to thank and recognize the efforts of Thomas Dompier, PhD, ATC; Kevin Guskiewicz, PhD, ATC; Karrie Hamstra-Wright, PhD, ATC; Mark Hoffman, PhD, ATC; Lisa Jutte, PhD, ATC; Kim Peer, EdD, ATC, LAT; William Pitney, EdD, ATC; Brian Ragan, PhD, ATC; Susan Saliba, PhD, ATC, PT; Stephen Straub, PhD, ATC; Erik Swartz, PhD, ATC; and Susan Walker-Yeargin, PhD, ATC, for their long hours of abstract reviews and preparation for the Free Communications programming. Finally, thank you to Leslie Neistadt and the staff at the editorial office of the *Journal of Athletic Training*.

I look forward to our meeting in St. Louis. Please take the opportunity to attend the Free Communications Peer Review Track, case studies, poster sessions, special interest groups, and Student Exchange Track poster presentations. Additionally, note that projects funded by the NATA Foundation are specified in this *Supplement.* Finally, if you have the opportunity, offer your thanks to those recognized above.

Sincerely,

Timothy L.Uhl, PhD, ATC, PT
Vice Chair for Free Communications
NATA Research & Education Foundation Research Committee

# JOURNAL OF ATHLETIC TRAINING

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## Table of Contents

# The Medal for Distinguished Athletic Training Research
# Presented in Honor of Joseph P. Torg, MD
# Sponsored by Riddell, Inc


## Douglas J. Casa, PhD, ATC, FNATA, FACSM
## University of Connecticut


## 100 Meters from the Finish Line—A Heat/Hydration Journey from Buffalo to St. Louis (and Still Trying to Win the Race)

Many people enter—and exit—college without a clue about what they want to do after graduation. However, for Douglas J. Casa, PhD, ATC, FNATA, FACSM, recipient of the 2008 Medal for Distinguished Athletic Training Research, a potentially tragic experience at a track meet as a teenage athlete gave him instant insight as to what he wanted to do when he grew up.

In 1985, at the age of 16, Casa suffered exertional heat stroke and collapsed during the last lap of a 10-K race on the track. He got up immediately and continued the race, only to collapse again (this time unconscious) 100 meters from the finish line. An athletic trainer covering the event was the first to reach him to provide assistance. This scary experience inspired Casa's fascination with exercise heat tolerance and hydration. In 2001, Casa learned that the athletic trainer who had helped him was Hall of Fame member Kent Scriber, EdD, ATC, of Ithaca College.

Casa is currently doing what he's always wanted to do: "change the world" with regard to education of sports medicine professionals about the best methods for preventing, recognizing, and treating heat stroke. He is currently the Director of Athletic Training Education and an Associate Professor at the University of Connecticut. Casa's 15-year research career has been centered on exercise heat tolerance and hydration issues of physically active populations. His long-term research goal is to continue furthering our understanding of exercise heat tolerance and hydration while mentoring master's and doctoral students and helping in the educational processes of sports medicine professionals.

Casa's dedication to his profession is evidenced by his involvement in athletic training-related activities: Chair of the Pronouncements Committee, Section Editor for the *Journal of Athletic Training*, Chair of the Inter-Association Task Force on Heat Illnesses, and Co-Chair of the Task Force on Preseason Policies. In 2007, Casa also was one of the first certified athletic trainers to participate in the development of a position statement from the American College of Sports Medicine. The topic? Exertional heat illness, of course.


Casa has a number of mentors and peers that he considers to be influential in his career: Lawrence Armstrong, PhD; Brent Arnold, PhD, ATC; Kevin Guskiewicz, PhD, ATC; MaryBeth Horodyski, EdD, ATC; Robert Howard, ATC; Christopher Ingersoll, PhD, ATC; Stavrous Kavouras, PhD; Carl Maresh, PhD; Stephanie Mazerolle, PhD, ATC; Linda Platt Meyer, EdD, ATC; Leslie, Neistadt, ELS; Pat Patane, MS, ATC; David Perrin, PhD, ATC; Susan Rozzi, PhD, ATC; Christine Stopka, PhD, ATC; Ginger Swann, MS, ATC; and Coach George Yuhasz. Casa is grateful for the support of his wife, Tutita Casa, PhD, and his parents, Edward and Patricia Casa, and also thanks the NATA staff for its ongoing encouragement and assistance.

# Joseph P. Torg, MD

Joseph Torg, MD, has long been a leader in sports medicine. Widely recognized for his work with spinal cord injuries, Dr. Torg is also responsible for perfecting medical techniques and spurring participation guidelines in sports.

A graduate of Haverford College and the Temple University School of Medicine, Dr. Torg is the founding director of the Temple University Center for Sports Medicine, the first affiliated with a university, which provided care for the athletes of Philadelphia. His research on the effect of the shoe–playing surface interface and its relationship to football knee injuries was directly responsible for both the National Federation of State High School Associations and the National Collegiate Athletic Association mandating that cleats be no longer than one-half inch. His published description of the Lachman test for anterior cruciate ligament instability, which he named for his professor, John Lachman, MD, is widely regarded as a classic work. Dr. Torg was also instrumental in opening Little League baseball to girls.

Dr. Torg's most well-known contribution has been his research identifying catastrophic cervical spine and cord injuries to result from the previously unrecognized axial loading mechanism of the spine from spearing and head-down contact. After analyzing data from the National Football Head and Neck Injury Registry, Dr. Torg recommended rule changes that resulted in a marked decrease in cervical cord injuries resulting in quadriplegia at both the high school and college level. He also described cervical cord neurapraxia resulting in transient quadriplegia as a distinct, benign clinical entity. Dr. Torg has published criteria for return to play following cervical spine injury.

In 1978, Dr. Torg was appointed Professor of Orthopedic Surgery and Director of the University of Pennsylvania Sports Medicine Program, where he initiated one of the first Sports Medicine Fellowships. He has since trained 36 fellows. Dr. Torg has co-authored three textbooks and well over 100 articles published in prestigious peer-reviewed journals. He served on President Reagan's Council on Physical Fitness and Sports.

Dr. Torg received the Ninth Annual Eastern Orthopedic Association award for spinal research, the Nicholas Andre Award, the North American Spine Association Annual Award, the NATA President's Challenge award, and the 2004 Elizabeth Winston Lanier Kappa Delta award. He is also an AOSSM Hall of Fame member.

# The New Investigator Award Presented in Honor of Freddie H. Fu, MD Sponsored by University of Pittsburgh Medical Center


## Tricia J. Hubbard, PhD, LAT, ATC
## University of North Carolina at Charlotte


## Mechanical Contributions to Chronic Ankle Instability

It's hard not to admire the excitement in Dr. Tricia Hubbard's voice when she proclaims, "I have the best job on the planet!" It is this earnest and unwavering commitment to her profession—coupled with her perseverance, devotion, and research excellence, of course—that has earned her the 2008 New Investigator Award.

Hubbard studies the contribution that ligament injury has on chronic ankle instability, a research area that piqued her interest while working on her senior thesis under the direction of Thomas Kaminski, PhD, ATC, at the University of Florida. Her goal is to not only learn how to manage ankle sprains better but to also decrease the disability that often follows this injury.

At the University of Florida, Hubbard completed her first research project, examining the effect of ankle taping on proprioception in patients with chronic ankle instability. She continued her graduate education and her academic partnership with Dr. Kaminski before pursuing her doctorate degree at Pennsylvania State University, where she collaborated with Jay Hertel, PhD, ATC. Hubbard considers both Dr. Kaminski and Dr. Hertel to be influential individuals in helping to shape to her athletic training research career.

Currently, Hubbard is an Assistant Professor at the University of North Carolina at Charlotte and the Director of the Undergraduate Athletic Training Program in the Department of Kinesiology. Hubbard thrives on the variety that her job offers and says that there's no such thing as a typical day; she spends her time teaching, working on research projects, and assisting with program management.

In addition to authoring or co-authoring 15 articles in peer-reviewed journals, Hubbard has also won numerous awards, including the NATA Foundation Student Free Communications Award. She is a reviewer for the *Journal of Athletic Training* and is on the editorial board at *Athletic Training Today*. Hubbard has also had her work published in several prestigious journals, including the *Journal of Athletic Training*, *Medicine and Science in Sports and Exercise*, *Sports Medicine*, *British Journal of Sports Medicine*, and *Foot and Ankle International*.

In addition to her mentors, Hubbard credits the support of her parents, Robert and Joan Hubbard; her sister, Jessica Hubbard; and her husband, Derek Bittner, as important components of her professional success.

# Freddie H. Fu, MD

Dr. Freddie H. Fu, a longtime advocate of certified athletic trainers, is a well-respected physician whose work in sports medicine has earned repeated honors.

The 1996 winner of the NATA President's Challenge Award, Dr. Fu is the David Silver Professor of Orthopaedic Surgery and Chairman of the Department of Orthopedic Surgery at the University of Pittsburgh School of Medicine and University of Pittsburgh Medical Center.

He has been the head team physician for the University of Pittsburgh Department of Athletics since 1986. He also was instrumental in establishing the Sports and Preventive Medicine Institute in 1985. Under his leadership, the facility – now called the UPMC Center for Sports Medicine – has grown into the region's largest, most comprehensive sports medicine center, regarded among the best in the country.

Dr. Fu holds secondary appointments as Professor of Physical Therapy and Health, Physical and Recreation Education. He was awarded an honorary doctorate of science degree from Point Park University and an honorary doctorate of public service from Chatham College.

Known worldwide for his pioneering surgical techniques to treat sports-related injuries to the knee and shoulder and his extensive research in the biomechanics of such injuries, Dr. Fu performs surgery at UPMC and sees patients at the UPMC Center for Sports Medicine. He also directs the University of Pittsburgh's Sports Medicine Fellows Society.

Dr. Fu is the editor of 26 major orthopedic textbooks and author of 75 book chapters on managing sports injuries. He has authored or co-authored 180 peer-reviewed articles and has given more than 600 national and international presentations.

Former president of the Pennsylvania Orthopaedic Society, he is a member of 40 other professional and academic medical organizations including the prestigious Herodicus Society. Currently he serves as Second Vice President of the International Society of Arthroscopy, Knee Surgery and Orthopedic Sports Medicine and will assume the presidency of ISAKOS in 2009. He is also on the Board of the American Orthopaedic Society for Sports Medicine and the Orthopaedic Research and Education Foundation. Dr. Fu has served as chairman of the board and executive medical director of the UPMC/City of Pittsburgh Marathon, company physician and board member for the Pittsburgh Ballet Theatre, and team physician for Mt. Lebanon High School.

**The Doctoral Dissertation Award**
**Presented in Honor of David H. Perrin, PhD, ATC**
**Sponsored by Friends of Dr. Perrin**

**Christopher Mendias, PhD, ATC**
**University of Michigan**

## Cellular and Molecular Mechanisms of Skeletal Muscle Atrophy

A common thread among many individuals who become athletic trainers is having sustained a sports injury in high school. Christopher Mendias, PhD, ATC, recipient of the 2008 Doctoral Dissertation Award, is no different. He was drawn to the athletic training profession as he recovered from a hip injury that occurred while playing high school football. As he spent more and more time with athletic trainers, he grew more and more interested in sports medicine.

Mendias attended the University of Arizona, where he majored in biology and completed the athletic training internship program. As an undergraduate student, Mendias' interest in research was piqued when the head athletic trainer at the University of Arizona, John Woolf, MS, PT, ATC, requested his assistance with collecting data for a study investigating strength training in elderly patients. While pursuing his master's degree in physiology, also at the University of Arizona, Mendias conducted research in the lab of Ronald Allen, PhD, a leading muscle stem cell researcher, and wrote his thesis on the effects of nonsteroidal anti-inflammatory drugs on skeletal muscle repair.

Mendias studies skeletal muscle repair and recently received his doctoral degree in molecular and integrative physiology from the University of Michigan, where he worked with John Faulkner, PhD, FACSM, a leading muscle biology researcher. Currently, Mendias is a research fellow in the Regenerative Sciences Program and a lecturer in the Division of Kinesiology at the University of Michigan. In the future, he hopes to become a professor at a research university and to improve manual therapy by determining how specific cytokines that are released after muscle injury lead to muscle atrophy and fibrosis. He considers the most rewarding aspect of his career to be the opportunity to help a large population and touch many lives through his research while making a positive contribution to the athletic training profession.

In addition to his "day job," Mendias has been the Communications Director and Webmaster of the Michigan Athletic Trainers' Society for the last 4 years. He has published a manuscript based on his doctoral research; additional activities include manuscript reviewer for the *Journal of Athletic Training*, the *Journal of Applied Physiology*, and *IEEE Transactions on Biomedical Engineering*.

Mendias would like to thank his mentors, J. Rigo Carbajal, MEd, ATC; John Woolf; and Riann Palmieri-Smith, PhD, ATC, for their ongoing support throughout his education and research endeavors.

# David H. Perrin, PhD, ATC

David H. Perrin, PhD, ATC, is a respected researcher, educator, mentor and friend of athletic training. This 2003 NATA Hall of Fame inductee is a noted pioneer of terminal degrees in sports medicine, and his dedication to athletic training is making an impact on the profession's development even today.

Serving as editor-in-chief of the *Journal of Athletic Training* and founding editor of the *Journal of Sport Rehabilitation* are only two of Dr. Perrin's significant achievements. Others include being awarded NATA's Sayers "Bud" Miller Distinguished Educator Award in 1996, Most Distinguished Athletic Trainer Award in 1998, and All-University Outstanding Teaching Awards from the University of Virginia in 1997 and 1998.

Dr. Perrin has built research education programs at the undergraduate, master's, and doctoral levels and has fully dedicated himself to mentoring and developing future scholars. Dr. Perrin makes every effort to maximize his students' potential by offering sound advice and helping them make the most of their educational programs. Many of his students have gone on to bright careers in the profession, as researchers, program directors, clinical supervisors, and award-winning scholars.

Dr. Perrin continues to mentor students and serve as a leader in the profession. He is provost at University of North Carolina at Greensboro. He oversees five academic departments, nearly 75 faculty members and more than 1200 students. The school's Ph.D. program in the Department of Exercise and Sport Science has been recognized as one of the country's best programs. Dr. Perrin remains involved in the profession by teaching a class and advising doctoral students who are certified athletic trainers. He also continues to write in athletic training and has recently published three books.

The NATA Foundation Doctoral Dissertation Award, presented in honor of David H. Perrin, recognizes outstanding doctoral student research and is a fitting tribute to a man who has dedicated the duration of his career to mentoring and developing future scholars.

### Sex Comparison Of Abdominal Muscle Thickness With And Without Controlling For Body Mass

Kulas AS, Schroeder KM: East Carolina University, Greenville, NC

**Context:** While poor trunk control predicts anterior cruciate ligament (ACL) injuries in females and not males, abdominal muscle dysfunction has been associated with both poor trunk control and low back pain. As muscle thickness is an indirect measure of force-producing capacity and is correlated to body mass, evaluation of abdominal muscle thickness in males and females may ultimately help to explain if muscle morphology, with and without body mass as a covariate, is a factor associated with trunk control and potentially ACL injuries. **Objective:** To compare sex differences in abdominal muscle thickness with and without body mass as a covariate. **Design:** Between-Groups Design **Setting:** Controlled, laboratory setting. **Patients or Other Participants:** Thirty (15M,15F) healthy college-aged volunteers (males: height= 1.80 ± .06m, mass= 78.45 ± 6.25kg; females: height= 1.65 ± .07m, mass= 61.43 ± 9.16kg) with no current history of injury and/or surgery to the lumbar spine or lower trunk region. **Interventions:** The independent variable was sex. All measures were taken on the right side with subjects in a relaxed supine position. Abdominal muscle thickness of the rectus abdominis (RA), internal oblique (IO), external oblique (EO), and transversus abdominis (TrA) were assessed with a Titan real-time ultrasound unit with a 38mm, 10-5Mhz linear array transducer (Sonosite, Bothell, WA). Transducer locations were in accordance with previously published literature. Three measurement trials for each muscle were obtained and digitally saved as 2D images for off-line muscle thickness quantification using ImageJ (NIH; Bethesda, MD). Day-to-day reliability (ICC 2,k) and precision (SEM 2,k) estimates on a subset of subjects (n=17) were all acceptable: ICC 2,k(SEM 2,k): RA=.98(.03cm), EO=.86(.06cm), IO=.96(.06cm), TrA=.88(.03cm). Sex differences in abdominal muscles were compared using one-way ANOVAs. To test for sex differences in abdominal muscle thickness while controlling for body mass, analyses of covariance (ANCOVAs) were performed. Alpha <.05. **Main Outcome Measures:** Dependent variables were thickness of the RA, EO, IO, and TrA all reported in centimeters (cm). **Results:** When comparing males vs females respectively, males had significantly thicker RA (1.41cm±.21 vs 1.12cm±.17, p<.001), EO (.81cm±.11 vs .64cm±.14, p=.001), IO (1.20cm±.29 vs .83cm±.16, p<.001), and TrA (.42cm±.09 vs .33±.08, p=.012). When using body mass as a covariate, there were no significant sex differences in abdominal muscle thickness. Body mass adjusted (69.9kg) abdominal thickness means for males vs females respectively: RA, 1.31cm vs 1.22cm (p=.355); EO, .76cm vs .68cm (p=.244); IO, 1.11cm vs .93cm (p=.151); TrA, .40cm vs .35cm (p=.279). **Conclusions:** While males have thicker abdominal muscles compared to females, these differences are most likely due to body mass and are not inherent abdominal morphological differences. Therefore, previous reports of poor trunk control in females as compared to males seem to be neuromuscular in origin. Future work is therefore needed to further explore neuromuscular factors related to trunk control in females and males.

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### Sex Comparison Of Electromechanical Delay And Rate Of Force Production In The Hamstrings

Norcross MF, Bell DR, Hudson JD, Engstrom LA, Blackburn JT: Motor Control Laboratory, University of North Carolina, Chapel Hill, NC

**Context:** Females demonstrate an increased risk of anterior cruciate ligament (ACL) injury compared to males. The hamstrings limit the stress introduced to the ACL by resisting joint perturbations. As such, sex differences in neural and mechanical contributions to hamstring force production may contribute to the higher ACL injury incidence in females. **Objective:** To compare electromechanical delay (EMD), time to 50% peak force (Time50%), and rate of force production (RFP) during isometric contraction of the hamstrings. We hypothesized that Males would demonstrate shorter EMD and Time50%, and greater RFP compared to Females. **Design:** Quasi-experimental (static group comparisons across sex). **Setting:** Research laboratory. **Patients or Other Participants:** A volunteer sample of 14 Females (Age 20.64±1.60 years, Height 1.64±.07 m, Mass 64.32±8.47 kg) and 14 Males (Age 20.86±1.70 years, Height 1.80±.10 m, Mass 79.43±10.76 kg). **Interventions:** Subjects were positioned prone with the right hip and knee supported in 30° of flexion. They performed five maximal isometric contractions of the hamstrings as quickly as possible in response to a visual light stimulus. Activity of the biceps femoris muscle (BF) was recorded using surface electromyography (EMG), and force output was recorded via a compression load cell. Mean values for EMD, Time50%, and RFP were compared across sex using one-tailed, independent samples t-tests with statistical significance established *a priori* at = 0.05. **Main Outcome Measures:** Dependent variables were derived using computer algorithms. EMD was defined as the time interval between EMG onset and the onset of force production. Time50% was calculated as the time interval between the onset of force production and the instant at which 50% of the peak force output was attained. This 50% of the peak force was then expressed relative to body mass (N/kg), and RFP was calculated as the ratio of this normalized force to Time50%. **Results:** EMD (Males: 127.62 ± 14.14 ms, Females: 124.38 ± 21.32 ms, p=0.320) did not differ between groups. There was also no difference in 50% peak force normalized to body weight (Males: 1.11 ± 0.38 N/kg, Females: 0.96 ± 0.29 N/kg, p=0.128). Males demonstrated a significantly shorter time to 50% peak force (Males: 95.88 ± 38.24 ms, Females: 141.38 ± 41.84 ms, p=0.003) and a greater RFP (Males: 13.61 ± 7.57 N/kg·sec$^{-1}$, Females: 7.50 ± 3.49 N/kg·sec$^{-1}$, p=0.007). **Conclusions:** These results indicate that while no difference in muscular strength between sexes was found when force was normalized for body weight, females did demonstrate a significantly lesser RFP compared to males. This diminished RFP may have direct implications for ACL injury risk. Females may be unable to attenuate external forces as quickly as males, and therefore may have an increased proportion of these forces transmitted to the ACL instead of resisted dynamically by the hamstrings. *Doctoral Student Award Finalist*

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**Lower Extremity Kinetic Differences During Drop-Jump Landings Between Prepubescent Males And Females**

Jackson KR, Garrison JC, Ingersoll CD, Hertel J: Exercise and Sport Injury Lab, University of Virginia, Charlottesville, VA

**Context:** Literature has demonstrated lower extremity biomechanical differences between adolescent and adult males and females during dynamic tasks such as drop-jump landings (DJL). These differences are believed to be associated with the gender bias related to anterior cruciate ligament (ACL) injuries. Little research has been conducted to investigate lower extremity biomechanics of youth athletes in a similar manner to determine if these differences are present in a prepubescent population. **Objective:** To assess sex differences in lower extremity kinetics during a DJL in a prepubescent athletic population. Our a priori hypothesis was that there would be no differences between sexes. **Design:** Cohort study. **Setting:** Motion analysis laboratory. **Patients or Other Participants**: Sixteen healthy, physically active subjects volunteered for this study (9 males, age= 9.6 ± 1.5 years, height= 1.5 ±.1 m, mass= 34.6 ± 6.1 kg; 7 females, age= 10.6 ± 0.8 years, height= 1.5 ±.1 m, mass= 35.1 ± 7.7 kg). All subjects were prepubescent according to the Pubertal Maturation Observation Scale. **Intervention(s)** Retroreflective markers were attached to the subject in accordance with the Vicon lower extremity maker set. Subjects performed 5 DJLs from a 40 cm box. They were instructed to step off the box with their dominant leg and land on 2 feet with only their dominant foot contacting a force plate. Immediately after landing subjects performed a maximal vertical jump. Kinetic data were recorded using a force plate synchronized with a 10-camera motion analysis system and data were analyzed during the stance phase of the DJL. Statistical analysis consisted of 6 independent t-tests comparing the sexes. **Main Outcome Measures:** The mean of peak external joint moments for hip extension, hip adduction, hip internal rotation, knee extension, knee abduction and knee internal rotation were calculated from all 5 trials. **Results:** Females had significantly greater joint moments than males for hip extension (f=2.52±.95 Nm/kg, m=1.01±.30 Nm/kg, P<.001), hip adduction (f=.87±.54 Nm/kg, m=.44±.2 Nm/kg, P=.04), hip internal rotation (f=.35±.25 Nm/kg, m=07±.02 Nm/kg, P=.005) and knee internal rotation (f=.26±.24 Nm/kg, m=.08±.03 Nm/kg, P=.05). There were no significant differences in peak joint moments between the sexes for knee extension (f=.75±.48 Nm/kg, m=.48±.12 Nm/kg, P=.13) or knee abduction (f=.31±.19 Nm/kg, m=.19±.12 Nm/kg, P=.13). **Conclusions:** Contrary to our hypothesis, prepubescent females exhibited greater joint moments at the hip and knee during a DJL than males of the same maturation level. This finding may indicate that neuromuscular training programs need to be targeted at an even younger population in order to minimize the amount of non-contact ACL injuries sustained by female athletes.

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**Comparison Of Hamstring Musculotendinous Stiffness And Material Properties Between Males And Females**

Blackburn JT, Bell DR, Norcross MF, Hudson JD, Kimsey MH: Motor Control Laboratory, University of North Carolina at Chapel Hill, Chapel Hill, NC

**Context:** Musculotendinous stiffness refers to the ratio of change in force to change in length of the musculotendinous unit, and a stiffer hamstring group may limit anterior cruciate ligament (ACL) loading by providing greater resistance to lengthening imposed by joint perturbation. Greater hamstring stiffness has been identified in males relative to females, but it is unclear if this difference is attributable to inherent characteristics of the musculotendinous unit (e.g. stress, strain, elastic modulus) or simply to greater hamstring size in males. **Objective:** To compare hamstring structural (stiffness) and material (stress, strain, and elastic modulus) properties across sex. We hypothesized that structural and material properties would be greater in males than females. **Design:** Quasi-experimental (static group comparisons). **Setting:** Research laboratory. **Patients or Other Participants:** Twenty-six healthy, physically active volunteers (13 males: age= 21 ± 2yr, mass= 79.11 ± 11.13kg, height= 1.79 ± 0.11m; 13 females: age= 21 ± 2yr, mass= 64.24 ± 8.82kg, height= 1.64 ± 0.07m). **Interventions:** Subjects were positioned prone with the right hip supported in 30° of flexion, and were required to contract the hamstrings to support a load of 10% body weight in 30° of knee flexion. A perturbation was applied to the shank, producing oscillatory knee flexion/extension. An accelerometer was used to characterize the damped oscillatory frequency from which linear hamstring stiffness (N/cm) was derived. These procedures demonstrate moderate-to-high reliability across repeated measures ($ICC_{2,1}$=0.70, SEM=1.63N/cm). Hamstring stress was calculated as the ratio of the change in hamstring force obtained from stiffness measures to hamstring cross-sectional area (CSA) obtained via ultrasound imaging. An electromagnetic motion analysis system was used to estimate hamstring length from three-dimensional origin/insertion coordinates, and hamstring strain was calculated as the ratio of the change in length resulting from the perturbation to the resting/pre-perturbation length. Sex differences in stiffness, stress, strain, elastic modulus, and hamstring length and CSA were assessed via one-tailed independent-samples t-tests ($\alpha$=0.05). **Main Outcome Measures:** Hamstring stiffness, stress, strain, elastic modulus, resting length, and CSA. **Results:** Hamstring stiffness was significantly greater in males (14.54 ± 3.63N/cm) than females (9.96±2.18N/cm) ($P$<0.001). Similarly, hamstring resting length (males: 44.14 ± 3.91cm, females: 41.38±3.47cm; $P$=0.034), CSA (males: 10.90 ± 2.62cm$^2$, females: 7.32 ± 1.08cm$^2$; $P$ < 0.001), and strain (males: 0.39 ± 0.29%, females: 0.71 ± 0.40%; $P$ = 0.012) were greater in males. However, hamstring stress (males: 1.21 ± 1.15KPa, females: 2.09 ± 1.49KPa; $P$ = 0.054) and elastic modulus (males: 3.07 ± 0.99KPa, females: 2.87 ± 0.71KPa; $P$ = 0.284) did not differ significantly across sex. **Conclusions:** While hamstring stiffness was greater in males than females, this difference was primarily attributable to discrepancies in muscle size, as elastic modulus did not differ across sex. However, the greater strain noted in females in response to a standardized load (10% body weight) suggests that the male hamstrings possess a greater capacity for resisting lengthening induced by joint perturbation, even after accounting for the influence of muscle size. This characteristic of the male hamstring musculature may represent a heightened protective mechanism against ACL injury.

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**Gender Differences In Knee Proprioception In Transverse Plane**

Nagai T, Sell TC, Nakagawa T, Abt JP, Fu FH, Lephart SM: Neuromuscular Research Laboratory, Department of Sports Medicine and Nutrition, School of Health and Rehabilitation Sciences, University of Pittsburgh, Pittsburgh, PA

**Context:** Afferent proprioceptive signals from mechanoreceptors play a vital role in achieving functional joint stability of the knee. Previous research has demonstrated that female athletes have a decreased ability to perform sagittal plane knee threshold to detect passive motion (TTDPM) into extension compared to their male counterparts. The ACL becomes taut with knee extension, internal rotation (IR), and valgus. As the mechanism of non-contact ACL injuries is likely multi-planar, with a significant rotational component, we hypothesized that females might exhibit decreased proprioception in the transverse plane. We have developed a method to test knee TTDPM in the transverse plane, and found good intersession and intrasession reliability (ICC=0.68-0.95) and precision (SEM=0.11-0.38°). **Objective:** To investigate TTDPM in the transverse plane and compare between genders. **Design:** Cross-sectional. **Settings:** University sports medicine laboratory. **Patients or Other Participants:** Twenty healthy collegiate individuals who participate in at least 20-30 min of exercises 3 times a week (10 males: Age: 24.7 ± 4.2 yrs; Height: 183.1 ± 8.2 cm; Mass: 81.4 ± 9.3 kg, 10 females: Age 21.7 ± 2.1 yrs; Height: 166.4 ± 9.0 cm; Mass: 59.7 ± 8.2 kg). **Interventions:** All TTDPM tests were performed on an isokinetic dynamometer. Subjects sat in the chair with the knee and hip positioned at 90° flexion, and wore a compression boot, blindfold, and headphones playing static noise. Initially, the knee was positioned at IR and ER terminal end-range (10° less than the maximum active IR and ER). The dynamometer initiated the movement toward either IR or ER direction at 0.25°/s at unannounced time. Subjects were instructed to press a stop-button when they first felt limb movement and were then able to detect the direction of movement. The arc between the initial and final positions was reported as TTDPM. Subjects performed a total of five trials for each direction (order of direction was randomized). The average of the middle three trials was used for statistical analyses. Independent t-tests were used to compare genders across all variables (alpha level = 0.05). **Main Outcome Measurements:** TTDPM toward IR and ER at both IR and ER positions. **Results:** Females had significantly decreased ability to perform the TTDPM toward IR at the IR position (Males: 0.77° ± 0.15°, Females: 1.18° ± 0.46°, p = 0.02). **Conclusions:** Gender differences in TTDPM were specific to the joint position, plane, and direction of motion. The results are in accordance with previous research. Females exhibited the decreased proprioception toward extension at the near terminal extension position and IR at near terminal IR position which are a position of potential ACL injury. Additionally, females exhibited decreased ability to perform TTDPM in all variables, suggesting that an intervention program to train multi-planar proprioception should be evaluated.

## Free Communications, Oral Presentations: ACL Risk Factors

Wednesday, June 18, 2008, 2:45PM-3:45PM, Room 260; Moderator: Sandra J. Shultz, PhD, ATC, CSCS

**Acoustic Perturbation Influences On Neuromuscular Hamstring/Quadricep Coactivation And Functional Stability**

Moffit DM, Sitler MR, Russ AC, Tierney RT: Biokinetics Research Laboratory, Athletic Training Division, Temple University, Philadelphia, PA

**Context**: Various risk factors are associated with acute non-contact injuries with neuromuscular control being at the forefront of scientific inquiry into their etiology. Two basic components underlying the stress-injury relationship are changes in general muscle tension and deficits in attention during stress. Disruption in neuromuscular control due to an acoustic perturbation and subsequent startle response may be a risk factor for acute non-contact injuries. **Objective**: To determine the effect of an acoustic perturbation on knee neuro-muscular activation and functional stability. **Design**: Repeated measures design. **Setting**: Controlled laboratory setting. **Patients or Other Participants**: Fifteen healthy NCAA Division I athletes (4 males [M], height= 178.75 ± 3.95cm, mass= 74.43 ± 4.44kg; 6 female follicular [FF], height= 165.0 ± 7.59cm, mass= 60.38 ± 5.19kg; 5 female luteal [FL] height= 168.2 ± 10.11cm, mass= 63.48 ± 5.61kg) volunteered as participants. **Interventions**: Participants performed a functional activity consisting of a two-legged standing broad jump with vertical reach, landing on the dominant leg and completing a lateral cutting maneuver. Participants completed six trials with randomization of either a startle (116 dB, 40 msec) or non-startle control. Data from electro-myography (EMG) were used to determine hamstring/quadriceps neuro-muscular coactivation, normalized to body weight. Data were collected 100 ms before the startle (pre-startle) and landing (preparatory) and 250 ms after the startle (post-startle) and landing (reactive). Stability data were collected on a force plate and normalized to body weight. Two and three factor analyses of variance with repeated measures were used to analyze the EMG and functional stability measures ($p \leq .05$). **Main Outcome Measures**: Neuromuscular coactivation of the hamstring/quadriceps by time (pre, post), condition (startle, non-startle control), and group (M, FF, FL); and stability measures of rate of loading, peak force, and ground contact time by condition and group. **Results**: A significant interaction existed for the hamstring/quadriceps coactivation ($F = 8.144$, $p = .006$). Simple main effects showed pre-startle hamstring/quadriceps coactivation being significantly greater (761%) for the FL than for the FF (FL = 2.13 ± 1.73, FF = .28 ± .14, $F = 5.479$, $p = .02$). During the landing, the startle had 432% higher coactivation than the non-startle control (startle = 3.88 ± .74, non-startle control = .90 ± .21, $F = 19.094$, $p = .001$). No significant differences existed for the functional stability data. **Conclusions**: Hamstring/quadriceps co-activation, important in knee stabilization, was affected by acoustic perturbation for the FL but not for the M or FF. Disruption in pre-planned muscle activation from acoustic perturbations may increase acute non-contact injury risk. Although functional stability was not affected by acoustic perturbation in the current study, its affect is yet to be determined. Future research should include a functional activity with a startle perturbation occurring closer to landing when an athlete is more vulnerable to injury. *Funded by a grant from the NATA Research and Education Foundation.*

**Differences In Lower Extremity Kinematics Between ACL-Injured And Non-Injured Individuals: A Prospective Cohort Study**

Padua DA, Marshall SW, Beutler AI, Boling MC: University of North Carolina, Chapel Hill, NC, and Uniformed Services University of the Health Sciences, Bethesda, MD

**Context:** Numerous studies have identified sex differences in lower extremity kinematics and ground reaction force (GRF) variables. As a result lower extremity kinematics and GRF are frequently hypothesized to be important risk factors for ACL injury. However, there is little prospective research available to verify lower extremity kinematics and GRF as risk factors for ACL injury. **Objective:** To compare lower extremity kinematics and GRF during a jump-landing task between ACL-injured and non-injured individuals. We hypothesized that ACL individuals would demonstrate different lower extremity kinematics and higher GRF compared to those individuals who do not sustain ACL injury. **Design:** Prospective cohort. **Setting:** Research laboratory. **Patients or Other Participants:** A total of 2,600 healthy participants (males= 1,602; females=998; age=18.6±0.6 yrs, ht= 173.5±9.2 cm, wt=71.9±12.9 kg) with no previous ACL injury history volunteered for this study. **Interventions:** Participants from Division I Universities were tested prior to the fall academic semester. Testing consisted of participants performing a jump-landing task (3-trials) by jumping from a 30-cm high box. Following the initial landing, the participants immediately jumped upward for maximal vertical height. Three-dimensional kinematics of the lower extremity were measured using an electromagnetic motion analysis system. Ground reaction forces (GRF) were measured using a non-conductive force plate. Individuals suffering ACL injury following the initial testing session were identified over a 3-year time period. A total of 21 ACL-injured (ACLI) subjects (males=13, females=8) were identified. Independent t-tests were used to compare variables between ACL-injured and non-injured (NONI) subjects ($\alpha \leq 0.05$). **Main Outcome Measures:** Three-dimensional hip and knee joint angles at initial contact and peak angles during the landing phase were determined. Peak GRF in the vertical, anterior-posterior, and medial-lateral directions during the landing phase were also quantified. The landing phase was defined as the time from initial contact (vertical GRF>10-newtons) until the first local minima in the vertical GRF. **Results:** ACL-injured individuals demonstrated greater hip external rotation at initial contact (ACLI= -8.7° ± 5.5, NONI= -4.1° ± 8.1, $P$= 0.04) and landing phase (ACLI= -10.9° ± 7.0, NONI= -6.1° ± 8.1, $P$= 0.008) in comparison to non-injured individuals. There were no other significant differences for any of the other joint kinematics or GRF variables ($P$>0.05). **Conclusions:** Increased hip external rotation may be risk factors for ACL injury. Thus, individuals displaying large amounts of hip external rotation during a jump-landing may be at greater risk for ACL injury. However, additional research involving a greater number of ACL injured subjects is needed to further investigate the validity of lower extremity kinematics and GRF variables as potential ACL injury risk factors. *(Funded by the NIAMS Division of the National Institutes of Health, #R01-AR050461001)*

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**Effects Of Landing Strategies On Lower Extremity Sagittal Plane Kinetics And Kinematics**

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**Context:** Landing with higher quadriceps contraction demands (i.e. knee extensor moment production demand), and lower hamstring contraction demands (i.e. hip extensor moment production demand), and higher ground reaction forces may increase the risk of non-contact Anterior Cruciate Ligament (ACL) injury, especially in conjunction with shallow knee flexion angles. Changing landing strategies may alter lower extremity biomechanics, possibly influencing ACL injury risk. **Objective:** To examine how different landing strategies influence lower extremity sagittal plane kinetics and kinematics **Design:** Within subject design **Setting:** Controlled laboratory **Patients or Other Participants:** Twenty healthy volunteers (10M, 10F; 23.4±3.6yrs, 171.0±9.4cm, 3.3±12.7kg) **Interventions:** Subjects performed 5 single-leg landings each from a box (M=45cm; F=30cm) in 3 different styles; 1) self-selected (SS), 2) leaning slightly forward (LF), and 3) with the upper body as upright as possible (UR). A 3-D electromagnetic tracking system and a non-conducting forceplate collected kinematic and kinetic data. Separate one-way repeated measures ANOVAs examined differences between landing styles, followed by pairwise comparisons with Bonferroni corrections at p=.05. **Main Outcome Measurements:** Sagittal plane peak knee extensor moment (KEMpk; Nm), hip extensor moment (HEM@KEMpk; Nm), ankle plantar flexor moment (APFM @KEMpk; Nm), and knee flexion angle at KEMpk (KFA@KEMpk; °), and peak vertical ground reaction force (vGRFpk; N). Positive directions were assigned to be extension or plantar flexion. **Results:** Significant differences across landing conditions were identified for all variables: KEMpk ($F_{2,38}$ = 22.76, p < 0.001; SS = 133.7±55.0, LF = 119.9±49.3, UR = 180.7 ±72.9), HEM@KEMpk ($F_{2,38}$ = 6.37, p < 0.001; SS = -6.3±35.3, LF = 45.4±25.1, UR = -75.8±38.4), APFM @KEMpk ($F_{2,38}$ = 23.81, p < 0.001; SS = 57.5±42.4, LF = 83.7± 39.6,UR = -37.0±92.9), KFA @KEMpk ($F_{2,38}$ = 12.33, p < 0.001; SS = -29.4±12.8, LF = -36.3±9.6, UR = -24.9±10.2, and vGRFpk ($F_{2,38}$ = 52.78, p < 0.001; SS = 3457.9±1072.0, LF = 2835.2±828.8, UR = 3969.4±1112.2). Bonferroni pairwise comparisons revealed significantly lower KEMpk and higher HEM@KEMpk in LF as compared to UR, but no significant differences existed between LF and SS. Further, larger APFM@KEMpk and KFA@KEMpk and lower vGRFpk were observed in LF as compared to both SS and UR. **Conclusions:** LF landings produced lower knee extensor moments and vGRFpk with larger hip extensor and plantar flexor moments and knee flexion angles as compared to UR landings. Further, LF landings also resulted in greater knee flexion angles and lesser vGRFpks than SS landings. LF landings may facilitate decreasing quadriceps contraction demands (lower knee extensor moments) while simultaneously increasing/maintaining hamstring (hip extensor moments) and ankle plantar flexor contraction demands along with greater knee flexion, resulting in softer landings. Our results support the theory that landing slightly leaning forward may be a possible strategy to reduce the risk of non-contact ACL injury.

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**Landing Error Scoring System Is Not Related With Hip Abduction And External Rotation Strength**

Cortes N, Onate JA, Kollock R, Hertel J, Arnold B, Marshall S, Ross S, Kramer L, Padua D, Van Lunen B: Old Dominion University, Norfolk, VA; University of Virginia, Charlottesville, VA; Virginia Commonwealth University, Richmond, VA; University of North Carolina at Chapel Hill, NC; Pennsylvania State University, State College, PA

**Context:** Poor landing mechanics have been proposed as potential risk factor for anterior cruciate ligament (ACL) tears and lateral ankle sprains (LAS). In addition, researchers have proposed insufficient muscular strength at the hip as a contributing factor to poor lower extremity kinematic landing patterns. Due to the rise of ACL and LAS injuries in sports requiring landing from a jump further research into this relationship between landing mechanics and hip strength is warranted. **Objective** The purpose of this study was to analyze the relationship between Landing Error Scoring System (LESS) scores and hip abduction strength and external rotation strength measurements. **Design:** Experimental single test session design. **Setting:** Sports medicine research laboratory and athletic training room. **Patients or Other Participants:** A sample of convenience of 36 male (20.03 ± 1.21 years, 178 ± 8.13 cm, 74.69 ± 9.01 kg) and 35 female (19.51 ± 1.01 years, 167 ± 6.36 cm, 63.77 ± 7.32 kg) Division I Collegiate Soccer Athletes volunteered to participate in this study. **Interventions:** Two video cameras were used to videotape drop jumps from a 30 cm box placed 30 cm from the landing area. Three trials were later analyzed and scored using the LESS. Hip abduction and external rotation strength were measured using a portable fixed dynamometer (Evaluator, BTE Technologies, Hanover, MD). A Pearson Product Correlation was used to assess the relationship between the LESS scores and strength measurements. An independent *t*-test was used to assess differences between genders in the various variables. Significance was set *a priori* at $p<.05$. **Main Outcome Measures:** Average LESS scores from the three trials were used to determine the relationship with strength measures. Strength was normalized as percentage of torque (%T) [(torque [Nm]/ weight [N] x height [m]) x 100]. **Results:** There were no statistical significant correlations between LESS scores (4.08±1.89) and hip abduction (12.99±3.86 %T), $r$=-.188, and external rotation (13.05±2.99 %T), $r$=-.048, strength measures. There were also no statistical significant correlations between LESS scores (males=3.86 ± 1.90%T; females= 4.30 ± 1.87 %T) and hip abduction (males= 14.73 ± 4.14%T, $r$= -.099; females= 11.22 ± 2.58%T, $r$= -249) and external rotation (males= 14.09 ± 3.57%T, $r$= -004; females= 11.99 ± 1.76%T, $r$= -.016) when evaluated by gender. Furthermore, there was a statistical significant difference between males and females in hip abduction (males= 14.73 ± 4.14%T; females= 11.22 ± 2.58 %T), $p<.01$ and hip external rotation (males= 14.09 ± 3.57%T; females= 11.99 ± 1.76%T), $p=.03$, but no statistical difference was found in LESS scores ($p>.05$). **Conclusions:** While males were significantly stronger than females, a significant correlation was not observed between hip strength and landing mechanics. Although there was not a significant correlation between hip strength and landing mechanics, strength deficits still may be a vital component in the female athlete's susceptibility to injury. *Funding Source: National Institutes of Health RO3: PA 04-002 NIAMS Small Grant Program for New Investigators: 1R03AR054031-01*

# Free Communications, Oral Presentations: Balance Assessment

Thursday, June 19, 2008, 1:00PM-2:00PM, Room 260; Moderator: Scott E. Ross, PhD, ATC

**Time To Stabilization: Number Of Practice And Test Trials Needed And The Influence Of Limb Dominance**

VanMeter A, Gribble PA: University of Toledo, Toledo, OH

**Context:** Time to Stabilization (TTS) has been used as a method for quantifying differences in dynamic stability in populations with lower extremity pathology. However, the number of practice trials and test trials needed to adequately study this variable has not been established. **Objective:** The primary purpose was to establish a standard protocol for the number of practice and test trials needed for testing TTS. A secondary purpose was to determine if limb dominance influences TTS in healthy subjects. **Design:** Single-session within subject design. **Setting:** Athletic Training Research Laboratory. **Patients or Other Participants:** Thirty-one healthy subjects (15 males, 16 females; age: 21.23±2.8yrs; height: 171.83±8.6cm; mass: 76.5 ± 13.21kg) volunteered for this study. **Interventions:** Subjects participated in a single session during which twenty trials of a jump-landing task were performed on each leg. The jump-landing task consisted of a single-leg landing from a double leg jump height equivalent to 50% of the subject's maximum jump height. Subjects started 70cm away from the center of the force plate. Subjects jumped off of both feet, reached up and touched the indicated marker, and landed on the forceplate on a single test limb. A one-minute rest was provided between each trial and a 10-minute rest was provided before beginning trials on the second testing limb. The landing leg was randomized. Ground reaction forces were used to calculate TTS in the medial/lateral (MLTTS) and anterior/ posterior (APTTS) directions. A separate Trial (1-20) by Side (dominant, non-dominant) repeated measures ANOVA was performed for APTTS and MLTTS. A Scheffe's post-hoc test was applied. Significance was set at $p<0.05$. **Main Outcome Measure(s):** APTTS and MLTTS **Results:** For APTTS, there was no significant Side by Trial interaction ($F_{19, 570}=0.973$, p=0.49), main effect for Side ($F_{1, 30}=0.081$; p=0.78; dominant: 1.18±0.02sec; non-dominant: 1.19±0.02sec) or Trial ($F_{19, 570}=1.34$, p=0.15). For MLTTS, there was no significant Side by Trial interaction ($F_{19, 570}=0.078$, p=0.67) or main effect for Side ($F_{1, 30}= 6.17$, p= 0.44; dominant: 1.61 ± 0.03sec; non-dominant: 1.63 ± 0.03sec). A significant main effect for Trial existed ($F_{19, 570}= 2.901$, $p<.001$). The multiple significant relationships between multiple individual trials are too numerous to display in total in this results section. However, trials 4-20 had significantly faster TTS compared to trials 1 (1.74±0.06sec), 2 (1.74±0.06sec) and 3 (1.69±0.06sec). **Conclusions:** It appears that both limbs of a healthy subject have similar TTS values, perhaps allowing more efficient matching procedures when comparing both limbs of healthy subjects to injured subjects. The number of trials needed to overcome a learning effect was not realized fully. We can cautiously conclude that three practice trials would allow a healthy subject to become familiar with the task. Further research is needed to assess if a learning effect

is associated with measures of TTS in healthy subjects.

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**Relationship Between The Star Excursion Balance Test And Functional Measures Of Strength, Power, And Agility**

Sabin MJ, Ebersole KT, Price JW, Martindale AR: University of Illinois, Urbana, IL

**Context:** The Star Excursion Balance Test (SEBT) is a unilateral balance task and may serve as a meaningful screening tool for injury or rehabilitation progress. However, the specific determinants of SEBT performance in a collegiate athletic population have not been established. **Objective:** To determine the relationship between the SEBT reach and various measures of functional performance reflecting strength, power, and agility. **Design:** Randomized controlled trial. **Setting:** Research laboratory. **Patients or Other Participants:** Nine male (age 19.56 ± 1.67yrs, weight 93.54 ± 7.99kg) and nine female (age 20.25 ± 1.04yrs, weight 76.66 ± 12.81kg) NCAA division 1 collegiate basketball players volunteered to participate in this study. **Interventions:** Each participant performed a battery of maximal strength, power, and agility tests resulting in the following independent variables: dominant limb hamstring to quadriceps strength ratio (H:Q) from concentric isokinetic leg extension and flexion at 180°/s, 1-repetition bilateral squat, 1-repetition power clean, one-step vertical jump, pro-lane agility run, and a weighted ball squat throw for total distance. Separate (one for each gender) Pearson Product Moment correlation analyses were performed to explore the relationship between SEBT performance and the various measures of strength, power, and agility. An alpha level of 0.05 was used for all analyses. **Main Outcome Measures:** The SEBT was performed in the anterior, medial, and posterior directions while standing on the dominant limb (based on kicking preference) on a stable and a semi-stable (foam balance pad) surface. Maximal reach distances were normalized to leg length and each direction was summed to form a composite score that was used in the correlation analysis. **Results:** For the males, moderate to strong negative correlations were found between SEBT reach and vertical jump in the stable (r=-.64, p=.062) and unstable (r=-.86, p=.003) conditions. Weaker non-significant correlations were found for the squat throw (stable, r=.51; unstable, r=.42), pro-lane agility run (stable, r=-.47; unstable r=-.37), power clean (stable, r=.29; unstable, r=.46), squat (stable, r=-.13; unstable, r=-.10), and H:Q (stable, r=.11; unstable r=.21). For the females, SEBT reach was strongly, but negatively related to H:Q in the stable (r=-.83, p= .039) and unstable (r=-.81, p= .053) condition. Weaker non-significant correlations were found for the squat throw (stable, r=-.45; unstable r=-.177), vertical jump (stable, r=.08; unstable r=.38), pro-lane agility run (stable, r=-.44; unstable, r= -.44), power clean (stable, r=-.15; unstable r=-.09), and squat (stable, r=.04; unstable r=-.05). **Conclusions:** These findings suggested that the underlying determinants of SEBT performance may differ across genders for basketball athletes. Further-more, the negative relationships suggested that improvement in strength and power in a healthy athlete may reduce SEBT composite reach distance. Additional research is needed to confirm these findings and determine the influence of training on SEBT reach in a healthy athlete.

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**Increased Abdominal Activation And Center Of Pressure Excursion During Static And Dynamic Movements**

Gage MJ, Hopkins JT: Brigham Young University, Provo, UT

**Context:** Abdominal activation may play a role in balance and postural control. The extent to which this activation and posture are affected by tasks of varying complexity is unknown. **Objective:** This study assessed internal oblique/transverse abdominis muscle activation and center of pressure excursion during four single leg balance tasks. **Design:** A repeated measures design compared 4 balance tasks. **Setting:** Performed in a controlled laboratory at the BYU Human Performance Research Center. **Patients or Other Participants:** Thirty-two physically active subjects volunteered for this study; 16 males (age = 23.9 ± 2.0 years, height = 180.68 ± 6.6 cm, mass = 72.5 ± 10.4 kg) and 16 females (age = 21.3 ± 3.0 years, height = 166.9 ± 6.4 cm, mass = 63.8 ± 12.2 kg). **Interventions:** The order of single-leg balance tasks were counter-balanced using a Latin square: stance on force plate, stance on Dyna-disc, 21cm and 35cm drop-landings. The order was randomly assigned and counterbalanced to account for an order effect. **Main Outcome Measures:** Subjects performed a maximum number of curl-ups prior to testing. Surface EMG electrodes were placed over the internal oblique/transverse abdominis to measure muscle activation. The subjects performed all tasks standing or landing on a force plate, which was used to measure center of pressure excursion. **Results:** Center of pressure excursion progressively increased ($F_{3, 90}$ = 28.36, $P$ < .001); single-leg stance 0.46 ± 0.17, Dyna-disc 0.76 ± .25, 21cm drop 1.95 ± 0.56, and 35cm drop 2.10 ± 1.65. Dominant side mean muscle activation progressively increased ($F_{3, 93}$= 5.38, $P$= .002); single-leg stance 0.08 ± 0.08, Dyna-disc 0.14 ± 0.11, 21cm drop 0.18 ± 0.19, and 35cm drop 0.14 ± 0.12. Non-dominant side mean muscle activation progressively increased ($F_{3, 93}$ = 4.14, $P$ = .008); single-leg stance 0.07 ± 0.08, Dyna-disc 0.11 ± 0.11, 21cm drop 0.14 ± 0.14, and 35cm drop 0.16 ± 0.22. Peak dominant muscle activation also progressively increased ($F_{3, 93}$ = 30.80, $P$ < .001); single-leg stance 0.27 ± 0.33, Dyna-disc 0.37 ± 0.27, 21cm drop 1.05 ± 0.89, and 35cm drop 1.42 ± 1.14. Non-dominant peak muscle activation progressively increased ($F_{3, 93}$ = 26.46, $P$ < .001); single-leg stance 0.21 ± 0.19, Dyna-disc 0.45 ± 0.53, 21cm drop 1.44 ± 1.42, and 35cm drop 1.45 ± 1.36. **Conclusions:** As the difficulty of single-leg balance tasks increased, abdominal muscle activation and center of pressure excursion progressively increased. These findings provide evidence that abdominal muscles play an important role in maintaining balance during dynamic and static movements, emphasizing the role of core musculature in prevention and rehabilitation of orthopedic injury.

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**Lower Extremity Alignment Relationships In Static And Dynamic Balance Of Soccer Athletes**

Thomas KS, Oñate JA, Ismaeli Z, Hertel J, Arnold B, Marshall S, Ross S, Kramer L, Padua D, Van Lunen B: Old Dominion University, Norfolk, VA; University of Virginia, Charlottesville, VA; Virginia Commonwealth University, Richmond, VA; University of North Carolina at Chapel Hill, NC; Pennsylvania State University, State College, PA

**Context:** The relationship between structural alignment and balance is of interest in identifying those individuals that may be "at risk" for lower extremity injuries. Balance is dependent upon afferent feedback and can be diminished by mechanical instabilities and structural alignment factors at the ankle and knee joint. **Objective:** To determine the relationship between navicular drop (ND) and quadriceps angle (QA) on balance scores as measured by the balance error scoring system (BESS) and star excursion balance test (SEBT). **Design:** Correlation design. **Setting:** Multiple university sports medicine research laboratories. **Patients or Other Participants:** Forty-nine male (19.73 ± 1.3yrs; 179.5 ± 6.27cm; 76.28 ± 7.59kg) and fifty-two female (19.7 ± 1.26yrs; 165.81 ± 5.18 cm; 62.14 ± 5.52kg) NCAA collegiate soccer players. **Interventions:** ND was measured from a seated to a standing position using a Mitutoyo™ vernier height gauge (506

series) caliper. QA was measured using a goniometry aligned with ASIS, points on the mid-patella, and tibial tubercle. Leg length was taken from ASIS to medial malleolus. Three measurements were averaged and used for analysis. Pearson's product moment correlations were performed to determine significant relationships between the four separate variables. Alpha level was set *a priori* of $p<.05$. **Main Outcome Measure:** BESS error scores were recorded and total error score in 8 conditions used for analysis. SEBT was performed in three reach directions anterior (Ant), posterior-medial (PM), and posterior-lateral (PL). An average of three reach distances were normalized to percent leg length (reach distance/leg length*100) to determine normative SEBT scores. **Results:** Pearson's product moment revealed a significant correlation between QA (10.90±3.44) and SEBT ANT (66.68±6.04) ($r=.204$; p=.041) and SEBT PL (73.76±8.41) ($r=.318$; p=.001) reach scores. There were no significant correlations between QA and SEBT PM (101.81±8.20) (p=0.21), or BESS (22.37±7.35) scores (p=0.18). No significant correlations occurred between ND (3.3±1.4) and the four conditions tested ($p<.05$) **Conclusions**: The results of this study indicate that there is a relationship between QA and dynamic balance as measured by the SEBT in both the anterior and PL reach. There is no relationship between lower extremity structural alignment measures (ND or QA) and static balance as measured by the BESS. Previous studies have shown a difference in ND during static and dynamic balance with high ND levels having greater variability in postural control however; these studies generally had a population with higher ND levels. This study consisted of soccer players with relatively low ND levels. Only twenty-one out of 101 subjects were assessed with a high ND (>5mm) level. QA's also appeared to be low in this population relative to the general population. Future studies need to address the relationship of QA and postural control on lower extremity injury risk. *Funding Source: National Institutes of Health RO3: PA 04-002 NIAMS Small Grant Program for New Investigators: 1R03AR054031-01*

# Free Communications, Oral Presentations: Foot Orthotics

Thursday, June 19, 2008, 2:15PM-3:15PM, Room 260; Moderator: Carl G. Mattacola, PhD, ATC

### Application Of A Multi-Segment Foot Model To The Investigation Of The Effect Of Custom Molded Foot Orthosis Intervention On Stance Phase Kinematics

Cobb SC, Tis LL, Wang YT, Johnson J, Geil M: Georgia State University, Atlanta, GA; Department of Human Movement Sciences, University of Wisconsin-Milwaukee, Milwaukee, WI; Georgia State University, Atlanta, GA; University of West Georgia, Carrollton, GA

**Context:** The efficacy of custom molded functional orthotic (FO) intervention is well accepted clinically. The mechanism by which FO intervention affects dynamic foot function, however, is not well understood. **Objective:** Investigate the effect of two different FOs on gait kinematics using a multi-segment foot model. **Design:** A mixed-model repeated measures design. **Setting:** Controlled, laboratory setting. **Participants:** Eighteen participants (11F, 7M; age=25.3 ±5.9 years; weight=158.9 ±33.0 N) with low arch and mobile foot structure, classified using the arch index and relative arch deformity ratio measurements, and no current musculoskeletal injury. **Interventions:** Participants were randomly assigned to a traditional rearfoot (RF) and forefoot (FF) FO (TRAD) or a medial longitudinal arch supported FO without RF or FF posting (MLA). Five functional joints [rearfoot complex (RC), medial forefoot (MFF), calcaneocuboid, calcaneonavicular complex, and 1st metatarsal phalangeal (1MTP)] were defined. Segments composing the joints were each defined by clusters of ≥ 3 retroreflective markers fixed to the participant's right foot and leg. Participants completed 5 walking trials along a 10 m walkway at a speed of 1.3–1.4 m/s during (-)FO and (+)FO conditions. Three-dimensional position data were captured using 8 optical electronic cameras sampling at 120 Hz. A custom software program was used to compute joint angles and discrete kinematic variables. The independent variables were a within-subject insert factor [(+)FO vs (-)FO] and a between-subject group factor (TRAD FO vs MLA FO). Statistical tests included repeated measures multivariate ANOVAs and relevant follow-up univariate ANOVAs. **Main Outcome Measures:** Dependent variables computed for the five functional joints were sagittal, frontal, and transverse plane peak angles, and peak angular velocities. **Results:** RC inversion angle [(-)FO=7.7 ±3.2°; (+)FO=9.2 ±3.5°; p=0.001] and internal rotation angle [(-)FO=3.8 ±3.4°; (+)FO=4.4 ±3.1°; p=0.016] were increased and eversion angle [(-)FO=-4.2 ±4.0°; (+)FO=-2.5 ±3.7°; p = 0.001] was decreased with FO intervention. MFF plantarflexion angle [(-)FO=7.2 ±5.7°; (+)FO=3.8 ±6.8°; p=0.002] and angular velocity [(-)FO=108.7 ±50.9°/s ; (+)FO=80.7 ±26.6°/s; p=0.004] were decreased with FO intervention. In addition, MFF inversion angle [(-)FO=5.9 ±3.2°; (+)FO=2.8 ±5.0°; p=0.001] and eversion angular velocity [(-)FO=-84.5 ±34.9°/s; (+)FO=-61.0 ±27.9°/s; p=0.003] were decreased and eversion angle [(-)FO= -7.0 ±4.3°; (+)FO=-10.0 ±5.3°; p=0.012] was increased with FO intervention. 1MTP eversion angle [(-)FO=-5.5 ±3.1°; (+)FO= -4.5 ±3.8°; p=0.046] was decreased with FO intervention. There were no statistically significant differences between the TRAD and MLA FOs. **Conclusions:** Custom molded FO intervention had a significant effect on gait kinematics in participants with low arch and mobile foot structure. In addition, the application of the multi-segment model suggests the effect of FO intervention is not isolated to the RC, but also involves the joints distal to the calcaneus. These findings may improve the clinician's understanding of the effect of FO intervention.

### Effect Of Forefoot Posted Orthotics On Plantar Pressure Patterns During Walking In Healthy Young Adults

Griffith M, Lee SY, Saliba SA, Parente W, Hertel J: University of Virginia, Charlottesville, VA

**Context:** Different orthotic posting techniques have been applied clinically to control abnormal foot movement. However, there is little scientific evidence regarding the effects of forefoot posting techniques on plantar pressure measures during gait. **Objective:** To examine the effects of different forefoot posted orthotics on plantar pressure patterns during walking in healthy young adults. **Design:** Crossover. **Setting:** Laboratory. **Patients or Other Participants:**

Twenty-one healthy, active young adults with no previous lower extremity injury history volunteered (6 males, 15 females, age= 22.6±4.8 years, height=166.0±11.2 cm, mass=68.8±12 kg). **Interventions:** Subjects walked on a treadmill at the pre-selected pace of 1.3 meters/second (3.0 miles/hour) under four conditions (3º medial forefoot post, 3º lateral forefoot post, insert without posting, control) while an in-shoe plantar pressure system with 99 sensors collected plantar pressure data at a sampling rate of 100 Hz. All subjects wore identical running shoes. For each dependent variable, a 1×4 repeated measures ANOVA was performed to assess the difference between conditions. **Main Outcome Measures:** Maximum pressure (MaxP) and time to maximum pressure (TMaxP) were calculated for nine regions of the foot (medial rearfoot, lateral rearfoot, medial midfoot, lateral midfoot, medial forefoot, middle forefoot, lateral forefoot, hallux, and lesser toes). **Results:** The control condition was associated with significantly increased MaxP compared to the other conditions in all foot regions except the medial and lateral midfoot (P's<.05). In the medial midfoot, there was a significant condition main effect on MaxP (P<.001). Pairwise comparisons indicated that the MaxP was significantly higher with medial posting (132.4±39.3KPa) compared to the control (93±17KPa), insert without posting (93±21.1KPa), and lateral posting (112.3±22.7KPa) conditions (P<.05). In addition, lateral posting significantly increased MaxP over the control condition (P=.05). Likewise, in the lateral midfoot, there was a significant condition main effect on MaxP (P=.002). Pairwise comparisons indicated that MaxP was significantly higher with lateral posting (129±35.4KPa) compared to the control (109±28.8KPa) and insert without posting (108.9± 29.6KPa) conditions (P<.05). Condition also had a significant effect on TMaxP in the medial midfoot (P<.001). Pairwise comparisons indicated that the TMaxP occurred significantly later with medial posting (55.4±11.1% of stance) compared to the control (45.1±16.3%), insert without posting (48±13%), and lateral posting (50.1±13.7% conditions (P<.05). Likewise, condition had a significant effect on TMaxP in the medial forefoot (P<.001). Pairwise comparisons indicated that the TMaxP occurred significantly later with medial posting (79.3±2.7%) compared to the control (77.2±2.6%) and insert without posting (78±3.9%) conditions (P<.05). There were not statistically significant differences between conditions in the other masks in the TMaxP (P>.05). **Conclusions:** Directional forefoot posting increased MaxP and delayed TMaxP on the side of the midfoot corresponding to the posting. Clinicians should be aware that forefoot orthotic posting techniques influence plantar pressure patterns in the midfoot.

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**A Comparison Of Ground Reaction Force In Ballet Dancers Landing In Flat Shoes Versus Pointe Shoes**

Walter HL, Docherty CL, Schrader J, Haven B: Indiana University, Bloomington, IN

**Context:** Previous literature states an increase in the number of lower extremity injuries in ballet dancers; however, few studies have identified the underlying causes of these injuries. Both increased ground reaction force and shoe type have been hypothesized as contributing factors to lower extremity injuries but limited research has been conducted. **Objective:** To determine if the type of dance shoe affects the maximal ground reaction force and jump height during a basic ballet jump. **Design:** A single group repeated measures design. **Setting:** This study was conducted in an athletic training research laboratory. **Patients or Other Participants:** Eighteen healthy collegiate female ballet dancers (19.94±1.16 years, 169.12±6.40 cm, 55.44±5.40 kg) volunteered to participate in this study. All participants had similar activity levels (22.97±8.47 hours of ballet training a week) and years of experience (14.17±2.92 years). Participants were excluded from the study if they had sustained an acute lower extremity injury in the eight weeks prior to testing. **Interventions:** Dancers performed an assemblé in two shoe conditions: flat shoes and pointe shoes. The order of shoe condition was counterbalanced for all participants. Participants landed the assemblé on a force plate (AMTI Accugait System Model ACG, Watertown, Massachusetts) to obtain maximal ground reaction values. A video camera (Panasonic PV-GS500) was used to capture maximum jump height data. Two dependent t-tests were conducted to determine differences between the shoe types, one for maximal ground reaction force and one for jump height. **Main Outcome Measures:** Dependent variables were maximal ground reaction force (Newtons) and jump height (centimeters). **Results:** We found a significant difference in maximal ground reaction force between the two shoe conditions (p = .003). Specifically, maximal ground reaction force was lower when dancers landed in pointe shoes (1612.72 ± 261.47N) compared to the flat shoes (1742.85 ± 252.62N). We found no significant difference in jump height between the two shoe conditions (p = .24). Means ± SD for jump height were 33.05 ± 7.69cm for the flat shoe and 32.42 ± 7.23cm for the pointe shoe. **Conclusions:** Results of this study demonstrate a significant decrease in maximal ground reaction force when the participants landed in pointe shoes. The multiple layers of the pointe shoe helped to absorb some of the forces and disperse them away from the dancer's body. Based on these findings, further research should be conducted on the potential benefits of using point shoes during technique dance classes.

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**The Effect Of Foot Type And Use Of Orthotics On Lower Extremity Muscle Timing Characteristics**

Kupiec S, Boling M, Butler R, Hirth C, Kashefsky H, Prentice W, Guskiewicz K: Sports Medicine Research Laboratory, The University of North Carolina at Chapel Hill, Chapel Hill, NC

**Context:** Excessive compensatory subtalar joint pronation is the primary factor in overuse related injury in the lower extremity. Therefore, understanding the effects of foot orthotic devices (FODs) on muscle timing characteristics may assist in treating patients who display this excessive motion. **Objective:** To explore the differences in lower extremity muscle activity (EMG) in individuals with a normal and pronated foot type. A secondary purpose was to determine the effect of FOD on muscle activity following a two-week accommodation period. We hypothesized that there would be group differences in lower extremity muscle activity pre and post FOD intervention. **Design:** Repeated measures design. **Setting:** Research laboratory. **Patients or other Participants:** Thirty-nine healthy active adults from the student, faculty, and staff population volunteered for participation. Subjects were separated into two groups based upon foot type: a normal group (n=20, age=23.20 years±6.57, height =167.89 cm±11.42, weight= 63.07kg ±12.85, navicular drop= 4.65mm ±2.00) and a pronated group (n=19, age= 22.26years±2.26, height =172.65 cm±11.16, weight=73.89kg ±14.64, navicular drop= 14.72mm±3.06). **Interventions:** Pre-test and post-test sessions were used to collect EMG data from the tibialis anterior (TA), peroneus longus (PL), vastus medialis oblique (VMO), and gluteus medius (GM) on the dominant limb during 5 walking trials. All subjects were fitted for the FODs by a podiatrist at the pre-test session. Approximately two weeks following the pre-test, all subjects returned for a second session to receive their FODs and instructions for wear. Each subject was given a two-week

accommodation period to the FODs and was then post-tested under two conditions: with (postFOD) and without FODs (post). 2(Group: normal and pronated) X3(test: pre, postFOD, post) mixed model ANOVAs were performed to determine differences across groups and testing sessions ($\alpha \leq 0.05$). **Main Outcome Measures:** Dependent variables included EMG onset and duration for the TA, PL, VMO, and GM during the stance phase of the walking trials. The stance phase was determined by the time in which the foot of the instrumented leg was in contact with the force plate. **Results:** Statistical analyses revealed no significant main effects for group ($P>0.05$) and testing session ($P>0.05$) across all muscle onsets and durations. Although not significant, there was a trend for a test main effect for VMO duration ($F_{1.685,37}=3.00$, $P=0.07$). The VMO duration decreased from 439.05±157.74ms at pre-test to 393.04 ±125.02ms at post and 393.49 ±137.79ms at postFOD. **Conclusion:** The results of this study indicate no differences between a normal and pronated foot-type with regards to the timing characteristics of the TA, PL, VMO, and GM at baseline and following the use of FODs. It is possible that timing characteristics of these muscles would not change with the use of FODs, however the amplitude of EMG may be altered. Future investigations should determine if the use of FODs alters EMG amplitude or kinematics of the lower extremity.

# Free Communications, Oral Presentations: Shoulder Assessment

Friday, June 20, 2008, 8:15AM-9:30AM, Room 260; Moderator: W. Steven Tucker, MS, ATC

**The Effects Of Six-Week Training Programs On Throwing Accuracy, Proprioception And Core Endurance In Baseball**

Lust K, Sandrey MA, Bulger SM, Wilder N: West Virginia University, Morgantown, WV, and Muskingum College, New Concord, OH

**Context**: Although various core and open and closed kinetic chain exercises have been recommended for training programs with baseball athletes, they have not been validated in the literature. **Objective**: To determine the extent to which throwing accuracy, core stability, and proprioception improved following completion of a six-week training program that included OKC, CKC, and/or core stability exercises. **Design**: Pre-test/post-test, repeated measures design. **Setting**: Division III college. **Patients and Other Participants**: Subjects consisted of 19 healthy baseball athletes (20.00±1.54 years, height 177.12±5.67 cm, and mass 90.39±22.59 kg) using a sample of convenience. The baseball athletes were randomly assigned into the two experimental groups: Open Kinetic Chain/Closed Kinetic Chain (OKC/CKC) and Open Kinetic Chain/Closed Kinetic Chain/Core Stability (OKC/CKC/CS). The control group of 15 (19.93±1.34 years, 176.19±7.45cm, and mass 97.51± 29.23 kg) consisted of healthy age, gender, and activity level matched individuals from the same institution. **Interventions**: Experimental groups performed the six-week supervised programs three times a week for an average of 45 minutes/session using the dominant (throwing) arm. The OKC/CKC group performed OKC (concentric/eccentric with resistance), CKC (stable and unstable surfaces) and plyometric exercises. The OKC/CKC/CS group performed the same OKC/CKC exercises with an addition of core stability exercises. Both experimental groups progressed with time, sets/reps/resistance weekly. Control group subjects (n=15) were contacted weekly. Pre and post-test measurements were randomized for Functional Throwing Performance Index (FTPI), Closed Kinetic Chain Upper Extremity Stability Test, Back Extensor Test, 45 Abdominal Fatigue Test, and Right and Left Side Bridging Test. Six separate 2 (time) X 3 (group) Repeated Measures ANOVA were used with a Bonferroni Correction factor (P=0.008). **Main Outcomes Measures**: Throwing accuracy using the FTPI, upper extremity proprioception using the Closed Kinetic Chain Upper Extremity Stability Test, and core stability, using the Back Extensor Test, 45 Abdominal Fatigue Test, and Right and Left Side Bridging Test. **Results**: An increase was evident in all pre/post-test results in the experimental groups except for right and left side bridging with percent improvement ranging from 1.36% to 140%. There were significant increases pre/post in the OKC/CKC and OKC/CKC/CS for FTPI (P< 0.001; 0.49±0.11/0.61±0.12 and 0.52±0.13/0.63±0.13), Closed Kinetic Chain Upper Extremity Stability Test (P< 0.001; 1.16±0.17/1.46±0.09 and 1.14± 0.18/1.42±0.27), Back Extensor Test (P = 0.002; 117.12 ± 41.61/172.37 ± 34.14 and 140.90 ± 50.97/160.54 ± 46.23), and Abdominal Fatigue Test (P< 0.001; 97.50±28.97/234.50±134.95 and 140.18± 78.78/256.63±210.11). There was significance for test by group for the FTPI (P = 0.001), and Closed Kinetic Chain Upper Extremity Stability Test (P< 0.001). There was no significant difference for group. **Conclusion**: The Open Kinetic Chain/Closed Kinetic Chain/Core Stabilization exercises may be used to improve throwing, and proprioception among upper extremity dominant subjects. OKC/CKC/CS exercises have an effect on the functional performance of healthy subjects with no upper extremity injuries.

**The Effect Of Shoulder Plyometric Training On Amortization Time And Upper Extremity Kinematics**

Swanik KA, Swanik CB, Thomas SJ, Huxel KC, Kelly JD: Neumann College, Aston, PA; University of Delaware, Newark, DE; Indiana State University, Terre Haute, IN; Temple University Hospital, Philadelphia, PA

**Context:** Plyometric training is credited with providing benefits in performance and dynamic restraint, however limited prospective data exists quantifying kinematic adaptations such as amortization time, glenohumeral and scapulothorasic position, which may underlie its efficacy for upper extremity rehabilitation or performance enhancement. **Objective:** To measure upper extremity kinematics before and after an 8 week upper extremity plyometric training program. **Design:** A randomized pre-test post-test control group study. **Setting:** This study was performed in a controlled laboratory setting. **Participants:** Forty recreationally active male volunteers participated with no history of upper extremity orthopedic pathology. Subjects were randomly assigned to either a Plyometric (age 20.43 ±1.4yrs; height 180.0 ±8.80cm; weight 73.07 ±7.21kg) or Strength training (Control) group (age 21.95 ±3.4yrs; height 173.98 ±11.91cm; weight 74.79 ±13.55kg). **Interventions:** The independent variables were group (plyometric vs. strength training) and time (pre and post test). Kinematic data was collected simul-taneously during a ball toss exercise using the Polhemus Liberty electromagnetic tracking system (Polhemus, Inc., Colchester, VT) to identify each phase of the plyometric exercise. Data was analyzed using a 2 (group) X 2 (time) ANOVA with repeated measures on time. **Main Outcome Measures:** The dependent variables were phase time (ms) (eccentric, amortization, and

concentric) and upper extremity kinematics for each phase (degrees) (scapular upward rotation, glenohumeral elevation, plane of elevation, and humeral rotation) while performing plyometric exercises (ball toss w/ plyoback rebounder device). **Results:** A main effect was observed where significantly less time was required for each phase after training (Eccentric= pre test 0.30±0.08ms; post test 0.23 ± 0.09ms; p= 0.0001: Amortization= pre test 0.07 ± 0.03ms; post test 0.05 ± 0.02ms; p= 0.0001: Concentric= pre test 0.27 ± 0.07ms; post test 0.22 ± 0.09ms; p= 0.004). Post testing also demonstrated significantly more scapular upward rotation for both groups in all phases (Eccentric= pre test 17.43 ± 8.34°; post test 22.45 ± 8.27°; p= 0.002: Amortization = pre test 13.72±8.15°; post test 18.20±8.49°; p = 0.002: Concentric = pre test 18.72±8.21°; post test 23.51±8.82°; p = 0.001). Both groups also significantly decreased glenohumeral external rotation after training (pre test 92.43 ± 9.64 °; post test 82.15 ± 5.45 °) and the plyometric group had significantly greater internal rotation after training than the control (Plyometric = pre test 40.85±6.63°; post test 47.77±6.17°; p = 0.041: Control = pre test 40.72±6.54°; post test 42.74±6.25°; p = 0.0001. There were no other significant differences. **Conclusion:** This was the first prospective study attempting to quantify the efficacy of upper extremity plyometric training through kinematic analysis. Clinically, these findings support the use of upper extremity plyometrics, but also strength training, which may reduce "risk factors" related to scapular and gleno-humeral motion commonly seen in overhead athletes. *Funded by a grant from the NATA National Research and Education Foundation.*

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**Joint Position Sense In Healthy And Unstable Shoulders**

Suprak DN, Osternig LR, van Donkelaar P, Karduna AR: University of Oregon, Eugene, OR, and University of Colorado, Colorado Springs, CO

**Context:** Joint position sense (JPS) studies in unstable shoulders have mainly focused on the capsuloligamentous receptors. However, testing has been done in the intermediate ranges, where these receptors are relatively inactive, and have most commonly employed passive protocols in uniaxial rotations. Few studies have explored JPS in three-dimensional paradigms. **Objective:** This study examined the effect of shoulder elevation angle on repositioning accuracy in healthy and unstable shoulders. We hypothesized that instability patients would exhibit greater repositioning error than healthy controls and that there would be an interaction between the effects of instability and elevation angle. **Design:** Two-group, Cross-sectional. **Setting:** Controlled laboratory setting. **Participants:** The instability group consisted of 12 individuals diagnosed with post-traumatic anterior shoulder instability. The control group consisted of 12 subjects with no history of shoulder pathology requiring surgery or physical therapy. **Interventions:** Kinematic data were collected using the Polhemus Fastrak magnetic tracking system (Colchester, VT). Sensors were placed on the sternum, humerus, and acromion, and bony landmarks digitized to track humeral movement with respect to the thorax. A head-mounted display provided kinematic output for direction to each position, while occluding other visual feedback. Subjects were seated on a pneumatic stool. Subjects assumed a predetermined shoulder position, directed by the output on the head-mounted display. The position was maintained for 5 seconds and the arm was returned to the side. Subjects then attempted to replicate the position. Positions included the elevation angles 30°, 45°, 60°, 70°, and 90° in the scapular plane. A two-way repeated measures analysis of variance (ANOVA) was conducted to determine the effect of shoulder instability and elevation angle on repositioning error. An a priori alpha level of 0.05 was set for all analyses. **Main Outcome Measures:** Repositioning error was defined as the angle between the humerus at the presented and reproduced positions. **Results:** Mean errors for the healthy controls with increasing elevation were: 8.31° ± 3.79, 9.36° ± 4.05, 7.34° ± 2.53, 7.68° ± 2.07, and 6.84° ± 3.15, while those for the instability group were: 7.48° ± 3.61, 7.00° ± 2.15, 7.23° ± 3.19, 6.98° ± 3.31, and 5.79° ± 1.23. The statistical analysis revealed no significant group by elevation angle interaction effect on repositioning error ($F$[2.97, 65.34]= 0.66, $p$= 0.58). In addition, no significant main effect of elevation angle was found for repositioning error ($F$[2.97, 65.34] = 1.68, $p$ = 0.18). There was no significant difference between the error ($p$= 0.32 and $p$= 0.61, respectively) seen in the unstable shoulders and healthy controls. **Conclusions:** We found no difference in error between groups. Patients with unstable shoulders may rely more on musculotendinous receptors for neuromuscular control than healthy individuals. The age range (20-48 yrs.) may have affected the results.

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**The Relationship Between Shoulder External Rotation Strength And Posterior Shoulder Tightness In Baseball Players**

Laudner KG, Moline M, Meister K: Illinois State University, Normal, IL, and TMI Sports Medicine and Orthopedics, Arlington, TX

**Context:** Posterior shoulder tightness has been linked with the development of restricted shoulder range of motion (ROM) and several upper extremity pathologies among baseball players. This tightness is hypothesized to be the result of the cumulative trauma placed on the posterior shoulder during the deceleration phase of the throwing motion. In addition to the posterior shoulder capsule's role in absorbing this force the shoulder external rotators eccentrically decelerate the arm after ball release and therefore may also aide in the dissipation of this force. **Objective:** To determine if a relationship exists between shoulder external rotation strength and posterior shoulder tightness (glenohumeral internal rotation and horizontal adduction ROM) in a group of professional baseball players. Our hypothesis was that a positive linear relationship would exist between external shoulder rotation strength and posterior shoulder ROM. **Design:** Descriptive statistics. **Setting:** Professional baseball athletic training room. **Patients or Other Participants:** Forty-five professional baseball players (20 pitchers and 25 position players) (age = 22.7 ± 2.5 years, height = 186.7 ± 5.1 cm, mass = 87.6 ± 8.2 kg) volunteered to participate. Subjects had no recent history (past 2 years) of upper extremity pathology or any previous surgery. **Interventions:** We randomly assigned the order of ROM and strength measurements and tested the dominant shoulder of each subject. We measured glenohumeral internal rotation and horizontal adduction ROM with the Pro 3600 Digital Inclinometer (SPI-Tronic, Garden Grove, CA) in a supine position and the scapula stabilized. We measured glenohumeral internal rotation ROM with the shoulder and elbow of each subject in 90° of abduction and flexion, respectively. We measured external shoulder rotation strength using a break test with the Lafayette Manual Muscle Test System (Model 01163; Lafayette Instrument, Lafayette, IN) in a prone position with the shoulder and elbow in 90° of abduction and flexion. We used Pearson Product Moment Correlation Coefficients (r) to determine if a relationship existed between the aforementioned variables ($P$ < 0.05). **Main Outcome Measures:** Glenohumeral internal rotation and horizontal adduction ROM.

**Results:** External shoulder rotation strength (20 ± 4 % body weight) showed a poor relationship with both glenohumeral internal rotation (45.2°±8.3°) (r=0.04, *P*=0.77) and horizontal adduction ROM (-11.5°±10.5°) (r=0.13, *P*=0.40). **Conclusions:** Our results indicate that there is little or no relationship between shoulder external rotation strength and posterior shoulder tightness among professional baseball players. As such, the posterior static restraints of the shoulder may absorb a large majority of the deceleration forces during the throwing motion. Therefore, routine stretching of the posterior shoulder soft tissue may be more beneficial than preventative strengthening of the dynamic restraints for decreasing posterior shoulder tightness and diminishing the risk of upper extremity pathology.

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**Internal Rotation And Total Motion Differences: A Comparison Of Baseball Pitchers And Position Players**

Thomas SJ, Swanik KA, Swanik CB: University of Delaware, Newark, DE, and Neumann College, Aston, PA

**Context:** Anectodal evidence suggests that baseball pitchers sustain pathologies such as labral and rotator cuff injuries at a higher prevalence than position players. These injuries have been associated with high repetition resulting in decreases in internal rotation (IR) and increases in external rotation (ER) glenohumeral motion and scapular dyskinesis. **Objective**: To measure glenohumeral (GH) IR and ER rotation, total ROM and scapular position in baseball pitchers and position players. **Design:** Cross sectional study **Setting:** It was performed in scholastic and collegiate settings. **Patients or Other Participants:** Forty healthy baseball players including twenty pitchers (age = 19.05± 2.21 years, mass = 90.64± 11.07 kg, and height = 187.07± 6.4 cm) and twenty position players (age = 17.9± 1.89 years, mass = 81.43± 12.0 kg, and height = 181.36± 6.02 cm) volunteered for participation. **Interventions:** Independent variables were position (pitchers and position player). A Saunders Digital Inclinometer (The Saunders Group Inc. Chaska, MN) measured scapular upward rotation and GH ROM; A Vernier Caliper (Mitutoyo Measurement Technology. UK) was used to assess scapular protraction. Separate 2-way MANOVA's were performed on dominant and non-dominant scapular upward rotation and protraction. Separate 2-way ANOVA's were performed for glenohumeral internal rotation deficit (GIRD), glenohumeral external rotation difference (GERD), and total motion deficit (TMD). **Main Outcome Measurements:** GH IR and ER were measured supine with the scapula stabilized. Total GH ROM was calculated as the sum of IR and ER measures. Scapular upward rotation was tested at rest, 60°, 90°, and 120° of GH abduction in the scapular plane; scapular protraction at 0°, hands on hips, and 90° of GH abduction in the scapular plane with maximum IR. **Results:** Pitchers had significantly more GIRD (pitchers 15.09°±7.37, position 10.10°±7.06, p=.035) and TMD (pitchers 11.79°±8.81, position 7.05°±5.04, p=.048) than position players. GERD was not significantly different between pitchers and position players (pitchers 3.05°±3.62, position 2.95°±5.85, p=.949). Scapular upward rotation and protraction in both the dominant and non-dominant arm was not significantly different between pitchers and position players. **Conclusion:** Baseball pitchers presented with significantly more GIRD and TMD compared to position players. No significant scapular position differences (upward rotation and protraction) were found between pitchers and position players. These findings may suggest that early treatment intervention of GIRD may offset traditional motion alterations that predispose pitchers to labral and rotator cuff injuries.

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# Free Communications, Oral Presentations: Overhead Throwing Athlete

Friday, June 20, 2008, 9:45AM-10:45AM, Room 260; Moderator: Joseph B. Myers, PhD, ATC

**Effect Of An Athletic Season On Glenohumeral Range Of Motion In Collegiate Overhead-Throwing Athletes**

Dwelly PM, Tripp BL, McGinn PA, Gorin S: Florida International University, Miami, FL; Nova Southeastern University, Ft. Lauderdale, FL; Institute of Sports Medicine, Aventura, FL

**Context:** Repetitive pitching at high velocities leads to altered range of motion (ROM) in the dominant (D) shoulder compared to non-dominant (ND) in overhead-throwers. Loss of glenohumeral (GH) internal rotation (IR), referred to as glenohumeral internal rotation deficit (GIRD), is associated with shoulder injuries. Therefore, evaluation of GIRD should be included in the clinical exam of the thrower's shoulder. **Objective:** To investigate differences in GH ROM measured at three separate times over the course of an athletic season (pre-fall, pre-spring, and post-spring). **Design:** Observational repeated-measures design. **Setting:** Collegiate Athletic Training Room. **Participants:** Forty-eight healthy NCAA Division-I or Division-II athletes (19 softball, 29 baseball; age=19±1y, height=174±14cm, mass=77.8 ±18.1kg). **Interventions:** Investigators (PD, PM) measured their respective athletes' passive IR and external rotation (ER) bilaterally using a mechanical inclinometer. We considered maximal motion achieved when rotation ceased with a firm capsular end-feel or when motion of the scapula was appreciated. We measured ROM in each arm twice and used the average for analysis. The investigators displayed excellent intra-rater reliability and excellent-to-good inter-rater reliability for these measures in a previous study. Analyses of variance in SPSS 14.0 (SPSS Inc., Chicago, IL) evaluated changes in GH ROM over time at three levels (pre-fall, pre-spring, and post-spring). Cochran's Q test to assessed changes in GIRD over time between the same three time-periods (significance level $p<0.05$ *a priori*). **Main Outcome Measures:** Degrees of GH IR, ER, total arc (ER+IR), and GIRD. We used two previously reported methods of calculating GIRD, a difference in GH IR (ND–D) and % total arc ([ND - D total arc]/ ND total arc*100). **Results:** Pre-fall D-IR was 45.5±11.1° and did not change over the athletic season ($p>0.05$). D-ER pre-fall (96.2±12.7°), pre-spring (104.0±17.0°) and post-spring (106.9± 19.9°) values increased between each time-period ($p<0.001$). D-total arc pre-fall (141.7±15.0°), pre-spring (151.4±16.9°) and post-spring (152.7± 19.9°) increased between pre-fall and pre-spring ($p<0.001$) and between pre-fall and post-spring ($p<0.001$). Pre-fall ND-IR (52.7±11.8°) did not change over the season ($p>0.05$). ND-ER pre-fall (92.0±10.0°), pre-spring (101.7±15.2°), and post-spring (104.4± 17.8°) values increased between pre-fall and pre-spring measures ($p<0.001$), and pre-fall and post-spring measures ($p<0.001$). ND-total arc pre-fall (144.7± 14.4°), pre-

spring (154.3±15.0°) and post-spring (156.6± 17.3°) values increased between pre-fall and pre-spring measures ($p$<0.001) and pre-fall and post-spring measures ($p$<0.001). We observed no significant differences in GIRD, however more athletes had GIRD (IR difference) in pre-fall (n=6) than pre-spring (n=1) and post-spring (n=4); more athletes had GIRD (% total arc) post-spring (n=6) than pre-fall (n=5) or pre-spring (n=4) ($p$>0.05). **Conclusion:** Division-I and Division-II athletes did not display changes in GH IR over an athletic season. Future research should investigate changes over multiple seasons. The two methods of calculating GIRD identified different athletes as 'at-risk' indicating further research is warranted to identify the clinical benefits of each.

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**The Relationship Between Pitching, Injury And Pain History And Health-Related Quality Of Life In High School And College Female Softball Pitchers**

Dykstra DL, Bay RC, Snyder AR, Sauers EL: Post-Professional Athletic Training Program, A. T. Still University, Mesa, AZ

**Context:** Softball pitchers are frequently exposed to high pitch counts and studies have demonstrated a high percentage of throwing-related upper extremity injuries in this population. The impact of pitching on health related quality of life (HRQOL) in this population has not been evaluated. **Objective:** To evaluate the relationship between pitching, injury and pain history and HRQOL assessed via two region-specific patient self-report scales in high school and college softball pitchers. **Design:** Cross-sectional. **Setting:** High school and college athletic training facilities. **Patients or Other Participants:** Twenty-five female softball pitchers (10 high school, 15 college; 18.0±3.0 years, 169.0±7.6cm, 67.5±10.3kg). **Interventions:** Self-reported pitching and injury history data were collected at mid-season and HRQOL was assessed using two region-specific shoulder scales: the Disabilities of Arm Shoulder and Hand (DASH) and the Functional Arm Scale for Throwers (FAST). Correlational analyses were used to evaluate the relationship between pitching, injury and pain history and the DASH and FAST scale scores. Group differences were compared using independent t-tests (p<.05). **Main Outcome Measures:** Summary statistics were calculated for the measured variables of pitching (years of pitching experience and average number of games pitched per week over past 3 months), injury [region (shoulder, elbow, wrist/hand), time loss (1 – 10 days and more than 10 days)] and pain (severity = mild, moderate, severe) history, the DASH total score, sport module and subscales, and the FAST total score, subscales, and pitching module. **Results:** Participants reported 8.1± 3.4 years of pitching experience. During the past 3 months, they had pitched in 2.8±1.8 games per week. 68% of respondents reported injuries from throwing that caused them to miss 1-to -10 days from practice or games; 24% reported injuries from throwing that caused them to miss more than 10 days. Among those reporting time-loss injuries, the most commonly reported site of injury was the shoulder (71%). 60% of respondents reported mild-to-severe shoulder pain after pitching during the competitive season. The DASH and the FAST total scale scores were substantially correlated (r=.79). Respondent report of shoulder pain correlated highly with the DASH Total (r=.69), the DASH Sports Module (r=.69), the FAST Total (r= .71), FAST Pain (r=.73), FAST Impair- ment (r=.76), FAST Functional Limita tion (r=.79), FAST Pitching Module (r=.65), Fast Disability (r=.52) and Fast Societal Limitations (r=.46). Subsequent exploratory analysis demonstrated that participants who reported ever having suffered a serious shoulder injury, in particular (n=5), showed elevated scores on the Fast Pitching Module, and Fast Impairment, Functional Limitation, Disability, and Societal Limitation subscales (p<0.05). **Conclusions:** These data suggest that injuries and pain are common among female softball pitchers. Reports of elevated pain in high school and college softball pitchers are associated with a diminished HRQOL that extends beyond the playing field. *Master's Student Award Finalist*

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**Changes In Glenohumeral Range Of Motion Over The Athletic Season: A Comparison Between Division-I And Division-II Overhead-Throwers**

Tripp BL, Dwelly PM, McGinn PA, Gorin S: Florida International University, Miami, FL; Nova Southeastern University, Ft. Lauderdale, FL; Institute of Sports Medicine, Aventura, FL

**Context:** The overhead-throw places large-magnitude forces on the shoulder often leading to changes in glenohumeral (GH) range of motion (ROM) in athletes. Changes in dominant-side (D) internal rotation (IR) or total arc of GH motion (TA) have been associated with shoulder injury, suggesting clinicians should monitor ROM in throwers. It remains unclear however, if changes are similar between different levels of competition. **Objective:** To compare changes in GH ROM measured three separate times over the season (pre-fall, pre-spring, and post-spring) between NCAA Division-I and II throwing-athletes. **Design:** An observational repeated-measures design comparing Division-I to Division-II athletes. **Setting:** Collegiate Athletic Training Room. **Participants:** Healthy NCAA Division-I (n=23) and Division-II (n=25) athletes (19-softball, 29-baseball, age=19±1y, height=174±14cm, mass=77.8± 18.1kg). **Interventions:** Using a mechan-ical inclinometer, investigators (PD, PM) measured their respective athletes' passive GH IR and external rotation (ER) bilaterally and considered maximal motion achieved when rotation ceased with a firm capsular end-feel or when motion of the scapula was appreciated. We measured each motion twice and used the average for analysis. The investigators displayed excellent intra-rater reliability and excellent-to-good inter-rater reliability for these measures in a previous study. Analyses of variance in SPSS 14.0 (SPSS Inc., Chicago, IL) examined differences in ROM changes between Division-I and II athletes (significance level $p$<0.05 *a priori*). **Main Outcome Measures:** We measured degrees of GH IR, ER and total arc (TA=ER+IR) bilaterally. Dependent variables were degrees of ROM difference between each of the three time intervals. **Results:** Pre-fall ROM for Division-I and Division-II athletes (respectively) were D-IR (39.4±10.3° and 50.6±9.2°), D-ER (101.0±11.9° and 91.8±12.1°), D-TA (140.4±14.0° and 142.4±16.0°), ND-IR (49.1±11.5° and 56.0±11.4°) ND-ER (92.0±11.9° and 91.6±8.2°), ND-TA (141.2±12.5° and 147.6±15.6°). Over the entire season (between pre-fall and post-spring) Division-I athletes gained more ROM than Division-II for D-IR (3.8° and -2.5°, $p$<0.001), D-ER (23.1° and -0.1°, $p$<0.001), D-TA (26.9° and -2.4°, $p$<0.001), ND-ER (26.7° and 0.2°, $p$<0.001) and ND-TA (26.2° and -0.5°, $p$<0.001). The majority of these differences reflected changes observed between pre-fall and pre-spring measures when Division-I athletes gained more ROM than Division-II for D-IR (5° and -0.5°, $p$=0.006), D-ER (17.5° and -0.5°, $p$<0.001), D-TA (22.7° and -1.1°, $p$<0.001), ND-ER (22.1° and -0.9°, $p$<0.001) and ND-TA (21.2° and -0.5°, $p$<0.001). Division-I athletes also gained more ROM than Division-II between pre-spring and post-spring in D-ER (5.6° and 0.6°, $p$=0.017) and D-TA (4.2° and -1.3°, $p$=0.036). **Conclusion:** This is the first report suggesting changes in GH ROM occurring

over an athletic season are different between Division-I and Division-II throwers. Over the season, Division-I throwers gained more D-IR and bilateral-ER, accounting for the greater gains in GH total arc of motion we observed compared to Division-II athletes. Clinicians should consider such differences when monitoring GH ROM in throwers.

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**Biomechanical Comparison Of Different Types Of Pitches In High School Softball Pitchers**

Miller LM, Kaminski TW, Richards J, Royer T: Athletic Training Research Laboratory, University of Delaware, Newark, DE

**Context:** Ample evidence exists concerning the stress of baseball pitching on the shoulder and elbow joints; however comparative evidence involving softball pitching is scarce. Anterior shoulder pain is a chief complaint in softball pitchers, and investigation into the stresses placed on the shoulder during different pitches is a vital first step toward understanding injury in this population. Current softball literature reports kinetic data for only one pitch. **Objective:** The objective of this study was to compare kinetic variables (moments and forces) at the shoulder during the delivery phase for three different types of softball pitches (fastball, change-up, drop). We hypothesized that there would be no differences between pitches. **Design:** Within-subjects comparison. **Setting:** A climate-controlled biomechanics laboratory. **Patients or Other Participants:** Eleven high school aged softball pitchers (age= 15.4 ± 1.2 yr., mass = 56.0 ± 8.2 kg, height= 159.2 ± 10.5 cm) were recruited to participate. To be included each pitcher had to demonstrate proficiency with throwing each type of pitch. **Interventions:** The independent variable was type of pitch. Following individualized warm-up, three-dimensional motion analysis was used to capture five trials for each type of pitch. Pitchers were instructed to throw the standard distance (13.1 m) into a target area attached to netting and located directly behind home plate. **Main Outcome Measures:** Data were extracted using a customized Labview program. Inverse dynamics were then used to calculate the kinetic variables (*average peak shoulder forces*, including: anterior/posterior, medial/lateral, and compressive/de-compressive forces and *average peak shoulder moments*, including: flexion/extension, horizontal flexion/extension, and internal/external rotation). Separate univariate analysis of variance protocols were performed to compare the variables between pitches. Alpha level was set at P=.05. **Results:** Compressive forces were significantly different (P = .001) between the fastball (428.3±97.9 N) and change-up (273.1±83.5 N) and between the drop (402.9± 81.6N) and change-up (273.1±83.5 N). Anterior forces were significantly different (P = .001) between the fastball (164.2±42.0 N) and the change-up (90.7±37.6 N) and between the drop (147.6±33.4 N) and change-up (90.7±37.6 N). Peak extension moments were significantly different (P=.001) between the fastball/change-up (fastball = 34.7±11.1 Nm *vs.* change-up = 19.8±14.0 Nm) and drop/change-up (drop= 44.9± 14.4 Nm *vs.* change-up = 19.8±14.0 Nm) pitch combinations. Additionally peak horizontal flexion moments were significantly different (P=.003) for the same combination of pitches; fastball/change-up (fastball = 9.9± 3.8 Nm *vs.* change-up = 0.145 ± 9.4 Nm) and drop/change-up (drop= 9.8±4.1 Nm *vs.* change-up = 0.145 ± 9.4 Nm). **Conclusions:** Shoulder compressive and anterior forces during different types of softball pitches were comparable to loads experienced during baseball pitching. Overuse injuries are well documented in baseball pitching, whether those same injury mechanisms are prevalent in softball pitchers remains unknown until further study is performed.

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## Special Interest Group #5: The Pediatric Overhead Athlete

Friday, June 20, 2008, 11:00AM-12:00PM, Room 260; Discussants: Joseph B. Myers, PhD, ATC, and Aaron Sciascia, MS, ATC; Moderator: Tracey Spigelman, MEd, ATC

## Special Interest Group #7: Posterolateral Hip & Knee Injuries

Friday, June 20, 2008, 3:15PM-4:15PM, Room 260; Discussants: Jennifer E. Earl, PhD, LAT, and Anh-Dung Nguyen, PhD, ATC; Moderator: Grace Golden, PhD, ATC, CSCS

**Eccentric Hip Torque Is A Significant Predictor Of Jump Landing Stabilization In Division I Female Athletes**


Webster KA, Siler ME, Gribble PA: University of Toledo, Toledo, OH


**Context:** The Time to Stabilization (TTS) method has been able to demonstrate deficits in dynamic stability when landing from a jump in subjects with lower extremity pathology. Hip strength is believed to play an important role in stabilizing the lower extremity when landing from a jump. The hip flexors and extensors contract concentrically and eccentrically during jump-landing tasks, but it is not known which portion of these muscle torques contributes the greatest to dynamic stability. **Objective:** The purpose of this study was to determine which aspect of sagittal plane hip muscle torque is the best predictor of dynamic stabilization after landing from a jump in NCAA Division I female athletes. **Design:** Within subject stepwise regression. **Setting:** Athletic Training Research Laboratory. **Patients or Other Participants:** Eleven intercollegiate female athletes (age: 19.09±0.83 years; height: 170.41±8.36 cm; mass: 67.99±8.52 kg) volunteered for the study. All subjects were free from lower extremity injury, were right-leg-dominant, and were currently participating in varsity intercollegiate volleyball (n=5) or soccer (n=6). **Interventions:** Subjects reported to the lab for two sessions. During the first session they performed five trials of a single-leg landing task for each limb with the order of side being randomized. Each subject stood 70 cm away from a force platform, jumped off two feet to 50% of their maximum jump height and landed on one foot. Subjects were asked to stabilize as quickly as possible within a 5-second period. Ground reaction forces were used to calculate TTS in the anterior/posterior direction (APTTS). On a separate testing day, subjects reported to the laboratory and peak torque was determined during concentric and eccentric hip flexion and extension on a dynamometer for both limbs. Subjects completed five consecutive trials. The average peak torques (reported as a percentage of body weight) from the trials were calculated for eccentric hip flexion (EccHF), concentric hip flexion (ConHF), eccentric hip extension (EccHE) and concentric hip extension (ConHE). A stepwise regression analysis was performed to determine the amount of variance in APTTS that could be predicted by the variance in EccHF, ConHF, EccHE, ConHE. **Main Outcome Measure(s):** EccHF, ConHF, EccHE, ConHE, and APTTS. **Results:** The most predictive model included EccHE, EccHF, and ConHF ($R^2$=0.76; p=.015). Of these variables, eccentric hip extension alone predicted 55% of the variance of APTTS when controlling all other variables. **Conclusions:** This finding is important to clinicians who wish to improve athletes' dynamic stability. Because eccentric hip extension was found to be the strongest predictor of stabilization after landing, emphasizing closed-kinetic chain, eccentric hip extension appears to be an appropriate way to prepare a Division I female athlete for rapid stabilization after landing from a single-leg jump. *Doctoral Student Award Finalist*

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**Hip Abductor Fatigue Decreases Knee Valgus Angle During Unanticipated Cutting in Healthy Women**


Van Riper MC, Jackson KR, Saliba SA, Parente WR, Hertel J: University of Virginia, Charlottesville, VA


**Context:** Landing from a jump and change in direction are the most common mechanisms for non-contact anterior cruciate ligament (ACL) injury. It is thought that the hip abductors play a role in eccentrically controlling hip internal rotation and knee abduction motions associated with ACL injury. **Objective:** To determine the effects of local hip abductor fatigue on knee valgus angles during an unanticipated cutting task in healthy adult women. **Design:** Randomized control trial. **Setting:** Gymnasium. **Patients or Other Participants:** A total of 21 healthy young adult women volunteered (age= 21.0±2.8 yrs; height=163.7±6.1 cm; mass=59.0± 5.6 kg). **Interventions:** All subjects performed 3 maximum isometric voluntary contractions (MVIC) against a hand-held dynamometer to determine their 1 repetition max for hip abduction strength. Subjects were then randomized into either control or experimental groups. The experimental group completed a fatigue protocol that consisted of sets of 15 repetitions of side-lying concentric hip abduction exercises with a 3.4 kg weight. After each set, their MVIC was reassessed until thresholds of 25% and 50% decline of MVIC were reached. Subjects performed a set of unanticipated cutting trials at baseline and after each fatigue threshold was reached. The control group performed 3 sets of cutting trials, resting between each set for 15 minutes. Maximum knee valgus angle was measured during the unanticipated cutting maneuver. Retroreflective markers were placed on the anterior superior iliac spine, medial and lateral condyles of the knee, and medial and lateral malleoli. The stance phase of the cut was visualized using a trigger mat calibrated to a light that remained illuminated with foot contact. Digital video imaging captured 2-dimensional relative position of the lower extremity segments during stance phase. The maximal knee valgus angle was measured using computer software by a blinded researcher ($ICC_{2,1}$= .97). A 2X3 mixed model ANOVA was computed. The independent variables were group (experimental, control) and time (baseline, posttest 1 and posttest 2). Tukey's post hoc tests were performed to identify specific differences. **Main Outcome Measures:** Maximum knee valgus angle. **Results:** A significant group by time interaction was identified (p=.02). In the experimental group, maximum knee valgus angles significantly decreased from baseline (16.1º+6.6º) after both 25% fatigue (14.0º+2.9º, *P=.02)* and remained significantly decreased at 50% fatigue (14.3º+3.2º, *P*=.03). There were no significant changes in knee valgus angles in the control group across baseline (16.6º+1.8º), posttest 1 (17.7º+1.8º), and posttest 2 (17.7º+2.3º) measures. **Conclusions:** Healthy women demonstrated a significant decrease in knee valgus angle during the unanticipated cutting task after fatigue of the hip abductor muscles. These unexpected results suggest that a bracing mechanism may occur within the lower extremity to protect against excessive knee valgus motion after fatiguing the hip abductors. *Master's Student Award Finalist*

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**The Effect Of Fatigue-Induced Hip Abductor Weakness On Knee Mechanics During Functional Tasks**


Geiser CF, Earl JE, O'Connor KM: University Wisconsin-Milwaukee, Milwaukee, WI, and Marquette University, Milwaukee, WI


**Context:** Anterior cruciate ligament injuries (ACL) and patellofemoral pain syndrome (PFP) are both common and significant injuries to the knee that have been associated with hip weakness in cross-sectional studies. Prospective studies have linked the risk of experiencing either injury to alterations in the frontal plane knee angle and moment during activity, which are theorized to be affected by hip abductor weakness. **Objective:** The

purpose of this study was to elucidate the effect of hip abductor weakness on knee joint mechanics. **Design:** Repeated measures design with each participant performing three tasks simulating athletic movements pre- and post-hip abductor fatigue protocol. **Setting:** Research laboratory. **Participants:** Twenty healthy recreation-ally active females (Age: 20.7±1.7 yrs, Height: 1.67±0.06 m, Mass: 63.0±10.3 kg) recruited from the local university population. **Interventions:** Participants performed three tasks while three-dimensional kinematic and kinetic data of the lower extremity were collected. Tasks started with a stride forward off of a height-normalized platform and a single-leg landing, followed immediately by a) a side-step cut, b) a vertical jump or c) a run forward, performed in counterbalanced order. Participants then performed an isolated hip abductor fatigue protocol in side-lying against isokinetic resistance, during which decreased force producing capacity of the hip abductor muscles was documented. Biomechanical data collection was immediately repeated. **Main Outcome Measures:** Joint angle and moment data were processed using standard techniques. The initial weight acceptance phase of landing (WA) was identified using the first trough in the resultant ground reaction force. Three dependant variables were extracted for analysis: frontal plane knee angle at initial ground contact (IC), frontal plane knee range-of-motion (ROM) over WA, and frontal plane knee moment over WA. Independent variables were task (cut, jump, run) and fatigue state (pre-fatigue, post-fatigue). Separate repeated measures ANOVA's ($p$<0.05) were used to analyze each dependant variable. **Results:** Following the hip fatigue protocol, regardless of which task was performed, the knee angle at IC was more adducted (pre: 0.7 ± 6.0°, post: 1.3 ± 6.9°, $F_{(1,19)}$=8.0, $p$=0.032), knee ROM over WA increased into abduction (pre: -2.5 ± 2.1°, post: -4.4 ± 2.5°, $F_{(1,19)}$=69.3, $p$<0.001), and the knee moment shifted toward a greater internal adductor moment during WA (pre: -0.2 ± 21.9N-m, post: 7.1 ± 23.6N-m, $F_{(1,19)}$=47.0, $p$<0.001). **Conclusions:** This study demonstrates that simulated hip abductor weakness creates changes in frontal plane knee mechanics. These changes occurred in the direction of a dynamic valgus movement pattern, which has been associated with increased risk of ACL injury and PFP. This study provides rationale for assessing hip abductor strength as part of injury preventative and rehabilitative programs for recreationally active college females.

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**Influence Of Sagittal Plane Trunk, Hip, And Knee Flexion Angles On Peak Anterior Tibial Shear Force During A Jump-Landing Task In Females**

Walusz H, Padua DA, Boling MC, McGrath M, Blackburn JT: Sports Medicine Research Laboratory, The University of North Carolina, Chapel Hill, NC

**Context:** Anterior tibial shear force (ATSF) is theorized as a risk factor for non-contact anterior cruciate ligament (ACL) injury. This theory is supported by previous research demonstrating increased ATSF in females, who are at greater risk for ACL injury, compared to males. In addition to sex, sagittal plane joint angles may also influence ATSF; however, limited research has investigated the influence of sagittal plane joint angles on ATSF in high risk individuals (females). **Objective:** To determine if a relationship exists between ATSF and knee, hip, and trunk flexion angles during a jump-landing task. We hypothesized that knee, hip, and trunk flexion angles would be negatively correlated with peak ATSF (i.e. smaller knee, hip, and trunk flexion angles would be associated with larger peak ATSF). **Design:** Correlational research design. **Setting:** Research laboratory. **Subjects:** Thirty-one healthy female recreational athletes with no prior history of ACL injury volunteered to participate in this study (age=19.7±2.00 years, height=165.23± 6.23cm, weight= 61.7±9.69kg). Each subject was required to have 2 years of varsity, club, or intramural experience in basketball, volleyball, or soccer, as these sports implement a jump-landing task. **Interventions:** Subjects performed 10 trials of a jump-landing task from a 30cm height. Knee, hip, and trunk flexion angles and landing forces were collected via an electromagnetic motion capture system interfaced with a non-conductive force plate. ATSF was calculated via a standard inverse dynamics procedure. Mean values for knee, hip and trunk flexion (relative to the world) angles and peak ATSF were calculated across the 10 trials, and Pearson correlation coefficients were calculated to assess the relationships between ATSF and each kinematic variable ($\alpha \leq 0.05$). **Main Outcome Measures:** Peak ATSF was measured during the stance phase of the jump-landing task and was standardized to body weight. The stance phase was defined as the time period in which the vertical ground reaction force was greater than 10N. Knee, hip, and trunk flexion angles were assessed at initial ground contact and the time of peak ATSF. **Results:** Knee flexion angle (r=-0.367, $P$=0.021,) and trunk flexion angle (relative to world) (r =0.309, $P$=0.046) at the time of peak ATSF were significantly related to peak ATSF. There were no other statistically significant correlations ($P$>0.05). **Conclusions:** While knee flexion angle was negatively related to ATSF, trunk flexion angle was positively related to ATSF. As sagittal plane knee and trunk angles appears to influence peak ATSF, ACL injury prevention programs aimed at decreasing peak ATSF may focus on altering these variables. However, future research is necessary to examine factors that influence peak ATSF and ACL injury risk.

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# Free Communications, Oral Presentations: Jump Landing & Movement Variability of the Knee

Saturday, June 21, 2008, 9:00AM-10:15AM, Room 260; Moderator: J. Troy Blackburn, PhD, ATC

**Force Attenuation Does Not Differ Following Isokinetic Fatigue in Volunteers with Quadriceps Muscle Inhibition When Landing**

Frye JL, Allaire PE, Kerrigan DC, Saliba EN, Weltman AL, Ingersoll CD: University of Virginia, Charlottesville, VA, and James Madison University, Harrisonburg, VA

**Context**: Individuals with previous knee injuries exhibit decreased quadriceps muscle activation despite being physically active. The effects of fatigue and lower levels of muscle activation are not understood. Inhibited quadriceps muscles may have a decreased ability to dampen forces transferred through the kinetic chain especially when fatigued. Over time the increased forces acting through the joints, specifically the knee, may increase the risk of overuse injuries. **Objective**: To compare the ability of volunteers with quadriceps muscle inhibition following isokinetic quadriceps fatigue to attenuate forces at contact from a 60-cm drop landing. We hypothesize that inhibited individuals will have a decreased ability to attenuate forces at the knee following fatigue when compared to individuals with high quadriceps activation. **Design:** 2 x 2 repeated measures design. **Setting**: University Research Laboratory. **Patients or Other Participants:** 11 healthy, active volunteers without history of lower extremity injury and a central activation ratio

(CAR) of 0.94 or above were controls (7 females, 4 males: age=27.10±7.4yrs, height=171.1±7.2cm, mass=71.52 ±19.6kg). 13 recreationally active volunteers (exercise 3-5 times/week) with a history of knee pain/ injury that had a CAR of 0.90 or less were in the muscle inhibition group (8 females, 5 males: age=26.3± 5.8yrs, height= 175.8 ±11.4cm, mass=80.9± 14.0kg). **Interventions:** Independent variables were group (non-inhibited and inhibited) and muscle state (non-fatigued and fatigued). The superimposed burst technique was used to measure quadriceps activation and to calculate the CAR grouping variable. Accelerometers were attached to the dorsum of the 2nd metatarsal head, tibial tuberosity, and sacrum. Joint position was measured at the ankle, knee, and hip with electric goniometers. Volunteers performed three consecutive single-leg drop landings from a 60-cm box (averaged). An isokinetic concentric quadriceps fatigue protocol was performed until quadriceps force reduced by 50%. Fatigued volunteers immediately performed three more consecutive single-leg landings (averaged). 2 x 2 ANOVA determined statistical differences. **Main Outcome Measures:** Acceleration and joint position information in an inverse dynamics equation calculated relative vertical acceleration. Peak vertical acceleration at the tibial tuberosity minus the acceleration measured at the sacrum at the time of peak knee acceleration was calculated and expressed as a percent change in peak acceleration. **Results:** No differences were found in attenuation ability between the quadriceps activated (pre-fatigue=10.2±11.5 g, post-fatigue= 10.3±15.4 g) and the quadriceps inhibited volunteers (pre-fatigue=10.0±8.7 g, post-fatigue= 9.3±6.8 g; $F_{1,22}$=0.019, $P$=0.892, $\eta^2$=0.001, 1-β=0.052). **Conclusions:** Following isokinetic fatigue, active volunteers with muscle inhibition (mean CAR=79.4) attenuate forces similarly during a drop landing compared to controls (mean CAR=96.6). Inhibited subjects do not appear to have a greater risk for overuse injuries due to a lessened ability to attenuate force when landing under these specific conditions.

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**Effect Of Filtering Parameters On Lower Extremity Muscle Activation Onset Times During Drop Jumps**

Ambegaonkar JP, Shultz SJ: Sports Medicine Assessment Research and Testing Laboratory, George Mason University, Manassas, VA, and Applied Neuromechanics Research Laboratory, University of North Carolina at Greensboro, Greensboro, NC

**Context:** Surface electromyography (sEMG) is extensively used to examine muscle activation relative to absolute timing and sequencing of muscles during activity (e.g. drop jumps). While it is common to filter the raw sEMG signal with a Root Mean Square (RMS) algorithm prior to extraction of onset times, there is little agreement as to the time constant that is used, with previous researchers using windows ranging from 3ms to 25ms. **Objective:** To examine the effect of different RMS filtering windows on muscle onset times during a drop jump. **Design:** Single-session, within-subject **Setting:** Controlled laboratory **Participants:** Fifty-five healthy females (20.4±2.2yrs, 166.5±7.1cm, 66.0±12.1kg) **Interventions:** Participants performed 5 double-leg drop jumps from a 45cm box. Muscle activity was recorded via sEMG for the lateral gastrocnemius (LG), medial and lateral hamstring (MH, LH) and lateral quadriceps (LQ) of the preferred landing leg during the initial landing phase. The trigger sweep acquisition mode was used to obtained identically timed trials from 500ms prior to 3000 ms following contact with the forceplate (>10N). sEMG signals were digitally filtered using a centered RMS algorithm with time window constants of 3ms, 10ms, 20ms and 25ms. The ensemble average of 5 trials for each RMS window was used for analyses. Separate repeated measures ANOVAs for each muscle compared onset times between the 4 RMS window conditions. Post hoc analyses consisted of Bonferroni pairwise comparisons at p=.05. **Main Outcome Measures:** Muscle onset (ms) was defined as time prior to ground contact when muscle activity exceeded 2 standard deviations above quiet standing baseline activity for at least 25ms **Results:** Significant differences in onset times across RMS windows were found in LG ($F_{3,162}$=4.48, p=.01; 3ms= 133.3±32.4,10 ms= 145.3±32.0, 20ms= 155.6±41.1, 25ms= 141.5±44.1), MH ($F_{3,162}$=5.22, p=.002; 3ms=114.5±22.9, 10ms=122.0± 22.1, 20ms= 127.6±27.9, 25ms=130.4± 36.8), and LH ($F_{3,162}$=8.76, p=.000; 3ms= 95.5±43.9,10ms= 88.6±42.1, 20ms= 104.7± 42.7, 25ms=124.4± 42.9), but not in LQ ($F_{3,162}$ =1.50, p=.14; 3ms=38.3±26.3, 10ms= 42.6±22.2, 20ms= 46.8±26.7, 25ms= 45.2± 26.3). Pairwise comparisons indicated earlier onset times in LG using a 3ms vs. 20ms window; in MH using a 3ms vs. 20ms and 25ms windows, and in LH using a 10ms vs. 25ms window. **Conclusions:** Our findings suggest that extraction of muscle activation onset times for the gastrocnemius and the hamstring muscles during a drop jump can be substantially affected (as much as 20–30 ms) when filtering raw sEMG data using RMS windows from 3ms to 25ms. To limit the negative effects of signal processing on raw sEMG data, a compromise is therefore needed between maximizing signal fidelity while still retaining meaningful time differences. Further research is necessary to determine the optimal RMS smoothing window to appropriately examine muscle timing variables during functional activity.

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**Movement Variability Differs About The Joints Of The Lower Extremity**

Goerger BM, Padua DA, Boling MC, McGrath ML, Blackburn JT: Sports Medicine Research Laboratory, The University of North Carolina, Chapel Hill, NC

**Context:** Movement variability about the knee has previously been examined as an indicator of inappropriate movement patterns and as a possible risk factor for injury. It is possible that the trunk, hip, and knee demonstrate different levels of movement variability; and within the joint itself variability may differ about the three cardinal planes of motion. Recognition of such differences may lead to a better understanding of the role movement variability plays in lower extremity injury. **Objective:** To compare discrete measures of movement variability across the trunk, hip and knee joints during a jump-landing task. **Design:** Cross-sectional, repeated measures design. **Setting:** Research laboratory. **Patients or Other Partic-ipants:** Thirty-one healthy female recreational athletes with no prior history of ACL injury volunteered to participate in this study (age=19.7±2.00 years, height= 165.23 ±6.23cm, mass=61.7± 9.69kg). Each subject was required to have 2 years of varsity, club, or intramural experience in basketball, volleyball, or soccer. **Interventions:** Participants performed 10 repetitions of a jump-landing task during a single testing session. The jump-landing task involved jumping from a 30cm box to a set of forceplates set 50% body height in front of the subject, then immediately jumping for maximum vertical height. Trunk, hip, and knee kinematic data were collected with an

electromagnetic motion analysis system (Ascension Technologies, Inc., Burlington, VT). **Main Outcome Measures:** Three-dimensional joint angles at the time of initial ground contact were determined for each jump-landing trial. Discrete movement variability was calculated as the standard deviation (SD) of the 10 jump-landing trials for each three-dimensional joint angle at the trunk, hip and knee. Separate repeated measures ANOVA were performed for each plane of motion with joint as the within subject factor (3 levels: trunk, hip and knee) ($\alpha \leq 0.05$). Post-hoc analyses were performed using t-tests with Bonferroni correction. **Results:** A significant main effect for joint was revealed for sagittal plane movements at initial contact ($p<0.001$). Post-hoc analyses revealed that discrete movement variability measures (SD) for knee flexion (mean=3.47º; 95% CI: 2.93,4.01) were significantly less than both hip flexion (mean=5.47º; 95% CI: 4.68,6.26) and trunk flexion (mean=5.11º; 95% CI: 4.36,5.87). No other significant differences were revealed for discrete movement variability measures in the frontal ($p=0.496$) and transverse ($p = 0.052$) planes. **Conclusions:** Our results indicate that movement variability is not consistent among all joints. Specifically, sagittal plane motion at the trunk and hip is more variable at initial contact than at the knee. Thus, interventions aimed at altering movement variability should consider multiple joints. The role of movement variability in injury risk is not clear and requires further study.

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**Reliability Of Lower-Extremity Coordination And Variability Analyses**

McGrath ML, Padua DA, Thigpen CA: Sports Medicine Research Laboratory, The University of North Carolina, Chapel Hill, NC, and Department of Athletic Training & Physical Therapy, University of North Florida, Jacksonville, FL

**Context:** Lower extremity coordination and variability are essential components of athletic performance. Disruption in coordination, or changes in movement variability, between two body segments are hypothesized to increase injury risk. However, the reliability of methods used to assess coordination and variability in the lower extremity is unknown. **Objective:** To assess the reliability of the Mean Absolute Relative Phase (MARP), a measure of coordination, and Deviation Phase (DP), a measure of variability, during a jump-landing task. **Design:** Single group cohort with repeated measures. **Setting:** Research laboratory. **Participants:** Twenty (12 Females, 8 Males) healthy, recreationally-active participants, with prior history playing basketball, volleyball, soccer, or lacrosse, volunteered for this study (age: 20.60 ±1.54years, height: 174.65±6.85cm, mass: 68.48±10.51kg). **Interventions:** Participants performed 10 repetitions of a jump-landing task at three separate sessions: two sessions on the same day separated by 15 minutes, and one session 2-3 days removed. The jump-landing task involved jumping from a 30cm box to a set of forceplates set 50% body height in front of the participant, then immediately jumping for maximum vertical height. Movements were recorded via 3-dimensional infrared videography synchronized with forceplate data, then exported to custom software. Sagittal-plane angles and angular velocities of the foot, shank, thigh, and trunk segments were calculated relative to the world reference system over the stance phase of each jump-landing. Relative phase plots (position vs. velocity) were created for each segment, and relative phase angles were calculated. These angles were used to calculate relative phase angles between the foot and shank, shank and thigh, and thigh and trunk, in order to assess coordination and variability between body segments. **Main Outcome Measures:** Mean MARP and DP were calculated for each segment pair for each session. Intraclass coefficients ($ICC_{2,k}$) and standard error of measurement (SEM) were calculated for the MARP and DP between the two sessions held the same day (within-day) and between the first sessions separated by 2-3 days (between-day). **Results:** Within-day reliability of MARP values were good to excellent for all segment pairs: Foot-to-shank: $ICC_{2,k}$=0.93, SEM= 1.58; Shank-to-thigh: $ICC_{2,k}$=0.78, SEM= 1.77; Thigh-to-trunk: $ICC_{2,k}$=0.94, SEM= 1.89. Within-day reliability of DP values were also good to excellent: Foot-to-shank: $ICC_{2,k}$=0.86, SEM=1.06; Shank-to-thigh: $ICC_{2,k}$=0.75, SEM=1.35; Thigh-to-trunk: $ICC_{2,k}$=0.82, SEM=0.98. Between-day reliability of MARP values ranged from fair to excellent: Foot-to-shank: $ICC_{2,k}$=0.82, SEM=2.57; Shank-to-thigh: $ICC_{2,k}$=0.55, SEM=2.52; Thigh-to-trunk: $ICC_{2,k}$= 0.96, SEM=2.09. Between-day reliability of DP values were fair to good: Foot-to-shank: $ICC_{2,k}$=0.57, SEM=2.03; Shank-to-thigh: $ICC_{2,k}$=0.72, SEM=1.26; Thigh-to-trunk: $ICC_{2,k}$=0.75, SEM=0.94. **Conclusions:** The reliability of MARP and DP calculations is generally good to excellent, both between- and within-days. The use of these variables to quantify movement coordination and variability in the lower extremity across testing sessions during discrete, sport-related tasks appears to be justified. Future research should investigate these variables as risk factors for lower extremity injuries. *Doctoral Student Award Finalist*

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**Influence Of Strength On Quadriceps And Hamstring Activation During A Drop-Jump Landing**

Leonard MD, Nguyen A, Schmitz RJ, Shultz SJ: University of North Carolina at Greensboro, Greensboro, NC

**Context:** Greater quadriceps activation during functional activities observed in females compared to males is thought to contribute to the increased prevalence of ACL injuries in females. As females have lower muscle mass/ strength to total body weight compared to males, increased quadriceps activation may reflect the need to activate the muscle to relatively higher levels to successfully perform the same task at a given body weight. **Objective:** To compare males and females on quadriceps and hamstring strength and activation during a drop-jump landing, and to determine if differences in strength predict differences in activation level. **Design:** Descriptive cohort study design. **Setting:** Controlled, laboratory setting. **Patients or Other Participants:** Sixty nine (28M, 22.7±2.8yrs, 178.4±9.1cm, 82.1±13.9kg; 41F, 22.0±2.9yrs, 163.1±6.7cm, 58.9±7.6kg) healthy college-aged participants with no current injury to the lower extremity. **Interventions:** Knee extension and flexion torques were measured at 25º knee flexion on the dominant leg during 3 maximal isometric voluntary contractions (MVICs) against an instrumented dynamometer. Surface electromyography (sEMG) recorded maximal quadriceps and hamstring signals during the MVIC trials and during five 45cm drop-jump landings. sEMG signals were processed using a root mean square algorithm of 25ms and 100ms time constants for landing and MVIC trials, respectively. Separate 2 (sex) x 2 (muscle) MANOVAs compared females and males on thigh strength and muscle activation. Separate step-wise linear regressions determined the extent to which thigh torque predicted thigh muscle activation during the drop-jump landing. **Main Outcome Measures:** Quadriceps and hamstring strength were measured in Newton-meters as the highest peak torque of the 3 MVIC trials and normalized to body mass (Nm/kg). Muscle activation was defined as the ensemble average peak RMS amplitude of 5 drop-jump landing trials during 250ms immediately post-landing, normalized to the peak RMS amplitude of MVIC trials (%MVIC). **Results:** Compared to males, females had lower normalized quadriceps

(2.61±.36 vs. 2.28±.44Nm/kg, P=.002) and hamstring (2.07±.30 vs. 1.78±.25Nm/kg, P<.001) peak torques, and higher quadriceps (0.77±0.21 vs. 0.93±0.27 %MVIC, P=.012) and hamstring (0.22±0.07 vs. 0.54±0.36 %MIVC, P<.001) activation during the drop-jump landing. Quadriceps torque was a negative predictor of quadriceps activation ($R^2$=.214, P=.002) in females but not in males (R= -.185). Quadriceps torque and hamstring torque were not predictors of hamstring activation in males ($R_{quad\ torq}$ = -.094, $R_{ham\ torq}$ = -.005) or females ($R_{quad\ torq}$ = -.186, $R_{ham\ torq}$ = -.296). **Conclusions:** Quadriceps dominant activation patterns often observed in females compared to males may in part reflect their lower relative strength to body weight, and the need to generate greater quadriceps activation to control a similar amount of body weight during functional activities. Future research should account for strength when examining sex differences in muscle activation patterns and their relationship to joint biomechanics during functional activities.
Supported by NIH-NIAMS Grants R01-AR53172 and 3R01AR053172 - 01A1W1

# Free Communications, Oral Presentations: Effects of Feedback on Lower Extremity Function

Saturday, June 21, 2008, 10:30AM-11:45AM, Room 260; Moderator: James A.Onate, PhD, ATC

**Monitored Rehab Functional Squat Coordination Test: Reliability, Learning Curve And Eccentric-Concentric Performance Comparisons**

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**Context:** Many clinical testing devices operate in open-chain fashion that may not be comparable to real-life activities. The Monitored Rehabilitation Functional Squat System (MRFSS) allows for objective assessment of closed-chain activities, yet to date this system has not been used to answer clinical research questions. It is first necessary to establish reliability and learning curves for MRFSS tests. The MRFSS neuromuscular coordination test could elucidate coordination differences between concentric and eccentric actions. Differences could affect training and/or injury prevention considerations. **Objectives:** To determine learning curve and reliability associated with repeated trials of the MRFSS coordination test and to compare tracking accuracy and learning curve during concentric and eccentric test elements. **Design:** One group, repeated-measures, intraclass correlation (ICC). **Setting:** Outpatient clinic. **Participants:** Convenience sample of 20 males (age 24.6±2.8; height 178.5±4.2cm; weight 91.5±14.1kg) with no leg or back conditions, and no central nervous system or uncorrected visual deficits. **Interventions:** After providing consent, subjects perform-ed a 5-minute bicycle warm-up then repeated trials of trajectory tracking during two-leg functional squatting (Session 1: 10 trials with 30-second rest intervals; Session 2: 1 trial). While observing real-time results on a monitor, subjects attempted to flex (eccentric) or extend (concentric) the legs to maintain cursor position precisely on the computer-generated path. Resistance was approxi-mately 25% of body weight. Subjects returned after 24-48 hours to perform one trial for reliability analysis. RMANOVAs (pairwise comparisons, Bonferroni correction) were used to quantify learning over Session 1 trials both for overall performance and for eccentric-concentric performance. ICC was used to test reliability between sessions. Paired t-tests were used to compare eccentric and concentric performance over 10 trials (corrected alpha=.005). **Main Outcome Measure:** Absolute error (mm; difference between subject's trajectory and computer path). **Results:** All subjects completed both sessions. Significant differences between the first 2 trials and later trials (e.g., Trial 3 mean error=4.3±1.4mm versus Trial 1 mean error=10.7±5.3mm, $P$<.001) led us to identify Trial 3 as the learning plateau trial. There was no difference in the rate of improvement of eccentric and concentric accuracy over the 10 trials. ICC correlating Trial 3 to Session 2's reliability trial demonstrated a strong relationship ($r$=.77, $P$<.001). Concentric scores were better than eccentric in all trials, with 4 comparisons reaching the corrected significance level (e.g., Trial 6 eccentric error=7.16±2.02mm, concentric error=5.96 ±1.6mm, $P$<.001). **Conclusion:** The MRFSS Coordination Test had strong reproducibility. Subjects made significant performance gains over the first 2 trials so future studies will incorporate 2 preliminary learning trials. Eccentric and concentric tracking accuracy improved similarly. Concentric tracking may be more accurate, though further research is required to confirm this finding and determine its clinical significance.

**Augmented Feedback Alters Knee Valgus Angles And Muscle Activity During A Jump Landing Task**

Bensman MM, DiStefano LJ, Bell DR, Padua DA: Sports Medicine Research Laboratory, The University of North Carolina at Chapel Hill, Chapel Hill, NC

**Context:** Anterior cruciate ligament (ACL) injuries are common and costly in the athletic population and prevention strategies are needed. Augmented feedback has been used to successfully modify possible risk factors, such as ground reaction forces, but has not been studied as a method to alter frontal plane kinematic and EMG data. **Objective:** To investigate the effects of augmented feedback on knee valgus angles and hip muscle activity during a jump landing task. **Design:** Randomized controlled trial. **Setting:** Research laboratory. **Participants:** Thirty-two healthy, recreationally active females (age =20.3±1.3yrs, height=166.5±7.4cm, mass= 66.6 ± 12.4kg) who demonstrated excessive medial knee displacement during a jump landing volunteered for this study. **Intervention:** All subjects performed a series of five jump landings and were randomly assigned to either a control group or an intervention group. Subjects in the intervention group completed a ten-minute technique modification program involving video and verbal feedback regarding their landing technique, as compared with an "expert" model's landing technique. All subjects then repeated a second set of five jump landings. **Main Outcome Measures:** Knee valgus angles at initial contact and at peak during the landing phase were measured by an electromagnetic motion analysis system. Mean amplitude of the gluteus medius (GMED), gluteus maximus (GMAX), and hip adductors (ADD) at initial contact and during the landing phase of the jump were measured through electromyography and normalized to maximal voluntary isometric contractions (MVIC). A mixed model ANOVA compared these dependent variables between groups and testing sessions. Tukey post hoc testing was used for significant findings. A correlation was conducted to evaluate the relationship between knee valgus angles and gluteus medius muscle activity. **Results:** A significant group by test interaction was observed for knee valgus at initial contact ($F$=13.5, $P$=0.001) and peak knee flexion ($F$=6.0, $P$=0.02) during landing. After the augmented feedback, the intervention group demonstrated a more varus knee alignment (pre:1.0±1.9°, post:3.1±2.6°) and increased their knee flexion

(pre:79.6± 11.8°, post:84.2±11.3°) following the augmented feedback. Significant interactions were also observed for GMED ($F$=4.3, $P$=0.04) and GMAX ($F$=9.7, $P$=0.004) muscle activity during landing phase. The intervention group decreased their GMED (pre:107.6±96%, post:79.2±60%) and GMAX (pre:78.9± 29%, post:63.5±23%) MVIC normalized mean amplitude following the intervention. A significant correlation between change scores for GMED mean amplitude and peak knee valgus angles was observed during the landing phase (r=-0.44, $P$=0.01). No differences were found for ADD and no other significant interactions or main effects were observed ($P$>0.05). **Conclusions:** Aug-mented feedback appears to decrease knee valgus and increase knee flexion angles, as well as reduce gluteal muscle activity, during a jump landing. A single session of augmented feedback may be beneficial with injury prevention programs to change muscle activation and kinematics.

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**Elevated Kinesiophobia In Football Players Is Associated With Altered Movement During A Jump-Landing Task**

Chmielewski TL, Tillman SM, Dunn JC, Lentz TA, George SZ, Indelicato PA, Moser MW: Shands Rehab Center, UF &Shands Orthopaedics and Sports Medicine Institute, Gainesville, FL; Department of Physical Therapy, University of Florida, Gainesville, FL; Department of Orthopaedics & Rehabilitation, University of Florida, Gainesville, FL

**Context:** Elevated fear of movement/re-injury (kinesiophobia) is a possible consequence of musculoskeletal pain and leads to altered movement in those with low-back pain. Altered lower extremity movement patterns in athletes can increase risk for injury or re-injury. **Objective:** To compare jump-landing movement patterns in football players with average and high levels of kinesiophobia. **Design:** A cohort study. **Setting:** Controlled laboratory setting. **Participants:** Division I collegiate football players (n=52) without activity restrictions. **Interventions:** Subjects performed a single leg forward drop from a 10 inch step. After retroreflective markers were attached to the body, several practice trials were given and both sides tested. Subjects stood on the test leg with hands on hips, looking forward, and then dropped onto a force platform (AMTI), landing on the test leg and holding the position for 3 seconds. Marker data were sampled at 200 Hz with 13 high-speed cameras (Motion Analysis Corporation), and knee joint angles were calculated with commercial software (Visual3D; C-motion, Inc). Force data were sampled at 1200 Hz. The independent variable was level of kinesiophobia. Kinesiophobia was quantified with a 13-item self-report questionnaire, Tampa Scale for Kinesiophobia (TSK-G), designed for administration to injured and uninjured individuals and reported previously. Questions were modified slightly to focus responses on the leg or leg pain (e.g. "Leg pain means the body is injured"). Each item was scored from 1-4, with higher scores indicating higher kinesiophobia. Subjects were assigned to average (AVE) or high (HIGH) kinesiophobia groups, with division at the sample TSK-G score mean plus 1 standard deviation. Group differences in TSK-G were compared with an independent t-test. Separate mixed model repeated measures (side) ANOVAs were conducted for each dependent variable. Alpha level was p<0.05. **Main Outcome Measures:** The dependent variables were peak knee flexion angle, peak vertical ground reaction force (PVGRF) and loading rate (LR) after landing. PVGRF was normalized to body weight (BW). LR was determined by dividing PVGRF by the time from initial contact to PVGRF. **Results:** Of 52 subjects, 9 were assigned to HIGH. TSK-G scores were greater in HIGH than AVE (25.7 vs. 14.1 points; p <0.001). Main effect for group was significant for PVGRF (p=0.017) and LR (p=0.011). PVGRF (3.82 vs. 3.47 BW) and LR (93.4 vs. 73.9 BW/sec) were greater in HIGH compared to AVE. **Conclusions:** Football players with elevated kinesiophobia demonstrate increased PVGRF and LR during a jump-landing task. These movement alterations indicate poor force absorption and could increase injury risk. Although less knee flexion during landing leads to higher PVGRF, no group differences were detected in peak knee flexion angle, suggesting the presence of other kinematic changes.

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**Visual Cues Do Not Effect Ground Reaction Forces During a Landing Tasks**

Onate JA, Joos ME, Cortes N, Padua DA, Van Lunen BL: Old Dominion University, Norfolk, VA, and University of North Carolina at Chapel Hill, Chapel Hill, NC

**Context:** Instructional interventions may need to be implemented to potentially reduce anterior cruciate ligament (ACL) injury incidence. The effects of these interventions on ground reaction forces need to be examined. **Objectives:** To evaluate the effectiveness of two modeling instructional interventions (global [G] and specific [S]) on vertical and posterior ground reaction forces during a box drop and running stop-jump task. **Design:** A 3 (group) x 4 (session) repeated measures design. **Setting:** Sports Medicine Research laboratory. **Patients or Other Participants:** A convenient sample of 73 physically active, healthy individuals (20.89±1.72 years; height: 172±9.87 cm; mass: 68.43±15.97 kg) volunteered as participants. Of these, 51 subjects (7 males; 44 females; 20.80±1.70 years) were selected to continue based on baseline performance of three trials of a box-drop task with LESS scores of ≤6. Individuals were quasi-randomly assigned per instructional group (control [C], G, and S modeling) for an equal amount of 17 individuals per group. The three instructional groups received different forms of visual instruction concerning proper jump-landing technique. [S] received a picture of proper alignment demonstrated by a model with individual joint positions identified. [G] received a picture of a model landing in an athletic "ready" position, whereas [C] received an non-related instruction. **Interventions:** Independent variables included instruc-tional group (S, G, C) and testing session (pretest [P], immediate posttest [IP], retention test [R], transfer tests [T]). After pretest, subjects returned (12.4±6.9 days) for 3 trials and received instructional intervention (S,G,C as per group assignment) between each trial**.** One-week later, (6.8±0.9 days) they completed 3 more trials without further instruction, followed by 3 trials of a running stop-jump task as a transfer test. Separate 3x4 repeated measures ANOVA, with an alpha level of $p$<.05, and Tukey's HSD were utilized to assess any significant differences across each dependent variable. **Main Outcome Measure:** Average Peak Vertical Ground Reaction Force (PVGRF), Average Peak Posterior Ground Reaction Force (PPGRF) measured in multiples of bodyweight (mbw). **Results:** There was no significant main effect for instructional group for both dependent measures. There was a signifi-cant main effect for time, with the transfer task (1.00± 0.19mbw) significantly higher than the other tasks (P:0.58±0.10mbw; IP:0.56 ±0.19mbw; R:0.59±0.11mbw) in PPGRF ($p$<0.001). There was a significant main effect for time, with the transfer test (3.32±0.69mbw) being significantly higher than the other tasks (IP=2.99±0.59mbw; R=3.05±0.54mbw) in PVGRF ($p$=0.001). No significant

interactions were found ($p$>0.05) **Conclusions:** The modeling pictoral intervention instructions had no significant effect on reducing ground reaction forces. Interestingly, the running stop-jump transfer test resulted in significantly higher PPGRF and PVGRF than the box-drop tasks. Realistic athletic motions may need to be utilized to assess instructional interventions. The investigation of additional force related cues (e.g., land softly) may need to be implemented in future studies.

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**Visual Cues Reduce Landing Error Scoring System Scores**

Joos ME, Onate JA, Cortes N, Padua DA, Van Lunen BL: Old Dominion University, Norfolk, VA, and University of North Carolina at Chapel Hill, Chapel Hill, NC

**Context:** Large-scale intervention strategies need to be developed to potentially reduce anterior cruciate ligament (ACL) injuries. Cost-effective interventions are needed to be utilized in conjunction with clinical screening tools to aid in the prevention of ACL injuries. **Objectives:** To evaluate the effectiveness of two modeling instructional interventions (global [G] and specific [S]) on jump-landing motion patterns using the Landing Error Scoring System (LESS). **Design:** A 3(group) x 4 (session) repeated measures design. **Setting:** Sports medicine research laboratory **Patients or Other Participants:** A convenient sample of 73 physically active, healthy individuals (20.89±1.72 yrs; height: 172±9.87 cm; mass: 68.43±15.97 kg) volunteered as participants. Of these, 51 subjects (7 males; 44 females; 20.80±1.70 yrs) were selected to continue based on baseline performance of three trials of a box-drop task with LESS scores of ≥6. Individuals were quasi-randomly assigned per instructional group (control [C], G, and S modeling) for an equal amount of 17 individuals per group. The three instructional groups received different forms of visual instruction concerning proper jump-landing technique. [S] received a picture of proper alignment demonstrated by a model with individual joint positions identified. [G] received a picture of a model landing in an athletic "ready" position, whereas [C] received a non-related instruction. **Interventions:** Independent variables included instruc-tional group (S, G, C) and testing session (pretest [P], immediate posttest [IP], retention test [R], transfer test [T]). After pretest, subjects returned (12.4±6.9 days) for three more trials and received instructional intervention (S, G, C as per group assignment) between each trial**.** One-week later, (6.8±0.9 days) they completed three trials without further instruction. Subjects performed three trials of a running stop-jump task as a transfer test. Separate 3x4 repeated measures ANOVA's, alpha level of $p$<.05, and Tukey's post hoc HSD tests were utilized to assess any significant differences. **Main Outcome Measure:** Average LESS scores (possible range 0-17) **Results:** Both instructional groups decreased their LESS scores from [P] (S= 8.08 ± 1.64;G = 8.96 ± 1.56) to [IP] (S = 4.63 ± 2.47;G = 4.08 ± 1.32) (p<0.001). All three groups decreased their LESS scores from the [P] (S = 8.08 ± 1.64; G = 8.96 ± 1.56;C = 8.02 ± 0.95) to [R] (S = 4.61 ± 2.09;G = 3.59 ± 1.41;C = 5.76 ± 2.36) ( p<0.001). Both instructional groups demonstrated lower LESS scores for [IP] compared to the control group (S= 4.63±2.47;G=4.08±1.32;C= 6.98±1.74) (p<0.001). Only the global group revealed lower LESS scores for [R] compared to the control group (G=3.59±1.41; C=5.76± 2.36) (p<0.001). All three groups showed no difference between [P] (S = 8.08 ± 1.64;G= 8.96±1.56;C=8.02±0.95) and [T] LESS scores (G=8.39±1.72;S=7.88±2.12; C=7.88 ±2.03) (p<0.001) and an increase in LESS scores between [R] (S=4.61±2.09; G=3.59± 1.41; C=5.76±2.36) and the transfer test (p<0.001). The two instructional groups also demonstrated increases from [IP] (S=4.62±2.47; G=4.08±1.32) to [T] (p<0.001). **Conclusions:** Both instructional interventions improved jump-landing motion patterns immediately following implementation. Global pictoral instructional can be used for improvement in jump-landing motion pattern retention. Neither set of instructions showed transferability to a novel stop-jump task.

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**The Effects Of Two-A-Day Practices On Cognitive Function And Symptom Reports Of Collegiate Football Players**


Strasser KM, Erickson S, Valovich McLeod TC: Athletic Training Program, A.T. Still University, Mesa, AZ, and Department of Sports Medicine, Arizona State University, Tempe, AZ



**Context:** The average length of football player participation is greater than ten years, which may result in an accumulation of countless subconcussive hits. There is some speculation these hits could result in long-term cognitive impairments. It is currently not known if the numerous repetitive contacts sustained during participation in preseason football practices could alter cognitive function and symptom reports. **Objective:** To examine the effects of two-a-day preseason practices on cognitive function and reported subjective symptoms of division I football players. **Design:** A prospective, repeated measures design. **Setting:** Division I University Sports Medicine Department and training camp facility. **Patients or Other Participants:** 17 collegiate male athletes, (age=20.7±2.08 years, height = 186.47± 6.48 cm, mass= 106.65±24.91 kg) were recruited from a division I University during the 2006 football preseason. Athletes were selected based on the following criteria: 1) were currently participating in division I varsity football 2) had not suffered a concussion in the previous 3 months 3) had full participation during the period of two-a-day practices, and 4) had a history of ≤3 previous concussions. **Interventions:** All subjects took the Immediate Post-Concussion and Cognitive Testing (ImPACT) for baseline measurement(pre-) before the start of two-a-day practices, during (mid-) (5-6d following pre) and after (post-) (10-12d after pre) two-a-day practices. **Separate repeated measures** analysis of variance were used to compare each dependent variable across time (3 levels: pre-, mid-, and post- two-a-days) and Tukey post hoc analyses were done when differences were significant ($p<.05$). **Main Outcome Measures:** Dependent variables included verbal memory composite score (VEM), visual memory composite score (VIM), reaction time composite score (RT), processing speed composite score (PS), total symptoms endorsed (TSE), **and total symptom score (TSS).** **Results:** We found significant differences for RT ($p=.036$), TSE ($p=.004$) and TSS ($p=.004$). RT was significantly slower at post- (.600±.092 sec) as compared to pre- (.565±.058) two-a-day practices. TSE was significantly higher at mid (3.41±3.47) compared to pre (.71±1.31) and post (1.12±1.56). TSS was also significantly higher at mid (12.06±14.88) compared to pre (1.59± 2.72) and post (2.77± 4.16). There were no significant differences across time for VEM ($p=.476$), VIM ($p=.569$) and PS ($p=.640$). **Conclusions:** We found slower RT at the conclusion of two-a-day practices and no alterations in other cognitive function, suggesting that the repetitive contact activity sustained during a short period of time does not produce deficits in memory or processing speed. The increase in reported symptoms and symptom severity during the middle of two-a-days could be the result of the physical and mental demands of these practices. Further research is warranted to identify whether long-term exposure to repetitive contact activity alters cognitive function and reported symptoms in collegiate football athletes. *Funded by a grant from the NATA Research and Education Foundation.*


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**Investigation Of Age Effects Of The Immediate Postconcussion And Cognitive Test (ImPACT) And Paper-Pencil Neuropsychological Tests**


Kontos DL, Register-Mihalik JK, Mihalik JP, Shields EW, Guskiewicz KM: Sports Medicine Research Laboratory, The University of North Carolina, Chapel Hill, NC



**Context:** Availability and usage of neuropsychological testing has increased in sports medicine. Understanding these commonly used measures is of great importance in order for the results to be interpreted properly. As neuropsychological tests become more available, their utilization will likely expand to include more young athletes, particularly those of high-school age. **Objective:** The purpose of this study was to determine the effects of age and practice on neuropsychological test performance. **Design:** Prospective repeated-measures design. **Setting:** Sports medicine research laboratory. **Patients or Other Participants:** Twenty college (20 ± 0.79 years) and 20 high-school athletes (16.00 ± 0.86 years) with no known history of injury or disorder affecting neurocognition were included. **Methods:** Participants completed both ImPACT (Version 3) and a battery of traditional paper-pencil neuropsychological tests on three separate occasions approximately two days apart. **Interventions:** Subjects were divided into two groups based on age. High-school athletes were defined as 15-17 year-old athletes and college athletes were defined as athletes between the ages of 19 to 21. An equal number of males and females were in each group. Two-by-three mixed-model ANOVAs were used to analyze each outcome measure. **Main Outcome Measures:** Hopkins Verbal Learning Test–Revised (HVLT-R) immediate and delayed total recall, Brief Visuospatial Memory Test–Revised (BVMT-R) immediate and delayed total recall, Trail-Making Test Form B (TMT-B) total time, Symbol Digit Modalities Test (SDMT) total score, Stroop Test total score, and five ImPACT composite scores (verbal memory, visual memory, visual motor speed, reaction time, and impulse control). **Results:** We observed a significant effect of age for TMT-B total time ($F_{1,38}=6.16$, $P=0.018$) with high-school athletes (49.66±14.50 sec) demonstrating a significantly greater overall time to completion compared to college athletes (41.46±13.71 sec). An effect of age was also observed for the ImPACT visual motor speed composite score ($F_{1,38}=5.029$, $P=0.031$) with high-school athletes (42.01±7.34) demonstrating a significantly lower overall composite score compared to college athletes (46.44±6.48). A significant effect of test-time was observed for BVMT-R immediate ($F_{2,76}=3.19$, $P=0.046$) and delayed ($F_{2,64}= 3.356$, $P=0.049$), TMT-B ($F_{2,66}=73.432$, $P<0.001$), Stroop Test ($F_{2,76}=96.851$, $P<0.001$), and the ImPACT visual motor speed ($F_{2,76}=5.08$, $P=0.005$). We observed no significant interactions for any measure. For all measures with a significant effect of time, scores significantly improved during the second session compared to the first indicating an overall practice effect. **Conclusions:** This study suggests that age affects two neuropsychological measures examined in this study. The clinician should be aware of this age difference when evaluating an athlete's performance. Clinicians should also be mindful of improvement on many of the measures from the first session to the second in healthy individuals as no improvement in injured individuals may indicate a deficit. Our data also suggest baseline scores on these tests for younger athletes should be reassessed as they get older.


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**An Assessment Of Head Impacts Incurred During A Season of Interscholastic Football**

Broglio SP, Zimmerman J, Alcaraz CA, Hadla T, Rao PR: University of Illinois, Urbana, IL, and Carle Foundation Hospital, Urbana, IL

**Context:** Head injuries are among the most complex and least understood in sports medicine. Presently, there is a dearth of research addressing the biomechanics of head impacts during sport participation, particularly at the interscholastic level. **Objective:** The objective of this study was to evaluate the frequency and magnitude of head impacts during a season of interscholastic football. **Design and Setting:** This observational field study was conducted on a high school football team during the 2007 season. **Participants:** Interscholastic varsity football athletes (N=32, 16.8±0.8yrs) volunteered to participate in this study. **Interventions:** The Head Impact Telemetry System (HITS) tracked head impact frequency, location (±0.41cm), and magnitude (±4%) incurred during football participation. Impact magnitude differences between player position (offensive line, defensive line, offensive skill, or defensive skill), session type (game or practice), and impact location (front, side, back, or top) were evaluated using analysis of variance. **Main Outcome Measures:** Linear head acceleration following impact was measured by the HITS in gravitational units (g). **Results:** A total of 19229 impacts were recorded throughout the season. Impacts to the front of the head were the most frequent (45.3%), followed by those to the back (25.3%), side (15.7%), and top (13.7%). The individual athlete sustained an average of 9.1±8.6 impacts per practice session and 24.5±22.4 impacts during games. Defensive linemen sustained the highest average number of impacts over all sessions (21.3±24.8), compared to the offensive line (15.2±14.9), offensive skill players (13.0±13.4), and defensive skill (12.1±11.4). Impacts to the top of the helmet (31.6±21.4g) produced significantly greater linear accelerations than those to the front (23.5±13.7g, $p<.001$), back (22.8±13.9g, $p<.001$), or side (20.3±11.8g, $p<.001$). The magnitude of game impacts (24.8±15.9) was significantly higher than practice sessions (23.3±14.5, $p<.001$). Offensive skill position players sustained significantly greater linear accelerations (24.9±17.6) than the defensive skill (23.3±15.5g, $p=.001$), offensive linemen (23.0±12.8, $p<.001$), and defensive linemen (23.9±13.8g, $p=.006$). **Conclusions:** Linear accelerations of the head resulting from participation in interscholastic football are greatest when they occur during games and when the athlete plays an offensive skill position. Although impacts to the top of the head were the least frequent, these impacts produced the greatest resultant acceleration. While it is not clear how these impacts influence the risk for injury, future investigations incorporating the HITS may provide a better explanation of injury biomechanics.

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**Evaluation Of Head Impact Acceleration During Soccer Heading In High School Athletes**

Markis EA, Tierney RT, Driban J, Higgins M: Department of Kinesiology, Biokinetics Research Laboratory, Athletic Training Division, Temple University, Philadelphia, PA

**Context:** Recent research has indicated that adolescents commonly experience concussion during soccer participation. Head acceleration is directly related to concussion risk. Factors influencing head acceleration during impact in collegiate soccer players include gender, head mass, and neck girth. There has been no research evaluating the relationship of these factors with head impact acceleration in high school soccer athletes. **Objective:** To evaluate factors that may be related to head impact acceleration during soccer heading in high school athletes. **Design:** Correlation. **Setting:** High school gymnasium. **Participants:** Seven (female N = 5, age = 16.2 ± 1.1yrs, height = 163 ± 7.1cm, mass = 62.5 ± 11.3kg, and males N = 2, age = 17.5 ± 0.7yrs, height = 173 ± 9.0cm, mass = 74.8 ± 3.2kg) soccer players with at least five years of heading experience volunteered for the study. Institutional Review Board approval and participant written informed consent and assent were obtained prior to data collection. **Interventions:** Participant head neck segment mass and neck girth were calculated using body mass and assessed using a tape measure, respectively. Participants then performed 4 straight (sagittal plane) soccer headers. Soccer balls were projected at an initial velocity, angle of projection, and range of 9.83 m/s (22 mph), 40 degrees, and 11m (35 ft), respectively. Head kinematics were assessed using a mouthpiece accelerometer (ICC 2,1 = .89; Endevco Corp., San Jaun Capistrano, CA) and portable Biopac MP150 data acquisition unit (BIOPAC Systems, Inc., Goleta, CA). Descriptive statistics and Pearson correlations were calculated using SPSS 14.0. **Main Outcome Measures:** The main outcome measures included head neck segment mass (kg), neck girth (cm), and peak resultant linear head acceleration (g). **Results:** Head-neck segment mass and neck girth values ranged from 3.9 – 6.4kg (mean = 5.4 $\pm$ .9kg) and 29.2 – 39.4cm (mean = 33.5 $\pm$ 3.3cm), respectively. Head impact acceleration values ranged from 30 – 52g (mean = 41.7 $\pm$ 7.4g). Mean head acceleration was 43 $\pm$ 6.8g for females and 39.5 $\pm$ 12.7g for males. Pearson correlations revealed high negative relationships between head impact acceleration and head-neck segment mass ($r$ =-.732, $p$ =.062) and neck girth ($r$ =-512, $p$=.240). Using $p \leq .05$, 15 subjects would be a needed to yield significant relationships for the reported r-values. **Conclusion:** Factors reported to be related to head impact acceleration and concussion risk in collegiate soccer players are also related to head impact acceleration in high school athletes. This may be clinically significant as many adolescents are smaller than their college counterparts and based on these findings may be at greater risk for brain injury. Due to the limited number of subjects in this study, further head impact research involving a larger sample of male and female high school soccer players is warranted. *Funded by a grant from the NATA Research and Education Foundation.*

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**Skull Fracture, Contra Coup Concussion, And Subdural Bleeding In Male Collegiate Pole Vaulter**

Schmunk JM, Clark AH, Sullivan KS, Sims JT: University of Oklahoma, Norman, OK

**Background:** This report deals with the treatment and management of a head injury that occurred during a collegiate track and field practice. The subject is a Caucasian, 22 YO, male student-athlete participating in pole vaulting drills. The drill consisted of the pole vaulter climbing onto a timing stand and holding a rope that hangs from the ceiling. The pole vaulter then swings off of the timing stand and out over the vaulting mat while mimicking the vaulting motion over the bungee cross-bar. Once the bungee cross-bar has been cleared, the pole vaulter releases the rope and performs the proper landing technique. In this case, the student-athlete swung out too far missing the mat and hit the posterior aspect of his head on the indoor track surface from a height of approximately 16 feet. Upon examination, the student-athlete was unconscious but breathing and his pulse was within normal limits. A student athletic trainer activated Emergency Medical Services (EMS) while the certified athletic trainer manually stabilized the cervical spine. The student-athlete regained consciousness moments before EMS arrived and complained of intense head pain but denied any other pain. The student-athlete was unable to recall

what had happened. EMS arrived on scene within minutes activation and placed a cervical collar on the student-athlete. He was spine boarded and taken to the local emergency room. The student-athlete will require medical clearance by a neurosurgeon, anti-seizure medication regulation by a neurologist, and psychological clearance from a neuropsychologist in order to participate. **Differential Diagnosis:** In this case, possible injuries include cervical fracture, skull fracture, concussion, subdural hematoma, epidural hematoma, subarachnoid or intracerebral bleeding. **Treatment:** Upon arrival at the emergency room, a CT scan revealed a longitudinal hairline fracture in the occipital bone of the skull, bleeding in the subdural space of the frontal and occipital lobes and in front of the brain stem. A contra coup concussion with loss of consciousness and anterior and posterior bruising were also diagnosed. No cervical fracture was noted. The student-athlete was transported to Oklahoma City where he could be placed in the care of a neurosurgeon in the intensive care unit. He stayed in intensive care for two days, followed by three days in a general unit before being released to his mother's care. One week post-injury, the student-athlete experienced extreme confusion and memory loss followed by a seizure. EMS again transported him to the local emergency room, where repeat CT scan showed no changes. The student-athlete was once again placed under the neurosurgeon's care for three days and then released to fly home with his parents by private jet. **Uniqueness:** Little research regarding pole vaulting injuries is available. There were 35 catastrophic head injuries reported to the National Center for Catastrophic Sports Injury Research between 1982 and 1998. Of the 32 studied, 16 resulted in death. The growing popularity of the sport and recent catastrophic injuries have stimulated research and discussions about requiring helmets and greater safety regulations for pole vaulting. No incident similar to this could be found. **Conclusions:** As a result of this traumatic brain injury, safety standards regarding pole vaulting were reviewed to ensure that the University standards are sufficient to adequately protect the student-athletes. This includes whether or not helmets should be required or given as an option at practice and/or competition. Additional concerns surfaced when it was discovered that a neurosurgeon was not always on call at the local emergency room. This was a particular concern given that high risk sports such as gymnastics, football, and pole vault take place daily at the University and local high schools.

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**Clinical Balance Performance Recovery In Individuals Reporting Posttraumatic Migraine Characteristics Following Sports-Related Concussion**

Register-Mihalik JK, Mihalik JP, Guskiewicz KM: Sports Medicine Research Laboratory, The University of North Carolina, Chapel Hill, NC

**Context:** Posttraumatic headache (PTH) is the most common postconcussive symptom in athletes. These headaches are often accompanied by characteristics of posttraumatic migraine (PTM). While increased neurocognitive deficits have been reported in athletes with PTM characteristics, little is known with respect to the effects of PTM characteristics on associated balance deficits following sports-related concussion. **Objective:** The purpose of this study was to examine the recovery of balance performance in individuals reporting PTM, PTH, and no headache (NHA) following concussion. **Design:** A prospective experimental study. **Setting:** Clinical field setting. **Patients or Other Participants:** Concussed high school and collegiate athletes (n=83, age = 17.16 ± 2.14 years, height = 177.57 ± 9.63 cm, mass = 80.86 ± 21.48 kg). **Interventions:** Athletes were stratified into one of three groups based on their self-reported symptoms on a graded symptom checklist. Based on International Headache Society guidelines, athletes were included in the PTM group (n=15) if they reported headache, nausea, and photophobia or phonophobia, during their initial post-concussion evaluation. Athletes reporting headache in the absence of other migraine-like symptoms were classified in the PTH group (n=54). Athletes not reporting headache, regardless of any other symptoms reported, were classified in the NHA group (n=14). Subjects completed preseason baseline balance performance testing, and were re-evaluated on days 1, 3, and 7 post-injury. A mixed model repeated-measures ANOVA was used to examine balance performance recovery among the three groups. **Main Outcome Measures:** The Balance Error Scoring System (BESS) error score was used to assess balance performance; a higher score indicates a decrease in balance performance. **Results:** The three headache groups did not differ at baseline on BESS performance ($F_{2,82}$=0.998, $P$=0.373) or concussion history ($\chi^2(2)$=1.632, $P$=0.442). A significant group by time interaction was observed ($F_{3,240}$=3.798, $P$=0.001) with the PTM group (errors=18.47±9.64) displaying a significantly higher BESS error score at day 1 post-injury than both the PTH (errors=13.69±6.22) and NHA (errors= 11.00± 5.35) groups. A significant main effect of day was also observed ($F_{3,240}$=15.206, $P$<0.001) with the NHA group improving at each session. The PTH and PTM groups' balance performance declined at day 1 post-injury but demonstrated improved performance above baseline values by day 7. All three groups performed similarly by day 7 post-injury. No significant difference was observed for the main effect of group ($F_{2,80}$=0.90, $P$=0.411). **Conclusions:** Our study suggests athletes experiencing PTM characteristics following sports-related concussion have greater balance impairments 24 hours post-injury than individuals experiencing PTH without migraine characteristics and those not experiencing headache. Our study adds an objective evaluation to current literature suggesting headache, including headache associated with migraine-like symptoms, may be a sign of impaired neurological function following sports-related concussion. These findings strongly support the recommendation that athletes be asymptomatic prior to considering return to play. *Doctoral Student Award Finalist*

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**Postural Control Returns To Baseline Within 13 Minutes Following Both Aerobic And Anaerobic Exercise Protocols**

Fox ZG, Mihalik JP, Blackburn JT, Battaglini C, Guskiewicz KM: Sports Medicine Research Laboratory, The University of North Carolina, Chapel Hill, NC

**Context:** The management of sports-related concussion remains elusive for many physicians and certified athletic trainers. While many certified athletic trainers implement preseason baseline balance testing, it is unclear how differing types of physical activity may affect sideline evaluations of postural control in athletes suspected of sustaining a sports-related concussion. As such, postural control deficits immediately following a suspected concussion may be attributable to fatigue, thus leading to false-positive concussive evaluations. **Objective:** To evaluate the effects of aerobic and anaerobic fatigue on postural control in healthy college-aged athletes. A secondary purpose was to establish an immediate recovery time course from each exercise protocol over which the effects of fatigue lessen, and postural control measures return to baseline levels. **Design:**

Counterbalanced repeated-measures design. **Setting:** Research laboratory. **Patients or Other Participants:** Thirty-six collegiate athletes (18 males and 18 females; age= 19.00±1.01 years, height=172.44±10.47cm, mass= 69.72 ±12.84kg) volunteered as participants in this study. **Interventions:** Participants completed two counter-balanced sessions within seven days of each other. Each session consisted of one exercise protocol (aerobic or anaerobic) followed by post-exercise measures of postural control evaluated at 3-, 8-, 13-, and 18-minute time intervals. The second session consisted of the counterbalanced exercise protocol. Baseline measures were established during the first session, prior to completing the initial exertion protocol. Separate 2x4 repeated-measures ANOVA were employed to evaluate protocol by time interactions and main effects. **Main Outcome Measures:** The Balance Error Scoring System (BESS) total score and two kinetic outcome variables (elliptical sway area and sway velocity) were obtained while administering the BESS on a force plate. **Results:** We found a significant decrease in postural control following each exercise protocol for all three dependent measures. A significant exercise protocol by time interaction effect for the BESS total score ($F_{3,105}$=5.437, $P$=0.002) suggested sustained aerobic exercise resulted in higher error scores 3 minutes following the exercise protocol (errors=10.03±3.19) compared to post-anaerobic exercise performance (errors=8.08±3.10) and relative to baseline measures (4.89±2.29). Although differences in BESS errors between protocols were not observed 8 minutes following exercise (aerobic=7.33±3.14, anaerobic=6.33±2.75), a main effect for time suggested impairments relative to baseline measures persisted. All measures of postural control returned to baseline by 13 minutes following both exercise protocols. **Conclusions:** Postural control was negatively affected following both aerobic and anaerobic exercise protocols as measured by the BESS total score, elliptical sway area, and sway velocity. The effect of strenuous aerobic or anaerobic exertion on balance performance seems to remain for as long as 13 minutes following exercise. Certified athletic trainers and clinicians should be aware of these effects and their recovery time course when determining an appropriate time to administer sideline assessments of postural control following a suspected mild traumatic brain injury.

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**Balance Performance With A Cognitive Task: A Continuation Of The Dual-Task Testing Paradigm**

Resch J, Ferrara M, May B, Tomporowski P: University of Georgia, Athens, GA

**Context:** Participation in athletics involves cognition in concert with postural stability. These two processes have been shown to be affected by mild traumatic brain injury (MTBI). **Objective:** To examine dual-task methodology as a plausible test for the concussed athlete in terms of postural stability and cognitive processing. **Design:** Randomized controlled trial. **Setting:** University research laboratory. **Participants:** Volunteer healthy sample. 9 males (21 ± 1.9 y, 84.5 ± 13.2 kg, 181.4± 6.1 cm) and 10 females (19± 89 y, 60.1±5.4 kg, 164.8±5.5cm). **Interventions:** Participants were tested over a 3 day period. On day 1, subjects were familiarized to each testing protocol. Days 2 and 3 were counter-balanced with participants performing either single (balance or cognitive) or a dual task (cognitive and balance) protocol dependent upon assignment. The balance task consisted of the Sensory Organization Test (Neurocom International, Inc., Clackamas, OR) incorporating six conditions (3 trials/per condition). Each trial lasted sixty seconds. Data were acquired for postural stability via the Neurocom Smart Balance Master equipped with the Data Acquisition Toolkit (DATa) version 2.0. Cognitive task consisted of an auditory task which entailed presenting letters (vowels or consonants) and numbers (odd or even) by clicking a corresponding mouse key. Stimulus conditions stayed constant (non-switch trial) or switched between letters and numbers (switch trial). For cognitive processing, Superlab 2.01 software (Cedrus) was utilized. Data analysis was performed on SPSS (Chicago, IL) version 15.0. **Main Outcome Measures:** A with-in subject 2(Task type) x 2(Test condition) x 6(Balance condition) ANOVA was utilized for cognitive data analysis. Composite balance, condition score and sub-scores were considered for postural stability between single- and dual-task sessions. Participants' response times (RT) during non-switch and switch tasks under each of the 6 dual-task conditions were analyzed. Paired t-tests were utilized to analyze postural stability. **Results:** Cognitive task results demonstrated a significant main effect for switch (1047.05 ± 20.53 ms) and non-switch trials (1011.20 ± 17.85 ms), $P < .001$. Balance data exhibited significant differences in condition 1 (fixed surface and fixed visual reference) single task (89.4 ± 5.9%) and dual task (91.6 ± 3.4%) $P = .030$ and condition 3 (fixed surface and visual reference) single task (84.1±9.5%) and dual task (89.7±4.2%) $P = .014$. **Conclusions:** Dual-tasking methodologies showed significantly longer response times but only under high involvement switch-task components, and improved balance scores compared to a single-task conditions in young healthy adults. Future research is needed to address these systematic changes in a concussed population to determine the applicability of dual-task methodology.

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**Identifying Current Teaching And Clinical Practices Regarding Sports-Related Concussion**

Covassin T, Elbin R, Stiller JL: Michigan State University, East Lansing, MI

**Context**: There are many consensus and position statements that have attempted to amalgamate current research on concussion in an attempt to provide clarity and agreement among research and practice. However, the utility of these consensus and position statements largely depend on the dissemination of this information to the clinical setting and to those responsible for educating future clinicians. **Objective:** To identify current concussion management methods and guidelines being taught in the classroom and clinical settings, and to investigate if the Vienna guidelines were being disseminated into the educational curriculum. **Design**: 17-item survey. **Setting**: All CAATE accredited under-graduate programs. **Patients or Other Participants**: A population based sample of program directors (n=135) and certified athletic trainers (ATC, n= 378) at CAATE programs. A total of 513 participants completed the survey, for a response rate of 34.2%. (years experience 11.1±8.29). **Intervention:** Survey-Monkey.com was the host site for the survey. The survey was a 17-item questionnaire which was adapted from a 21-item survey used by Ferrara et al. (2001). An expert panel of ATCs and program directors developed the questionnaire and reviewed it for face and content validity. Survey questions addressed topics including years of certification, employment setting as well as assessment of a concussion and return-to-play guidelines utilized in the clinical setting and in the classroom. Other items addressed clinical and teaching preferences for existing position statements and concussion grading systems. The Vienna Guidelines' "simple" and "complex" definition of a concussion was provided with the return-to-play stepwise approach. Descriptive statistics were calculated for each response. Chi-square

analyses were used to examine any significant relationship that years experience had with using and teaching the Vienna guidelines. **Main Outcome Measures**: Frequencies determined for each item; chi-square for years of experience. **Results**: The NATA position statement was the most widely used method for managing (61%) and making return-to-play decisions (47%) among participants. Over half of participants (66%) have never heard of the Vienna Guidelines. After reading the Vienna Guidelines' definition and return to play criteria, 73 % agreed with them, 68% said that they would use them, and 84% reported they would teach them. There were no significant relationships between years of experience as an ATC and using the Vienna guidelines (p=.247). There was a significant relationship between years experience and teaching the Vienna guidelines (p=.002). After reading the Vienna guidelines there was a significant relationship between years experience and using the Vienna guidelines (p<.001) and teaching the Vienna guidelines (p<.001). **Conclusions**: The majority of program directors and ATCs use a multidimensional approach to assess and manage a concussion. Findings indicate that the NATA position statement and Vienna guidelines are underutilized in both classroom and clinical settings.

**An Assessment Of High School Coaches' Knowledge Of Sports-Related Concussion**

O'Donoghue EM, Oñate JA, Van Lunen BL, Peterson CL, Zirges SD: Old Dominion University, Norfolk, VA, and James Madison University, Harrisburg, VA

**Context:** Since medical personnel are not always present at every athletic contest, coaches oftentimes are the first supervisors to assess sport-related concussion in high school athletics. Knowledge of sport-related concussion for all individuals who supervise athletes is essential. **Objective:** To assess high school coaches' knowledge of the recognition, management, and prevention of sport-related concussion utilizing a coaches knowledge of concussion survey (CoKC). **Design:** Cross-sectional design using an original survey instrument and demographic questionnaire. **Setting:** Public and private secondary schools in Southeastern Virginia. **Patients or Other Participants:** One hundred twenty-six athletic coaches, 81 males and 42 females (38.78±11.52 years, 12.67 years of experience, 5 private, 7 public schools) response rate=57%. **Interventions:** A two-part survey instrument (demographic assessment and CoKC) was created from the NATA Position Statement on Sport-Related Concussion. A panel of eight experts in the fields of sport-related concussion and/or survey research reviewed the instrument for content and face validity. A packet was sent to the athletic director with a script to be read to the coaches, a demographic questionnaire (educational background, coaching experience, and history of concussion) and the CoKC. The CoKC consisted of three sections of eight questions, with a maximum of score of eight points each, for a maximum correct score total of 24. Grouped analysis of variance (ANOVA) tests with homogeneity statistics were completed to determine the effect of demographic data on total Coaches' Knowledge of Concussion (CoKC) scores, with an alpha level of p<.05 set *a priori*. **Main Outcome Measures:** The total scores of the prevention, management, and recognition sections. **Results:** Overall, the coaches demonstrated a moderate knowledge, having correctly answered 79% or better for each section of the CoKC survey, of sports-related concussion (20.27±2.10). The greatest area of knowledge was recognition (7.40±0.81 = 92.5%) and the lowest were management (6.33±1.02 = 79.1%) and prevention scores (6.53±1.34 = 81.6%) . Male coaches scored significantly higher than females 7.59±0.63 vs. 7.02±0.97 ($p$< .01) and coaches with a history of concussion ($p$=.04) scored significantly higher on the recognition section (7.61±0.67 vs. 7.30±0.85). Coaches who attended a workshop on concussion scored higher ($p$=.02) on the management section (6.81±0.87 vs. 6.24±1.02). **Conclusions:** Our results suggest that high school athletic coaches demonstrated a moderate knowledge of concussion, but increased experiential knowledge (e.g., attending a workshop or a past history of concussion) improved the coaches' scores on the CoKC. Coaches' workshops on concussion may be an effective means for improving knowledge of sports-related concussion. *Funded by a grant from the NATA Research and Education Foundation.*

## Special Interest Group #1: Strategies for Implementing a Successful Concussion Protocol

Wednesday, June 18, 2008, 11:15AM-12:15PM, Room 261; Discussants: Stephen P. Broglio, PhD, ATC, and Tamara C. Valovich McLeod, PhD, ATC; Moderator: Tracey Covassin, PhD, ATC

## Free Communications, Oral Presentations: Psychosocial Interventions

Wednesday, June 18, 2008, 2:45PM-3:45PM, Room 261; Moderator: William A. Pitney, EdD, ATC

**Symptoms Related To Posttraumatic Stress Disorder (PTSD) In Athletes With Season-Ending Injuries**

Randolph KL, Powers ME: Shenandoah University, Winchester, VA

**Context:** Posttraumatic stress disorder (PTSD) is classified as an anxiety disorder associated with traumatic events. Ross's Grieving Process Model suggests that an athlete may undertake attitudes following traumatic injury that are similar to those used as criteria for the determination of PTSD. Thus, it is possible that athletes can experience symptoms of PTSD following significant trauma. **Objective:** To determine if athletes suffering season-ending injuries experience symptoms associated with PTSD. **Design:** Surveys were administered to athletes suffering a season ending injury. **Setting:** High school or collegiate athletic training room. **Patients or Other Participants:** Eleven high school and collegiate athletes who had suffered a season ending injury were surveyed. Seven athletes competed at the collegiate D-III level (3 males and 4 females) while three competed at the D-I level (3 males). The most common season ending injury involved the anterior cruciate ligament. **Interventions:** The Impact Event Scale (IES) and the Screen for Posttraumatic Stress Symptoms (SPTSS) were administered to athletes one and two months following initial trauma. The IES is a 15-item questionnaire that assesses the avoidance

and intrusion phases of PTSD. Subjects rate the items on a 4-point scale according to how often each has occurred in the past seven days. It has a test-retest reliability of 0.87, 0.89, and 0.79 for the total stress scores, intrusion subscale, and avoidance subscale respectively. The SPTSS is a 17-item test that screens for symptoms involved in PTSD. Subjects rate the items on a 5-point scale according to how often each has occurred in the past two weeks. The SPTSS has been found to be a reliable tool for varying populations because of its basic reading level and instructions. **Main Outcome Measures:** The sums of the IES and the averages of the SPTSS were used in the analyses. A sum score of 19 on the IES suggests a high cause for clinical concern and shows predisposition toward PTSD. An average score between 3.5 and 5.0 on the SPTSS suggests cause for concern. **Results:** No statistical difference (p=.578) was observed in the SPTSS scores between the first (.59 ±.51, range = 0.00 to 1.24) and second months (.52 ±.54, range = 0.00 to 1.65) following injury. None of the subject's scores were considered cause for concern at either month. A significant decrease (p=.038) was observed in IES scores when comparing the first (23.0 ±19.47, range = 1 to 55) and second months (13.0 ±11.59, range = 0 to 34) following injury. Six of the athletes showed a high cause for concern at the first month while only two showed cause for concern at two months following injury. **Conclusions:** The results suggest that athletes suffering season ending injury experience avoidance and intrusion phases associated with PTSD.

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**Athletic Trainers Use Of Sport Psychological Techniques In Clinical Practice**

Thomas EH, Torres-McGehee TM, Monsma E: University of Tennessee, Knoxville, TN, and University of South Carolina, Columbia, SC

**Context:** The use of sport psychology techniques in the athletic training room are among the psychosocial competencies now required by the Athletic Training Educational Competencies (ATEC). Consistency in the way athletic trainers (ATs) are educated about such techniques is questionable especially given the variation of internship or curriculum education. The extent ATs employ these techniques are also unclear. **Objective:** The two purposes of this study were 1) to examine the means by which ATs have been exposed to sport psychology techniques and 2) to examine what type of techniques are used in physical injury and psychological cases. **Design:** Structured open-ended interviews and grounded theory were the modes of qualitative inquiry. **Setting:** Individual interviews were collected at the researcher's university and participant offices. **Participants:** Six male and six female ATs (N = 12), 33.30 ± 9.53 years of age, with 7.50 ± 8.66 years of experience from Western, Midwestern and Southeastern regions representing four different levels of athletics: high school (n =4), NCAA Division I (n = 4), Division II (n = 2), and Division III (n = 2). Criterion sampling was used to ensure participants were certified prior to the implementation of the 4th Edition of the ATEC. **Data Collection and Analysis:** Interviews were recorded and transcribed verbatim. The constant comparative method was used to inductively analyze the data until themes emerged and crystallized. The strength of the theme was determined by the frequency of respondents reporting the theme. Trustworthiness was ensured using peer reviewed method. **Results:** Three major themes regarding education of psychological techniques emerged: 1) hands on experience (75%), 2) observation (50%) and 3) undergraduate sport psychology coursework (33%). Themes of psychological techniques used for treating physical injuries included goal setting (75%), social support (75%) and imagery (42%). The themes for psychological cases included social support (50%), goal setting (42%) and were not as strong; 67% of ATs referred psychological patients. **Conclusion:** The majority of ATs learned techniques through hands on experiences or observation, formal education appears to be limited questioning the knowledge base of ATs. The landscape of techniques thematically represented is inconsistent with those required not only in current ATEC but also the previous edition. For example, relaxations techniques were apparently not used. AT programs must address the critical need for consistency in educating not only their students but provision of continuing education opportunities that target the recommended techniques.

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**The Influence Of Psychosocial Mediators On Injury In College Athletes**

Sibold JS, Zizzi SJ: West Virginia Wesleyan College, Buckhannon, WV; University of Vermont, Burlington, VT; West Virginia University, Morgantown, WV

**Context:** Prevention of injury is the first domain of athletic training. In order to prevent injury, we must be able to identify those at risk. Research has shown clear evidence of a moderating relationship between psychosocial variables and injury, however the literature has not compared these variables to orthopedic data in injured populations. **Objective:** To determine the influence of psychosocial mediators on injury in college athletes, and to compare psychosocial data to orthopedic screening data between injured and uninjured populations. We hypothesized that athletes with high life stress, high competitive anxiety, and low coping skills would incur more days missed due to injury, and that orthopedic data would be similar to psychosocial data in its ability to predict injury. **Design:** A descriptive correlational design was employed. **Setting:** An NCAA division II institution. **Patients or Other Participants:** Convenient sampling resulted in the recruitment of 177 athletes representing six NCAA sports (116 males, 61 females; age=19.4±1.4years). **Interventions:** Pre-season measures of competitive trait anxiety, life stress, coping skill and a novel orthopedic risk score generated from the grading of the institution's orthopedic screening tool were compared in injured and uninjured athletes. Pilot testing resulted in an inter-tester reliability coefficient of .98 for the orthopedic instrument. The Life Events Survey for College Athletes (LESCA), Athletic Coping Skills Inventory-28 (ACSI-28), and Sport Anxiety Scale (SAS), were used for psychosocial independent variables. **Main Outcome Measures:** We recorded total number of injuries and days missed due to injury for each athlete across their respective season. **Results:** An independent samples t test was performed, and significant differences in somatic anxiety (t(175)=2.729, p=.00 7, d=0.48), negative life event stress (t(175)=2.089, p=.038, d=0.31), and orthopedic screening score (t(175)=2.253, p=.026, d=0.38) were found between injured and uninjured populations. Further analyses on gender differences revealed significantly higher levels of worry (t(125)=-5.481, p=.000, d=1.06), concentration disruption (t(125)=-3.698, p=.000, d=.73), and negative life stress (t(125)=-3.274, p=.002, d=.69) in injured females. **Conclusions:** These findings support previous research on the

stress-injury relationship, and are unique in the comparison of orthopedic and psychosocial differences in the injured population. Effect sizes in this analysis suggest that psychosocial markers *may* be better predictors of athletic injury, and thus warrant further exploration in the field. Use of this data may lead to better early identification of athletes at risk for injury and subsequent preventative interventions aimed at reducing injury risk in the athletic population.

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**Severe Anxiety To Medical Treatment In A Female Equestrian Athlete**

Ramos T, Reifsteck F, Courson R, Brown C, Ferarra M: University of Georgia, Athens, GA

**Background**: An 18 year old female collegiate equestrian reported to her pre-participation physical examination (PPPE) in the fall. Her previous history included a traumatic episode when she was little girl in which she was held down by her doctor and stuck with a needle. The athlete's mother phoned the athletic trainer months in advance inquiring about the PPPE and what tests would be administered. The parent was made aware that routine lab work would be taken as well as a routine physical, along with an echocardiogram. The mother explained to the athletic trainer that her daughter typically gets violent during her visits and has been known to punch, kick, bite, and throw herself to the ground and against walls. The athletic trainer identified the athlete and informed the medical staff about the athlete's past violent behavior during doctor's visits. A few days prior to the physical, the athlete contacted the athletic trainer and refused the pre-participation physical. The athlete was in a constant state of stress, could not eat, sleep, or stop crying. Her biggest concern was that she was not going to be able to give blood without her support team accompanying her, that being her mother, best friends and other family members. The athlete was made aware that the PPPE was necessary for her to get cleared to compete on the equestrian team. The athlete was accompanied by two team coaches and certified athletic trainer during all phases of the physical. She was medicated before the physical examination and was put on a priority status to get her through the physical as quickly and safely as possible. **Differential Diagnosis**: Needle Phobia, general anxiety, PTSD, and childish behavior. **Treatment**: The athlete took Lorazepam 2mg 30 minutes prior to her PPPE. The athletic trainer and two team coaches accompanied the athlete to get her echocardiogram. The athlete vomited twice immediately following the echocardiogram. Once the physical examination was completed, the doctor told the athlete that she was 85% complete with the exception of giving a blood sample. The athlete cried for several minutes and was physically held and comforted by her coaches. The athlete decided to proceed with the blood draw by grabbing the alcohol swab and telling the technician that she had to be in control. The coaches held one arm each and counted down several times in preparation for the needle stick. As soon as the needle pierced the athlete's arm, there was a loud cry and immediate rejoicing after the needle was removed. She felt very accomplished that she made it through her physical without her mother and support team. **Uniqueness**: The athlete had never given blood by a needle other than this traumatic episode as a child. She typically would undergo a pin prick to one of her fingers. Behavior is not typically seen in a college age athlete. The athlete may have been coddled by mother to the point that she felt she could not go to the doctor without her. Athlete also sees a therapist to deal with this anxiety. **Conclusions**: This case demonstrates that with a team approach and a support group, the athlete can accomplish difficult tasks. The athlete needed to have some level of control during the blood draw. Certified athletic trainers need to exercise sensitivity and resourcefulness in psychosocial situations.

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## Special Interest Group #3: Fluid & Electrolyte Balance in Athletes

Thursday, June 19, 2008, 1:00PM-2:00PM, Room 261; Discussants: Sandra Fowkes Godek, PhD, ATC, and Joseph Verbalis; Moderator: Douglas J. Casa, PhD, ATC

## Free Communications, Oral Presentations: Fluid & Electrolyte Balance in Athletes

Thursday, June 19, 2008, 2:15PM-3:15PM, Room 261; Moderator: Michelle A. Cleary, PhD, ATC

**Youth Hydration Status, Sweat Rate, Fluid Consumed And Educational Intervention During Soccer Camp**

McDermott BP, Casa DJ, Ganio MS, Decher NR, Lopez RM, Yamamoto LM, Yeargin SW, Griffin TM, Love KT, Myers SL, Pinkus DE, Warchol MD: University of Connecticut, Storrs, CT

**Context**: There is currently limited research focusing on youth hydration during summer soccer camps. Preliminary research has shown hypohydration in soccer and football youth during summer camps. **Objective**: To measure hydration status, sweat rate, and fluid consumed during summer soccer camps. Additionally, we sought to evaluate the effectiveness of a brief hydration educational intervention (EI). **Design**: Observational with rando-mized controlled comparison. **Setting**: Field setting during 5-day summer soccer camps (mean ± SD: WBGT=26.4 ± 3.1°C). **Participants**: A total of 120 volunteers (63 males: 13±2y, 49.9±14.4kg, 142.9± 29.2cm, 8±2y soccer experience; 57 females: 13±1y, 47.5±10.9kg, 132.5± 26.5cm, 7±2y soccer experience; overall: 13 ± 2y, 48.8 ± 12.9kg, 137.9 ± 28.3cm, 8 ± 2y soccer experience) participated in 2005 and 2007. **Interventions**: Urine samples were collected before breakfast and dinner daily to assess hydration status. Sweat rate was calculated by comparing body mass pre and post soccer activities, correcting for fluid consumption. Fluid consumption was measured via individual containers utilized for soccer activities. Containers were completely filled prior to activity and remaining fluid was measured after practices and games. This amount was divided by activity time to assess rate of fluid consumption. Subjects were stratified for age and mass and randomly assigned to an EI or no intervention (control) group. EI consisted of ~5 min meetings in groups of 2-5 following dinner on days 2-4. At the conclusion of camp, subjects rated their ability to properly hydrate during camp. Multivariate and repeated measures ANOVA statistics were used to compare differences between gender, age (young= 11 ± 1y, range:9 - 12y; old= 14 ± 1,range: 13-17y) and EI versus control with significant $\alpha \leq 0.05$. **Main Outcome Measures**: Hydration status via

urine osmolality ($U_{osm}$), sweat rate, and fluid consumption. Perceived ability to hydrate was compared to average $U_{osm}$. **Results**: Overall, subjects reported to camp hypohydrated (825 ± 246 $m_{osm} \cdot L^{-1}$). There were no significant hydration status differences over time or between groups ($p>0.05$). Males were more hypohydrated than females ($p=0.03$). Males demonstrated greater sweat rates than females ($p<0.01$). Older males (0.97 ± 0.35 $L \cdot hr^{-1}$) sweat more than younger males (0.75 ± 0.35 $L\ hr^{-1}$;$p<0.05$), but females did not demonstrate this difference (old: 0.68 ± 0.20 $L \cdot hr^{-1}$ versus young: 0.67± 0.23 $L\ hr^{-1}$;$p>0.05$). EI consumed significantly more fluid during practices (0.75±0.31$L \cdot hr^{-1}$; $p=0.04$) and games (0.86±0.36$L \cdot hr^{1}$; $p=0.02$) compared to controls (game = 0.62 ± 0.24 $L \cdot hr^{-1}$; practice= 0.69 ± 0.26 $L \cdot hr^{-1}$). Subjects did not match their perceived hydration ability to average $U_{osm}$ ($r=-.144$, $p=0.18$). **Conclusions**: Youth soccer players maintained an overall hypohydrated condition throughout a 5-day summer camp. EI showed a significant increase in fluid consumption during activities. Youth were unable to accurately perceive their overall hydration status. EI seemed to be effective during soccer activities, but future research is needed on EI efficacy outside of soccer activity periods.

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**Racial Differences In Sweat Sodium Concentration And Gross Sodium Losses In Professional And Collegiate Football Players During Practices In A Hot And Humid Environment**

Kopec J, Heinerichs S, Armstrong N, Bertini T, Fowkes Godek S: H.E.A.T Institute at West Chester University, West Chester, PA

**Context:** We previously reported no differences between black and white NFL players in sweat rates or gross sodium losses but the cohort of white players was small and the groups were not physically matched. We also reported no differences in sweat rates between NFL and college players matched by race and physical characteristics but racial comparisons of sweat sodium concentrations ([SwtNa+]) in physically matched football players has not been done. **Objective:** The purpose of this investigation was to compare [SwtNa+] and gross sodium losses in black and white players matched by size, position and playing time using a convenience sample of NFL and college football players. **Design:** Observational cohort design. **Setting:** Data was collected during practices of the respective teams pre-season training camps at the end of the first week so that [SwtNa+] would be unaffected by acclimatization. **Patients or Other Participants:** Sixty-four subjects were used in this study, 48 professional and 16 NCAA Division II football players. We found no differences in physical characteristics, which included: the black players (n=32) had age=26.0±3yr, height=182.27± 6.72cm, mass=111.84± 21.98 kg, BSA (as per Dubois) =2.35± 0.24$m^2$ and the white players (n=32) had age=23.2±4yr, height=188.66 ± 7.48cm, mass=111.92±19.13kg, BSA=2.37± 0.22$m^2$. **Interventions:** Before practice, the skin of the right upper forearm was wiped with alcohol, washed with deionized water and dried with sterile gauze. A sterile sweat patch was applied and secured with an impermeable microfilm tape, extending 15 mm beyond the sweat patch. During practice, the patches were removed and immediately placed in siliconized sterile, low retention tubes and centrifuged on site within 30 minutes of collection at 2500rpm for 10 minutes. The sweat samples were frozen and later analyzed using flame photometry. Sodium losses (mg/hr) were calculated using simultaneous sweat rate data collected relating to another study. Paired t-tests were used for statistical analysis. **Main Outcome Measures:** [SwtNa+] and sodium losses. **Results:** WBGT was 77.1± 4.4ºF for AM and 82.42± 3.2ºF for PM practices and were not different. [SwtNa+] were not different between black (48.6±19.3 mmol/L, range= 15 to 85 mmol/L) and white (44.3±21.6 mmol/L, range=13 to 99 mmol/L) players, $P = .43$, nor were there differences in sodium losses. Black players lost 1780 ±796 mg/hr (range = 517 mg/h to 3.67 g/h) and white players lost 2074.6± 1444 mg/h (range= 353 mg/h to 3.88 g/h), $P = 34$. **Conclusions:** Race does not appear to be a factor in sweat sodium concentration or gross sodium losses. Importantly, the mean sodium losses in all of the data of 1.92 g/h and in one player 3.88 g/h suggests that regardless of race many college and professional football players require substantial dietary sodium intake during pre-season.

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**The Effects Of Pickle Juice, Gatorade, And Water Ingestion On Plasma Variables In Rested, Euhydrated Humans**

Miller KC, Mack GW, Knight KL: Brigham Young University, Provo, UT

**Context**: Athletes susceptible to exercise associated muscle cramps (EAMC) are often recommended to modestly increase their dietary salt intake based on the assumption that electrolyte loss during exercise contributes to the development of EAMC. Approximately 25% of ATCs go beyond these recommendations by having their athletes ingest pickle juice; some ATCs claim that drinking 1-2 oz of pickle juice can alleviate acute EAMC within 1 minute of ingestion. These clinicians theorize that this effect is due to restoring electrolytes. Other health professionals discourage pickle juice ingestion because they fear that ingesting extremely hypertonic solutions will contribute to dehydration-induced hypertonicity thereby prolonging dehydration. **Objectives**: No data exists regarding pickle juice's effects on plasma variables. We asked: (1) Does ingesting pickle juice cause increases in plasma sodium concentration ($[Na^+]_p$), plasma potassium concentration ($[K^+]_p$), plasma magnesium concentration ($[Mg^{+2}]_p$), plasma calcium concentration ($[Ca^{+2}]_p$), plasma osmolality ($OSM_p$), or plasma volume (PV)? and (2) Do changes in these variables occur within 1 minute of ingestion? **Design**: 3 x 11 (fluid and time) factorial with repeated measures on time, crossover design. **Setting**: Biochemistry laboratory. **Patients or Other Participants**: Nine healthy males (age = 24.7 ± 1.9 yrs; height= 71.8 ± 2.9cm; mass= 86.3 ± 16.7kg). **Interventions**: Euhydrated subjects ingested 1 ml/kg body weight of pickle juice, Gatorade, or water on 3 different days separated by ≥72 hours. Resting blood samples were collected before ingestion, immediately post-fluid ingestion, and 1, 5, 10, 15, 20, 25, 30, 45, and 60 minutes post-fluid ingestion. **Main Outcome Measures:** Plasma electrolytes, $OSM_p$, and PV were analyzed. **Results:** Mean fluid intake was 86.3 ± 16.7 ml (~3 oz). Compared to baseline, $[Na^+]_p$, $[Mg^{+2}]_p$, $[Ca^{+2}]_p$, $OSM_p$, and PV did not change during the 60 min following ingestion of each fluid ($P > 0.05$). However, water ingestion decreased $[K^+]_p$ at 60 minutes compared to baseline ($P < 0.05$). $[Na^+]_p$ was slightly higher (≤1.3 ± 2.2 mmol/L) following pickle juice ingestion than water and Gatorade at 15 and 25 minutes and 25-30 minutes, respectively ($F_{20, 160} = 1.84$, $P = 0.02$). Pickle juice elicited a slightly higher $[K^+]_p$ (≤0.26 ± 0.39 mmol/L) than water at 30 and 60 minutes; $[K^+]_p$ was slightly higher (≤0.32 ± 0.53 mmol/

L) with Gatorade than water at 45 and 60 minutes ($F_{20, 160}$=1.78, *P*=0.03). **Conclusions:** Ingesting 1 ml/kg body weight of pickle juice and Gatorade does not cause substantial changes in plasma electrolytes, $OSM_p$, or PV nor lead to hypertonicity in rested, euhydrated subjects. Concern that ingesting small volumes of pickle juice might exacerbate an athlete's risk of dehydration-induced hypertonicity appears unwarranted. If EAMC are caused by electrolyte losses, these volumes of pickle juice are unlikely to restore any deficit incurred by exercise.

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**Influence Of Hydration Status On Pacing Ability During Trail Running In The Heat**

Stearns RL, Casa DJ, Lopez RM, McDermott BP, Ganio MS, West AE, Yeargin SW, Silverberg EJ, Friend KJ, Boyd PW, Armstrong LE, Maresh CM: University of Connecticut, Storrs, CT

**Context:** Some research has shown that dehydration has a negative impact on running performance. There is little field research that has examined the effects of hydration on an athlete's pacing ability Determining these effects has clinical relevance in athletic performance and training settings. **Objective:** To determine the influence of hydration status on the pacing ability of trail runners in the heat. **Design:** A randomized, crossover study. **Setting:** Field study conducted at park trails in the heat (WBGT =26.0±2.2°C) within a 2-week period. **Participants:** Seventeen (9 male, 8 female), competitive, well-trained distance runners (27±7 yr, 171±9 cm, 64.2±9.0 kg, 14.6±5.5 %fat) completed the study. **Interventions:** Subjects completed races while hydrated (HYR) and dehydrated (DHR). For each race, subjects ran three loops (4 km/ loop, 12 km total) on trails with a four-minute rest between loops. For DHR, dehydration was achieved by fluid restriction prior to and during the run. Runners were placed in groups with similar running abilities and instructed to run as fast as possible with monetary performance incentives. Statistical analyses consisted of repeated measures ANOVA for performance differences within and between the two trials. Significance was set at $p \leq 0.05$. **Main Outcome Measures:** Each lap was timed for individual trials. Dependent variables were lap times and overall performance. **Results:** The DHR had a greater body mass loss pre and post race (-2.05±1.25, -4.3±1.25%) in relation to a 3-day baseline versus HYR (-0.79±0.95, -2.05±1.09%). Subjects ran faster ($p < 0.001$) for the entire 12 km for the HYR versus DHR. Within trials, differences between fastest and slowest laps during HYR (54±40 s) were significantly smaller than DHR (111±93 s; p =0.041). Significant differences were found on lap 1 (HYR 1039±116s versus DHR 1071±123s; p=0.028), lap 2 (HYR 1066±123s versus DHR 1105±148s; p=0.01) and lap 3 (HYR 1081±132s versus DHR 1168±189s; p=0.003). Fastest individual lap times were significantly faster (p = 0.028) for HYR (1036±116 s) than fastest lap times in DHR (1060±131 s). Slowest individual lap times for HYR were significantly faster (1090±132 s) when compared to the slowest DHR laps (1172±184 s; p = 0.004). **Conclusions:** Hydrated subjects completed race trials with more similar lap times than dehydrated subjects as evidenced by the smaller range from slowest to fastest laps. Differences between the fastest and slowest laps between trials demonstrated an increased ability for hydrated individuals to evenly pace themselves. These findings revealed that dehydration decreases one's ability to run at an even pace.

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# Free Communications, Case Reports: Cardiopulmonary Conditions

Friday, June 20, 2008, 8:15AM-9:30AM, Room 261; Moderator: Michael Jansen, MD

**The Development Of Cardio-Pulmonary Distress Subsequent To Treatment For Exercise Associated Muscle Cramping In A Football Athlete**

Godek JJ, Verbalis JG, Fowkes Godek S: DevTay Enterprises, Kennett Square, PA; Georgetown University Medical Center, Washington, DC; The HEAT Institute at West Chester University, West Chester, PA

**Introduction:** An African American football player (age = 24, ht= 188 cm, mass = 118 kg, body fat = 12%) reported to the athletic training room with cramping of the triceps, back, quadriceps and hamstring muscles following the morning practice on day 8 of pre-season training camp. Pertinent medical history includes episodes of exercise associated muscle cramps (EAMC), EIA with prescribed Albuterol, and hospitalization at 20 and 17 months prior for pneumonia. An initial blood analysis revealed $Na^+$ = 138 mmol/l, $K^+$ = 7.1 mmol/l, $Cl^-$ = 98 mmol/l, lactate = 3.4 mmol/l, Hct = 52% and Hb = 17mg/dl. The team medical staff initiated IV infusion with 2L of .45% saline and 5% dextrose. Approximately 10 min into the treatment the athlete's cramping resolved significantly. However, shortly thereafter he reported throat and chest pain, dyspnea and an urge to sit up and cough. The athlete sat up and expectorated blood followed by pink, frothy sputum. A second blood analysis revealed: $Na^+$ = 134 mmol/l, $K^+$ = 4.6 mmol/l, $Cl^-$ = 98 mmol/l, lactate= 2.4mmol/l, Hct = 48% and Hb = 16.2 mg/dl. **Differential Diagnosis:** Cardiac impairment, pulmonary edema, hemothorax, acute renal failure. **Treatment:** The athlete was transported to the local ER via EMS. En route his cramping and cardio-pulmonary signs and symptoms abated. Physical exam at triage was unremarkable except for decreased breath sounds in the right lung base posteriorly. This finding was absent in subsequent physical examinations. Vital signs were: BP= 136/78 mm/hg, HR= 67 b/min, RR= 20 r/min, tympanic temperature=96 ºF. An IV infusion with 1 liter normal saline was initiated with an 18 gauge needle at a "wide open" rate. Approximately 3 hrs later an additional infusion of 1 liter of normal saline was administered at the same rate. The results of a twelve lead EKG initiated within minutes of beginning the first IV infusion were WNL. Chest Xrays and CT scan were normal. Urine analysis via dipstick was WNL and USG = 1.005. Hospital conducted blood analysis revealed $Na^+$ = 139 mmol/l, $K^+$ = 4.4 mmol/l, $Cl^-$ = 103 mmol/l, Hct= 40.8%, Hb = 15.2 mg/dl, Cr = 1.8 mg/100ml, CK = 5102 u/l; CKMB = 7.5 ng/ml. The patient had a glomerular filtration rate of 47 ml/min per 1.73 $m^2$ with a value of 57 ml/min per 1.73 $m^2$ when corrected for race. The diagnosis by the ER physician was acute dyspnea, severe dehydration, minor hemoptysis, mild rhabdomyolysis, and mild acute renal failure secondary to dehydration. The patient's condition continued to improve. After five hours he was discharged to the team medical staff and told to avoid strenuous activity for one day. Blood analysis the next AM by the team medical staff revealed $Na^+$ = 140 mmol/l, $K^+$= 4.9 mmol/l, $Cl^-$ = 107 mmol/l, Hct = 48%, Hb= 15.3 mg/dl. The athlete returned to practice with no further difficulties. **Uniqueness:** A blood $K^+$ of 7.1 mmol/l is critical and associated with cardiac impairment. Development of cardio-pulmonary distress is not a normal outcome of IV infusion for the treatment of EAMC. The diagnoses by the ER physician did not completely account for the cardio-pulmonary signs and symptoms for which the patient was referred. The nature and timing of cardio-pulmonary signs and symptoms is suggestive of pulmonary edema.

**Conclusion:** Diligence is indicated in the selection of fluid type and infusion rates for IV rehydration. Rapid infusion can lead to iatrogenic volume overload with resulting pulmonary edema even in dehydrated individuals.

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**Prolonged QT Wave In A Female Collegiate Swimmer**

Dame L, Reifsteck F, Courson R, Ferrara M, Brown C, Gandy W: University of Georgia, Athens, GA, and Atlanta Cardiology Group, Atlanta, GA

**Background:** An 18-year-old female collegiate swimmer presented at pre-participation physical examinations with a significant cardiac history. The athlete returned the health history questionnaire indicating 'yes' to numerous questions related to personal and family history of cardiac disease. After being evaluated by the Sports Medicine team, the athlete was cleared pending attaining and reviewing documentation for thyroid, neurological disorder, and cardiac stress test. The ECG performed during pre-participation physicals suggested a prolonged QT interval of 492 ms and a QTc of 420 ms. The athlete was referred to the team cardiologist who repeated an echocardiogram, ECG, and exercise stress test in office. The echocardiogram produced normal results, the ECG remained abnormal and during the exercise stress test the QT interval failed to shorten as with chronotropic increase to the degree expected. The athlete was then referred to a cardiologist specializing in Long QT Syndrome (LQTS) to determine participation status. **Differential Diagnosis:** Long QT Syndrome, PVC's secondary to Hashimoto's thyroiditis, mild postural tachycardia syndrome, and chronic fatigue syndrome. **Treatment:** Further cardiac evaluation was warranted. This included: electrocardiogram, electro-physiology with an epinephrine injection, an exercise stress test, and an echocardiogram. The tests performed by the LQTS specialist found no compelling objective evidence to convincingly support the diagnosis of LQTS. This was further supported by the athlete never presenting any clinical symptoms consistent with LQTS and she also did not demonstrate an overt QT prolongation. The cardiologist felt that if the athlete did have LQTS, it could be termed "concealed LQTS". There was a U-wave present on two of the ECG's performed that raised suspicion for Andersen-Tawil syndrome, which has been termed type 7 LQTS, and the exercise test showed that the QT interval shortened appropriately. The epinephrine test also showed that the QT interval shortened appropriately, ruling out type 1 LQTS with a 96% negative predictive value. However, the athlete did develop a G2 notching of the T-waves during the epinephrine test, suggesting that type 2 LQTS may be present. However, the cardiologist felt that it may indicate type 2 LQTS, but is by no means pathognomonic, which increases the potential for false positives. The family and the athlete were advised to pursue genetic testing, avoid drugs that are known to trigger an increased heart rate in people with inherited LQTS, encourage hydration and electrolyte replacement, and remove sound triggers during sleep. **Uniqueness:** In review of the ECG with PVC's that prompted the referral, the cardiologist felt that a QTc of 462 ms is present in 5% of all women in the population. Any genetic glitches in the heart's electrical system seem to be enhanced by swimming. Studies have shown that approximately 15% of LQTS diagnoses have occurred following a syncopal episode during swimming. Although further study needs to be done in order to understand why and how it occurs, the genetic defect that cause LQTS are specific to their individual triggers. Medical clearance through pre-participation physicals prompted the need to determine which gene was being affected. **Conclu-sions:** Although the family was highly considering genetic testing, even if the athlete had genetically-proven concealed LQTS, according to the Bethesda Conference Guidelines (2005), the athlete is not restricted from competitive sport. LQTS has 6 genetic subtypes, with type 1 as the most sensitive to be triggered by swimming. The most common sign that occurs with LQTS is spontaneous syncope. Approximately 5% of people with LQTS experience sudden death as their first symptom. This usually occurs during physical activity, emotional upset, or after being startled by sudden noise. Options for treatment of LQTS include: no treatment, beta-blocker medications, and an implantable cardioverter defibrillator.

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**Corrected Aortic Coarctation In A Collegiate Soccer Player: A Case Report**

Manspeaker SA, Marchetti DP: Marietta College, Marietta, OH, and Old Dominion University, Norfolk, VA

**Background**: A National Collegiate Athletics Association Division III female soccer player (21 y/o, height, 157 cm; weight, 54 kg) presents with a confirmed diagnosis of aortic coarctation that was surgically corrected three days after birth with a follow-up surgery at age six. Aortic coarctation is a narrowing of the aorta just distal to the origin of the left subclavian artery. During intense sport participation, the athlete reports symptoms of shortness of breath, chest pain/pressure, weakness in the legs, and significant overall body soreness and fatigue; the athlete shows signs of audible heart murmur with auscultation, lethargy, dyspnea, significant pallor at the face and hands, and decreased athletic performance. Echocardiograms performed prior to the start of each soccer season reveal moderate left atrium enlargement, mild aortic outflow blockage, a small bicuspid aortic valve, abnormalities within the mitral and tricuspid valves, as well as a mildly increased lung pressure. **Differential Diagnosis**: Due to the diagnosis at birth, extensive and consistent physician care and documentation, no differential diagnosis has been sought. **Treatment**: The athlete is prescribed Lisinopril and Digoxin, 30mg and .25mg per day, respectively for control of blood pressure. Blood Pressure is measured daily on the athlete to confirm close proximity to 120/66. During episodes of increased signs and symptoms, the athletic training staff has found success in applying ice to the athlete's chest, posterior neck, and radial arteries bilaterally. Following a stressful episode, the athlete is typically removed from sport participation for 24 hours, has blood pressure measured two times per day, and is instructed to rest and hydrate. **Uniqueness**: This case is unique as most physicians have not cleared persons with corrected aortic coarctation for sports participation. Due to the high fitness level and self-awareness of the athlete, the sports medicine team, with guidance of the cardiologist, allows her to participate as tolerated until the symptoms occur. It is anticipated that issues may arise in regard to lung pressure should the athlete become pregnant, but proper planning and monitoring will be performed to limit complications. Potential genetic issues with this athlete include possible increase in aneurysms. **Conclusions**: It is imperative to conduct thorough medical histories on all athletes, and maintain full communication with the entire sports medicine team in regards to athlete healthcare.

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**Blunt Chest Trauma In A Collegiate Football Player: A Case Study**

Ashton JC: University of Minnesota, Minneapolis, MN

**Background:** This case presents a 21-year old collegiate football player who suffered a blunt trauma to his chest while being tackled after a catch. This injury occurred during an off-season full contact scrimmage. The athlete removed himself from the scrimmage after the subsequent series complaining of "having the wind knocked out of him" and coughing up

bright red blood. The athlete was evaluated by ATC and the team physician on the sideline. He presented with equal breath sounds bilaterally and no observable sign of oropharynx laceration. The athlete was removed from participation, however he continued to have some shortness of breath (SOB) and hemoptysis approximately 1 hour after injury. At this time, the athlete was transported by ATC to the University Hospital Emergency Department (ED) for further evaluation and treatment. **Differential Diagnosis:** pneumothorax, hemothorax, pulmonary contusion, rib fracture, costochondral injury. **Treatment:** Once at the ED, the athlete underwent chest x-rays as well as a chest CT without contrast. The chest x-rays were normal. However, the CT scan showed some airspace opacity in the right upper lobe, indicative of pulmonary contusion. No other pathology was noted during this exam. The athlete was discharged to the care of the University Athletic Medicine Staff with orders for no activity until asymptomatic. The athlete continued to exhibit signs of hemoptysis for 3 days, reporting asymptomatic 4 days status post injury. At this time, he was cleared to progress into exertional activities. The athlete tolerated a 20 minute exercise bike workout, a 50 minute weight lifting session, and 20 minutes of agilities monitored by the athletic training staff without exacerbation of his hymoptysis. Upon evaluation on the 5th day the athlete had no complications from the progression into activity and was cleared to participate in practice. At 7 days status post injury the athlete participated in a full contact scrimmage without further complication. **Uniqueness:** Pulmonary contusions most commonly occur in motor vehicle accidents, although they can occur with the high-impact forces common with some sports. The signs and symptoms of pulmonary contusion may be subtle, however it is important to make a proper diagnosis as the potential for respiratory failure occurs over time rather than immediately following injury. Moreover, this condition may be exacerbated do to exercise before the lung tissue has healed leading to complications such as infection or respiratory failure, potentially leading to mechanical ventilation. **Conclusion:** Pulmonary contusion is the most common potentially life-threatening, chest injury. Proper recognition and treatment of this condition is paramount to the well being of the student athlete. This football player sustained a blunt force trauma to his chest resulting in both shortness of breath and hemoptysis during a scrimmage. After this diagnosis, the care of the athlete was mostly supportive. Nevertheless, the athletic medicine staff had to take careful consideration for proper return to play allowing for this condition to fully resolve. Since no preset parameters were found for return to play, the departments mild traumatic brain injury (concussion) progression was utilized as a template for progression into activity to ensure a safe return to play. The athlete was able to tolerate a progression through light exertion, weight lifting, and sport specific activity before return to full contact sport activity 7 days status post injury. This controlled progression allowed the lung to fully heal, thereby helping prevent complications such as infection or even respiratory failure.

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**Rare Pulmonary Event In A In A Collegiate Basketball Player**

Dolak K, Lewis M, McKeon J: University of Kentucky, Lexington, KY, and Asbury College, Wilmore, KY

**Background:** An 18 y/o female basketball player reported to the athletic trainer complaining of intermittent chest pain. She localized the pain to her left lateral chest, 4-inches below the axilla. She had no history of costal, pulmonary, or internal injuries. Upon initial evaluation, pain had been present for 3 weeks, often at night, with increasing severity. She could not recall a mechanism, but was tender to palpation of ribs 3 and 4. Pain was exacerbated by deep inspiration, active right lateral flexion, and right rotation of the spine. Initial treatment was conservative management of a rib contusion, including heating and stretching prior to practice with ice after. After one week with no symptom reduction, the athlete was referred to campus health services. She was diagnosed with a gastrointestinal disorder and instructed to take Zantac® twice a day to control gastric acid production. Her prescribed use of erythromycin, for the treatment of acne, was discontinued to minimize stomach acid. The athlete saw the physician twelve days later (2.5 weeks after initial presentation) and reported no episodes of pain since starting the Zantac®. Three days later, (three weeks after initial presentation), the athlete presented to the athletic trainer in excruciating pain. She was instructed to follow up with her physician immediately. **Differential Diagnoses:** rib contusion/fracture, muscle strain, psychosocial stress, abdominal disorder, pulmonary disorder. **Treatment:** In a local urgent care facility, a diagnostic ultrasound was performed to examine the athlete's abdomen. The results suggested an abnormality in her spleen and she was immediately referred to the emergency room for further imaging. A CT scan revealed no injury to the spleen and instead, several disruptions were discovered in both lungs. The athlete was subsequently admitted to the hospital. A pulmonary specialist conducted a thorough history and discovered that the athlete had recently been on 4 cross-country flights. She was also taking Yasmin® oral contraceptives. With this history, the athlete was diagnosed with multiple pulmonary thrombi and transferred to the intensive care unit (ICU). She was treated in the ICU with blood thinners and pain medication for four days. She remained in the hospital for 3 additional days, and was subsequently released. Eight weeks after initial presentation the athlete continues to take Coumadin® daily and her blood work is monitored weekly. She has been permanently removed from all contact sports. **Uniqueness:** Cases of pulmonary thrombi are rare in young, healthy athletes. The difficulty diagnosing this case was compounded by atypical presentation. Blood clots often form following acute trauma or after surgery and often manifest in the extremities; neither was the case here. These clots likely formed during multiple cross country flights, occurring nearly two months before she was treated in the hospital. During that time, she continued to play basketball and even experienced temporary symptom relief from medication prescribed for gastrointestinal symptoms. **Conclusion:** This case highlights the importance of complete history and early referral. This athlete's use of oral contraceptives and multiple flights over a short time are factors that increased the likelihood of pulmonary thrombi development and were not considered prior to hospitalization. Research has reported blood clots are an infrequent occurrence, but there is an increased incidence rate for females, frequent air travelers, and oral contraceptive users. Several studies also suggest that third generation progestin oral contraceptives, such as Yasmin® increase the occurrence of deep vein thrombosis and pulmonary embolism. Extensive air travel and oral contraceptive use are important considerations when examining a patient with insidious chest pain. Also, for female athletes considering Yasmin®, and other third generation progestins, the amount of travel, both personally and for athletics, should be considered.

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# Free Communications, Case Reports: General Medical Conditions

Friday, June 20, 2008, 9:45AM-10:45AM, Room 261; Moderators: Margot Putukian, MD, FACSM, and Nina Walker, MA, ATC

**Complicated Diagnosis Of Foot Ulcerations In Female Tennis Player**

Herrema JL, Courson R, Ferrara MS, Brown CN: University of Georgia, Athens, GA

**Background:** A 20 year old female collegiate tennis player reported to the athletic training staff complaining of pain and tenderness between her 4th and 5th digits on both feet. Past medical history indicated similar conditions that resolved when treated as tinea pedis. Athlete was instructed to keep area clean and dry and use a medicated powder until symptoms resolved. All symptoms resolved in 4-5 days. Athlete presented three months later with similar pain and redness between 4th and 5th toes and was treated again using the same protocol. Pain and redness worsened over the next 4-5 days and started showing ulcerations and exposure of dermal layers of tissue in the web spaces of both toes. **Differential Diagnosis:** Tinea Pedis, macerated corns, hammertoe with digital ulcerated lesion bilateral, acquired keratoderma. **Treatment:** Athlete was referred by athletic trainer to the team physician with these signs and symptoms. The team physician debrided the web spaces between 4th and 5th toes of both feet using a scalpel. Athlete was instructed to alter shoes so that it permitted more space for her toes to move and a hole was cut in the lateral sides of her tennis shoes at the level of the 5th toe. Further instructions were given to keep the area clean and dry and put antibiotic ointment to treat the infection. Athlete was also referred to a podiatrist. X-ray revealed the medial side of the head of her proximal phalanx on the 5th toe was rubbing against the base of the proximal phalanx of her 4th toe bilaterally. She was diagnosed with acquired keratoderma in the web spaces which became infected from the friction between the two bones. A syndactaly with arthroplasty 5th toe bilaterally was recommended. Another treatment option was to use devices such as toe pads or spacers to alleviate the pain and rubbing, but it would not correct the bony deformity and she would continue to have problems while playing elite tennis. Since it was early in the spring season, she elected to have the surgery at the end of the season. In the meantime, the lesions between her toes were regularly debrided and she applied drying agents to keep it free from infection. At the end of the season, she underwent a syndactaly with arthroplasty 5th toe bilaterally. The athlete completed post-operative rehabilitation and has had no problems since. **Uniqueness:** What originally presented as a case of tinea pedis and then macerated corns, was actually a deformity in the bony structure of the foot. The athlete had no previous history of significant foot problems though she had played tennis her whole life. This condition is very rare and is usually seen in basketball players. The correlation between basketball and tennis is high though because of the constant cutting actions and sliding of the feet in the shoes. **Conclusions:** It is important athletic trainers examine all sources of corns or ulcerations in the foot, especially when between the toes. They are not always caused by outside forces and could be caused by the structural deformity of the foot. A detailed evaluation, including using x-ray or other diagnostic tests, with help detect if any structural deformity exists.

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**Idiopathic Gastroparesis In A Middle Distance Runner: A Case Report**

Donovan KM, Reifsteck F, Ferrara MS, Brown CN: University of Georgia, Athens, GA

**Background:** The patient is a 21-year-old Australian male middle distance runner (59.1 kg, 173 cm, 19.8 BMI) with a previous history of various orthopedic injuries resulting in lost training time, including right tibial stress fracture, left foot synovitis, plantar fasciitis, bilateral torn hamstrings, intercostal strain, and grade III medial tibial stress syndrome. This athlete has a significant history of asthma controlled with medications. The patient presented to the athletic trainer with early satiety, bloating, belching, flatulence, and hunger. Patient reported he had been seen by a doctor in his home country for previous similar symptoms over a year ago, was told he had a "tropical virus" and was given the prescription antibiotic Metronidazole. Symptoms did not return until March of 2007, when symptoms began interfering with the patient's running performance and daily activities. **Differential Diagnosis:** Functional dyspepsia, gastroesophogeal reflux disease, *Helicobacter pylori*, irritable bowel syndrome, or gastrointestinal virus. **Treatment:** Patient was initially treated with an over-the-counter antacid with relief, but was consuming large amounts of medication daily. Upon exam by the team physician, a metabolic panel and CBC were found normal and Levsin and Prevacid were prescribed with minimal relief. Patient was then referred to a gastroenterologist. At this time additional symptoms consisting of diarrhea, constipation, sharp abdominal pain, and chronic abdominal distention were noted. Diagnostic testing including an abdominal ultrasound, stool sample, and an esophogastro-duodenoscopy were ordered and all found normal. A gastric emptying study was performed and results were abnormal. A normal score on the gastric emptying test is 37min +/-7 min. The patient scored 65 min and was diagnosed with gastroparesis, defined as delayed gastric emptying. The patient was given the prescription medication metoclopramide, a prokinetic agent to speed up gastric emptying and control his symptoms, but the patient was concerned about the side effects associated with the medication. Possible side effects include: severe muscle twitching, insomnia, anxiety, depression, sedation and restlessness. The risk of side effects increases with higher doses and consumption over long periods of time, as this medication is not intended for long-term use. The patient opted to forego the medication, but underwent nutritional counseling and chose to alter his diet, consuming 10-12 small meals or snacks over the course of the day. In order to control his condition, strict adherence to the diet, avoiding high fiber foods, high fat foods, and large meals is required. **Uniqueness:** Gastroparesis is commonly secondary to, or associated with diabetes mellitus, systemic disorders and neurological disorders, and is more prevalent in women than men. Gastroparesis can be associated with a gastrointestinal infection, but does not usually affect young healthy athletes. No reports on gastroparesis in runners or in relation to physical activity were found. Runners usually have regular bowel movements due to their high activity level, but this occurs in the colon, not the stomach, which is the organ effected by gastroparesis. Additionally, there is not sufficient evidence showing a relationship between age and prevalence of gastroparesis, but research generally studies 30-50 year-olds, possibly reflecting an increased risk for that age group. Gastroparesis can follow anorexia nervosa, but there is no reason to believe the patient sustained this condition. **Conclusions**: Gastroparesis is difficult to diagnose because it cannot be easily predicted based on symptoms. Onset of symptoms to diagnosis was over two years for this patient. It is unclear as to why this patient was at risk for this disease; the patient may have sustained a gastrointestinal infection or the patient's low weight (down to 55.5kg, BMI: 18.5 at diagnosis) may have put him at risk for this condition, but results are inconclusive.

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**Bilateral Hernia Repair In A Division I Collegiate Women's Basketball Player**

Baker AG, Carson EW, Hertel J:
University of Virginia, Charlottesville, VA

**Background:** A 21-year old female collegiate basketball guard (162.6 cm, 65.9 kg) complained of intermittent left anterior hip pain for 18 months and right anterior hip pain for 3 months. Her chief complaint was bilateral pain in the inguinal crease with a concomitant popping sensation in this area. During the athlete's first season of collegiate basketball, she complained of anterior left hip pain at the conclusion of the season. At this time she was diagnosed with a hip flexor strain which resolved with rest and therapy. Pain returned during the middle of her second season and this time resolved after a course of non-steroidal anti-inflammatory drugs (NSAIDs) and therapy. Due to continued complaints of left hip pain following her second season, she was referred to a general surgeon for hernia evaluation but this was negative. An MRI requested by the general surgeon revealed a small left ovarian cyst. A full gynecological work-up was performed but was unremarkable with exception of the cyst. Multiple diagnostic ultrasound examinations were performed over the next 6 months but these also proved unremarkable. During the athlete's third season, intermittent left hip pain returned and became constant over the last 4 weeks of the season. MRI exam at the conclusion of the third season revealed iliopsoas bursitis and the athlete received a corticosteroid (Kenalog) injection, which resulted in complete relief of symptoms. Her pain returned at the end of summer workouts preceding the athlete's fourth year of college basketball and a second injection provided no relief. Following her third season, she also participated in an overseas tour which consisted of 2 weeks of practice and 3 games. At the conclusion of this tour, she reported right anterior hip pain similar to the pain felt in her left hip. She participated in modified summer workouts, therapy, and was prescribed NSAIDs. With minimal improvement in symptoms at the end of summer workouts, another MRI was performed but was unremarkable on both sides. At this point the athlete was referred to an international hernia specialist for further examination. **Differential Diagnosis:** Iliopsoas bursitis, adductor muscle strain, rectus abdominus strain, femoral neck stress fracture, intra-articular hip pathology, osteitis pubis, ovarian pathology, femoral hernia, inguinal hernia, obturator hernia, sportsman's groin. **Treatment:** Diagnostic ultrasound and physical examination by the hernia specialist revealed bilateral protrusions on the posterior inguinal wall (often referred to as "sportsman's groin"). Right and left hernioplasties (Muschaweck minimal repairs) were performed on consecutive days. On day 3 following surgery, the athlete was allowed to begin light activity with a lifting restriction of 20kg. On day 8 following surgery, the athlete returned to the basketball court in non-contact activities. On day 13, the athlete completed full practice without pain or residual soreness. She is currently 6 weeks post-operative and is participating fully in intercollegiate basketball without symptoms. **Uniqueness:** "Sportsman's groin" injuries in females are relatively rare with published estimates indicating that this diagnosis occurs 14 times more often in men compared to women. We are unaware of any previous reports of bilateral sportsman's groin pathology in a female athlete. Following the accurate diagnosis and performance of the Muschaweck minimal repairs, the athlete was able to return to sport very quickly. **Conclusions:** This clinical case demonstrates the importance of a thorough differential diagnosis and exploring all avenues to determine a successful treatment and outcome. The diagnosis of bilateral sportsman's groin and performance of bilateral hernioplasties brought an almost immediate relief to this athlete's persistent hip pain.

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**Mixed Germ Cell Tumors Of The Pituitary And Pineal Glands Involving Field Compression Of The Optic Chiasm With Secondary Diabetes Insipidus And Hyperprolactinemia In A Collegiate Football Player**

Harkins TW, Harkins KR, Patterson TL, Keller BK: Charleston Southern University, Charleston, SC

**Background:** We present the case of a 20 year-old male collegiate football player who reported to the Athletic Training Center on June 19, 2007 clearly distressed, complaining of malaise and a noted lack of energy. The athlete was referred to the team general medical practitioner on the same day. Blood tests were completed and returned within normal limits. Due to a decrease in symptoms, the athlete was cleared for participation two days later. On July 7, 2007, the athlete once again reported to the Athletic Training Center with similar complaints. The athlete was referred back to the team general medical practitioner who ordered an MRI of the athlete's brain. The MRI revealed two masses, with one measuring1.5 x 1.5 x 2.0cm and the larger measuring 2.1 x 2.3 x 2.7cm. This result necessitated further diagnostic testing, and a spinal tap was completed showing increased levels of beta human chorionic gonadotropin and alpha-fetoprotein thus indicating that the athlete's masses were indeed cancerous. At this time the athlete was referred to the Medical University of South Carolina for further investigation of the condition. Throughout this time period, the athlete's symptoms began to worsen. The athlete reported fatigue, decreased sweating, increased acne on the arms, back, and chest, dizziness, frontal headaches, nausea and vomiting, galactorrhea, blurred vision, diplopia, polyuria, and polydipsia, consuming up to 4 gallons of water per day. In addition, the athlete had developed Diabetes Insipidus, and eventually had a complete loss of vision. **Differential Diagnosis:** Astrocytoma, ganglioglioma, meningioma, choriocarcinoma, diabetes insipidus, hyperprolactinemia, and/or mixed germ cell tumor. **Treatment:** On August 21, 2007, biopsies of the masses were taken using an endoscope through the athlete's right nostril. The athlete was diagnosed as having two mixed germ cell tumors with histological evidence of Germinoma and Embryonal Carcinoma. After careful consideration, the medical staff decided to treat the athlete non-operatively with medication and chemotherapy with etoposide and cisplatin. The athlete was scheduled to begin chemotherapy on the week of September 10, 2007. However, on September 4, 2007, the athlete presented to the emergency room due to a complete loss of vision, accompanied by headaches, and recurrent nausea and vomiting. Chemotherapy and high dose steroids were immediately initiated. On September 9, 2007 the athlete was discharged with minimal improvement in his vision. Over the course of the following months, the athlete's vision slowly returned to normal due to shrinkage of the tumor that was actively impinging his optic chiasm. The athlete will continue chemotherapy and is currently relishing in a very positive prognosis. **Uniqueness:** An extensive research of the literature revealed no other previously reported cases involving mixed germ cell tumors of the pituitary and pineal glands in an athletic population. In addition, a recovery of this magnitude warrants disclosure. **Conclusions:** The importance of the relationship formed between the athlete and the athletic trainer should be highly valued. While the athlete was not initially forthcoming with the entirety of his signs and symptoms, the athlete was referred to the general medical practitioner merely due to the fact that the athlete's mental status was obviously distressed. In addition, the importance of incorporating quality health care professionals into your sports medicine team whom are willing to exhaust each and every viable option when treating your athletes is magnified in this instance, and ultimately may save an athlete's life.

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**Proximal Tibiofibular Joint Dislocation In High School Football Player**


Szendrei N, Slatky J, Wimberly K, Crawford K: Texas Tech Health Sciences Center, Lubbock, TX; Lubbock Sports Medicine and Associates, Lubbock, TX; Sports and Industrial Rehab, Lubbock, TX


**Background**: A seventeen-year-old football varsity high school defensive end was injured after making a tackle during game play. On field evaluation was performed. The athlete presented with a chief complaint of lateral left knee pain. A hyperflexion, forced internal rotation mechanism was described with no feelings of dislocation. No radicular symptoms were reported. He had no previous knee injuries, nor any applicable family history. Physical examination revealed no bony tenderness, negative bump test and no gross deformity or dislocation about the knee. Lachman's was negative. A small area of deformity was noted at the proximal tibiofibular joint. Neurological exam was benign. The athlete was assisted off the field and further clinical evaluation was performed. There was an obvious fibular head prominence anterolaterally to its anatomical position, but no noticeable swelling. Examination revealed a ROM of 15-80 degrees, strength WNL, and a pain score of 8 out of 10. Special tests performed included Lachman's, Anterior Drawer, Varus/Valgus Stress Tests and Mc-Murray's. All were unremarkable except some slight laxity noted with Lachman's and the Varus Stress Test. The athlete was compressed and given crutches with orders to be non-weightbearing. Follow up examination with the team orthopedist was scheduled for the following day. **Differential Diagnosis:** Consisted of tibial plateau fracture, proximal fibular head fracture, proximal tibiofibular dislocation, ACL and/or LCL sprain. X-ray revealed an anteriorly dislocated proximal fibula. The physician ordered an MRI without contrast to further evaluate the area. Results showed a partial tear of the anterior tibiofibular ligament, low grade ACL sprain and contusions to the fibular head, lateral tibial plateau and the lateral femoral condyle. Findings were felt to coincide with those of a proximal tibiofibular dislocation. A closed reduction was scheduled. Prior to the scheduled reduction, the dislocation spontaneously reduced when the athlete slipped during crutch ambulation and the lower leg externally rotated. Upon reduction, the athlete's pain level was dramatically decreased. It was the physician's opinion that the planned post-reduction care was appropriate following the spontaneous reduction. **Treatment:** Initial rehabilitation protocol consisted of ROM, advancement to PWB as tolerated by patient, proprioception and strength exercises, i.e. one-legged reach, BAPS board, and single leg press. The patient was compliant 3x/week for 4 weeks. At this point the athlete was able to perform dynamic exercises and maintain a normal gait pattern. Pain was noted to be a 1 out of 10 at the posterior lateral knee and joint capsule when performing strenuous activities. **Uniqueness**: Proximal tibiofibular dislocations are rare within athletics at any level. This injury is most often seen in the skeletally immature, which makes it particularly unique to a seventeen-year-old. **Conclusions**: There is limited research on injuries and post injury rehabilitation of the proximal tibiofibular joint. This may present as a challenge to the Athletic Trainer both when attempting to create prevention plans as well as post-injury management. It has been stated that dislocations at the proximal tibiofibular joint are often a result of ankle instability and sometimes underlying pathological conditions. Complications of this injury may include, but are not limited to recurrent dislocations, peroneal nerve parasthesia and foot drop. Other associated complications are probable and merit further research of the joint and its potential pathologies.

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**The Occurrence Of Distal Tibiofibular Ankle Sprains In Division I Collegiate Football: A Case Series**


Joseph CJ, Johnson PD, Schmidt PW: University of Michigan, Ann Arbor, MI


**Background:** Throughout the course of one football season, we have seen a high number of distal tibiofibular ankle sprains. This report covers a roster of 116 male collegiate football players with a total of 34 ankle injuries from August 2007 to November 2007. Of those 34 ankle injuries, 24 were ankle sprains, with 11 (44%) sprains to the distal tibiofibular ligaments and interosseous membrane. The injured athletes ranged from 18 to 23 years of age, and involved a variety of positions on offense and defense: 3 tight ends, 3 offensive linemen, 1 running back, 1 defensive lineman, and 3 linebackers. Immediate examination of these injuries proved difficult due to minimal or inconsistent findings. However, all of these individuals presented within 24 hours with minimal swelling, point tenderness along the anterior and/or posterior tibiofibular space, increased pain with full weight bearing ambulation causing an antalgic gait, no medial or lateral ligamentous laxity, no syndesmotic instability, functional limitations demonstrated by an inability to squat or calf raise due to localized pain, and no clinical signs of a fibular fracture. **Differential Diagnosis:** Fibular Fracture, Syndesmotic Instability, Medial Ankle Sprain, Lateral Ankle Sprain, Lateral Low Leg Contusion, Talar Dome Pathology, Anterior Inferior Tibiofibular Ligament Sprain, Posterior Inferior Tibiofibular Ligament Sprain **Treatment:** No diagnostic imaging was done due to the lack of clinical signs and symptoms of a fracture or major tibiofibular instability. Video was used to determine the mechanism of injury for each case. The common mechanism was a lateral blow to the lower leg with the foot planted causing forced eversion and external rotation in all 11 cases. These injuries occurred in ½ inch cleats (n=6) and turf shoes (n=5); on grass (n=4) and on field turf (n=7); and in taped (n=3) and braced (n=8) ankles. The time missed due to injury ranged from 2 to 22 days of activity, and all 11 had some degree of limiting symptoms that lingered for multiple weeks after return. Each individual was immobilized in a walking boot for up to six days depending on severity and ability to ambulate without pain. Once the individuals returned to athletic participation, each received increased ankle support using Leukotape® for syndesmotic strapping and the Don Joy Velocity® for de-rotational bracing. Of these 11 injured athletes, 4 suffered a re-injury after returning to activity due to the same mechanism. **Uniqueness:** There has been a recent increase in the number of distal tibiofibular ankle sprains on our team, from a total of 13 in the past three football seasons (August through December), to 11 with 4 recurrences in the 2007 season. This is a problematic time loss injury, even if properly managed. It can be difficult to assess a distal syndesmotic injury due to the inconsistency of immediate symptoms presented and the number of possible differential diagnoses. The time loss from a syndesmotic ankle sprain seems to correlate with the distance of point tenderness measured proximally along the tibiofibular syndesmosis from the distal lateral malleolus; the greater length of point tenderness yielding an increased amount of time missed. **Conclusion:** We have been unable to isolate any common risk factors based on our data to support the increase in occurrence of Syndesmotic ankle sprains this past season. Further investigation is needed to determine some commonality in causes, possible risk factors, and a more effective preventative measure to reduce the incidence of this type of injury. Additionally, more information is needed to determine accurate predictors of return to activity to reduce the likelihood of recurrence

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**Transient Peroneal Nerve Palsy In A Male Collegiate Football Player**

Miller EM, Courson R, Brown CN, Ferrara MS: University of Georgia, Athens, GA

**Background:** A 21 year old male wide receiver presented to the athletic training room with a complaint of "dragging" his foot and requesting ankle tape to prevent "rolling his ankle." Patient had no history of injury to the left ankle or foot and was nine months post ACL reconstruction with an allograft. He had no return to play problems other than occasional mild joint effusion with functional activities. Upon examination, the patient was unable to dorsiflex or evert his left foot. Passive ROM was WNL, and he complained of no pain in the leg or foot. The patient reported that on the previous day, he experienced some numbness and tingling on the lateral portion of his left lower leg that he attributed to an ice bag being wrapped on his knee too tightly with plastic wrap. He stated that he removed the ice bag and had no further problems with numbness or tingling in the leg. Patient had a positive Tinel's sign over the junction of the superficial and deep peroneal nerves, and some paresthesia on the dorsum of his left foot. In an attempt to discover a more detailed etiology, the athlete recalled a history of numbness and tingling associated with ice on the left knee as well as improper wearing of a compression stockinette (rolled down to his proximal to mid calf while icing), and this was hypothesized to have contributed to the occurrence of the peroneal nerve palsy. **Differential Diagnosis:** Peroneal strain or rupture, lateral ankle sprain, acute compartment syndrome, peroneal nerve palsy. **Treatment:** Patient was evaluated by athletic training staff and team orthopedic physician's assistant. X-rays were taken to rule out a bony injury or re-injury of his ACL allograft, but findings were unremarkable and showed good and normal placement of his inferential screws. Patient was placed in an ankle-foot orthosis and taped into dorsiflexion to prevent drop foot gait. Athletic trainers performed direct stimulation of the peroneal nerve with Russian stimulation and induced depolarization of the nerve tissue with a probe. Upon regaining active dorsiflexion and eversion function, theraband exercises and balance training were added to overcome his transient loss of motor function. The patient's symptoms resolved over the next week and he has had no further problems or incidences. **Uniqueness:** Peroneal nerve palsy is uncommon in athletics, and the mechanism of injury in this case is especially unusual. Peroneal nerve palsy can occur as the result of a traumatic blow to the head of the fibula because of its superficial positioning or as a secondary injury in the case of a knee dislocation, but an atraumatic etiology not associated with a general medical condition is rare. By wearing his stockinette rolled up around his lower leg while icing, this athlete mechanically obstructed his peroneal nerve function. This and the ice over the superficial peroneal nerve at the fibular head are potential causes for impaired nerve function. **Conclusions:** As an athletic trainer, it is important to quickly recognize and diagnose conditions such as this. Had the athletic trainer not performed a physical exam of the athlete, he may have returned to practice and potentially damaged other structures of his ankle or foot. Further, since prevention is a large part of athletic training, education of the athlete on the dangers of improper use of equipment or supplies as well as on the importance of early reporting of signs and symptoms is crucial. Fortunately for this athlete, the damage was not severe and quickly resolved, but it could have been permanent and catastrophic to his athletic career.

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**Use Of The Interosseous Tenderness Length Measurement To Assess A Syndesmotic I Ankle Sprain In A Collegiate Baseball Outfielder**

Elmore CJ, Yeargin SW, Landis ML: Indiana State University, Terre Haute, IN

**Background**: A twenty-two year old, male baseball outfielder was injured three weeks into the fall baseball season during an outfield drill. The athlete was moving laterally to his right, changed directions, and became un-balanced. He attempted to catch himself with his left leg, causing a valgus force on the knee and forced eversion of the ankle. A "pop" was reported by another player at the time of injury. He was ambulatory but with a limp because of pain. Previous history includes bilateral ankle sprains and functional rear foot valgus. Mild edema was present over the Anterior Talofibular Ligament. No ecchymosis or marked deformity was present. Evaluation findings: (-) Bump test, (-) Anterior Drawer test, (-) Talar Tilt resulting with a 3/5 pain level, (-) Kleiger's test resulting in a 4/5 pain, and (+) Squeeze test resulting in a 4/5 pain level throughout the length of the fibula. Palpation of the fibula revealed a localized spot that elicited pain (4+/5). AROM and PROM revealed full motion for inversion and plantarflexion but limitations in dorsiflexion and eversion due to pain. Minor discomfort at the end range of motion during plantarflexion was noted. Good strength was found with plantar-flexion and inversion (4/5) and a minor deficit with eversion and dorsiflexion (3/5) due to pain. He experienced pain during functional testing, including heel/toe walks (2+/5). Neurological testing was normal. His initial interosseous tenderness length (ITL) was measured to be 9 cm. ITL is measured from distal end of the lateral malleolus to the last spot of point tenderness over the lateral lower leg. **Differential Diagnosis**: Grade one or two syndesmotic ankle sprain, fibular fracture, MCL injury due to the valgus force on his knee. **Treatment**: X-rays were negative for a fibular fracture and no diastasis of the talocrural joint was present. Final diagnosis was a grade one syndesmotic ankle sprain. The initial treatment consisted of ice, a compression wrap, and being placed in an air cast during ambulation. Functional testing three days post-injury revealed little to no deficit in strength. Tests included heel/toes raises, double and single leg squats, and hopping. He experienced only minor pain (1+/5). He returned to practice four days after the injury, with minor tenderness. He received cryotherapy treatment for two weeks before being released. He was rechecked every other day for changes in ITL. Day 3 was measured to be 7cm, Day 5 was 6cm, Day 7 and Day 9 were measured to be 5cm, Day 11 was measured to be 2cm, and Day 13 was less than 1cm. According to Nussbaum et al (2001), and the formula for return to full functionality based on ITL, this athlete was predicted to be out between ten and seventeen days. The athlete was able to return to practice in four days, and was symptom free during activity by Day 13 or 14. This corresponded directly to the interosseous tenderness length being less than 1cm. **Uniqueness**: The ITL is a relatively new technique used to assess the severity of syndesmotic ankle sprains and appears to be very accurate. Despite the aggressive return to activity in this case, resolution of symptoms did not occur until the time period given by the return to play formula. **Conclusions**: This is a classic mechanism for a syndesmotic ankle sprain. Interosseous tenderness length supported the diagnosis and provided an indication of his progress during the recovery. The ITL corresponded directly with his return to full functionality. This assessment is very simple to use and advantageous when dealing with similar ankle pathologies.

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**Retrosternal Hematoma In A Collegiate Football Linebacker**


Koshansky K, Penna J, Boergers R: Stony Brook University, Stony Brook, NY


**Background:** We present the case of a traumatic injury to a Division I collegiate football player resulting in a substernal hematoma with early pericardial tamponade. The subject, a 19y/o male (body mass=95.5 kg, height=185.4 cm), described falling onto another player's facemask while making a tackle. This was reported as a low speed event by both the athlete and on-site personnel. The subject experienced pain at the time of the event but was able to successfully continue to participate and complete practice. Initial post-practice evaluation identified a small amount of erythema on the left chest wall. Palpation elicited point tenderness over the sternum and left costochondral margin. The subject's pulse and blood pressure were normal but his breathing was shallow and labored. He complained of severe stabbing pain in his chest (10/10) and radiating pain into the left arm. The subject was promptly transported via ambulance to University Hospital. **Differential Diagnosis:** sternal contusion, sternal fracture and/or substernal hematoma. **Treatment:** Upon arrival to the emergency department (ED), PA and lateral x-rays of the chest were unremarkable. The subject was given ketorolac for pain management which effectively reduced the pain (5/10). He was fully alert and conversant, vitals remained stable and his breathing pattern had normalized. At this point he was discharged with instructions to return for any change in symptoms. Later that evening the subject returned to the ED with increasing discomfort, difficulty swallowing, nausea, tachycardia (100 bpm) and hypertension (140/90). CT scan of the chest revealed a (16.5 x 6.5 cm) retrosternal hematoma which was compressing the heart raising concern for impending cardiac tamponade. Cardiothoracic consultation recommended and performed an open evacuation of the retrosternal hematoma and cauterization of mammary artery. He had an unremarkable post-operative course. Three months post surgery, he returned to conditioning activities and at 6 months he was cleared for full contact. The subject successfully competed in 2 more seasons of football without incident. **Uniqueness:** Previously undescribed, potentially life threatening injury resulted from a relatively unremarkable event. **Conclusions:** A substernal hematoma which progressed to pericardial tamponade demonstrated in this case, resulted from the direct blow of a helmet to the chest. Perhaps a lower threshold for the utilization of CT scan after sports related chest trauma should be considered by those caring for athletes competing in these high risk activities.

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**Posterior Sternoclavicular Dislocation In A College Football Player**


Muir TA, Gay J, Butterfield TA: University of Kentucky, Lexington, KY, and Centre College, Danville, KY


**Background:** A 19 year old male wide receiver was tackled by an opponent while running with the ball during a pre-season college football scrimmage. The athlete landed on his left shoulder, while two subsequent defenders continued to "pile on" to the athlete. Once the play was stopped, the athlete could not move his arm, or get into any comfortable position with his upper extremity. On-field assessment showed no gross signs of fracture or dislocation, nor any vascular, neural, or respiratory compromise. The athlete was able to walk himself off the field, supporting his left arm with the right upper extremity. A sideline evaluation was begun by palpating under the pads for any sign of glenohumeral (GH) dislocation, humeral fracture, and point tenderness. The athlete was then slipped out of his jersey and pads, keeping the left arm immobilized at the athlete's side. There was a lack of AC joint deformity, but the athlete complained of slight point tenderness over the AC joint, with pain progressing over the medial 2/3 of the clavicle, and most severe over the sternoclavicular joint. Past medical history revealed no previous shoulder pathologies. The athlete reported no numbness or tingling, the extremity showed normal pulse and capillary refill, and the athlete had no difficulty breathing. The clinically significant finding was the inability to find a comfortable position for the left upper extremity. **Differential Diagnosis**: Clavicular fracture- body or physeal plate of clavicle**,** Sternoclavicular (SC) sprain, SC dislocation, Acromioclavicular (AC) sprain, manubrium fracture, first rib dislocation/ fracture. **Treatment:** The athlete was taken by personal vehicle (the parent's car) to the local hospital. X-Rays were negative for fracture or obvious dislocation, although the athlete remained in pain and discomfort. Only after intravenous administration of morphine did the athlete report decreased pain in his shoulder and clavicle. A subsequent CT scan revealed a posterior SC dislocation. Because open reduction was considered, the athlete was transported to the UK emergency room by emergency vehicle. X-rays of the C-spine, chest and shoulder, as well as CT of the chest with contrast were sent to the UK ER. A closed reduction of the SC joint was successful, and the athlete was released the following morning. The athlete was placed in a sling for 6 weeks, and allowed to begin range of motion exercises after three to four weeks of initial immobilization. **Uniqueness:** Posterior SC joint dislocations are very rare, and usually require open reductions. The dislocation in this case was not obvious enough to be seen by normal radiograph, thus the importance of a CT or MRI to diagnose this condition is apparent with this case. Although no secondary injuries were sustained, immediate recognition of vascular or respiratory compromise is essential in proper treatment and referral to an emergency facility. **Conclusions:** Due to the possibility of life threatening complications, posterior SC dislocations often require open reduction. Therefore, the athlete was transferred to a larger hospital before attempting the closed reduction. In this case on-field examination revealed no immediate threats to life, and referral to the emergency room was based upon the athlete's level of discomfort and pain, as well as the inability reduce pain with simple positioning. Because insidious onset of life-threatening symptoms has been documented in previous cases, to assure a high standard of care to athletes presenting with this injury an elevated level of suspicion is required during assessment.

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**Treatment Of A Female Collegiate Rower With Costochondritis: A Case Report**


Grindstaff TL, Beazell JR, Saliba EN, Ingersoll CD: University of Virginia, Charlottesville, VA


**Background:** A 21 year old female collegiate rower with multiple episodes of costochondritis over a one year period of time. Symptoms were localized to the left 3rd costosternal junction and bilaterally at 4th costosternal junction. Her worst pain was localized to the left 3rd costosternal junction. Moderate swelling was present over each of the associated costosternal joints. Pain was rated using a visual analog scale (VAS) with worst pain (6/10) occurring with rowing, running, elliptical, deep breathing, weight training, and movements which required

shoulder horizontal adduction. Pain was sometimes accompanied with an intense "popping" sensation which would provide temporary mild relief of symptoms. Prior interventions had included stretching anterior chest musculature, therapeutic exercise targeting the pectoralis major, and modalities (electrical stimulation, pulsed ultrasound, iontophoresis, and cryotherapy) localized to the costosternal joints. Medical interventions consisted of oral non-steroidal anti-inflammatory medications, topical lidocaine patches, and three fluoroscopic guided corticosteroid injections. Despite these measures and relative rest, only mild and temporary relief of symptoms was attained. **Differential Diagnosis:** Imaging included plain film x-rays which were negative for fracture or displacement and bone scan which was negative for stress fracture. Rib contusion was not likely due to insidious onset and lack of specific trauma. Hypomobility of the upper thoracic spine (T1-4) was noted with posterior to anterior glide, left more involved than the right, hypomobility at T3-4 costovertebral joints on the left side with posterior to anterior glide, and restricted mobility of the lateral ribs with passive accessory motion. Forward head, rounded shoulder posture, and pectoralis major and minor tightness were also thought to be an underlying associated factor. **Treatment:** Interventions included sustained pressure techniques to reduce tightness of pectoralis minor muscle, lateral rib mobilizations, and posterior thoracic spine joint mobilization/manipulation to address hypomobility. Therapeutic exercise included postural correction, cervical stabilization, and scapular stabilization exercises. Over a three week time period the pain the athlete experienced throughout the day had subsided (VAS 0/10). She was able to resume running and elliptical aerobic training with minimal discomfort (VAS 2/10) and began to reintegrate into collegiate rowing. **Uniqueness:** This case provides additional insight into the evaluation and treatment of costochondritis in an elite athlete. **Conclusions:** Examination of the lateral ribs, cervical, and thoracic spine should be part of the comprehensive evaluation of individuals with costochondritis localized to the anterior chest. Hypomobility and tightness of posterior structures may place additional stresses at the anterior joints of the chest wall, which may manifest as hypermobility. Solely directing interventions at the site of pain and swelling may not fully abate symptoms. Addressing hypomobility of posterior spinal structures and reinforcement of correction via postural reeducation and exercise can decrease loads placed on the joints of the anterior chest wall, allowed for a more thorough recovery in this case study.

## Free Communications, Case Reports: Upper Extremity Surgical Interventions

Friday, June 20, 2008, 4:15PM-5:15PM, Room 261; Moderator: David C. Dome, MD, ATC, and Timothy L. Uhl, PhD, ATC, PT

### Operative Stabilization And Rehabilitation Of A Symptomatic Os Acromiale In A Division 1 Collegiate Football Player

Madaleno JA, Amponsah GP, Silvestri PG, Johnson DL, Medina McKeon JM: University of Kentucky, Lexington, KY

**Background:** A 22 y/o defensive lineman suffered a grade 1 acromioclavicular(AC) sprain in his right shoulder during a game. Side-to-side comparison radiographs of his shoulders revealed bilateral os acromiale. In a chance occurrence, the athlete suffered a grade 1 AC sprain of his left shoulder 3 weeks later. Similar to the athlete's first injury, he regained full range of motion (ROM) and strength, and missed no games. Although the athlete was fully functional and the AC joint stable, he continued to have mild pain in his left shoulder and received lidocaine injections prior to each game. The athlete was able to complete the 2006 football season. Off-season conservative management consisted of electrical modalities, ice, rotator cuff strengthening, and one subacromial corticosteroid injection. Throughout off-season conditioning and weightlifting, the athlete's left shoulder remained moderately painful. The athlete started spring practice, but was removed from participation 2 weeks later due to pain. He was scheduled to receive an MRI. Imaging results revealed edema around the os acromiale in the left shoulder, indicating a possible fracture. **Differential Diagnosis:** Acromion fracture, acromioclavicular joint sprain, rotator cuff tendonitis, subacromial bursitis, anterior shoulder impingement. **Treatment:** The athlete was diagnosed with symptomatic os acromiale. After consultation with colleagues, the team physician recommended surgery to stabilize the region. The athlete underwent open reduction internal fixation(ORIF) with bone grafting on his left acromion process in April 2007. He was splinted post-operatively in a gunslinger brace locked in neutral. Two weeks status post(s/p), he began active internal and external rotation 3 times per day. Shoulder flexion was limited to less than 90° in order to avoid stressing the fixation. Eight-weeks s/p, he regained nearly full internal and external rotation. He was instructed to wear a bone stimulator for 20 minutes per day. At 12-weeks s/p the brace was removed and the athlete began performing over-head active ROM exercises. Rehabilitation progressed rapidly with no range of motion deficits. Follow-up x-rays indicated new bone formation over the acromion. At 14-weeks s/p, he was cleared to begin strengthening exercises. The initial strengthening program consisted of Theraband® resisted strengthening exercises, which included internal and external rotation at 30° abduction, shoulder flexion to 90° shoulder abduction to 90°, scapular protraction, and upright-rows. In addition, the athlete performed aquatic-resisted shoulder flexion, extension, internal and external rotation. He was able to complete these exercises easily and with no symptoms, and soon began an advanced strengthening program. This program consisted of Bodyblade® exercises in shoulder flexion and abduction, shoulder perturbations, wall push-ups, and physio-ball walk-outs and push-ups. Within 1 week, the athlete progressed to medicine ball chest passes, weighted "lumbar jack chops" and upper body ergometer sprints. He began individual sport-specific drills at 16-weeks s/p. Prior to the 2007 season, the athlete was released for full participation. **Uniqueness:** In anatomical studies, os acromiale is reported to be present in 8% of the population and is rarely symptomatic. There were no previously established rehabilitation protocols after surgical fixation of os acromiale in a collegiate football player and the outcome was unknown. In this case, a Division 1 defensive lineman was able to return to full participation 18 weeks s/p without complications or manifestation of symptoms following an aggressive progressive rehabilitation program. **Conclusions:** Controlled, aggressive rehabilitation of a surgically-repaired, symptomatic os acromiale in a football player resulted in a relatively short return to participation with no complications. Clinicians should focus on protecting the fixation during the first 12 weeks, while maintaining internal and external rotation to prevent joint stiffness. In addition, clinicians should be cognizant of the athlete's ability to tolerate aggressive strengthening early in the rehabilitation process.

**Osteochondral Defect In An Adolescent High School Baseball Pitcher**

Felton SD, Corneil JE, Guerra JJ: Florida Gulf Coast University, Fort Myers, FL

**Background:** A 15-year–old male high school baseball athlete presented after pitching in a mid-season baseball game with complaints of non-specific pain in the cubital fossa and along the medial joint line of the humero-ulnar joint. The athlete denied any known mechanism of injury or any recent traumatic injury. The evaluation by the certified athletic trainer revealed a 20-degree flexion range of motion limitation and full extension range of motion. The athlete had normal strength bi-laterally. There were no palpable or gross deformities observed, no severe pain noted during the evaluation, and no ligamentous instability noted. The athlete did note a previous elbow injury three years prior. The athlete reported falling off of a skateboard landing directly on the posterior aspect of the elbow. At the time of that injury, he was evaluated by a physician and X-rays were conducted which were negative. No further consultation occurred. **Differential Diagnosis:** Medial Epicondylitis, Chronic Muscle Strain, Capsular Adhesion, Loose Body Defect, Olecranon Fracture, Non-healed Fracture. **Treatment:** Initial treatment consisted of ice for 20 minutes. The athlete was then referred to the Team Orthopedic Physician. Diagnostic imaging consisted of an X-ray and MRI which revealed a Nelson Grade IV Osteochondral Defect present on both the radius and ulna with accompanying loose body fragments. The athlete underwent surgery within three weeks from clinical diagnosis to have the area debrided of the loose bodies. After successful surgery, the athlete began rehabilitation and made a full recovery within eight weeks. The athlete continued strengthening exercises and was allowed to begin throwing four weeks later. The athlete then completed a throwing progression protocol prior to returning fully to high school baseball. The athlete has made a full recovery but was advised not to resume the role of pitcher and to evaluate his playing status beyond high school. **Uniqueness:** Osteochondral Defects are a common ailment and diagnosis for athletes that are exposed to continuous stress on the body's anthology. It is most often a problem associated with older athletes that have experienced years of stress and trauma. In recent years it has become more prominent in the adolescent athlete likely due to year around training programs. Specifically, this case is unique due to the large range of motion deficient experienced by the athlete and his ability, prior to surgery, to fully participate until the middle of the competition season without complaint or treatment. **Conclusion:** This case highlights the diagnosis of Osteochondral Defects in a high school baseball pitcher. The athlete has made a full recovery but has been cautioned about continuing his baseball participation beyond high school. It is important for the certified athletic trainer to be aware of the clinical signs and symptoms of Osteochondral Defects so that appropriate referral can be made. This diagnosis is becoming more prevalent due to the increasing trend of year around practices and competition of adolescent sports.

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**Pectoralis Major Rupture In A Recreational Snow Skier**

Warren AJ, Stubbs SN: Oklahoma State University, Stillwater, OK, and OrthoOklahoma, PC, Stillwater, OK

**Background:** We present a relatively rare type of muscular trauma involving the pectoralis major that occurred from a fall while skiing. The patient was a 35 year-old male with no prior history of musculoskeletal pathology to the upper extremity. The injury occurred from a fall with maximal eccentric contraction of the pectoralis major with the arm positioned in an abducted and extended position. A tearing sensation was felt upon impact. Physical examination revealed swelling on the anterior axilla and medial brachial area with ecchymosis along the medial upper arm. Obvious weakness and pain were noted in active and resistive shoulder adduction and internal rotation. An obvious deformity was observed in the anterior axilla with medial retraction of the muscle belly. An absence of the tendon was noted with palpation. **Differential Diagnosis:** Pectoralis major rupture at the musculotendinous junction, tendinous avulsion at the humeral insertion of the pectoralis major, pectoralis major muscle belly rupture, or partial tear of the pectoralis major tendon. **Treatment:** MRI results indicated a near complete distal attachment tear of the pectoralis major tendon involving the distal two-thirds of the tendon. It was unclear from the imaging whether the tear occurred at the musculotendinous junction or at the tendon insertion. Surgical treatment by anatomic repair occurred two weeks after the onset of injury. A deltopectoral incision was made with retraction of the deltoid muscle. Upon visual inspection, it was noted that the tear occurred mostly in the tendon with some involvement at the musculotendinous junction. Since there was a clear remnant of the distal tendon attachment, repair was made by direct suturing of the tendon and the muscle to the tendon. Post operatively the arm was immobilized for four weeks with pendulum range of motion exercises beginning after two weeks of immobili-zation. Free movement of the arm was allowed after immobilization with full shoulder mobility achieved six weeks post operatively. **Uniqueness:** Ruptures of the pectoralis major muscle are uncommon. Some research has shown that most injuries of this muscle involve complete ruptures and are most commonly avulsions at the humeral insertion. Others have shown that ruptures occurring at the musculotendinous junction and intramuscular tears are usually caused by a direct blow. In addition, distal ruptures are usually complete, with complete ruptures occurring more frequently than partial tears or incomplete ruptures. In this particular case, the rupture began on the distal inferior attachment of the clavicular and sternal fibers of the muscle, but the superior abdominal fibers remained intact. Over 50% of pectoralis major injuries occur in athletes, particularly weightlifters performing the bench press where the rupture begins at the superior aspect of the tendon insertion propagating to the inferior fibers. In a review of the literature, no cases have been reported involving a fall while snow skiing. **Conclusions:** While shoulder injuries in skiing are quite common, they usually involve joint or bony pathology. Injuries such as this are more common in the weight room or involve direct contact. This case demonstrates that it should not be discounted as a possibility in the sport of skiing. There is ongoing debate as to the efficacy of surgical intervention of near complete versus complete pectoralis tendon ruptures. In most cases, near complete ruptures are treated conservatively with immobilization and rehabilitation, although this may lead to loss of function and strength. In this case, complete functional recovery and restoration of full range of motion has been accomplished. Six months post operative strength is normal in all planes of motion with strength grades of 5/5 in adduction (horizontal and vertical), 5/5 with internal rotation, and 5/5 in shoulder flexion.

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**Person To Person Contact Injury In A Football Player**

Waugh A, Johnson D, Boland M, Branam B, Madaleno J: University of Kentucky Department of Orthopaedics and Sports Medicine, Lexington, KY

**Background**: Athlete is an African-American male, 20 years of age. This college football cornerback sustained a blow to the wrist from the helmet of an opposing athlete. He felt immediate and intense pain and was unable to move his wrist. No deformity was

visualized, there was some immediate swelling as well as crepitus over his carpus. The stadium was equipped with radiograph equipment so x-rays were taken immediately on site. **Differential Diagnosis:** Ligamentous injury (sprain), scaphoid and/or other carpal fracture, TFCC tear, lunate dislocation, perilunate dislocation. **Treatment:** X-rays taken on site revealed a perilunate dislocation. Immediate attempts were made to reduce the injury with no success. Athlete was taken to the local university emergency department (accompanied by team orthopaedic fellow) for reduction. Local anesthesia (10cc of .5% Bupivacaine) was injected to the joint and reduction attempted. The attempt was unsuccessful. The patient then underwent a closed reduction while consciously sedated (Propofol) and with the assistance of finger traps. This closed reduction was successful and confirmed by plain film radiograph. The athlete was splinted and referred to an orthopaedic hand and wrist specialist for surgical follow-up. Prior to surgery, MRI findings by the radiologist indicated a non-displaced fracture to the proximal pole of the scaphoid, central ligament tear of the scapholunate ligament, partial thickness tear to the dorsal and volar aspect of the scapholunate ligament, TFCC peripheral tear, and perforation of the lunotriquetral ligament. Orthopaedist reading of the MRI focused on the scapholunate and lunotriquetral ligament tears, scapholunate angle of 90 degrees, and questionable fracture of the scaphoid. Pre-operative plans were to repair the ligament tears with fixation of scaphoid if indicated during surgery. Operative procedure was performed 4 days after injury. A dorsal approach was used. Once the carpus was clearly visualized an open reduction of the scapholunate joint was performed. An ECRB tendon weave procedure was used to reconstruct the scapholunate interosseus ligament. The lunotriquetral ligament and dorsal capsule were found to be avulsed from the lunate. These were sewn to the reconstructed ligament. Upon closure and sterile dressing the wrist was placed in a sugar-tong splint. **Uniqueness:** This injury is usually caused from a fall on an outstretched hand from a significant height or a very high impact with the wrist extended. The person to person contact mechanism of this injury is rare. Through a literature review one article concerning lunate and perilunate dislocations in football players was found. The authors concluded that in a five year study 10 of these injuries occurred and were treated through a variety of methods. All required some treatment other than immobilization, but open versus closed reductions were inconclusive as to effectiveness. **Conclusion:** While perilunate dislocations are no longer career ending injuries the method of treatment is still varied. It would be beneficial in determining treatment to understand the long-term outcome of each with regards to the early onset of arthritis that typically accompanies this injury. This patient returned to full competition in a cast four weeks following injury. Percutaneous pinning was not performed due to the athlete's desire to return to play and the accompanying risk of the pin breaking in such a situation. The athlete continues to follow-up with the physician to monitor healing of the wrist.

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# Free Communications, Oral Presentations: Assessment and Treatment of Patellofemoral Pain

Saturday, June 21, 2008, 9:00AM-10:15AM, Room 261; Moderator: Timothy L. Uhl, PhD, ATC, PT

### The Influence Of Patellofemoral Pain On The Star Excursion Balance Test Performance

Ebersole KT, Sabin MJ, Haggard HA, Kusch BM: University of Illinois, Urbana, IL

**Context:** Past research has demonstrated that unilateral chronic ankle instability may result in limb and group (healthy vs injured) differences in performance on the Star Excursion Balance Test (SEBT). Patello-femoral pain (PFP) is a multifactorial condition which may be accompanied by functional deficits in postural control. **Objective:** To investigate the influence of unilateral PFP on SEBT reach performance. **Design:** Randomized controlled trial. **Setting:** Research laboratory. **Patients or Other Participants:** Eight females with current signs and symptoms of PFP in one limb (age 31 ± 4yrs, weight 68.5 ± 14 kg, height 161 ± 6.6 cm) and eight healthy (CTL) females (age 34 ± 4yrs, weight 59±9.1 kg, height 162±5.6cm) volunteered to participate in this study. **Interventions:** Independent t-tests were used to examine group differences in score on the Kujala knee pain questionnaire. Each participant performed a series of 5 maximal reaches in the anterior (A), medial (M), and posterior (P) directions. All testing was done on both limbs. Prior to collecting test data, participants were familiarized to the SEBT during a separate orientation session as well as provided 3 practice reaches in each direction on the day of the test session. A 3-way mixed factorial ANOVA (group x limb x reach) was used to examine the group and limb differences in SEBT performance. An alpha level of 0.05 was used for all analyses. **Main Outcome Measures:** Maximal reach distances were normalized to leg length. In addition to the maximal reach distance in the 3 reach directions (A, M, and P), the reach distance from each direction was summed to form a composite reach score and included in the analysis. **Results:** The PFP group had a significantly lower Kujala score (72.1±8.2 vs 100 ± 0.0; $p<0.001$). There was no significant ($p=.185$) group x limb x reach distance interaction, but the 2-way interaction for group x reach collapsed across limb was significant ($p=.011$). Follow-up analyses found that in comparison to the PFP group, the CTL group reach significantly farther in the P direction (0.65±0.08cm vs 0.78±0.05cm; $p=.004$) and had a greater composite reach (2.18±0.22cm vs 2.56±0.12cm; $p=.014$). **Conclusions:** In contrast to the existing chronic ankle instability literature, these findings indicated no functional differences in SEBT performance between limbs in individuals with PFP. Furthermore, these findings suggested that the posterior reach direction and composite score may be most appropriate for detecting functional deficits due to PFP when compared to a healthy individual. Additional research is needed to confirm these findings and further explore the sensitivity of the SEBT to PFP.

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### Predictors Of Hip Internal Rotation During Running: Evaluation Of Hip Strength And Femoral Morphology In Females With And Without Patellofemoral Pain

Souza R, Powers C: University of Southern California, Los Angeles, CA

**Context:** Recent literature has suggested that excessive hip internal rotation during dynamic activities is associated with patellofemoral joint malalignment, patellofemoral joint stress, and the development of patellofemoral pain (PFP). Although diminished hip muscle strength and altered femoral morphology (i.e. femoral anteversion & inclination) have been implicated in contributing to abnormal hip

mechanics in persons with PFP, no study has confirmed this hypothesis. **Objective:** To compare measures of hip muscle strength and femoral morphology between females with PFP and pain-free controls, and to identify which of these variables best predict hip internal rotation during running. **Design:** Cross-sectional **Setting**: Biomechanics laboratory **Patients:** Nineteen females with PFP and 19 gender-matched pain-free controls. **Main Outcome Measures:** Lower extremity kinematics (8-camera Vicon Motion Analysis System; 120 Hz) were quantified as subjects ran along a 15 meter walkway. Measures of hip abductor, extensor and external rotator strength and endurance were obtained using a Primus RS dynamometer. Measures of femoral anteversion and inclination (i.e. coxa valga/vara) were obtained using T1-weighted magnetic resonance imaging (MRI). Independent-samples t-tests were used to compare average hip internal rotation during the first 50% of the stance phase of running, measures of hip strength, and femoral morphology between groups. Step-wise linear regression was used to determine whether measures of hip strength and/or femoral structure were predictive of hip internal rotation during running. **Results:** Females with PFP demonstrated significantly higher degrees of average hip internal rotation during the stance phase of running compared to the control group (8.2 ± 6.6 vs. 0.3 ± 3.6 degrees; $p<0.001$). The PFP group also demonstrated reduced hip muscle strength in 6 out of 8 hip strength measurements obtained. The largest between-group difference in hip muscle strength was observed in isotonic hip extensor endurance (16.6 ± 7.5 vs. 31.9 ± 7.8 repetitions; $p<0.001$). Females with PFP had greater degrees of femoral inclination when compared to the control group (132.8 ± 5.2 vs. 128.4 ± 5.0 degrees; $p=0.11$), however no differences in femoral anteversion were found. Step-wise regression revealed that isotonic hip extension endurance was the only predictor of hip internal rotation during running, with decreased endurance being associated with greater degrees of motion ($r =-0.451$; $p= 0.004$). **Conclusions:** Our results add to the growing body of literature supporting the link between abnormal hip function and PFP. Although females with PFP demonstrated greater degrees of hip internal rotation, diminished hip muscle strength and altered femoral morphology compared to the control group, isotonic hip extension endurance was the only predictor of hip internal rotation during running. Evaluation of hip muscle performance appears should be considered as part of the management of patellofemoral joint dysfunction.

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**Lower Extremity Mechanics In Individuals With And Without Patellofemoral Pain During A Stair-Stepping Task**

Boling MC, Padua DA, Creighton RA: Sports Medicine Research Laboratory, The University of North Carolina, Chapel Hill, NC

**Context:** To develop effective intervention programs for individuals with patellofemoral pain (PFP), clinicians need to understand how movement patterns differ between individuals with and without PFP during activities that elicit pain, such as stair-stepping. **Objective:** To compare lower extremity kinematics and kinetics during a stair-stepping task between individuals with and without PFP. We hypothesized that the PFP group would demonstrate greater hip internal rotation, hip adduction, and knee valgus angles and moments compared to the control group during both stair ascent and descent. **Design:** Case-control. **Setting:** Research laboratory. **Patients or Other Participants:** Nine teen subjects with PFP (age=26.7±4.4yrs, mass=73.3±17.3kg, height=171.0±8.3cm) and nineteen control subjects (age=25.4±3.0yrs, mass=70.3 ±17.3kg, height=169.4±9.1cm) volunteered for participation. PFP subjects met the following criteria: knee pain ≥ 3cm on a 10cm visual analog scale, insidious onset of symptoms not related to trauma, pain with palpation of patellar facets, and knee pain during two of the following activities: stair climbing, jumping or running, squatting, kneeling, or prolonged sitting. Control subjects were matched to the PFP subjects based on sex, age, mass, and height. Control subjects were excluded if they had a prior history of PFP, knee surgery in the past two years, or current lower extremity injury that limited participation in physical activity. **Interventions:** An electro-magnetic motion analysis system interfaced with a non-conductive force plate was used for data collection. Three-dimensional joint angles and internal moments of the hip and knee were sampled as subjects performed five trials of stair ascent and descent. Separate 2(Group: PFP, Control) x 2(Phase: ascent, descent) repeated measures ANOVA were performed for each dependent variable ($\alpha\leq0.05$). **Main Outcome Measures:** Peak three-dimensional knee and hip joint angles and moments were calculated over the stance phase of stair ascent and descent tasks. The stance phase was defined as the time period in which the vertical ground reaction force was greater than 10N. All moment data were normalized to the product of weight and height (%BW*H). **Results:** Independent of phase, knee flexion angle was significantly decreased in the PFP group compared to the control group (PFP = 69.61±15.57°; Control=87.60 ±8.12°; $P$=0.05). Additionally, during both stair ascent and descent, the PFP group utilized decreased knee extension moment compared to the control group (Ascent: PFP=-0.05±0.03%, Control=-0.09±0.03%, $P$=0.01; Descent: PFP=-0.06±0.03°, Control=-0.09±0.03°, $P$=0.01). No other main effects for group or group by phase interactions were revealed for the other dependent variables ($P$>0.05). **Conclusions:** Our findings disagreed with our hypotheses that frontal and transverse plane kinematics and kinetics at the hip and knee would differ between individuals with and without PFP. The differences in sagittal plane knee kinematics and kinetics are most likely attributed to compensations to decrease the stresses placed on the patellofemoral joint and in turn decrease pain.

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**Effects Of Patellar Taping And Patellofemoral Pain Syndrome On Lower Extremity Movement Coordination During A Dynamic Postural Control Task**

Aminaka N, Robinson RH, Gribble PA: University of Toledo, Toledo, OH

**Context:** Dynamic postural control is diminished in those with patellofemoral pain syndrome (PFPS), and patellar taping has been utilized to reduce pain and enhance function. Relative phase analysis is a method to describe relative motion between two joints within a limb, and may provide insight to the effect of injury on intralimb coordination. However, no previous study has applied relative phase analysis to investigate the effect of patellar taping on knee-hip coordination. **Objective:** To determine if patellar taping changes the knee-hip coordination in people with and without PFPS. **Design:** Single-session repeated measures design. **Settings:** Athletic Training Research Laboratory. **Patients or Other Participants:** Nineteen subjects with PFPS (12 females, 7 males; 20.3 ± 1.87yrs; 170.1 ± 10.17cm; 71.57 ± 14.04kg) and twenty control subjects (12 females, 8 males; 21.25 ± 2.67yrs; 172.08 ± 8.76cm; 70.91 ± 11.41kg) volunteered for the study. All subjects were free from any traumatic injury to the lower extremity. Subjects in the PFPS group presented with diffuse anterior knee pain for at least 8 weeks prior to the study, which was elicited or increased with activities, but not related to a traumatic event. Members of the control group were assigned an injured leg matched to the PFPS group for the purpose of between group comparisons. **Interventions:** Independent variables were

group (PFPS, Control), side (injured, non-injured), and taping condition (taped, non-taped). Subjects performed three reaches in the anterior direction of the star excursion balance test (SEBT) under taped and non-taped conditions on the stance leg. The McConnell's medial glide taping technique was used. The order of testing legs and taping conditions was randomized. An electromagnetic tracking system was used to measure hip and knee flexion, and calculate angular velocity and knee-hip relative phase. The four dependent variables were the mean absolute relative phase (MARP) and deviation phase (DP) at 100ms pre- and post-touchdown (the point of maximum reach). For each DV, a one-between (group), two-within (side, condition) 3-way ANOVA was utilized. **Main Outcome Measurements:** Pre- and post-touchdown DP and MARP were recorded under taped and non-taped conditions. **Results:** A significant group main effect was observed for MARPpre ($F_{1,35}$= 4.763; p= 0.036; PFPS= 44.467 ± 3.488, Control= 34.112 ± 3.216) and MARPpost ($F_{1,35}$= 5.646; p= 0.023; PFPS=44.573±3.642, Control= 32.803±3.358). A significant group by side interaction existed for DPpost ($F_{1,35}$=5.619; p=0.023) such that the non-injured leg of PFPS subjects (14.723±1.361) displayed more variability (DP) after touchdown compared with the non-injured leg of Control subjects (10.337±1.255). There was no significant main effect of taping in any of the variables. **Conclusions:** Although PFPS subjects demonstrated a more out-of-phase and less stable intralimb coordination during the SEBT, patellar taping did not modify these factors. Further research is warranted to determine whether differences in intralimb coordination among injury groups and sides may be the result of compensatory mechanisms.

**Patient Outcomes, Strength, And Lower Extremity Biomechanics Following A Proximal Rehabilitation Program In Women With Patellofemoral Pain Syndrome**

Earl JE, Hoch AZ, Labisch T, Lachacz J, Truebenbach C, Ochsenwald J, Worman R: University of Wisconsin-Milwaukee, Milwaukee, WI, and Froedtert Memorial Lutheran Hospital/Medical College of Wisconsin, Milwaukee, WI

**Context:** Evidence suggests that hip and core weakness may be related to poor dynamic alignment and lead to patellofemoral pain syndrome (PFP). **Objective:** To evaluate the outcome of a rehabilitation intervention focusing on strengthening the hip, core, and quadriceps muscles in women with PFP. **Design:** Pre-test/post-test cohort. **Setting:** Research laboratory and sports medicine clinic. **Patients or Other Participants:** 19 women (Age: 22.68±7.19yrs; Height: 1.64±.07m; Mass: 60.2± 7.35 kg) diagnosed by a physician with PFP with insidious onset and no concurrent lower extremity injury. **Interventions:** An 8-week, supervised rehabilitation program with a goal of strengthening the hip and core muscles, and improving dynamic control of the leg. Most exercises were closed-chain and included multi-plane movement, and perturbations to improve dynamic stability. No taping, bracing, medication, or modalities (other than ice) were used. Pain (visual analog scale), functional ability (Kujala questionnaire), isometric hip abduction and external rotation strength (normalized to body mass), core endurance (timed plank exercise), and 3-D lower extremity motion during a single-leg stepdown were collected before and after the intervention. Paired t-tests were used to analyze differences in the dependent variables between pre and post measurements. **Main Outcome Measures:** Pain, functional ability, isometric hip abduction and external rotation strength (% body weight), and core endurance. 3-trial averages of joint ROM during the stance phase of the stepdown for: rearfoot eversion, knee flexion, abduction, and internal rotation, and hip adduction and internal rotation. **Results:** Significant improvements in pain (Pre, Post) (40.1 ± 18.2, 4.9 ±7.3; p<.001), functional ability (70.4 ± 11.2, 83.7± 11.2; p<.001), lateral core endurance (48.3 ± 30.6, 73.3 ± 49.2 sec; p=.001), hip abduction strength (33.7 ± 7%, 37.9 ± 7.5%; p=.008), and hip external rotation strength (12.1 ± 3.9%, 14.2 ± 3.5%; p=.032). There were no significant changes in eversion (-5.5 ±5.5°, -4.4 ± 3.9°; p=.113), knee flexion (81.2 ±9.8, 80.1 ± 11.6; p= .901), knee abduction (3.6 ± 3.9°, 2.9 ± 3.2°, p=.371), knee internal rotation (4.5 ± 2.9°, 5.2 ± 4.0°; .423), hip abduction (-10.5 ±9.7°, -9.5 ± 9.8°; p=.550), or hip internal rotation (-4.4±2.7°, -3.4±2.7°; p=.145). **Conclusions:** The significant improvement in outcome and strength measures indicates that this rehabilitation protocol effectively reduces the symptoms of PFP and has an effect on proximal strength. Although there were no changes in joint ROM during the stepdown task in the grouped data, several subjects did show improvements in the angles that were measured. This indicates that there may be a subgroup of patients who benefited most from this type of intervention. Future studies should identify PFP patients with hip weakness and poor dynamic alignment and examine the effectiveness of this rehabilitation protocol in this subgroup.

## Free Communications, Oral Presentations: Measurement and Evaluation

Saturday, June 21, 2008, 10:30AM-12:00PM, Room 261; Moderator: Brian G. Ragan, PhD, ATC

**The Design And Development Of The Functional Arm Scale For Throwers© (FAST©)**

Ellery TE, Sauers EL, Snyder AR, Bay RC: Post-Professional Athletic Training Program, A. T. Still University, Mesa, AZ

**Context:** Little is known about the impact of arm injury on baseball and softball throwers' health-related quality of life (HRQOL). Existing patient self-report scales for the upper extremity were not developed for use in high demand athletic populations, such as overhead throwers. **Objective:** To design and develop a region specific patient self-report outcome scale for the assessment of HRQOL in baseball and softball players with arm injuries. Further, we sought to create a single self-report scale that could be used to assess global HRQOL through the measurement of 5 disablement domains (pain, impair-ment, functional limitation, disability, and societal limitation) using both sport-related and non-sport related questions. **Design:** Scale development. **Setting:** Various healthcare facilities and high school, college, and professional athletic facilities. **Participants:** Phase I: 4 developers. Phase II: A 55-member expert panel (18 healthcare providers, 24 high school throwing athletes, 8 college throwing athletes, 1 professional baseball athlete, and 4 baseball/softball coaches). Phase III: A 6-member interpretability focus group (3 high school baseball players, 3 high school softball players). **Interventions:** During Phase I (Item Generation and Classification

Consensus), scale items were generated, and then a consensus process was used to classify each item into one of the 5 disablement domains and to further classify each item as 'sport-related' or 'non-sport related'. During Phase II (Expert Panel: Item Importance and Item Reduction), the importance of each item for determining the impact of the thrower's arm injury on HRQOL was rated on a 5 point Likert scale and the total number of items was reduced. During Phase III (Focus Group: Interpretability), a focus group of adolescent throwers was used to assess the interpretability of each item. **Main Outcome Measures:** Item disablement domain, sport-relatedness, importance, and interpretability. **Results:** Phase I item generation yielded an 88-item scale. The Phase II item importance and item reduction by the expert panel reduced the scale to 55 items plus a 9-item pitcher module. Phase III identified one question that was difficult for adolescents to interpret, so it was removed. This resulted in a final scale of 54-items, plus a 9-item pitcher module, with the items classified accordingly: Pain = 11 (6 sport-related and 5 non-sport related), Impairment = 16 (8 sport-related and 8 non-sport related), Functional Limitation = 14 (12 sport-related and 2 non-sport related), Disability = 15 (10 sport-related and 5 non-sport related), and Societal Limitation = 7 (1 sport-related and 6 non-sport related). **Conclusion:** We designed and developed a region specific patient self-report scale for the assessment of HRQOL of throwers with arm injury called the Functional Arm Scale for Throwers© (FAST©). The next stages of development should include field-testing for final item reduction and subsequent assessment of the scale's measurement properties.

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**Development Of The Physical Activity Attitudes Response (PAAR) Inventory**

Scott CB, Mack MG, Ragan BG, Herrmann SD: Behavioral Measurement Research Laboratory, University of Northern Iowa, Cedar Falls, IA

**Context:** The term "mental toughness" can refer to the ability to cope with competition, training, and the demands of a physically-active lifestyle. It is a psychological advantage that allows one to remain focused, determined, and confident. These same attributes may contribute to a patient's successful completion of a therapeutic exercise regime. Mental toughness might be a critical factor in physical activity levels during rehabilitation, specifically, adherence to a therapeutic exercise program. **Objective:** To develop a pencil-and-paper measure of mental toughness as it relates to attitudes toward physical activity. **Design:** Cross-sectional survey. **Setting:** University classroom. **Patients or Other Participants:** A total of 202 participants (mean±SD; age= 21.5±3.5years) volunteered for the study (males $n$ = 111; females $n$ = 89). **Interventions:** The Physical Activity Attitudes Response (PAAR) inventory was created by modifying the MeBTough, which examines mental toughness in a competitive sport setting. Participants were asked to complete the PAAR, which took approximately 5-10 minutes during physical education classes. The participants' responses were compiled and analyzed using the Rasch Rating Scale Model. After calibration, item difficulty and participants' ability were placed on a common metric. **Main Outcome Measures:** Model-data fit for the items was evaluated using infit and outfit statistics (>0.5 and <1.5). A Wright item-person map was used to assess if alignment of the item difficulties and persons' ability estimates were a match. Response categories were analyzed for order and to ensure that each response option was the most probable at some point on the metric. **Results:** The model fit the data well with 41/43 items having acceptable infit/outfit statistics. The two items that did not fit were "balance work and rest" and "physical activity exceed coping capacity" with infit and outfit statistics of 1.6 and 1.9, respectively. The Wright item-person map showed an acceptable alignment between item difficulty and person abilities with little variation in ability estimates' conditional standard error of measure (CSEM = .26 ± 03 logits), indicating equal discrimination. The two easiest items were "heat of battle" (difficulty ± SE; -1.44 ± .14 logits) and "commit 100% to battle" (-.93 ± .13 logits). The two most difficult items were "optimal state during stress" (1.57 ± .11 logits) and "emotional shifts don't bother me" (1.17 ± .11 logits). The mean participant ability estimate was 1.49 ± 1.06 logits, where a higher score represents higher ability. The response categories were ordered and each response option was the most probable on the metric. **Conclusions:** Results of this study provide initial psychometric support for the new 41 item PAAR inventory. The significance of the PAAR is that it may assist exercise specialists when developing physical activity programs.

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**Validity And Reliability Of The Online Assessment Of Athletic Training Education Outcomes Content-Knowledge Test Items**

Carr W, Frey BB, Swann E: The University of Kansas, Lawrence, KS

**Context:** Administrators, accreditors, and legislators are increasingly requiring education programs to provide evidence of education effectiveness. Prospective students and their parents are increasingly shopping around and comparing programs before deciding which institution to attend. Various outcome measures are collected by Athletic Training Education Programs (ATEPs) without common methods that would allow for comparison. An online instrument was created to longitudinally track various end-of-the-road education outcomes for ATEPs using a standardized methodology. A content-knowledge exam was created as one measure of program success. **Objective:** The purpose of this study was to explore the validity and reliability of the content-knowledge exam items. **Design:** An exploratory study was conducted to determine the functionality of the instrument. A descriptive study was conducted to test the validity and reliability of the content-knowledge items. **Setting:** Accredited ATEPs. **Participants:** Over the first two years of initial development, a sample of convenience yielded 83 ATEPs registered to participate. Of those registered (n = 44, 25 state and 19 private institutions, average university enrollment was 10,220 ± 11,169 students, average tuition was $14,189 ± $9,136) 53% had students that completed the entire assessment. 808 students were enrolled and of those enrolled (n = 297, 113 males, 184 females; 22.6 ± 2.15 years) 36.8% completed the entire assessment. **Data Collection and Analysis:** Data was collected with a web-based survey utilizing XHTML web page code and stored in a Microsoft© Access™ database. Responses to each content-knowledge item were collected for each student. Data analysis was conducted utilizing Microsoft© Excel™ and SPSS 15.0. **Results:** An advisory board of educators from around the nation was recruited to provide input on the methodology and to provide an argument for face validity of the instrument. Content validity for the items was based upon the National Athletic Trainers' Association - Education Council's Educational Competencies. Items were created for each of the 12 domains. A discrimination index was calculated for each item as a measure of validity (range of -.01 to .41, mean=.21± .09). As a measure of reliability, coefficient alphas were calculated for each subscale (alpha=.23 to.44), and for

the entire pool of items (alpha=.84). A difficulty index was calculated for each item as a measure of reliability (range of .03 to .09, mean= .74±.25). **Conclusions:** The results indicated that the item pool had very low internal reliability for each domain but the single-scale internal reliability analysis for the entire item pool yielded a much higher level of reliability. The next phase of the project will develop a test blue print based upon the 12 domains with additional weighting of each identified sub-domain. We believe that this revised blue print will increase the internal reliability within each domain.

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**Intra- And Intertester Reliability Of Computer Aided Lateral Digital Photography Goniometry At The Knee Joint**

Berry DC, Miller MG, Berry LM: Weber State University, Ogden, UT, and Western Michigan University, Kalamazoo, MI

**Context:** Clinicians normally employ standard goniometry (SG) to assess joint range of motion (ROM). A new method of measuring knee ROM using Computer Aided Lateral Digital Photography Goniometry (CALDPG) has demonstrated a significant linear relationship between SG and CALDPG knee measurements suggesting that CALDPG may be a viable option for assessing knee ROM. **Objective:** The purpose of this study was to determine intra- and intertester reliability of CALDPG measurements for active knee flexion (KF) and extension (KE) on healthy subjects. **Design:** Test-retest reliability study. **Setting:** Athletic training laboratory. **Patients or Other Participants:** Lateral digital photos of KF and KE from 47 subjects, 25 males and 22 females (age, 21.7±3.8 years; height, 172.2±10 cm; mass, 71.9±19.2 kg) free of lower extremity injuries and pain for six months were analyzed by three testers. **Interventions:** Subjects were placed supine for a single session measurement of KF and KE active ROM. To control measurement error, a polyvinyl chloride (PVC) frame was placed at the pelvis to maintain a 90° hip joint angle. Stickers were placed over the following bony landmarks; greater trochanter, lateral epicondyle, and fibula head. Subjects were instructed to maximally flex and extend the knee joint. A digital photograph of each maximal joint position was taken and downloaded to a laptop computer. Using Jasc Paint Shop Pro 6.0ä (Ottawa, Canada) 3 testers performed 2 repeated measurements for the 2 knee motions in a counterbalance design. Testers identified each bony landmark's X and Y coordinates by placing a crosshair device on the center of landmark's marker for all subjects. The coordinates were transferred to an Excel file where we applied the Law of Cosines ($a^2 = b^2 + c^2 – (2bc\ CosA) – 180$) to calculate the joint's angle. We used intraclass correlation coefficients (ICC) to determine intra- ($ICC_{3,1}$) and intertester ($ICC_{2,2}$) reliability for KF and KE. The mean value from the 2 trials of each tester were used in the intertester reliability analysis. **Main Outcome Measures:** Knee flexion and extension joint ROM measured in degrees. **Results:** The ICC measurements for intratester reliability values were high, ranging between .9930-.9985 (KF) and .9902-.9997 (KE). Intertester reliability values were also very high, .9985 (KF) and .9986 (KE). **Conclusion:** Results of this study demonstrated that CALDPG has both a very high intra- and intertester reliability when measuring active knee flexion and extension ROM. These results combined with a previous study examining the relationship between CALDPG and SG of the knee suggests that CALDPG is a viable option for assessing active knee ROM. Further research is needed to validate the use of CALDPG for other joint motions and to determine whether SG or CALDPG is more accurate in measuring active knee ROM.

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**Intertester Reliability Of A Semi-automatic Digital Imaging Method To Measure Acute Wound Healing**

Beam JW, Wells S: University of North Florida, Jacksonville, FL

**Context:** Standards to assess acute wound healing are absent in the literature. Several studies have used the measures of wound contraction (WC), chromatic red (CR), and luminance (L) as indicators of healing. **Objective:** To determine intertester reliability of a semiautomatic digital imaging method for assessment of acute wound healing using the measures of WC, CR, and L. **Design:** Controlled, counterbalanced repeated-measures design. **Setting:** Research laboratory. **Patients or Other Participants:** Digital images of standardized, partial-thickness abrasions from 16 healthy volunteers, 10 females and 6 males (age=21.93±1.48years, height =171.29± 8.99cm, mass = 74.41 ± 16.25kg) were analyzed by two testers. **Interventions:** We inflicted four, standardized partial-thickness abrasions on the lateral lower leg of each subject. A film, hydrogel, and hydrocolloid occlusive dressing and no dressing (control) were applied in a counterbalanced technique. Subjects returned on post-wound days 1, 3, 5, 7, 10, and 14 for dressing removal, irrigation, imaging, and dressing replacement. Each imaging session followed standard subject position, camera, and lighting procedures. Three digital images (3008 X 1960 pixels, TIF format) were recorded of each wound. Using Adobe Photoshop CS2 (version 9.0; Adobe Systems, Inc, San Jose, CA), we analyzed 60 randomly selected images (10 from each post-wound day) for WC, CR, and L with standard procedures on separate weeks using the same personal computer. Wound area was determined by manual tracing with the mouse cursor. Wound perimeter was defined as visual differences between the colors of red and pale pink. Following tracing, the selected portion of the image (wound area) was used to calculate an average of each value for red, green, and blue colors. With no visual differences between the colors of red and pale pink, the wounds were considered fully contracted and the center of the original wound was selected for red, green, and blue color values. Using Microsoft Office Excel 2003 (Microsoft Corporation, Redmond, WA), WC (width x height), CR ([100 x red]/[red + green + blue]), and L ([red + green + blue]/3) measurements were calculated. WC, CR, and L measurements from the testers were used for data analysis. Intraclass correlation coefficients and standard error of measure (SEM) were calculated for intertester reliability (ICC 2,k). **Main Outcome Measures:** WC in $cm^2$ and CR and L in red, green, and blue color values. **Results:** Intertester reliability was high for WC (ICC=.87, SEM= 1.15$cm^2$), CR (ICC=.93, SEM=2.64), and L (ICC=.96, SEM=4.78). **Conclusions:** Results demonstrated that the semi-automatic digital imaging method has high intertester reliability when assessing healing of partial-thickness abrasions using WC, CR, and L. While further research is needed, this method may serve as a viable option to assess acute wound healing.

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**Test-Retest Reliability Of Responses To The ImPACT Neurocognitive Program**

Piland SG, Gould TE, Sumrall A, Martin K, Dixon J: The University of Southern Mississippi, Hattiesburg, MS

**Context:** Serial testing of athletes utilizing neuropsychological testing batteries and measures of composite self-report symptoms is a common and recommended practice. This

paradigm serves to facilitate an indication of the athlete's resolution from the concussive insult. With return-to-play decisions in the balance, it is imperative that clinicians understand that these decisions have consequences. As such, it is necessary to provide continued psycho-metric evidence regarding the use of these scores so that clinicians understand the level of confidence they should or should not place upon score inferences. Therefore, information towards the test-retest (stability) reliability of scores is warranted. Ideally, scores should demonstrate high (R=1) stability so that score fluctuation can be attributed to variation in concussive symptoms and not random error variation. **Objective:** The purpose of this study was to analyze the 10-day test-retest reliability of responses used to calculate 5 of the composite scores generated in the ImPACT computer-based neurocognitive testing program. **Design:** This prospective analysis involved two testing sessions separated by 10 days. **Setting:** Data was collected in a laboratory located at a southeastern Division I institution. **Patients or Other Participants:** The group was comprised of healthy, physically active volunteer male students (N=27, age= 21.10±2.0) enrolled in a southeastern Division I institution. **Interventions:** Test subjects were provided informed consent in accordance with requirements from the involved institution and completed a brief health history questionnaire as well as the ImPACT computer-based neurocognitive testing program (version 6.0) on two occasions. The method of Shrout and Fleiss (1,1) was used to calculate 5 intraclass correlation coefficients (ICCs) from composite scores provided by the software. **Main Outcome Measures:** Mean values provided from responses to the ImPACT software. **Results:** Com-posite self-report symptoms ($time_1$= .59±1.11, $time_2$=1.07±2.33) yielded an ICC of (R=.039), memory composite verbal ($time_1$=.91±.08, $time_2$=.89±.09, R=.43), memory composite visual ($time_1$=.78±.13, $time_2$=.76±.14, R=.78), visual motor speed composite ($time_1$=40.61±11.16, $time_2$= 39.93±7.99, R=.91) and reaction time composite ($time_1$=.53±.06, $time_2$=.53±.06, R=.95). **Conclusions:** Evidence of score stability is important towards the clinician's ability to draw appropriate inferences from responses to any of the multi-faceted measures of concussion. Due to the fact that there is no single biological marker for the injury, researchers must continue to evaluate the measurement properties of individual facets of test scores. Low score stability, as indicated for the composite symptoms and memory composite verbal scores of the ImPACT program, suggest that clinicians should continue to utilize a multi-faceted approach and understand the effects of poor measurement properties upon score inferences. In the same respect, high score stability, as demonstrated in memory visual, visual motor speed, and reaction time composites, provide support for reliable score interpretations.

# Free Communications, Oral Presentations: Effects of Physical Agents on the Motoneuron Pool

Wednesday, June 18, 2008, 8:15AM-9:15AM, Room 274; Moderator: J. Ty Hopkins, PhD, ATC

**A Menthol Counterirritant Does Not Facilitate The Quadriceps Motoneuron Pool In Healthy Subjects**

Huffman DH, Pietrosimone BG, Grindstaff TL, Hart JM, Saliba SA, Ingersoll CD: University of Virginia, Charlottesville, VA

**Context:** Cryotherapy has been reported to facilitate motoneuron pool excitability in inhibited and healthy subjects. Cryotherapy induced motoneuron pool facilitation has been theorized to be due to stimulation of thermoreceptors surrounding a joint. It is unknown whether menthol counterirritants, which also stimulate thermoreceptors, have the same effect on motoneuron pool excitability. **Objective:** To compare quadriceps motoneuron pool excitability following a menthol counterirritant application to the anterior knee, a sham counterirritant application, and a control treatment in healthy subjects. **Design:** A blinded, randomized controlled trial. **Setting:** A controlled laboratory. **Participants:** Thirty healthy, subjects (16 males, 14 females; age= 24.1 ± 3.9; height = 170.6 ± 11.4 cm; mass = 72.1 ± 15.6 kg) with no history of lower extremity surgery volunteered for this study. **Intervention:** The independent variables included treatment group and time. Subjects were randomly assigned to 1 of 3 groups including menthol application, sham menthol application, or control. The sham product, manufactured specifically for this study, was of similar texture and smell but did not contain menthol. Approximately 2 mL of the menthol or sham counterirritant was lightly massaged into the skin of the anterior knee for approximately 1 minute by a certified athletic trainer, while subjects in the control group sat quietly for 1 minute. A towel was then applied to the top of the knee to blind the investigator to the treatment. Measurements were taken at 5 separate times including baseline, 5, 15, 25 and 35 minutes post initial treatment application. A 3x5 repeated measures, mixed model ANOVA was used to determine group differences over time, with an *a priori* level of $P < .05$. **Main Outcome Measures:** The $H_{max}$:$M_{max}$ ratios of the vastus medialis were used to estimate motoneuron pool excitability of the quadriceps at baseline, 5, 15, 25 and 35 minutes post initial application. **Results:** $H_{max}$:$M_{max}$ ratios for all groups significantly decreased over time ($F_{4,108} = 10.52$, $P < .001$) (menthol: baseline =.32 ±.20, 5min=.29 ±.18, 15min=.27 ±.18, 25min=.28 ±.19, 35min=.27 ±.18; sham: baseline =.46 ±.26, 5min=.36 ±.20, 15min=.35 ±.19, 25min=.35 ±.20, 35min=.34 ±.18; control:baseline=48 ±.32, 5min=.37 ±.27, 15min=.37 ±.27, 25min=.37 ±.29, 35min=.35 ±.28). There were no significant differences ($F_{2, 27} = 0.62$, $P = .55$) in $H_{max}$:$M_{max}$ ratios between groups or a significant group x time interaction ($F_{8,108} = .65$, $p = .74$, $1-\beta = .29$). **Conclusions:** Menthol did not have a facilitory effect on the quadriceps motoneuron pool excitability of healthy subjects over time. It is possible that increased motoneuron pool excitability reported following cryotherapy is not only caused by stimulated thermoreceptors, but also by mechanoreceptor stimulation not associated with menthol application. *Master's Student Award Finalist*

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**Focal Knee Joint Cooling Facilitates Quadriceps Motor Neuron Pool Excitability In Healthy Subjects**

Pietrosimone BG, Hart JM, Ingersoll CD: Exercise and Sport Injury Laboratory, University of Virginia, Charlottesville, VA

**Context:** Focal knee joint cooling has been reported to disinhibit/facilitate the motor neuron pool excitability of inhibited quadriceps. Little evidence exists regarding if knee joint cooling-induced increases in motor neuron pool excitability will translate to increased ability to activate the quadriceps musculature during dynamic activities, such as a knee extension. **Objective:** Our objective was to investigate if a 20-minute cryotherapy treatment would increase the area under the electro-myographical (EMG) spectral curve (*f*EMG) change scores for the vastus lateralis (VL) and rectus femoris (RF) during a maximal voluntary isometric contraction (MVIC) in healthy subjects. **Design:** Crossover. **Setting:** A controlled research laboratory. **Patients or Participants:** Eleven healthy volunteers (6m/5f, age= 25 ± 5yrs; ht= 171 ± 10cm, mass= 77 ± 21kg) were included in the analysis. **Interventions:** Independent variables included treatment groups and time. Order of the two treatment groups were counterbalanced and completed 3 - 14 days apart. Groups included a joint cooling intervention consisting of two 1.5L ice bags applied to the knee joint for 20-minutes and a control. Measurements were taken four separate times (Baseline, 20, 30 and 45 minutes post intervention application) as subjects performed maximal isometric knee extensions at 70° of knee flexion. A 2x2 repeated measures ANOVA was used to determine group differences over time, with an *a priori* level of $P \leq .05$. **Main Outcome Measures:** The primary outcome measure evaluated during the time series was *f*EMG determined by extracting a 15ms time epoch of EMG signal during a MVIC. The time signal of the EMG was transformed into the frequency domain using a Fast Fourier Transformation. The area under the spectral frequency curve was used to estimate motor neuron activation. **Results:** There were significant main effects for time ($F_{2,20} = 7.27$, $P=.004$), and condition ($F_{1,10} = 8.75$, $P=.014$) for the VL muscle only. Post hoc t- tests revealed that change scores for VL *f*EMG were significantly greater in the cryotherapy session than the control session at 20-minutes (10.69±13.2 vs. -16 ±24.00; $t_{10} = 2.609$, $P=.026$) and 45-minutes post cryotherapy (2.76 ±19.28 vs. -24.06±27.88; $t_{10}10 = 3.234$, $P=.009$) and trended to be higher at 30–minutes post intervention (7.39±18.46 vs. -9.26± 20.41; $t_{10}=1.976$, $P=.076$. **Conclusions:** Individual motor units are hypothesized to fire with specific frequencies; therefore evaluating the EMG in the frequency domain allows us to assess alterations in the amount of activated motor units. Using the interpretation that the increase in *f*EMG represents an increase in the amount of motor neurons activated in performing a task, we conclude that a 20-minute knee joint cooling intervention facilitates the VL motor neuron pool at 20 and 45 minutes post intervention in a healthy population.

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**Influences Of Cryotherapy On Motorneuron Pool Excitability In Subjects With Chronic Ankle Instability**

McVey ED, Hertel J, Taylor AG, Ingersoll CD: University of Virginia, Charlottesville, VA

**Context:** Subjects with chronic ankle instability (CAI) have been previously reported to have a decrease in the H:M ratio of the soleus and peroneals indicating they have muscle inhibition. Cryotherapy has been reported to increase motoneuron pool excitability but its effect on CAI patients has not been previously investigated. **Objective:** To examine the effect of 20-minutes of cryotherapy on percent changes in the H:M

ratio of the soleus and peroneals compared to no intervention in healthy subjects and those with unilateral CAI at baseline, and at 5, 10, 15, and 20-minutes. **Design:** 2x2x5 mixed model cohort study where subjects served as their own controls. **Setting:** Laboratory. **Patients or Other Participants:** 20 subjects (9 CAI (4 male; 5 female; age= 23.1 ± 3.7 years; height= 157.37 ± 33.2 cm; mass= 70.25 ± 12.38 kg; FADI=85.8%; FADI sport=68.75% and 11 healthy (4 male, 7 female; age=22.09±2.59 years; height= 166.6 ± 07.9 cm; mass= 69.39±10.93 kg) volunteered. Subjects in the CAI group reported unilateral CAI using the Foot and Ankle Disability Index (FADI) (≤90%) and subjects in the healthy group had no history of lower extremity injury. **Interventions:** Subjects were randomized to a treatment order (cryotherapy or control first). The Hmax:Mmax ratios for the soleus and peroneals were acquired at baseline, and at 5,10,15, and 20-minutes for each condition. The bootstrap method for data analysis was used to evaluate the effects of cryotherapy on the percent change in soleus and peroneal Hmax:Mmax over time. The mean and corresponding 95% confidence interval (CI) were obtained for each data point and a lack of overlap of CIs between groups or conditions represented a significant difference. **Main Outcome Measures:** Percent change of Hmax:Mmax over time. **Results:** Compared to the control condition, there was a significant difference in the percent change of the Hmax:Mmax in the peroneal muscles of the CAI group after cryotherapy at 10-minutes (cryotherapy mean difference=23.47, 95% CI: 18.33-28.61; control=-5.91, -13.3-1.48), 15-minutes (cryotherapy=22.13, 19.56-24.70; control=-20.54, -25.92 to -15.15), and 20-minutes (cryotherapy=6.58, 0.40-12.76; control=-10.30, -17.57 to -3.04). In the peroneals of the healthy group there was a significant difference in the percent change of the Hmax:Mmax after 20-minutes of cryotherapy (21.96, CI: -3.66-47.58) compared to the control condition (-18.01, -26.10 to -9.92). In the CAI group there was an increase in percent change in the Hmax:Mmax of the soleus between cryotherapy and control conditions at 5-minutes (cryotherapy: 3.96, 0.76-7.16, control=-4.96, -7.26 to -0.67), 10-minutes (cryotherapy=4.28, 0.82-7.74, control= -12.79, -20.50 to -5.09), 15-minutes (cryotherapy= 2.48, 0.08-4.87, control=-13.31, -18.99 to -7.63), and 20-minutes (cryotherapy=5.00, 1.64-8.36, control=-9.27, -11.13 to -7.40). There was no significant difference between conditions in the soleus of the healthy group. **Conclusions:** The peroneal and soleus motorneuron pools of subjects reporting CAI was able to be disinhibited during a 20-minute bout of cryotherapy.

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**A 20 Minute Cryotherapy Application Does Not Increase The Vastus Medialis Oblique H:M Ratio In Subjects Following ACL Reconstruction**

Guisbert K, McVey ED, Hertel J, Hart JM, Ingersoll CD: University of Virginia, Charlottesville, VA

**Context**: Cryotherapy has been shown to disinhibit the quadriceps muscle following artificial knee joint effusion; however, the effects of cryotherapy on arthrogenic muscle inhibition have not previously been examined in a clinical population, specifically in patients that have recently undergone ACL reconstruction. **Objective**: The purpose of this study was to compare the effect of a 20 minute cryotherapy session or a 20 minute sham cryotherapy session on the Hmax:Mmax ratio of the vastus medialis oblique over time (measurements taken pre-treatment application, and at minutes 5, 15, 20, 25, and 30 post-treatment application) in subjects 10-14 days post ACL reconstruction. **Design**: A 2 x 6 mixed model randomized controlled trial was used to compare treatment groups across time intervals. The interventions included treatment groups (cryotherapy or sham) and measurement intervals (pre-treatment, and 5, 15, 20, 25, and 30 minutes). The outcome measure was the vastus medialis Hmax:Mmax ratio. **Setting**: University research laboratory. **Patients or Other Participants**: 13 subjects (8 males, 5 females; age = 22 ± 6.5 years, height = 173 ± 9.2 cm, mass = 70.1 ± 13.1 kg.) with unilateral ACL reconstruction volunteered for this study. **Intervention(s)**: Subjects (8 Cryotherapy, 5 sham) received either a 20 minute cryotherapy or a 20 minute sham cryotherapy treatment (thermal neutral "candy corn" in a plastic bag) to the affected joint. Hmax:Mmax ratios were acquired at 6 intervals (pre-treatment, 5, 15, 20, 25, and 30 minutes). Hmax:Mmax data were collected using a BIOPAC MP150. The average of 3 maximal H-reflexes at the same intensity and the average of 3 maximal M responses at the same intensity were calculated and formed into the Hmax:Mmax ratio for each data point. The statistical test employed was a 2 way repeated measures ANOVA. **Main Outcome Measures**: The dependent variable was the Hmax:Mmax ratio percent change from baseline. **Results:** No overall differences were detected in the Hmax:Mmax ratio percent change from baseline over time for either group. No time by group main effect was detected ($F_{1,4}$=.896; P=.474; 1-β=.261) for percent change at Baseline, 5, 15, 20, 25, and 30 minutes (Sham: 0, 11.54±18.38; -5.67± 10.0; -0.67±14.34; 8.74±19.95; -4.01±25.38) (Cryotherapy: 0, -2.67±34.34; -0.29±14.03; 13.51±36.50; 8.55±41.70; -4.35±30.70). **Conclusion**: One 20-minute cryotherapy session does not cause an increase in the H:M ratio of the vastus medialis oblique in subjects who have undergone ACL reconstruction.

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# Free Communications, Oral Presentations: Clinical Application of Heat and Cold

Wednesday, June 18, 2008, 9:30AM-11:15AM, Room 274; Moderator: Stephen J. Straub, PhD, ATC

**Moistness Level Of Hot Pack Covers Does Not Effect Anterior Thigh Temperatures**

Ellis SC, Priddy ML, Demchak TJ, Brucker JB, Huxel K: Indiana State University, Terre Haute, IN

**Context:** Clinicians often re-use hot pack covers throughout the day. The covers may not fully dry between patients and therefore be somewhat moist. Moisture help conduct heat **Objective:** Determine the effect of using a dry versus a moistened hot pack cover (1 terry cloth and 1 towel) on tissue temperatures during and after a 20-minute hot pack treatment. **Design:** Cross-over **Setting:** Laboratory. **Patients or Other Participants:** Sixteen physically-active volunteers (M: 7, F: 9, age: 24.4 ± 3.8 y, ht: 172.6 ± 12.5 cm, mass: 70.5 ± 13.7 kg, skinfold thickness: 23.5 ± 2.7 mm, thigh girth: 54.9 ± 4.5 cm). Volunteers were excluded if reported any circulatory or cardiovascular abnormalities, or had skinfold thickness measures outside 20 – 30 mm. **Intervention(s):** Independent variables were treatment condition (MOIST and DRY) and time (baseline, 10-minutes, 20-minutes during treatment and 10-minutes post, 20-minutes post). Prior to data collection correction equations for all thermocouples were generated. Subjects reported for two sessions, where they rested prone. Once intramuscular temperatures stabilized (± 0.2°C) for 5 minutes the appropriate hot pack treatment was applied. Treatment order was balanced. Each subject

received both DRY and MOIST 20-minute hot pack treatments. MOIST treatment used hot pack covers moistened evenly with 0.23kg of 40°C water, which is based on the moisture retained after 5 consecutive treatments. Hydrocullator water temperature was maintained at 76.2±0.8 °C. All hot packs used for treatments had been in the hydrocullator for at least 24 hours. Two, 2x5 ANOVAs with repeated measures were used to analyze the effect of condition and time on interface and intramuscular temperatures. **Main Outcome Measure(s):** Interface temperature (°C) and intramuscular temperature (°C) of the right anterior thigh 1 cm plus ½ skinfold thickness**. Results:** There was no difference between treatment conditions for both interface (P=0.133) and intramuscular temperatures (P=0.82). There was a main time effect on interface and intramuscular temperature (P<.001). Interface temperatures increased from baseline to 10 min (31.9±1.6 to 41.8±0.7°C). Temperatures decreased from 10-min through 20-min post. Intramuscular temperatures increased from baseline to 10 minutes (35.6°C ± 0.1°C to 36.2°C ± 0.2°C), and continued to 20 minutes (36.8°C ± 0.1°C). There was no difference from 20 minutes to 10 minutes-post and temperatures decreased from 10 minutes-post to 20 minutes-post. **Conclusions:** There are no differences between interface and intramuscular temperatures of the anterior thigh when either a dry or moist hot pack cover is used, nor does the moistness of the covers affect cooling after the removal of the hot pack. Clinicians can use either a dry or moist hot pack covering to achieve the same heating effects during a 20 minute hot pack treatment, therefore a terry cloth cover does not have to fully dry between treatments before being re-used.

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**Effect Of Two Different Athletic Short Barriers On Interface And Intramuscular Temperatures Following Exercise**

Lange T, Diehl R, Brucker JB, Demchak TJ, Huxel KC: Indiana State University, Terre Haute, IN, and Southern Illinois University at Edwardsville, Edwardsville, IL

**Context:** Athletes often place ice bags over their shorts, despite the negative effect barriers have on cooling. New athletic apparel such as Under Armour claims an increased capacity to help remove heat. Currently, the only athletic short tested as a barrier during focal cooling has been 100% nylon. **Objective:** Compare the effect of Under Armour, nylon shorts, and no barrier on thigh interface and intramuscular cooling using an ice bag following exercise. **Design:** Crossover. **Setting:** Laboratory. **Participants:** Seventeen healthy volunteers (M: 12, F: 5, age: 22.2 ± 3.5 y, ht: 175.1 ± 9.1 cm, mass: 76.7 ± 16.5 kg, right leg skinfold thickness: 20.5 ± 5.5 mm, left leg skinfold thickness: 20.7 ± 5.5 mm) with no lower extremity injuries 3 months prior, circulatory or cardiovascular abnormalities, or cold allergies. **Intervention(s):** Independent variables were barrier condition [no barrier (NoB), nylon short (NS), and Under Armour (UA)] and time (Pre-ice bag, 1-, 5-, 15-, 30-, and 45-minutes during ice bag treatment). Subjects reported for two sessions. After treadmill running for 15-min at 80-85% of their age-predicted MHR while wearing either Under Armour or nylon athletic shorts, they quickly lay supine while thermocouples were inserted. Thereafter, a 1-kg ice bag was secured to each leg for 45 minutes. One ice bag was applied over the shorts while another ice bag was applied to the skin of the contralateral leg, simultaneously. Treatment order was counterbalanced. Two 3 x 6 repeated measures ANOVAs were used to determine the effects of treatment and time on interface and intramuscular temperatures, separately. **Main Outcome Measure(s):** Intramuscular (2 cm plus ½ the superficial tissue thickness) and interface temperatures of the anterior thighs to the nearest 0.1°C. **Results:** Interface temperatures decreased ($P$<0.001) over time for all conditions (NoB 30.8±1.7 to 3.1 ± 2.1°C; NS 30.5 ± 2.3 to 8.2 ± 2.9°C; UA 30.7 ± 1.8 to 6.7 ± 2.8°C) . The main effect for barrier condition (P<0.001) indicated that NoB interface temperatures were 8.25, 4.8, and 4.35 °C colder than NS and UA conditions at the 5-, 30-, and 45- minute time intervals, respectively. There was a 7°C difference ($P$<.001) between NoB and NS at the 15-minute interval. There was no difference between NS and UA conditions at the 5- ($P$=.6), 30- ($P$=.052), and 45- minute ($P$=.12) time intervals. Barrier condition had no effect ($P$=.182) on intramuscular temperatures. However, intramuscular temperatures decreased ($P$<.001) over time from 38.0 ± 0.15 °C to 30.4 ± 0.81 °C. **Conclusions:** Although neither athletic short barriers affected the ice bag's ability to remove muscle heat, they did slow surface heat removal post-exercise, as well as overall cooling. Thus, depending on treatment goals these barriers may or may not be detrimental.

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**The Effect Of Lower Extremity Ergometry on Deltoid Interface And Intramuscular Temperatures During And After A 30-Minute 1-Kg Ice Bag Treatment**

Takeuchi S, Brucker JB, Demchak TJ, Huxel KC, Edwards JE: Indiana State University, Terre Haute, IN

**Context:** It is known that muscle activity prior to, during, and following focal ice bag treatments affect cooling efficacy differently. This knowledge does not provide insight into the practice of stationary cycling for cardiovascular benefits, while applying an ice bag to the upper extremity. **Objective:** Determine the effect a 60 to 65% $VO_{2max}$ lower body exercise has on interface and intramuscular deltoid temperatures during a 30-minute 1-kg ice bag treatment and 30-minutes following treatment. **Design:** Counter-balanced experimental. **Setting:** Laboratory. **Participants:** Twenty physically-active, volunteers (M: 15, F: 5, age: 22.5±2.7y, ht: 174.1±9.9cm, mass: 68.4±9.1kg, skinfold thickness: 14.2±3 .5 mm, $VO_{2Max}$: 37.0±9.2ml/kg/min) with no reported extremity injuries 3 months prior, circulatory or cardiovascular abnormalities, allergies to cold, or deltoid skinfold thickness measures outside 5-20 mm. **Intervention(s):** Independent variables were exercise condition (BIKE and REST) and time (baseline, 1-, 10-, 20-, and 30-minutes). During the 1st 30 minutes (during application) a 1-kg ice bag was plastic wrapped to the deltoid during either 30-minutes of stationary cycling at 60 to 65% of $VO_{2max}$ or sitting in a chair. After ice-bag removal, all volunteers sat in, or remained seated, a chair an additional 30 minutes (post application). Exercise condition order was counterbalanced. Two (during cooling and post application) 2 X 5 repeated measures ANOVAs were performed for both interface and intramuscular temperatures, separately. **Main Outcome Measure(s):** Dominant shoulder deltoid muscle interface and intramuscular (1 cm plus ½ the superficial tissue thickness) temperature (°C). **Results:** During application, exercise did not ($P$ = .63) influence interface temperature, which continuously decreased ($P$ < .05) from 33.5 ± 1.2 °C to 6.8 ± 2.7 °C. Likewise, regardless of exercise during application, intramuscular temperature cooled over time (REST 35.8 ± 0.5 °C to 19.4 ± 4.5 and BIKE 35.7 ± 0.4 to 22.4 ± 3.7). However, cycling did ($P$ < .001) affect intramuscular temperature with these temperatures being 1.3°C, 2.7°C, and 3.0°C warmer at the 10-min ($P$ = .05), 20-min ($P$ < .001), and 30-min ($P$ < .001) times. Post application BIKE interface temperatures (5.9 ± 3.6 to 28.1 ± 3.8 °C) increased faster ($P$<.05)

than the REST (7.7 ± 5.8 to 25.7 ± 2.2 °C;) with difference indicated at the 10-min ($P$ < .001), 20-min ($P$ < .001), and 30-min ($P$ < .001) times. Intramuscular temperatures post application warmed similarly (BIKE 22.4 ± 3.7 °C to 29.3 ± 3.6 °C and REST 19.4 ± 4.5 °C to 26.6 ± 2.1°C; $P$ =.48) regardless of exercise condition. **Conclusions:** 30-minutes of stationary cycling at 60 to 65% of $VO_{2max}$ to maintain CV benefits while cooling the deltoid muscles should not be considered contradictory. However, to maximize ice bag effectiveness during and post application the exercise and cooling should be done separately.

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**Effect Of Walking While Cooling The Quadriceps Intramuscular Tissues Following A 20-Minute Bout Of Running**

Compton CJ, Godwin CN, Brucker JB, Demchak TJ, Edwards JE, Huxel KC: Indiana State University, Terre Haute, IN

**Context**: Research shows that resting followed by walking with ice on the calf negates intramuscular (IM) cooling. However, ice "to go" is commonly applied post-practice and activity prior to ice bag treatments reportedly enhances cooling. The combination of applying ice "to go" post exercise and walking during the treatment more closely mimics clinical practice. **Objective**: Examine the effect of walking during a quadriceps ice bag treatment on IM temperature changes following an exercise bout. **Design**: Crossover trials **Setting**: Laboratory. **Participants**: Both quadriceps of 17 physically-active, healthy, volunteers (M: 11, F: 6, age=21.67± 2.5yrs, ht=176.9 ± 7.5cm, mass=74.5 ± 14.1kg, right skinfold= 15.1 ± 7.5mm, left skinfold= 15.1 ± 7.6mm, right girth= 56.6 ± 5.0cm and left girth= 56.5 ± 5.0cm). **Intervention(s)**: Independent variables were activity during treatment (walk or rest), treatment (ice or no ice bag), and time (immediate post-running, and 1-, 10-, 20-, & 30-minutes during cooling). Subjects reported for two sessions during which they all ran for 20-minutes at 70-80% of a Karvoven predicted target heart rate on a treadmill. After running, a thermocouple was inserted into each quadriceps group and a 1-kg ice bag was applied to one of the quadriceps with tensor wrap (49.5 mm Hg). The subjects either walked at a comfortable pace (1.5 ± 0.5 mph) or rested supine during the 30-minute treatment. Data were analyzed using a 2x2x5 ANOVA with repeated measures. Post hoc analyses were 5 separate 2x2 ANOVAs and paired t-tests with Bonferroni correction. **Main Outcome Measure**: Quadriceps IM (2 cm plus ½ skinfold thickness) temperature to the nearest 0.1 °C. **Results**: A significant 3-way interaction was found on IM temperature. Following post hoc analyses, there were no differences in IM temperature immediately post-running (Walk/Ice=37.54 ± 0.52°C, Rest/Ice=37.53 ± 0.62°C, Walk/No ice=37.57 ± 1.16°C, Rest/ No ice=37.72 ± 0.58°C, P > 0.05) or 1-min during cooling (Walk/Ice=37.05 ± 0.76°C, Rest/Ice=37.01 ± 1.34°C, Walk/No ice=37.04 ± 1.34°C, Rest/ No ice=37.52 ± 0.58°C, P>0.05). At 10-min, the ice treatment was cooler than no ice, regardless of whether they were walking or resting (Walk/Ice=34.76 ± 1.74°C, Rest/ Ice=35.73 ± 2.00°C, Walk/No ice=36.77 ± 1.34°C, Rest/ No ice=37.08 ± 0.52°C, P<0.001). At 20-min and 30-min, the walking activity was cooler than the rest activity (P=0.03) and the ice was cooler than the no ice treatment (P<0.001); 20-min: Walk/ Ice=31.86 ± 2.01°C, Rest/Ice=33.56 ± 2.88°C, Walk/No ice=36.47 ± 1.32°C, Rest/ No ice=36.73 ± 0.53°C; 30-min: Walk/ Ice=29.64 ± 2.37°C, Rest/Ice=31.68 ± 3.34°C, Walk/No ice=36.22 ± 1.35°C, Rest/ No ice=36.50 ± 0.56°C. **Conclusions:** Post-exercise, the "to go" application of an ice bag and walking is not detrimental to IM cooling. In fact, walking during and ice treatment may be a more effective method to achieve IM cooling.

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**Effects Of Continuous Circulating Water And Cyclical Compression On Intramuscular And Surface Temperatures**

Trowbridge CA, Davis DR, Womochel KS, Ricard MD: The University of Texas at Arlington, Arlington, TX

**Context:** Tissue cooling with different cryotherapy modalities including continuous circulating water and constant or cyclical compression. **Objective:** To investigate the effects of continuous circulating water and cyclical compression on muscle and skin temperature in the distal quadriceps after a 30 minute treatment and 30 minute re-warming. **Design:** Two 4 X 6 (treatment x time) crossover repeated measure designs. Alpha was set *a priori* at 0.05. **Setting:** Neuromuscular Research Laboratory. **Patients or other Participants:** Eight male and eight female (n=16) volunteers (age = 22.1±3.7 yrs; mass = 72.3±15.9 kg) with quadriceps skinfold between 10-30mm. **Interventions:** Four counterbalanced treatments including two ice bags and compression, Polar Care® and compression (PC), Game Ready™ with sleeve no additional compression (GR), Game Ready™ with sleeve and automatic cyclical compression(5-50 mm Hg)(GRC) and time (5,10,15,20,25,30 minutes). A thermocouple inserted 1.5 cm below subject's subcutaneous adipose tissue sampled intramuscular temperature and a skin thermocouple sampled surface temperature. Thermocouples were interfaced to a desktop computer through an Isothermex®. Each ice bag had 2 L of crushed ice, Polar Care® and Game Ready™ coolers were filled to maximum capacity with water and 4 L of crushed ice. The Game Ready™ knee sleeves were secured via Velcro sleeve. Six-inch double elastic wraps secured the ice bags and Polar Care® knee pads. The amount of compression with the elastic wraps was standardized (pressure between 20-30 mmHg) using a blood pressure bladder between the skin and the elastic wrap. Patients recorded cooling sensations on Visual analog scales (VAS) (0=no cold & 10=very cold) at 5-minute intervals. Data were analyzed with separate repeated measure ANOVAs. **Main Outcome Measures**: Intramuscular (IM) temperature changes (°C) from baseline for 30 minute treatment and IM changes (°C) from end of treatment for 30 minute re-warming. VAS scale (cm) measures for all 5 minute intervals. **Results:** Mean±SE IM temperature changes from baseline at 30 minutes were -5.9±0.6°C (ice bags), -4.3 ±0.57°C (PC), -3.6±0.37°C (GR), -5.1 ±0.47°C (GRC). At 25 and 30 minutes the GRC and ice bags cooled more than PC and GR ($p$<0.05). GRC was not colder than ice bags ($p$>0.05). PC perceived cooling was significantly less than GRC or ice bags ($p$<0.05) at all time points. Continued IM cooling occurred, mean±SE IM temperature changes at 30 minutes of re-warming from the post treatment temperature were -0.63 ±0.45 °C (ice bags), -0.32±0.25 °C (PC), -1.24±0.2 °C (GR), and -0.89±0.37 °C (GRC). GR continued cooling more than ice and PC ($p$>0.05) and GRC more than PC ($p$>0.05). **Conclusion:** Type of compression and cooling delivery affected the temperature outcomes. Cyclical compression may have added benefit to cooling when continuous circulating water is applied through knee pad. Therefore, more research needs to be done to determine application parameters for these types of modalities.

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**Ultrasound Heating Of The Achilles Tendon: A Comparison Of Direct And Indirect Application Techniques**

Rubley MD, Peluaga MN, Mendoza J, Threat J, Holcomb WR, Tritsch AJ, Tandy RD: Athletic Training Research Laboratory, University of Nevada, Las Vegas, Las Vegas, NV

**Context:** Ultrasound may be applied directly with gel or indirectly using either a gel pad or immersion of the area in water. It has been

shown that the gel and gel pad applications are equal in the heating of the lateral ankle. What remains unknown is if the heating is equal in a tendon when using direct and indirect applications. **Objective:** To determine temprature rise in an Achilles tendon during a 5-minute 3 MHz ultrasound treatment at 100% duty cyle at 1.0 W/cm$^2$ using direct and indirect coupling medium. **Design:** A randomized control study with repeated measures. **Setting:** The data were collected in a controlled laboratory setting. **Patients or Other Participants:** Eighteen healthy subjects (11M, 7F, age: 24.6 ± 5.0yrs, ht: 172.2 ± 10.9cm, wt: 74.9 ± 16.9kg), with no history of Achilles injury in the previous 6 months. **Interventions:** The independent variable was coupling technique (ultrasound gel, a gel pad (gel on the top and bottom), and immersion in distilled water at skin temperature) and the dependent variable was tendon temperature. A thermocouple was laterally inserted via a 21 gauge needle to a frontal plane depth of ½ the thickness of the left Achilles tendon, 2cm superior to the calcaneus, and 5mm below the skin surface in the sagittal plane. Subjects rested on a plinth for 15 min before onset of treatment. All 3 ultrasound treatments were completed in one session. Between applications, subject's temperature return to baseline was defined as a return to pretreatment temperature followed by no change (>0.1 ºC) in tissue temperature in 1 minute. The treatment area was an area controlled by a template twice the size of the 2cm$^2$ sound head over the distal portion of the Achilles tendon. A metronome was used to ensure even application of ultrasound at 4cm/s. The direct technique was applied with sufficient amount of gel, the gel disk treatment was applied with gel on both sides and the immersion was applied using distilled water heated to the subject's skin temperature. **Main Outcome Measures:** Temperature changes in the Achilles tendon with direct and indirect applications of ultrasound. **Results:** Initial temperature for each coupling medium was (28.8°±1.37°). Average temperature increases during the 5-min ultrasound treatments were: gel (10.9°±2.9°), disk (8.7°±1.8°), and water immersion (9.3°± 2.9°). There was a significant interaction between coupling medium and time during ultrasound treatment (F=6.123, p=.024). At the conclusion of treatment (5 min) gel resulted in a higher tendon temperature compared to disk (p=<.001) and water (p=.002). No difference was found between disk and water coupling mediums at 5 min. **Conclusion:** To maximize the heating of Achilles tendon a direct method of coupling should be utilized.

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**Development Of An Acute Injury Model In Humans**

Hawkins JR, Knight KL, Rich BSE, Millward C, Cassat D: Brigham Young University, Provo UT, and Utah Valley Sports Medicine, Intermountain Health Care, Provo, UT

**Context:** A suitable injury model that produces a consistent injury is needed to evaluate the effectiveness of therapeutic modalities for the treatment of acute soft-tissue injury. **Objective:** Develop a model to induce a bruise that will enable scientists to research the effects of various therapeutic modalities on healing. We hypothesized that individuals would bruise the same with no differences in pain associated with the trauma. **Design:** Repeated measures. **Setting:** Laboratory. **Participants:** 14 college age volunteers (M: 6, F: 8; age: 22.4±1.9yrs; weight: 79.7±19.3kg; height: 175.3±11.2cm). **Interventions:** On 2 occasions separated by 3 weeks, participants were hit in the distal hamstring with a tennis ball fired from a tennis ball machine at ~31m/sec from 45.7cm. Digital pictures were taken of the trauma site immediately before and after, and on days 1, 2, 3, 4, 7, and 9 post trauma. Participants reported pain on a 100m visual analog scale immediately after contact, at 5, 10, 15, 20, 25, and 30 minutes post trauma, and on each day pictures were taken. **Main outcome measures:** Pain was self-reported using a 100mm visual analog scale. Luminance (homogeneity of color) and chromatic red (percentage of red in overall color) were computed from average red, blue, and green pixel counts from normalized 100 pixel count pictures. These values were determined using Bersoft Image Measurement Software. Luminance increases and chromatic red decreases as tissue heals. Data were analyzed using repeated measures ANOVA, followed by Bonferroni post hoc analysis, a£0.05. **Results:** Pain (($F_{1,169}$)=.137, *P*=.711) and chromatic red (($F_{1,74}$)=3.347, *P*=.071) did not differ between trials. Initial pain values, 64.6 ± 12.5 out of 100 for trial 1 and 61.0 ± 19.4 out of 100 for trial 2, decreased to single digits within 10 minutes (5.5 ± 9.0 out of 100 and 6.5±13.5 out of 100 respectively). Chromatic red values ranged from 28.3 ± 4.5 – 30.1 ± 5.0 for trial 1 to 27.5 ± 4.2 – 28.4 ± 5.0 for trial 2. Luminance did differ between trials (($F_{1,85}$)= 10.687, *P*= .002). Luminance values ranged from 103.9±15.4–114.4±16.1 for trial 1 to 114.5±17.3–121.3±16.6 for trial 2. **Conclusions:** Using a tennis ball and a tennis ball machine, we produced a readily identifiable and measurable superficial bruise, with minimal pain, that completely resolved in 10 days without treatment. Further efforts need to be made to address the homogeneity disparity we believe this is related to using female participants and the fluctuations associated with the menstrual cycle over a 5-week period. Bruising participants twice on one occasion using both limbs will be investigated to address this issue.

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## Special Interest Group #2: Clinical Trials in Therapeutic Modalities

Wednesday, June 18, 2008, 11:30AM-12:30PM, Room 274; Discussants: Craig R. Denegar, PhD, ATC, PT, and Mark A. Merrick, PhD, ATC; Moderator: Sarah Brown, MS, ATC

**Comparison Of Core Body Temperature As Assessed By Rectal And Aural Thermometry In Hyperthermic, Exercising Individuals: A Meta-Analysis**


Huggins RA, Glaviano NR, Negishi N, Casa DJ, Hertel J: University of Virginia, Charlottesville, VA, and University of Connecticut, Storrs, CT


**Context:** Recent position statements by multiple sports medicine organizations have recommended the use of rectal thermometry over aural (tympanic) thermometry for the assessment of core body temperature in athletes suspected of having exertional heat illness. There are, however, some discrepancies in the literature regarding the differences in values obtained from these two measurement techniques. **Objective:** To perform a meta-analysis to compare the mean differences in body temperature assessed via rectal thermometry and aural thermometry in hyperthermic, exercising individuals. **Data Sources:** Medline, Sport Discus, and CINAHL were searched from their inception until November 2007 using the terms "thermometer", "thermometry", "temperature", "thermistor", "rectal", "tympanic", "aural", "core body temperature", "core temperature", and "exercise". The search was limited to English language studies that utilized human subjects. **Study Selection:** Original research articles which met these criteria were included: 1) concurrent measurement of aural and rectal temperature of subjects either during or after prolonged exercise, 2) mean temperature by at least one measurement technique had to reach at least 38ºC during or after exercise, and 3) means, standard deviations, and sample sizes needed to be reported in the original article or have been provided to us by the original authors after we requested this information from them. **Data Extraction:** Seven articles were included and three independent reviewers scored these articles using the PEDro scale (mean=5.1±0.4). The means and standard deviations for both temperature measurement techniques were compiled at all time intervals reported in the original studies. We divided the data into three time periods for analysis: 1) baseline (pre-exercise), 2) during exercise (range: 30 to 180 minutes), and 3) after cessation of exercise. Not all included studies provided data for each of the three time periods. **Data Synthesis:** Meta-analyses were performed to determine pooled weighted mean differences between rectal and aural temperature assessment in each of the three time periods. For the baseline pre-exercise measures, the rectal temperature was 0.27ºC (95% CI: 0.15º-0.39ºC) higher than the aural temperature (Z=4.44, 95% CI: 4.32-4.56). For the measures during exercise, the rectal temperature was 0.96ºC (95% CI: 0.84º-1.08ºC) higher than the aural temperature (Z=16.08, 95% CI: 15.96-16.20). For the post-exercise measures, the rectal temperature was 0.71ºC (95% CI: 0.65º-0.78ºC) higher than the aural temperature (Z=21.63, 95% CI: 21.57-21.70). **Conclusion:** Rectal temperature was consistently greater than aural temperature when measuring core body temperature in hyperthermic, exercising individuals. The greatest magnitude of mean difference (.96ºC) between the two techniques was found when individuals were engaged in exercise as opposed to pre- or post-exercise. Clinicians should be aware of the differences in temperature magnitude between rectal and aural measurement techniques when assessing core body temperature in hyperthermic, exercising individuals. *Master's Student Award Finalist*

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**Gender Differences In Thermoregulation And Performance During Trail Running In The Heat**


Lopez RM, Casa DJ, Stearns RL, McDermott BP, Ganio MS, Yeargin SW, Decher NR, Scruggs IC, Eckert MT, Christensen KJ, Keegan BP, Mazerolle SM, Armstrong LE, Maresh CM: University of Connecticut, Storrs, CT


**Context:** There is a paucity of data on the influence gender may have on thermo-regulation and performance while running at different intensities and hydration states. Previous researchers have suggested females demonstrate decreased thermoregulatory efficiency compared to males. **Objective:** To determine differences existing between males and females in the ability to thermoregulate while exercising at varying intensities and hydration states. **Design:** Randomized, controlled, counterbalanced crossover design. **Setting:** Field setting (trails) in warm environment (mean ± SD: WBGT: 26.5±2.2°C). **Participants:** Seventeen male (n=9; 27±9yr, 177±5cm, 69.1±5.6kg, 10.2±2.5%fat) and female (n=8; 27±4yr, 164±7cm, 58.6±7.9kg, 19.4± 3.5%fat) competitive, well-trained endurance runners. **Interventions:** Participants completed the following four conditions: a) hydrated/race (HYR), b) dehydrated/race (DHR), c) hydrated/sub-max (HYS), d) dehydrated/sub-max (DHS). On each occasion subjects ran three loops (4km/loop, 12km total) on trails with a four-minute rest between loops. For DHR and DHS dehydration was achieved by fluid restriction for the 12-hr prior and during the run. For race trials, runners were instructed to run as fast as possible with performance incentives. In sub-max trials, subjects ran at a moderate pace that was matched between trials by providing feedback about pace throughout each loop. Gastrointestinal temperature ($T_{GI}$) and heart rate (HR) were continually monitored. Statistical analyses consisted of a one-way MANOVA for percent performance differences and repeated measures MANOVA for all other measures. Significance was set at $p \leq 0.05$. **Main Outcome Measures:** $T_{GI}$, HR, percent body mass(BM) loss, percent performance differences, ratings of perceived exertion(RPE). **Results:** $T_{GI}$ did not differ between genders during any trial ($p>0.05$). Maximum $T_{GI}$ did not differ ($p>0.05$) between HYR(39.45±0.50ºC) and DHR(39.58 ±0.31ºC), but was significantly greater during DHS(39.21±.40ºC) compared to HYS (38.91±.30ºC) ($p=0.005$). Maximum $T_{GI}$ was not significantly different between genders($p>0.05$). HR increased significantly ($p<0.001$) pre- to post-exercise, however there were no differences between genders overall ($p>0.05$). While maximum HR was significantly greater($p=0.037$) for DHR (189±10bpm) compared to HYR (187±8bpm)and for DHS(184±7bpm) compared to HYS(177 ±8bpm) ($p=0.002$), there were no differences in maximum HR between genders ($p>0.05$). Despite significant differences in percent BM losses from pre- to post-exercise for all conditions ($p<0.001$), there were no differences between genders ($p>0.05$). Percent performance deficits between HYR and DHR tended to be greater for females(-6.48%) compared to males(-3.03%) ($p=0.052$); however, there were no differences in pacing for HYS and DHS between genders($p>0.05$). There were no differences between genders in RPE ($p>0.05$). **Conclusions:** Trail running at various intensities and hydration states in a warm environment resulted in significantly increased thermal and physiological strain. Despite previous viewpoints that males and females may differ in their ability to thermoregulate, the present study found no significant differences between genders in thermo-regulatory responses. There was a strong trend toward greater decrements in performance in female versus male runners. *Doctoral Student Award Finalist*

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**Changes In Body Weight Correlate With Changes In Blood Volume After Football Practice While The Orthostatic Hypotension Test Is Not Correlated With Hypovolemia**

Saliba E, Pugh, K, Baker A, Pietrosimone B, Saliba S: University of Virginia, Charlottesville, VA

**Context**: An orthostatic hypotension test (OHT) is used in nursing to clinically determine hydration status of patients and this test has not been reported in an athletic setting. The technique is based on the cardiovascular response to a hypovolemic state. The reduced cardiac output is not adequate to maintain blood pressure when changing positions and there is a reactive increase in heart rate when a person moves from a supine to standing position quickly. Typically, body weight changes of greater than 3% are indicative of dehydration in athletes. Body weight changes are an effective tool if accurate weight is known prior to an exercise condition, but this information may not be available. **Objective:** The purpose of this study is to compare OHT and body weight changes to changes in the blood volume in football players before and after practice. **Design:** Correlational Design. **Setting:** University Athletic Training Clinic. **Patients or Other Participant:** 24 division I college football players (age = 20.82 ± 1.19 years, height = 191± 6.96 cm, mass = 121.6 ± 17.35 kg) volunteered as part of a larger study. **Intervention(s):** All subjects participated on 2 separate occasions during preseason. They were weighed in dry shorts before and after practice. Subjects had blood drawn 2 hours prior to practice and within 30 minutes of completing practice. OHT was measured after practice by first assessing heart rate with the athlete in a supine position. The athlete then stood for 30 seconds and we again measured the heart rate. The OHT was the difference in standing and supine heart rates. Heart rate measurements were taken manually by a certified athletic trainer at the carotid artery for 30 seconds and doubled. Blood samples were analyzed for hemoglobin concentration (Hb), hematocrit (Hct), and serum osmolality. Changes in blood volume (BV) were calculated from Hct and Hb and were reported as percent changes from the baseline value. **Main Outcome Measures:** Correlation of OHT to BV changes, weight changes; correlation of weight changes to BV changes. **Results**: There were no significant correlations between the changes in OHT (15.0±10.6bpm) and BV (0.35±1.8%) ($r^2$= 0.888, $P$=0.223), or changes in weight (2.65±2.7lbs) ($r^2$= 0.095; $P$=0.527). The correlations for body weight changes before and after practice were significantly correlated to changes in BV ($r^2$= 0.377; $P$=0.010). **Conclusions:** Although there are other clinical tests that may indicate dehydration in athletes, body weight changes remain a good indicator of hydration status as determined by BV. The relatively small changes in BV from football practice may have been too small to influence the OHT or the football players' size or fitness level may have affected the heart rate. Athletic trainers should continue to use body weight changes as an indicator of dehydration. Supported by a grant from University of Virginia General Clinical Research Center NIH grant RR00847

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**A Comparison Of Blood Measures While NFL Players Are Experiencing EAMC And After IV Treatment When EAMC Are Alleviated**

Fowkes Godek S, Bartolozzi AR, Peduzzi C, Burkholder R, Dorshimer G: HEAT Institute at West Chester University, West Chester, PA; Pennsylvania Hospital, Philadelphia, PA; Philadelphia Eagles, Philadelphia, PA; Delancy Medical Associates, Philadelphia, PA

**Context:** Electrolyte imbalances and specifically sodium ($Na^+$) losses have been implicated in exercise associated muscle cramps (EAMC). **Objective:** To measure blood electrolytes, hemoglobin, hematocrit and lactate while players have EAMC and make comparisons to those same measures immediately after IV treatment when EAMC are alleviated, and to compare sweat rate (SwtR), sweat $Na^+$ concentration [$SwtNa^+$] and sweat $Na^+$ losses in these players to matched controls with no EAMC (No-EAMC). **Design:** Observational cohort design. **Setting:** Pre-season training camp of one NFL team. **Patients or Other Participants:** Seven NFL players who sustained EAMC with the following physical characteristics: age=25±3yr, mass=114±24 kg, height=188±6cm, BSA=2.39±0.27$m^2$ and BSA/mass =213±20$cm^2$/kg agreed to participate and were matched with 7 No-EAMC volunteers with age=27±3yr, mass=111±30 kg, height=187±10cm, BSA=2.34±0.34$m^2$ and BSA/mass=216±25 $cm^2$/kg. **Interventions:** Seven cc of blood was drawn from players during EAMC and immediately analyzed. A second blood sample was taken after IV treatment with 1 liter of 9% saline and I liter of ½ saline with 5% dextrose. Blood sodium, potassium and chloride were analyzed by ion-selective electrode, hematocrit by microhematocrit technique, and hemoglobin and lactate by hemoglobin and lactate meters respectively. All 14 players (7 EAMC and 7 No-EAMC) participated in sweat testing during the second week of camp. Sweat samples were collected from sweat patches applied to the upper forearm after the skin was washed with deionized water and dried with sterile gauze. The neat sweat samples were frozen and later analyzed by flame photometry for [$SwtNa^+$]. Sweat rate was calculated as change in mass plus fluids consumed minus urine produced/practice time. Paired t-tests were used for comparisons between pre and post IV blood measures and between EAMC and No-EAMC sweat measures. **Main Outcome Measures:** Blood sodium, potassium, chloride, hemoglobin, hematocrit and lactate, and SwtR, [$SwtNa^+$] and $Na^+$ losses. **Results:** Compared with pre IV there were significantly lower post IV blood measures of sodium (141.8±2.8 versus 138.6± 2.9mmol/l, $P$ = .02), hemoglobin (17.3±1 versus 14.7±1 mg/dl, $P$ = .004), and hematocrit (51±3% versus 44±2% $P$ < .001). Conversely, chloride increased significantly post IV (99±2 versus 104±2 mol/l, $P$<.001) and in 6 of the 7 players was clinically low, < 100 mmol/l during EAMC. There were no differences in lactate or potassium but pre IV potassium ranged from 3.7 – 7.6 mmol/l. There were no differences between EAMC and No-EAMC in physical characteristics, SwtR (1.7±.2 and 1.8±.6 l/h), [$SwtNa^+$] (52±19 and 49±23 mmol/l) or $Na^+$ losses (2109±1203 and 1983±997 mg/h). **Conclusions:** Low blood chloride may be important in the etiology of EAMC, potentially caused by a pathologic anion gap from excessive alkalosis, or by reducing hyperpolarization of the alpha motor promoting hyperexcitability. Hyperkalemia in a concern and EAMC appears to be unrelated to [$SwtNa^+$] or sodium losses.

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# Free Communications, Oral Presentations: Innovations and Directions in Clinical Education

Thursday, June 19, 2008, 1:00PM-2:00PM, Room 274; Moderator: Jennifer Ostrowski, MS, ATC

**Standardized Patients Are Feasible For The Evaluation Of Athletic Training Clinical Proficiencies**

Walker SE, Weidner TG: Ball State University, Muncie, IN

**Context**: Individuals serving as a standardized patient (SP) are trained to consistently portray an injury or illness. Over the past 30 years SPs have been utilized in medical education both for teaching and evaluation purposes. **Objective**: To determine the feasibly of utilizing SPs with athletic training students for evaluating clinical proficiencies. **Design:** Feasibility study. **Setting**: Athletic Training Research and Education Laboratory, On-campus athletic training room, and Clinical Proficiency Evaluation Room. **Patients or Other Participants**: All undergraduate athletic training students in a Midwestern CAATE-accredited ATEP who had completed the lower extremity orthopedic evaluation course in either the fall 2005 or 2006 semesters were recruited to participate in the study. **Interventions**: Twenty-nine (100%) of the participants completed an ankle and knee clinical proficiency evaluations with SPs. **Main Outcome Measures**: The SP Encounter Feedback Form consisted of 7 Likert scale items (1 = strongly disagree-5 = strongly agree) regarding the participants' perceptions of the SP encounter (e.g., worthwhile, authentic, confidence with future SPs and real-time patients, useful SP feedback). Data was analyzed using descriptive statistics. **Results**: 29 (100%) of the participants for the ankle, and 28 (96%) for the knee SP encounters strongly agreed or agreed that the experience was worthwhile. 26 (90%) of the participants for the ankle and 28 (96%) for the knee SP encounters strongly agreed or agreed that the experience was realistic. 26 (90%) of the participants for the ankle, and 29 (100%) for the knee SP encounters strongly agreed or agreed and the challenge presented was appropriate. 29 (100%) participants for the ankle and knee SP encounters strongly agreed or agreed that learning lower extremity evaluations were helped by this experience. 25 (86%) of the participants for both the ankle and the knee SP encounters strongly agreed or agreed that the encounters made them feel more comfortable about future evaluations with standardized patients. 25 (86%) of the participants for both the ankle and the knee SP encounters strongly agreed or agreed that the encounters made them feel more comfortable about future evaluations with actual patients. 27 (93%) of the participants for the ankle and 25 (86%) for the knee SP encounters strongly agreed or agreed that they were provided adequate feedback by the SP on their performance. None of the participants reported any disagreement or strong disagreement with any of the statements on the SP Encounter Feedback Form. All participants successfully passed the ankle and knee clinical proficiencies with SPs. **Conclusions**: It is feasible to utilize SPs to evaluate athletic training clinical proficiencies. Participants felt the experiences were realistic, learned from the experiences, and are more comfortable with future ankle and knee orthopedic evaluations.

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**Athletic Training Approved Clinical Instructors Primarily Utilize Simulated And Real-Time Evaluations For Clinical Proficiency Evaluations**

Weidner TG, Armstrong KJ, Walker SE: Ball State University, Muncie, IN

**Context:** Appropriate evaluation of clinical proficiencies is an essential step in ensuring competence for professional practice. **Objective:** To investigate the various methods Approved Clinical Instructors (ACIs) utilize to evaluate students' clinical proficiencies. **Design**: Cross-sectional. **Setting:** Public and private institutions in NATA District 4. **Participants:** All program directors of athletic training education programs (ATEPs) accredited by CAATE as of April, 2007 in District 4 (n = 81). A total of 44 ATEPs (54.3%) completed the "Institutional" survey, while 135 ACIs completed the "Methods of Clinical Proficiency Evaluation in Athletic Training" (MCPEAT) survey. **Interventions:** Two previously validated surveys were utilized in this follow-up investigation and administered electronically. Phi correlation coefficients determined the measure of agreement on dichotomous questions. Median coefficients were .787 and .609 for the Institutional and MCPEAT surveys, respectively. Pearson correlation coefficients determined the test/re-test reliability for non dichotomous data. Median coefficients were .954 and .635 for the Institutional and MCPEAT surveys, respectively. Descriptive statistics were computed for both surveys. An analysis of variance (ANOVA) and independent t-tests analyzed differences between demographic characteristics of the ACIs and the barriers, methods, educational content areas and settings regarding clinical proficiency evaluation. The alpha level was set at.05. **Main Outcome Measures:** The Institutional survey consisted of 11 items regarding institutional/ATEP demographics/characteristics (e.g., number of ACIs, population of city/town). The MCPEAT survey consisted of 14 items regarding demographic characteristics of the respondents (e.g., practice setting, years of experience as an ACI), and Likert scale items (1 = strongly disagree-5 = strongly agree) regarding clinical proficiency evaluation methods, barriers, educational content areas, and clinical experience settings. **Results:** Simulated (n = 106, 79.7%) and real-time (n= 99, 74.4%) evaluations were the most prevalent methods of clinical proficiency evaluation. Half (55.1%) of the ACIs reported that they feel students engage in a sufficient number of real-time clinical proficiency evaluations to prepare them for entry-level practice. An independent t-test revealed that no clinical experience setting provided more opportunities for real-time clinical proficiency evaluations. The occurrence of injuries not coinciding with the clinical proficiency evaluation timetable ($4.00 \pm 0.832$) was a barrier to real-time evaluation. The assessment and evaluation ($4.36 \pm 0.847$) and therapeutic modalities ($4.30 \pm 0.769$) content areas scored the highest relative to sufficient opportunities existing in each for real-time clinical proficiency evaluations. One-way ANOVAs revealed no significant differences between ACI demographic characteristics and opportunities and barriers regarding real-time evaluations across various clinical experience settings. **Conclusions:** A majority of the clinical proficiencies are being evaluated via simulations and real-time encounters with patients. In order to assure that athletic training students are clinically proficient for entry-level employment, it seems particularly imperative that ATEPs take a disciplined approach to simulated clinical proficiency evaluations.

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**Evaluation Of Athletic Training Clinical Instruction Via The Perceptions Of Various Stakeholders**

Plos JM: Western Illinois University, Macomb, IL

**Context:** Evaluation of the effectiveness of clinical instruction provided by Approved Clinical Instructors (ACIs) is often left to the perceptions of athletic training students. To accurately identify the degree of effectiveness of clinical instruction by ACIs, perceptions of various stakeholders should be incorporated. **Objective:** The purpose of this study was to evaluate the clinical instruction of ACIs via the perceptions of students, peer athletic trainers, and ACI (self) stakeholders. **Design:** Respondents used a 5-point Likert scale to evaluate the clinical instruction of their assigned ACIs based on 7 standards and 50 associated criteria developed by Weidner & Henning (2004). **Setting:** Athletic Training Education Program at a Division I University. **Patients or Other Participants:** Convenience sample: 20 students (87%) and 9 ATCs-ACIs (100% response rate). The student group was comprised of 12 (60%) males and 8 (40%) females, aged 19 to 22 years ($M$ = 21 years). Seventeen (85%) students completed their field experience in a college clinical setting and 3 (15%) students completed their field experience in a high school clinical setting. The ATC-ACI group was comprised of 6 (67%) males and 3 (33%) females, aged 22 to 53 years ($M$ = 29 years). Six (67%) of the ATC-ACIs were GAs and 3 (33%) ATCs-ACIs were full-time staff members. **Interventions:** Of 56 electronically mailed surveys, 53, including 28 student, 16 peer, and 9 self evaluation instruments were electronically returned (95% survey return rate). Descriptive statistics were used to calculate mean scores of the independent stakeholder groups' perceived effectiveness ratings and one-way ANOVAs were performed to determine if there were significant differences between student, peer, and self-perceptions. Cronbach's alpha levels for the comprehensive assessment (0.937) and the individual student (0.895), peer (0.944), and self- (0.936) stakeholder groups indicated high reliability. **Main Outcomes Measures:** Mean scores for student, peer, self, and overall sample stakeholder groups were computed for the overall effectiveness of clinical instruction by ACIs. Mean scores for each stakeholder group and the overall sample were compared to a predetermined clinical instruction effectiveness rating scale (highly effective $\geq$ 4.50; effective = 4.00 – 4.49; ineffective $\leq$ 3.99). **Results:** Student and peer stakeholders perceived overall clinical instruction of ACIs as *highly effective* ($M$ = 4.68, 4.67). ACIs perceived their own clinical instruction as *effective* ($M$ = 4.47). Overall, there were no significant differences ($p < .05$) between student, peer, and self-perceptions. **Conclusions:** Student, peer, and self-evaluations can be used as reliable assessment tools in determining the overall effectiveness of clinical instruction provided by ACIs. Student, peer, and self-evaluations should be part of overall programmatic assessment practices.

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**Incidence Of The Foundational Behaviors Of Professional Practice In Entry-Level Athletic Training Student Clinical Education**

Jordan KI, Doherty-Restrepo JL, Tripp BL, Odai ML: Florida International University, Miami, FL

**Context:** There is no standardized assessment tool available to athletic training educators to evaluate the professional behaviors of athletic training students (ATS). Therefore, it is difficult to recognize, address, and correct behavioral deficits before the ATS becomes a certified athletic trainer. **Objective:** To determine the frequency ATSs incorporate the Foundational Behaviors of Professional Practice of the *Athletic Training Educational Competencies* into practice using the Abilities-Based Assessment (ABA); compare professional behaviors among ages, education level and gender; and observe the relationship between age and professional behaviors. **Design:** The ABA is a cross-sectional, descriptive survey. **Setting:** Commission on Accreditation of Athletic Training Education-accredited entry-level athletic training education programs. **Patients or Other Participants:** A purposeful, non-random sample of 331 ATSs from CAATE-accredited entry-level athletic training programs recruited through their program directors via e-mail. 208 clinical ATSs completed the survey (age=21.53±2.05y, 51 male, 157 female, 4 freshman, 28 sophomores, 52 juniors, 108 seniors, 16 entry-level graduate students). **Interventions:** The survey queried ATSs regarding their professional behaviors in the academic and clinical settings. Using the web-based questionnaire (Survey-monkey.com, Portland, OR), students assessed how frequently they performed 152 behaviors on a 5-point Likert scale for which 1=rarely, 2=seldomly, 3=occasionally, 4=usually and 5=always (Cronbach's $\alpha$=.839). Researchers utilized SPSS 15.0 (SPSS Inc., Chicago, IL) to perform analyses of variance to compare frequencies in professional behaviors among ages, education level at 2 levels (1-underclassmen [freshman and sophomores] and 2-upperclassman [juniors, seniors and entry-level graduate students]) and between genders. Researchers also used a correlation to observe the relationship between age and professional behaviors. **Main Outcome Measures:** Researchers identified 70 behaviors from the ABA that clearly described one of the seven constructs from the Foundational Behaviors of Professional Practice and categorized them according to construct: (1) Primacy to the Patient; (2) Teamed Approach to Practice; (3) Legal Practice; (4) Ethical Practice; (5) Advancing Knowledge; (6) Cultural Competence; and (7) Professionalism. Students' average score for each construct was used for statistical analyses. **Results:** Students reported frequency of behaviors as "usually" for Primacy of Patient (4.34±.46), Teamed Approach to Practice (4.22±.47), Legal Practice (4.05±.81), Ethical Practice (4.45±.59), and Professionalism (4.16±.64). Students reported "occasional" frequency of behaviors for Advancing Knowledge (3.81±.52) and Cultural Competence (3.99±.60). Upperclassman reported less frequent behaviors in Ethical Practice as compared to underclassmen (4.09±1.32 and 4.61±.33 respectively, p=.021). There were no differences in professional behaviors between genders (p>0.05). As student age increased, frequency of behaviors central to Advancing Knowledge increased (r=.15, p=.027). **Conclusions:** Upperclassman reported less frequency of behaviors regarding the Ethical Practice construct compared to lower classmen. Athletic training students across all education levels reported a mean score less than 4 for the Advancing Knowledge and Cultural Competence constructs, indicating key areas that warrant further investigation.

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## Special Interest Group #4: Integration of Academic & Clinical Athletic Trainers

Thursday, June 19, 2008, 2:15PM-3:15PM, Room 274; Discussants: Matt Gage, MS, LAT, ATC, and R. Williams; Moderator: Paul Plummer, MA, ATC

**A Comparison Of Two Rehabilitation Protocols On Dynamic Stability And Self-Reported Function In Subjects With Chronic Ankle Instability**


Gribble PA, Shinohara J: University of Toledo, Toledo, OH



**Context:** Dynamic stability, as measured with Time to Stabilization (TTS), and self-reported function, as measured with the Foot and Ankle Disability Index (FADI) and the FADI-Sport questionnaire instruments, are diminished in those with chronic ankle instability (CAI). It is not known if TTS and FADI scores can be improved through different forms of rehabilitation. **Objective:** To compare the influence of two rehabilitation protocols on TTS and FADI scores. **Design:** Within-subject, between-groups repeated measures design. **Setting:** Athletic Training Research Laboratory. **Patients or Other Participants:** Thirty-five subjects with unilateral CAI (17 males, 22 females; 19.9±2.0yrs; 174.5±7.9cm; 74.1±10.9kg) volunteered for the study. **Interventions:** Subjects reported to the laboratory for two testing sessions 6 weeks apart during which TTS was assessed with a jump-landing task, and the FADI and FADI-Sport was administered. During the pre and post-test sessions, five trials of a jump-landing task were performed on each leg consisting of a single-leg landing from a double-leg jump height equivalent to 50% of the subject's maximum jump height. Subjects jumped off of both feet from a distance 70cm away from the center of the forceplate, reached up and touched the indicated marker, and landed on the forceplate on a single test limb. The task was repeated for both limbs in a randomized order. Ground reaction forces were used to calculate TTS in the medial/lateral (MLTTS) and anterior/posterior (APTTS) directions. The FADI and FADI-Sport consist of questions that inquire about the level of self-reported instability in the pathological ankle during various physical activities. The scores are reported as a percentage. After the pre-testing session, subjects were randomly assigned to one of 3 rehabilitation groups: Ankle (AR), Knee (KR), or Control/None (NR). Subjects in the AR and KR reported 3 times/week for 6 weeks for supervised rehabilitation according to group assignment. For APTTS and MLTTS, a separate Group (AR, KR, NR) by Time (pre, post) by Side (injured, non-injured) repeated measures ANOVA was performed. For the FADI and FADI-Sport scores, a separate Group by Time repeated measures ANOVA was performed. Significance was set a priori at $p<.05$. **Main Outcome Measure(s):** APTTS, MLTTS, FADI score, FADI-Sport score. **Results:** For the FADI-Sport, a significant Group by Time interaction existed ($F_{2,34}=3.741$; $p=0.036$). Both rehabilitation groups experienced a significant improvement in the reported scores (AR - pre: 78.39 ± 14.22%, post: 88.03 ± 12.56%; KR - pre:71.19±11.03%, post: 84.73 ±14.03%) while there was no significant changes in the NR group (pre:77.55±14.98%, post: 77.08±13.41%). There were no significant relationships observed for APTTS or MLTTS. **Conclusions:** Both rehabilitation protocols were associated with an improvement in self-reported function for these subjects with CAI. Rehabilitation did not significantly influence dynamic stability as measured with TTS. Continued research is needed to determine the best measures of functional outcomes for rehabilitation of CAI.


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**Balance Assessments For Discriminating Between Functional Ankle Instability And Stable Ankles**


Ross SE, Linens SW, Arnold BL: Virginia Commonwealth University, Richmond, VA



**Context:** Center-of-pressure velocity (COPV) and area (COPA) are force plate measures that have detected single leg balance deficits associated with functional ankle instability (FAI), and have predicted ankle sprain injury. Additionally, the number of balance errors with the Balance Error Scoring System (BESS) has assessed single leg balance impairments. However, one measurement (COPV, COPA, BESS errors) might be a more sensitive clinical assessment for identifying balance deficits associated with FAI. **Objective:** The objectives of this study were to: 1) determine the single leg balance assessment (COPV, COPA, BESS errors) that discriminated FAI from stable ankles; and 2) determine a cutoff score for discriminating between FAI and stable ankles. **Design:** Case control study. **Setting:** Research laboratory. **Patients or Other Participants:** Participants in this study included fifteen healthy subjects without a history of ankle injury (166±9 cm, 65±15 kg, 23±5 yr) and fifteen subjects with FAI (172±10 cm, 74±10 kg, 23±3 yr) who reported "giving-way" sensations at their ankle and recurrent ankle sprains with physical activity. **Interventions:** Subjects stood on a force plate, kept their eyes closed, and remained as motionless as possible while standing on a single leg for 20 seconds. Subjects performed three single leg balance trials. Means and standard deviations (SD) were calculated over three trials for each assessment measure. A stepwise discriminant function analysis determined the balance assessment that predicted ankle group membership ($\alpha=.05$). A receiver operating characteristic (ROC) curve determined a cutoff score for identifying balance deficits associated with FAI (asymptotic significance =.05). A cutoff score was determined by the score with the greatest sensitivity and least false positive score (1-specificity). **Main Outcome Measures:** Resultant center-of-pressure velocity vector (COPV), 95th percentile center-of-pressure area ellipse (COPA), and total number of balance errors occurring in 20 seconds quantified balance. The BESS errors included: 1) lifting hands off hips; 2) excessive hip flexion or abduction (>30°); 3) lifting the forefoot or heel; 4) remaining out of testing position; and 5) opening eyes. Greater values for all assessment measures were indicative of poor balance. **Results:** Means (±SD) for the 3 assessment measures were: 1) COPV: FAI=7.84 ± 2.46 cm/s, stable= 6.21 ± 1.48 cm/s; 2) COPA: FAI= 42.28 ± 30.00 $cm^2$, stable= 25.46 ± 17.60 $cm^2$; and 3) BESS errors: FAI= 2.10 ± 1.53, stable= 1.82 ± 2.01. Only COPV significantly contributed to the prediction model (Wilks' lambda=.853, $F_{(1,28)}=4.82$, P=.04). A cutoff score of 6.22 cm/s (COPV) had the greatest sensitivity (.80) and least false positive score (1-specificity=.33) for discriminating between ankle groups (asymptotic significance=.03). **Conclu-sions:** COPV performed better than COPA and BESS errors at discriminating between FAI and stable ankles. Our results are clinically relevant as clinicians can identify balance deficits in individuals with FAI with COPV scores ≥ 6.22 cm/s. Future research should examine the ability of our cutoff score to predict ankle sprains associated with FAI.


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**Effect Of Two Rehabilitation Protocols On Lower Extremity Kinematics During Landing Among Subjects With Chronic Ankle Instability**


Shinohara J, Gribble PA: University of Toledo, Toledo, OH



**Context:** Landing patterns of the lower extremity have been shown to be altered in those with chronic ankle instability (CAI). It is not known if these patterns can be improved

through different forms of rehabilitation. **Objective:** To compare the effect of traditional therapeutic ankle rehabilitation with a rehabilitation protocol focused on knee strength and function in influencing landing patterns in those with CAI. **Design:** Within-subject, between-groups repeated measures design. **Setting:** Athletic Training Research Laboratory. **Patients or Other Participants:** Thirty-five subjects with unilateral CAI (17 males, 22 females; 19.9±2.0yrs; 174.5±7.9cm; 74.1±10.9kg) volunteered for the study. **Interventions:** Subjects reported to the laboratory for two testing sessions 6 weeks apart during which motion of the ankle, knee and hip was assessed during a jump-landing task. The jump-landing task consisted of a single-leg landing from a double leg jump height equivalent to 50% of the subject's maximum jump height. Subjects started 70cm away from the center of the forceplate. Subjects jumped off of both feet, reached up and touched the indicated marker, and landed on the forceplate on a single test limb. Five trials were performed on each limb; the landing leg was randomized. During the dynamic postural control testing, three dimensional kinematics of the ankle, knee, and hip were quantified prior to and at the point of ground impact using an electromagnetic tracking device. After the pre-testing session, subjects were randomly assigned to one of 3 rehabilitation groups: Ankle (AR), Knee (KR), or Control/None (NR). Subjects in the AR and KR reported 3 times/week for 6 weeks to supervised rehabilitation according to group assignment. All subjects returned to the laboratory for post-testing identical to the pre-testing. The dependant variables were ankle dorsiflexion (DF), knee flexion (KF) and hip flexion (HF) assessed 100-msec prior to landing and at ground impact. For each dependant variable, a Group (AR, KR, NR) by Time (pre, post) by Side (injured, non-injured) repeated measures ANOVA was performed. Significance was set a priori at $p<.05$. **Main Outcome Measures:** DF, KF, and HF measured 100 ms pre-landing and at ground impact. **Results:** A significant Time main effect for KF at ground impact was observed ($F_{2,34}$ =3.741; p=0.049; pre-test: 1.93±5.23º, post-test: 4.11±7.31º). No other significant relationships were observed for any of the kinematic variables. **Conclusions:** Previous work has demonstrated altered lower extremity kinematic patterns associated with deficits in dynamic stability in subjects with CAI compared with healthy subjects. There were no influences of the rehabilitation protocols on landing kinematics during the selected dynamic stability task. It is possible that the rehabilitation protocols were not functional enough to influence these measures of dynamic motion. Further research is needed to determine what techniques are most appropriate for assessing the effectiveness of rehabilitation for CAI.

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**Does Short Term Balance Training Enhance Sensorimotor Function In Chronically Unstable Ankles?**

Sefton JM, Hicks-Little CA, Hubbard TJ, Koceja DM, Clemens MG, Yengo CM, Cordova ML: The University of North Carolina at Charlotte, Charlotte, NC; Auburn University, Auburn, AL; Indiana University, Bloomington, IN

**Context:** Chronic ankle instability (CAI) is the tendency toward repeated ankle sprains and recurring symptoms, afflicting more than 70% of individuals who have suffered a lateral ankle sprain. Recently, research has focused on the relationship between CAI and the sensorimotor system. However, little research has assessed the effect of rehabilitation protocols on sensorimotor measures in individuals with CAI. **Objective:** To assess the effect of acute bouts of balance training on multiple variables in 4 sensorimotor constructs in subjects with CAI. It was hypothesized that balance training would produce improvements in motoneuron pool excitability and static balance. **Design:** This study utilized a 2x2 repeated measures experimental design. **Setting:** Research laboratory. **Patients or Other Participants:** Twenty-four with CAI volunteered; 17 subjects (5 males/12 females) with CAI (age = 22.0 yrs, height = 168.1 cm, mass = 71.2 kg) participated in the training portion of the study, 7 (2 males/5 females) were randomly chosen as CAI controls (age = 20.6 yrs, height = 167.6. cm, mass = 65.7 kg). **Interventions:** The independent variables were balance training (training, control), and time (pre-test, post-test). Four sensorimotor areas were assessed before/after balance training: joint kinesthesia (Biodex, joint position sense), static balance (Bertec force platform), functional balance [Star Excursion Balance Test (SEBT)], and motor neuron pool excitability (Biopac EMG and stimulator, H-reflex). The test subjects completed 3 balance training sessions using a maze balance board. Descriptive statistics, and MANOVA with follow-up univariate F tests and *t*-tests were used to assess the effect of the intervention on the dependent variables. **Main Outcome Measures:** **Joint kinesthesia:** Plantarflexion constant error, plantarflexion absolute error, plantarflexion variable error, inversion constant error, inversion absolute error, inversion variable error. **Static balance:** Center of pressure (COP) medial/lateral displacement, root mean square of COP medial/lateral displacement, COP anterior/posterior displacement, total COP displacement, total COP medial/lateral velocity, total COP anterior/posterior velocity, total COP average velocity. **Dynamic balance:** SEBT in the anterior medial, medial and posterior medial directions. **Motoneuron pool excitability:** double-legged paired reflex depression, double-legged recurrent inhibition, maximum H-reflex amplitude, maximum M-wave amplitude, Hmax/Mmax ratio, single-legged paired reflex depression, single-legged recurrent inhibition. **Results:** The reflex training protocol produced significant changes in 4 measures; 2 dynamic balance variables: SEBT in the medial [pre(88.49 ± 6.83cm); post(93.42 ± 9.02cm)]; $t(21) = -3.618$, $P = 0.003$) and posterior medial [pre(91.21±7.83cm); post(96.98 ± 11.47cm)]; $t(21) = -884$, $P = 0.002$) directions; and 2 variables in the static balance construct: medial/lateral displacement [pre(-3.15± 2.03mm); post(0.76±1.32mm)]; $t(16) = 17.755$, $P = 0.001$) and velocity [pre(-0.15± 60.10mm); post(0.62±0.04mm)]; $t(16) = 20.080$, $P < 0.001$). There were no significant pre- to post-test changes in the CAI control group. **Conclusions:** This study demonstrated that the short term balance training produced immediate improvements in 2 static and 2 dynamic balance measures in subjects with CAI.

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**Balance Training Significantly Improves Function And Postural Control In Those With Chronic Ankle Instability**

McKeon PO, Ingersoll CD, Kerrigan DC, Saliba EN, Bennett BC, Hertel J: University of Virginia, Charlottesville, VA, and University of Kentucky, Lexington, KY

***Context:*** Balance training has been proposed to be an effective intervention in the treatment of chronic ankle instability (CAI); however there is inconsistent evidence as to whether there are detectable postural control improvements. ***Objective:*** To determine the effect of a 4-week balance training program on static postural control and self-reported functional outcomes in those with CAI. ***Design:*** Randomized controlled trial. ***Setting:*** Laboratory. ***Patients or Other Participants:*** Thirty-one young adults with self-reported CAI were randomly assigned to a balance training group (6 males,10 females: age:22.2±4.5 years, height:168.9±7.7 cm, mass:63.0±8.8 kg, 6.3±7.1 previous ankle sprains) and a control group (6 males, 9 females: age:19.5±1.2 years, height:173.1±9.5 cm, mass:67.3±13.3 kg, 4.6±2.5 previous

ankle sprains). ***Intervention:*** The balance training group participated in a 4-week supervised balance training program, 3 times per week, that emphasized dynamic single limb stabilization. ***Main Outcome Measures:*** All subjects were tested twice separated by five weeks. Subjects performed three, ten-second trials of barefoot single-limb stance on a forceplate with eyes closed. Time-to-boundary (TTB) was calculated from the forceplate center of pressure position and velocity data in the anteroposterior (AP) and mediolateral (ML) directions. The mean of each measure for the three trials was used for analysis. Subjects also completed the Foot and Ankle Disability Index (FADI) Sport questionnaire a week prior to the pretest and during the posttest. Main outcome measures included self-reported function on the FADI Sport (%); the mean of TTB minima(s) and standard deviation of TTB minima(s) in (AP) and (ML) directions. Separate 2X2 repeated measures ANOVAs were used to determine the effect of group (balance training, control) and test (pretest,posttest) on all main outcome measures. Post hoc Tukey HSD tests were used for pair-wise comparisons for significant interactions. The alpha level was set *a priori* at $P \leq 0.05$. ***Results:*** There was a significant group by test interaction found for the FADI Sport scores with the balance training group having significant improvements in after balance training compared to their pretest measures (pre: 69.9±12.1, post: 85.0±14.4%, $p<0.05$). There was no significant change in the control group (pre: 66.5 ± 9.8%, post: 66.3 ± 11.8%). There were significant group by test interactions for the mean of TTBML ($p=0.05$) and TTBAP minima ($p=0.05$), and the standard deviation of TTBAP minima ($p=0.006$). The balance training group had significant increases in the mean of TTB minima in the ML (pre: 1.84 ± 0.53s, post: 2.15 ± 0.61s, $p<0.05$) and AP (pre: 5.32 ± 1.77s, post: 6.04 ± 1.88s, $p<0.05$) directions and standard deviation of TTB minima in the AP direction (pre: 3.11±1.06s, post: 3.91±1.20s, $p<0.05$). There were no significant differences between the pretest comparisons between groups or the pretest to posttest comparisons for the control group. ***Conclusions:*** Four weeks of supervised balance training significantly improved self-reported function and spatiotemporal measures of postural control in those with CAI. *Funded by a grant from the NATA Research and Education Foundation.*

# Free Communications, Oral Presentations: Ankle Epidemiology

Friday, June 20, 2008, 10:00AM-10:45AM, Room 274; Moderator: Jay Hertel, PhD, ATC

**Incidence Of Ankle Sprains Within A Young Physically Active Population**

Jones CJ, Cameron KL, Owens BD: United States Military Academy, West Point, NY

**Context:** According to the Centers for Disease Control and Prevention millions of Americans participate in organized recreational athletics. While studies have examined the incidence of injuries in interscholastic and intercollegiate athletics little is know about the injury patterns among recreational athletes. **Objective:** To examine the incidence rates and injury patterns for ankle sprains in subjects competing in intramural athletics between 1994 and 2005 at the United States Military Academy (USMA). **Design and Setting:** Injury data was obtained from the Injury Surveillance System (ISS) and the Cadet Injury and Illness Tracking System (CIITS) from 1994 through 2005. All injuries sustained by cadets at USMA are treated through a closed healthcare system and ISS and CIITS are used to document all injuries sustained by cadets. Using the data obtained from these databases, incidence rates (IR) were calculated per 1000 exposures for 10 different sports. Incidence rates were only included for sports in which at least seven years of data could be obtained. Injury was defined as any ankle sprain that resulted in one or more days of limited activity. Exposure was defined as one subject participating in one activity session. All injuries and exposures were documented in the surveillance systems. **Participants:** The study population included all male and female cadets involved in intramural athletics during the study period. **Main Outcome Measures:** The primary outcome measures in this study were IR per 1000 exposures and the average time lost due to injury in each sport. **Results:** During the ten year study period, a total of 40,020 cadets participated across the ten intramural activities. There were a total of 606 ankle sprains during the study period and athletes were exposed to injury 631,615 times. The highest rate of injury was found in rugby at 1.80 (CI=1.5-2.1), followed by football at 1.40 (CI=1.2-1.6), and soccer at 1.10 (CI=.9-1.3). The lowest rates of injury were found in boxing (IR=0.13, CI=0-.2), followed by wrestling (IR=0.44, CI=.2-.7) and cross country (IR=0.45, CI=.3-.7). On average, athletes participating in football had the greatest amount of days lost to injury at 18.65, with orienteering next at 16.39, followed by team handball at 15.87. The overall IR for ankle sprain injuries across all ten activities was 0.96 (CI=.9-1). Football had the highest number of ankle sprains with 162 (27% CI=.02-.05), followed by rugby, 134 (22% CI=.18-.26) and then basketball, 109 (18% CI=.15-.21). **Conclusions:** As seen in previous studies, higher ankle injury rates seem to occur in contact sports and activities that require a lot of cutting and jumping. Further studies should further examine differences that exist between gender, race, and age. Research efforts should also focus on identifying risk factors for ankle injuries in order to initiate appropriate preventative risk management procedures.

**Trends In Ankle Ligament Injuries In Collegiate Sports: NCAA Injury Surveillance System**

Hootman JM, Agel J, Marshall SM, Dick R: Centers for Disease Control and Prevention, Atlanta, GA

**Context:** Trend data on ankle ligament sprains (ALS) can potentially inform prevention initiatives. **Objective:** To describe the incidence and time trends of ankle ligament sprains (ALS) in 14 collegiate sports. **Data Sources:** NCAA Injury Surveillance System (ISS), 1988-89 to 2003-04. **Design:** Annual, cross-sectional study. **Setting**: NCAA member institutions, Divisions I - III. **Patients or Other Participants:** The NCAA ISS enrolls a 10% sample of all member schools annually and collects data from ATCs on time loss injuries, exposures and other characteristics. Data on 7 Men's sports [Baseball (BSB), Basketball (MBB), Fall Football (F-FB), Spring Football practice (S-FB), Ice Hockey (MIH), Lacrosse (MLX), Soccer (MSO), Wrestling (WR)], and 7 Women's sports [Basketball (WBB), Field Hockey (FH), Gymnastics (WGY), Lacrosse (WLX), Soccer (WSO), Softball (SB), Volleyball (WVB)] were included. The average number of schools participating was 71±33 (range: 20 WGY to 113 WBB). **Interventions:** Injury rates were stratified by sport and activity (practice versus games). **Main Outcome Measures:** Injuries were defined as: 1) occurring from sport participation, 2) required medical treatment, and 3) restricted the athlete's participation for 1+ days. ALS

injuries included injuries of any grade to any ligament of the ankle. An exposure was defined as 1 athlete participating in 1 practice/game. ALS rates/1000 athlete-exposures (AE), game:practice rate ratios (RR), and 95% confidence intervals (CI) were calculated. Rates based on less than 20 cases are not reported due to low reliability. Significance was determined by non-overlapping 95% CIs or $p < 0.05$. Time trends in ALS rates were calculated using negative binomial regression models. **Results:** A total of 27,176 ALS injuries were reported across sports (ALS rate = 0.82, CI 0.81-0.83), accounting for 14.9% of all injuries. In practice, MIH had the lowest (0.11; CI 0.09-0.13) and S-FB the highest (1.34; CI 1.27 – 1.40) rate of ALS injuries. In games, BSB had the lowest (0.43; CI 0.38 – 0.48) and F-FB the highest (5.39; CI 5.24 – 5.54) rate. ALS injuries, as a percent of all injuries, ranged from 5.5% (MIH) to 29.4% (WVB) in practice and from 4.0% (MIH) to 44.1% (WVB) in games. ALS rates were significantly higher in games than practices (range: RR = 1.73 in WVB to RR = 11.98 in F-FB) in all sports. Across all sports, games and practices, there was no significant trend in ALS rates (-0.1% change, $p = 0.68$), but significant declines were noted in FH (-4.3%) and WGY (-4.7%) games, and in SB (-1.2%), FH (-5.7%), WSO (-3.0%), and WVB (-3.0%) practices. **Conclusions:** ALS injuries are common in every sport, but WVB and FB have the highest relative burden. Rates have decreased in some sports over time, but increased uptake of known effective interventions for ALS may also further reduce rates.

**Incidence Of Stress Fractures Within A Large Physically Active Population**

Cameron KL, Svoboda SJ, Chu JC: Keller Army Hospital, United States Military Academy, West Point, NY

**Context**: Opportunities for athletic trainers working within the military have recently begun to emerge. Understanding the injury patterns and healthcare needs within this physically active population will be critical to successfully developing injury prevention initiatives and monitoring treatment outcomes in this setting. **Objective**: To examine the incidence of stress fractures among active duty military personnel between 1998 and 2006. **Design and Setting:** Injury data was extracted from the Defense Medical Surveillance System (DMSS) from 1998 through 2006. The DMSS captures injury and illness data for all hospitalizations and ambulatory visits service members make to Department of Defense network healthcare providers world wide. All data are coded according to the International Classification of Diseases 9th Revision (ICD-9). Specifically, we examined data for ambulatory visits with ICD-9 codes 733.93 (tibia or fibula stress fracture), 733.94 (metatarsal stress fracture), and 733.95 (stress fracture other bone) listed as the primary diagnosis. For the purposes of this study we limited cases to those injuries reported as first occurrences. Using the injury data extracted from DMSS incidence rates (IR) were calculated per 1000 person-years at risk to injury by age, gender, race, rank and service. Incidence rate ratios (IRR) between male and female service members were calculated by age, race, service, and rank using males as the reference group. **Participants:** The study population included all military personnel that were on active duty serving in the Army, Marine Corps, Navy and Air Force during the study period. Over the 9 year period examined in the present study, 12,425,859 person-years at risk to injury were documented in DMSS with an average of 1,380,651 US service members at risk for injury each year. **Main Outcome Measures:** The primary outcome measures in this study were the IR per 1000 person-years at risk to injury. Rates were calculated by service, age, gender, race and rank. **Results**: During the study period 44,506 stress fractures and 12,425,859 person-years at risk to injury were documented in DMSS. Overall, the IR for stress fractures among active duty US service members was 3.58 (95% CI=3.58-3.58) per 1000 person-years at risk. Stress fractures in the tibia and fibula were most common (48%, 95% CI=.47-.48), while stress fractures to the metatarsals were least common (18%, 95% CI=.18-.18). A large proportion (35%, 95% CI=.34-.35) of stress fractures occurred in other bones. Overall females experienced stress fractures 3.5 times as often as males (IRR=3.5, 95% CI=3.44-3.57). The overall rate for stress fractures was highest in the Marine Corps followed by the Army, Navy, and Air Force. **Conclusions**: Female service members appear to experience significantly higher rates for stress fractures regardless of age, race, service, and rank. Age, race, service and rank also appear to be related to stress fracture.

## Special Interest Group #6: Lower Extremity Overuse Injury

Friday, June 20, 2008, 11:00AM-12:00PM, Room 274; Discussants: Monique Butcher, PhD, ATC, and Reed Ferber, PhD, ATC, CAT(C); Moderator: S. Lee

## Free Communications, Oral Presentations: Post-Professional and Continuing Education

Friday, June 20, 2008, 3:15PM-4:15PM, Room 274; Moderator: Gail Samdperil, ATC

**Curricular Satisfaction Levels Of NATA-Accredited Post-Professional Athletic Training Graduates**

Henry KJ, VanLunen BL, Udermann B, Siemers AJ, Wade JW, Oñate JA: Old Dominion University, Norfolk, VA, and University of Wisconsin-La Crosse, La Crosse, WI

**Context:** Curricular assessment should be conducted within educational programs to determine satisfaction in meeting educational standards. Programs rely on outcomes assessments to determine if changes in the curriculum are necessary. One of the more constructive evaluations can come from recent graduates of the program. **Objective:** To examine the satisfaction levels of recent graduates (2005-2006) of NATA-Accredited Post-Professional Athletic Training Education Programs (PATEPs) as related to the 2002 *Standards and Guidelines*. **Design:** Original online survey instrument and demographic questionnaire. **Setting:** Online survey completed on personal computer. **Patients and Other Participants:** 123 of 211 available PATEP graduates (61 males 24.76 ± 1.20yrs. and 62 females 25.93 ± 2.19yrs.) from 2005 and 2006 responded (58.29% response rate). **Interventions:** Subjects provided demographic information: gender, gradua-tion year, program length(PL), time between degree programs(TBD), extra time needed to complete degree requirements(ET), GPA, credit hours, GRE score, faculty totals, and clinical assistantship site information.

Separate ANOVAs and independent T-tests were used to determine statistical significance. The survey instrument (reliability ICC=0.60–0.97) assessed subjects' satisfaction levels based on ten standard areas: depth of learning (DL), breadth of learning(BL), critical thinking(CT), instructor availability (IA), theoretical basis(TB), writing, scholarly growth(SG), community return(CR), leadership, and overall program satisfaction (OPS). Satisfaction scores were based on percentage brackets (ie.80-89%) corresponding with a ten-point Likert scale. **Main Outcome Measures:** Satisfaction scores (%) for each of the ten standard areas. **Results:** The population was between 65.3% and 75.1% satisfied within the ten standard areas. Seventy percent of the population was at least 80% satisfied concerning critical thinking, scholarly growth and overall satisfaction. No significant differences in PATEP satisfaction were found between genders (p= 324-.983) or for program length (p=.083-.706). There were no significant differences in relation to any of the ten standard satisfaction areas for TBD (greater than six months) (p=.101-.952). Graduates who required more than the allotted amount of time to complete their degree when compared to those graduates who completed their requirements on-time were significantly less-satisfied in the areas of (DL) (63.00% vs. 77.10%) (*t= 2.367,p= 0.027)*, BL (50.00% vs. 68.30%) (*t=3.451, p=0.001)*, IA (56.00% vs. 77.00%) (*t=3.138,p=0.005)*, writing (56.50% vs. 76.40%) (*t=2.467,p=0.022)*, and OPS (59.50% vs. 78.20%) (*t=2.625,p=0.016)*. No statistically significant differences were found in the areas of CT, TB, SG, responsibility for CR, and leadership. **Conclusions:** Graduates are generally satisfied across all areas of their graduate education, however, if a student does not complete their degree requirements within the projected time period it affects their satisfaction with the program. PATEP standards and guidelines revisions were completed in 2002, therefore continued evaluation of student satisfaction needs to be assessed as programs have recently revised curriculums.

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**Clinical Education Satisfaction Of NATA Accredited Post-Professional Athletic Training Education Program Graduates**

Siemers AJ, Van Lunen BL, Henry KJ, Wade JW, Onate JA: Old Dominion University, Norfolk, VA

**Context**: Athletic training clinical positions are commonplace within most NATA Accredited Post-Professional Athletic Training Education Programs (PATEPs) however evaluation of clinical education is an optional component of the Standards and Guidelines. This potentially could have an effect on the satisfaction within these clinical positions. **Objective**: To determine clinical education satisfaction levels of recent graduates of NATA Accredited PATEPs, as related to 2002 *Standards and Guidelines*. **Design**: Original survey instrument and demographic questionnaire. **Setting**: Online survey completed on personal computer. **Patients or Other Participants:** 123 of 211 available PATEP graduates (61 males and 62 females, age = 25.34) from 2005 and 2006 responded (58.29% response rate). **Interventions**: Demographics included type of clinical site, graduate assistantship placement, existence of an entry-level athletic training education program, supervision of athletic training and work-study students, time-off between undergraduate and graduate programs, program length, and type of research completed. The instrument (ICC = 0.463– 0.878) assessed subjects satisfaction levels based on eight standard areas: organization and structure of the clinical experience, effective learning opportunities, pro-gressive development of clinical skills, evaluation of clinical aspects, respon-sibilities within the clinical, decision-making opportunities, number of hours not interfering with classroom and research experiences, and overall clinical education satisfaction. Satisfaction scores were based on percentage brackets (ie. 80-89%) corresponding with a ten-point Likert scale. Independent t-tests were utilized to assess differences between demographic variables for each standard. Significance was set *a priori* at p<.05. **Main Outcome Measures**: Satisfaction scores (%) for each of the eight standard areas. **Results**: No significant differences in clinical satisfaction scores were found for the eight standard areas in regards to supervision of entry-level athletic training or work-study students (p=.05-.94) taking time off between undergraduate and graduate degrees (p=.13-.97) and for length of program (p=.05-.86). Satisfaction scores were higher for off-campus experiences (76.8%) than on-campus (69.4%) for organization and structure (*t*= 2.202,*p*=.030), and higher for those who did not have an entry-level program for organization and structure (77.7% vs. 66.8%)(*t*= 3.101,*p*=.003) effective learning opportunities (78.3% vs. 71.3%)(*t*= 2.001,*p*=.048), progressive development (80.4% vs. 70.8%)(*t*= 2.616, *p*= .011), decision-making skills (81.3% vs. 76.2%)(*t*= 1.997,*p*=.048), number of hours not interfering with classroom and research experiences (74.0% vs. 64.9%)(*t*= 2.185, *p*=.031), and overall satisfaction (80.6% vs. 74.0%) (*t*= 2.015, *p*= .046). Clinical satisfaction scores were higher for those who completed a research project versus a thesis for the way in which individuals were evaluated clinically (79.7% vs. 72.4%) (*t*= -2.301, *p*=.023). **Conclusions**: Graduates are generally satisfied with clinical education across all standard areas, however having an entry level athletic training program decreased clinical satisfaction scores. Because over half of the PATEPs have an entry level program, it may be beneficial to further examine the reasoning behind decreased clinical satisfaction of the PATEP students.

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**Research Satisfaction Levels Of NATA-Accredited Post-Professional Athletic Training Graduates**

Wade JW, Van Lunen BL, Henry KJ, Siemers AJ, Oñate JA: Old Dominion University, Norfolk, VA

**Context:** A research experience is one of the many distinguishing characteristics that are identified by the Standards and Guidelines to provide graduate students with in-depth educational experiences. These research experiences vary between programs and have not been evaluated within curriculums. **Objective:** To examine research satisfaction levels of recent graduates of NATA Accredited Post-Professional Athletic Training Education Programs (PATEPs) as related to the 2002 *Standards and Guidelines*. **Design:** Original survey instrument and demo-graphic questionnaire. **Setting:** Online survey completed on personal computer. **Patients and Other Participants:** 123 (61 males and 62 females, age=25.93±1.85yrs) of 211 available PATEP graduates from 2005 and 2006 responded (58.29% response rate). **Interventions:** Subjects provided various demographic information (program length, time between degrees, extra time needed to complete requirements, GPA, credit hours, etc). The survey instrument(ICC=0.60–0.97) assessed subjects' satisfaction levels based on sixteen research questions: overall satisfaction(OS), critical thinking skills (CT), scholarly growth(SG), depth of knowledge(DK), overall involvement(OI) of faculty mentor(FM), initiation of research(IR) idea by FM, finalization of research experience(FR) by FM, availability(AF) of FM, courses offered (CO), fit with faculty's area of expertise(FE), clearly defined research experience(CDRE), defined long term goals(DLG), defined short term goals (DSG), time allotted to finish(TF), time allotted from clinical experience(TCE), and time allotted from course load(TCL). Satisfaction scores were based on percentage brackets(ie.80-89%) corresponding with a

ten-point Likert scale. An ANOVA and Independent t-tests (due to unequal group means) were used to determine statistical significance with an alpha level at p<.05. **Main Outcome Measures:** Satisfaction scores for the sixteen research questions. **Results:** The mean satisfaction scores ranged from 68.2%(± 22.5%) to 81.1%(± 15.8%). Respondents were most satisfied with their increase in the depth of knowledge(81.1%) due to their research experience followed by scholarly growth (78.4%) and critical thinking(76.5%). The lowest amount of overall satisfaction was reported in regards to the courses offered for the research experience(68.2%). There were no significant differences for evaluation of time-off from school between attainment of a Bachelor's Degree and entrance into their Masters Program($p$=.443-980). Graduates who completed a thesis were more satisfied in SG(80.7% vs 73.3%) ($t$=2.00,$p$=.047), DK(83.6% vs 75.6%) ($t$=2.28,$p$=.027), DLG(78.5% vs 66.9%) ($t$=2.36,$p$=0.21), and DSG(76.8% vs 67.6%)($t$=2.10,$p$=.037). Graduates of two year programs were more satisfied in TF(78.5% vs 69.8%) ($t$= 2.33,$p$=.022) and TCE(76.5% vs 67.3%) for the research requirement($t$=2.10,$p$=.038). Graduates who attended a PATEP that also had a doctoral program were less satisfied in TCE(67.3% vs. 78.2%)(F=7.04,$p$=.009). **Conclusions:** Graduates are generally satisfied across areas of their graduate education as it relates to their research experience. Students who complete a thesis are satisfied in more areas and this may be attributed to the formalized structure that a thesis is associated with. An organized plan for completion of research within PATEPs is essential in order to provide a good experience. *Master's Student Award Finalist*

**Formal And Informal Continuing Education Activities Are Perceived To Enhance Athletic Training Professional Practice**

Armstrong KJ, Weidner TG: Ball State University, Muncie, IN

**Context**: Continuing education (CE) is intended to promote professional growth and development and enhance one's professional practice. Common formal CE activities include conferences/symposia, while informal CE activities include reading professional journals. **Objective**: To determine Certified Athletic Trainers (ATs) preferred types/ formats and related barriers regarding formal (i.e., approved for CE credit) and informal (i.e., not approved for CE credit) CE activities. Further, is CE perceived to impact athletic training practice with regards to enhancing knowledge, improving clinical skills/abilities, changing attitudes toward patient care, and improving patient care. **Design**: Cross-sectional. **Setting**: Athletic training practice settings. **Participants**: The population consisted of a geographic stratified random sample of 1,000 ATs. A total of 306 (30.6%) ATs completed the survey. **Interventions**: The Survey of Formal and Informal Athletic Training Continuing Education Activities (FIATCEA) was developed for this investigation and administered electronically. Cronbach's alpha determined internal consistency for items within each of the three section (participation and perceived impact on practice, preferred type/format of CE activities, and barriers to CE participation) of the survey. Alpha coefficients were .945, .638, and .860 for each section, respectively. Descriptive statistics were computed for all items. An analysis of variance (ANOVA) and dependent t-tests determined differences between AT demographic characteristics and participation in CE and perceived impact on practice, preferred type/format of CE, and barriers to CE participation. The alpha level was set at .05. **Main Outcome Measures**: The FIATCEA survey consisted of demographic characteristic items and Likert scale items (1 = strongly disagree, 5 = strongly agree) regarding CE participation and perceived impact on practice, preferred types/formats of CE activities, and barriers to CE participation. **Results**: Reading professional journals (n = 236, 75.5%) was the most frequently completed CE activity, while non-NATA workshops, symposia, and conferences were preferred for formal CE ($4.44 \pm 0.737$). Formal CE activities were perceived to enhance knowledge ($t_{301}$ =2.073, $P$ = .03) and informal CE activities (e.g., being mentored by a colleague, obtaining a specialty certification not approved for CE) were perceived to improve patient care attitudes ($t_{296}$ = -2.225, $P$ = .027). The cost of attending CE ($4.13 \pm 1.005$) and distance required to travel to CE activities ($4.13 \pm 0.973$) were reported as barriers to CE participation. Women indicated that the cost in attending CE ($F_{305}$ = 18.885, $P$ < .001) and conflicting family roles ($F_{305}$ = 7.101, $P$ = .008) were barriers to CE participation more than men. **Conclusions**: A majority of respondents frequently read professional journals for CE, but formal CE activities are preferred. Barriers to CE participation included cost and related travel. Both formal and informal CE activities were perceived to enhance athletic training professional practice. Informal CE activities should be explored and considered for CE credit.

## Free Communications, Oral Presentations: Ankle Taping and Bracing

Friday, June 20, 2008, 4:30PM-5:30PM, Room 274; Moderator: Steven M. Zinder, PhD, ATC

**The Effects Of Prolonged Prophylactic Ankle Brace Use In High School Basketball Athletes On Dynamic Postural Control**

Crockett NJ, Sandrey MA, Erickson J, Zizzi S: West Virginia University, Morgantown, WV, and North Carolina Central University, Durham, NC

**Context**: Few studies have evaluated the long-term effects of prophylactic ankle brace use on dynamic postural control and functional performance during a competitive sport season. **Objective**: To determine if the use of prophylactic ankle brace use over a 16-week high school basketball season had any adverse effects on dynamic postural control and functional activity. **Design**: Pre/Mid/Post-test, repeated measure design **Setting**: High school athletic facility. **Patients or Other Participants**: Twenty-one high school basketball athletes (42 ankles) consisting of 13 girls (15.69 ± .630 yrs, Ht. 171.35 ± 5.14 cm, mass 58.74 ± 4.29 kg) and 8 boys (16.25 ± 1.035 yrs, Ht 182.88 ± 7.80 cm, mass 73.64 ± 13.07 kg) completed the study. The subjects had no history of injury or surgery to the lower extremity, or balance disorders and were not participating in a balance training program. **Interventions**: The subjects were issued two Ankle Stabilizing Orthosis (ASO) ankle braces. Braces were worn per manufacturer's instructions on both extremities during the 16-week competitive high school basketball season. The subjects were tested in a randomized order using the Star Excursion Balance Test (SEBT) and on three functional tests three times during the season; before, midway, and after the season. For the SEBT a 2 (limb) x 3 (time)

x 8 (direction) repeated measures ANOVA and for functional testing three separate 2 (limb) x 3 (time) repeated measures ANOVA were used. **Main Outcome Measures**: Eight reach distances of the SEBT normalized to leg length for anterior, anterolateral, lateral, posterolateral, posterior, posteromedial, medial, anteromedial and three single-leg(SL) hop tests (SL triple cross-over hop, SL vertical hop, SL 6-M hop for time) **Results**: The SEBT ANOVA revealed a significant main effect for time (P<.001) and direction (P<.001). The largest significant differences (P≤.05) for the right and left side were pre/post (range -6.8±8.8 to -14.3±11.0; range -9.7±6.5 to -12.8±8.4), pre/mid (range -7.1±6.9 to -11.5±11.3; range -6.6 ± 6.7 to -10.2± 7.6) with the least differences between mid/post (range -2.1±2.7 to -3.7±3.5; range -2.6±3.9 to -3.6±3.3). For the SL leg triple cross-over there was a significant main effect for time (P<.001). Distances increased between pre/mid/post-season for both right (165.5±35.8; 176.4±4.7; 182.06±43.6) and left (168.0±37.2; 177.9±39.5; 183.8±39.8). There was a significant main effect of both limb (P<.001) and time (P<.001) for SL vertical hop. All distances increased between pre/mid/post-season for right (10.6±2.7; 11.4±2.8; 12.3±2.9) and left (11.4±2.8; 12.7±2.9; 13.5±3.0). For the SL 6-M hop there was a significant main effect of time (P < .001). Recorded times decreased between pre/mid/post-season for right (1.9±.3s; 1.8±.3s; 1.7±.2s) and left (2.0±.3s; 1.8±.2s; 1.7±.2s). **Conclusions**: Long-term use of ASO braces did not have detrimental effects on dynamic postural control or a decrease in performance of the three SL Functional tests. *Funded by a grant from the NATA Research and Education Foundation.*

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**The Effects Of Ankle Support On Static Balance Of Subjects With Or Without Functional Ankle Instability**

Linens SW, Ross SE, Arnold BL: Virginia Commonwealth University, Richmond, VA

**Context:** Ankle braces and tape are used to improve ankle stability, restrict range of motion, improve balance, and/or reduce ankle sprain injury in physically active individuals with functional ankle instability (FAI). Applying an ankle brace overtop ankle tape has been used clinically, yet no research exists that indicates the efficacy of this treatment technique to improve ankle stability or balance. **Objective:** The purpose of this study was to determine balance differences between single leg stance tests under 4 treatment conditions: 1) ankle brace, 2) ankle tape, 3) a combination of ankle tape and brace, and 4) no ankle tape or brace. **Design:** Crossover trial. **Setting:** Research laboratory. **Patients or Other Participants:** Participants in this study included fifteen subjects with no history of ankle injury (23.1±5.4 yrs, 167.2±9 cm, 66.6±14.6 kg) and fifteen subjects with a history of FAI (22.7±3 yrs, 171.8±10 cm, 74.5±10 kg) who reported "giving-way" sensations at their ankle and recurrent ankle sprains with physical activity. **Interventions:** Subjects stood on a single leg on a force plate with their eyes closed and remained as motionless as possible for 20 seconds. Three trials were performed for each treatment condition. Testing order was counterbalanced. Means and standard deviations were calculated over three trials. A 2 x 2 x 2 mixed-model repeated measures ANOVA with 2 within factors with 2 levels (tape: no brace, brace; brace: no brace, brace) and 1 between factor (ankle: FAI, stable) was used for statistical analysis for each dependent measure ($\alpha$=.05). **Main Outcome Measures:** Resultant center-of-pressure velocity vector (COPV) was calculated from a force plate. The Balance Error Scoring System (BESS) was used to record balance errors each time one of the following movements occurred: 1) lifting hands off hips; 2) excessive hip flexion or abduction (>30°); 3) lifting the forefoot or heel; 4) remaining out of testing position; and 5) opening eyes. Faster velocities and greater errors were indicative of poor balance. **Results:** Main effects for tape (no brace=7.77±2.16 cm/s, brace=7.22±2.01 cm/s; p=0.028), brace (no brace=7.29±2.17 cm/s; brace=7.7±20 cm/s; p=0.014), and group (FAI=8.26±1.9, stable=6.73±1.95; p=0.023) were found for COPV. Main effects for tape (no brace=2.56±1.89; brace=3.94±2.21; p<0.001) and brace (no brace=2.84±2.21; brace=3.66±2.05; p<0.001) were found for the BESS. No group main effect (FAI=3.58±1.94, stable =2.92±2.33; p=0.32) was found for the BESS. **Conclusions:** The application of tape or brace impaired single leg balance in subjects with or without FAI. A brace applied overtop tape did not alter balance in our subjects. We speculate that ankle supports may have restricted ankle motion and caused subjects to sway excessively, resulting in increased COPV and greater balance errors. Future research should examine the association between balance with ankle supports and recurrent ankle sprain injury in individuals with FAI.

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**Effects Of Ankle Taping And Bracing On Rearfoot Plantar Pressure During Walking**

Morrison SE, Lee SY, Drewes LK, Hart JM, Saliba SA, Hertel J: Exercise and Sport Injury Laboratory, University of Virginia, Charlottesville, VA

**Context:** Ankle taping and bracing are commonly employed to prevent ankle sprains in athletes. The effect of ankle taping and bracing on plantar pressure and force patterns during walking has not been previously investigated. **Objective:** To evaluate the effects of ankle taping and bracing on plantar pressure and force measures in the rearfoot during walking. **Design:** Crossover. **Setting:** Laboratory. **Patients or Other Participants:** Twenty-five healthy, physically active volunteers without a history of lateral ankle sprain (10 males, 15 females, age=23.0±6.9 years, height 168.0±9.0 cm, mass=77.0±4.6 kg). **Interventions:** Subjects walked on a treadmill at the pre-selected pace of 1.3 meters/second (3.0 miles/hour) under three conditions (ankle taping, ankle bracing, control) while an in-shoe plantar pressure system with 99 sensors collected plantar pressure and force data at a sampling rate of 100 Hz. All subjects wore identical running shoes. The foot was divided into 9 masks, but for the purpose of this abstract only the data from the medial and lateral rearfoot masks will be presented. For each dependent variable, a 1x3 repeated measures ANOVA was performed with condition at 3 levels (taping, bracing, control). Pairwise comparisons were made in the event of a significant ANOVA. **Main Outcome Measures:** Dependent variables were maximum force, time to maximum force, force time integral (FTI), maximum pressure, time to maximum pressure, and pressure time integral (PTI) in the lateral and medial rearfoot masks. **Results:** Condition had a statistically significant influence on time to maximum force (% of stance) in the medial rearfoot (P=.005). Pairwise comparisons among the three groups indicated that the time to maximum force occurred significantly later in the stance phase with taping (15.0±4.2%, P=.009) and bracing (15.4±3.5%, P= .006) compared to controls (13.0±3.8%). Condition also had a statistically significant influence on time to maximum force in the lateral rearfoot (P=.006). The time to maximum force was significantly delayed with taping (14.9±4.3%, P=.006) and bracing (14.8±3.6%, P=.01) compared to controls

(12.8±3.7%). There were not statistically significant differences between taping and bracing conditions for the time to maximum force in the medial (P=.66) or lateral (P=.96) rearfoot. There were not statistically significant differences between conditions in the medial or lateral rearfoot in the maximum force, FTI, maximum pressure, time to maximum pressure, and PTI variables (all P's>.05). **Conclusions:** Ankle taping and ankle bracing significantly delayed the time to maximum force in both the medial and lateral rearfoot during walking. While the magnitude of peak force and the FTI were not significantly changed with taping or bracing, the delay in time to peak force may allow more time for the foot to attenuate forces in the rearfoot and may provide additional time for the peroneal muscles to respond to episodes of unexpected ankle inversion.

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**Prophylactic Ankle Taping Does Not Increase Valgus Torque About The Knee During A Side-Step Cut-Maneuver**

House AJ, Mangus BC, Mercer JA, Tandy RD, Neumann ES: Sports Injury Research Center, Department of Kinesiology, School of Allied Health Sciences, University of Nevada, Las Vegas, Las Vegas, NV, and Neuromuscular Research Laboratory, Department of Sports Medicine and Nutrition, School of Health and Rehabilitation Sciences, University of Pittsburgh, Pittsburgh, PA

**Context:** A lateral shift in the ground reaction force center of pressure (COP) during gait has been observed with the application of prophylactic ankle taping. Although this may reduce the overall risk for inversion ankle injury, a lateral shift in the COP may potentially translate pathogenic forces to other lower extremity joints. Specifically in tasks demanding greater frontal plane motion like the side-step cut maneuver, a lateral shift in COP may increase the overall external valgus torque about the knee. **Objective:** To compare the peak valgus torque about the knee during the side step cut-maneuver between untaped and taped conditions. **Design:** Within subjects pretest-posttest design. **Setting:** Biomechanics Research Laboratory. **Participants:** A total of 9 male NCAA Division I athletes (age = 20.1 ± 0.9 yrs, mass = 76.1 ± 6.8 kg, height = 179.0 ± 5.2 cm) with no history of lower extremity surgery and/or injury within 6 months prior to testing volunteered. **Interventions:** The independent variable was taping condition (untaped vs. taped). The same Certified Athletic Trainer applied a standard closed basket weave to the right ankle using 1.5" athletic tape incorporating one subtalar sling using 2" Elastikon tape. Subjects performed a figure-of-eight run on a 3x6 m course for 10 minutes at a self selected speed preceding both counter-balanced conditions, for a total of 2 warm-ups during each test session. Subjects were fitted with sixteen 25 mm retro-reflective markers according to the Plug-in-Gait model. An inverse dynamics procedure calculated the external valgus moment about the knee using a 12-camera Motion Capture System (Vicon, v. 4.6, Oxford Metrics, Oxford, UK, fs = 120 Hz) and a force plate (Kistler, Model_8600B, fs = 1080 Hz). Approach velocities were monitored using photocell timing lights. For each condition, subjects were asked to complete 10 successful side step cut-maneuvers which included an approach velocity between 3.5-5.5 m/s, right foot plant on the force plate, and exit within an indicated target range of 35-55°. External valgus torque about the knee was computed and exported using VICON workstation software. The dependent variable mean peak external valgus torque about the knee was compared using a two-tailed dependent t-test between conditions, $\alpha$=.05 set a priori. **Main Outcome Measures:** Peak valgus torque about the knee within the first 20% of stance, was normalized to subject mass and averaged across 10 trials per condition for each subject. **Results:** Mean peak external valgus torque about the knee was not significantly different ($t$=.55, $p$=.60) between conditions, untaped = -0.37±.51 Nm/kg and taped = -0.42±.37 Nm/kg. **Conclusions:** The application of prophylactic ankle taping does not alter the peak external valgus torque about the knee observed within the first 20% of stance during the side step cut-maneuver.

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**Differences In Sweat Sodium Concentration In Professional Ice Hockey Players When Exercising In Two Different Environmental Conditions**


Bertini T, Armstrong N, Kopec J, McCrossin J, Fowkes Godek S: The HEAT Institute at West Chester University, West Chester PA, and Philadelphia Flyers/Phantoms, Philadelphia, PA


**Context:** Sweat rate, fluid turnover and sweat sodium loses have been measured in professional hockey players (AHL) during on ice practice in the winter months. However, these variables have not been measured in AHL players during a dry land practice nor have the variables been compared between two different environmental and equipment conditions. **Objective:** The purpose of this study was to compare sweat rate (SwtR), sweat sodium content [$SwtNa^+$], and sodium losses (mg/hr) in AHL players during a dry land practice in July to those same measures during a standard on ice practice in October. **Design:** Observational cohort design. **Setting:** Data was collected during dry-land testing in July (subjects ran continuously for 20 minutes while wearing only shorts and sneakers) and 3 months later during an on ice practice in October (full equipment). **Patients or Other Participants:** Fourteen AHL players with age=21.6±2.0y, height=183.7±4cm, mass =88.9±5.0kg, BSA=2.12±.08$m^2$ and % body fat=12.1±3.6 volunteered to serve as subjects. **Interventions:** Before practices the skin of the upper right forearm of each subject was cleaned with alcohol, washed with de-ionized water and dried with sterile gauze. A sterile sweat patch was applied to the skin and secured with a microfilm tape. Following practice, the patches were removed and placed in sterile, low retention tubes which were then centrifuged at 2500 rpm for 10 minutes. The sweat samples were frozen and later analyzed by flame photometry. Body mass was recorded before and after each practice while dressed in shorts. They consumed water during practice from pre-measured individual containers. Following practice they emptied their bladder completely for measurement of urine volume. SwtR was calculated by change in mass adjusted for fluids consumed and urine excreted divided by practice time in hours. Comparisons were made using correlated t-tests. **Main Outcome Measures:** SwtR, [$SwtNa^+$], sodium losses (mg/hr). **Results:** WBGT was assessed 3 times during practices, all variables were different except RH; $P<.001$, (July WBGT= 78.2 ± 3ºF, $T_a$=, RH= 30.5 ± 7%,$T_g$ = 104 ± 5ºF and October WBGT= 47.7 ± 3ºF, $T_a$ = 54 ± 5ºF, RH= 41.6 ± 9%, $T_g$ = 55.5 ± 6 ºF). Practice time was longer in October (1.28±.1hr) versus July (0.33hr); $P<.001$. There were differences in [$SwtNa^+$] (July=82.9±14mmol/L, ranging from 64.3 to 110.6 mmol/L and October 58.4 ± 19mmol/L, ranging from 17.8 to 85.7 mmol/L; $P<.001$), sodium losses (July= 5174.9 ± 1790.6mg/hr and October 2262.5 ± 1702.6mg/hr; $P<.001$) and SwtR (July= 2.68 ± .7L/hr and October=1.6±.8L/hr; $P<.001$). **Conclusions:** The significantly higher [$SwtNa^+$] in July while players ran continuously for 20 minutes in hot conditions is likely explained by the higher sweat rates compared to October when players practiced on ice in cold conditions. The higher SwtR would not allow the eccrine sweat glands the same amount of time to reabsorb the sodium. Higher SwtR in the July was expected due to the continuous exercise in hot (90±5 ºF) environmental conditions.

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**Sweat Rates, Sweat Sodium Concentration And Sodium Losses In Three Groups Of Professional Football Players**


Peduzzi C, Fowkes Godek S, Burkholder R, Condon S, Kopec J, Bartolozzi AR: Philadelphia Eagles, Philadelphia, PA; HEAT Institute at West Chester University, West Chester, PA; Pennsylvania Hospital, Philadelphia, PA


**Context:** We previously reported differences in sweat rates (SwtR) and sodium losses between interior linemen (LM) and receivers and running/defensive backs (BKS) but we had not studied the mid-sized players like linebackers, fullbacks and quarterbacks (LB/QB) **Objective:** To compare SwtR, sweat sodium concentration [$SwtNa^+$] and sodium losses in three groups of players, BKS, LB/QB and LM, to determine if positional and therefore size differences exist. We expected to find SwtR in LM>LB/QB>BKS but no differences in [$SwtNa^+$] **Design:** Observational cohort study. **Setting:** Data was collected during morning full padded practices in the second week of two consecutive pre-season training camps. **Patients or Other Participants:** Eighteen BKS with age= 26 ± 2.3y, height= 82 ± 5.5cm, mass = 93 ± 6kg, BSA= 2.14 ± 0.09$m^2$, BSA/mass = 230 ± 8 $cm^2$/kg, 12 LB/QB with age=27±3y, height=189±4cm, mass =110.5±5kg, BSA = 2.37±0.07$m^2$ and BSA/mass =215 ± 5$cm^2$/kg, and 15 LM with age= 26±3y, height = 193±4cm, mass= 134 ± 18kg, BSA=2.61 ± 0.16 $m^2$ and BSA/mass = 97 ± 15 $cm^2$/kg volunteered. **Interventions:** Prior to practices a sterile sweat patch was applied the right upper forearm of each player after the skin was cleaned with alcohol and de-ionized water. The patches where removed during practice and placed in sterile, low retention tubes and centrifuged on site. The sweat samples were frozen and later analyzed by flame photometry. Subjects recorded body mass before and after practice while dressed in dry shorts. They drank water and/or sports drinks during practice from pre-measured individual containers. After practice they voided their bladder for volumetric measurements SwtR was calculated by change in mass adjusted for urine produced and fluids consumed divided by practice time in h. Comparisons were made using one-way ANOVA. **Main Outcome Measures:** SwtR, [$SwtNa^+$] and sodium losses. **Results:** WBGT across all days was 78.5±3.5 ºF. All physical characteristics except age were different between all three groups, $P < 001$. SwtR was lower in BKS (1.42 ± .45 l/h) compared to LB/QB (1.98 ± .49 L/h), $P<.05$ and LM (2.16 ±.75 l/h), $P <.01$ but there were no differences between LB/QB and LM. [$SwtNa^+$] was not different between groups (BKS =50 ±16 mmol/l, LB/QB =48 ± 24 mmol/l and LM =54 ± 25 mmol/l) and overall ranged from 15 to 99 mmol/l. Sweat $Na^+$ losses ranged from 642 mg to 6.7 g/h and group differences approached significance, $P = .08$. On days when players practiced 4.5 h, calculated sodium losses ranged from 2.3 to 22.2 g/d. There was a moderate correlation between BSA and SwtR, r = .5, $P<.001$. **Conclusions:** Smaller BKS sweat at lower rates compared to both mid-sized LB/QB and large LM but the mid-sized players sweat at similar rates as linemen. Sweat sodium content and therefore daily sodium losses ranges considerably. Regardless of position heavy, salty sweaters clearly require increased dietary consumption of sodium during pre-season.

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**Positional Differences In Core Temperature Response In NFL Players During Preseason Practices In Full Pads Versus Shell And Shorts**

Burkholder R, Fowkes Godek S, Peduzzi C, Kopec J, Bartolozzi AR: Philadelphia Eagles, Philadelphia, PA; HEAT Institute at West Chester University, West Chester, PA;Pennsylvania Hospital, Philadelphia, PA

**Context:** We reported that NFL interior linemen (LM) reach higher maximal core temperatures ($T_{cmax}$) during practices compared to smaller backs and receivers (BKS), but when LM and BKS are grouped together they reach similar $T_{cmax}$ during practices regardless of equipment condition, full pads (PADS) or shorts and shells (SHELLS). **Objective:** To determine if positional differences exist in $T_{cmax}$ in NFL LM and BKS when practicing in two different equipment conditions (PADS versus SHELLS). We hypothesized that BKS would reach similar $T_{cmax}$ under both conditions but the LM would not. **Design:** Observational cohort study. **Setting:** Data was collected during both morning (PADS) and afternoon (SHELLS) practices on days 2 – 4 of 3 consecutive pre-season training camps. PADS and SHELLS practices for this NFL team on days 2, 3 and 4 are nearly identical except there is no live tackling in SHELLS. **Patients or Other Participants:** Eighteen LM with age= 27 ± 3.3y, mass= 136 ± 4kg, height= 192 ± 4cm, BSA= 2.64 ± 0.18$m^2$, BSA/mass= 195 ± 15$cm^2$/kg and 14 BKS with age= 26.5 ± 2.5 y, mass= 97 ± 10 kg, height= 182 ± 7 cm, BSA= 2.2 ± 0.14 $m^2$ and BSA/mass = 226 ± 9.8 $cm^2$/kg participated. **Interventions:** Subjects ingested a temperature sensor (HQ,I) prior to data collection as previously reported. Core temperature was recorded before and then every 10 min during 2 h of similar practices in PADS and SHELLS. Only data was used if $T_{cmax}$ was acquired from a player in both practices on the same day. Pre and post practice body weight was used to determine % change in mass (%"mass). Independent and correlated t-test were used with a Bonferoni correction when indicated and P<.05. **Main Outcome Measures:** $T_{cmax}$ and %"mass. **Results:** All physical characteristics except age were different between LM and BKS, all $P$ <.001. LM reached higher $T_{cmax}$ in PADS compared to SHELLS (102.3±1 versus 102.0±.9 ºF), $P$ = .02 but BKS reached identical $T_{cmax}$ in both conditions (101.8±1 and 101.8±1 ºF). Similarly, LM reached a higher $T_{cmax}$ compared to BKS only in PADS, $P$ =.02. Overall in a total of 202 player practices (PADS and SHELLS combined) $T_{cmax}$ was higher in LM (102.1±1, range=100.3 to105.9 ºF) compared to BKS (101.8±.9, range=99.6 to 105 ºF), $P$ = .02. There was a moderate correlation between PADS and SHELLS, r = .53, $P$<.001 but no correlation between $T_{cmax}$ and %"mass, r = .13 and $P$ = .2. Differences in %"mass between LM (1.02%) versus BKS (1.32%) approached significance, $P$ = .07. **Conclusions:** Since BKS run the same patterns and similar plays regardless of equipment condition we were not surprised that $T_{cmax}$ was identical in PADS and SHELLS. Unlike LM who appear to work harder in PADS, it is likely that BKS exercise at similar intensities during both practices. Modest losses in body mass likely have little effect on $T_{cmax}$ in both BKS and LM.

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**Reliability And Validity Of A Novel Perceived Hydration Scale During And After Indoor Exercise In The Heat**

West AW, Ganio MS, Casa DJ, Lopez R, McDermott BP, Scruggs IC, Stearns RL, Armstrong LE, Maresh CM: University of Connecticut, Storrs, CT

**Context**: Despite increased public hydration awareness, inadequate fluid replacement continues among athletes, laborers, and military personnel. Perceptual scales have been developed regarding perceived exertion, thermal sensation and thirst; none have examined one's ability to perceive hydration level. **Objective:** The purpose of this study was to examine the reliability and validity of a newly developed perceived hydration scale (PHS). **Design:** Repeated measures conducted over two identical trials. **Setting:** Environmental heat chamber (WBGT = 35.1±2.3°C, 44±7% RH). **Participants:** Eighteen individuals ages 19-28 y: 11 males and 7 females (mean±SD age, 22.5±2.3 years; mass, 72.02±10.33 kg; body fat, 16.2±6.2%). **Interventions:** After becoming familiarized with scales and obtaining baseline body mass (BM), subjects performed two identical 120min trials walking (5.6 km/h, 5% grade) in the environmental chamber (35.1±2.3°C, 44±7% RH). The PHS scale ranges in 0.5 increments from -6 (severely dehydrated) to +6 (severely overhydrated) which correspond with percent BM change. PHS was recorded before and every 30min during exercise. BM was measured before, at 60min, and after exercise. Following exercise, subjects sat in cool (22°C) conditions for 135min; during the first 45min they were rehydrated with water equal to 150% of the BM lost during exercise. During rehydration (min125-170), PHS was measured every 15min and thereafter was measured every 30min. A two-way ANOVA was performed with follow-up paired samples t-tests to identify significant differences in %BM change and the PHS between and within trials. Reliability of PHS between trials was measured using Bland-Altman plots [(mean difference, limits of agreement (LOA)]. Validity of PHS was assessed by calculating mean difference between actual %BM change and PHS during exercise and post-exercise. The scale was considered valid and reliable if the mean difference was ≤±0.5. **Main Outcome Measures:** PHS and %BM change. **Results:** Percent BM change between trials was not significantly different (p= 0.14) showing identical trials. Regarding reliability of PHS there were no significant differences between trials (r=0.73, p=0.852). Trial one PHS and actual %BM change were significantly different (p = 0.034) at the 155min time point only. PHS and %BM change during trial 2 differed at min 140(p=0.02), 155(p=0.03) and min 260 (p = 0.03). Mean differences and LOA between trials for PHS were -0.1, 1.39, and -0.1, 1.39 for %BM change respectively. However, mean differences between PHS and %BM were 0.2 in trial 1 and 0.32 in trial 2 meeting the criterion set for validity. **Conclusion:** This study established the reliability of the PHS. However, data showed that subjects more accurately perceived their hydration levels while exercising than rehydrating or resting. PHS was valid during exercise in this laboratory study, but future research should test this scale in a variety of settings.

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**The Relationship Between Anterior Tibial Shear Force During A Jump Landing Task And Quadriceps And Hamstring Strength**


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**Context:** Greater anterior tibial shear force (ATSF) has been linked to greater anterior cruciate ligament (ACL) loading. Jump-landing tasks have been associated with ACL injury due to the substantial ATSF generated by the eccentric quadriceps contraction that is required to decelerate the body. Imbalances in quadriceps and hamstring strength may contribute to excessive ATSF and ACL loading. **Objective:** To evaluate relationships between ATSF during a jump landing task and eccentric quadriceps strength ($Quad_{Ecc}$), concentric hamstring strength ($Ham_{Con}$), and the $Quad_{Ecc}/Ham_{Con}$ strength ratio. **Design:** Correlational. **Setting:** Research laboratory. **Patients or Other Participants:** Twenty-seven healthy, physically active females (age = 19.48 ± 1.83 years, height = 165.62 ± 6.45 cm, mass = 61.84 ± 9.75 kg) volunteered as participants. Each subject was required to have at least two years of varsity, club, or intramural experience in a sport that implements a jump landing task (e.g. basketball, volleyball, or soccer) without having followed a professionally designed training or ACL injury prevention program. To be eligible for participation, subjects were required to meet the following criteria: 1) between the ages of 18 and 25 years, 2) participate in sporting activity 2-3 times per week for at least 30 minutes per session, 3) no current lower extremity injury, and 4) no prior history of ACL injury or knee surgery within the previous two years. **Interventions:** An electromagnetic motion analysis system interfaced with a non-conductive force plate was used to sample lower extremity kinematics and landing forces during a jump landing task from a 30cm height. Peak ATSF (N) was calculated from these data via inverse dynamics. Peak $Quad_{Ecc}$ and $Ham_{Con}$ torques (Nm) were assessed at three testing velocities (60°/s, 180°/s, and 300°/s) using an isokinetic dynamometer. ATSF was standardized to body weight, and strength measures were standardized to the product of weight and height. Respective relationships between ATSF (dependent variable) and each strength measure ($Quad_{Ecc}$, $Ham_{Con}$, and $Quad_{Ecc}/Ham_{Con}$ ratio) were assessed by calculating Pearson product-moment correlation coefficients. Statistical significance was established *a priori* as $\alpha$=0.05. **Main Outcome Measures:** ATSF, $Quad_{Ecc}$, $Ham_{Con}$, and $Quad_{Ecc}/Ham_{Con}$ ratio. **Results:** In isolation, $Quad_{Ecc}$ and $Ham_{Con}$ were not significant predictors of ATSF at any of the testing velocities ($P > 0.05$). However, significant positive correlations were found between ATSF and the $Quad_{Ecc}/Ham_{Con}$ ratio at both 60°/s (r = 0.529, $P = 0.005$) and 180°/s (r = 0.556, $P = 0.003$). **Conclusions:** $Quad_{Ecc}$ and $Ham_{Con}$ strength alone do not predict ATSF. However, when considered in combination as the $Quad_{Ecc}/Ham_{Con}$ ratio, these strength measures are moderate predictors of ATSF. These results suggest that in the presence of high functional $Quad_{Ecc}/Ham_{Con}$ ratios, female recreational athletes may be predisposed to higher ATSF and subsequent ACL injury risk.


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**Anterior Cruciate Ligament Injury Prevention Programs Alter Technique In Youth Soccer Players**


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**Context:** Preliminary research on anterior cruciate ligament (ACL) injury prevention programs show promising results with changing movement patterns. Little information exists regarding whether a standard program or a program designed for an individual's specific movement errors is more effective. **Objective:** To compare a season-long generalized(GEN) and customized(CUS) ACL injury prevention program on altering landing technique. A secondary objective was to evaluate which specific movements changed to influence landing technique. **Design:** Cluster-randomized controlled trial. **Setting:** Soccer field. **Participants:** Twenty-seven youth soccer teams (males: n=90, age=13±2years, height=166±13cm, mass=54±14kg; females: n=83, age=13±2 years, height=160±8cm, mass=50±10kg), stratified by gender and age, volunteered to participate and were randomly assigned to either a GEN or CUS program. **Intervention:** Subjects performed three jump-landing trials that were videotaped before and after the program. Video imagery was reviewed by two raters using the Landing Error Scoring System (LESS). Both programs were performed as a ten-minute warm-up consisting of various lower-extremity stretching, strengthening, and plyometric exercises. Players on GEN teams performed all of the same exercises. Players on the CUS teams were divided into three groups based on their movements during the pre-season movement screen: medial knee displacement(MKD), toe-out(TO), or neither. These players performed exercises theorized to correct their movement errors. We used a generalized linear model to compare change scores on the LESS(post-pre) between genders and programs ($\alpha \leq 0.05$). Logistic regression was used to compare individual item improvement. We adjusted for compliance and used generalized estimating equations to account for the fact that the program was randomized by team. **Main Outcome Measures:** The LESS is scored using a binary system based on jump-landing characteristics including knee flexion, knee valgus, and trunk flexion angles, foot position, and stance width. A higher LESS score indicates a greater number of movement errors committed. The average LESS score across 3-trials was used for analyses. Individual landing characteristics were compared between players who improved the landing error and those who did not improve following the injury prevention program. **Results:** Both programs appear to improve LESS scores based on negative change scores, however no difference was observed between programs ($p>0.05$; change scores=GEN:-1.16±0.33, CUS:-.56±0.22). No other significant differences existed between change scores ($P>0.05$). During the individual item analysis, 30%(9/30) of the females improved TO after the program, however, only 17%(6/36) of the males improved TO(Wald=4.7, $P$=0.03). The opposite occurred with MKD as 33%(14/42) of the boys at pre-test changed, but only 14%(10/71) of the girls improved. **Conclusions:** Both injury prevention programs appear to improve landing technique. There appears to be a gender effect with altering certain movement errors as boys were more successful with changing MKD and girls improved TO more effectively. Future studies should evaluate whether these movement changes result in reduced injury rates. *(Funded by the National Academy of Sports Medicine)*


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**The Effects Of Static Stretching On Muscle Activity During A Drop Landing**

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**Context:** Static stretching has been shown to cause deficiencies in various forms of muscle recruitment. No previous studies have been conducted to determine if static stretching causes a change in mean EMG activity during a functional task requiring dynamic stability. A drop landing is a functional task requiring muscle activation to complete a movement that is similar to the actions of many athletes. **Objective:** To determine if static stretching, acutely or over 2 weeks, has an effect on mean pre and postlanding EMG activity during the functional action of a drop landing. **Design:** A mixed model design was used to detect differences between groups (stretch and control) over time (baseline, acute posttreatment - following initial stretching session, final posttreatment – following a 14 day stretching regimen). **Setting:** Biomechanics laboratory in the Human Performance Research Center. **Patients or Other Participants:** 27, healthy and physically active volunteers (15 females (age, 22 ± 2 years, height, 1.68 m ± .05 m, weight, 63.27 kg ± 10 kg) and 12 males (age, 25 ± 3 years, height, 1.79 m ± .05 m, weight, 78.11 kg ± 7 kg)) were recruited for this study. **Interventions:** 14-day static stretching regimen undertaken by the stretch group. The stretching regimen consisted of stretches focused on increasing hamstring and quadriceps flexibility. **Main Outcome Measure(s):** Normalized EMG was recorded from 7 trials. EMG data were divided into pre and post-landing with a 100 msec window analyzed immediately prior to and following foot contact. These values were averaged for the vastus medialis, vastus lateralis, medial hamstrings, and biceps femoris muscles by dropping the high and low values and averaging the remaining five trials of the pretreatment, acute posttreatment, and final posttreatment readings for each subject. **Results:** A 14-day static stretching regimen resulted in no significant changes in prelanding (VL ($F_{(2,48)}$=0.560, *P*=.575; (stretch) 0.94±0.44, 0.92±0.47, and 1.14±0.52 versus (control) 1.08±0.52, 1.59±1.18, and 1.64±0.98 for the 3 respective time intervals), VM ($F_{(2,48)}$=0.083, *P*=.921; 1.21±0.48, 1.25±0.55, 1.42±0.58 versus 1.35±0.70, 1.32±0.64, 1.52±0.82), MH ($F_{(2,48)}$=0.935, *P*=.400; 6.25±4.83, 6.14±4.36, 8.02±4.35 versus 6.03±3.96, 5.99±4.61, 6.45±5.52), or BF ($F_{(2,48)}$=0.585, *P*=.561; 4.63±4.05, 4.56±3.95, 5.47±3.99 versus 3.86±1.78, 4.06±1.64, 5.79±4.58)) or postlanding (VL ($F_{(2,48)}$=0.244, *P*=.784; 4.56±1.63, 4.69±2.29, 8.10±7.64 versus 5.57±3.01, 6.95±5.21, 11.15±8.68), VM ($F_{(2,48)}$=0.147, *P*=.864; 3.73±1.39, 3.91±1.66, 6.05±4.02 versus 4.61±2.72, 4.56±2.1, 7.61±7.47), MH ($F_{(2,48)}$=0.262, *P*=.770; 7.83±4.07, 8.61±6.57, 11.1±5.1 versus 6.73±2.5, 6.24±2.63, 10.62±8.95), or BF ($F_{(2,48)}$=1.776, *P*=.180; 9.78±9.75, 7.9±6.91, 9.17±6.82 versus 6.11±3.03, 6.04±2.48, 7.12±6.38)) mean normalized EMG activity during a drop landing. **Conclusions:** Static stretching done acutely or over a 14-day period does not appear to result in measurable differences of mean EMG activity during a functional activity. The dynamic stabilization required during a drop landing is not effected by static stretching either prior or after landing.

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**The Effect Of Short-Term Use Of Protonic Knee Device On Hip Flexibility And Pelvic Alignment**

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**Context:** Increasing hip musculature flexibility and altering pelvic alignment has been theorized to play a role in influencing the rehabilitation process of various knee pathologies (e.g., patellofemoral pain). **Objective:** To examine the effect of the Protonics™ knee device on altering hip flexibility and pelvic alignment through the use of repositioning exercises during a one-week time period. **Design:** Repeated-measures experimental design. **Setting:** Sports Medicine Research Laboratory. **Participants:** Thirty college-aged subjects volunteered for the study and were randomly assigned to one of three experimental groups (brace [n=10, age= 20.2 ±1.31yrs, ht= 174.94±7.83cm, mass= 74.54±9.10 kg], no brace [n=10, age= 20.9 ±1.66yrs, ht= 168.59±9.92cm, mass= 65.45±13.38 kg], control [n=10, age= 19.6±1.26yrs, ht= 169.79±8.63 cm, mass= 67.72±11.9 kg]). All subjects presented clinically or were diagnosed in the past six months with at least one symptom of anterior knee, patellofemoral, or patellar tendonitis pain. **Intervention:** The brace group, while wearing the Protonics knee device, and the no brace group completed four knee flexion exercises in prone, supine, sitting and standing followed by a 10 minute walk. The control group did not complete any exercises. Subjects reported for training and testing three times during a one week period separated by one day of rest. A Universal inclinometer and Palpation Meter (PALM) were used to evaluate pelvic alignment (PALM Frontal and Sagittal) and hip flexibility (Thomas Test: hip flexor; Ober Test: iliotibial band). All measurements were taken pre-(P), immediate post-(IP) following session one, and delayed post-test (DP) following session three, by two investigators. Both investigators were blinded to the subject group assignment. Separate 3 (group) x 3 (test) repeated measures ANOVA's were conducted on the PALM Frontal plane, PALM sagittal plane, Thomas, and Ober Test at the p<.05 alpha level with Tukey's post hoc HSD tests used to analyze any significant differences . **Main Outcome Measures:** Four dependent variables were assessed and reported in angular degrees: Thomas Test (hip flexor extensibility), Ober (iliotibial band extensibility), PALM Frontal, and PALM Sagittal were all recorded in angular degrees. **Results:** There were significant increases from baseline for Thomas Test (p=.003) (P:10.86±7.63, IP:12.31±8.21, DP:14.50±5.82) and Ober test (p<.001) (P:8.78±6.07, IP:13.71±8.46, DP:14.48 ±7.47) measures for all groups over each time period. No significant interactions between group and time were noted for Thomas or Ober tests. No significant main effects were noted for PALM frontal and sagittal plane measures, respectively. **Conclusions:** Short-term (one-week) use of the Protonics knee device had enhanced effect on hip flexibility and pelvic alignment as measured over time. Clinicians should not expect enhanced hip flexibility and pelvic alignment changes with three sessions of the Protonics knee device. Future studies should investigate the effects of the Protonics knee device following longer use.

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**Development And Validation Of A Movement And Activity In Physical Space (MAPS) Score As A Functional Outcome Measure**

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**Context:** Assessing function is an important outcome measure in establishing evidence based practice. The World Health Organization has defined function to include a person's physical activity within their environment. Currently, there are no accepted functional measures that encompass both physical activity and environment. A measure that quantifies function by assessing the person-environment interaction can provide

further insight into functional status. **Objective:** To develop and validate a quantifiable functional measure that incorporates physical activity and environment. **Design:** Observational matched-pair. **Setting:** Free-living conditions. **Patients or Other Participants:** Fourteen volunteer participants (age [mean ± SD] = 28.9 ± 12.0 years; height = 171.9 ± 8.4 cm; weight = 80.9 ± 16.6 kg) were assigned to two groups; post-surgical ($n$ = 7; < 7 days after surgery = 4.1 ± 2.8 days) and control ($n$ = 7). The post-surgical group surgeries were 3 ACL, 2 meniscus, and 2 debridements. The control group was matched for age, gender, occupation, and perceived physical activity level. Power analysis of pilot data (power = .80, alpha = .05, effect size = 1.7) indicated sample size of 12 was necessary. One pair of outliers ($z$-score = 9.9) was identified and excluded. **Interventions:** The independent variable was group assignment (post-surgical vs. control). Two physical activity measures, step count and activity count, were obtained using minute-by-minute accelerometry. Step count is the number of steps a person takes and activity count represents intensity of movement. Participant's location and travel were recorded using a GPS receiver. Participants, under free-living conditions, wore the accelerometers and GPS receivers on their waist for 3 consecutive days. Locations other than home represented environmental interaction. The Movement and Activity in Physical Space (MAPS) equation was created to include both physical activity and environmental data. The amount of steps and activity counts were assessed for each location, divided by minutes-per-location, summed for each day, and averaged over 3 days for a $MAPS_{sc}$ and $MAPS_{ac}$ scores, respectively. $MAPS_{sc}$ and $MAPS_{ac}$ scores for 3 days had acceptable reliability (ICC[1, 1] = .86 and .83). $MAPS_{sc}$ and $MAPS_{ac}$ were analyzed with independent $t$-tests to determine group differences (post-surgical vs. control) with Bonferroni adjustment ($\alpha$ = .05/2). **Main Outcome Measures:** Dependent variables were $MAPS_{sc}$ and $MAPS_{ac}$. **Results:** There were significant differences between post-surgical and control groups for both $MAPS_{sc}$ ($t_{10}$ = -2.74; p = .02; post-surgical = 13.63 ± 11.39, control = 43.83 ± 24.45) and $MAPS_{ac}$ ($t_{10}$ = -2.67; p = .02; post-surgical = 470.60 ± 397.55, control = 1478.39 ± 835.63). **Conclusions:** The group differences in MAPS scores provide known-difference validity evidence for its use as a functional outcome measure. The importance of MAPS scores is that it measures of function by incorporating physical activity and environment. *Funded by a grant from the NATA Research and Education Foundation.*

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**Effect Of Board Length And Slide Speed On Lower Extremity Muscle Activation Patterns During Slideboard Exercise**

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**Context:** The slideboard has been used to rehabilitate various injuries by athletic trainers and physical therapists for over 20 years. Many studies have been conducted to determine the cardiovascular benefits of this exercise; however, there is little research on the neuromuscular benefits of this mode of rehabilitation. **Objective:** The purpose of this study was to determine if manipulating board length and slide speed altered the lower extremity muscle activation pattern (MAP) during slideboard exercise. **Design:** A simple observational study **Setting:** Data was collected in the Biomechanics Research Laboratory. **Participants:** 24 (12M, 12F, age = 20.30 ± 1.63 yrs, height = 173.78 ± 9.11 cm, mass = 70.91 ± 9.95) recreational athletes with no history of lower extremity injury in last 6 months participated in this study. **Interventions:** All data was collected from the dominant leg. Electromyographical (EMG) data was collected from eight lower extremity muscles during slideboard exercise at two speeds (10% above and 10% below self selected) and at two lengths (150% and 250% of leg length). The data was divided into 6 phases based on the slideboard motion. Muscle activation patterns (MAP) were then determined from the EMG data for each muscle during each phase. Chi-square tests were used to determine if there was a change in MAPs due to the manipulations in board length and slide speed. **Main Outcome Measures:** The MAP for each muscle was categorized as On (throughout phase), Off (throughout phase), and Variable (on/off throughout phase). Contraction of the muscles was defined as EMG activity 2 standard deviations away from the mean from the baseline data that lasted for >10 milliseconds or more. **Results:** The results indicated that MAP was significantly different in different phases for the different muscles. The adductor magnus was the only muscle that did not show a significant difference in any phase for the two trials. The tibialis anterior (Phase5: $X^2$= 9.600, $p$<.01), vastus lateralis (Phase6: $X^2$=17.02, $p$<.01), and gluteus medius (Phase4: $X^2$=14.18, $p$<.01) were significantly different in only one phase. The peroneus longus (Phase2: $X^2$=15.81, $p$<.01; Phase 3: $X^2$=20.10, $p$<.01), biceps femoris (Phase4: $X^2$=13.26, $p$<.01: Phase6: $X^2$=15.91, $p$<.01), and semitendinosus (Phase1: $X^2$=14.40, $p$<.01; Phase3:$X^2$=10.15, $p$<.01) were significantly different in only two phases. The vastus medialis was significantly different in all phases (Phase1: $X^2$=18.818, $p$<.01; Phase2:$X^2$=18.033, $p$<.01: Phase3:$X^2$= 20.625, $p$<.01; Phase4:$X^2$=14.152, $p$<.01; Phase5:$X^2$=16.007, $p$<.01; Phase6:$X^2$= 16.154, $p$<.01) between the two conditions. **Conclusions:** Our findings revealed that manipulation of the board length and slide speed will cause the lower extremity MAP to change resulting in more muscles utilized during slideboard exercise. *Funded by a grant from the NATA Research and Education Foundation.*

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**Comparison Of Lower Extremity Kinematics During Rehabilitation Tasks Between Genders**


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**Context:** Despite the increased awareness of intra-articular hip injuries, little is understood regarding functional alterations following injury. Previous studies have observed gender differences in lower extremity kinematics during landing, squatting, and jumping; however, movement patterns during common lower extremity rehabilitation exercises are unknown. In order to better identify abnormalities in patients with hip pathology, movement patterns of healthy individuals during these exercises need to be assessed. **Objective:** To determine if lower extremity kinematics differ between genders while performing common rehabilitation exercises. **Design:** Cross-over Design **Setting:** Research Laboratory. **Patients or Other Participants:** Twenty-one female (23±6yrs, 167.6±5.1cm, 63.7±5.9kg) and 21 male volunteers (23±4yrs, 181.4±7.4cm, 85.6±16.5kg) with no prior history of lower extremity surgery or injury within the last year participated in this study. **Interventions:** Three-dimensional kinematics were collected for the hip and knee using an active electromagnetic sensor system. Sensors were placed on the dominant limb sacrum, thigh and shank. Exercises included the Single-leg Squat(SLSQ), Step-up-and-over(SUO) and Lunge(LUN). Subjects performed three trials of each exercise. **Main Outcome Measures:** Maximum hip adduction, flexion, extension, and external rotation and knee valgus and flexion angles were used for data analysis. Separate 2x3 repeated-measures ANOVA's were computed for each dependent variable. The independent variables were Gender (male,female) and Exercise(SLSQ, SUO, LUN). Post hoc Bonferroni comparisons were performed for all significant findings. Alpha level was set *a priori* at $p \leq 0.05$. Effect sizes (ES) and 95% confidence intervals (CI) were generated for all significant comparisons. ES were calculated as the mean difference divided by the pooled standard deviation. ES were interpreted using the following criteria: Small ES<0.30, moderate ES=0.3-0.8, large ES>0.80. **Results:** A significant gender by task interaction was observed for hip flexion (p=.05). Males demonstrated significantly greater hip flexion during SLSQ versus females (males:61.7±17.4º, females:50.7 ±17.4º; p=.05; ES=0.63, 95%CI:-5.89 to 4.63). A significant main effect for gender was observed for knee flexion (p=.02) and hip extension (p=.001). For all three tasks, females demonstrated significantly less knee flexion (females:74.7±6.2º, males:79.2±6.2º; p=.02; ES=0.73, 95%CI:-1.15 to 2.60) and greater hip extension (females:10.1±4.8º, males:5.02±4.8º; p=.001; ES=-1.06, 95%CI:-2.51 to 0.39). **Conclusion:** We found statistically significant differences in hip and knee kinematics between men and women during three functional tasks. Although the effect sizes for these differences were moderate to large, these results may not be clinically meaningful as the 95% CIs for all three effect sizes crossed zero. This indicated that there may not be actual differences in hip and knee kinematics between genders for these tasks. It was apparent that the electromagnetic system we used was sensitive enough to detect significant differences even when comparing two groups of healthy subjects. This method of kinematic analysis may be suitable to detect alterations in the movement patterns of individuals with lower extremity pathology.

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**Validation Of Nagi's Disablement Process Model In Orthopedic Knee Patients**


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**Context:** Nagi's disablement process model depicts the relationship between pathology, impairments, functional limitations, and disability and health-related quality of life (QOL). Recently this model, that has been validated in chronic disease and aging populations, was proposed for athletic orthopedic injuries. To date, there is a paucity of empirical data to support its use in athletic training. **Objective:** To validate Nagi's disablement process model in orthopedic knee patients. **Design:** Observational design. **Setting:** Data were collected from a local rehabilitation clinic, physician's office, and university athletic training center. **Patients or Other Participants:** Eighty participants (males = 45; females = 35; Age [Mean ± SD] = 31.3 ± 17.1 years) currently receiving rehabilitation for an orthopedic knee injury volunteered for the study. Patient injuries included: 18 ACL, 14 trauma, 11 knee replacements, 11 patella femoral pain syndrome, 8 meniscus, and 18 other. **Interventions:** Patients completed the Knee Injury and Osteoarthritis Outcomes Score (KOOS) instrument, which is a tool appropriate for a wide range of populations/conditions. The KOOS contains subscales that measure pain, symptoms, function in daily living, sports/recreation, and QOL. These mean subscale scores were used as indicator variables to the latent variables (impairment, function, and disability) in Nagi's model. Structural equation modeling was used to test the Nagi's model in an orthopedic knee population. Data analyses were performed in two steps; the measurement model fit and the structural model fit. All analyses were performed using AMOS 6.0 with full information maximum likelihood estimation. Impairments were modeled with the KOOS subscale scores of symptoms and pain. Functional limitations were modeled with the subscales function in daily living and sports/recreation. The KOOS QOL subscale was used as the sole indicator of disability. The structural model included direct effects of impairment on functional limitations and functional limitations on QOL. **Main Outcome Measures:** To determine model fit multiple fit indices were used including the $\chi^2$ statistic, root mean square error of approximation (RMSEA), and the comparative fit index (CFI). Good model fit was indicated by a non-significant $\chi^2$ statistic, RMSEA less than .06, and CFI greater than .95. **Results:** The measurement model with the two latent variables, impairment and function showed excellent model fit ($\chi^2_1 = 0.3$, p =58, RMSEA = 0.0, CFI = 1.0). The structural model fit was excellent ($\chi^2_4 = 5.28$, p = .26, RMSEA = .06, CFI= 0.96). The significant standardized path coefficients were impairment with functional limitations (= 1.0) and functional limitations with QOL (= 0.81). **Conclusions:** The results support Nagi's disablement process model with orthopedic knee patients.

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**Effect Of Increasing Levels Of Fatigue On Knee Joint Position Sensibility**

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**Context:** Epidemiological studies indicate that the occurrence of ACL injuries in female athletes is up to eight times that of males. Differences in fatigue levels between genders may play a role in joint position sense, which might contribute to the higher ACL injury rate in females. **Objective:** The purpose of this study was to examine the effect of increasing levels of fatigue on active reproduction of passive positioning (ARPP) at the knee in males and females. **Design:** Repeated measures post test design. **Setting:** Laboratory setting. **Patients or Other Participants:** 20 basketball and soccer athletes (10 male [20.8 ± 1.1 yrs. old, 190.0 ± 8.9 cm, 91.1 ± 11.9 kg, 12.30 ± 3.6 yrs. in sport] and 10 female [19.5 ± 1.2 yrs. old, 166.1 ± 6.9 cm, 64.5 ± 7.1 kg, 12.30 ± 2.0 yrs. in sport]). **Interventions:** Fatigue was operationalized as a percentage decrease in peak hamstring torque. Concentric knee extension and flexion was performed through 90 degrees of motion at angular velocities of 90º·s$^{-1}$ for 10 repetitions, 180º·s$^{-1}$ for 15 repetitions, 240º·s$^{-1}$ for 20 repetitions, and 300º·s$^{-1}$ for 25 repetitions, and at 180º·s$^{-1}$ until the hamstring peak torque value dropped 10%, 30%, and 50% below the peak isokinetic torque for three consecutive repetitions. Thirty seconds rest was provided between each set. **Main Outcome Measures:** ARPP was tested on the same isokinetic dynamometer, with the subject blindfolded to eliminate visual cues. A starting angle of 60º of knee flexion was used for each trial. The subject's leg was passively extended to one of the test angles (45º, 30º, or 15º of knee flexion), and concentrated on for 3 seconds. The subject's leg was returned to the starting position. Following a 3 second rest period; the subject had 5 seconds to actively reproduce the presented joint angle. A repeated measures ANOVA was used for data analysis. **Results:** A significant gender effect for the test angles of 15º ($p = 0.640$), 30º ($p = 0.474$), 45º ($p = 0.443$) was not found and the data pooled. ARPP 15° [fatigue level 10% (3.080º ± 1.634), 30% (2.950º ± 2.288), 50% (2.892º ± 1.316)] was not statistically significant for fatigue ($F_{2,38} = 0.066$, $p = 0.936$). ARPP 30° [fatigue level 10% (3.335º ± 1.913), 30% (2.845º ± 1.755), 50% (4.010º ± 3.207)] was not statistically significant for fatigue ($F_{2,38} = 2.959$, $p = 0.064$). ARPP 45° [fatigue level 10% (3.490º ± 2.844), 30% (3.240º ± 2.134), 50% (3.400º ± 2.994)] was not statistically significant for fatigue ($F_{2,38} = 0.073$, $p = 0.930$). **Conclusions:** Fatigue has been theorized to be a contributing factor in proprioception. Results from this study did not show a difference between gender and level of fatigue in joint position sense.

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**Comparison Of Fatigue Effects Between Genders Using A Novel Functional Fatigue Protocol**

Douex AT, Kaminski TW: Athletic Training Research Laboratory, University of Delaware, Newark, DE

**Context**: It has been proposed that the effects of neuromuscular fatigue may be manifested differently between genders. The deleterious outcomes elicited by fatigue may carry strong implications for noncontact injuries. Perhaps the well-documented disparities concerning gender and injury can better be explained by understanding these differences. **Objective**: To assess the effects of intense exercise-induced fatigue on EMG and quadriceps/hamstring torque production between genders using a functional fatigue protocol (FFP). A secondary purpose was to validate the FFP against these measures. **Design:** A between-subjects, randomized and controlled pretest/posttest study design was utilized. **Setting**: Testing was performed in a climate-controlled laboratory. **Patients or Other Participants**: Thirty healthy subjects (15 male, 15 female; age: 20.5±3.3 yrs.; height: 170.8±8.9 cm; mass: 68.6±14.5 kg) volunteered for the investigation. Inclusion criteria were: (1) deemed healthy by the *Physical Activity Readiness Questionnaire (PAR-Q)*; (2) free from illness/injury at present time; (3) physically able to complete the FFP. **Interventions**: All subjects completed isokinetic strength testing for knee flexion (KF) and extension (KE) while simultaneous EMG was recorded from the Vastus Medialis (VM), Vastus Lateralis (VL), Biceps Femoris (BF) and Semitendinosus (ST). Subjects were fatigued through a novel circuit that consisted of a series of timed sprinting, cutting, and jumping tasks. At the conclusion of each trial a Borg (RPE) score was taken. Subjects continued to run subsequent trials with intermittent 15-second rest periods until specific blinded termination criteria were met. Upon conclusion all subjects were immediately re-tested using the isokinetic strength assessment protocol. **Main Outcome Measures**: Isokinetic peak (PT) and average torque (AT) data were extracted for concentric (CON) and eccentric (ECC) KF and KE. Root Mean Square (RMS) and Median Spectral Frequency ($F_{med}$) values were extracted from EMG data for each muscle. All data were visually inspected and analyzed using custom software. Comparisons were made using repeated measures ANOVA ($P<0.05$). **Results**: KE CON and ECC PT ($P=0.015$ and $P=0.001$) and AT ($P=0.0001$ and $P=0.003$) were significantly reduced following the FFP, while KF measures remained largely unaffected for all subjects. ECC $F_{med}$ values were significantly decreased in VM ($P=0.011$) and VL ($P=0.018$) indicative of KE fatigue. Each gender demonstrated similar changes in KE PT (CON: males=12 Nm decrease vs. females=11 Nm decrease; ECC: males=28 Nm decrease vs. females=30 Nm decrease), while KE and KF CON AT deficits were more pronounced in males (18 Nm) than females (4 Nm). **Conclusions**: The FFP caused a similar effect on KE torque production, regardless of gender. Interestingly, following the FFP, females maintained better activation and torque production from their KF muscles, perchance challenging the quadriceps-dominance theory, albeit relative to the maneuvers incorporated in the FFP and isokinetic testing. Perhaps the gender-related disparities following fatigue are better examined through more complex biomechanical testing.

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**Examining Athletes' Help-Seeking Tendencies For Pains And Injuries Experienced During Sport Participation**


Stadden SA, Gill DL: The University of North Carolina at Greensboro, Greensboro, NC, and Lenoir-Rhyne College, Hickory, NC


**Context:** Coping with stress has received significant attention in psychology and health psychology (Vaillant, Bond, & Vaillant, 1986; Strack & Feifel, 1996). Within sport psychology, research has focused on factors that influence athletes' risks for injuries, emotional and behavioral responses following injuries, and effects of these responses on rehabilitation compliance. Limited research has addressed the in-between step of immediate help-seeking tendencies for pains and injuries. **Objective:** To examine athletes' instru-mental and emotional social support help-seeking tendencies following athletic injury. **Design:** Cross-sectional survey. **Setting:** Team meetings in classroom setting. **Participants:** Convenience sample of 221 NCAA Division III intercollegiate athletes (116 male, 105 female). **Interventions:** Participants were current members of basketball, ice hockey, and swimming teams at two NCAA Division III institutions. Participants completed several measures, including the COPE Inventory, which assesses a broad range of associative and disassociative coping responses to stressors (Carver et al., 1989). Participants were asked to focus on athletic injury as the stressor. The COPE Inventory was expanded to address athletes' help-seeking tendencies from sport-specific personnel, including coaches, teammates, and athletic trainers. Reliability analyses of the modified COPE Inventory scales revealed coefficients ranging from $\alpha$=.82 to $\alpha$=.92. Multivariate analysis of variance was performed to determine group differences in instrumental social support (ISS) and emotional social support (ESS) help-seeking tendencies based on gender, sport, and their interaction. **Outcome Measures:** Dependent variables were total scores for each ISS and ESS scale of the COPE. **Results:** Significant gender differences were found for ISS-teammates [F=10.13, p<.01; male mean (sd) = 10.57 (2.93), female mean (sd) = 11.71 (2.74)], ESS-teammates [F=31.71, p<.01; male mean (sd) = 10.41 (3.53), female mean (sd) = 13.03 (3.12)], and ESS-athletic trainers [F=5.54, p<.05 male mean (sd) = 7.17 (3.18), female mean (sd) = 8.02 (3.55)]. Significant sport differences were found for ISS-coach [F=14.56, p<.01; basketball mean (sd) = 9.54 (3.18), ice hockey mean (sd) = 8.58 (3.22), swimming mean (sd) = 11.23 (3.03)], ISS-athletic trainers [F=13.23, p<.01; basketball mean (sd) = 11.79 (3.56), ice hockey mean (sd) = 11.10 (3.61), swimming mean (sd) = 8.87 (4.01)], ESS-coach [F=5.56, p<.01; basketball mean (sd) = 8.49 (3.32), ice hockey mean (sd) = 7.03 (3.07), swimming mean (sd) = 8.44 (3.11)], and ESS-athletic trainer [F=11.43, p<.01, basketball mean (sd) = 8.51 (3.32), ice hockey mean (sd) = 8.09 (3.62), swimming mean (sd) = 6.07 (2.55)]. **Conclusions:** Participants' social support help-seeking tendencies for pains and injuries differed by sport and gender. These differences may be related to gender role socialization, acceptance of pains and injuries within certain sport cultures, and perceived availability of sport support personnel. Additional research is needed to better understand the myriad of factors that influence athletes' help-seeking tendencies following athletic injury.

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**Maturity, Gender, And Previous Experiences With Counseling Are Related To Athletes' Attitudes Toward Counseling**


Donohoe K, Smith-Goodwin E, Tecklenburg L: Wilmington College, Wilmington, OH


**Context:** The entry level athletic trainer must possess the ability to recognize, intervene, and refer when appropriate patients exhibiting sociocultural, mental, emotional, and psychological behavioral problems/issues. (NATA Undergraduate Athletic Training Educational Competen-cies - Psychosocial Intervention and Referral Domain, 4th) But what is the culture of such interventions in the athletic population? Are there factors and perceptions that athletic trainers should be aware of when working with this population? Objective: The purpose of this study was to examine athletes' attitudes towards counseling at one Midwestern Division III College. Counseling includes both cognitive-behavioral (training behavioral reaction to stresses), and psychoanalytic (examines the cause of the stress) therapies. Design: Cross-sectional descriptive survey. Setting: NCAA Division III College. Participants: The convenience sample target population (N=78) included Men's and Women's Cross Country, Men's and Women's Soccer teams. Overall return rate was 90% (n=70). Men's Soccer 31% (n=22), Women's Soccer 34% (n=24), Cross Country 34% (n=24). Male 50% (n=35), Female 50% (n=35). Freshmen 39% (n=27), Sophomores 33% (n=23), Juniors 13% (n=9), Seniors 16% (n=11). Athletes with previous counseling experience 16% (n=11), no previous counseling 84% (n=59). Interventions: A survey was developed using a Table of Specifications (ToS) which addressed attitude towards counseling (questions 1-4), attitude toward professionals (questions 5-9) and demographics (questions 10-13). A panel of experts and a ToS were used for face and content validity respectively. IRB approval was obtained. The surveys were administered during team meetings. Chi Square tests, frequency counts and percentages were calculated using SPSS 15.0. Alpha level was set at 0.05. Main Outcome Measures: A Likert Scale of 1= Strongly Disagree, 2= Disagree, 3=Undecided, 4=Agree, 5=Strongly Agree was used. Questions 1 and 5 were recoded to be positive. Questions 1-4 were computed for overall attitude toward counseling scores. Results: Upperclassman (40% n=8) had a more positive attitude toward counseling than underclassman (4% n=2) - statistically significant ($\chi^2$=16.469, df=6, p=.011). There was a significant difference ($\chi^2$=8.501, df=2, p=.014) between those with previous experience with counseling (a more positive attitude toward counseling) and those with no previous experience. There was a significant difference between gender [females (23% n=8) more so than males (6% n=2)] and positive attitude towards discussing anxiety issues with an ATC ($\chi^2$= 6.900, df = 2, p = 0.032). Athletes with a positive attitude towards counseling had a positive attitude towards seeing a Sport Psychologist ($\chi^2$=42.913, df=8, p=0.001). Conclusions: This study identifies factors of maturity, gender, and previous experiences with counseling are related to athletes' attitudes toward counseling. These factors should be considered when intervening and referring athletes for psychosocial intervention. *Student Poster Award Finalist*

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**The Relationship Between Athletic Trainer Efficacy And Proxy Efficacy In High School Contexts**


Volpe A, Monsma E, Mensch J: University of South Carolina, Columbia, SC


**Context:** Efficacy of Athletic Trainers (ATs) in psychosocial domains is important to consider given the recent extension of AT responsibilities outlined in the 2004 NATA

Educational Competencies. Low AT efficacy in roles of handling issues like anxiety and eating disorders may affect job performance and degree of confidence another individual has in the ATs capabilities. Proxy efficacy is a rating of strength in the degree an individual has in another individual's capabilities. **Objective:** 1) to examine the variation among athletes', their parents' and coaches' proxy efficacy; 2) to examine correlates of proxy efficacy involving psychosocial issues; and 3) to determine the amount of variance in AT self-efficacy explained by proxy efficacy in those same psychosocial domains. **Setting:** Private high schools in a Southeastern state. **Participants:** Fifty high school male (n = 25) and female (n = 25) athletes, their parent (n = 50), coaches (n = 25) and ATs (n = 5) representing a variety of team and individual sports. **Interventions:** Criterion sampling was used to ensure a unit of analysis would reflect the athlete-parent-coach-AT efficacy relationship (N = 50). Covariates included athletes' gender, injury severity, rehabilitation adherence efficacy and time with AT. Correlations were used to examine correlates of self-efficacy and proxy efficacy. MANOVA was used to examine variation across proxy agents. Hierarchical regression analysis was used to determine the amount of variance accounted for in AT efficacy from proxy efficacy sources. **Main Outcome Measures:** A 6-item 10-point Likert scale (1 = low, 10 = high) was used to assess confidence in the AT dealing with clients who had the following issues: depression, rehabilitation adherence, nutritional supplements, eating disorders, performance anxiety and academic stress. ATs completed the same items from a self-efficacy perspective. Scores for respective coaches and ATs were weighted by athlete for the regression analysis. **Results:** Correlations between time with AT and athletes' disordered eating proxy efficacy ($r = .49$, $p<.01$) and adherence efficacy ($r = -.55$, $p < .001$) were significant. MANOVA indicated athletes and parents had lower proxy efficacy than coaches for depression, eating disorders, rehabilitation adherence and academic stress (Pillai's Trace = .38, $F(3,232) = 3.00$, $p<.001$, Eta squared = .19). A positive relationship between parent's proxy efficacy and AT self-efficacy was found, predicting 38% of the total variance in the composite of AT psychosocial domain efficacy $F(3, 47)=11.51$, $p<.001$. **Conclusion:** Despite spending the most amount of time with ATs, athletes report lowest proxy efficacy scores and are less confident in their ability to adhere to rehabilitation. Parents may play a role in enhancing AT efficacy. Education about the AT roles should be expanded to the array of social agents in the AT network.

# Free Communications, Poster Presentations: Effectiveness of Materials and Protective Equipment

Wednesday, June 18, 2008, 1:00PM-5:00PM, 2nd Floor Atrium; authors present 2:00PM-3:00PM

**A Comparison Of Injury Rates And Game Characteristics Between Wood And Non-Wood Bat Usage In High School Baseball**

Sipes RC, Laudner KG, Holman A: Illinois State University, Normal, IL; Eastern Illinois University, Charleston, IL; Illinois High School Association, Normal, IL

**Context**: Individuals have speculated that there is an increased risk of injury for pitchers and position players in games using non-wood bats because these bats produce higher ball velocities upon impact compared to wood bats. However, others have argued that broken wood bats may splinter, thereby increasing the risk of injury. Furthermore, the cost of replacing wood bats that break may make such equipment an illogical option for the high school setting. **Objective**: The purpose of this study was to determine if differences exist in the injury rates and offensive game statistics of baseball games played with non-wood bats compared to wood bats and to determine the incidence of bat breakage for wood bats. **Design**: Prospective cohort study. **Setting**: High school baseball fields. **Participants**: Five high school baseball conferences volunteered to participate in this study with 32 teams submitting data on wood bat usage. Of those 32 teams, 11 reported data for both wood and non-wood bat games. **Interventions**: Teams played all non-conference games with non-wood bats and used wood bats for all conference games. A Chi-square ($x^2$) analysis was used to determine significance of injury ($P = .05$), while dependent t-tests were used to determine significance of the game characteristic variables. ($P = .05/3$, or $P = .017$) **Main Outcome Measures**: At the end of each game the baseball coaching staff for each school was asked to complete questionnaires regarding the type of bat used, number of injuries, hits, runs scored, duration of the game, and number of broken bats (if using wood bats). **Results**: Wood bat games (n=143) averaged 6.5±1.98 hits, 4.5±2.24 runs, 113±13.09 minutes, and produced 1 injury, while non-wood bat games (n=144) averaged 8.8±2.51 hits, 7.1±3.06 runs, 125±11.48 minutes, and produced 5 injuries. There were no statistical differences between wood and non-wood bats for the number of injuries/game ($x^2 = 2.48$, $P = .12$, RR = 4.73, CI = .04-571.9) or the number of runs scored/game ($P = .03$). However, games using non-wood bats had a significantly greater number of hits per game ($P = .005$) and resulted in a significantly longer game ($P = .009$). Furthermore, wood bats had a breakage rate of 28.3 broken bats for every 1000 at-bats or 35.5 at-bats before breakage. **Conclusions**: Our results show no statistical association exists between bat usage and injury rate among high school baseball players, and even more important is the very low number of injuries regardless of bat type reported during the baseball games. However, non-wood bats did produce greater offensive statistics than wood bats, which also tended to break at a semi-frequent rate. These results would suggest that non-wood bats are a safe and viable option for use in high school baseball.

**The Efficacy Of Sterilization Procedures With The Use Of Implantable Equipment**

Peluaga MN, Rubley MD, Klaassen JM, Tandy RD: Athletic Training Research Laboratory, University of Nevada, Las Vegas, Las Vegas, NV

**Context:** Currently in the athletic training literature there appears to be no consistent method for the sterilization of implantable thermocouples for intra-tissue temperature measurement. A detailed review determined that Cidex© or CidexPlus© immersions are the most common sterilization techniques used. The times for immersion range from 20 minutes to 24 hours, yet the manu-facturer recommendations are 20 min for "high level disinfection" to 10 hours for "sterilization". Further it is not clear if CidexPlus© immersion is as effective as steam autoclave sterilization. **Objective:** The purpose for this study was to determine the ability of 1 uncommon and 2 common methods of thermocouple cleansing to minimize the growth of *Staphylococcus aureus*. **Design:** This was a randomized

control study. **Setting:** The data were collected in a controlled laboratory setting. **Patients or Other Participants:** 30 equal length (5.7±0.6 cm), segments of 5 Columbus TX-23-21 thermocouples (Columbus Instruments International Corporation, Columbus, OH) were used. **Interventions:** The independent variables were cleaning technique (1. CidexPlus© for 20 min, 2. Cidex Plus© for 10 hrs, and 3. steam autoclave sterilization), and the dependent variable was *Staphylococcus aureus* growth. Each thermocouple received all three treatments. The thermocouple wires were each sterilized in a Ritter M9 Steam Autoclave according to the manufacturer's recommendation using a 5 minute 132°C under 27.1 psi sterilization program with a 30 minute dry time prior to use. The 5 thermocouples were cut into 30 segments to allow for all probes to be inserted and completely immersed in a single suspension of McFarland 0.5 density suspension of *Staphylococcus aureus* (ATCC 29213) for two minutes. The probes where then placed into individual T-soy broth tubes using aseptic techniques and incubated at 35°C for 18 hours to detect potential remaining organisms. This is a common procedure for standardized testing of sterilization procedures. A Chi-square test for independence was used to determine differences in *Staphylococcus aureus* growth. **Main Outcome Measures:** The growth of *Staphylococcus aureus* (ATCC 29213) after 18 hours of incubation at 35°C. **Results:** The 20 minute CidexPlus© treatment demonstrated growth on 7 of 30 (23.3%) segments. This was significantly more Staphylococcus aureus growth ($X^2(2) = 15.181$, $p<.001$) than the zero growth shown during the 10-hour CidexPlus© and Autoclave treatments. **Conclusion:** The findings of this study suggest that in order for the *Staphylococcus aureus* growth to be completely eliminated either a steam Autoclave or immersion in CidexPlus© for 10 hours must be used. *Student Poster Award Finalist*

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**Relative Cost Effectiveness Of ECG Screening Male And Female Athletes In High School Preparticipation Physical Examinations In Texas**

Knoblauch MA, O'Connor DP: Laboratory of Integrated Physiology, University of Houston, Houston, TX

**Context:** Sudden cardiac death among athletes is rare but tragic. Preparticipation physical examinations typically do not include electrocardiography (ECG), because in mass screenings ECG produces a relatively high false positive rate, resulting in prohibitive costs when the required follow-up cardiac testing is considered. Preparticipation ECG screening would be more cost-effective if performed only in high-risk athletes. For example, cardiovascular abnormalities are more prevalent in males than females, so the cost effectiveness of ECG screening should be higher in males.**Objective**: To estimate the cost-effectiveness of ECG screening for only the male versus only the female public high school athletes in Texas. **Design**: Epidemiological modeling. **Setting**: Texas public high schools. Patients or Other Participants: High school athletes. **Interventions**: From the literature, we identified estimates of sensitivity (70%) and specificity (85%) for ECG screening in high school athletes, estimates of prevalences for potentially fatal cardiovascular abnormalities in high school age males (0.09%) and females (0.01%), the costs of screening and follow-up cardiac testing, and the potential years of life gained (20 to 40 years) when abnormalities are detected in this population. Athlete population (755,000, 60% males) was based on the 2006-2007 Texas public high school participation rates. Two ECG screening models (males and females) were constructed. **Main Outcome Measures**: Expected number of athletes with cardiovascular abnormalities, expected number of positive ECG examinations, estimated total cost of ECG screening plus follow-up testing (after positive ECG), estimated years of life gained, and estimated cost per year of life gained.**Results**: Annually, 407 males and 30 females would be expected to have a serious cardiovascular abnormality in the Texas public high school population. An expected 113,000 males and 75,500 females would have a positive ECG, but approximately 30% (122 males and 9 females) of the athletes who have abnormalities would go undetected. The estimated total cost of ECG screening and follow-up cardiac testing was $63 million for males and $42 million for females. The estimated relative cost effectiveness in terms of cost per year of life gained was $10,000 in males and $91,000 in females.**Conclusions**: The estimated cost effectiveness of ECG was higher in males because the prevalence of potentially fatal cardiovascular abnormalities is much higher in males. The mass ECG screening scenarios commonly suggested would limit the utility and effectiveness of using ECG for identifying serious cardiac abnormalities in high school athletes. Designing a more accurate method for identifying athletes at high cardiovascular risk (e.g., including sociocultural, ecological, and lifestyle factors) and ECG testing only the high-risk athletes would increase the cost-effectiveness of preparticipation cardiovascular screening and increase the ability to detect those athletes who have cardiovascular abnormalities. *Student Poster Award Finalist*

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**Face Mask Removal Efficiency In A Newly Designed Quick Release Face Mask Attachment System**

Swartz EE, Decoster LC, Raskow J, Hernandez A: University of New Hampshire, Durham, NH

**Context:** Newly designed quick release face mask loop straps may impact the effectiveness by which emergency responders are able to access the airway of a football player via face mask removal. **Objective:** Evaluate the efficiency of quick release loops straps during face mask removal. **Design:** Repeated measures, cross sectional design. **Setting:** Controlled laboratory setting. **Participants:** Nineteen subjects (12 male, 7 female, age = 30.20 ± 10.0 years) taken from a sample of convenience among the local population of certified athletic trainers (10, 12.4 ± 3.38 years certified) and general population. Subjects were free from significant upper extremity or central nervous system injury. **Interventions:** Subjects reported to the laboratory and signed an informed consent. Instructions to the subject asked them to first remove the two quick release straps on the side followed by the traditional style straps at the top with either a cordless screwdriver (SD) or anvil pruners (AP). Subjects were given time to practice. A stopwatch was used to record the time to remove the quick release straps and the time to fully remove the face mask. Three trials for each tool condition were performed. Order of conditions was randomized. Following trials, subjects rated the difficulty of the task (modified CR10 RPE scale). Face masks removed in less than 3 minutes were labeled successful. **Main Outcome Measures:** Independent variables included tool (SD, AP) and athletic training certification (NATABOC certified or not). Dependant variables included: removal success, split time (time to remove the quick release loop straps only), total removal time, minimal removal time, and rating of difficulty. Descriptive statistics were used to calculated means, ranges, and measures of variance. A series of One-way ANOVA's and Paired Samples T-tests tested for group differences. Confidence level was set at = .05. **Results:** One face mask out of 114 trials failed to be completely removed (success rate = 99%). Average total time of face mask removal regardless of tool was 42.41 ±11.87s. Average minimum total time did not differ between the SD 31.43 ±5.52s and AP 36.97 ±17.98s ($P > .05$). Average split time was 7.66 ±1.67s. Regardless of tool, the average RPE was 2.68

±1.22 and 2.83 ±1.20 for the AP (P > .05). No differences in time variables existed between subjects with (45.60 ± 12.28s) or without (38.91 ± 11.00s) NATABOC certification (P>.05).**Conclusions:** Face mask removal utilizing the quick release system was nearly perfect, while times and RPE were similar or superior to previous research incorporating other removal techniques. The times for removal revealed no differences between tools or between subjects with NATABOC certification and those with no prior training. These results suggest the quick release face-mask system is efficient.

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**A Comparison Of Collegiate Men's Lacrosse Injury Rates Depending On Helmet Style**

Bowman TG, Bradney DA, Dompier TP: Lynchburg College, Lynchburg, VA, and University of South Carolina, Columbia, SC

**Context:** Concussions and lacerations of the face are common injuries among men's collegiate lacrosse players. However, few studies to date have compared injury rates of athletes wearing different styles of lacrosse helmets. **Objective:** Evaluate concussion and facial laceration rates of men's lacrosse athletes in relationship to helmet style. **Design:** Cross-sectional survey. **Setting:** NCAA sponsored institutions offering men's lacrosse. **Patients or Other Participants:** Athletic trainers (AT) completed an online survey following the 2005 and 2006 seasons. The response rate was 25% (110 out of 448), with 25, 12, and 63 AT's participating from NCAA Division 1, 2, and 3 sponsored institutions, respectively. **Intervention(s):** The independent variable was helmet style. AT's reported the number of participating athletes, the brand/style of helmets, the number of games and practices, and the number of concussions and facial lacerations sustained in practices and games. Face validity of the survey instrument was deemed acceptable by a panel consisting of experts from lacrosse and sports medicine. Exposures were calculated by multiplying the number of athletes wearing each style helmet by the number of practices or games that each helmet was worn. Injury rates (IR) per 10,000 exposures and injury rate ratios (IRR) were calculated with 95% confidence intervals (CI). The null value was set at 1.0. Therefore, an IRR CI's that included 1.0 indicated no significant difference between rates. **Main Outcome Measures:** Concussion and facial laceration rates for games and practices for each helmet style. Concussions were defined as all mild traumatic brain injuries assessed as such by a physician or AT that caused cessation of participation. Lacerations were defined as any open wound necessitating wound care from an AT, or sutures. **Results:** Data on 11 helmets were collected. There were a total of 301 concussions and 204 lacerations reported. Practices accounted 83.1% of the 339056 exposures. The game concussion rate (IR=25.7, CI 21.6-29.9) was significantly higher than the practice rate (IR=5.4, CI 4.6-6.3), with an IRR of 4.7 (CI 3.8-6.0). The game laceration rate (IR=18.4, CI 14.9-22.0) was significantly higher than the practice rate (IR=3.5, CI 2.8-4.2), with an IRR of 5.3 (CI 4.0-7.0). The IR's for concussions in individual helmets ranged from 3.5 (CI 0.4-6.6) to 13.0 (CI 7.2-18.9) while IR's for lacerations ranged from 1.7 (CI 0.5-2.8) to 6.8 (CI 2.6-11.1). **Conclusions:** Consistent with previous research, game concussion and laceration injury rates are higher than practice. In addition, various helmet styles may protect athletes from concussion and facial lacerations differently. Further research is needed to examine possible explanations for style differences.

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**A New High Performance Polymer Athletic Mouthguard Material Outperforms Contemporary Ethylene-Vinyl Acetate Materials**

Gould TE, Piland SG, Hoyle CE, Nazarenko S, Huanyu W: The University of Southern Mississippi, Hattiesburg, MS

**Context:** The most common mouthguard material in use today is ethylene-vinyl acetate (EVA). However, EVA may not be the most ideal for dissipating impact-related forces to the tooth-jaw complex. As a thermoplastic material, EVA's properties are known to be affected by temperature and repetitive impacts. As a result, a new thermoset material platform, thiol-ene-acrylate (TEA), has been developed for mouthguard applications. **Objective:** The twofold purpose was to: 1) compare the effect of repetitive impacts on energy dissipation of EVA and TEA materials, and 2) compare the effect of temperature on energy dissipation between the materials. **Design:** A benchtop dynamic mechanical analysis study. **Setting:** Sport and high performance materials laboratory. **Patients or Other Participants:** As this is a materials experiment, no human subjects were utilized and no demographics are necessitated. A popular EVA dental material (Proform™) and the photopolymerized TEA material were prepared into two sets of ten 22mm X 22mm X 4mm specimens. **Interventions:** We measured the materials capacity to dissipate energy upon impact using a Charpy tup mounted on a Tinius Olsen Model 92T pendulum (ASTM D6110-02). The device was set to impart 1.13J or 3.0J of energy to the specimen. To determine the effect of repetitive impacts, the materials were impacted in the same location over a series of 25 drops. Effects of temperature upon energy absorption were evaluated by cooling the materials to -50°C and impacting every 5°C as they warmed. Materials were then heated to +50°C and impacted every 5°C as they cooled to room temperature. Mean values were determined from multiple samples. **Main Outcome Measures:** Mean energy (Joules) dissipated and percent energy dissipated. **Results:** Impacts with 1.13J demonstrated that mean EVA absorption decreased 3.4% ± 0.02% by the 25$^{th}$ impact. Impacts with 3.00J of energy resulted in mean EVA absorption decreasing 7.0% ± 0.13% by the 25$^{th}$ impact. No change in attenuation performance was recognized for the TEA material at either impact force. We observed significant differences between mean EVA and TEA energy absorption values (P < .001). Effects of temperature upon mean EVA energy absorption values varied from a high of 75% ± 0.01% at -10°C to a low of 36% ± 0.03% at -50°C. TEA materials varied from a high of 88% ± 0.01% at 20°C to a low of 29% ± 0.01% at -40°C. We also observed significant differences between mean EVA and TEA peak absorption temperatures (P<.001). **Conclusions:** The TEA thermoset material outperformed the contemporary EVA material. These results, coupled with a new ASTM classification calling for thermosetting materials, provide support for the continued development of TEA-based materials in mouthguard applications. Future research should illuminate the efficacy of this material in reducing athletic dental injuries.

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**Effect Of Helmet Fit On Cervical Spine Motion During Emergency Cervical Inline Stabilization Procedures In Collegiate Ice Hockey Players**

Mihalik JP, Petschauer MA, Beard JR, Prentice WE, Guskiewicz KM: Sports Medicine Research Laboratory, The University of North Carolina, Chapel Hill, NC

**Context:** Certified athletic trainers often manage cases in which an athlete requires inline cervical stabilization and transport to advanced medical facilities. On-field management guidelines for athletic cervical spine injuries are based primarily on football-related research. Their applicability to other sports such as ice hockey is largely unknown. **Objective:** To evaluate the effect of helmet fit on cervical

spine motion in healthy ice hockey players during a prone log roll and while secured to a spineboard under three separate helmet fit conditions: properly-fitted helmet (PFH), competition helmet (CH), and helmet removed (HR). **Design:** Prospective counterbalanced design. **Setting:** Research laboratory. **Patients or Other Participants:** Eighteen club ice hockey players (age=21.29±2.47 years, height= 181.12±5.99 cm, mass= 80.29±8.91 kg) volunteered for this study. Athletes with a history of cervical dislocation or fracture, or who had sustained a neck injury within six months prior to testing, were excluded from participating. **Interventions:** A three-dimensional electromagnetic motion analysis system was used to capture cervical spine motion during a standard emergency log roll under the PFH, CH, and HR conditions. Cervical spine motion under these same helmet conditions was then captured while the athlete was fully secured to a spineboard. A separate one-way within-participants repeated measures ANOVA was completed for each plane of cervical spine motion across the three helmet conditions for the emergency prone log roll and again when the athlete was secured to a spineboard (six in total). **Main Outcome Measures:** Cervical spine motion in frontal, sagittal, and transverse planes measured in degrees/second during log roll procedures and in degrees of movement when the athlete was secured to the spineboard. **Results:** When performing the prone log roll, significantly less sagittal and transverse plane motion occurred during the HR condition (sagittal=13.92±9.79°/sec; transverse=28.18±6.97°/sec) compared to both the PFH (sagittal=21.89±15.64°/sec; transverse=31.48±8.04°/sec) and CH (sagittal=19.32±11.28°/sec; transverse=33.17±7.03°/sec) conditions (sagittal: $F_{2,32}$=6.25, $P$=0.005; transverse: $F_{2,32}$=7.691, $P$=0.002). No differences in frontal plane motion between the three helmet conditions were observed ($P$=0.163) during the prone log roll. When the athletes were secured to the spineboard, we observed significantly less sagittal plane motion in the HR condition (7.32±3.39°) compared to the PFH (11.95±5.52°) and CH (16.37±7.05°) conditions ($F_{2,34}$=36.16, $P$<0.001). While we did not observe any significant differences in frontal and transverse motion between the HR and PFH conditions, they both resulted in significantly lower motion compared to the CH condition (frontal: $F_{2,34}$=12.69, $P$<0.001; transverse: $F_{2,34}$=19.34, $P$<0.001). **Conclusions:** Our study suggests removing a helmet reduces the amount of sagittal cervical spine motion during an emergency prone log roll in hockey players. In securing an athlete to a spineboard, removing the helmet and applying a cervical collar was the most effective way of minimizing cervical spine movement. In all instances, the athlete's competition helmet resulted in significantly higher cervical motion.

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**The Effects Of Kinesio Taping® On Delayed Onset Muscle Soreness**

Oshiro T, Powers ME: Shenandoah University, Winchester, VA

**Context:** It has been suggested that Kinesio Tape® can decrease edema and pain associated with tissue trauma. Although the effects of Kinesio Tape® have been assessed using other outcome measures, the effects on pain and inflammation have not been investigated. **Objective:** To examine the efficacy of kinesio taping on pain and inflammation associated with delayed onset muscle soreness (DOMS). **Design:** A single blind pretest post test control group design. **Setting:** Controlled laboratory setting. **Patients or Other Participants:** Twenty two healthy male and female subjects (age=24.5±3.4 years, height= 168.2±8.1 cm, mass=66.2±9.47 kg) who had not participated in any type of upper extremity resistance exercise or experienced any upper extremity pathology during the previous six months volunteered. **Interventions:** DOMS was induced in the non-dominant elbow flexors using a bout of eccentric resistance exercise. Immediately following exercise, subjects were randomly assigned to a Treatment or Control group. Subjects in the Treatment group had Kinesio Tape® applied using the manufacturer's suggested technique immediately after exercise. The tape was removed for all post testing, but reapplied following testing at 48- and 72-hrs post exercise. Subjects in the Control group received no intervention. Separate 2x4 (group x time) ANOVA with repeated measures ($p<.05$) were used to assess differences between groups over time. **Main Outcome Measures:** Pain perception, elbow extension range of motion (ROM), and upper extremity girth were assessed in all subjects immediately before and at 48-, 72-, and 96-hrs following DOMS inducing exercise. Pain perception was assessed using a visual analogue scale while a 40-N force was applied to the biceps brachii approximately 3-cm above the musculo-tendinous junction. Resting ROM was assessed using a standard goniometer and an anthropometric tape measure was used to assess upper extremity girth at four sites; 5-cm below, directly over, and 2- and 6-cm above the joint line. The sum of the four sites was used as the girth measure. Each dependent measure was performed three times and the means were used in the analyses. **Results:** A significant increase in pain ($p<.001$) was observed at 48- (20.54 ±17.09 mm) and 72-hrs (17.68 ±17.84 mm) as compared to pre-exercise (9.23 ±9.78 mm). Likewise, a significant loss in ROM ($p<.001$) was observed at 48- (18.44 ±14.82°) and 72-hrs (13.79 ±11.20°) as compared to pre-exercise (2.44 ±5.92°). Significant increases in girth ($p<.001$) were observed at 48- (108.38 ±13.15cm), 72- (108.55 ±13.25 cm), and 96-hrs (107.81 ±12.84 cm) as compared to pre-exercise (105.22 ±12.91 cm). Kinesio taping had no effect however as significant Time x Treatment interactions were not observed for pain ($p=.603$), ROM ($p=.629$), or girth ($p=.613$). **Conclusions:** The bout of exercise was sufficient for inducing DOMS however Kinesio Tape® was not an effective treatment for reducing the pain and inflammation associated with it.

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# Free Communications, Poster Presentations: Modalities

Wednesday, June 18, 2008, 1:00PM-5:00PM, 2nd Floor Atrium; authors present 2:00PM-3:00PM

**An Exploratory Study Of Ketoprofen Drug Concentrations In Swine Tissue Using Ultrasound With Pluronic Lecithin Isopropyl Palmatate Coupling Medium**

Lininger ML, Miller MG, Michael TJ, Baker RJ, Holcomb WR, Berry DC: Western Michigan University, Kalamazoo, MI; UNLV, Las Vegas, NV; Weber State University, Ogden, UT

**Context:** Ketoprofen, a non steroidal anti-inflammatory drug (NSAID), has been shown to be a highly effective analgesic when taken orally but has numerous reported side effects with this method. Ultrasound has been used to deliver various medication with coupling mediums but none with a coupling medium called pluronic lecithin isopropyl palmatate (PLO). **Objective:** To examine tissue presence of ultrasonically applied ketoprofen mixed with PLO compared to a standard gel solution at frequencies of 1 MHz and 3 MHz. Furthermore, during a second trial, the tissue concentration of ketoprofen was examined at depths of5 mm and 10 mm. **Design:**

Randomized experimental. **Settings:** Human Performance Research Laboratory. **Patients or Other Participants:** Four swine thighs were used as designated tissue. **Interventions:** For the first trial, 20 sites (10 for each condition) were measured on the swine thighs and 5 ml of ketoprofen mixed with either PLO or regular ultrasound gel was delivered with the following treatment parameters: 1 MHz at 1.0W/cm², continuous, for 10 minutes and 3 MHz at 1.0W/cm², continuous, for 10 minutes using an Omnisound 3000 ultrasound unit with a 5cm² transducer head in an area two times the transducer head. Immediately following the treatments, tissue was extracted from the middle of the treatment area to a depth of 2 centimeters and then placed in 50 ml test tube and frozen. For the second trial, 12 sites (6 for each condition) were conducted under the same aforementioned parameters. After the tissue was extracted, it was divided in half and frozen separately. All samples were analyzed using LC/MS/MS (liquid chromatography tandem mass spectrometry) methods. Independent t-tests were used to examine differences between frequency and gel type with ketoprofen drug concentrations for trial 1 and frequency, gel type, and tissue depth for trial 2. The alpha level of $P < .05$ was set for analysis. **Main Outcome Measures:** Ketoprofen tissue concentrations measured in parts per million. **Results:** In trial 1, there were no differences with ketoprofen concentrations between frequency (177± 236 and 134± 209 ppm, $P$=.0.670) or gel type (196± 280 and 115 ± 136 ppm, $P$=0.418). For trial 2, there were no differences in the ketoprofen concentration between tissue depths (9.67± 3.55 and 10.54 ± 8.75 ppm, $P$=0.754), gel type (11.28 ± 7.59 and 8.93 ± 5.37 ppm, $P$=0.391), or frequency (11.50 ± 6.42 and 8.71 ± 6.64 ppm, $P$=0.308). **Conclusion:** Delivery of ketoprofen via ultrasound occurred for both 1 and 3 MHZ frequencies and the gel type does not appear to alter the absorption or depth of the drug concentration. Results warrant further analysis with ketoprofen concentrations in human tissues mixed with PLO using ultrasound.

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**Ice Bag Application May Negate The Effects Of Interferential Electrical Stimulation**

Tsang KKW, Morris LM, Hand JW: California Lutheran University, Thousand Oaks, CA

**Context:** The therapeutic effects of cold modalities and electrical stimulation, as individual entities, in the treatment of musculoskeletal injuries are well established in the clinical setting and are well documented in the research literature. Although the simultaneous application of both modalities is empirically accepted, the summative effects of such treatments have not been supported by research evidence. Intuitively, the two modalities would appear to function in opposition. **Objective:** The objective of this study was to examine the effects of individually and concomitantly applied cold modality and electrical stimulation on sensory receptor function. **Design:** This study employed a single session, repeated measures design. **Setting:** Athletic Training Laboratory. **Participants:** Twenty subjects (9 males, 11 females; age= 19.9 ± 1.1yrs; height= 172.7 ± 8.6cm; mass=71.5±9.1kg) volunteered to participate in the study. Exclusion criteria included known allergy to cold, pace maker, metal implants, and present trauma to the thigh. **Interventions:** Subjects were randomly assigned to either the Ice Bag or Ice Bag & Interferential Stimulation group. Baseline sensory acuity (ability to feel) was established prior to modality application. Total modality application was 30 minutes. A 5"x5" template was used to indicate the treatment area, the center portion used to assess sensory acuity. Subjects were blindfolded throughout the testing session. A standard plastic bag was used to hold crushed ice. An electrical stimulator was used to provide interferential stimulation (carrier frequency: 4000 Hz; beat frequency: 80-150 Hz). Electrodes were setup in a standard quadripolar contiguous configuration. Stimulation intensity was established at the level at which the subject reported feeling a moderate level of "static" sensation. Crosstab analysis and descriptive statistics were used to describe frequencies and means where appropriate. **Main Outcome Measure(s):** Sensory acuity (brush, electrical stimulation) was assessed every 2 minutes during treatment application and continued for 10 minutes after removal of modality. **Results:** Chi-Square analysis revealed no significant differences in sensory acuity between the groups at all assessment times ($\chi^2$=2.22; df=1; $P > .136$). Descriptive analysis revealed impaired sensory acuity (brush stimulus) in 50% (n=10) of all subjects within 2 minutes of ice bag application increasing to 90% (n=18) of all subjects by 24 minutes; 70% (n=14) of subjects reported not feeling the electrical stimulation stimulus within 2 minutes of ice bag application increasing to 100% (n=20) of subjects by 8 minutes. **Conclusions:** While our findings support existing evidence of therapeutic effects of cold modalities, the results indicate a possible counterproductive effect with concomitant applications of cold and electrical stimulation modalities. As therapeutic electrical stimulation targets sensory nerve fibers to initiate ascending pain control, the subsequent decrease in the function of those nerves due to a cold modality may render the system ineffective. Our findings warrant further investigation and discussion into this common clinical practice.

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**The Effect Of Low Level Laser On Inflammation**

Johns LD, Zhang X: Department of Physical Therapy, Quinnipiac University, Hamden, CT

**Context:** The US Food and Drug Administration has approved the use of Low Level Laser Therapy (LLLT) for treatment of carpal tunnel syndrome and experimental applications, including inflammation. While some evidence shows that LLLT alters an immune response, it is unclear as to how LLLT modulates inflammation. Mechanistic evidence describing how LLLT modulates inflammation will provide scientific support to clinicians in the development of clinical trials over a wide variety of clinical indications. **Objective:** Identify the effects of LLLT on T cell proliferation, percent of Th17 cells and the presence of two regulatory cytokines (IL-2 and IL-17) that are central to chronic inflammation and autoimmune disease. **Design:** Fully randomized design. **Setting:** Immunology laboratory. **Patients or Other Participants:** Lymphocytes from 4-6 week old female SJL mice. **Interventions:** Independent variables were LLLT dose (0, 15 or 30 J/cm²) and time following antigen activation (12, 24, 36, 48, 72 and 96 hrs). Following activation, cell supernatants were collected at 12hr intervals and assessed for changes in IL-2 and IL-17 protein concentration via ELISA. Proliferation was assessed by Brdu incorporation at 96hrs post stimulation. Changes to the percent of Th17 cells at 96hrs was determined by FACS analysis of fluorescently stained lymphocytes ($CD4^+IL\text{-}17^+$). ANOVA's were used to analyze the effects of LLLT on proliferation and protein production with appropriate post-hoc analysis. All techniques reported here are widely used and commonly accepted immunological methods. **Main Outcome Measures:** Cellular pro-liferation, percent of Th17 cells and production of IL-2 and IL-17. **Results:** Treatment of lymphocytes with LLLT (15 and 30 J/cm²) resulted in significant increases ($P=.02$) in proliferation (control=2.399±0.095; 15J/cm²= 2.621 ±0.091; 30 J/cm²=2.829±0.017, absorbance 450nm). Increases in proliferation were supported by increases ($P<.001$) in the lymphocyte growth factor, IL-2, at 36hr (Control=413±35 pg/ml; LLLT 30 J/cm²= 552±45 pg/ml) and 48hr (Control=169±14

pg/ml; LLLT 30 J/cm$^2$=297±20 pg/ml). While LLLT induced a significant increase in proliferation, the overall percent of the Th17 ($CD4^+IL\text{-}17^+$) subpopulation decreased (96hrs) from 10.38% in controls to 7.15% in LLLT 15 J/cm$^2$ (31% decrease) and to 6.33% in LLLT 30 J/cm$^2$ treated lymphocytes (39% decrease). A decrease in IL-17 ($P$<.001, a key marker protein for Th17 cell activity) was also observed at 72hr (control=6091±643 pg/ml; LLLT 30 J/cm$^2$=3514±400 pg/ml) and 96hr (control=6871±702 pg/ml; LLLT 30 J/cm$^2$=3478±254 pg/ml). **Conclusions:** A body of evidence is rapidly accumulating supporting the premise that Th17 cells are critical for the development of chronic inflammation and autoimmune inflammatory-mediated diseases (i.e. rheumatoid arthritis, multiple sclerosis, allergic asthma, transplant rejection). Our data demonstrates that LLLT increases antigen specific proliferation and the IL-2 growth factor while at the same time suppressing Th17 cells and IL-17 production. These data provide a possible mechanism by which LLLT alters chronic inflammation and autoimmune responses.

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**Concomitant Application Of Ice And Electrical Stimulation Does Not Improve Pain Threshold**

Newing AB, Tsang KKW, Thomas KE, Hand JW: California Lutheran University, Thousand Oaks, CA

**Context:** The use of cold modalities and electrical stimulation in the treatment of musculoskeletal injuries is well established in the clinical setting, documented in the research literature, and highlighted in instructional texts. The general physiological effects of cold modalities include local transient vasoconstriction, decreased cellular metabolism, and decreased nerve conduction velocity resulting in a decrease in pain perception. Interferential stimulation is a common form of therapeutic electrical stimulation aimed at reduction of edema, eliciting muscle contractions, and decreasing pain perception via the gate mechanism. Although the simultaneous application of both modalities is empirically accepted, the summative effects of such treatments have not been supported by research evidence. **Objective:** The objective of this study was to examine the effects of individually and concomitantly applied cold modality and electrical stimulation on pain threshold. **Design:** This study employed a single session, repeated-measures design. **Setting:** Athletic Training Laboratory. **Participants:** Twelve subjects (6 males, 6 females; age= 20.1 ± 1.6yrs; height= 173.4 ± 15.7cm; mass=68.7±14.9kg) participated in the study. **Interventions:** Subjects were randomly assigned to either the Ice Bag (IE) or Ice Bag and Interferential Stimulation (IE/IFS) group. Baseline pain threshold was established prior to modality application with a pressure algometer. Total modality application was 30 minutes. A 5x5 (inch) template was used to mark off the treatment area on the thigh of each subject. The center of the treatment area indicated the site of algometer readings. Subjects were lying supine and blindfolded throughout the testing session. A standard plastic bag was used to hold crushed ice. An electrical stimulator was used to provide interferential stimulation (carrier frequency: 4000Hz; beat frequency: 80-150Hz). Electrodes were setup in a standard quadripolar contiguous configuration. Stimulation intensity was established at the level at which the subject reported feeling a moderate level of "static" sensation in the treatment area. A one-way analysis of variance (ANOVA) with repeated measures for time was used to assess pain threshold. **Main Outcome Measure(s):** Pain threshold was assessed every 2 minutes after initial modality application and continued for 10 minutes after removal of modality. **Results:** No significant interaction was found between treatment group and pain threshold ($F_{1,20}$ = .745, $P$ = .776, 1 - β = .565). Overall mean pain threshold for the IE group was 3.298±.93kg and 3.415±1.46kg for the IE/IFS group. A main effect was found for time ($F_{1,20}$ = 1.899, $P$ = .014). Overall, pain threshold improved by .68kg after 30 minutes of modality application. **Conclusions:** While our findings suggest that cold modalities are effective in decreasing the perception of pain, the addition of electrical stimulation does not result in summative effects and additional treatment enhancements are not produced. The culture in the clinical practice of simultaneous cold and electrical stimulation therapy should be re-evaluated.

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**A 15-Minute Ice Immersion Is Effective At Reducing Plantar Sensation For Laboratory Assessment Of Induced Neuropathy**

Carlson AJ, Shaffer S, Mattacola CG, McKeon PO: University of Kentucky, Lexington, KY

**Context:** Research has demonstrated that peripheral nerve function is impaired after ice immersion. However, the influence of exercise on the duration of ice immersion induced neural dysfunction is currently unclear. **Objective:** The aims of the current study were to examine if 15 minutes of ice-immersion resulted in impaired plantar nerve electrophysiological function and if this effect remained following a brief bout of balance exercises. **Design:** A single group pre-post test study. **Setting:** This study was performed in a controlled research laboratory setting. **Patients or Other Participants:** A convenience sample of 39 healthy subjects was recruited from the general population at the University of Kentucky. The mean age, height and weight of participants was 21 ± 2 yr, 171.4 ± 8.2 cm and 72.2 ± 14.6 kg. **Interventions:** The independent variable was TIME and included 3 levels (pre-ice, post-ice, and post-exercise conditions). Pre-ice nerve conduction medial plantar distal sensory latencies (MPDSL) and tibial distal motor latencies (TDML) were recorded. Subjects were then asked to submerse the plantar aspect of the foot in ice for 15 minutes and nerve conduction measures were immediately repeated. Next, participants completed simple balance exercises (star-excursion balance test, single leg balance on a firm surface, and single leg balance on a foam pad), and the final nerve conduction measures were recorded. An analysis of variance was used to analyze the MPDSL and TDML between the 3 levels. **Main Outcome Measures:** Medial plantar distal sensory latencies and TDMLs were completed with the Sierra Wedge II neurodiagnostic instrument by Cadwell Laboratories (Kennewick, WA). Time was also recorded between post-ice and post-exercise nerve conduction testing. **Results:** There was a significant difference between the pre-ice condition and the post-ice condition (TDML: pre-ice=4.36±.53ms; post-ice=6.41±.15ms; p<.001 and MPDSL: pre-ice=3.46±.02ms; post-ice=5.33±.02; p<.001). There was a significant difference between pre-ice condition and the post-exercise condition (TDML: pre-ice=4.36±.53ms; post-exercise =5.78±.07ms; p<.001 and MPDSL: pre-ice=3.46±.02ms; post-exercise= 4.32 ±.03ms; p<.001). The average amount of time between the post-ice and post-exercise was 11 minutes 13 seconds ± 2 minutes 8 seconds. **Conclusions:** Findings stress the impact of ice immersion on plantar electrophysiological nerve function and suggest that neural dysfunction remained even after a brief period of balance exercises. Further research is needed to determine if ice immersion desensitization impacts postural stability and the duration of such effects. This level of critical analysis may provide health care providers with a non-invasive model for examining distal neural dysfunction and assist in guidelines for return to play following ice immersion.

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**The Effectiveness Of Strain-Counterstrain In Reducing Pain In Upper Trapezius Tender Points**

Perreault A, Kelln B, Pugh K, Hertel J, Saliba S: University of Virginia, Charlottesville, VA

**Context**: Tender points are common in the upper trapezius muscles and can cause persistent pain and muscle spasm in otherwise healthy individuals. Limited research is available to support the use of strain-counterstrain, a manual therapy technique for the treatment of tender points. **Objective**: The purpose was to evaluate strain-counterstrain as a treatment for tender points in the upper trapezius for the reduction of resting pain, pressure threshold and provoked pain compared to a sham treatment. **Design**: A randomized, double blinded, control trial. **Setting**: University athletic training clinic. **Patients or Other Participants**: 20 subjects (11 males, 9 females, age: 22.4 +/- 2.6 years, height: 172.4 +/- 9.75 cm, mass: 74.99 +/- 14.33 kg.) who had self-reported upper trapezius pain and tightness volunteered to participate in this study. **Intervention(s)**: The experimental treatments included a single treatment application of strain-counterstrain for an upper trapezius tender point as described by Jones, or sham treatment ("laying of the hands"). **Main Outcome Measures**: A 10-cm visual analogue scale was used to evaluate resting and provoked pain. A pressure threshold meter (Model PTH, Pain Diagnostics and Treatment, INC, Great Neck, NY) was used to assess pressure threshold (PTH). The pressure threshold meter was also used to apply a 4.0Kg/cm$^2$ for females or a 5.5kg/cm$^2$ pressure to the tender point for the provoked pain score. All measurements were done prior to treatment (or sham), immediately afterwards and 24 hours following the intervention. Three 2x3 ANOVAs were used to analyze data. **Results**: Resting pain scores had a significant main effect for time (P=.003); but there was no statistically significant difference between the strain-counterstrain and sham treatments. The PTH levels showed no significant improvements over time or between conditions. The provoked pain score showed no statistical significance in decrease of pain, (baseline = 5.84 ± 2.31mm, post treatment = 5.42 ± 2.71mm, and 24 hours later=4.28± 2.59mm). **Conclusions**: There is not statistical evidence to recommend the use of strain-counterstrain over a sham treatment in the treatment of upper trapezius tender points. Although empirical evidence suggests a benefit for the use of strain-counterstrain we cannot support its effectiveness to decrease pain or tender point sensitivity in the upper trapezius in patients who are not seeking medical treatment.

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**Effect Of Duration And Amplitude Of Direct Current When Lidocaine Is Delivered By Iontophoresis**

Teeter C, McKeon P, Saliba EN, Ingersoll CD, Saliba S: University of Virginia, Charlottesville, VA

**Context**: Dosage for the galvanic stimulation during iontophoresis treatments are typically described in milliamp· min (mA·min). There are no clinical guidelines for manipulation of either the length of time or the amplitude of current to improve iontophoresis effectiveness. **Objective**: To compare the anaesthetic effects of lidocaine HCL(2%) using a long duration, low electrical amplitude treatment to a short duration, high amplitude treatment. **Design:** Double-blinded, crossover design. **Setting**: Collegiate athletic training clinic. **Patients or Other Participants**: 21 subjects volunteered (8 females; 13 males). Age: 21.2 ± 4.25, height 170.7 ±10.29 cm, mass 82.1 ±19.24 kg). All participants were healthy with no lidocaine or adhesive allergy and no skin abnormalities. **Intervention(s)**: Three treatments using a Phoresor II®; 2ml, 2% lidocaine HCL in standard iontophoresis electrodes were administered to each subject in a random order on the volar aspect of the right forearm. (1) HASD (40 mA·min): High amplitude (4mA), short duration (10 min); (2) LALD (40 mA·min): Low amplitude (2mA), long duration (20 min); (3) Sham condition (0 mA, 20 min). All treatments were separated by at least 48 hours. **Main Outcome Measures**: Semmes-Weinstein monofilament scores were taken pre and post intervention to measure sensation changes in the area designated for the treatment electrode. Two-way ANOVA with repeated measures was used to compare sensation scores. Post hoc pair-wise comparisons were performed to explain significant interactions. **Results**: Both iontophoresis treatments: LALD (4.2 ±0.32mm) and HASD (4.2 ±0.52mm) significantly increased Semmes-Weinstein monofilament scores, indicating an increase in anaesthesia in these conditions compared to the sham condition (3.6 ±0.06mm) $p<0.05$. Neither LALD nor HASD was more effective than the other. There was no difference in anaesthesia with the sham condition. **Conclusions**: Lidocaine delivered via iontophoresis is effective in reducing cutaneous sensation when applied at 40mA·min. However, there was no benefit in either a high amplitude, short duration or low amplitude, long duration treatment at this treatment dose for cutaneous anaesthesia.

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**Effects Of High-Voltage Pulsed Electrical Current On Pain, Swelling And Function Following Delayed Onset Muscle Soreness**

Hamilton MS, Anguish BM, Koch DW, Bibi KW, Mendel FC, Dolan MG: Department of Sports Medicine, Health and Human Performance, Canisius College, Buffalo, NY; Department of Health Sciences, Northeastern University, Boston, MA; Department of Pathology and Anatomical Sciences, State University of New York at Buffalo, Buffalo, NY

**Context:** Delayed onset muscle soreness (DOMS) commonly affects athletes and the general population following unaccustomed bouts of intense exercise. High-volt pulsed current (HVPC) is commonly applied to curb pain and edema formation, which is thought to hasten recovery following soft tissue injuries, although no research conclusively supports this notion or practice. **Objective:** To determine if, following DOMS, intermittent or continuous HVPC curbs pain or swelling, or hastens recovery relative to controls. **Design:** Double-blind, placebo-controlled, randomized clinical trial. **Setting:** Research Laboratory. **Patients or other Participants:** A sample of 13 uninjured college student volunteers (seven females: 21+/- 3 years, and six males: 21+/- 3 years) was randomly divided into two groups. Simulating an athletic training or physical therapy setting, one group (4 females and 4 males) received daily 20 minute treatments of HVPC for three consecutive days. The other (3 females and 2 males) received HVPC continuously for approximately 72 hours. **Interventions:** DOMS was induced in both calves of each subject by performing a series of bi-lateral calf raises. Subjects were fitted with bipolar stocking electrodes that were powered by miniature HVPC stimulators. One limb of each subject received sub-sensory HVPC, and the other limb received placebo stimulation. Placebo channels provided live stimulation, but for just 3 minutes after the final subsensory intensity settings were entered. Indicator lights remained illuminated regardless of actual output. Subjects and data collectors were blind to stimulator assignment throughout data collection. **Main Outcome Measure(s):** Pain and self assessment of function (via visual analog scales), lower leg swelling (via girth measurements), and function (via one-legged hop tests) were measured before and after DOMS induction and for the next 5 days. Changes from baseline (i.e., Post DOMS – Pre DOMS) were calculated for each variable. Data were

analyzed by repeated measures ANOVA, with alpha level was set at 0.05. **Results:** HVPC, whether intermittent or continuous, did not influence pain ($F(4,48) = 0.319$, $p = 0.643$, MSE = 15.26), pain during walking ($F(4,48) = 0.063$, $p = 0.878$, MSE = 13.91), pain during hopping $F(4,48) = 0.555$, $p = 0.509$, MSE = 16.601), swelling ($F(4,48) = 0.591$, $p = 0.605$, MSE = 0.218), or distances hopped ($F(4,48) = 1.895$, $p = 0.148$, MSE = 51.945), compared to control limbs. **Conclusions:** HVPC, as applied in this study, did not curb pain, swelling, or hasten return of function compared to sham stimulation following experimentally induced DOMS. The 'placebo', as it was applied in this study, had no discernable effects on the dependent variables.

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**The Influence Of High Volt Electrical Stimulation On Edema Formation Following Acute Injury: A Systematic Review Of The Literature**

Perotti AL, Bay RC, Snyder AR: Post-Professional Athletic Training Program, A.T. Still University, Mesa, AZ

**Context:** Electrical stimulation is often used in the treatment of acute injury for the purpose of limiting or reducing edema formation. Basic science investigations using animal models have examined the treatment parameters for the management of acute edema formation following acute injury. However, it is unknown whether these basic science findings translate into clinically meaningful changes in human subjects. **Objective:** To systematically review the literature regarding high volt electrical stimulation (HVPS) following acute injury to 1) identify the optimal treatment parameters (time of application, duration, and polarity, etc.) for the management of edema formation, and to 2) identify its effectiveness for limiting acute edema formation. **Data Sources**: CINAHL (1982- present), Medline (1966- present), PubMed, and Sports Discus databases were searched for relevant English language articles using the following keywords: "edema," "electrical stimulation," "high volt electrical stimulation," and combinations of these terms. Additionally, reference sections of relevant articles were hand searched. **Study Selection:** Articles were included if the study was an investigation into sensory level HVPS and its effect on edema formation following acute injury and included outcome measures specific to edema, such as limb volume or circumference. **Data Extraction:** A total of 13 articles met the inclusion criteria and were ultimately included in the review. Articles were divided into 2 categories: animal (N = 11) and human (N = 2) studies. **Data Synthesis**: Animal studies were utilized to review the basic science underlying HVPS and to identify optimal treatment parameters. Human studies were examined to evaluate the clinical effectiveness of HVPS. Studies were critiqued by electrical stimulation treatment parameters, including mode of stimulation, polarity, frequency, duration of treatment, voltage, intensity, number of treatments, overall time of treatments, and combination treatments. Eight animal studies (73%) reported that HVPS limited edema formation when compared to no treatment. The treatment parameters associated with a positive treatment outcome were stimulation delivered in a cathodal mode, at a frequency of 120pps, and at an intensity of 90% visible motor threshold. Continuous stimulation treatments of 3 hours in duration or successive 30 minute treatments applied immediately following injury appear to be most beneficial in limiting edema formation in animals. The two investigations using human subjects failed to support the use of HVPS for the control of acute edema formation. However, these studies did not use the same parameters as the animal studies. **Conclusions**: The results of this review indicate that, in animal subjects, HVPS can limit edema formation following acute injury. However, there are no data to support the use of HVPS for achieving clinically meaningful changes in edema formation in human subjects.

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**The Effect of Intramuscular Tissue Temperature on Hamstring Extensibility**

Moore AL, Silvey JR, Brucker JB, Demchak TJ, Huxel KC: Indiana State University, Terre Haute, IN

**Context:** *In vitro* animal studies in which ligament temperatures were raised 4°C above baseline or reached an absolute temperature of 40°C increased tissue extensibility. Currently, modality effects on human flexibility studies have reported hypothesized temperature levels in the tissues being elongated by referencing temperatures from other research. **Objective:** Determine the effect of intramuscular temperature, as increased by different diathermy treatments, on hamstring extensibility, *in vivo*. **Design**: Single-blinded, crossover **Setting:** Laboratory. **Participants:** Nineteen (M: 17, F: 2, age: 24±3.7 y, ht: 178.8±11.9 cm, mass: 96.3±23.1 kg, hamstring skinfold thickness: 20±7.6 mm) with a resting straight leg raise angle of inclination ≤ 80°. **Intervention(s):** Independent variables were time (pre-, & post-diathermy treatment) and hamstring intramuscular temperature after Sham, 10-min, and 20-min diathermy treatments. Subjects reported for 3 sessions at least 24 hours apart consisting of pre- treatment measures, diathermy treatment, and post-treatment measures. Diathermy (Magnatherm SSP Model No. 1000SS) treatments were applied, in a balanced order, to each of the mid-bellies of the right and left hamstrings using one of two-22.82 cm diameter drums covered with a towel. The right leg was connected to a passive straight leg pulley device including a digital inclinometer. A passive motive force equal to 15% of the subject's body mass was used to flex the hip. The investigator responsible for recording inclinometer measures left the lab between pre- and post-measures. Three hamstring extensibility measures were taken pre-and post-treatment. The last two measures were averaged and analyzed using a 2 (time) X 3 (temperature) ANOVA with repeated measures. Intramuscular temperatures were measured using thermocouples inserted 3 cm plus ½ the superficial tissue thickness. Temperatures were analyzed using a 2 x 3 ANOVA to ensure diathermy treatment duration caused different heating levels. **Main Outcome Measure(s):** Left hamstring intramuscular temperature and right hamstring extensibility as quantified by angle of inclination to the nearest 0.1°. **Results:** Hamstring intramuscular temperatures did not change during the sham treatment ($P>0.05$), but increased 2.82±1.01°C during the 10-min treatment (0-min = 36.26±0.68°C, 10-min = 39.08±1.35°C, $p < .001$), and 3.88±0.64°C during the 20-minute treatment (0-min = 36.26±0.68°C, 20-min = 40.14 ±0.60°C, $p < .001$). 10-minute and 20-minute post-treatment temperatures were different ($p < .006$). Hamstring extensibility increased 5.7°± 1.70° between pre- and post-measurements (Pre = 64.79°±7.41°, Post = 70.47°±9.11°, $P<.001$). However, there was no effect of muscle temperature on extensibility ($P<0.652$). The amount of increase from pre-test for each intramuscular temperature was: 36.26 °C = 3.92°±7.93°, 39.08 °C = 6.03°±7.88°, 40.14 °C= 7.11°±8.11°. **Conclusions:** Hamstring temperature increases up to 3.88 °C have no effect on hamstring extensibility as measured using these techniques.

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**Ice Bath Immersion Of The Hand Does Not Alter Vibratory Sensory Threshold**

Ferguson KN, Meyer RB, Evans TA, Ragan BG: Athletic Training Outcomes Research Laboratory, University of Northern Iowa, Cedar Falls, IA

**Context:** Recently performed cross-validation confirmed the attenuating effects of cryotherapy on sensory pressure discrimination. However, only a continuous (non-moving) pressure stimulus was applied,

therefore targeting only one type of cutaneous mechanoreceptor. The effects of cryotherapy on other types of mechanoreceptors, such as those that sense vibration, are uncertain. **Objective**: Our purpose was to examine the effects of an ice bath immersion on cutaneous mechanoreceptors responsible for sensing vibration. **Design:** A repeated measures experimental design was used. **Setting**: Controlled laboratory setting. **Participants:** Nineteen participants (age = 20.37 yrs ± 1.07; mass = 74.26 ± 14.81 kg; height = 171.45 ± 10.13 cm) volunteered in accordance with IRB protocol. **Interventions:** Our independent variables were a ten minute control treatment and a ten minute ice bath (4ºC) treatment with the hand immersed up to the wrist. The control treatment consisted of 10 minutes of quite sitting. The dependent variable was the vibratory sensory threshold of the distal phalanx of the 2nd finger. Vibratory sensory threshold was assessed with the Case IV Computer Aided Quantitative Sensory Evaluator (Medical Electronics Co., Stillwater, MN). The Case IV Evaluator administered a series of vibratory stimuli via a plunger-like device positioned over the distal phalanx. The stimuli magnitudes varied according to the computer algorithm sequence test. Participant's, prompted by a light, respond "yes" or "no" to indicate if a stimulus was felt. Testing continued until the computer determined the weakest vibratory stimulus the participant could detect. Delta scores were analyzed using a Freidman's repeated-measures analysis (ice bath and control). Significance level was set at .05. **Main Outcomes Measures:** The minimal detectable vibratory stimulus (µm) was recorded before and after the control and ice bath immersion. **Results:** Vibratory sensory threshold over the distal phalanx was not significantly reduced following the ice bath immersion ($\chi^2$ = 0.25, p = 0.62). Mean change values for the control and ice bath treatments were 1.02µm ± 1.96 and -1.73µm ± 6.08, respectively. **Conclusions:** Although the application of ice has been shown to diminish sensitivity to a continuous pressure stimulus, these results indicate that a ten minute ice bath immersion of the hand does not alter sensitivity to vibratory stimulus at the finger. Therefore, cryotherapy may impact cutaneous mechanoreceptors, such as Ruffini endings, that are responsible for the detection of a sustained pressure stimulus, but not receptors such as Pacinian corpuscles that sense vibration. Continued exploration into the effects of cryotherapy on the various cutaneous mechanoreceptors will aid in understanding the mechanisms through which it effects sensation. *Student Poster Award Finalist*

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**Ice Bath Immersion of the Hand Alters Continuous Pressure Sensory Threshold**

Meyer RB, Ferguson KN, Evans TA, Ragan BG: Athletic Training Outcomes Research Laboratory, University of Northern Iowa, Cedar Falls, IA

**Context:** Previous research from our laboratory indicated that ice application over the upper trapezius diminished sensory discrimination when assessed with a continuous (non-moving) pressure stimulus. However, it is uncertain if these changes are apparent at different body locations with a greater concentration of cutaneous mechanoreceptors, such as the hand. **Objective**: Our purpose was to examine the effects of a ten minute ice bath immersion on sensory discrimination of the hand using a continuous pressure stimulus. **Design:** We used a repeated measure experimental design. **Setting**: The study was performed in a controlled laboratory setting. **Participants**: Twenty volunteers (age = 20.70 yrs ± 1.81; mass = 74.74 ± 14.58 kg; height = 171.77 ± 9.96 cm) participated in accordance with IRB protocol. **Interventions:** Each participant underwent a control treatment and a ten minute ice bath immersion (4ºC) to the dominant hand. The control treatment consisted of quiet sitting for ten minutes. Sensory pressure threshold was assessed at the dorsal aspect of the hand with the Von Frey Touch-Test Evaluator (North Coast Medical, Inc.). The Von Frey hairs are 20 monofilaments similar to paintbrush hairs, ranging from very fine to thick. The fiber tip is pressed against the skin at right angles until the fiber bends at the calibrated pressure. The examiner continues touching/bending with fibers of increasing thickness until the participant feels a fiber touch and responds "yes". Independent variables were the ten minute ice bath treatment (4ºC) to the hand and the control treatment. The dependent variable was pressure sensory threshold. Delta scores (change between pre- and post- measurements) were calculated for the ice bath and control treatments and analyzed using a Freidman's repeated-measures analysis ($p < .05$). **Main Outcomes Measures:** The main outcome was sensory pressure threshold, measured in grams, recorded before and after a control and an ice bath treatment. **Results:** Sensory discrimination at the dorsum of the hand was significantly reduced following ice bath immersion ($\chi^2$ = 12.80, p <.001). When comparing mean change values, the ice bath immersion ( = -0.72g ± 0.80) produced greater differences than the control treatment ( = -0.02g ± 0.18). **Conclusions**: Our results indicate that a ten minute ice bath immersion reduces sensory pressure discrimination at the dorsum of the hand. This supports previous research from our laboratory indicating that sensory discrimination, assessed with continuous pressure from the Von Frey filaments, is reduced following ice application. However, the aim of using cold prior to activity is to facilitate movement. Although our findings suggest caution be used when using cold to facilitate movement during rehabilitation, future research should examine the impact of ice immersion on the ability to sense a moving pressure sensory stimulus such as vibration.

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**The Effects Of Pulsed Shortwave Diathermy And Stretch On The Torque-Angle Relation Of The Calf (Plantar Flexor) Muscles Associated With Passive Stretch Both During And After Treatment**

Schorr MJ, Ricard MD, Trowbridge CA, Fincher AL: The University of Texas at Arlington, Arlington, TX

**Context:** Tissue heating with passive stretch may reduce musculotendinous stiffness; however, current research has not established guidelines for the clinical application of heat and stretch protocols. **Objective:** The purpose of this study was to asses the effects of stretching applied both during and/or after pulsed shortwave diathermy (PSWD) on the torque-angle relation of the triceps surae muscles. **Design:** We used a 3 X 4 (Time X Treatment) crossover repeated measure designs. Alpha was set *a priori* at 0.05. **Setting:** Neuromuscular Exercise Science and Research Laboratory. **Patients or Other Participants:** Sixteen males volunteered (height, 175.8 ± 9.13 cm; mass 82.3 ± 17.1 kg; age, 22.9 ± 3.7 yrs) for our study. Subjects had no previous history of lower leg injury, no hypersensitivity to needles, and a calf skinfold measurement of less than 25 mm (0.98 in). **Interventions:** Independent variables included time (pre, post, post 15 minutes) and treatment (stretching during diathermy (PSWD_10), stretching after diathermy (PSWD/10), and stretching during and after diathermy treatment (PSWD 5/5), and a control group (CON)). PSWD treatment was delivered at 27.12 MHz, 800 pps, 400 µsec for 20 minutes and stretching was 10 minutes of low load long duration passive stretching at maximum tolerated dorsiflexion position. Passive tension data were collected using a Biodex® dynamometer during 3 minutes of passive ankle motion through 30º of ankle ROM (from maximum dorsiflexion) at a speed of 5º/sec. Intramuscular temperature was sampled using an intramuscular thermocouple inserted 2.5 cm into medial gastrocnemius. Temperature data was collected using an Isothermex® interfaced with desktop computer. Surface EMG of tibialis

anterior, gastrocnemius, and soleus were also sampled. Reproducibility of average stiffness (ICC = 0.836) and peak torque (ICC = 0.803) measurements were computed from familiarization and pre test data using a two factor mixed effects model and type consistency. Data were analyzed with separate repeated measures ANOVAs. **Main Outcome Measures:** Dependent variables were peak torque (Nm), average stiffness (Nm/rad), and intramuscular temperature (°C). **Results:** Intramuscular temperature significantly increased from baseline ($p<0.05$) for all PSWD treatments (average: 3.51±0.27°C). Peak torque decreased 12% ($p=0.01$) from pre to post test (PSWD5/5:19.28±1.40 Nm (pre) and 16.77±1.29 Nm (post); PSWD/10:19.68±1.33 Nm (pre) and 17.27±0.94 Nm (post)) and remained below the pre test value at post 15 minutes ($p<0.05$) for both groups (PSWD 5/5:17.77±1.52 Nm; PSWD/10:17.80±0.98 Nm). Average stiffness decreased 10% ($p=0.01$) from pre to post test (PSWD5/5:60.85±4.78 Nm/rad (pre) and 53.63±4.22 Nm/rad (post); PSWD/10:61.77±4.52 Nm/rad (pre) and 56.32±3.45 Nm/rad (post)); however, the changes were not significant at post 15 minutes ($p>0.05$). **Conclusions:** Our data indicates that in order to decrease musculotendinous stiffness the best time to stretch is after the tissue has been heated and while the tissue is cooling. *Funded by a grant from the NATA Research and Education Foundation.*

# Free Communications, Poster Presentations: Assessment Tools and Instrumentation

Wednesday, June 18, 2008, 1:00PM-5:00PM, 2nd Floor Atrium; authors present 2:00PM-3:00PM

### Accuracy Of The Diagnostic Tests Used In The Assessment Of Superior Labrum, Anterior And Posterior (SLAP) Lesions

Rosen AB, Chhabra S, Kaminski TW: Athletic Training Research Laboratory, University of Delaware, Newark, DE

**Context:** A superior labrum, anterior and posterior (SLAP) lesion is a common injury in the overhead athlete. It is imperative to diagnose the SLAP lesion accurately and subsequently treat to avoid "dead arm" and/or damage to the shoulder joint. Several clinical tests have been proposed to diagnose the SLAP lesions; however it is unclear as to which of those tests are effective in assisting the clinician in the assessment process. **Objective:** To perform a systematic review to determine the best clinical test/combination of tests to identify SLAP lesions. **Data Sources:** A computerized search of MEDLINE, ISI Web of Science, and PubMed was performed back to 1966, using the keywords SLAP, Labr$, Clinical, Lesion, Superior AND Labr$, Superior AND lesi$. **Study Selection:** Studies were selected if they met the following requirements (1) utilized human subjects; (2) published in English; (3) included any kind of SLAP lesion; and (4) compared results to another clinical test(s). **Data Extraction:** Two reviewers assessed methodological quality using the PEDro scale. Measures of accuracy including specificity, sensitivity, positive (+LR) and negative (–LR) likelihood ratios were scrutinized in each report. **Data Synthesis:** Thirteen studies (1427 subjects and 13 different clinical tests) met inclusion criteria. We calculated the mean values for sensitivity, specificity, +LR, and –LR by using the weighted average method described by the following equation: $Averaged\ value = \sum (Number\ of\ subjects\ tested * value\ of\ parameter) / \sum Number\ of\ subjects\ tested$ In the equation, the "parameter" represents either of the accuracy measures (sensitivity or specificity or +LR or –LR). The highest rated tests from a specificity point of view were the Pain Provocation (90%) and Yergason's (91%) tests; while from a sensitivity standpoint the Active Compression (O'Brien's) test (69%) rated highest. The Active Compression test was best with *combined* sensitivity (69%) and specificity (66%) values. Although the Pain Provocation test (4.37) had the highest +LR; this represents a "small" value ("sometimes important" clinical test). The best clinical test from a –LR standpoint was the Active Compression test (0.47). This too represents a "small" value ("sometimes important" clinical test). No tests had either "strong" or "moderate" +LR or –LR. **Conclusions:** There are a variety of clinical tests that have been reported to aid in the diagnostic process; however most were unable to pass our careful, evidence-based analysis. There is no "ideal" clinical test to diagnose SLAP lesions when all four accuracy measures are examined simultaneously; however, the Active Compression, Yergason's, and Pain Provocation tests are of reasonable quality when two or three of the accuracy measures are taken into account. We conclude that individual clinical tests alone are inadequate in the diagnosis of SLAP lesions and recommend that a careful and complete shoulder history be considered in conjunction with clinical testing for a successful evaluation.

### Functional Deficits Following Isokinetic Versus Overloaded Isotonic Eccentric Resistance Exercise

Parr JJ, Yarrow JF, Garbo CM, Borsa PA: University of Florida, Gainesville, FL

**Context:** Recent studies have shown that rehabilitation protocols involving eccentric resistance exercise performed with loading >100% concentric 1RM (i.e., overloaded) are effective in increasing functional capacity following musculoskeletal injury. The mode (isokinetic vs. isotonic) of eccentric exercise may be an important factor in limiting symptoms such as delayed onset muscle soreness (DOMS) and improving functional recovery following injury. Studies designed to compare the magnitude of symptoms and functional recovery following different modes of overloaded eccentric exercise may lead to improvements in the design and implementation of rehabilitative exercise protocols. **Objective:** To compare functional and symptomatic responses (strength, range of motion (ROM) and point tenderness) following an isotonic versus an isokinetic exercise protocol matched for total exercise volume. **Design:** A repeated measures with subjects randomized into two groups. **Setting:** Controlled research laboratory. **Patients or Other Participants:** Twenty-four healthy untrained college-age males (n=12) and females (n=12) volunteered for this study (age 21.2±0.6; ht. 171.40±10.09cm, wt. 72.85±16.32kg). **Interventions:** Participants were randomly assigned to overloaded isotonic (3 sets x 10 eccentric-only repetitions at 140% concentric 1RM) or maximal isokinetic (10 sets x 5 repetitions at 30°/sec CON and 60°/sec ECC) exercise groups and performed a single bout of overloaded resistance exercise involving the elbow flexors. Separate one-way ANOVAs and 2 (Groups) x 5 (Time) repeated measure ANOVAs were used to determine outcome differences. Tukey's post-hoc test was performed when indicated. **Main Outcome Measures:** Measurements of elbow flexion and extension, isometric strength, and muscular point tenderness were obtained prior to exercise (baseline) and during follow-up sessions (Days 2, 4, 7 and 14). **Results:** At baseline, no differences were present between groups for any measure. Specifically, total training volume was similar between groups (isotonic 2697.56±1496.69J vs. isokinetic 2475.44±1014.19J, $p>0.05$) and the average total ROM for isokinetic (145.8±3.9°) and isotonic (146.6±8.0°) was also not

significantly different between groups ($p>0.05$). Isotonic exercise was shown to produce significantly greater functional deficits when compared to isokinetic. Isotonic exercise resulted in a 30-36% deficit in muscular strength [$F(4, 44)=7.44$, $p<0.01$], a 5-7% reduction in elbow flexion and a 6-8% reduction in elbow extension at follow-up days 2 and 4. This resulted in an extension lag of $21.2\pm15.1^{o}$ on day 2 and a $9.7\pm11.6^{o}$ on day 4. The isokinetic exercise did not alter muscular strength or ROM at any time point when compared to baseline ($p>0.05$). Point tenderness was found to have a significant main effect [$F(4, 44)=7.62$, $p<0.01$), but no interaction between exercise protocols. **Conclusions:** Our results indicate that more pronounced functional deficits occur following a single bout of overloaded eccentric isotonic exercise then from isokinetic exercise. These deficits were likely induced through muscle microtrauma and DOMS and could possibly delay or impair early-phase functional recovery in athletes undergoing rehabilitation.

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**Students Are Reliable Assessing A Peer Performing An Athletic Training Psychomotor Skill**

Marty MC, Henning JM, Willse JT: The University of North Carolina at Greensboro, Greensboro, NC

**Context:** Peer assessment is defined as students evaluating the products or outcomes of learning. The reliability and validity of peer assessment needs to be determined to establish the appropriateness of its use. **Objective:** Determine the reliability and validity of peer assessment of a psychomotor skill. **Design:** Non-experimental repeated measures. **Setting:** Entry-level master's athletic training education program (ATEP). **Participants:** First-year (n=8) and second-year (n=9) students enrolled in an entry-level master's ATEP. **Interventions:** Participants evaluated ten videos of a peer performing a psychomotor skill on two occasions using a valid assessment tool. Each video had intentional errors to assist in determining the reliability of the peer assessment. **Main Outcome Measures:** The reliability of the students' assessment of a peer instructing a patient to do a supraspinatus strengthening exercise was examined through a generalizability study, which partitions error variance into facets. A decision study using the generalizability theory was performed to compare how consistency is affected by the number of raters and number of occasions. Validity was examined using a t-test. **Results**: A majority of the error in the ratings came from the different videos (44.61%) and the items in the video (52.41%). This was expected because the videos were constructed with variance. Rater variance accounted for 2.93% of the variance and occasion accounted for 0.04% of the variance. The decision study showed that having one rater on one occasion has a phi=0.70. The phi can be increased to meet accepted standards by having two raters assess on one occasion (phi=0.82) or having one rater assess on three occasions (phi=0.80). A repeated measures ANOVA showed the participants were consistent in ratings from occasion one to occasion two ($F(1,14)=1.29$, $p=0.275$). Mean scores on occasion one were $87.25\pm4.40$ for first-year and $91.25\pm2.31$ for second-year students; a perfect score was 100. A t-test test showed the assessments were significantly different than the perfect score for first-year students ($t(7)=-6.86$, $p=0.00$) and second-year students ($t(7)=-8.95$, $p=0.00$). **Conclusions:** The results of this study indicate that students enrolled in an entry-level master's ATEP can reliably assess a peer performing a psychomotor skill. The reliability of peer assessment can be enhanced by having the skill assessed by more than one peer or on more than one occasion. While the students did not assess their peers with 100% accuracy, their assessments were still within an acceptable range. The average number correct was greater than 87%, although one of the first-year students scored below 80%.

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**A Comparison Of Standard Goniometry Versus Computer Aided Lateral Digital Photography Goniometry For Wrist Flexion And Extension**

Henderson JW, Berry DC, Hennessy EF, Ruden TM: Weber State University, Ogden, UT

**Context:** Range of motion (ROM) is normally assessed through standard goniometry (SG). SG measurements though are often inconsistent due to a variety of measurement errors. Therefore, clinicians have attempted to find alterative methods of accurately assessing joint motion. **Objective:** To compare the relationship between wrist flexion and extension active ROM using SG and computer aided lateral digital photography goniometry (CALDPG) using a non-corrected and corrected technique. **Design:** Quasi-experimental design. **Setting:** Athletic training laboratory. **Patients or Other Participants:** Thirty-nine subjects, 16 males and 23 females (age, 21.7 + 3.0 years; height, 170.2 +11.2 cm; mass, 70.7 + 15.2 kg) free of upper extremity injuries and pain for six months participated. **Interventions:** Subjects were seated for a single session measurement of wrist flexion and extension through a full ROM. To control measurement error, subjects' elbows were placed at 90° with the same tester identifying each landmark's position. Measurements were counterbalanced to control effect bias. SG ROM was assessed using traditional landmarks; ulnar styloid process, ulna long axis, and fifth metacarpal long axis. CALDPG ROM was assessed using markers placed over the ulnar styloid process, ulna long axis, and center of the 5th metacarpophalangeal joint. Upon reaching maximal joint movement, a digital photograph of each position was taken and downloaded to a laptop computer. We viewed each photo in landscape mode using a specially designed computer program to assess non-corrected and corrected CALDPG. Non-corrected CALDPG was measured by placing a crosshair device on each site marker's center to identify the X,Y coordinates. To correct for deviations in marker position (due to variations in bony landmarks), corrected CALDPG was measured by selecting the perceived position of the anatomical landmarks (due to deviations in landmark position) and replacing the 4th metacarpophalangeal joint with the 5th. The Law of Cosines ($a^2 = b^2 + c^2 - [2bc\ CosA] - 180$) was applied to calculate joint angles. We used a Pearson Product Moment Correlation Coefficient to determine the relationship between SG and CALDPG wrist motion. **Main Outcome Measures:** Wrist flexion and extension ROM measurements using SG, non-corrected and corrected CALDPG measured in degrees. **Results:** Wrist flexion SG, non-corrected, and corrected CALDPG mean (SEM) scores were 77.2° (1.07°), 79.1° (1.49°), and 75.3° (1.27°). Extension SG, non-corrected, and corrected CALDPG mean (SEM) scores were 66.53° (1.23°), 31.39° (2.06°), and 62.2° (1.17°). The following relationships were found between SG and corrected CALDPG for flexion and extension, $r\ (37) = .536$, $r^2 = 0.29$, $P < .001$ and $r\ (37) = .717$, $r^2 = 0.51$, $P < .001$, respectively. **Conclusion:** Results suggest corrected CALDPG for wrist motion offers the potential to properly assess ROM. Further research is warranted to examine marker placement due to joint deviations and intra- and intertester reliability.

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**The Usefulness Of The SANE Score To Diagnose Knee Injuries In High School Athletes**

McGuine TA, Landry GL, Leverson G, Buchholz AL: University of Wisconsin Health Sports Medicine Center, Madison, WI

**Context:** The SANE (Single Assessment Numeric Evaluation) score is a simple patient-based outcome scale utilized by researchers and clinicians to assess knee function in adults. However, the usefulness of the SANE score

to assess knee function in high school athletes has not been reported. Determining the reliability of the SANE score and comparing it to other outcome scales are necessary steps to determine if the SANE is an appropriate measure to use for high school athletes with a knee injury. **Objective:** To determine the reliability of the SANE knee score and compare it to other more complex scales in a population of high school athletes with a knee injury. **Design:** Correlation Study. **Setting:** Outpatient sports medicine clinic. **Participants:** Seventy two (44 Male and 28 Female) athletes (16.3 ± 1.4 years) who sustained a knee injury while participating in high school sports. Ninety percent (65/72) of the athletes sustained acute injuries while 54.1% (39/72) required surgery. Injuries were sustained in Football (n = 30), Soccer (n = 23), Basketball (n = 8), Volleyball (n = 4), Cross Country (n = 4) and Cheer/Dance (n = 3). **Measures:** Subjects completed the: 1) SANE , 2) 2000 International Knee Documentation Committee (IKDC) Functional Knee Scale and 3) The Physical Health Summary (PHS) of the Pediatric Quality of Life Inventory for Teens v 4.0 during their initial MD visit and again within 5 – 14 days. **Results:** The scores (Avg. ± St. Dev., (95% CI)) at the initial MD visit were SANE = 49.29 ± 23.6 (43.9, 54.7), IKDC = 47.2 + 18.9 (42.8, 51.6) and PHS = 52.5 + 24.2 (46.9, 58.1). The mean difference between the first and second administrations of the SANE = -4.9 + 15.4 (-8.4, -1.4). The correlation (r, (95% CI)) between the first and second SANE score was r = 0.777 (0.666, 0.854). Correlation's for the SANE to the IKDC were r = 0.842 (0.767, 0.902) and to the PHS r = 0.669 (0.558, 0.802) respectively. **Conclusions:** The SANE knee score is reliable when used on high school athletes in a clinical setting. In addition, it compares favorably to the 2000 IKDC as an outcome measure to help clinicians determine knee function in high school athletes with a knee injury. Future research needs to be conducted to determine if the SANE is responsive to change over time in high school athletes as they recover from their knee injuries.

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**A Comparison Of Standard Goniometry Versus Computer Aided Lateral Digital Photography Goniometry For Elbow Flexion And Extension**

Hennessy EF, Berry DC, Henderson JW, Ruden TM: Weber State University, Ogden, UT

**Context:** Clinical assessment of joint range of motion (ROM) traditionally uses standard goniometry (SG) measurements. A new method of measuring ROM using Computer Aided Lateral Digital Photography Goniometry (CALDPG) has demonstrated linear relationships between SG and CALDPG knee and ankle ROM, suggesting CADLPG is a possible option for assessing joint ROM. **Objective:** The purpose of this study was to compare the relationship between elbow flexion and extension active ROM using SG and CALDPG using a non-corrected and corrected technique. **Design:** Quasi-experimental design. **Setting:** Athletic training laboratory. **Patients or Other Participants:** Thirty-nine subjects, 16 males and 23 females (age, 21.7 + 3.0 years; height, 170.2 +11.2 cm; mass, 70.7 + 15.2 kg) free of upper extremity injuries and pain for six months participated. **Interventions:** Subjects were placed supine for a single session measurement of elbow flexion and extension through a full ROM. To control measurement error, a towel was placed under the distal posterior humerus and the same tester identified each landmark's position. Measurements were counter-balanced to control effect bias. Standard goniometric elbow ROM was assessed using traditional landmarks; lateral epicondyle, long axis of humerus, and radial styloid process. A digital photograph of each position was taken and downloaded to a laptop computer. We viewed each photo in landscape mode using a specially designed computer program to assess non-corrected and corrected CALDPG. Non-corrected CALDPG was measured by placing a crosshair device on each site marker's center to identify the X,Y coordinates. Corrected CALDPG was measured to correct for deviations in marker position by selecting the perceived position of the anatomical landmarks. The Law of Cosines ($a^2 = b^2 + c^2 - [2bc\ CosA] - 180$) was applied to calculate joint angles. We used a Pearson Product Moment Correlation Coefficient to determine the relationship between SG and CALDPG elbow flexion and extension. **Main Outcome Measures:** Elbow flexion and extension ROM measurements using SG, non-corrected and corrected CALDPG measured in degrees. **Results:** Elbow flexion SG, non-corrected and CALDPG mean (SEM) scores were 144.0° (.92°), 140.7° (1.03°), and 142.8° (.79°). Extension SG, non-corrected and corrected CALDPG means (SEM) were 1.7° (.56°), -9.6° (1.80°), and .14° (.77°). The following relationships were found between elbow flexion SG and non-corrected $r$ (37) = .459, $r^2$ = 0.21, $P$ = .003 and corrected $r$ (37) = .715, $r^2$ = 0.51, $P$ < .001 CALDPG. **Conclusion:** The accuracy of the non-corrected CALDPG appears less than desirable under the present methods. A clinician's knowledge of anatomical landmarks however, appears more accurate to assess elbow flexion rather than relying on the application of markers to mimic the anatomic landmarks. Therefore, more research is needed to develop an accurate system to examine CALDPG at the elbow. *Student Poster Award Finalist*

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**Reliability Of A Portable-Fixed Dynamometer For Use During Large Scale Pre-Participation Physical Examinations**

Kollock R, Oñate JA, Van Lunen B: Old Dominion University, Norfolk, VA

**Context:** Hand-held and isokinetic dynamometry are often used to quantify the strength of the lower extremity musculature. Although investigators have reported moderate to high reliability of various instruments, they possess clinical and logistical limitations, such as the need for the tester to exert adequate tester-patient force-counter-force and limited portability. These limitations restrict their use during large-scale, pre-participation physical examinations (PPE). Therefore, it is necessary to assess the reliability of other devices that can address these limitations. **Objective:** To evaluate the reliability of a novel portable fixed dynamometer (PFD) design in measuring isometric strength at the hip and knee. **Design:** A test re-test design was utilized in this study to assess intra-session and inter-session reliability. **Setting:** Sports medicine research laboratory **Patients or Other Participants:** The sample population consisted of 11 healthy college graduate students (23.27±1.01 years, 168.56±7.47 cm, 71.46±17.45 kg). **Interventions:** The study evaluated the use of a PFD by one tester across three-test sessions separated by one day. Subjects performed 3 trials of a 5 s max isometric contraction with a 10 s rest period between each trial. A 10% coefficient of variation (CV) was set to ensure a consistent effort by subjects across each trial. The motions assessed were hip abduction (AB), hip adduction (AD), hip internal rotation (IR), hip external rotation (ER), hip flexion (HF), hip extension (HE), knee extension (KE), and knee flexion (KF). Data were collected using a PFD, the Evaluator (BTE Technologies, Hanover, MD). Intraclass correlation coefficients (ICC) along with associated standard error of measure (SEM) were calculated to determine intra-session ($ICC_{2,1}$), and inter-session ($ICC_{2,k}$) reliability of the device in accurately assessing hip and knee strength. **Main Outcome Measures:** The dependent variables for the study were AB, AD, IR, ER, HF, HE, KF, and KE peak force measures recorded in pounds (lbs). **Results:** The intra-session (ICC, SEM) values across three test sessions for each hip and knee motion were as follows: session-one [hip AB

(.99,.08), AD (.92,.28), IR (.95,.18), ER (.90,.19), HF (.88,.41), HE (.97,.20), KF (.88,.41), and KE (.89,.61)], session-two [AB (.99,.05), AD (.94,.20), IR (.94,.19), ER (.93,.27), HF (.95,.19), HE (.99,.06), KF (.85,.46), and KE (.87,.90)], and session-three [AB (.96,.11), AD (.95,.19), IR (.96,.11), ER (.93,.23), HF (.96,.13), HE (.96,.11), KF (.92,.31), and KE (.92,.67)]. The inter-session (ICC, SEM) values per motion were as follows: hip AB (.94,.75), AD (.95,.56), IR (.97,.33), ER (.96,.38), HF (.96,.50), HE (.95, 35), KF (.87,.88), and KE (.95,.73). **Conclusions:** The Evaluator PFD showed excellent intra- and inter-session reliability values for hip and knee strength. The Evaluator PFD is a reliable option to addressing many of the concerns associated with the use of hand-held and isokinetic dynamometry during large-scale PPE.

# Free Communications, Poster Presentations: Secondary School and Adolescent Issues

Wednesday, June 18, 2008, 1:00PM-5:00PM, 2nd Floor Atrium; authors present 2:00PM-3:00PM

### Health-Related Quality Of Life Is Affected By Recent Injury In Adolescents

Valovich McLeod TC, Bay RC, Teeters JC, Parsons JT, Sauers EL, Snyder AR: Post-Professional Athletic Training Program, A.T. Still University, Mesa, AZ

**Context:** Health-related quality of life (HRQOL) is a global concept that takes into account the physical, psychological, and social domains of health. This broad view considers the whole-person and extends beyond the physiological and psychosocial components of health by addressing the person's disability and societal limitations. Determining to what extent HRQOL is affected by injury is an important aspect of athletic training practice to enable clinical outcomes comparisons across different conditions in diverse patient groups. **Objective:** To examine the extent to which a self-reported recent injury affects HRQOL in adolescents utilizing two generic patient self-report scales, the Medical Outcomes Short Form (SF-36) and the Pediatric Outcomes Data Collection Instrument (PODCI). **Design:** Cross-sectional. **Setting:** High school classrooms and athletic training facilities. **Patients or Other Participants:** A convenience sample of uninjured (n=336, 203 females, 133 males, age=15.9±1.1 years, grade=10.8±1.0 level) and injured (n=67, 43 females, 24 males, age=15.9±1.2 years, grade=10.7±1.0 level) adolescents. **Interventions:** The independent variable was injury status; uninjured (UNI) vs. injured (INJ). All subjects completed a self-administered brief health status questionnaire and the SF-36 and PODCI in a counterbalanced manner. Both instruments are commonly used measures of HRQOL with reliability coefficients of the .84-.95 (SF-36) and .76-.97 (PODCI). Group differences were assessed with the Mann-Whitney U test ($p \leq .05$) and reported as median [interquartile ranges(IQR): 25th, 75th]. **Main Outcome Measures:** Dependent variables included: 8 subscale scores of the SF-36 [physical functioning (PF), role limitations due to physical health problems (RP), bodily pain (BP), general health perceptions (HP), vitality (VT), social functioning (SF), role limitations due to emotional problems (RE), and mental health (MH)], two composite SF-36 scores [physical (PCS), mental (MCS)], the 5 subscale scores of the PODCI [upper extremity and physical functioning (UE), transfer and basic mobility (TBM), sports and physical functioning (SPF), pain/comfort (PC), happiness (HAP)] and the PODCI global score. Higher scores on both measures indicate better HRQOL. **Results:** On the SF-36, the INJ group reported significantly lower HRQOL for the PF [p<.001: UNI=57.1 (IQR:55.1,57.1); INJ=55.0 (IQR:51.0,57.1)], RP [p<.001: UNI=56.6 (IQR:51.9,56.6); INJ= 51.9(IQR:44.7,56.6)], BP [p<.001: UNI=54.2(IQR:50.1,60.9); INJ=45.1(IQR:40.5,50.1)], and SF [p=.007: UNI=56.4(IQR:45.6,56.4); INJ=51.0 (IQR:45.6,56.4)] subscales and the SF-36 PCS score [p<.001: UNI= 54.8 (IQR: 51.7,56.7); INJ= 50.9 (IQR: 46.1,54.7)]. On the PODCI, the INJ group reported significantly lower HRQOL for the PC [p<.001: UNI= 48.5 (IQR: 38.2,53.3); INJ= 35.6 (IQR: 26.8,42.0)] subscale and the global score [p<.001: UNI= 50.0 (IQR:42.4,54.8); INJ= 40.6 (IQR:30.0,45.4)]. **Conclusions:** Adolescents with a self-reported injury demonstrated lower HRQOL compared to their uninjured peers. Recent injury affected physical functioning and pain. Interestingly, there was also a decrease in social functioning (SF-36) and global HRQOL (PODCI) that indicate injuries affect areas outside the expected physical component of health. Future studies should include these or similar generic measures of HRQOL to assess the influence of injury on the whole-person in athletic populations with sport-related injury.

### The Reliability Of The Headache Impact Test And Pediatric Migraine Disability Assessment For Measuring The Impact Of Headache On Health-Related Quality Of Life In Adolescents

Piebes SK, Bay RC, Snyder AR, Valovich McLeod TC: Post-Professional Athletic Training Program, A.T. Still University, Mesa, AZ

**Context:** Health-related quality of life (HRQOL) is a global concept that considers whole person health by addressing disability and societal limitations, in addition to physical complaints. Symptoms associated with athletic injury can greatly affect an individual's HRQOL. Headache is a commonly reported symptom among otherwise healthy athletes as well as the primary symptom associated with sport-related concussion. Studies of the adult population have found recurrent headaches to significantly impact HRQOL. However, similar studies have not addressed adolescents nor have the measurement properties of headache-specific outcomes instruments been adequately studied in this important population. **Objective:** To evaluate the measurement properties of the Headache Impact Test (HIT-6) and Pediatric Migraine Disability Assessment (PedMIDAS) in healthy adolescent athletes. **Design:** Descriptive Survey **Setting:** High school athletic training facilities. **Patients or Other Participants:** 147 athletes (female=69, male=78, age=15.4±.99 years, grade =10.2±.96) from a convenience sample. **Interventions:** All subjects completed a self-administered concussion history survey, the HIT-6, and the PedMIDAS on two occasions, two weeks apart. Internal consistency was evaluated on both test days with Chronbach's alpha. Test-retest coefficients were analyzed using Pearson R for both the total scores and individual items on each scale. **Main Outcome Measures:** Dependent variables were the HIT-6 and PedMIDAS item and total scores. Both scales are 6-item self-report instruments with the higher composite score indicating a greater impact of headache/ migraine on HRQOL. Composite scores on

the HIT-6 range from 36 (answering "never" to all items) to 78 (answering "always" to all items). The PedMIDAS score is the composite of the 6 items with the value representing the number of days migraine has resulted in disability (0-10=little disability, 11-30=mild, 31-50=moderate, >50=severe). **Results:** The internal consistency of the HIT-6 was .88 and .91 on the test and retest sessions, respectively. The test-retest reliability of the HIT-6 total score was .70 with individual item coefficients ranging from .47 (Item 4)-.72 (Item 1). The internal consistency of the PedMIDAS was .72 and .73 on the test and retest sessions, respectively. Test-retest reliability of the PedsMIDAS was .81 and individual item reliability coefficients ranged from .02 (Item 1)-.85 (Item 4). **Conclusions:** Both instruments demonstrated acceptable internal consistency in an adolescent athlete population. We found moderate reliability on the total scores for both the HIT-6 and PedMIDAS and individual item reliability ranged from poor to good. Clinicians should be cautious when using these tools to measure the impact of recurrent headaches on a "normal" population of adolescent athletes. While the inter-item analysis values for the PedMIDAS were comparable to those reported in the original development article, the numbers are not sufficient to assume clinical relevance. Future research should consider the usefulness of these or similar instruments in the evaluation of injured (concussed) athletes.

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**Cross-Sectional Study Of The Health-Related Quality Of Life Using The Pediatric Data Collection Instrument In An Adolescent Population**

Teeters JC, Valovich McLeod TC, Bay RC, Martinez JC, Parson JP, Sauers EL, Snyder AR: Post-Professional Athletic Training Program, A.T. Still University, Mesa, AZ

**Context:** The Pediatric Data Collection Instrument (PODCI) is a patient-based outcome scale for adolescents with orthopaedic conditions. An understanding of the representative values for the PODCI in adolescents participating in different activities is necessary for assessment of the impact of injury yet these data are currently unavailable. **Objective:** To compare HRQOL in healthy student athletes (ATH), students involved in clubs/activities (CLUB), and students not involved in school activities (NON). **Design:** Cross-sectional. **Setting:** High school classrooms and athletic facilities. **Patients or Other Participants:** Convenience sample of adolescents who were classified as either ATH (n=205, 108 females, 97 males, age=16.1±1.1, grade=10.8±1.0), CLUB (n=91, 76 females, 15 males, age=16.1±1.0, grade=11.0±.9), or NON (n=104, 59 females, 45 males, age=15.7±1.2, grade=10.5±1.1). **Interventions:** The independent variable was group; ATH, CLUB, NON. All subjects individually completed a brief health status questionnaire and the PODCI during a single class period. The PODCI has previously reported subscale reliability coefficients ranging from .76-.97. Preliminary omnibus tests (Kruskal-Wallis; $p<.05$) were conducted to test for differences across the groups. Pairwise tests [Mann-Whitney U (test of mean ranks); $p<.05$] were subsequently conducted to identify group differences on those subscales that were significant on the omnibus test (SPF, PC, and HAP) and are reported as median [interquartile range(IQR): $25^{th}$, $75^{th}$] for descriptive purposes. This analysis was exploratory and adjustments for multiplicity were not made. **Main Outcome Measures:** Dependent variables included 5 subscale scores of the PODCI [upper extremity and physical functioning (UE), transfer and basic mobility (TBM), sports and physical functioning (SPF), pain/comfort (PC), happiness (HAP)] and the PODCI global score. Higher scores indicate better HRQOL. **Results:** ATH reported better HRQOL on the SPF [$p<.001$: ATH=55.8 (IQR= 50.2,55.8); CLUB= 50.2 (IQR= 42.6,55.8)] and HAP [$p<.001$: ATH=54.4 (IQR=48.9,60.0); CLUB=46.1; 37.8,51.7)] subscales when compared to CLUB. ATH reported better HRQOL on the SPF [$p<.001$; ATH=55.8 (IQR=50.2,55.8); NON=52.0 (IQR=44.9,55.8)] and HAP [$p=.006$: ATH=54.4 (IQR=48.9,60.0); NON=51.7 (IQR=43.3,57.2)] subscales and lower HRQOL on the PC [$p=.002$: ATH=44.6 (IQR= 34.3,53.3); NON=50.8 (IQR= 42.0,57.2)] subscale when compared to NON. CLUB reported lower HRQOL on PC [$p=.017$: CLUB= 44.6 (IQR= 38.2,53.3); NON=50.8 (IQR=42.0,57.2)] and HAP [$p=.007$: CLUB= 46.1 (IQR= 37.8,51.7); NON=51.7 (IQR=43.3,57.2) subscales when compared to NON. **Conclusions:** Healthy adolescent athletes reported higher levels of physical functioning and happiness when compared to their peers, indicating that athletes may be more active and happier than those not participating in school athletics. Based on these group differences, athletes should be considered a distinct population when assessing HRQOL in adolescents. Future research should use the PODCI to investigate the effect of sport-related injury on the physical function and happiness of the high school athlete to allow athletic trainers to manage injured athletes across all domains of the disablement model. These data demonstrate that participation in interscholastic athletics may improve HRQOL.

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**Cross-Sectional Study Of The Health-Related Quality Of Life Using The Medical Outcomes Short Form In An Adolescent Population**

Martinez JC, Valovich McLeod TC, Bay RC, Teeters JC, Parsons JP, Sauers EL, Snyder AR: Post-Professional Athletic Training Program, A.T. Still University, Mesa, AZ

**Context:** Patient-based outcome measures addressing health-related quality of life (HRQOL) should be included in patient evaluations to ensure patient-centered care. Interpretation of these measures is vital to understanding the influence of athletic injury on HRQOL. However, representative values for HRQOL specific to adolescents participating in different activities are unavailable, and it is unknown whether healthy adolescents report HRQOL similarly. **Objective:** To compare HRQOL in student athletes (ATH), students involved in clubs/activities (CLUB), and students not involved in school activities (NON) using the Medical Outcomes Short Form (SF-36). **Design:** Cross-sectional. **Setting:** High school classrooms and athletic training facilities. **Patients or Other Participants:** Convenience sample of healthy high school adolescents who were classified as either ATH (n=205, 108 females, 97 males, age=16.1±1.1, grade=10.8±1.0), CLUB (n=91, 76 females, 15 males, age=16.1±1.0, grade=11.0±.9), or NON (n=104, 59 females, 45 males, age=15.7±1.2, grade=10.5±1.1). **Interventions:** The independent variable was group; ATH, CLUB, NON. All subjects individually completed a brief health status questionnaire and the SF-36 during a single class period. In the general population, reliability of SF-36 subscales ranges from .84-.95. **Main Outcomes Measures:** Dependent variables included the 8 subscale scores of the SF-36 [physical functioning (PF), role limitations due to physical health issues (RP), bodily pain (BP), general health perceptions (GH), vitality (VT), social functioning (SF), role limitations due to emotional problems (RE), and mental health (MH)], and the two composite scores [physical (PCS), mental (MCS)]. Preliminary omnibus tests (Kruskal-Wallis; $p<.05$) were conducted to test for differences across groups. Follow-up pairwise tests [Mann-Whitney U (test of mean ranks); $p<.05$] were conducted to identify group differences on those subscales that were significant on the overall test (PF, BP, GH, SF, MH) and reported as median

[interquartile range(IQR): 25th, 75th] for descriptive purposes. The analysis was considered exploratory and no adjustment was made for multiplicity. **Results:** ATH reported better HRQOL on the GH [p<.001; ATH=49.6 (IQR=44.9,54.3); CLUB=47.3 (IQR=42.6,60.0)]; SF [p=.044: ATH=56.4 (IQR=51.0,56.4); CLUB= 51.0 (IQR =45.6,56.4)]; and MH [p=.005: ATH=52.3 (IQR=46.8,57.9); CLUB=49.6 (IQR =41.4,55.1)] subscales and the MCS [p=.014: ATH=51.4 (IQR=45.2,56.4); CLUB= 49.3 (IQR= 38.5,54.6)] composite score when com-pared to CLUB. ATH reported better HRQOL for the PF [p=.02: ATH= 57.1(IQR:55.1,57.1); NON= 57.1 (IQR=53.0,57.1)], GH [p=.001: ATH=49.6 (IQR=44.9,54.3); NON=47.3(40.8, 52.0)]; SF [p=.043: ATH=56.4 (IQR=51.0,56.4); NON= 51.0 (IQR=45.6,56.4)]; and MH [p=.030: ATH=52.3 (IQR=46.8,57.9); NON=49.6 (IQR= 50.1,57.9)] subscales and lower on the BP [p=.005: ATH=54.2 (IQR=45.1,60.9); NON=54.2 (IQR= 50.1,60.9)] subscale when compared to NON. CLUB and NON did not differ. **Conclusions:** Athletes reported higher levels of global health, social functioning, and mental health compared to their peers. Based on the differences observed between groups, healthy athletes should be considered as their own population when evaluating HRQOL. These data support the participation of adolescents in school-based athletics for improving HRQOL.

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**Coaches First-Aid And Injury Prevention Knowledge And Knowledge Retention After Taking The P.R.E.P.A.R.E. Program**

Barron MJ, Branta CF, Powell JW, Ewing ME, Marier KS: Michigan State University, East Lansing, MI, and Marywood University, Scranton, PA

**Context:** With the high participation rate in youth sports, youth coaches should be educated in injury prevention and first aid techniques. A number of studies have evaluated the first aid and injury prevention knowledge of youth coaches. All of the studies have found a severe lack of first aid and injury prevention knowledge in coaches. In 2002 the National Center for Sports Safety (NCSS) and the NATA developed a first-aid and injury prevention program entitled P.R.E.P.A.R.E. This on-line program educates coaches about first-aid and injury prevention techniques. There are seven modules to the program: Emergency planning, heat and cold illnesses, emergency recognition, medical conditions, principles of first aid, head/neck/facial injuries, warm-up and cool down. At the conclusion of each module is an examination, in which one needs to score ≥ 70% to pass and move onto the next module. **Objective:** To test the first-aid and injury prevention knowledge after taking the P.R.E.P.A.R.E program and knowledge retention of youth football coaches. **Design:** A repeated measures design was utilized. Each of the coaches completed the program and the examination. Three months after taking the program the coaches retook the examination. **Setting:** Two Mid-Michigan youth football programs. **Participants:** Participants were 19 (41.89±7.03 years) youth football coaches who coached in the football programs. Years of being a youth football coach were M=3.22 (SD=3.10). **Measurements:** The overall and module specific means of the first P.R.E.P.A.R.E. examination were compared to the means of the second examination using the paired *t*-test procedure. **Results:** All of the coaches passed the first examination M=64.37(SD=2.19), fourteen (73.7%) coaches passed the second examination M=61.37(SD= 3.82). Coaches scored significantly higher on the first examination t(18)=4.046, p<0.001. The coaches scored significantly higher on modules two $t(18)=4.14$, $p<0.001$, three $t(18)=3.63$, $p=0.002$, and seven $t(18)=2.535$, $p=0.021$ of the first examination. There were no other differences between the first and second examinations. **Conclusions:** Some of the information gained through the P.R.E.P.A.R.E program is retained by youth football coaches. The modules with significant decreases in knowledge contained information related to heat and cold illnesses, emergency recognition, and warming up and cooling down. Further development of the P.R.E.P.A.R.E program may be needed and should stress these three areas.

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**South Florida High School Football Coaches' Awareness Of Lightning Safety Guidelines**

Abadeer SS, Doherty-Restrepo JL, Willoughby H, Tripp BL: Florida International University, Miami, FL

**Context:** The prevalence of lightning-related deaths occurring during athletic activities in South Florida suggests that athletic staff may not be aware of lightning safety guidelines. No published research has examined the level of coaches' awareness of lightning safety guidelines set forth by the National Collegiate Athletic Association and National Severe Storms Laboratory. **Objective:** We assessed South Florida high school football coaches' (FC) awareness of lightning safety guidelines during the 2007 football season using a cross-sectional Coaches Awareness of Lightning Safety Guidelines Survey (CALSGS) consisting of 22 multiple-choice and true/false questions. **Design:** Descriptive survey. **Setting:** South Florida High Schools. **Patients or Other Participants:** A purposeful, non-random sample of 36 male South Florida FC were surveyed (age=38±6y, coaching experience =8.8 ±2.2y, highest level of education= High School Diploma [n=13], Associates Degree [n=4], Bachelor Degree [n=16], Masters Degree [n=3], CPR/AED certification status= Neither CPR or AED [n=14], CPR only [n=9], AED only [n=0] and CPR and AED [n=13]). **Interventions:** The CALSGS assessed FCs' awareness of National Collegiate Athletic Association and National Severe Storms Laboratory lightening safety guidelines. A panel of 8 Certified Athletic Trainers (ATs) reviewed the survey to establish content and construct validity and internal consistency. To ensure clarity, the survey was pilot-tested by a panel of 4 coaches. Paper CALSGS were administered by the AT employed at each high school. We used SPSS 12.0 (SPSS Inc., Chicago, IL) to perform analyses of variance to compare CALSGS scores among FCs' education level at 4 levels (1-High School Diploma, 2-Associates Degree, 3-Bachelor Degree and 4-Masters Degree, among CPR/AED certification status at 3 levels (1-Neither CPR or AED, 2-CPR only and 3-CPR and AED and among age groups at 3 levels (18-29, 30-41 and >42y). **Main Outcome Measures:** The dependent variable was CALSGS score. **Results:** FCs performed poorly on the CALSGS (56.82±14.23%), with only 5.5% (n=2) earning above 75%. There were no statistically significant difference among age groups (p=0.64), CPR/AED certification status (p=0.47), or education level (p=0.53). **Conclusions:** South Florida FCs, regardless of age, CPR/AED certification status or education level have a poor understanding of lightning safety guidelines. Results suggest that lightning safety education for FCs is warranted in an effort to reduce the prevalence of lightning-related deaths, particularly in South Florida where lightning-related deaths are most prevalent. *Student Poster Award Finalist*

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**Assessment Of High School Athletic Coaches Knowledge Of The Prevention, Recognition, And Treatment Of Heat Illnesses**

Borgia EL, Van Lunen BL, Walker SE, Thomas KS, Onate JA: Old Dominion University, Norfolk, VA, and Ball State University, Muncie, IN

**Context:** Heat illness is the 3rd leading cause of death in high school athletics. Many high

schools have medical personnel on staff however, oftentimes the coach is the only responsible caretaker for injury/illness for the athlete. **Objective:** To assess high school athletic coaches' knowledge of the prevention, recognition, and treatment of exertional heat illnesses (EHI). **Design:** Survey research design. **Setting:** High schools within southeastern Virginia. **Patients or Other Participants:** Eighty three of two-hundred surveys (42.5% response rate) were collected from high school coaches(51 males [39.08±10.41 yrs], 32 females [34.84±9.36 yrs]) from the southeastern region of Virginia. **Interventions:** Coaches provided demographic information such as: level of education, first aid certification, previous experience with EHI, heat illness workshop attendance, and years coaching experience (11.40±9.35yrs). A multiple-choice survey assessment (25 questions) was developed to measure knowledge levels concerning recognition, treatment, and prevention of EHI. The instrument was reviewed by a panel of experts for face and content validity and piloted to determine its test-retest reliability prior to distribution (Cronbach's Alpha =.66 –1.00). Pearson's *r* was used to determine correlations between knowledge levels and years of experience, and level of education. A 2x3 ANOVA was used to compare section scores. The alpha level was set *a priori* at p<.05. **Main Outcome Measures:** Response scores for individual sections and overall scores (points). **Results:** The mean overall score on the EHI Assessment Survey was 15.01/25 ± 2.79 (60%).The mean scores for each section were: recognition section = 4.34/8 ± 1.35 (54%), prevention section = 5.75/10 ± 1.62 (58%), and treatment section = 5.01/7 ± 1.25 (72%). There was no significant difference between gender overall knowledge scores (male=15.05±2.84; female=14.72±2.69). Level of degree was not related to knowledge scores (r =.112, p=.541). Coaches who were certified in First Aid scored significantly higher (5.38±.91) on the treatment section than those without (4.67±1.4) ($F_{1,80}$= 7.38;*p*=.008). Coaches with more high school coaching experience scored higher on the assessment (*r*= .260*, p=018),* and coaches with more years of coaching experience had higher prevention section scores (*r*=.264, *p*=.016). No significant difference (p=.76) in overall knowledge level was found between coaches who have personally suffered from EHI (14.76±2.58) and those that have not (14.92±2.83). Coaches that attended an informational session on heat illness (27/85) scored significantly higher (4.55±1.19) on the recognition section ($F_{1,80}$ =.064;*p*=.049). **Conclusions:** These results suggest that high school athletic coaches may benefit from further education in the areas of recognition, prevention, and treatment of exertional heat illnesses. Further research should create educational materials for exertional heat illnesses and then examine their effectiveness on increasing knowledge levels and retention rates, as well as attitudes and behaviors. *Funded by a grant from the NATA Research and Education Foundation.*

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# Free Communications, Poster Presentations: Performance and Injury

Thursday, June 19, 2008, 1:00PM-5:00PM, 2nd Floor Atrium; authors present 2:00PM-3:00PM

### An Investigation Of Performance Time On Astro-Turf, Astroplay, And Natural Grass

Miller KB, Bates JL, Docherty CL, Black RE, Schrader J: Indiana University, Bloomington, IN

**Context:** Discrepancy exists as to which type of playing surface, artificial or natural, is optimal for sport participation. More specifically, it has been proposed that increased injury rates occur when participating on artificial turfs, and these injuries may be a result of increased player speed. **Objective:** To determine if there is a difference in performance time during a side-step cutting task on three different playing surfaces. **Design:** A single group repeated measures design. **Setting:** This study was conducted in three athletic facilities; each facility had a different playing surface. The playing surfaces included: indoor AstroTurf XIII, outdoor Astro-Play, and natural grass. Data collection was completed in a midwestern climate with temperatures ranging from 18-32 degrees Celsius, with no rain the day prior and the day of data collection. **Patients or Other Participants:** Twenty-one recreationally active participants (20.48 ± 3.52yrs; 177.13 ± 22.19cm; 74.76 ± 44.53kg) volunteered to participate in this study. Participants had no history of lower extremity surgery and no acute injury to the lower extremity within the past six months. **Interventions:** The independent variable was playing surface at three levels: indoor Astro-Turf XIII, outdoor AstroPlay, rye-blue mix natural grass. A wireless electronic timing system (Speedtrap 2, Brower Timing Systems, Draper, UT) was used to collect the total time to complete the side-step cutting task. Participants performed a total of nine trials, three trials on each surface. The best performance time on each surface was used for data analysis. A repeated measures analysis of variance (RMANOVA) was used to determine differences in performance time between playing surfaces. Tukey post hoc was calculated on any significant findings. **Main Outcome Measures:** The dependent variable was time (sec.) to complete the 15 yd side-step cutting task. **Results:** The results of the RMANOVA revealed a significant difference in performance times between the three surfaces (p=0.001). The Tukey post hoc test identified significantly faster performance on both AstroPlay (5.92 ± 0.60 sec) and Astro-Turf (5.80 ± 0.65 sec) compared to performance on natural grass (6.12 ± 0.59 sec). There was not a significant difference in performance between the Astro-Turf and AstroPlay surfaces. **Conclusions:** Our findings reveal significantly faster performance times on both artificial surfaces compared to the natural grass surface. Future research should be conducted on how this increased speed may affect lower extremity injuries.

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### An Evaluation Of Mechanical Energy Transfer During Traditional And Spring-Loaded Crutch Ambulation

Bateman TD, Seeley MK, Roggia AM, Larson BJ, Draper DO: Brigham Young University, Provo, UT

**Context:** Spring-loaded crutches may decrease metabolic energy expenditure during ambulation, compared to traditional crutch use, by transferring additional mechanical energy from a compressed spring in the crutch post to the patient. Prior to the present study, this idea had not been comprehensively evaluated. **Objective:** The purpose of this study was to determine whether spring-loaded crutches provide additional kinetic energy to patients, compared to traditional crutches. We hypothesized that subjects utilizing spring-loaded crutches would exhibit greater peak velocities (Kinetic Energy = ½ · mass · velocity$^2$), in the direction of progression, than subjects using traditional crutches. **Design:** Within-subjects. **Setting:** Controlled biomechanics laboratory. **Participants:** Twenty healthy volunteers (10 males, 10 females; Age = 23 ± 2 yrs; Height = 1.73 ± 0.10 m; Mass = 69.2 ± 13.7 kg). **Interventions:** The independent variable was

crutch type. Subjects performed five ambulation trials with traditional crutches and five ambulation trials with spring-loaded crutches; the order of crutch use was randomized. Subjects were required to ambulate at a standardized speed (0.97 m/s ± 5%), and immediate feedback regarding ambulation speed was provided to subjects using an opto-electronic timing device. Whole-body center of mass velocity was derived from center of mass position; center of mass position was determined using six high-speed video cameras and 35 reflective markers placed over various anatomical landmarks. Mean differences were evaluated using a paired *t*-test ($\alpha = 0.05$). **Main Outcome Measures:** The dependent variable was peak whole-body center of mass velocity, in the direction of progression. This peak velocity was identified between two events: 1) whole-body center mass moving anterior to the crutch-ground interface and 2) crutches lifting away from the ground. **Results:** The aforementioned peak velocity was 5% greater ($p < 0.001$; $t_{0.05,19} = -4.598$) for subjects using spring-loaded crutches (1.29 ± 0.08 m/s) than for subjects using traditional crutches (1.23 ± 0.10 m/s). **Conclusions:** The present data supported our hypothesis, that instantaneous kinetic energy, in the direction of progression, is greater for subjects using spring-loaded crutches than for subjects using traditional crutches. However, these differences were relatively small and should be interpreted with caution. The direction of the difference supports the notion that spring-loaded crutch use may require less metabolic energy expenditure than ambulation using traditional crutches. However, reduced metabolic energy expenditure should not be assumed from these data alone, as other factors influence metabolic energy expenditure rate. A direct measure of metabolic costs for patients utilizing spring-loaded and traditional crutches would further clarify this issue. *Student Poster Award Finalist*

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**The Effects Of Eccentrically-Induced Fatigue On Ankle Proprioception**

Simon JE, Morin GE, Davie EE: Southern Connecticut State University, New Haven, CT

**Context:** It has been suggested that fatigue can cause a decrease in ankle protective proprioception, increasing incidence of ankle injury. **Objective:** To measure the effect of fatiguing isokinetic exercise of the ankle everters and inverters on subject balance and proprioception. **Design:** A single group pre-post test study. **Setting:** This study was performed in a controlled laboratory setting. **Participants:** Eleven healthy female collegiate aged participants (21.27+/-1.42 years, 163.4 +/-4.5 centimeters, 70.84kg+/-16.89 kilograms), with no current history of injury to the lower extremity, or any previous history that would affect the proprioception of the lower extremity. **Interventions:** The independent variable was fatiguing exercise of the medial and lateral ankle muscles. Statistics included a repeated measure MANOVA to analyze the effects of the fatiguing exercise on subject balance. Univariate comparisons were used to identify differences between each of the three variables. Exercise was conducted on a Biodex System 2 dynamometer. Fatigue was defined when the subjects' torque output dropped below 50% of their peak inversion and eversion. Proprioception was measured on the Biodex Balance System. **Main Outcome Measures:** Pre- and post-fatigue measures were recorded for subject balance scores on the Biodex Balance System. Dependent variables were dynamic balance, dynamic limits of stability, and medial/lateral stability. **Results:** Multivariate results displayed a significant decrease in proprioception in the post-fatigue group (p=0.031, Effect size=0.552). Post-fatigue scores were poorer for the post-fatigue group in the dynamic balance (pre=2.18+/-0.62, post=2.78+/-0.94, p=0.013), dynamic limits of stability (pre= 114.72 seconds +/- 25.55, post=139.09 seconds, p=0.007) and medial/lateral stability (pre=1.25+/-0.39, post=1.71+/-0.91, p= 0.031). **Conclusions:** Results indicate that fatiguing exercise significantly decreases proprioception as measured on the Biodex Balance System. The decline in proprioception may dispose the ankle to injury and exercise programs should consider increasing muscle endurance and proprioception as part of ankle conditioning and rehabilitation programs after an injury. Further work is needed to determine if the proprioception reduction is sufficient to affect dynamic proprioception control and postural control during functional activities.

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**Kinematic Adaptations With Interceptor Body Armor In Soldiers Of The Army 101st**

Abt JP, Lephart SM, Sell TC, Nagai T, Chu Yungchien, Rowe R, McGrail M: Neuromuscular Research Laboratory, Department of Sports Medicine and Nutrition, School of Health and Rehabilitation Sciences, University of Pittsburgh, Pittsburgh, PA, and Department of the Army, 101st Airborne Division (Air Assault), Ft Campbell, KY

**Context:** Interceptor body armor (IBA) is critical to the protection of military personnel. The additional weight of the IBA may increase the musculotendinous demands and susceptibility to injury if training requirements have not specifically addressed the extra loads. **Objective:** The purpose of this study was to compare kinematic and force changes with and without IBA during a drop landing task. It was hypothesized that wearing IBA would result in altered landing mechanics and forces. **Design:** A within-subject, repeated measures design was utilized. **Setting:** University sports medicine laboratory. **Patients or Other Participants:** Twenty five 101st Airborne Soldiers participated (Age: 28.2 ± 6.9 years; Height: 1.78 ± 0.07 m; Mass: 82.8 ± 11.6 kg). **Interventions:** A 3D motion analysis and force plate system was used to capture kinematic and force data while subjects performed a single-leg, 50 cm drop landing task. The task was performed under eyes open and eyes closed conditions and with and without IBA. The IBA weighed 13.6 kg and represented the minimum additional weight required to be carried by the Soldiers. **Main Outcome Measures:** The dependent variables were knee flexion and valgus angle at initial contact, maximum knee flexion, time to maximum knee flexion, peak ground reaction forces, time to peak ground reaction forces, and average and peak slope of the ground reaction forces. **Results:** For the eyes opened condition, maximum knee flexion increased (NIBA: 80.9 ± 16.5°; IBA: 91.0 ± 13.4°; $p < 0.001$), time to maximum knee flexion increased (NIBA: 242.3 ± 99.0 ms; IBA: 350.9 ± 217.2 ms; $p = 0.004$), peak ground reaction forces increased (NIBA: 352.2 ± 88.4 %BW; IBA: 378.6 ± 76.0 %BW; $p = 0.011$), time to peak ground reaction forces increased (NIBA: 36.3 ± 12.1 ms; IBA: 41.5 ± 8.7 ms; $p = 0.011$), and average slope of peak ground reaction forces decreased (NIBA: 36.3 ± 12.1 ms; IBA: 41.5 ± 8.7 ms; $p = 0.011$). For the eyes closed condition, maximum knee flexion increased (NIBA: 78.9 ± 15.0°; IBA: 85.5 ± 10.8°; $p = 0.001$), time to maximum knee flexion increased (NIBA: 242.0 ± 118.1 ms; IBA: 300.0 ± 80.9 ms; $p = 0.003$), and peak ground reaction forces increased (NIBA: 353.8 ± 80.3 %BW; IBA: 373.6 ± 66.2 %BW; $p = 0.039$). **Conclusions:** Wearing IBA during the drop landing tasks resulted in altered mechanics and ground reaction forces. Proper integration of IBA into training is necessary to ensure musculoskeletal adaptation to carrying the additional loads required of tactical operations. Insufficient adaptations will likely result in undue musculotendinous stress and increase the risk of unintentional injury.

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**Lower Extremity Strength In Return-To-Play ACL Injured Soccer Athletes**

Ismaeli ZC, Onate JA, Cortes N, Kollock R, Hertel J, Arnold B, Marshall S, Ross S, Kramer L, Padua D, Van Lunen B: Old Dominion University, Norfolk VA; University of Virginia, Charlottesville, VA; Virginia Commonwealth University, Richmond, VA; University of North Carolina at Chapel Hill, NC; Pennsylvania State University, State College, PA

**Context:** Deficits in strength of the lower extremity (LE) have been widely associated with anterior cruciate ligament (ACL) injury and Return-to-Play decision-making criteria. **Objective**: To determine the difference of LE strength and ratio measures between male and female soccer athletes with and without history of an ACL injury following return to play. **Design**: Experimental cross-sectional design. **Setting**: Sports medicine research laboratory. **Patients or Other Participants**: A convenient sample of collegiate soccer athletes with a self-reported history of ACL injury during college: 8 males (19.62 ± 1.3yrs, 177 ± 5.7cm, 73.94 ± 5.7kg), 7 females (19.43 ± 1.5, 165 ± 1.0cm, 63.17±8.3kg), matched sample without a history of ACL injury: 8 males (18.74±1.0, 175.6 ± .05cm, 71.79 ± 1.2kg), 7 females (18.75 ± 1.0 yrs., 163.8 ± 0.05cm, 59.13 ± 1.9kg). **Interventions:** A portable fixed dynamometer (Evaluator, BTE Technologies, Hanover, MD) was used to measure isometric strength of either the ACL-injured or dominant limb during a pre-participation physical examination: knee flexion (KF), knee extension (KE), hip flexion (HF), hip external rotation (HER), hip internal rotation (HIR), hip extension (HE), hip abduction (HAbd), and hip adduction (HAdd) along with associated isometric ratios: knee flexion/extension (KF/E), hip flexion/extension (HF/E), hip internal rotation/external rotation (HIR/ER), and hip abduction/adduction (HAbd/HAdd). The average of three trials for each strength measure was normalized to body weight (mbw) and utilized for analysis. A 2 (gender) x 2 (group) MANOVA with an alpha level set at $p<.05$. **Main Outcomes**: LE strength measures normalized to body weight (mbw). **Results:** No significant differences (range p=.16 to .89) were found on the eight hip and knee strength measures between males with vs. without ACL injury (KE= 60.91 ± 13 vs. 66.65 ± 12, KF= 39.25 ± 7.0 vs. 33.80 ± 2.7, HE= 27.52±4.9 vs. 29.39±3.6, HF=30.85±8.5 vs. 26.81±4.2, HER= 24.54 ± 6.4 vs. 18.28 ± 1.6, HIR= 23.08±8.0 vs. 23.45±0.1, HAbd=23.28±8.1 vs. 22.38 ± 3.6, HAdd= 31.76 ± 9.1 vs. 32.55 ± 9.3). No significant differences (range p=.12 to .96) were found on the eight hip and knee strength measures between females with and without ACL (KE= 56.89±8.3 vs. 51.32±9.4, KF=34.69±9.7 vs. 31.55±4.3, HE=23.49±7.6 vs. 20.13 ±4.8, HF=22.13±4.0 vs. 25.87±3.3, HER= 19.75±3.6 vs. 21.63±3.7, HIR=18.65±6.1 vs. 20.53±4.7, HAbd= 20.28±6.0 vs. 18.98±6.7, HAdd= 23.29 ± 6.4 vs. 26.88±9.3). There was no significant difference (p=.44 to .96) on the four hip and knee strength ratios between males with vs. without ACL injury (KF/E=.66±.15 vs. .76±.38, HF/HE=1.5±.42 vs. 1.02±.20, HIR/ER=.97±.26 vs. .98±.22, and HAbd/HAdd=.81±.48 vs. .79±.21) There was no difference (range p=.07 to .93) on the four hip and knee strength ratios between females with and without ACL injury (KF/E =.61±.12 vs. .70±.20, HF/HE=.99±.22 vs. 1.2±.32, HIR/ER=.94±.26 vs. .93±.25, HAbd/HAdd=.88±.15 vs. .78±.26). There were no significant differences in normalized strength ratios across gender (range p=.08 to .23) **Conclusion**: Athletes who sustain an ACL injury to their dominant limb can regain comparable isometric strength and ratio levels as compared to matched athletes. Further studies should investigate a larger sample size and bilateral comparisons pre- and post-injury. Funding Source: National Institutes of Health RO3: PA 04-002 NIAMS Small Grant Program for New Investigators: 1R03AR054031-01

# Free Communications, Poster Presentations: Female Health Issues

Thursday, June 19, 2008, 1:00PM-5:00PM, 2nd Floor Atrium; authors present 2:00PM-3:00PM

**Immune Response Of Collegiate Female Soccer Athletes Participating In Sport Training And Competition**

Vardiman JP, Riggs C, Gallagher PM, Touchberry C: Department of Health Sport and Exercise Science, Applied Physiology Laboratory, University of Kansas, Lawrence, KS, and Department of Health, Kinesiology, Recreation and Dance, Human Performance Laboratory, University of Arkansas, Fayetteville, AR

**Context:** Sport training can cause a decrease in the concentration of salivary immuno-globulin-A which provides protection against pathogens introduced to oral and nasal mucosa, which in turn could increase the risk of upper respiratory tract infections (UTRI). **Objective:** To determine if participation in high intensity, short duration sport training and competition will cause a decrease in salivary immunoglobulin A (S-IgA) resulting in an increased incidence of URTI. **Design:** A two-way repeated measures design was used across 13 weeks of the soccer season. Salivary samples were collected bimonthly. All data were analyzed with a Two-Way ANOVA and are presented as means ± SEM. **Setting:** All saliva samples were collected on the field and analyzed in a controlled, laboratory setting. **Patients or Other Participants:** Twelve female collegiate soccer athletes (20± 0.4 years, 164.47± 1.83 cm, 59.82± 1.41 kg) and eight female controls (21± 0.0 years, 166.37± 3.0 cm, 68.03± 5.85 kg)) who were free of the symptoms of UTRI. **Interventions:** Thirteen weeks of soccer sport training and competition. **Main Outcome Measure(s):** Salivary immuno-globulin A/ total protein ratio ($\mu g \cdot \mu g^{-1}$) (S-IgA/ TP) and total symptom days (TSD) of URTI symptoms. **Results:** Analysis of pre-sport training S-IgA/ TP levels ($\mu g \cdot \mu g^{-1}$) indicated that there was a significant ($p<.05$) interaction of collection times and the groups during pre-sport training. Post-hoc comparison of pre-sport training S-IgA/TP levels ($\mu g \cdot \mu g^{-1}$) for groups indicates that on the 11th week of collection, the athletes S-IgA/ TP levels (66.27± 21.14) were significantly ($p<.05$) lower than the control's levels 126.58± 17.47). Post-hoc comparison with simple effects with weeks indicated significant differences from Week 1(4.98± 4.11) to Week 5(126.91± 29.66) and Week 1 to Week 7 (88.19± 46.99) in the athlete group and significant ($p<.05$) differences between Week 1(11.06± 10.06) and Week 7 (106.43± 28.60) in the control group. The analysis of Post-Sport S-IgA/ TP levels ($\mu g \cdot \mu g^{-1}$) indicated that there was a significant ($p<.05$) interaction of both collection times and groups during and post-sport training saliva collections, respectively. Post-hoc comparison of groups for post-sport training indicated that S-IgA/ protein levels ($\mu g \cdot \mu g^{-1}$) for Week 3(84.84± 15.77), 5(126.91± 29.66), 9(21.82± 1.76) and 11(91.0± 13.28) were significantly ($p<.05$) lower in the athletes when compared to the controls. Analysis of URTI (TSD) indicated that there was no significant ($p < 0.05$) interaction between the collection times and athletes and controls. **Conclusions:** The results of this study indicate that female collegiate athletes that participate in high-intensity, short-duration sport training periodically have suppression in S-IgA/ TP ($\mu g / \mu g^{-1}$) post sport training which could allow for the onset of URTI. The analysis of URTI(TSD), indicated that sport training did not cause an increased incidence of URTI.

**Incidence Of Iron Depletion And Iron Deficiency Without Anemia In Asymptomatic, Apparently Healthy Intercollegiate Female Athletes**

Saliba S, Tran J, Saliba E, MacKnight J, Kreps, C, Densmore J, Weltman A: University of Virginia, Charlottesville, VA

**Context**: It is well accepted that iron depletion, with or without anemia, is common in competitive female athletes, can result in serious health implications and negatively impacts athletic performance. Although experts suggest that female athletes should be screened for iron deficiency anemia, routine iron screening is atypical for pre-participation physicals in intercollegiate athletes and iron parameters are often not assessed unless there are symptoms associated with fatigue. Indeed, a recent survey of Division I NCAA schools indicated that only 40-45% of these institutions routinely screen all of their female athletes. In addition, treatment guidelines are difficult to ascertain because of variability in laboratory studies and their interpretation for clinical cutoffs in an athletic population. Surprisingly there is a paucity of prospective studies that examine the utility of screening for hematological and iron-related variables in intercollegiate female athletes. **Objective**: The purpose of this study was to examine the prevalence of iron depletion, iron deficiency without anemia and frank anemia among apparently healthy female intercollegiate athletes. **Design:** Descriptive study. **Setting**: Division I Athletic Training Clinic. **Patients or Other Participants**: 58 female athletes (age: 19.8±1.4 yrs; height: 171.2±s6.8cm; mass: 63.5±2.7kg) from several sports (cross country, volleyball, field hockey, swimming, rowing and track) volunteered to participate in a larger study that examines mechanisms related to iron deficiency in athletes. Athletes taking iron supplements were excluded. **Intervention(s)**: As part of the initial screening procedure, subjects consented to blood tests that included a complete blood count and levels of plasma ferritin, transferrin saturation, serum iron and soluble transferrin receptor (sTfR). **Main Outcome Measures:** Iron depletion, was defined by either a) ferritin level below 20 µg/L or b) sTfR above 2.4 mg/L. Iron deficiency without anemia was defined by ferritin levels below 12 µg/L and transferrin saturation below 16%. Frank anemia was also assessed, defined as hemoglobin (Hgb) <12µg/L. **Results**: Iron depletion using serum ferritin values was found in 37.9% of study participants (mean = 13.4 ± 4.5 µg/L) and in 74.1% using sTfR (mean = 3.4 ± 0.7 mg/L). Iron deficiency without anemia was found in 12.1% of subjects. Anemia was observed in 1/58 subjects (2%). **Conclusion:** A high prevalence of iron depletion and iron deficiency without anemia was found among apparently healthy female intercollegiate athletes. At most NCAA institutions these women would not be identified as iron depleted unless they presented with symptoms of fatigue. The present data support the notion that all female intercollegiate athletes should be screened for iron depletion and suggest that uniform guidelines for screening, iron supplementation, and nutritional counseling be developed. Supported in part by grants from: United States Department of Defense, US Swimming, and the University of Virginia General Clinical Research Center NIH grant RR00847

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**Perceptions Of Body Image And Prevalence Of Eating Disorder Risk In NCAA Division I Varsity Equestrian Athletes**

Torres-McGehee TM, Mady AN, Laursen RM: University of South Carolina, Columbia, SC

**Context:** Female varsity equestrian is an aesthetic sport and commonly judged on how the athlete looks while riding horseback. It is ideal for these athletes to have a slender frame; thus showing some implications of potential disordered eating and/or eating disorders particularly those participating in Western riding. **Objective:** To evaluate collegiate equestrian athletes' attitudes toward eating and perceived body images in daily clothing verses competitive clothing (uniforms) in English and Western disciplines. In addition, to estimate eating disorder prevalence by associated risk characteristics. **Design:** A volunteer, cross-sectional study was used. **Setting:** Seven of the nineteen NCAA Division I Varsity Equestrian teams from across the United States were sampled using an online survey. **Participants:** Volunteer sample of female collegiate varsity equestrian athletes (n=138, English n=91, Western n=47; age 19.87±1.31yrs; weight 62.72±10.78kg; height 165.91±15.70cm). **Interventions:** Participants self-reported height, weight, ideal weight, and menstrual cycle function. Eating Attitudes Test (EAT-26) was used to assess attitudes toward eating (0.79 reliability for anorexia subjects, and 0.94 for control). Scores of 20 or higher or answering "yes" to one supplemental question indicated potential eating disorder risk. Gender-base BMI silhouette were used to assess body image (reliability Pearson correlation at P<.0001, r=0.85 for current body image and ideal body image r=0.82). Questions regarding perceived body image (PBI) and desired body image (DBI) in everyday clothing verses uniforms were asked. An independent t-test compared EAT-26 scores, subscales and body image for both disciplines; and paired sample t-tests compared estimated BMI (EBMI), PBI and DBI in daily clothing and uniforms. **Main Outcome Measures:** BMI was estimated using self-reported height and weight (22.1±2.97kg/m²). Total EAT-26 scores were used to estimate prevalence for potential risk for eating disorders. **Results:** Two-hundred and eleven individuals were contacted, the overall response rate was 65.4% (n=138). Prevalence for potential eating disorder risk for all participants was estimated at 43.0% (95% CI: 43.0%±8.6%) and then separated into disciplines English at 41.9% (95% CI: 41.9±10.4%) and Western at 45.2% (95% CI: 45.2%±15.1%). Body image, EAT-26 total score and subscales were not significant when comparing English and Western Riders. All participants perceived themselves larger in PBI for daily clothing *(P*<.001;22.1±2.97kg/m², 23.65±3.27kg/m²) and uniform (*P*<.001; 22.1±2.97kg/m², 23.64± 4.11kg/m²) and smaller DBI for daily clothing (*P*<.001; 22.1±2.97kg/m², 21.03±1.34 kg/m²) and uniform (P<.001; 22.1±2.97kg/m², 20.88±1.30 kg/m²) compared to their EBMI. In addition, participants perceived themselves smaller for PBI compared to their DBI in daily clothing (*P*<.001; 23.65±3.27kg/m², 21.03±1.34kg/m²) and uniform (*P*<.001; 23.64±4.11kg/m², 20.88±1.30kg/m²). Participants desired to be smaller in uniforms compared to daily clothing (*P*=0.03; 21.03±1.34kg/m², 20.88±1.30kg/m²). **Conclusion:** While this study did reveal Varsity Equestrian athletes are at an increased risk for developing eating disorders, it did not show significant evidence that one discipline is at greater risk than the other.

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**The Prevalence Of Disordered Eating, Menstrual Dysfunction And Musculoskeletal Injury In Female High School Athletes**

Thein-Nissenbaum JM, Rauh MJ, Carr KC, McGuine TA, Loud K: University of Wisconsin-Madison, Madison, WI

**Context:** The interrelationships between disordered eating, menstrual dysfunction and bone loss, commonly known as the Female Athlete Triad Syndrome (Triad), have been studied extensively in collegiate athletes. Few studies have examined more than one component of the Triad among high school athletes. **Objectives:** To determine the prevalence of disordered eating and menstrual dysfunction among high school athletes, and to examine the relationship between these

components and musculoskeletal injury. **Design:** Prospective cohort. **Setting:** Three Wisconsin public high schools. **Patients or Other Participants:** Subjects were female athletes (mean age: 15.4 ± 1.2) competing on an interscholastic sport, cheer squad, poms or dance team. **Interventions:** None. **Main Outcome Measures:** Disordered eating (DE) behaviors and menstrual history/status were assessed in 334 female athletes using interview-assisted questionnaires. The Eating Disorder Examination-Questionnaire (EDE-Q) was used to classify athletes with and without DE. Subjects were classified as having DE if they had a mean score of ≥4.0 on the EDE-Q global or any subscale score. Menstrual dysfunction (MD) and musculoskeletal injury (MI) were determined from the Healthy Wisconsin High School Female Athlete Survey (HWHSFAS). MD was defined as having 9 or less menstrual cycles in the past 12 months or considered as primary amenorrheic (athletes who had not started menses by age 16). Musculoskeletal injury was defined as any injury incurred as a direct result of sport participation during the 2006-07 school year. Athletes were also classified into 3 sport group types based on their initial participation in the study. Overall 51.9% were considered team/anaerobic sport, 35.1% endurance sport, and 13.0% aesthetic sport. Using logistic regression, Odds ratios [OR] and 95% confidence intervals [CI]) were calculated to determine the risk relationships between DE, MD, and MI. **Results:** The prevalence of DE and MD were 34.7% and 18.9%, respectively. Overall, 64.7% of the athletes incurred a sport-related musculoskeletal injury. Athletes reporting DE were twice as likely (OR=2.0, 95% CI: 1.1-3.6) to report MD, particularly for athletes participating in sports considered aesthetic or endurance. After adjusting for MD, sport group type, and bodyweight, DE (OR=2.4, 95 % CI: 1.4-4.1) was significantly associated with sports-related MI. No significant relationship was found between MD and sports-related MI. **Conclusions:** The results of this study indicate that DE and MD are prevalent at the high school level. The findings also suggest that athletes reporting disordered eating behaviors are at greater risk for sports-related musculoskeletal injury. The data suggest the need for screening female high school athletes for disordered eating behaviors. Interventions designed to educate female high school athletes on the importance of appropriate nutrition are recommended. *Funded by a grant from the NATA Research and Education Foundation*

# Free Communications, Poster Presentations: Shoulder Assessment and Rehabilitation

Thursday, June 19, 2008, 1:00PM-5:00PM, 2nd Floor Atrium; authors present 2:00PM-3:00PM

**Scapular Kinematics And Muscle Activity During Modified Blackburn Scapular Retraction Exercises**

Oyama S, Myers JB, Wassinger CA, Lephart SM: Department of Exercise and Sport Science, University of North Carolina at Chapel Hill, Chapel Hill, NC, and Department of Sports Medicine and Nutrition, University of Pittsburgh, Pittsburgh, PA

**Context:** Blackburn exercises, originally introduced as rotator cuff strengthening exercises, are being modified and widely used to strengthen scapular retractor muscles. The exercises consist of sustained contractions of scapular retractors with the upper-limb in six varying positions. Changing upper-limb position theoretically allows preferential activation of specific retractor muscles, and therefore results in varying scapular movements. **Objective:** To describe scapular kinematics and scapular muscle activity during the modified Blackburn exercises. **Design:** A descriptive study. **Setting:** A university biomechanics laboratory. **Patients or Other Participants:** Twenty-five healthy subjects (14 males/11females, age= 23.2 ± 2.4yrs, height= 173.7 ± 9.9cm, mass= 74.9±18.0kg) participated. **Interventions:** Three-dimensional scapular kinematics, measured using an electromagnetic tracking device, and muscle activity were recorded simultaneously during each exercise. The upper-limb was abducted 90° during exercises I&II, and 120° during III&IV, with the upper-limb in neutral rotation during I&III, and in external rotation (ER) during II&IV. During V, the upper-limb was abducted 45° with 90° of elbow flexion. The upper-limb was in full extension during VI. Three repetitions of six second contractions were performed per exercise. **Main Outcome Measures:** Scapular kinematics and mean normalized muscle activity of upper, middle, and lower trapezius, and serratus anterior during the exercises were recorded. Scapular positions/orientations at neutral stance and during exercises I-VI were compared using repeated measures analysis of variance, followed by pair-wise comparisons using Bonferroni post-hoc analyses (a priori alpha-level=0.05). Muscle activity was considered moderate or marked, when the group means were 21-50% and >50%, respectively. **Results:** Exercise I resulted in significant ER (mean difference from neutral stance ± standard error: 14.1±2.1°, $p<0.001$), upward rotation (UR) (10.3±2.6°, $p=0.016$), retraction (7.9±1.8°, $p=0.005$) and depression (17.5±2.8°, $p<0.001$). Exercises II&V resulted in significant ER (II;18.3±2.8°, $p<0.001$, V;12.3±4.5°, $p<0.001$), UR (II;19.3±2.3°, $p<0.001$, V;18.7±2.4°, $p<0.001$), posterior tilt (II;17.0±2.2°, $p<0.001$, V;24.6±1.9°, $p<0.001$), retraction (II;13.0±1.5°, $p<0.001$, V;15.1±1.6°, $p<0.001$), and depression (II;10.2±2.7°, $p=0.022$, V;10.5±2.6°, $p<0.001$). Exercises III&IV resulted in significant UR (III;41.7±3.4°, $p<0.001$, IV;38.7±4.4°, $p<0.001$), posterior tilt (III;21.4±3.4°, $p<0.001$, IV;22.3±4.6°, $p=0.002$), and retraction (III;18.0±1.6°, $p<0.001$, IV;16.8±1.7°, $p<0.001$). Exercise VI resulted in significant depression (15.9±2.9°, $p<0.001$). Upper trapezius activity was marked in III(73.2±40.7%) and IV(73.2±40.7%), and moderate in I(41.5 ± 25.3%), II(48.4 ± 27.4%), and V(46.7 ± 26.3%). Middle trapezius activity was marked in I(56.6 ± 21.4%), II(67.7±24.4%), III(76.3±28.2%), IV(77.3±25.8%), and V(67.4±28.5%), and moderate in VI(26.8±15.1%). Lower trapezius activity was marked in III(68.1 ± 22.6%), IV(71.9 ± 26.7%), V(54.4 ± 26.5%), and VI(52.3 ± 35.7%) and moderate in I(41.8±25.9%) and II(47.4±26.1%). Serratus anterior was moderately active in IV(21.3±30.3%). **Conclusions:** The six modified Blackburn exercises resulted in varying scapular movement and muscle activity. Altered scapular kinematics and weakness of scapular retractors are associated with various shoulder injuries. Therefore, understanding scapular kinematics and muscle activity elicited during exercises may allow clinicians to select exercises that are more tailored to the specific pattern of scapula dyskinesia and muscle weakness found in patients.

**Reliability, Precision And Validity Of A Clinical Method For Pectoral Minor Length Assessment In Overhead Athletes**

Rondeau MW, Padua DA, Harrington S, Thigpen CA, Prentice WE: Sports Medicine Research Laboratory, The University of North Carolina, Chapel Hill, NC, and The University of North Florida, Jacksonville, FL

**Context:** Shortness of the pectoralis minor muscle has been shown to influence both postural alignment and scapula positioning. As a result, researchers have hypothesized a link between pectoralis minor shortness and the development of shoulder impairment (e.g. pain, range of motion loss, and function loss). Due to the potential role of pectoralis minor shortness in shoulder impairment, it is important to develop valid and reliable methods of assessing pectoral minor length (PML) that may be performed in a clinical setting. **Objective**: To determine the criterion validity, reliability and precision of a clinical method for PML assessment. **Design:** Correlational research design. **Setting:** Research laboratory. **Patients or Other Participants:** Twenty-nine (males=15, females=14; age= 20.4 ± 2.4yrs; ht= 172.7 ± 12.4cm; mass= 72.9 ± 12.7kg) healthy individuals volunteered for this study. All subjects participated in volleyball, softball, baseball, or tennis at the NCAA Division I or recreational club sport level for at least 45-minutes a day, three times a week. **Intervention:** PML was measured as the linear distance between the coracoid process to the 4th intercostal space of the subject's dominant and non-dominant arms. All measures were taken with the subject in a standing, relaxed position using both an electromagnetic motion analysis system (EMAS) (Ascension Technologies, Inc., Burlington, VT) and Palpation Meter (Performance Attainment Associates, St. Paul, MN). **Main Outcome Measures:** PML values were taken across three separate trials using both the EMAS and Palpation Meter. Pearson correlation coefficients were calculated for the average PML values taken from the EMAS and Palpation Meter ($\alpha \leq 0.05$) to determine the validity of PML measures using the Palpation Meter. Intraclass correlation coefficients ($ICC_{2,k}$) and standard error measures (SEM) were calculated to determine the intra-rater reliability and precision of PML measures using the Palpation Meter. **Results:** There were significant correlations between PML measures from the EMAS and Palpation Meter for the dominant (r= 0.695, *P*=0.005) and non-dominant (r=0.837, *P*=0.005) arms. The Palpation Meter was also found to be reliable and precise in the dominant (ICC= 0.980, SEM=.320 cm) and non-dominant (ICC=.990, SEM=.29 cm) arms. **Conclusions:** The Palpation Meter was shown to be a valid, reliable and precise tool for measuring PML in overhead athletes. Due to its ease of use and cost efficiency in comparison to an EMAS or other similar devices, the Palpation Meter may be utilized by clinicians to gain valid, reliable, and objective measures of PML. *Student Poster Award Finalist*

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**3-D Scapular Position And Muscle Strength Are Related In Professional Baseball Pitchers**

Thigpen CA, Reinold MM, Padua DA, Young J, Smith AR, DiStefano LJ, DiStefano MJ, Gill TJ: University of North Florida, Jacksonville, FL; Boston Red Sox, Boston, MA; University of North Carolina-Chapel Hill, Chapel Hill, NC; Massachussets General Hospital, Boston, MA

**Objective:** Alterations in scapular position are hypothesized to influence the scapular stabilizing muscles' force production capabilities. The lower trapezius (LT) and serratus anterior (SA) are thought to be particularly important as they may aid in proper shoulder position and arm deceleration during overhead throwing. There is limited evidence examining the relationship between scapular position and muscle strength. Therefore, the purpose of this study was to examine the relationship between 3-D scapular position and pectoralis minor length (PML) with LT and SA strength. **Design:** Descriptive **Setting:** Field laboratory & athletic training room **Participants:** Scapula resting position was assessed in 41 professional baseball pitchers (mean age=22; height=189 cm; weight=94 kg) during spring training. All pitchers were currently asymptomatic and participating without restriction, in all training, practice, and games. Subjects that had undergone a shoulder surgery within the last 12 months were excluded. **Interventions:** An electromagnetic tracking system was used to measure 3-D scapular angles for upward/downward rotation (U-D), internal-external rotation (IR-ER), and anterior-posterior tilting (A-P) as well as PML while subjects stood with their arms at their side. PML was determined as the distance from the coracoid process to the 4th intercostal space and normalized to body height. Isometric muscle strength was measured as recommended by Kendall, using a hand held dynamometer for 2 trials and peak force recorded in Newtons then normalized to body weight. LT strength was assessed with the subject prone and the glenohumeral joint abducted to 120° and externally rotated while performing scapular retraction, depression and humeral elevation in the scapular plane. Resistance was applied over the posterior acromion for 5 seconds over the posterior acromion. SA strength was assessed with the athlete sitting and the arm elevated in the scapular plane. A downward force was given for 5 seconds on the humerus, just below the deltoid tuberosity while the heel of the 2nd hand pushed the lateral border of the scapula medially. Pearson product moment correlations were performed to assess the relationship between resting 3-D scapula angles, PML, and LT/SA strength ($\alpha \leq .05$). **Results:** There was a positive association between PML and SA strength (r= 0.48,p<.001) and a negative association between 3-D IR-ER and LT strength (r=0.33, p<.03). There were no other statistically significant associations between 3-D U-D, A-P, IR-ER, PML and LT or SA strength measures. **Conclusions:** Our results indicate that shorter PML length was related to decreased SA strength while greater 3-D IR angles (protracted scapula) was related to decreased LT strength in professional baseball pitchers. These results support theories suggesting altered scapula position influences LT and SA muscle force production. Clinicians should consider the relationship of scapular position as well as LT and SA muscle strength when examining overhead athletes and in the development of preventative and rehabilitation programs in baseball players. **Key Words:** shoulder, assessment, kinematics, overhead throwing athlete

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**Electromyography Of The Scapular Stabilizers During Upper Extremity Closed Chain Exercises With "Plus Phase" Protraction**

Tucker WS, Gilbert ML, Campbell BM, Gribble PA: University of Toledo, Toledo, OH, and Bowling Green State University, Bowling Green, OH

**Context:** The addition of full scapular protraction (plus phase) to a standard push-up is commonly used by clinicians. Limited research exists comparing the scapular muscle activity of the push-up plus (PU) to other upper extremity closed chain exercises. **Objective:** The purpose of this study was to examine two methods of closed chain exercise, the PU and Cuff Link® plus (CL), to compare the amount of muscle activation in the serratus anterior (SA), middle trapezius (MT) and lower trapezius (LT). **Design:** A within-subjects repeated measures design.

**Setting:** A controlled laboratory environment. **Patients or Other Participants:** Twenty healthy male subjects (20.7±2.89 yrs, 177.9±9.45 cm, 80.52±14.38 kg) with no previous history of shoulder or low back injury volunteered to participate in this study. **Interventions:** Subjects performed five separate trials of full weight-bearing push-ups followed by a "plus phase" (protraction) and five separate trials of clockwise revolutions on the Cuff Link® followed by a "plus phase". There was a one minute rest period between trials. The tasks were randomized and performed on the same day. Trunk and shoulder positioning were normalized to the subject's height. Trial velocity was controlled using a metronome (trials performed in four seconds). Surface electromyography (EMG) recorded muscle activity at 1000 Hz. For EMG comparisons, each task was divided into two phases: 1) exercise phase, 2) plus phase. The EMG signals were rectified and smoothed (50 ms moving window). The mean EMG values for the three muscles were normalized as a percentage of a maximum voluntary isometric contraction. The independent variables were task (PU and CL) and phase (exercise and plus). The dependent variables were the muscle activity of the SA, MT and LT. For each dependent variable, a separate two-within factor (task x phase) repeated measures ANOVA was performed with an alpha level of $p<0.05$. **Main Outcome Measures:** Mean muscle activity of the SA, MT and LT. **Results:** A statistically significant interaction for the SA ($F_{1,19}= 9.985; p= 0.005$) existed such that the CL plus phase (43.74 ± 17.31%) had significantly more activation than the CL exercise (26.26 ± 12.54%); and the PU exercise (47.5 ± 20.74%) had significantly more activation than the CL exercise. A statistically significant interaction for the MT ($F_{1,19}=51.154; p<0.001$) existed such that the PU exercise (29.58±13.75%) had significantly more activation than the CL exercise (9.81±6.39%), and the PU exercise had significantly greater activation than the PU plus phase (16.56 ± 7.91%). A statistically significant interaction for the LT ($F_{1,19}=23.794; p<0.001$) existed such that the PU exercise (32.68±14.76%) had significantly greater activation than the CL exercise (12.45±8.72%). **Conclusions:** These results suggest that differences in scapular muscle activation exist in the push-up and Cuff Link® with plus phase protraction. Clinicians should consider the muscles of interest when incorporating the push-up, Cuff Link® or "plus phase" into a rehabilitation protocol.

# Free Communications, Poster Presentations: Professional Issues

Thursday, June 19, 2008, 1:00PM-5:00PM, 2nd Floor Atrium; authors present 2:00PM-3:00PM

**Undergraduate Athletic Training Students' Attitudes Towards The Care Of Athletes With Disabilities**

Murdock JL, Smith-Goodwin E: Wilmington College, Wilmington, OH

**Context:** The NCAA is encouraging athletes with disabilities to participate in sports. Therefore, ATCs must be aware of the medical needs and limits that might be placed on an athlete with a disability. The literature points out that many athletic trainers may not feel comfortable caring for these athletes. **Objective:** The purpose of this study was to investigate undergraduate athletic training students' (ATS) attitudes towards curriculum addressing the care of athletes with disabilities. **Design:** Cross sectional survey. **Setting:** The survey was administered in athletic training courses by grade level. **Patients or Other Participants:** Convenience sampling was used with a 90% (N= 75) return rate. Demographics included 48% freshman (n= 36), 21% sophomores (n=16), 15% juniors (n=11), and 16% seniors (n=12). **Interventions:** The survey was composed of 15 questions. A Table of Specifications (TOS) was used to develop the 15 question survey. Two questions (#1, #14) related to disability athletes in general. Questions 2- 5 investigated the students' knowledge of cerebral palsy. Questions 6-9 addressed spina bifida and questions 10-13 covered epilepsy. Question 15 asked grade level. The survey was reviewed by a panel of experts for face validity and the TOS established content validity. Institutional Review Board approval was obtained. Surveys were distributed in classes. Descriptive statistics (frequency counts, percentages, mean, and standard deviation) were calculated using SPSS 15.0. A one way Analysis of Variance (ANOVA) was performed with year in school as the grouping variable. Post hoc tests (Tukey's test) were performed to see which means were different from one another. The alpha level was set at p=.05. **Main Outcome Measurements:** A Likert scale of 1=strongly agree, 2=agree, 3=neutral, 4=disagree, and 5=strongly disagree was used. Dependent variables were survey responses. **Results:** Only 50% (n=38) of ATS agree they are confident in caring for an athlete with disability. 12% (n=9) of ATS agree that the curriculum has prepared to care for an athlete with a disability. There was a significant differences in confidence in caring for an athlete with a disability by year in school ($F(3,71)=2.936, p=.039$). Post hoc tests (Tukey's test) determined that the mean difference between freshman and seniors was significant (difference p=.046). The seniors (n=12) had a mean of 3.25±.866 and the freshman mean was 2.44±.939. Surprisingly, freshmen were more confident than seniors. **Conclusion:** Medical Conditions and Disabilities is a content domain in the Athletic Training Educational Competencies for undergraduate athletic training curriculums. However, students are not confident in their abilities in caring for an athlete with a disability. Perhaps, a clinical rotation with sports for athletes with disabilities will better prepare undergraduate ATS. *Student Poster Award Finalist*

**Profession Familiarity Effects Orthopedic Surgeons Attitudes Of Certified Athletic Trainer's (ATC's) Rehabilitation Skills**

Bumgardner JD, Smith-Goodwin E, Walker J: Wilmington College, Wilmington, OH

**Content:** Educating and surveying other health care professionals about the field of Athletic Training and its educational components will increase awareness of the scope of practice as well as harbor better working relationships with other allied health fields. **Objective:** The purpose of this study was to investigate orthopedic surgeons' (in southwestern Ohio) attitudes of rehabilitation skills of certified athletic trainers (ATC). **Design:** Nonexperimental cross-sectional descriptive survey. **Setting:** Orthopedic Clinics. **Patients or Other Participants:** The target population was a convenience sample of orthopedic surgeons (N=20) in southwestern Ohio. The response rate was 80% (n=16). All sixteen respondents were males. Orthopedics with 1-5 years experience was 25%(n=4), 38%(n=6) had 6-10 years experience, 18%(n=3) had 11-15 years experience and 18%(n=3) had 16 or more years experience. Orthopedics who had working experience with an ATC was shown to be 88%(n=14), while the orthopedic surgeons who had no experience with an ATC was 12%(n=2). **Interventions:** The survey consisted of 16 questions including demographics. The questions were formatted from domain IV (treatment, rehabilitation, and

reconditioning) of the 2003 Role Delineation Study for Certification as an Athletic Trainer. A Table of Specifications (ToS) established content validity; a panel of experts reviewed established face validity. Questions addressed administering therapeutic and conditioning exercises (#1-2), administering therapeutic modalities (#3-4), application of braces, splints, or assistive devices (#5), reassess the status of injuries and or conditions (#6-7), educating the appropriate individuals in the treatment, rehabilitation, and reconditioning of injuries (#8-10), providing guidance and/or counseling for the appropriate individuals in the treatment, rehab, and reconditioning of injuries (#11-13), and demographics (#14-16). The surveys were sent out either by fax or mail. Surveys were returned via mail. Chi Square tests, frequency counts and percentages were calculated using SPSS 15.0. Alpha level was set at 0.05. **Main Outcome Measures:** A Likert type scale of 1=strongly agree, 2=agree, 3=disagree, 4=strongly disagree was used. **Results:** Orthopedic surgeons that had prior experience with an ATC had a more positive attitude of their rehabilitation skills [statistically significant - $x^2$=11.429, df=2, and p=.003 (M=1.18 $\pm$.402,M=2.4$\pm$.816)]. Orthopedics had the highest attitudes towards ATCs understanding of the use of therapeutic modalities [81% (n=13) strongly agreed], educating athletes about treatment [82% (n=13) strongly agreed], and providing guidance or counseling for athletes about treatment, rehab, and reconditioning [88% (n=14) strongly agreed]. 12% (n=2) of the orthopedics disagreed that ATCs were capable of reassessing injuries, could formulate a rehabilitation protocol or effectively educate athletes about rehabilitation. **Conclusion:** Although limited by sample size, the more experience orthopedic surgeons had with an ATC the more positive attitude toward their rehabilitation skills.

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**Athletic Training Students Perceived Academic Preparation For The Board Of Certification Examination**

Massie JB, Whitman AB: Miami University, Oxford, OH

**Context:** A review of the literature has demonstrated the need for further study into student perceived academic preparation in athletic training education programs (ATEP). **Objective:** To determine athletic training students' perception of their ATEP in relation to their preparation for the Board of Certification (BOC) examination, and to identify perceived inadequacies of the ATEP curriculum. **Design:** Cross-Sectional. **Setting:** CAATE Accredited Undergraduate Athletic Training Education Programs. **Participants:** All candidates who sat for the BOC examination during the April, 2007 testing period (n=1052). Approximately 62.3% (n=665) completed the survey instrument. **Interventions:** A panel of peers established content and construct validity, and analyzed the website for ease of navigation. A Combined-Pearson was .804. Participants completed an online survey. T-tests were performed to compare certification test result and satisfaction of academic preparation across the specific knowledge content areas. Alpha level was set at .05. **Main Outcome Measures:** The survey was comprised of one multiple answer question pertaining to the sections of the certification examination successfully passed by the candidate. A second multiple choice question measured the candidate's perceived satisfaction of their academic preparation for the certification examination. Thirteen questions utilized a 5-point Likert scale to ascertain the candidate's satisfaction of academic preparation across the content areas comprising the knowledge and skill set of the entry-level athletic trainer as defined by the NATA Education Council. **Results:** 32.7% (n=344) of the first time exam candidates passed all three sections of the BOC examination during this exam period. Of the respondents, 49.8% (n=326) passed the written portion, 60.3% (n=395) passed the simulation, and 65.3% (n=428) passed the practical on the first attempt. 16% (n=165) of the respondents did not pass any portion of the exam. 87.6% (n=573) of the respondents perceived their academic preparation as satisfactory, while 12.4% 81 (n=81) perceived their preparation as unsatisfactory. Significant differences on satisfaction with preparation existed between those respondents passing the written ($M$=1.92, $M$= 2.77, $t(652)$= -12.081, $p<.001$), simulation ($M$ = 2.03, $M$ = 2.84, $t$ (652) = -11.219, $p <$ .001), and practical ($M$ = 2.11, $M$ = 2.80, $t$ (652) = -8.943, $p < .001$) portions of the exam on the first attempt compared to those who failed those sections. Of the content areas, only Pharmacology ($M$=3.31), Psychosocial Intervention ($M$= 2.89), and Nutrition ($M$=2.82) had mean scores above 2.50 (1=Excellent, 5=Poor). **Conclusions:** As perceived by athletic training students who sat for the certification examination, ATEP's are adequately preparing their students for the BOC examination and thereby entry-level positions within the profession. Content areas that need improvement are Pharmacology, Psycho-social intervention, and Nutrition. ATEP's must continually evaluate their curricula to meet the needs of their students as well as to provide a better understanding of the educational process.

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**Most Professional Athletic Training Education Programs Are NOT Housed With Peer Healthcare Professions**

Sauers EL, Moran CL, Bay RC: Post-Professional Athletic Training Program, A. T. Still University, Mesa, AZ

**Context:** In 1997, the NATA Education Task Force (Task Force) recommended that all new athletic training programs, if possible, be housed in colleges of health professions to take advantage of resources and for student socialization (Recommendation 12). The environment of professional athletic training education programs and compliance with this recommendation has yet to be examined. **Objective:** To classify the environment of professional athletic training education programs as either a traditional academic setting or a health professions setting, compare their institution and program characteristics, and to evaluate compliance with Task Force Recommendation 12. **Design:** Survey and secondary data analysis. **Setting:** Web-based. **Participants:** Program and institution data were assessed for 356 Commission on the Accreditation of Athletic Training Education (CAATE) accredited and candidacy professional athletic training education programs (PATEPs). Program Directors from each PATEP were then surveyed to further assess program characteristics. **Interventions:** All 356 PATEPs were categorized as being housed in either a traditional academic or health professions environment based on a majority percentage of peer healthcare programs (MD/DO, PT, OT, PA, AuD, etc) housed within the academic unit. The initial year of accreditation was determined from the CAATE website for all PATEPs. A web-based survey was developed to further examine basic program environment characteristics, including whether or not the PATEPs institution had a school/college of Health Sciences/Medicine. Summary descriptive data were calculated for all variables. **Main Outcome Measures:** The measured variables included classification of all PATEPs as being housed within an academic or health professions environment; percentage of PATEPs at institutions with a school/college of Health Science /Medicine, and the percentage of PATEPs in compliance with Task Force Recommendation 12. **Results:** The response rate by Program Directors was 40.4% (n = 144). The primary finding of this study was that, when peer healthcare groups are used to operationally define the academic environment, only 5.3% (19/356) of all PATEPs are housed within a health professions environment. Among the 144 programs who responded to the survey, 44% (n=63) could have complied with

Recommendation 12 because they reported having a school/college of Health Sciences/ Medicine at their institution and were accredited in 1998 or later (data from CAATE). From this subgroup, only 15.8% (10/63) of PATEPs that emerged within institutions that have a School/College of Health Sciences/Medicine complied with Task Force Recommendation 12. **Conclusions:** Despite the fact that athletic training is a healthcare profession, very few PATEPs are housed in health professions settings where the majority of other programs are also health professions. The majority of PATEPs that emerged after the 1997 Task Force recommendations, very few programs complied with Recommendation 12. This study provides valuable data that may be used for future studies and educational policy aimed at improving athletic training education.

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**Examining Career Mobility Patterns Of Athletic Trainers In Major Professional Sports-(NFL, NBA, MLB, NHL)**

Mensch J, Gordon, K, Donner D, Herrin S, Hargenrader J, French K: University of South Carolina, Columbia, SC

**Context:** Attaining a position in professional sports is a goal many students and current certified athletic trainers (ATs) aspire to obtain. An accurate career path of individuals currently employed in professional sports may assist aspiring individuals in making educational, professional, and employment choices that enhance their chances of working in professional sports such as the National Football League (NFL), National Basketball Association (NBA), Major League Baseball (MLB), and National Hockey League (NHL). **Objective:** To examine the career path and subsequent educational and professional choices of ATs employed in the NFL, NBA, MLB, and NHL during the 2005-06 season. ***Design:*** A descriptive study using sport-specific open-ended questionnaires was used to gather demographic, educational, and professional information relevant to athletic trainer employment patterns. **Setting:** Electronic emails containing sport-specific questionnaires were sent to all head and assistant athletic trainers employed in the NFL, NBA, MLB, and NHL during the 2005-06 season. **Participants:** One hundred and forty ATs employed in professional sport participated (NFL-55, NBA-25, MLB-38, NHL-22). **Data Collection and Analysis:** Descriptive data obtained from email responses were categorized accordingly into an Excel spreadsheet. Categories associated with participant demographic information, educational experiences, and professional experiences were identified to create a career map for each professional sport. **Results:** Descriptive data revealed a variety of trends within each professional sport setting based on variables such as highest level of education, graduate assistantship experience, level of undergraduate and graduate institution, networking within the organization, prior athletic training experience, and number and venue of professional internships. Specific examples from each sport include; 44/55 (80%) of NFL ATs worked at least one internship (season long or training camp) and 34/44 (77%) worked more than one internship. 12/25 (48%) NBA ATs held two or more professional credentials other than ATC and 11/25 (44%) knew at least one other individual working in the NBA prior to obtaining their job. 34/38 (89%) MLB ATs spent a minimum of two years in the minors and the average number of years spent in the minor league for all MLB ATs was 10.69 years. 9/22 (41%) of NHL ATs attended college in Canada. **Conclusions:** Individuals interested in pursuing a career in the NFL, NBA, MLB, or NHL need to be aware of the educational and professional choices that will help them obtain their goal. Results suggest specific trends toward achieving a career within each professional sport. Decisions that may influence ATs opportunities to gain employment in professional sports may include; University choice, type and length of professional internships and graduate assistantships and knowing someone within the professional organization. It is also important for program directors and clinical supervisors to provide accurate information and advice to individuals seeking a career in professional sports.

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## Free Communications, Poster Presentations: Factors Affecting Ankle Instability

Thursday, June 19, 2008, 1:00PM-5:00PM, 2nd Floor Atrium; authors present 2:00PM-3:00PM

**Ankle Dorsiflexion Kinematics Are Altered During Walking And Jogging In Young Adults With Chronic Ankle Instability**

Hertel J, McKeon PO, Lee SY, Kerrigan DC: University of Virginia, Charlottesville, VA

**Context:** Individuals with chronic ankle instability (CAI) have demonstrated dorsiflexion range of motion deficits, however little research has assessed whether these deficits manifest themselves during gait. **Objective:** To compare sagittal plane ankle kinematics during walking and jogging between a CAI group, a group of copers who had a history of ankle sprain but did not develop CAI, and a group of controls who had never sprained their ankles. **Design:** Cohort **Setting:** Laboratory. **Patients or Other Partici-pants:** The CAI group included 29 physically active volunteers (12 males, 17 females, age= 21.1 ± 3.7 years, height= 170.8 ± 9.2 cm, mass= 65.3 ± 11.5 kg) with a self-reported history of repetitive ankle sprains and associated functional deficits. The control group included 12 physically active volunteers (4 males, 8 females, age=22.1±3.6 years, height=168.5±11.2 cm, mass=66.8±17.2 kg) without history of sprain to either ankle. The coper group included 12 physically active volunteers (6 males, 6 females, age=23.5±4.7 years, height=170.1±8.4 cm, mass= 65.8±10.5 kg) with a self-reported history of ankle sprain, but no recurrent sprains for at least 12 months and minimal functional deficits. **Intervention:** Subjects walked (1.86 km/hr) and jogged (3.72 km/hr) barefoot on a treadmill with an embedded forceplate while a ten-camera motion analysis system collected 3-dimensional lower extremity kinematic data. We compared the sagittal plane ankle kinematics from three-15 second trials at each pace between the CAI, coper, and control groups. Each stride of the gait cycle was normalized to 100 increments. Group means and 95% confidence intervals (CI) were calculated via bootstrapping at each increment of the gait cycle. Curve analyses using an alpha level of $P<.05$ were performed to identify intervals where the CI bands for the groups did not cross (ie, there were statistically significant group differences at the .05 level). Mean(±SD) differences between groups were calculated during intervals identified as being significantly different. **Main Outcome Measures**: Ankle dorsiflexion-plantar flexion angles were calculated at each increment and averaged across all strides. **Results:** During walking, the CAI group was significantly less dorsiflexed than the controls from 50%-63%(3.86°±1.29°) and the copers from 52%-60%(3.47°±0.55°) of the gait cycle. There were no significant differences between coper and control groups during walking. In jogging, the CAI group was significantly less dorsiflexed than controls during 22%-34%(5.61°±1.59°) and 84%-100% and the first 1%(5.44°±1.37°) of the gait cycle.

Copers also were significantly less dorsiflexed than controls during 19%-30%(2.71°±1.82°), and 86%-100% and 1%-2%(5.63°±1.82°) of the gait cycle during jogging. There were no significant differences between the CAI and coper groups during jogging. **Conclusions:** During walking, the CAI group was less dorsiflexed than copers and controls during late stance phase. Interestingly, during jogging, both the CAI and coper groups were less dorsiflexed than the controls during late stance, late swing, and just after initial contact. *This project was funded in part by a grant from the National Football League Charities.*

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**Subjective Disability And Dynamic Postural Stability Scores Predict Ankle Instability Status**

Wikstrom EA, Tillman MD, Chmielewski TL, Cauraugh JH, Borsa PA: University of Florida, Gainesville, FL

Context: A small percentage of people who sprain their ankle function as if they were uninjured (copers) due to a mechanism that has not yet been defined or characterized. Understanding differences between copers and ankle instability (AI) patients may elucidate the underlying mechanisms and may help develop an evidence based model that can predict increased risk of AI. Objective: Two objectives were to determine: 1) best predictors of ankle group membership (coper vs. AI), and 2) sensitivity and specificity for identifying copers. Design and Setting: The design was a nonexperimental multivariate correlational study. Subjects completed 3 questionnaires of ankle disability (foot and ankle disability index, foot and ankle disability index-sport, self report questionnaire of ankle function (SRQAF), 4 common hop tests (single leg hop for distance, triple crossover hop for distance, figure eight hop test, and side to side hop test), an instrumented anterior drawer test, and underwent a lateral radiograph of their ankle. In addition, single-leg static balance trials and single leg hop stabilization tests, that required a jump to 50% of their maximum vertical leap and landing on a single-leg, were completed. Subjects: Twenty-four copers (20.8±1.5 years, 173±11cm, 78±27kg) and 24 AI patients (21.7±2.8 years, 175±13cm, 71±13kg) participated. Copers and AI patients had a history of at least one moderate to severe ankle sprain that required acute care. Each coper resumed all pre-injury activity without limitation and without recurrent episodes of injury/giving way for at least 12 months prior to testing. The coper group scored >24 on the ankle joint functional assessment tool (AJFAT). In comparison, the AI patients had at least one recurrent sprain within 6 months of testing and scored <20 on the AJFAT. Measurements: Questionnaires of ankle disability were scored and distance or time measures were taken for the hop tests. Anterior/posterior (AP), medial/lateral (ML) sway, and dynamic postural stability indices (calculated from the vertical, AP, and ML ground reaction forces) were calculated for static balance trials and single leg hop stabilization tests respectively. An instrumented arthometer generated ankle joint stiffness while positional fault was measured as the distance between the anterior tibia and anterior fibula. A stepwise linear regression determined which variables significantly contributed to group classification. A discriminate analysis then predicted group classification based on the variables identified by the regression analysis. Results: Two significant predictors of group membership were the SRQAF [$r^2$=.38, $F_{change}(1,70)=42.95$, $p<.01$] and the ML stability index [$r^2$=.44 (change of .06), $F_{change}(1,69)=7.64$, $p<.01$]. Further, sensitivity and specificity probabilities were 0.80 (20/24 copers) and 0.79 (19/24 AI) respectively. Conclusions: Clinicians should use SRQAF and ML stability index scores to identify copers. Planned research will identify additional variables that enhance the sensitivity and specificity of coper classification.

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**Ankle Instability Status Affects Symptomatic Response But Not Functional Performance**

Naugle KE, Wikstrom EA, Borsa PA, Tillman MD, Chmielewski TL, Cauraugh JH: University of Florida, Gainesville, FL

**Context:** Ankle instability (AI) develops in 40-75% of people after acute ankle trauma but the underlying mechanisms of remain unknown. However, a small percentage of people who sprain their ankle can maintain high level activities and are thought to have a coping mechanism (copers) which would limit functional and/or mechanical adaptations suggested to be the cause of AI from occurring. This coping mechanism would allow copers to function as if they were not injured. Studying the differences between copers and AI patients may provide insight into the mechanisms of AI. **Objective:** To determine if symptomatic response (self-report questionnaires of disability) and functional performance (clinical hop tests) differ among healthy, coper, and AI groups. **Design and Setting:** This study was a quasi-experimental cross-sectional design. **Subjects:** Twenty-four healthy controls (21.8±2.6 years, 170±10cm, 73±16kg), copers (20.8±1.5 years, 173±11cm, 78±27kg) and AI patients (21.7±2.8 years, 175±13cm, 71±13kg) participated. Healthy controls had no previous head or lower extremity injury in the three months prior to testing. Copers and AI patients had a history of at least one moderate to severe ankle sprain that required acute care. Copers also resumed all pre-injury activity without limitation and without recurrent episodes of injury/giving way for at least 12 months prior to testing. Copers also scored >24 on the ankle joint functional assessment tool (AJFAT). AI patients had at least one recurrent sprain within 6 months of testing and scored <20 on the AJFAT. **Measurements:** Subjects completed 3 self-report questionnaires of disability for each ankle: the foot and ankle disability index (FADI), foot and ankle disability index-sport (FADI-S), and the self report questionnaire of ankle function (SRQAF). In addition, 4 common hop tests were completed with each limb: the single leg hop for distance (SHD), triple crossover hop for distance (TC), figure-8 hop test (F8), and the side to side hop test (STS). Separate 2x3 MANOVAs were used to determine group (healthy, coper, AI) and limb (involved, uninvolved) differences. **Results:** Significant symptomatic response group [$F(6,272)=9.67$, $p<0.01$] and limb [$F(3,136)=4.56$, $p<0.01$] main effects were revealed. Further analysis indicated that the FADI (AI=96.6±5, coper=99.3±3, healthy=99.6±1), FADI-S (AI=95±5, coper= 99.2 ± 3, healthy= 99.3±3), and SRQAF (AI=89.6±9, coper=97.7±7, healthy=99.2±3) scores were significantly lower in the AI group. Similarly, the involved limb had lower FADI, FADI-S, and SRQAF scores. No functional performance interaction [$F(8,270)=.330$, $p=.954$], group [$F(8,270)=.688$, $p=.702$] or limb [$F(4,135)=.485$, $p=.747$] main effects were identified. **Conclusions:** The results suggest that AI status affects symptomatic response but not functional performance. Implying that current rehab protocols may restore functional performance impairments associated with acute trauma but do not address subjective feelings of disability.

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**Quadriceps Fatigue Decreases Dynamic Balance**

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**Context:** The quadriceps muscles group serves an important role in dynamic balance. Fatigue of this muscle group may present an obstacle in performance of dynamic balance tasks, including clinical balance tests such as the Star Excursion Balance Test (SEBT). If fatigue influences balance performance, it could affect interpretation of balance test performance. **Objective**. To

determine if fatigue of the quadriceps effects dynamic balance as assessed by the SEBT. **Design:** 2 x 3 crossover design with repeated measures. **Setting**. A controlled laboratory setting. **Patients or Other Participants:** Sixteen volunteers (8 males, age=26.75±8.4 years, height=181.45±5.9 cm, mass=87.66±14.5 kg; 8 females, age=26.25±6.6 years, height =164.78±7.0 cm, mass=60.44±7.2 kilograms) with no history of disease or illnesses that would affect balance, no lower extremity surgery, no lower extremity injury in the past six months, and no cerebral concussions in the past six months participated. **Intervention(s):** Subjects performed 3 trials in three directions (anterior, posteromedial, and posteriolateral) of the SEBT and then performed bouts of 30 seconds isometric extension contractions of the knee until a 10-15% decrease in EMG median frequency of the vastus lateralis muscle was observed representing a standardized fatigue of the quadriceps. Then, another 3 trials in the three directions on the SEBT were performed. A 2x3 mixed model ANOVA was performed with the independent variables being test (pre-, post-fatigue) and reach direction (anterior, posteromedial, and posteriolateral). **Main Outcome Measures:** Normalized reach distances (reach distance/leg length) on the 3 directions of the SEBT were assessed before and after fatigue. **Results:** There was no test by direction interaction ($F_{2,30}$ = .998, P=.381), but there were significant main effects for both test ($F_{1,15}$ = 266.9, P <.001). When all directions were pooled together, pre-fatigue reach distance (92.7%±1.2%) was greater than post-fatigue percent reach distance (85.5%±1.4%; $F_{1,30}$ = 266.9, P < .001). Post-fatigue normalized reaches were smaller than pre-fatigue normalized reaches for the anterior (pre=87.3%±1.6%, post=80.9%±1.5%), posteromedial (pre= 97.0±1.7%, post=89.0%±2.0%), and posterolateral (pre= 93.9%±1.5%, post= 86.7%±1.9%) directions (P<.001). **Conclusions:** Fatigue of the quadriceps has a negative effect on dynamic balance as assessed with the SEBT. Use of the SEBT for assessment purposes will need to be performed only when fatigue is taken into consideration. Fatigue may cause a clinician to underestimate progress or overestimate potential deficits.

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**Four Weeks Of Short Foot Exercises Affect Lower Extremity Function, But Not Alignment, In Patients With Lower Extremity Injuries**

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**Context:** Short foot exercises target recruitment of the plantar foot intrinsic muscles and are used to treat patients for a variety of lower extremity injuries. However, there is limited evidence to show that this intervention is clinically effective. **Objective:** To evaluate the effects of a 4-week course of short foot exercises on measures of lower extremity function and alignment. **Design:** Case series. **Setting:** Outpatient physical therapy clinic. **Patients or Other Participants:** Fifteen patients (8 males, 7 females; age=30±10 years, height=173±9 cm, mass=77±12.3 kg) volunteered for the study. All patients were actively receiving physical therapy and were prescribed short foot exercises as part of the treatment regimen for their lower extremity injuries. **Interventions:** Subjects were taught the short foot exercise and completed 100 repetitions of the short foot exercise per day for 4 weeks. For each dependent variable, a 1x3 repeated measures ANOVA was performed with time at three levels (baseline, two-week, four-week). **Main Outcome Measures:** Dependent variables were standing Q-angle, standing rearfoot angle, navicular drop, step down test score (6-point scale), intrinsic foot muscle test score (3-point scale), and Lower Extremity Functional Scale (LEFS) score. Measurements of alignment and function were taken at baseline (before instruction of short foot exercises) and at two- and four-week follow-up. **Results:** Analysis of the within-subjects effects indicated a statistically significant difference in the step-down test scores over the four week study period (P<.001). Pairwise comparisons indicated a significant difference between baseline (4.7±1.1) and two-week (2.4±1.4, P<.001) and four-week (2.0±1.4,P<.001) follow-up. There was not a significant difference in step-down test scores between two-week and four-week measurements (P=.18). There was a significant difference in the intrinsic foot muscle test scores over the four week period (P<.001). Pairwise comparisons indicated a significant difference between baseline (1.6±0.8) and two-week (2.2±0.6, P=.004) and four-week (2.3±0.6, P<.001) follow-up for the intrinsic foot muscle test, but no significant difference between two-week and four-week measurements (P=.38). Results indicated a significant difference in the LEFS score over the four weeks (P=.03). Pairwise comparisons indicated the only significant difference was between the two-week (65.5±9.3) and four-week (70.0±8.3) LEFS score (P=.006). There was no statistical significance between baseline (66.4±10.7) and two-weeks (P=.60) and baseline and four weeks (P=.09). There were no significant differences for any of the alignment measurements (P>.05). **Conclusions:** Patients who performed short foot exercises over four-weeks for treatment of a lower extremity injury had increased self-reported function and demonstrated improvement on two functional tests, but did not have changes in lower extremity alignment. While these results are promising, the clinical efficacy of short foot exercises in the treatment of specific lower extremity injuries must be confirmed through randomized controlled trials.

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**Differences In Ankle Range Of Motion Before And After Exercise In Two Taping Conditions**

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**Context:** Athletic tape has been used to restrict ankle range of motion and to prevent ankle injuries. Results from previous research found that with physical exercise athletic tape loses some of its restricting properties. Recently, a new taping product was developed that may maintain range of motion restriction regardless of exercise participation. **Objective:** To evaluate the effectiveness of a new taping product, Andover Power-Tape™/PowerFlex™, on ankle range of motion restriction before and after exercise. **Design:** A single group repeated measures design. **Setting:** Testing was conducted in a research laboratory and the exercise was performed in an indoor gymnasium. **Patients or Other Participants:** Twenty physically active college participants (9 male, 11 female, age = 19.8 ± 1.7 years, height = 171.3 ± 11.4 cm, mass = 68.1 ± 8.8 kg) volunteered from a large Division 1 university population. Subjects had no history of ankle injury in the last six months, and no prior surgeries to the lower extremity. The dominant limb was used in all testing. **Interventions:** The independent variables were tape at three levels (No tape, Andover tape, and white cloth tape) and time at three levels (baseline, pre-exercise, post-exercise). A custom-made electric goniometer was used to measure ankle range of motion. Two separate repeated measures Analysis of Variance (RMANOVA) were performed to determine differences between the tape conditions and time intervals, one for each dependent variable. Tukey post hoc analysis was performed on any significant findings. **Main Outcome Measures:** In each tape condition, the subject's ankle range of motion was measured prior to applying the tape condition(baseline), immediately after applying the tape condition(pre-exercise), and after 30 minutes of physical exercise(post-exercise). The dependent variables were inversion to eversion and dorsiflexion to plantarflexion range of motion (degrees). **Results:** We identified a significant tape by time interaction for inversion to eversion range of motion (p < .001) and

dorsiflexion to plantarflexion range of motion ($p < .001$). For inversion to eversion range of motion the white tape significantly decreased range of motion immediately after application, but not after the exercise protocol (baseline= 32.01 ± 8.79", pre= 27.77 ± 9.87", post= 31.82 ± 10.80"). Conversely the Andover tape significantly reduced inversion to eversion range of motion immediately after application and after the exercise protocol (baseline= 30.00 ± 8.16", pre= 22.66 ± 7.83", post= 25.76±9.68"). For dorsiflexion to plantarflexion range of motion the white tape and Andover tape both significantly decreased range of motion immediately after application and after the exercise protocol (baseline= 68.37 ± 13.51", pre= 56.04 ± 13.77", post= 60.7313 ±.62"; baseline= 67.84 ± 12.77", pre= 51.05 ± 12.50", post=57.74 ± 12.52", respectively). **Conclusions:** We can conclude that the Andover tape maintained the inversion to eversion range of motion restriction both before and after 30 minutes of exercise, while the white cloth tape condition lost some of its restricted properties after 30 minutes of exercise.

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**Effects Of Lateral Ankle Sprain On Mechanical Characteristics Of The Ankle-Complex In Female College Athletes**

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**Context:** Studies on ankle sprain injury have revealed high recurrence rates and an association with neuromuscular and proprioceptive dysfunction following injury; however, previous research on the consequences of recurring ankle sprain and its effects on the mechanical characteristics of the ankle-complex in athletes are rare. **Objective:** To identify the effects of lateral ankle sprain on ankle-complex laxity and stiffness in female college athletes. **Design:** Case-control. **Setting:** Research laboratory. **Participants:** Both ankles of 51 NCAA female volleyball, basketball, and soccer athletes (19.34 ± 1.2 year; 65.9 ± 8.7 kg; 170.9 ± 9.1 cm) were tested pre-season. All athletes completed an injury questionnaire. None reported symptoms of functional instability and all participated in their sport. Fifty-seven ankles (56%) were reported sprained with 2.14 ± 1.5 sprains per injured ankle; 45 ankles (44%) had no history. For the sprained ankles, no incidences were reported within the previous 3 months (3 to 6 months, 12%; 6 to 12 months, 28%; greater than 1 year, 60%). It was indicated that 42 (73.7%) of the sprained ankles were pain free with any activity; seven (12.3%) had only minor pain after strenuous activity, and eight (14%) had moderate to significant pain after strenuous activity. All ankles were asymptomatic at testing. **Interventions:** All ankles were tested with an instrumented ankle arthrometer using previously reported methods. Ankles were loaded in anterior drawer and inversion-rotation at 10° plantarflexion. Sprained and uninjured ankles were compared with *t* tests; $\alpha = .05$. **Main Outcome Measures:** Anterior displacement (mm) at 100 N and end-range stiffness (N/mm) between 50 and 100 N; inversion rotation (degrees of ROM) at 4 Nm and end-range stiffness (Nm/degree) between 2 and 4 Nm. **Results:** Greater inversion rotation was observed for the sprained ankles (34.72 ± 8.9°) when compared to the uninjured ankles (29.69 ± 5.9°) ($P < .001$), but not the sprained (7.29 ± 2.0 mm) versus uninjured (6.57 ± 2.7 mm) ankles for anterior displacement; $P = .07$. Inversion stiffness was significantly lower ($P = .045$) for the sprained (.145 ± .39 Nm/deg) when compared to the uninjured ankles (.158 ± .35 Nm/deg) and for anterior stiffness of the sprained (14.31 ± 5.5 N/mm) versus the uninjured ankles (18.15±9.0N/mm) ($P$=.009). **Conclusions:** Individuals with a history of ankle sprain are more likely to show increased ankle-complex laxity. The decreased end-range stiffness observed in the sprained ankles indicates an alteration in the passive tension (elasticity) characteristics of the surrounding soft-tissues of the ankle-complex. When performing an anterior-drawer or inversion-stress test of a sprained ankle, increased laxity implies that the ligamentous structures are injured and the resulting end-feel (stiffness) indicates the extent in which the intact ligamentous and secondary structures function to control joint motion.

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**Stop Jump Movement Variability In Recreational Athletes With Chronic Ankle Instability**

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**Context**: Chronic ankle instability (CAI) is common after lateral ankle sprain, and movement variability may influence episodes of instability. Mechanical (MAI) and functional ankle instability (FAI) and a comparison group of "copers" who had an ankle sprain but did not subsequently develop CAI may exhibit altered variability. **Objective**: To determine if individuals with MAI or FAI exhibit greater movement variability in the kinematics and kinetics of a stop jump compared to a coper group. **Design:** Cross-sectional. **Setting:** Sports Medicine Research Laboratory. **Patients or Other Participants:** Sixty-three volunteer recreational athletes, (11 males, 10 females per each of 3 groups) matched for gender, age, height, weight, and limb dominance. MAI: age 22.38±4.30 years, height 173.40±10.57 cm, mass 71.49±13.03 kg; FAI: age 22.14±3.84 years, height 171.90±9.58 cm, mass 72.98±13.14 kg; Copers: age 21.71±4.85 years, height 175.24±8.75 cm, mass 69.92±10.66 kg. Participants had a history of moderate-severe ankle sprain; MAI and FAI groups had ≥2 episodes of instability in the last year and reported decreased function. MAI subjects had clinically lax lateral ankle ligaments while FAI and coper subjects did not. **Interventions:** Participants performed a maximum speed approach run and a two-legged stop jump followed by a maximum vertical jump. Ankle, knee, and hip motion in 3 planes, and ground reaction forces (GRF) in 3 directions were measured from initial contact to take-off into the vertical jump. Trials were normalized to 100% of stance phase and average ensemble curves of the 8 trials were created. The coefficient of variation (CV) and average standard deviation (SD) of the ensemble curve of each variable were identified. Because they violated assumptions of normality for ANOVA tests, a $\log_e$ (ln) transformation was performed on the data. One-way ANOVAs tested for group differences and Tukey post-hoc testing was utilized with $\alpha$=0.05. **Main Outcome Measures:** The $CV_{ln}$ and $SD_{ln}$ of ankle, knee, and hip flexion, adduction, and rotation, and GRF in 3 directions were identified. The $CV_{ln}$ is a unitless measure and the $SD_{ln}$ has no clinically meaningful unit of measure following $\log_e$ transformation. **Results**: The FAI group demonstrated greater $CV_{ln}$ ankle inversion/eversion (3.56±1.19) than the MAI (2.77±0.95) and copers (2.74±1.05) ($P$=0.05 and $P$=0.04), and greater $SD_{ln}$ ankle inversion/eversion (1.07±0.78) than copers (0.61±0.31) ($P$=0.01). The MAI group demonstrated greater $CV_{ln}$ anterior-posterior GRF (3.69±0.27) than FAI (3.43±0.25) ($P$=0.02). **Conclusions**: Individuals with FAI demonstrated greater ankle frontal plane movement variability during a stop jump task, which may put them at risk for episodes of instability. MAI subjects demonstrated greater anterior-posterior GRF variability, which may indicate difficulty mitigating landing forces with lax ligaments. Variability is different in CAI subjects compared to copers, and movement retraining may be an important tool in rehabilitation to prevent future sprains. *Student Poster Award Finalist*

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**Ankle Stiffness Increases Linearly With Increased Axial Load**

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**Context:** A segmental body system that lacks biomechanical stability is at a high risk of musculo-skeletal injury. The inability of the system to remain near its equilibrium position may result in large joint displacements and excessive strain on its passive supporting structures. Lack of stability has been theorized to be a primary cause of musculoskeletal injury. It has been shown that biomechanical stability is a function of muscle stiffness, geometry of the joint, and the applied load. **Objective:** To investigate the effect of an increase in applied axial load on the stability of the ankle. **Design:** A single group repeated measures design. **Setting:** This study was performed in a controlled laboratory setting. **Participants:** 28 subjects (11 men, 17 women, age = 24.97±6.16 years, height = 170.04 ± 12.73 cm, and mass= 69.25 ± 13.06 kg) volunteered for the study. **Interventions:** Loads were placed through the longitudinal axis of the tibia at 0% ($BM_0$), 25% ($BM_{25}$), and 50% ($BM_{50}$) of body mass. Loads were designed to add potential energy to the system, while adding no external moment about the ankle. **Main Outcome Measures:** Medial/lateral ankle stiffness was measured via a damped oscillatory technique following perturbation in each load condition. EMG was collected on the tibialis anterior (TA), peroneus longus (PL), and soleus (SO) for pre-activation (mean EMG amplitude for the 250ms prior to trigger activation) and reflex amplitude (magnitude of the M2 reflex response). **Results:** Statistical analysis revealed significant increases ($P<.0001$) in medial/lateral ankle stiffness with increased axial load ($BM_0$ =11.02±1.87 Nm/rad, $BM_{25}$ =19.96±4.72 Nm/rad, $BM_{50}$ =28.77±7.47 Nm/rad). Muscle pre-activation levels increased significantly across all muscles ($P=.030$), but that effect was so small (approximately 0.5% of MVIC increase) that it cannot be considered clinically relevant. Increased axial load ($P<.0001$) had a facilitory effect on reflex amplitude (PL: $BM_0$ = 56.77 ± 41.13 %MVIC, $BM_{25}$ = 85.63 ± 61.83 %MVIC, $BM_{50}$ = 128.10 ± 59.23 %MVIC). **Conclusions:** Inherent time delays associated with reflex muscle activation may be too slow to aid in the biomechanical stability of a joint. This, combined with the minimal increase in pre-activation, suggests the most probable cause for the observed increase in ankle stiffness was the passive contributions from joint compression and friction. Also interesting to note is that the stiffness increased almost linearly as load increased. This may imply that stiffness levels continue to increase to provide stability to the system as the loads applied to it get larger. It has been documented that loads on the body as high as 1200% of body mass have been observed in functional situations, possibly causing a dramatic increase in joint stability.

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**Effects Of An Acoustic Perturbation On Neuromuscular Activation And Functional Stability In The Ankle During A Functional Activity**

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**Context:** Disruptions in the neuro-muscular control system are a risk factor for acute non-contact ankle injury. The stress-injury model describes that stress leads to changes in muscle tension and increased distractibility, increasing injury risk. An acoustic perturbation and the resulting startle response may affect neuromuscular control, increasing risk of acute non-contact ankle injury. **Objective:** To examine the effects of an acoustic perturbation on neuromuscular control and functional stability of the ankle. **Design:** Repeated measures design. **Setting:** Controlled laboratory setting. **Patients or Other Participants:** Fourteen healthy NCAA Division I athletes (4 males [M], height = 74.43 ± 4.44 cm, mass = 178.75 ± 3.95 kg; 5 female follicular ([FF], height = 162.80 ± 8.47 cm, mass = 60.46 ± 5.80 kg; and 5 female luteal [FL], height = 168.20 ± 10.11, mass = 63.48 ± 5.61 kg) volunteered as participants. **Interventions:** The functional activity was a two-legged standing broad jump with a vertical reach, landing on the dominant leg and completing a lateral cutting maneuver. Participants completed six trials with randomized conditions of startle (116 dB, 40 msec) and non-startle control. Data from electromyography (EMG) were used to determine neuromuscular coactivation of the tibialis anterior/peroneus longus (TA/PL), tibialis anterior/medial gastrocnemius (TA/MG), and peroneus longus/medial gastrocnemius (PL/MG), which were normalized to body weight. EMG data were collected 100 ms before landing (preparatory) and 250 ms after landing (reactive). Data from the force plate were normalized to body weight and used to evaluate functional stability. Two and three factor analyses of variance with repeated measures were used to analyze EMG and force plate data ($p \leq .05$). **Main Outcome Measures:** Neuromuscular coactivation of TA/PL, AT/MG, and PL/MG by time (preparatory, reactive) condition (startle and non-startle control), and group (M, FF, FL); and stability measures of rate of loading, ground contact time, and peak force by condition and group. **Results:** Post-land, TA/PL coactivation was 824% higher in the startle land than the non-startle control (startle = 17.09 ± 15.45, non-startle control = 1.44 ± 2.73, $F = 13.00$, $p = .004$). TA/MG coactivation had a 46% increase in activity post landing (preparatory = .21 ± 0.4, reactive = .45 ± .11, $F = 7.32$, $p = .02$). No significant differences existed in functional stability data. **Conclusions:** The TA/PL coactivation was affected during a landing when an acoustic startle occurred. This could be attributed to the startle flexion response disrupting pre-planned neuromuscular coactivation strategies. The TA/MG and PL/MG did not display differences, possibly due to the activity's lateral motion specificity. Although functional stability was not affected by the increase in neuromuscular control, the relationship between increased neuromuscular activity and functional stability is unknown. Further research should examine this relationship by including more ankle-specific functional activities.

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**An Examination Of Group Agreement Among Self-Reported Functional Ankle Instability Participant Inclusion Criteria**

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**Context:** Although functional ankle instability (FAI) has been commonly identified in the literature as a cause of ankle injury and dysfunction, researchers have not used consistent criteria in selecting and identifying participants for FAI research. These inconsistencies in FAI research participant selection criteria may explain conflicting FAI research results. However, it is uncertain if, and to what magnitude, these selection criteria differ. **Objective:** The purpose of our study was to examine group agreement regarding selection criteria among researchers who have recruited and classified participants with self-reported FAI. In addition, the prevalence of functional ankle instability was identified. **Design:** Non-experimental, observational design. **Setting:** Public high schools and university. **Patients or Other Participants:** One-hundred-ninety physically active high school and college-aged participants (74 men: Mean ± SD = 19.0

yrs ± 2.49, and 115 women: 18.5 yrs ± 2.13) volunteered and provided informed consent in accordance with IRB policy. **Interventions:** Independent variables included self-reported FAI inclusion criteria published in previous research. We reviewed 75 esearch publications addressing FAI. Twenty-five of those exclusively used self-reported FAI inclusion criteria and were therefore included in our study. Protocols that incorporated objective FAI criteria were excluded. Ten of the sets of criteria allowed two different FAI participant classifications (stable, unstable). Fifteen sets of criteria allowed for three different FAI classifications (stable, unstable, other). The 25 sets were then consolidated into one comprehensive set of inclusion criteria. Participants responded to a questionnaire consisting of the consolidated inclusion criteria. Level of agreement of participants' FAI classification (stable, unstable, other) between the researchers' criteria were examined using proportion of agreement and pairwise agreement. The prevalence of FAI, based upon each authors' criteria was also calculated. **Main Outcome Measures:** The dependent variables were the FAI classifications (stable, unstable, other). Main outcomes included agreement between the 25 sets of criteria and FAI prevalence. **Results:** There was low average proportional agreement (2 x 2 contingency tables; 85.8% ± 8.24) and low pair wise agreement (k=.10; range = -.04 - .91) between criteria allowing for two FAI classifications. There was also low average proportional agreement (3 x 3 contingency tables; 55.1% ± 14.3) and low pairwise agreement (k=.15; range = -.11 – 1.0) between criteria allowing for three FAI classifications. According to each of the 25 sets of inclusion criteria, participants qualifying as functionally unstable ranged widely from 0-59 of the total 190 participants (Mean = 16.36 ± 17.08 FAI participants). **Conclusions:** Overall, the results indicate that the self-reported inclusion criteria used in previous FAI research is inconsistent. Therefore, researchers have potentially been study ing FAI participants with different characteristics. This casts doubt on the validity of FAI research and emphasizes the need for an expert consensus on the criteria for FAI. *Student Poster Award Finalist*

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**Effect Of Proprioceptive Measures On Detecting Functional Ankle Instability: A Meta-Analysis**

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**Context:** The link between proprioceptive deficits and functional ankle instability has been thoroughly investigated, yet numerous studies continue to produce equivocal outcomes. Various definitions of proprioception, multiple testing methods, and inconsistent subject selection criteria may be potential confounders. **Objective:** To determine significance of combined results of multiple measures of proprioception across different studies of functional ankle instability (FAI) using a meta-analysis, and to determine whether selected subject and testing characteristics (giving way, mechanical instability, exclusive unilateral sprains, contraction direction, contraction type) affected these findings in FAI proprioceptive assessments. **Data Sources:** A computerized search for pertinent articles was performed using the PubMed, Pre-CINAHL, CINAHL, and Sports Discus databases, from 1970 through 2006, using keywords "ankle instability" and "proprioception AND/OR kinesthesia". Limits: English, journals, humans. **Study Selection:** Proprioception was defined as the "sensation of movement and position of the joints and sensations related to the muscle force". Original research studies reporting means and standard deviations for an FAI group and control group for the following measures were included: joint reposition sense (JRPS), joint movement sense (JMS), threshold to detection (TTD), and the Slope Box Test. Fourteen of 287 studies met criteria for inclusion. **Data Extraction:** The full document of 14 studies meeting the inclusion criteria were independently reviewed by two investigators on a 17-point scale developed specifically for use with non-randomized ankle instability studies. Study quality averaged 3.43 points. Means and standard deviations, or sample size and t-value, were extracted for studies with independent groups. For paired groups sample size and t-value, means and t-value, or means and p-value were extracted. **Data Synthesis:** Proprioceptive outcome measures were coded as: JRPS(n=10); JMS(n=1), TTD(n=2), or Slope Box Test(n=1). Moderator variables entered included contraction direction, contraction type, giving way, mechanical instability, and exclusive unilateral sprains. For studies reporting more than one outcome measure, the mean effect for outcomes was used in the analysis. A random effects model revealed a significant overall effect of proprioceptive difference between stable and unstable ankles (Z=5.048; P<.001; d=.594; 95% CI=.363-.824; fail-safe N=175). The presence of selected testing and subject characteristics did not influence the results. Mixed effect analyses revealed no differences among outcome measures (JRPS, JMS, TTD, or Slope Box) (Q=3.824; P=.281). **Conclusions:** The results of this meta-analysis reveal no significant differences among multiple proprioceptive measures. Furthermore, proprioceptive deficits appear to be present in functional ankle instability. Additional factors did not influence these results. Because combined means were used for studies reporting more than one outcome, this analysis was not conducted. Suggestions for future research include investigating whether contraction direction or type influence overall outcomes. *Student Poster Award Finalist*

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**Dynamic Postural Stability In Chronically Unstable And Stable Ankles During A Laterally Directed Single Leg Jump Landing**

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**Context:** Laterally directed jumping movements are very common in sports and many recreational activities. As individuals with chronic ankle instability (CAI) re-sprain their ankles multiple times, it is important to understand how laterally directed jumps may influence dynamic postural stability. Comparing a group of individuals with CAI to those who have stable ankles may give insight into possible mechanisms of injury and ideas for appropriate exercises for the rehabilitation process. **Objective:** To determine differences in dynamic postural stability between individuals with CAI and those without (CON) during a laterally directed single leg jump. **Design:** Cross-sectional. **Participants:** Thirty-nine volunteer female recreational athletes (CAI 22, CON 17). CAI participants (age = 20.0 ±1.2 years, mass = 63.7 ±7.9 kg, height = 167.8 ±5.8 cm) reported a history of multiple inversion ankle sprains, decreased function, and ≥2 episodes of the ankle "giving way" in the last year. CON participants (age = 20.3 ±1.2 years, mass = 62.3 ±9.0 kg, height = 166.2 ±6.0 cm) reported no episodes of giving way. **Intervention:** Participants performed 10 laterally-directed single leg jump landings with the unstable ankle side (CAI) or the matched side (CON). Participants jumped a distance of 70 cm at 50% of their maximum vertical jump height and had to balance for 3s

upon landing. Raw ground reaction force data were exported into MATLAB and filtered (4th order recursive low-pass Butterworth at 200Hz). Data were analyzed to determine a stability index score in the anterior-posterior (SIy), medial-lateral (SIx), and vertical (SIz) directions which were subsequently used to determine the dynamic postural stability index (DPSI) using previously published equations. Independent t-tests determined differences between the CON and CAI groups ($\alpha$=0.05). **Main Outcome Measures:** The dependent variables, DPSI, SIz, SIy, SIx were rounded to three decimal places and averaged across the ten trials for comparison. A higher score on the dependent variable indicated decreased stability. **Results:** The CAI group displayed a significantly higher SIz (.331 ±.05, p = .021) and DPSI (.352 ±.05, p = .025) than the CON group (SIz=.300 ±.03, DPSI= .323 ±.03). However, no differences were found between groups in the SIx (CAI =.107 ±.01; CON =.107 ±.01, p=.98) and SIy (CAI =.049 ±.007; CON =.050 ±.008, p=.82). **Conclusions:** When performing lateral single leg jump landings the CAI group displayed decreased stability in the vertical direction component (SIz) and in the compilation of all directions (DPSI). A decrease in stability may put CAI participants at risk for sprains or long-term joint damage. Rehabilitation programs may need to incorporate lateral movements in order to address this lack of stability.

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**Dynamic Instability In Patients With Functional Ankle Instability**

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**Context:** Functional ankle instability (FAI) may be prevalent in as many as 40% of patients following an acute sprain of the lateral ligament complex. Peroneal dysfunction is often considered a key contributor to FAI. **Objective:** To compare dynamic response characteristics (timing and magnitude) of the peroneal musculature between groups (patients with unilateral FAI and matched controls) and limbs (affected and unaffected) when exposed to an ankle inversion perturbation while walking. **Design:** A cross-sectional design. **Setting:** Neuromuscular Research Laboratory. **Patients or Other Participants:** Twenty-one (18F, 3M) subjects with unilateral FAI (Age = 21± 2 yrs, Height = 171 ± 7 cm, Weight = 65 ± 9 kg) and 21 (18F, 3M) matched controls (Age = 21± 3 yrs, Height = 169 ± 9 cm, Weight = 64 ± 10 kg) volunteered to participate. **Interventions:** Prior to testing, all subjects were fitted bilaterally with surface EMG electrodes over the peroneals and goniometers secured over the lateral ankles. Subjects were then asked to walk the length of an 8.5 m runway 25 times. A trap door mechanism was released upon heel contact of six randomly assigned trials for each leg. Subjects walked to the beat of a metronome and wore goggles which blocked their inferior field of view. An electromagnetic switch marked the release of the trap door. Custom software, verified by visual inspection, identified the peroneal muscle onset, which was used to calculate reaction time and normalized RMS EMG for the 100 ms following onset of muscle activity. Two 2 x 2 ANOVAs with repeated measures on leg, were used to compare between groups and legs for each dependent variable. **Main Outcome Measures:** Dynamic ankle stability was quantified using average peroneal RMS EMG amplitude and peroneal reaction time. **Results:** FAI subjects displayed significantly higher latencies and lower EMG amplitudes in their affected ankle (lat = 106.6 ± 48.7; EMG =1.7 ± 1.3) compared to their uninjured ankle (lat = 74.3 ± 23.3; EMG =3.3 ± 3.1) ($P < 0.001$). The control subjects did not demonstrate differences in latency or EMG between limbs (Dominant lat = 83.3 ± 15.3 and EMG = 3.0 ± 2.5; Non-dominant lat = 84.6 ± 18.6 and EMG = 3.0 ± 2.8 ($P = 0.758$). FAI subjects exhibited significantly higher latencies and lower EMG amplitudes in their affected limb compared to a matched limb in the control subjects (lat = 84.6 ± 18.6; EMG = 3.0 ± 2.8) ($P < 0.001$). **Conclusions:** Dynamic ankle stability is impaired in functionally unstable ankles during walking. The diminished ability of the peroneals to counteract inversion moments likely contributes to chronic ankle instability.
*Funded by a grant from the NATA Research and Education Foundation.*

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**Effects Of Bracing On Dynamic Postural Stability In Subjects With Chronic Ankle Instability**

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**Context:** Ankle braces are used in the athletic population to help prevent lateral ankle sprains after landing from a jump. Measures of Time to Stabilization (TTS) during a jump-landing task have demonstrated deficits in dynamic stability in subjects with chronic ankle instability (CAI), but it has not been well documented if a brace can help improve dynamic stability in these individuals. **Objective:** The purpose of this study was to compare a lace-up ankle brace with a no-brace condition on the ability to return an athlete with CAI to a stable state by measuring the TTS following a jump-landing task. **Design:** Repeated measures within-subject design. **Setting:** Athletic Training Research Laboratory. **Patients or Participants:** Sixteen subjects with unilateral CAI (11 males, 5 females; age: 18.56±0.81 years; height: 174.10±7.19 cm; mass: 69.29±8.27 kg) volunteered for this study. **Interventions:** Subjects participated in two separate testing sessions during which a jump-landing task was performed with one of two conditions: lace-up ankle brace or no ankle brace. The brace condition was randomized. During each session, five trials of a jump-landing task were performed on each leg. The jump-landing task consisted of a single-leg landing from a double-leg jump height equivalent to 50% of the subject's maximum jump height. Subjects jumped off of both feet from a distance 70cm away from the center of the force plate, reached up and touched the indicated marker, and landed on the force plate on a single test limb. The landing leg was randomized. Ground reaction forces were used to calculate TTS in the medial/lateral (MLTTS) and anterior/posterior (APTTS) directions from the mean of the 5 trials. The independent variables were Condition (brace, no brace) and Side (injured, non-injured). A separate two-within (Condition, Side) repeated measures ANOVA was performed for APTTS and MLTTS. **Main Outcome Measure(s):** APTTS and MLTTS. **Results:** For MLTTS, a significant main effect for Condition existed ($F_{1,15}$=6.413; p=.023) such that MLTTS was significantly longer with the brace (1.243±.09sec) compared to the no brace condition (1.206±.06sec). There was no significant main effect for Side for MLTTS ($F_{1,15}$=2.958; p=.106). There were no statistically significant relationships observed for APTTS. **Conclusion:** When wearing a lace-up ankle brace, dynamic stability was diminished in the medial lateral plane when landing from a jump as observed by an increased MLTTS. Surprisingly, there was no influence of Side on this relationship. It appears that a brace may not help an individual with unilateral CAI when attempting to stabilize after a jump-landing task, as evidenced by the lack of differences in the APTTS, and may potentially create more of a deficit in dynamic stability in the medial/lateral direction. Additional testing is needed on other forms of prophylactic support to determine the full impact on CAI.
*Funded by a grant from the NATA Research and Education Foundation.*

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**Non-Displaced Glenoid Neck Fracture In A Female Collegiate Softball Player**

Flavell AP, Gallant GG: Geisinger Wyoming Valley Sports Medicine, Wilkes-Barre, PA, and Delaware Valley College, Doylestown, PA

**Background:** A 19-year-old female collegiate softball player reported to the athletic trainer with complaints of severe pain at the left posterior shoulder. Patient reported back pedaling for a fly ball when an outfielder collided with her from behind. Patient stated her left arm was at 90° of shoulder abduction and 90° of elbow flexion during direct trauma. Patient reported hearing a pop and severe pain at time of injury. Patient presented with a slouched left shoulder while maintaining shoulder internal rotation and elbow flexion. Point tenderness was present at the left anterior and posterior glenohumeral joint, lateral one-half of the spine of the scapula, and axilla region. Active range of motion for left shoulder flexion and abduction was 10°. Active movement above this range produced unbearable pain levels. Active range of motion for left shoulder extension could not be performed secondary to unbearable pain. Active range of motion for the right shoulder was within normal limits with sport kept in consideration. Manual muscle testing of the left shoulder revealed: 4/5 upper trapezius and 3/5 deltoids at limited range of motion. All other strength tests were deferred secondary to pain at the left shoulder. Manual muscle testing of the right shoulder revealed 5/5 for all relevant muscles. An upper quarter dermatological screen was negative and intact. At initial evaluation, no special tests for performed secondary to pain. However, 3 days post injury, the following tests were positive in the left shoulder: anterior apprehension, posterior apprehension, and posterior drawer. Examination of the right shoulder revealed all negative tests. **Differential Diagnosis:** Glenoid neck fracture, posterior shoulder subluxation, anterior shoulder subluxation, proximal humerus fracture. **Treatment:** Upon evaluation, the patient was given a sling for immobilization and referred to the emergency room for x-rays. The x-rays revealed a 6-cm longitudinal non-displaced glenoid neck fracture of the left scapula. The patient was referred to an orthopedic physician who opted conservative treatment. This consisted of immobilization in a sling for 4 weeks to allow the fracture to properly heal. During these 4 weeks pain relieving modalities were utilized, such as cryotherapy and electrical muscle stimulation. The follow-up x-ray 4 weeks post injury revealed a healed fracture of the glenoid neck. As per physician's recommendations, aggressive range of motion and isometric exercises were implemented at this time. Codman's pendulum, walking the wall, ball circles, theraband and pulley system exercises were utilized to begin regaining range of motion in the patient's left shoulder. Another emphasis at this early stage of rehabilitation was regaining adequate mobility of the left scapula. Sport-specific exercises for the patient's batting mechanics were also implemented. After 2 weeks, Buchberger-12 and Bodyblade exercises were added to progress strength and neuromuscular control at the left shoulder. The Buchberger-12 is a rotator cuff strengthening and scapular stabilizing program that was developed for professional baseball players. The patient responded very well to all treatment, and was discharged 2 months from initial injury upon meeting all short and long term goals. **Uniqueness:** Fractures to the scapula are rare in athletics, more commonly occurring in automobile accidents. When scapular fractures occur in athletics they are usually seen in contact sports, such as football or rugby. Direct trauma to the scapula usually does not result in such a severe injury. However, the position of the scapula in this case may have played a role in the outcome. **Conclusion:** Although rare in athletics, especially softball, glenoid neck fractures need to be considered when direct trauma is involved. Additionally, the current injury should be looked for even closer when the mechanism is that of the present case.

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**Elbow Trauma To A High School Football Player**

Finn M, Scala L, Straub SJ: Quinnipiac University, Hamden CT, and Notre Dame High School, New Haven CT

**Background:** A 17 year old male football player with no previous history of left upper extremity injuries fell on an outstretched arm as an opposing player applied a blunt posterior-valgus force to the athlete's distal humerus. The athlete felt a "pop," but did not feel his elbow dislocate;his pain was 7/10, there were no noticeable deformities. Palpation revealed tenderness on the olecranon process, lateral and medial humeral epicondyles, radial head, distal biceps and triceps brachii tendon, and proximal tendon of the wrist extensor group. The athlete had full range of motion (ROM) with increased pain; vascular and neural screenings were within normal limits. Strength was 4/5 in elbow flexion, extension, wrist flexion, and extension secondary to pain; and all other motions of the upper extremity were 5/5. **Differential Diagnosis:** Ulnar/radial collateral ligament sprain, dislocation, fracture of the ulna/radius, muscular strain (biceps, triceps, wrist extensors) **Treatment:** Until fracture was ruled out, the athlete was splinted with a sling in 90° elbow flexion. After 5 minutes, athlete's pain increased; upon re-evaluation the athlete was restricted to 85-110° of elbow motion and he was transported to the emergency room. Initial radiographs revealed fracture fragments in the athlete's left elbow. Upon follow up with the physician, additional X-rays and a CT scan revealed an anteromedial coronoid fracture with presence of fracture fragments within the humeroulnar joint, resulting from a suspected elbow dislocation. Subsequent surgical repair included subcutaneous transposition of the left ulnar nerve, open reduction-internal fixation of left coronoid, and repair of the left elbow common extensor tendon and lateral ligament complex. During surgery ~17 fracture fragments were identified along with fat droplets at the fracture site. During surgical intervention, the coronoid fracture was classified as type III using Regan and Morrey classification. Post surgery the athlete underwent single dose radiation to inhibit mediators which promote cellular differentiation into ectopic bone following severe elbow trauma. The athlete was immobilized in a soft cast for two weeks. ROM/Strengthening rehabilitation protocol was implemented as per doctor's instructions. A hinged elbow brace was fitted four weeks status post (s/p). The athlete was cleared for participation four months s/p provided he wore padding, however in his spring semester a rehabilitation protocol was reimplemented due to lost ROM. The athlete regained full ROM and was cleared to play. **Uniqueness:** Anteromedial coronoid fractures associated with humeroulnar dislocations are not commonly seen in athletics because of its unique mechanism of injury. Also, the complexity of the injury was not fully known until surgical intervention which revealed ~17 fracture fragments and fat droplets at the fracture site. **Conclusion:** The extent of an elbow injury may not be fully revealed by diagnostic imaging as it was not until surgical repair that the full complexity of the injury was known. Associated with traumatic elbow injuries, multiple complications can result such as chronic instability, elbow stiffness,

arthrosis, or heterotropic ossification. Treatment for the disruption of the coronoid process, trochlear notch articulation, and capsuloligamentous structures still remains challenging; however surgical repair is essential for restoration of elbow stability. Determination as to whether the injury resulted from a compressive or tensile force is essential for application of appropriate diagnostic testing. It is important to note that compressive forces resulting in impaction fractures are sometimes missed on plain radiographs, as was the case for this athlete. Despite difficulty in determining proper management, successful results have been shown following initial surgical repair of the articular and ligamentous structures as well as implementing an early ROM rehabilitation

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**Posterior Shoulder Pain In A Collegiate Baseball Catcher**

Garcia GG, Uhl TL, Mair SD, Yochem EM: University of Kentucky, Lexington, KY

**Background:** A 20-year old junior catcher, presented with non-dominant left shoulder posterior pain after batting practice. Past medical history revealed a previous episode of left posterior shoulder instability 3 years prior when he fell on an outstretched hand in high school football. He reported the physician diagnosed a possible posterior labral tear by MRI and was treated conservatively. He reported posterior shoulder pain with other overhead activities but denied any neurological symptoms. Upon examination, no deformity or atrophy was observed. Active ranges of motion of both shoulders in elevation, external and internal rotation were pain free and equal bilaterally. Resisted left external rotation was painful but full strength was present; all other strength tests were normal bilaterally. Patient reported pain but not instability with posterior load and shift test and demonstrated a positive Hawkins and O'Brien's on the left shoulder. No tenderness upon palpation was reported. Based on evaluation and previous medical history, he was referred to our team orthopedic surgeon, who performed a standard clinical exam and reviewed previous MRI films. **Differential Diagnosis:** Shoulder impingement, recurrent shoulder instability, tendonitis, bursitis, muscle strain, posterior labral tear. **Treatment:** He was treated initially with NSAIDs and shoulder strengthening for the rotator cuff and scapular musculature for 8 weeks. He continued to participate in baseball activities as tolerated. At 2nd medical consult, he continued to have symptoms of posterior shoulder instability with batting and was unable to effectively play baseball. He had a positive jerk test, and all other initial signs and symptoms were the same. Based on the previous MRI, patient history, and lack of progress the athlete was offered a surgical intervention. A left shoulder diagnostic arthroscopy revealed left shoulder recurrent posterior instability, mild posterior Bankart lesion and a large posterior capsular humeral avulsion of the glenohumeral ligament (HAGL) lesion approximately 3x2cm with a clear split off the humeral head. A posterior labral repair and repair of the HAGL lesion was performed arthroscopically. He was placed in a 30° external rotation brace for 4 weeks. The athlete began elbow range of motion at 2 weeks but remained in the sling in neutral rotation. Active assistive shoulder range of motion began at 4 weeks with supine elevation in the scapular plane and gentle external rotation at the side with. Internal rotation was not allowed for 8 weeks. When the athlete achieved full active range of motion in elevation and external rotation at 0° abduction, the athlete began a progressive resistive strengthening shoulder program. The rehabilitation program progressed to functional and position-specific exercises as tolerated. At 12 weeks post-op he was cleared to return to team strength and conditioning, avoiding exercises that would load his posterior shoulder. **Uniqueness:** Approximately 90% of all traumatic shoulder instabilities are anterior but this case of traumatic posterior instability from a relative common mechanism of injury is atypical. The surgical finding of the HAGL lesion contributes to this case's uniqueness. Complete return to full sport activity in these injuries is also unique due to high recurrence rate. **Conclusions:** Athletic trainers should learn from this case that although clinical examination reveals non-specific findings their level of suspicion should stay elevated based on mechanism and recurring symptoms in athletes with posterior shoulder injuries. Conservative management allowed continued participation for 3 years, which is important to note but surgical intervention may eventually be needed to address the likely progression of the initial injury over time. The anatomical surgical correction of the labrum and posterior capsule and an ATC supervised rehabilitation restricting internal rotation and posterior loads allowed full return to sport participation with out functional deficits in 16 weeks.

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**Right Shoulder Injury In A High School Athlete**

Lee CL, Hosey RG, Boston CD: University of Kentucky Orthopaedics and Sports Medicine, Lexington, KY

**Background:** A 15 yr old male football player attempted a tackle during a freshmen game. He missed and grabbed the opposing player forcing his shoulder into abduction, external rotation and placing an anterior force to the forearm, this caused a traction type injury. He continued to play the rest of the game with no mention of injury. The next day he came into the athletic training room stating that there was mild pain in his posterior shoulder with some radiating pain into his neck. There was no instability but had pain with apprehension test. There was no numbness/tingling. He had full ROM in his shoulder with pain >90 in flexion and abduction, and pain at extreme internal rotation, as well as with resisted external rotation, pain with O'Briens test. He had 3/5 strength for supraspinatus/infraspinatus muscles. He was point tender along the right trapezius, supraspinatus, and infraspinatus, as well as mild atrophy at the right supraspinatus. He had full ROM in his neck with discomfort in lateral bending to the right. Full ROM found in upper extremity with sensation throughout and 5/5 strength in grip, wrist, and elbow. Initial treatment included restriction from activity, ice, stim, NSAIDS, and scapular stabilization exercises. Strength improved over the first week and then rapidly diminished. The athlete was sent to the doctor for further evaluation. **Differential Diagnosis:** Brachial Plexus injury, Occult fracture, Nerve root injury, Rotator cuff injury (supraspinatus/infraspinatus), Shoulder subluxation **Treatment:** Athlete was seen by a sports medicine physician that ordered plain radiographs of the shoulder that were negative. He was to remain restricted from football and obtain a MRI the next week of his C-spine and plexus. MRI showed fracture at the transverse process of T1 and nerve roots in area. He began physical therapy at this time for supraspinatus/infraspinatus weakness. A CT was ordered at 6 weeks post injury. The CT confirmed the fracture without other injury. On exam after the CT scan, the athlete had full ROM of neck and shoulder as well as full strength. There was no point tenderness of C-spine or T-spine and no atrophy present. He was neurovascularly intact. After a consult with a spine specialist, the athlete was able to gradually return to football activities and full contact. **Uniqueness:** This is an uncommon football injury. The fracture site, along with the lack of typical symptoms of fracture is rare. **Conclusions:** The athlete is one year

post injury. He was able to finish the middle school season last year and played with no further complications for the high school team this season.

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**Acute Shoulder Trauma: Bicycle Fall**
Brindle TJ, Baker S, Boden BP: Physical Disabilities Branch, NIH, Bethesda, MD

**Background:** The patient was a 41 year old male who sustained a traumatic shoulder injury after a bicycle accident. He was a healthy recreational athlete with no significant medical history at the time and was training for a local marathon. The patient presented with pain in the right shoulder and scapular region, and reported temporary nausea following the injury. Right upper extremity motion was limited due to pain and a palpable step-off deformity of the distal clavicle was present. The patient was immediately immobilized in a sling and transported to the emergency room for radiographs and follow-up care. **Differential Diagnosis:** acromion-clavicular (AC) separation, a clavicle fracture, scapular fracture or a humeral head fracture. **Treatment:** Initial radiographs revealed distal comminuted clavicle fracture. The patient was placed in an arm sling, provided pain medications and referred to an othopaedic surgeon. The surgeon recommended internal fixation with a "hook plate" (AO Synthes®, Switzerland)[2,3]. Postoperatively, the patient was treated with a sling and swath. Two weeks following surgery the patient initiated gentle glenohumeral capsule stretching (internal/external rotation) and light strengthening with Theraband ® (The Hygenic Corporation, Akron, OH) into flexion and abduction with arms below 90 degrees. Motion approaching 90 degrees of flexion and abduction caused sub-acromial pain which has been reported in published literature [3]. Keeping arm movement below 90 degrees was done so as not to induce clavicular movement that may interfere with bony healing. The internal fixation device was surgically removed at 13 weeks. Following removal of the hardware, aggressive rehabilitation focused on regaining shoulder complex range of motion and strength. There was particular emphasis on strengthening scapular stabilizers. **Uniqueness:** Fractures to the mid third of the clavicle are more common (80%) than distal clavicle fractures and are typically managed conservatively (sling and/or a figure-8 brace). Distal fractures, particularly comminuted fractures, have higher rates of non-union than fractures to the mid-third of the clavicle. Suitable methods of immobilizing and maintaining AC alignment were major concern to ensure proper bony healing. The hook-plate system provided a unique system to maintain AC alignment, however sub-acromial pain has been reported with this internal fixation method [3]. The athletic trainer needs to be aware of the different approaches to the more common mid-clavicular fracture and distal fractures. Moreover, proper alignment is essential to restoring upper extremity function, even though sub-acromial pain may be evident with this fixation device. **Conclusion:** Distal clavicle fractures are more commonly managed surgically than mid-third clavicle fractures due to the high risk of non or malunion [1]. It is important surgically to maintain AC alignment, however, athletic trainers need to be cognizant of possible complaints of subacromial pain that appear to be due to this type of internal hardware. One year post initial injury, the patient was able to train and complete the marathon he was training for when he was initially injured. At two years follow-up this patient demonstrates normal ROM and strength. Remaining complaints include local tenderness on fracture site and slight limitation of horizontal adduction, neither of which affect his functional upper extremity use. Although not a highly competitive athlete, this patient is able to swim and recently completed a short-distance triathlon.

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**Wrist Dislocation And Ulnar Styloid Fracture In A Collegiate Football Player**
McCarthy TJ, Manwaring PJ, Pirog KB, Waskowitz RS: Central Connecticut State University, New Britain, CT

**Background:** During a weight lifting session, a 20-year old male football player was performing the second repetition of a "hang-clean" lift with 215 pounds (87.5% of athlete's max). During the "catch" phase of the lift, the athlete lost control of the bar with severe pain and reported the right dominant wrist "giving out". He immediately self-immobilized with the inability to move the wrist secondary to compromised function. *Chief Complaint:* Immediate complaints included pain and limited mobility of the wrist, hand and fingers. Rapidly, the wrist became swollen and pain intensity increased. *Physical Examination:* Gross deformity of the radio-carpal joint and distal radio-ulnar joint were evident with the hand and wrist held in neutral rotation but appearing dorsal to the distal forearm. Active wrist motion was absent and active finger ROM was limited due to pain. Neurovascular examination revealed intact radial and ulnar pulses and normal sensation of the hand and fingers. Skin was otherwise intact. **Differential Diagnosis**: Radiocarpal dislocation; distal radius and/or ulna fracture; carpal dislocation; carpo-metacarpal dislocation and/or fracture. **Treatment:** The athlete's hand, wrist and forearm were placed in a volar splint and transported to the emergency department. Plain film radiographs confirmed a dorsal dislocation of the radio-carpal joint and a displaced ulnar styloid fracture. The orthopedic team physician evaluated the injury pattern and recommended emergent reduction and stabilization. The athlete was taken to surgery and underwent a closed reduction of the wrist dislocation and percutaneous pinning of the ulnar styloid fracture in an anatomic position. Post-operatively the forearm and wrist were placed in a sugar-tong splint in neutral to slight supination and the wrist appeared stable and in good alignment. The athlete was discharged to home the following day with an intact neurologic exam and minimal pain. One week post-operatively the arm was placed in a long-arm cast and an MRI was obtained to assess the extent of soft tissue trauma. The MRI revealed a small non-displaced distal radius dorsal "lip" fracture and extensive edema in the surrounding carpal soft tissues. Also noted was a possible tear of the scapholunate ligament. Two weeks post-operatively after soft tissue swelling had subsided, the athlete was referred to an orthopedic hand specialist. New radiographs revealed approximately five millimeters of diastasis at the distal radio-ulnar joint. A closed reduction of the distal radio-ulnar joint was performed and a new long-arm cast was applied with the wrist in full supination. Six weeks post-operatively, radiographs demonstrated sufficient healing of the ulnar styloid fracture. The long-arm cast was removed and the percutaneous pin was removed. A removable sugar-tong splint was fashioned maintaining supination, and the athlete was referred for physical therapy. The splint was to be removed for exercise sessions, and then reapplied. Passive wrist pronation was contraindicated. Follow-up clinical exam and repeat x-rays of the wrist out of the splint s was scheduled for four weeks later. **Uniqueness:** This case represents a rare mechanism of injury sustained while performing a common weight training technique. Additionally, this injury represents one of only a few relative emergent injuries necessitating urgent evaluation and treatment. **Conclusion:** Wrist dislocation with or without associated fracture and/or soft tissue injury represents a significant traumatic event that may be season and/or career ending in an athlete. This injury pattern necessitates immediate attention and early treatment in an attempt to obtain the best outcome. This athlete is currently eight weeks post-operative treatment and is continuing the moderate but progressive process of regaining motion, strength and function.

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**Nodular Flexor Tenosynovitis In The Hand Of A Young Certified Athletic Trainer: A Case Report**

Calderone SC, Dover GC: University of Florida, Gainesville, FL

**Background:** A 23-year-old female certified athletic trainer reported to an orthopedic surgeon with a four-month history of wrist abnormalities and a three-month history of clicking in the wrist. The sensation was most noticeable during the heel lock phase when taping an ankle. A small palpable lump in the palm had developed one month prior to the doctor's appointment. The patient had no previous hand or wrist injuries and no significant family medical history. In addition, the patient did not have paresthesia, and provocative testing for peripheral compressive neuropathy was negative. **Differential Diagnosis:** Lyme disease, rheumatoid arthritis, carpal tunnel syndrome, flexor tendon nodule, trigger finger, ganglion cyst, or neuroma. **Treatment:** X-rays were negative for fractures, dislocations, bony lesions, and static carpal tunnel instability. MRI one week after the doctor's evaluation revealed a 0.9 cm heterogeneous nodule between the 3rd and 4th flexor digitorum superficialis tendons with involvement of the flexor digitorum profundus tendons. The nodule was located midway between the 4th MCP joint and the carpal tunnel. There was no evidence of significant tenosynovitis and the median and ulnar nerves were not affected. General labs for rheumatoid arthritis and Lyme disease were negative. The doctor and patient agreed that surgery was needed but due to scheduling restrictions, the surgery was not performed until four months after the initial diagnosis. The patient underwent a radical flexor tenosynovectomy with an excisional biopsy, and an open carpal tunnel release. Both a large soft tissue mass from the 4th flexor tendon sheath in the palm and a significant amount of flexor tenosynovitis were debrided and sent as specimens, which were later diagnosed as nodular tenosynovitis and chronic tenosynovitis with synovial hyperplasia, respectively. The patient was placed in a short-arm cast for four days, then was placed in a removable splint and reported to occupational therapy for postoperative management. The rehabilitation included cryotherapy, general finger pumping exercises and passive wrist stretching. Ten days after the operation, the patient had normal sensation, a brisk capillary refill, and was able to make a full fist. Further rehabilitation incorporated electrical stimulation, friction massage, fluidotherapy, ultrasound, and putty exercises for strength. Three weeks after surgery, the patient had full ROM, 5/5 intrinsic strength testing, and a normal neurovascular exam with minimal scar tissue and adhesions. The patient reported being able to rip athletic tape three weeks after the operation. The patient returned to work after one month of rehabilitation and reported only minimal limitations. **Uniqueness:** Flexor tendon nodules causing triggering at the wrist are rare and have been associated with numerous diagnoses, all involving a combination of pain, carpal tunnel syndrome, and rheumatoid arthritis. These nodules have been referred to by several terms such as giant cell tumor of the tendon sheath, fibroma of the tendon sheath, nodular tenosynovitis and trigger wrist. The triggering of the fingers at the wrist presented in this case did not involve pain, numbness, or tingling, nor was it the cause of, or caused by, either rheumatoid arthritis or carpal tunnel syndrome. Chronic nodular tenosynovitis presenting in the palm and wrist is rare, with only 4.9% of 671 cases presenting in this location. The patient had a carpal tunnel release as a means to remove the flexor tenosynovitis, not due to suffering from carpal tunnel syndrome. This patient was also much younger than the average 41.4 years as reported by 317 patients in other cases. **Conclusions:** Although a rare injury, clinicians should be aware of triggering of the fingers at the wrist. Special considerations are required for people who need their hands for their profession.

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**Grade V Acromioclavicular Joint Sprain, Chronic In A Collegiate Football Player**

Baggett JB, Navitskis L, Courson R, Ferrara MS, Brown CN: University of Georgia, Athens, GA

**Background:** A 19 year old NCAA Division I football player (tight end) presented at the preparticipation physical with a history of left shoulder injury and a large deformity over his left acromioclavicular (AC) joint. The athlete stated that he had sustained an AC joint sprain during the first game of his senior season diving into the end zone. He continued to compete through his senior season wearing a custom protective AC joint pad. However, he remained untreated throughout the remainder of that season with the exception of pre-game corticosteroid injections. Upon examination, the athlete exhibited normal shoulder range of motion (ROM) with bilaterally equal upper extremity manual muscle tests. The athlete showed no signs of neurological deficiencies and had normal glenohumeral stability. Team physicians ordered baseline x-rays of his AC and glenohumeral joints to determine the extent of any structural damage. **Differential Diagnosis:** Distal clavicle fracture, deltoid contusion, acromion fracture, coracoid fracture, os acromionale and loose bodies. **Treatment:** X-rays revealed a grade V AC sprain as classified by the Rockwood scale. A grade V sprain indicates rupture of the AC ligament, joint capsule, and coracoclavicular ligament (CC) with clavicular elevation resulting in the detachment of the deltoid and trapezius. Team physicians felt that the joint was stable enough to participate in off season workouts with conservative treatment and rehabilitation, including RICE, continuous ultrasound, and NSAIDs. The athlete was also placed on a shoulder rehabilitation program that specifically focused on strengthening and stabilizing the musculature surrounding the glenohumeral and AC joints. Initially, the athlete was restricted from all over head lifting. He was also limited in most of the team Olympic style lifting. During the off season workouts the athlete again became symptomatic. The athlete complained of increased joint pain, loss of ROM, and weakness in the musculature surrounding the shoulder. The athlete described a stabbing pain that radiated into his superior trapezius. The athlete's signs and symptoms did not reduce with the conservative care. Subsequently he received two corticosteroid injections from the team physicians. The injections failed to relieve his symptoms and he continued to have diminished function. He therefore required surgical stabilization of the acromioclavicular joint. This was accomplished with a modified Weaver-Dunn procedure with hamstring allograft backup. The athlete remained in a sling for 6 weeks and was allowed limited PROM. After 6 weeks the athlete progressed through a conservative rehabilitation program, incorporating PROM, AROM, AAROM and limited progressive resistive exercises. A second procedure was performed to remove the retained hardware at 16 weeks. The athlete was placed in a sling post-op for comfort, and treatment and rehabilitation were continued. **Uniqueness:** Untreated grade V AC joint injuries that are able to return to a high level of activity are rare in collegiate athletics. **Conclusions:** Due to the chronic instability of the athlete's AC joint, aggressive surgical intervention was deemed necessary to restore normal shoulder function and allow the athlete to participate in competitive collegiate athletics. The surgical intervention was effective in restoring functional AC joint stability while allowing adequate glenohumeral joint ROM.

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**Brachial Plexus Nerve Root Avulsion Of A Collegiate Football Player**


Blair KR, Tymkew JA: Eastern Illinois University, Charleston, IL


**Background:** A 22 year old male linebacker was running down the field on kickoff when he was hit by an opposing player. The athlete's neck was in left lateral flexion when the opposing player's helmet struck the superior aspect of his right shoulder. The athlete fell to the ground with paresthesia of all extremities. Full sensation returned within seconds except in the right upper extremity where there was no motor or sensory function. The athlete had no midline neck pain and was alert and oriented. Cervical fracture was ruled out and the athlete was assisted off the field. The athlete had a previous history of multiple stingers bilaterally. No history of cervical injuries. **Differential Diagnosis:** Cervical disc injury, cervical fracture, brachial plexus injury, nerve root avulsion. **Treatment:** X-rays of the cervical spine completed at the football field were negative. Athlete was sent to the hospital for further examination due to extreme pain. Physicians requested a MRI, contrast-enhanced CT scan, and CT angiogram, which showed no cervical fractures or disc herniations. The athlete had 0/5 MMT of all right upper extremity muscles, no sensation of C4-T1 dermatomes, and no deep tendon reflexes. Athlete was diagnosed with a brachial plexus injury and released with pain medications, placed in a sling, and referred to a physical therapist. Physical therapy began three days after release from the hospital and included joint mobilizations, passive ROM, edema massage, and joint loading of the fingers, wrist, elbow, and shoulder. Daily rehabilitation was completed by the athletic trainer. Three weeks post injury an EMG demonstrated no motor or sensory function of the right upper extremity. A CT myelogram was then ordered to determine the extent of nerve damage. Results demonstrated dorsal and ventral root ruptures of the right side at levels C4, C5, C7, C8, and T1, and a ventral nerve root rupture of C6. Following the CT myelogram a neurosurgeon consult was completed to discuss surgical options. Surgery was completed two months after the date of injury at Barnes Jewish Hospital in St. Louis, MO. Surgery included transfer of the distal accessory nerve to the suprascapular nerve, third, fourth, and fifth intercostals nerves to the musculocutaneous nerve, sixth intercostal nerve to the long thoracic nerve, and seventh and eighth intercostal nerves to the medial antebrachial cutaneous nerve. Following surgery the athlete was placed in an immobilizer. No physical therapy was completed on the shoulder joint following surgery to allow for nerve healing, yet rehabilitation continued on the wrist, fingers, and elbow. Eight months following surgery, the athlete began to regain shoulder internal rotation. The athlete is currently 14 months post-injury. He has significant amounts of atrophy in the upper right extremity and is developing adhesive capsulitis of the fingers and thumb. No other significant improvements in function or sensation have occurred. **Uniqueness:** The multiple level nerve root avulsion of this athlete is normally seen only in traumatic events such as automobile and motorcycle accidents. No previous reports have shown an injury to this extent within athletics. Surgical intervention usually includes nerve grafting, yet in this case a nerve transfer technique was employed. **Conclusion**: Injuries to the brachial plexus are common in football; however an injury to this extent is unique. It is important for athletic trainers to understand proper evaluation and diagnostic tools of a nerve root avulsion. Knowledge of treatment and rehabilitation protocols will aid in proper conservative and surgical management.

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**Back Pain In A High School Female Basketball Player**


McNew S, Seeley K, Cassidy R, Shaffer W: University of Kentucky Orthopaedics & Sports Medicine, Lexington, KY


**Background**: A healthy 17 year old female high school basketball player developed mid-upper back pain after landing from a rebound. She felt an immediate tearing, burning type pain in her upper-mid back radiating down to her right buttock and thigh. She was able to continue play but not to her normal level. She stated her pain had a sudden onset, became worse with exercise and sitting and better when she was lying down. Her cervical and lumbar motor and sensory examinations were normal bilaterally. Her reflexes were symmetric with normal range of motion. Strength was 5/5 throughout. **Differential Diagnosis:** Upper back strain, fracture, cervical or lumbar disk herniation, thoracic disk herniation. **Treatment**: X-rays were negative for any abnormalities. A MRI of the thoracic and lumbar region revealed a small thoracic disk herniation at T10-11 with an intrusion upon the spinal cord. No myelopathy was seen. The athlete was told to discontinue any type of athletic activity due to the risk of further disk herniation. Due to limited room around the spinal cord in the thoracic region, a herniation in this area can put pressure on the cord and affect related nerve function. She was allowed to walk for exercise and began McKenzie exercises. She was placed on non-steroidal anti-inflammatory medication as well as a muscle relaxer. She began shooting and dribbling at 2 months with no increase in pain. At three months, her leg pain was gone and she was allowed to begin low impact aerobics. At 5 months she was allowed to begin jogging and sport specific exercises gradually working into playing basketball. She was released to full activity at nine months. One year from the initial injury, she was hit in a basketball game and began having increased back pain with radiation into her right chest wall. She was placed on a Medrol Dosepak. This did not decrease her pain and she developed upper right arm pain and right leg pain again. Another lumbar, thoracic MRI was obtained. Her T10-11 disk herniation had not increased. A syrinx (fluid filled cyst in the spinal cord) was found at the T4 level. At this time, all athletic activity was stopped and she was referred to a Neurosurgeon to address the syringomyelia. Since there was no evidence of trauma to the spinal cord at T4 or adjacent levels, it was felt this was a congenital finding. She did have improvement with her leg pain but continued to have right chest wall pain. She was given a course of epidural injections which greatly decreased her pain. She did not play basketball after this final episode. **Uniqueness:** The thoracic vertebrae are more stable than the others due to their arrangement with the ribs. Because of this, thoracic disk herniations are relatively rare compared to lumbar and cervical disk herniations. They make up approximately 1% of all protruded disks. The majority of these herniations occur at T11 and T12 as the thoracic and lumbar region meet at this level. This area is subject to many forces occurring from daily living such as bending and twisting which lead to degeneration of the disk. This is the main cause of thoracic disk herniations. **Conclusion:** The thoracic disk herniation this athlete sustained was atypical due to the mechanism and location at T10-11. If an athlete does resume athletic activity, any pain must be taken seriously as further herniation can result in a spinal cord injury.

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**Jefferson Burst Fracture In A Collegiate Football Player**

Duncavage L, Moffit D, Driban J, Stansbury D: Department of Athletics, Department of Kinesiology, Temple University, Philadelphia, PA

**Background:** This report will present a unique case of a cervical spine fracture at the C1 level. A twenty-one year old male (height = 177.8 cm, mass = 93.12 kg) Division I NCAA football running back with no prior neck injury was on a turf-field during a routine pre-season practice. The play was unremarkable to those watching and the athlete walked off the field. Later, during video review of the play, spearing by the athlete was observed suggesting an axial compression loading to the head and neck, followed by hyperextension. He ran to the end of the field where an athletic training student noticed his eyes were glazed. Upon the student's initial evaluation, the athlete complained of severe stiffness and inability to move his neck in any direction. The athlete's right posterio-lateral neck was painful to the touch. He described the pain as sharp, shooting pain that traveled down his neck. The ATC was unable to test neck muscle strength and range of motion except for right lateral flexion because of pain and stiffness. Cranial and peripheral nerve tests were negative, indicating no neurological deficit. **Differential Diagnosis:** Cervical strain, cervical sprain, brachial plexus trauma, or cervical muscle spasm. **Treatment:** The head ATC placed the athlete in a Philadelphia collar and immediately transported him in a seated position to the local hospital for x-rays, a CT scan (angiography and cervical spine), and an MRI of the cervical region. The angiography showed no evidence of vascular injury. The cervical CT scan and MRI reports revealed minimally displaced comminuted fractures involving the anterior and posterior ring of C1, extending into the lateral mass. The films also showed a displaced fracture involving the posterior ring on the left side of C1 with extension into the posterior aspect of the left lateral mass. The intervertebral disk heights were unremarkable and the remaining vertebral bodies were normal, as was the spinal cord. There was no disk herniation, neural foraminal encroachment, or central spinal canal stenosis. The impression was that the athlete sustained a C1 Jefferson burst fracture. He was kept in the hospital and a halo was applied for approximately nine weeks. After removal of the halo, the athlete was put into a Miami J Collar. The final prognosis has been undetermined at this time. The athlete has been performing light upper and lower body exercises using body weight only while wearing the Miami J Collar. He is scheduled for follow up testing and evaluations with the neurosurgeon to be cleared for further rehabilitative activity. He has been cleared to use a stationary bike, but is restricted from overhead lifting. **Uniqueness:** Upper cervical spine fractures are life-threatening injuries uncommon in sports. The prevalence of this type of fracture in intercollegiate football is rare with the mortality rate high. This specific instance did not indicate any neurological deficits that would indicate a major cervical injury. Not many patients survive to see the outcome of this injury. The athlete was fortunate to not have had any spinal cord injury, permanent disabilities, or paralysis. The treating physicians feel this may not have been the case had he been spineboarded, which would have disrupted the fracture and compromised the spinal cord. **Conclusion:** It may often be difficult to determine the extent of a neck injury, especially when there is no evidence of neurological deficits. It is imperative that conservative measures be taken when mechanism of injury is unclear. However, it is important for athletic trainers to evaluate each case individually. The athletic trainers did not spineboard the athlete, which is conservative protocol, but in this case appropriate.

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**Evaluation And Treatment Of Low Back Pain In A Female Collegiate Basketball Player Using The Selective Functional Movement Assessment™**

Walters SL, Landis M: Indiana State University, Terre Haute, IN

**Background:** A 20-year-old female collegiate basketball player presented with right sided low back pain and stiffness. The athlete indicated that her pain was over her right erector spinae in an area ranging 2 to 4 inches superior to her PSIS. She also complained of parasthesia in the left lateral lower extremity encompassing portions of the L4, L5, and S1 dermatomal and sciatic nerve areas. The athlete reported she had experienced intermittent low back pain for approximately 1 year and had been treated for sacroiliac dysfunction during that time without experiencing any long term change in symptoms. The athlete's Oswestry Low Back Pain Disability Questionnaire (ODQ) score was 5/50 prior to examination. Pain at examination was rated as 1/10, worst pain the past 24 hours was 5/10 with basketball practice, best pain the past 24 hours was 0/10. The athlete was not tender to palpation and no palpable changes in muscle tone were observed. All sacroiliac exam findings (including palpation for position and symmetry, palpation for mobility, FABER's, SI compression and distraction) were negative as was a prone instability test for the lumbar spine. Athlete's left hip passive internal rotation range of motion was limited compared bilaterally. All lower extremity dermatomes (tested with eyes closed), myotomes, and reflexes were normal and equal bilaterally. Passive intervertebral movement testing of the lumbar spine was rated as normal at 3/6. With the Selective Functional Movement Assessment™ (SFMA), the athlete demonstrated a functional range and movement pattern with multi-segmental extension and deep squatting but experienced pain with both. Both movements required both upper extremities to be flexed overhead thus placing the latissimus dorsi on a stretch. The multi-segmental extension regressional pattern was assessed further and pain was eliminated when the right upper extremity was in a relaxed position. Pain was also eliminated when the right hip was flexed and the foot placed on a six inch stool. These findings indicated tightness of the right latissimus dorsi and hip flexors. **Differential Diagnosis:** Based on the patient history, but prior to the examination, the differential diagnosis included: sacroiliac dysfunction, lumbar segmental instability, discogenic pain and/or dysfunction, diminished motor control of the lumbar stabilizers, and muscle tightness. **Treatment:** The athlete's right latissimus dorsi, right hip flexors, and left hip external rotators were stretched passively for 4 sets of 20-30 seconds each. Following instruction in a self stretching program, multi-segmental extension and deep squatting were reassessed. During the reassessment the athlete stated that her pain had resolved at rest, with the multi-segmental extension movement, and with the deep squat movement. She also was no longer experiencing parasthesia. She has continued to perform her stretching program for the past month and has not experienced a reoccurrence of low back pain or lower extremity parasthesia. Her ODQ score 2 weeks after the initial evaluation and treatment was 0/50. **Uniqueness:** This case is unique in that a functional movement assessment was used to quickly identify muscular tightness that appears to have caused low back pain. Once the identified muscles were stretched the SFMA allowed for a quick reassessment to determine the effectiveness of the treatment. **Conclusions:** The Selective Functional Movement Assessment™ can be used to assess an athlete with low back pain, support a diagnosis, and provide insight into proper treatment. Medical professionals can use the SFMA as a quick and easy evaluative tool in the athletic population.

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**Transient Quadriparesis In A High School Football Player: A Case Study**

Sulewski A, Dover GC: University of Florida, Gainesville, FL

**Background:** This case is about a cervical spine injury sustained by a high school football player. A 16 year old male football player first noted pain in his lumbar spine after a helmet to helmet collision with another player. He continued to play in the game even as the symptoms worsened without notifying a coach or the certified athletic trainer. Later in the same game, while running down the field, the athlete was thrown to the ground by his facemask. The athlete felt as though his head and torso went in one direction and his legs went in another. His chief complaint was severe pain in the lumbar spine which radiated down into his legs. The lumbar spine and lower extremity symptoms were similar to those to an injury he had experienced earlier in the season. The athlete experienced brief paralysis of all four limbs which lasted less than 10 seconds. Palpation of the lumbar spine revealed point tenderness along the spinous processes and surrounding musculature. After the initial 10 seconds, the athlete reported numbness and tingling in all four extremities. Grip strength was 3/5 bilaterally and within minutes the athlete reported an increase of pain along his entire spinal cord. At this time the athlete was disoriented and began to lose consciousness. A distinguished drop in the radial and carotid pulse was noted and at this point EMS arrived. The athlete was spine boarded and taken to a local emergency room. **Differential Diagnosis:** Central cord syndrome, brachial plexus injury, cervical spine injury and lumbar spine fracture. **Treatment:** Upon arrival to the emergency department, lumbar spine radiographs were taken and did not indicate any fractures. The athlete was released the same night with pain still present in his lumbar spine. A follow up appointment was made for four days post injury with a spine specialist because significant low back pain was still present which resulted in the inability to walk and/or sit comfortably. In the four days following the injury, pain and neurological symptoms began to appear in the cervical spine and upper extremities. The doctor noted weakness in the C2, C3, and C4 myotomes. A radiograph and an MRI of the cervical spine was ordered. Radiographs indicated an anterior subluxation of C2 on C3. No ligamentous damage was present on the MRI. The athlete was placed in a cervical collar which provided almost immediate relief of all cervical and lumbar pain. The injury was diagnosed as transient neurapraxia with quadriparesis in his upper and lower extremities secondary to a cervical spine injury. The C2 subluxation may have been present prior to the injury. The athlete was cleared for unrestricted participation but chose not to continue playing football. Six weeks after the injury the he returned to wrestling without limitation, complications, or residual symptoms. **Uniqueness:** Transient neurapraxia with quadriparesis is rare, occurring in 1.3 per 10,000 football exposures. A complete resolution of symptoms typically occurs within 10 minutes to 48 hours. In this case, the athlete's signs and symptoms in his lumbar spine were relieved by the use of a cervical collar. Retrospective studies suggest that those who suffer from transient neurapraxia are not at a higher risk to suffer permanent neurological injury. **Conclusion:** Transient neurapraxia with quadriparesis is an uncommon injury seen in athletics. Symptoms may include temporary paralysis, numbness, tingling and decreased motor function. All medical personnel should be aware of its signs and symptoms and as with any spinal cord injury, extra precautions should be taken to limit additional damage to the spinal cord until diagnostic imaging can be done to rule out a severe injury.

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**Temporary Para Paresis In A High School Football Player**

Collins RJ, Dimeff RJ, Bell G: Cleveland Clinic Foundation, Cleveland, OH

**Background:** 15-year-old high school football player received a direct blow to the frontal aspect of head causing a hyperextension of C-spine. On field, athlete complained of Para paresis of both arms. During on-field, systematic evaluation, athlete regained sensation and motor function in both upper extremities. Athlete was removed from field under own power. Sideline exam revealed no point tenderness in trapeziums or para spinal muscles. Compression test was negative for pain. Neck strength: 5/5 flexion, extension, lateral flexion and rotation. Shoulder strength normal except for IR/ER, which was 4/5. Athlete did sustain a previous trapezium contusion two weeks prior, which resolved in two days. No previous complaints of brachial plexus issues. He has been participating in contact football since the age of 7. **Differential Diagnosis:** Cervical fracture, cervical strain, cervical disc herniation, cervical stenosis, syringomyelia. **Treatment:** Athlete was evaluated by team physician four days post injury. X-rays revealed: No obvious fractures or dis-locations. There was an absence of cervical lordosis, indicative of a "spearing spine". MRI revealed normal crainocervical junction with normal morphology and signal characteristics. C4-5 Disc-broad-based central disc protrusion with mild cord effacement, mild central and moderate bilateral foraminal stenoses. C5-6 Disc left Para central disc protrusion with thecal sac compression and minimal foraminal extension. Remainder MRI was unremarkable. MRI was reviewed by orthopaedic spine surgeon prior to follow-up with athlete. Follow-up exam post MRI, athlete was medically disqualified from participating in collision sports with clearance to participate in basketball and track with restrictions on long jump, high jump, and pole vaulting. **Uniqueness** Most incidences of cervical injuries in high school athletics are benign in nature. Brachial Plexus neuroproxia, cervical strains/sprains are most common occurrences. With the sudden onset of para paresis, with spontaneous resolve, suspicion of more serious but sub-acute/chronic injury warranted investigation. Findings from the x-rays and MRI were not expected **Conclusion:** A debate could ensue that the athlete should have been immobilized and transported for evaluation. The decision to not transport was based on lack of physical findings on the field as well as off and the relative quick return of motor and sensation. Congenital defects affecting the spine mostly manifest after trauma. This athlete was fortunate enough to have no effects that could last a lifetime.

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**Bracial Plexopathy In A Collegiate Football Player**

Payne SS, Wilkins JC: Otterbein College, Westerville, OH; MAX Sports Medicine Institute, Mount Vernon, OH; OhioHealth Sports Medicine, Westerville, OH

**Background** An 18-year-old male linebacker reported to his pre-season participation physical exam prior to beginning football practice. During the pre-participation exam the athlete reported that he had experienced "neck problems" and repeated "stingers" while playing high school football. The athlete complained of several episodes during his senior football season and he would experience the symptoms after making what he described as any hard tackle. His symptoms included numbness and tingling into the left hand and complaints of a "dead arm" that would be transient. He was always able to return to competition. An initial evaluation of the athlete was completed by the athletic trainers. It was also noted that the athlete had visible atrophy of the left supraspinous fossa and of the left infraspinatus muscle posteriorly. The left scapula was maintained with increased protraction and upward rotation with the athlete in a standing position with the arms at the side. Atrophy was also noted of the left

middle deltoid. Upon performing active elevation in the scapular plane scapular dyskinesis was noted upon the lowering or eccentric phase of the motion. The athlete was noted to have full cervical ROM. The athlete had full AROM for bilateral shoulder flexion, extension, abduction, adduction, horizontal abduction and horizontal adduction. Right PROM for ER= 112 degrees, IR = 57 degrees. Left PROM for ER= 94 degrees and IR= 50 degrees. The athlete had decreased strength of left shoulder flexion, extension, abduction and external rotation. He was also noted to have decreased strength of the middle trapezius, lower trapezius, serratus anterior, and latissimus dorsi. The athlete had pain with the Neer and Hawkins-Kennedy shoulder impingement tests. He had increased laxity of the left shoulder with a posterior drawer and a positive Sulcus sign on the left. Glenohumeral apprehension and the Jobe Relocation test were performed and were positive for anterior glenohumeral instability as well. The athlete had a negative O'Brien's test bilaterally and a negative Adson's test for thoracic outlet. **Differential Diagnosis** Based upon the athlete's history and physical findings initial diagnoses would include spine tackler's disease, shoulder instability, cervical disc disease, shoulder impingement secondary to postural deviations, and thoracic outlet syndrome. **Treatment** The team physician reviewed the results of the athlete's x-ray and MRI from high school. The impression on the x-ray report was unremarkable for any injury. The MRI report indicated a mild right foraminal stenosis at C3-C4. Otherwise the MRI report was unremarkable for further stenosis. The team physician cleared the athlete for full contact at that time and recommended an evaluation by the athletic training staff. During the evaluation it was determined the symptoms of the brachial plexopathy were not solely caused by pathology in the cervical region. The evaluation also revealed that the athlete had multidirectional instability of the left shoulder. Identified impairments included decreased rotator cuff and scapular stabilization strength, scapular dyskinesis, and loss of total glenohumeral rotation. The athlete was also instructed in a shoulder rehabilitation program. The program included high repetition rotator cuff work with the scapula unsupported, dynamic scapular stabilization and shoulder complex proprioception training. The athlete continued participation in football and complete two weeks of intensive rehabilitation followed by a maintenance program as described above. He was able to complete the season without any incidence of brachial plexus symptoms. **Uniqueness** The athlete had been treated unsuccessfully in high school by managing him for stinger syndrome. Treating the athlete for his multidirectional shoulder instability resulted in a positive outcome for this athlete. **Conclusions** It is important to screen for shoulder instability in athletes presenting with symptoms of brachial plexopathy.

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**Persistent Neck Pain In A Collegiate Wrestler**

Buselli ML, Dodge TM, Laursen RM: Boston University, Boston, MA, and University of South Carolina, Columbia, SC

**Background:** This case presents a 22 year old male wrestler with a weight of 64 kilograms and a height of 160 centimeters. The patient presented with pain in the lower cervical spine in December 2006 after falling directly on his forehead and nose during live wrestling practice. The cervical spine was in a flexed position upon landing. The patient's prior medical history revealed multiple brachial plexus traction injuries. Palpation revealed tenderness over the trapezius along the spinous process at C7-T1. Neurological testing and cervical range of motion assessments were normal. **Differential Diagnosis:** Trapezius strain, spinous process fracture, transverse process fracture, spondylytic defect, facet joint pathology, cervical disk herniation, clay shoveler's fracture. **Treatment:** X-Rays of the cervical spine taken in December 2006 were read negative. However, the spinous process of the T1 vertebra was noted to have a right lateral shift. Diagnosis was a right trapezius strain. At this time, the patient took two weeks off from wrestling for the holiday season however he continued his normal conditioning routine. In February 2007, the patient returned to the athletic training room with a recurrence in neck pain. Evaluation revealed spasm in the middle trapezius, rhomboids, and cervical paraspinals, specifically at the C7-T1 level. Palpation of the cervical spine indicated that the spinous process of the T1 vertebra remained shifted to the right. Active right rotation of the cervical spine increased pain. Manual muscle testing also increased pain with rotation to the right. The patient also presented with a positive spring test for pain (T1 level) and stated that overpressure at the end range of cervical flexion increased his pain level. Treatment at this time focused on reducing the right sided muscle pain and spasm. The patient was able to complete the season, receiving treatments 2-3 times per week. Following the wrestling season, the patient returned for a follow up with a new complaint. Lifting objects in the plane of the scapula caused neck pain with occasional weakness. Further imaging was ordered to rule out a possible occult fracture of the spinous process. The MRI revealed a non-displaced vertically oriented fracture through the T1 posterior spinous process. An increased T2 signal in the adjacent left multifidus muscle with associated thickening of the attaching tendon was also present, indicating a partial tendon tear. The patient was removed from contact activities for the following 8 weeks. He was allowed to complete endurance exercises such as running and biking, but was restricted from exercises that engaged the trapezius muscles. In May 2007 x-ray revealed negative findings and the patient was allowed to continue with non-contact activities. The patient returned to full participation 2 months later in August 2007 after a second negative x-ray. **Uniqueness:** The etiology of the injury is unknown. It could have been caused via the initial fall with the cervical spine in flexion, or through the excessive forced neck flexion that accompanies the sport of wrestling. However, the injury had a similar presentation to a clay shoveler's fracture, which is an avulsion of the spinous process that is caused by excessive spasm in the trapezius. This injury was common among road workers shoveling heavy soil in the early twentieth century. **Conclusions:** In this case an occult fracture lay hidden on diagnostic x-ray imaging behind persistent neck pain with secondary spasm appearing months later on MRI. This case highlights the importance of ongoing re-evaluation to detect underlying pathologies. Also noteworthy is the importance of exercising caution when making clinical return to play decisions when such underlying pathologies are suspected.

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**Unilateral Lumbosacral Transitional Vertebrae In A Female Division I Collegiate Basketball Player**

Blum AL, Liceralde PE, Dodge TM, Venis LE: Boston University, Boston, MA, and University of Nevada, Las Vegas, Las Vegas, NV

**Background:** This case presents a 19 year old female division I collegiate basketball player (height = 191 centimeters, weight = 79 kilograms). Initial complaints included chronic pain in her right hip with tenderness over the greater trochanter and anterior hip/iliopsoas musculature. In addition to sharp pain with running and jumping activities, she reported difficulty sleeping and inability to sit in one position for prolonged periods of time. **Differential Diagnosis:** spondylolysis, spondylolisthesis, sacroiliac joint dysfunction, facet joint dysfunction, psoas attachment dysfunction, intervertebral disc herniation, trochanteric bursitis, acetabular

labral tear, femoral neck stress fracture. **Treatment:** Conservative treatment for trochanteric bursitis and iliopsoas tightness did not resolve her pain. Evaluation with MR-Arthrogram revealed no internal derangement, stress reaction, or damage to the acetabular labrum. A cortisone injection within the right hip joint did not reduce the symptoms. Due to the chronic symptoms, the athlete was referred to a physical therapist specializing in spinal evaluation. It was discovered that the pain originated from a lumbosacral dysfunction caused by a taut right sacrotuberous ligament, taut bilateral iliopsoas muscle complex, bilateral hypomobility of the inferior lumbosacral spine, and hypermobility of the upper (L1-L3) lumbar spine combined with diminished core stability. The sacrum was counternutated, leading to a reduced lordotic curve within the lumbar spine. There were no neurological symptoms. Treatment included joint mobilization of the sacroiliac joints and lumbar spine, deep tissue massage of the sacropelvic ligaments and iliopsoas muscle, and therapeutic exercise to increase activation of the gluteal and lumbar intrinsic musculature. As symptoms decreased in the right lumbosacral area over 3 months, pain began to increase in the left lumbosacral region. The patient also reported radiating neurological symptoms in the left leg. X-rays of her pelvis and lumbar spine revealed a congenital lumbosacral transitional vertebra (LSTV) at L5. There appeared to be pseudosacralization of the left L5 transverse process with the sacral base. In addition, an unusually formed left facet joint existed between L5-S1, which included an irregular articulation in the transverse plane, causing an abnormal stress reaction at this location. Treatments continued in order to resolve the mechanical dysfunction within the lumbosacral region. The athlete was allowed to progress to full activity by the middle of her junior season. Lumbar joint mobilization was avoided due to the facet anomaly located on the left of L5-S1. Unfortunately, the increased activity led to increased fatigue and spasm within the gluteal musculature, with increased neurological symptoms. An MRI after her junior season of her lumbar spine revealed mild bulging within the L4-5 intervertebral disc, but no impingement on the peripheral spinal nerve roots. Treatment goals were developed to decrease the bilateral spasm in her gluteal muscles using deep tissue and active release techniques. Another treatment goal was to increase her core stability. Cortisone facet injections at the L4-5 were utilized to alleviate her pain, but there was only moderate success with this procedure. The athlete has since returned to full activity, but continues to receive deep tissue and therapeutic exercise treatments 3-4 times per week. **Uniqueness:** Lumbosacral transitional vertebrae are prevalent in approximately 30% of the population, yet not commonly seen in division I collegiate athletics. With a bilateral LSTV, athletes can be completely functional due to the stability of the lumbar spine at the involved level. However, unilateral LSTV requires the non-involved side to withstand increased stresses due to the hypomobility of the involved side. **Conclusions:** Although LSTV is fairly prevalent, it does not always result in pain, even in athletes. A level of suspicion should be maintained when a lumbosacral dysfunction is diagnosed with an associated hypomobility in the inferior lumbar spine.

## Free Communications, Poster Presentations: ACL Risk Factors

Friday, June 20, 2008, 8:00AM-12:00PM, 2nd Floor Atrium; authors present 11:00AM-12:00PM

### The Effect Of Axial Load On Anterior Tibial Translation (ATT) And Quadriceps And Hamstring Muscle Activations When Transitioning From Non-Weight Bearing To Weight Bearing

Kim H, Schmitz RJ, Shultz SJ: University of North Carolina at Greensboro, Greensboro, NC

**Context:** The ACL is the major restraint to anterior translation of the tibia relative to the femur (ATT), and unopposed quadriceps muscle contraction near full knee extension is considered a major source to cause ATT. While compressive joint loads and thigh muscle activity are associated with the amount of ATT in vitro, less is know about these characteristics when transitioning from non weight bearing to weight bearing in-vivo. **Objective:** To investigate the effect of increasing axial loads on ATT and thigh muscle activation in healthy knees during the transition from non-weight bearing to weight bearing. **Design:** Single cohort descriptive design. **Setting:** Controlled, laboratory setting. **Patients or Other Participants:** Twenty two (11M, 11F) healthy participants (24.9±3.2 yrs, 169.9±7.9 cm, 68.3±12.2 kg) with no history of knee ligament injuries. **Interventions:** ATT was measured on the dominant limb (stance leg when kicking a ball) with the subject supine and knee flexed to 20 in the Vermont Knee Laxity Device (VKLD; University of Vermont, Burlington, VT). The VKLD allowed controlled loading of the tibiofemoral joint by first creating a zero shear load condition across the knee while unweighted, then compressive loads of 20%, 40%, and 60% body weight were applied through the ankle and hip axes to simulate weight-bearing. Three trials of each load were applied in a counterbalanced order while electro-magnetic sensors measured ATT, and surface electromyography (sEMG) recorded thigh muscle activation in response to the applied loads. Maximum voluntary isometric contractions (MVICs) for the quadriceps and hamstring muscles at 20° knee flexion were measured with an instrumented dynamometer to normalize sEMG data. Repeated measure ANOVAs followed by pairwise comparisons with bonferroni corrections compared ATT and thigh muscle activations between the three loads. Bivariate correlations examined relationships between muscle activation and ATT within each load. **Main Outcome Measures:** ATT was measured in millimeters (mm). Quadriceps and Hamstring activations were measured as the normalized peak RMS amplitudes (%MVIC) during the first 250ms of the transition from non-weightbearing to weightbearing. **Results:** ATT signifi-cantly increased with each weight bearing load (20%=4.7+1.7mm < 40%=7.1+1.9mm < 60%=8.8+2.1mm; p=.000), as did quadriceps (20%= 23.6 + 14.9%MVIC < 40%= 32.7 + 11.8%MVIC < 60%= 41.1 + 13.5%MVIC; p= .000) and hamstring (20%= 15.5 + 15.7%MVIC < 40%= 23.0 + 16.4%MVIC < 60%= 27.6 + 19.1%MVIC; p= .000) activations. However, little to no correlations were noted between quadriceps and hamstring activation and the amount of ATT within each load (pearson r range=.033 - .294; all p<.185). **Conclusions:** Our results suggest that greater axial loads experienced at initial foot contact with the knee near full extension may result in greater ATT, regardless of increasing quadriceps and hamstring muscle activation levels. Further work is needed to determine the effects of pre-activation and knee flexion angle on the relationship between ATT and quadriceps and hamstring muscle activation during early weight bearing activities in-vivo. *Student Poster Award Finalist*

**Vertical Leg And Knee Flexor Stiffness Do Not Change Across The Menstrual Cycle**

Bell DR, Blackburn JT, Ondrak KS, Norcross MF, Hudson JD, Padua DA, Hackney AC: Motor Control Laboratory, Applied Physiology Laboratory, University of North Carolina at Chapel Hill, Chapel Hill, NC

**Context:** Reproductive hormonal fluctuations across the menstrual cycle potentially contribute to the higher female ACL injury rate. Furthermore, muscle stiffness is suggested as a contributor to joint stability. While hormonal receptors have been identified on skeletal muscle tissue, the influence of hormonal fluctuations on muscle properties has yet to the identified. **Objective:** The purpose of this study was to determine if vertical leg stiffness ($K_{vert}$) and knee flexor stiffness ($K_{flx}$) change across the menstrual cycle. **Design:** A cross-sectional quasi-experimental study. **Setting:** Laboratory setting. **Patients or Other Participants:** 12 males (height=1.80±0.10m, mass= 78.71±10.8kg, age=20.84±1.77yrs) and 9 females (height=1.65±0.09m, mass= 65.03±11.31kg, age=20.40±1.78yrs) volunteered for this study. All subjects were free from lower extremity injury and females were not using oral contraception. **Interventions:** $K_{vert}$ and $K_{flx}$ were assessed at two time points in each subject. Males were tested 7 days apart and served as a control group based on the hypothesis that stiffness would not differ between sessions. Females were tested at points in the menstrual cycle corresponding with periods of low estrogen (menses) and high estrogen (ovulation) concentrations. The test sessions occurred 3-5 days after the onset of menses and 2-4 days after a positive ovulation test using urine based ovulation test kits. $K_{vert}$ was assessed by hopping on a force plate at a rate of 2.2Hz for 60 seconds, and evaluating the ratio of the change in vertical ground reaction force to the vertical displacement of the total body center of mass. $K_{flx}$ was assessed with the subjects prone and the right hip supported in 30° of flexion. Subjects were required to contract the hamstrings to support a load of 10% body weight in 30° of knee flexion. A perturbation was applied to the shank, producing a damped oscillatory knee flexion/extension pattern which was characterized by an accelerometer secured to the shank. Active linear hamstring stiffness (N/cm) was then calculated as a function of the damped frequency of oscillation. A 2 (sex) x 2 (time) repeated measures ANOVA was used for analysis, and statistical significance was established at $\alpha \leq 0.05$. **Main Outcome Measures:** Vertical leg stiffness (kN/m) and knee flexor stiffness (N/cm). **Results:** The sex by time interaction was non-significant for both $K_{flx}$ ($P$ =0.73) and $K_{vert}$ ($P$=0.74). Additionally, the main effect for time was non-significant for both $K_{flx}$ (Session 1: 12.88 ± 0.66 N/cm, Session 2: 13.17 ± 0.55 N/cm, $P$ =0.57) and $K_{vert}$ (Session 1: 22.89 ± 1.48 kN/m, Session 2: 25.16 ± 1.44 kN/m, $P$ =0.054). **Conclusions:** These results indicate that muscle and leg stiffness did not change across the menstrual cycle using our testing model. Future research should replicate our work and include blood analysis to draw definitive conclusions about the influence of reproductive hormones on muscle properties.

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**Relationships Between Types And Dosages Of Oral Contraceptives And Joint Laxity**

Smith K, Schmitz RJ, Perrin DH, Shultz SJ: University of Toledo, Toledo, OH, and University of North Carolina at Greensboro, Greensboro, NC

**Context:** Joint laxity has received attention as a risk factor for the higher prevalence of ACL injuries among females. While relationships between sex hormones and anterior knee laxity have been identified in normal menstruating females, less is known how variations in synthetic hormones concentrations found in oral contraceptives (OCPs) may modify joint laxity. Given estimates that 40-55% of intercollegiate female athletes use OCPs, understanding this relationship is equally relevant. **Objectives:** To examine the relationships between OCP type and dosages with measures of joint laxity, and to determine whether duration of OCP exposure modifies joint laxity. OCP compounds with greater dosages of ethinyl estradiol, lower dosages of progesterone, and a lower affinity for serum hormone binding globulin (SHBG) were hypothesized to predict greater joint laxity. **Design:** Descriptive cohort study design. **Setting:** Pre-season athlete screening. **Patients or Other Participants:** Forty-four NCAA Division I female athletes (19.5±1.4yrs; 167.9± 7.2cm; 64.1±7.3kg) using OCPs for at least 3 months with healthy knees and no known connective tissue disorders. **Interventions:** Participants completed a validated menstrual history questionnaire which identified the brand and duration (months) of OCP use. Maximum and minimum estradiol and progesterone dosages and %SHBG binding affinity were estimated for each OCP brand based on manufacturer's prescribing information. Participants were measured for general joint laxity (GJL) using the Beigton and Horan Joint Mobility Index, anterior knee laxity (AKL) using a KT 2000™ knee arthrometer, and supine active genu recurvatum (AGR) using a standard goniometer. Separate stepwise linear regressions examined the extent to which OCP dosage and %SHBG binding affinity predicted measures of joint laxity. Secondary regression analyses examined the relationship between duration of OCP use and each joint laxity measure. **Main Outcome Measures:** AKL was recorded in mm as the amount of anterior tibial displacement relative to the femur at 133N of applied force. GJL represented the composite score of all 5 joints tested (0-9) and AGR was measured in degrees. **Results:** Means ± SDs for GJL, AKL, and AGR were 1.6±1.5, 7.8±1.7mm, 5.7±3.0°, respectively. Estradiol and progesterone dosages and %SHBG binding affinity were reported to range from 20-50µg, 0.1-3.0mg, and 0-47%, respectively. Regression analyses revealed no significant relationships between OCP dosage and %SHBG binding affinity with GJL (P=0.352), AKL (P=0.457) or AGR (no variables entered). Duration of OCP use (Mean ± SD 23.63±18.57 months) was also not related to GJL (P=0.181), AKL (P=0.164) or AGR (P=0.197). **Conclusions:** Although synthetic hormones in OCPs are biologically active, the types and dosages of ethinyl estradiol and progesterone levels in current low-dose OCPs, or their length of exposure, do not appear to influence joint laxity. Further work is needed to better understand the effects of OCPs on soft connective tissues, and their relationship with injury and performance.

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**Landing Error Scoring System Scores Differ During Various Types Of Jump-Landing Tasks**

Henry KA, McKim AE, Onate JA, Van Lunen BL: Old Dominion University, Norfolk, VA

**Context:** Large-scale inexpensive pre-participation examination screening tools need to be developed to evaluate individuals at risk for lower extremity injury (e.g., anterior cruciate ligament [ACL]). One tool, the Landing Error Scoring System (LESS) has shown promise in assessing clinical biomechanical jump-landing motion patterns in an inexpensive manner. However, the effectiveness of the LESS to assess various types of jump-landing tasks has yet to be reported. **Objectives:** To determine the effects of a box-drop (BD) jump-landing task versus a running stop-jump (SJ) task with or without the presence of an overhead object. **Design:** Experimental

single session repeated measures design. **Setting:** Athletic training facility **Patients or Other Participants:** Thirty (15 male and 15 female) Division I healthy collegiate athletes (20.03±1.52 yrs; height: 177±11.09 cm; mass: 80.61±21.46 kg) volunteered as participants. **Interventions:** Independent variables consisted of two levels of jump-landing tasks (BD and SJ) and three levels of overhead goal (none, VERTEC, Basketball). The BD task consisted of dropping off a 30cm box, landing, and then jumping to reach overhead. The SJ task consisted of the athletes taking a four-meter approach at preferred running speed to stop in a 60cm x 80cm taped square and then jumping to reach overhead. Maximum vertical jump height (MVJH) was calculated using a VERTEC (Questtec Corp, Northridge, CA). Overhead objects, either a single VERTEC vane or a basketball, were set at 80% of MVJH. Individual's performed three trials each of the six tasks in a counterbalanced order. Two standard Sony S-VHS video cameras (30Hz) were placed in the sagittal and frontal planes and two raters computed LESS scores (range of 0-17) based on jump-landing patterns using Windows Movie Maker software on a Dell Inspiron Notebook computer. A 2 (task) x 3 (goal) repeated measures ANOVA, alpha level of $p<.05$, and Tukey's post hoc HSD tests were utilized to assess any significant differences. Intraclass correlation coefficients (3,k) were calculated to assess the reliability of the two raters LESS scores across each of the tasks. **Main Outcome Measure:** Average LESS scores (possible range 0-17). **Results:** The ICC values for inter-rater correlation of LESS scores were good to excellent ranging from $ICC_{3,k}$ = . 71-.95. A significant difference was found for task ($p<.001$) with a lower LESS score for all BD landing tasks (means ranging from 5.32 to 5.99) when compared to the SJ tasks (means ranging from 8.09 to 8.49). No significant differences were noted between jumps involving different overhead goal requirements.. **Conclusions:** The LESS shows good inter-rater reliability and may be a useful clinical tool in assessing jump-landing technique. Running stop-jump landing tasks result in higher LESS scores which requires further investigation to the LESS scoring criteria dependent on the type of jump-landing task. *Student Poster Award Finalist*

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# Free Communications, Poster Presentations: Low Back and Sacroiliac Issues

Friday, June 20, 2008, 8:00AM-12:00PM, 2nd Floor Atrium; authors present 11:00AM-12:00PM

**Short Term Effects Of Muscle Energy Technique On Innominate Rotation, Leg Length Discrepancy, And Pain In Individuals With Sacroiliac Pain**

Parent NM, Grindstaff TL, Cross KM, Pugh K, Hertel J, Saliba S: University of Virginia, Charlottesville, VA

**Context:** Muscle Energy Technique (MET) is a manual therapy often used to correct pelvic malalignment where the patient voluntary contracts specific muscles against resistance produced by the clinician. Studies regarding magnitude and duration of effectiveness are limited. **Objective:** To determine MET effectiveness on subjects with acute low back pain (LBP) localized to the sacroiliac (SI) joint. **Design:** Double blind randomized control trial. **Setting:** Athletic training clinic of a military institute. **Patients and Other Participants:** Twenty subjects (16 male, 4 female: Age 26.9±9.97years; Height 174.28±10.84cm; Mass 78.72±14.98kg) volunteered for this study with self reported LBP. **Interventions:** The independent variables included treatment group and time. Subjects were randomized into two groups; MET or control, after pelvic malalignment was determined. MET of the hamstrings and iliopsoas consisted of four, five second hold/relax periods, while the control group received a sham treatment. Separate 2x3 ANOVAs with repeated measures were used to determine group differences over time for innominate rotation (IR), apparent leg length (ALLD), true leg length (TLLD), and pain. Mann-Whitney U test was used to assess pain provocation tests. The a priori level was set to $P<0.05$. **Main Outcome Measures:** Static alignment (IR, TLLD, and ALLD) and pain (current, worst pain, and pain with SI pain provocation tests) were measured at baseline, immediately following intervention and 24 hours following intervention. All outcome measures were performed by an examiner blinded to the intervention. **Results:** VAS for worst pain in the past 24 hours decreased for the MET group (4.3± 19.9mm, P=.03) and increased for the sham group (17.1±21.2mm, P=.03). When all subjects were compared together as one group of 20 subjects, current pain decreased from baseline (27.4±21.4 mm) to (19.3±19.8 mm) and the pain provocation test that produced the most pain decreased from baseline (30.0±23.9 mm) to (22.5±24.6 mm). There was not a significant difference (U=40, P=.48) in the number of positive pain provocation tests between days. A decrease in ALLD was reported across both groups from baseline to immediately post-intervention (5.6±4.2mm, $P<.001$) and 24 hours following intervention (4.5±5.3mm, $P<.001$). There was not a Time x Group interaction for IR ($F_{2,36}$=0.51, P=.60, 1-β=.13), TLLD ($F_{2,36}$= 0.09, P=.92, 1-β=.06) or ALLD ($F_{2,36}$=1.93,P=.16, 1-β=.37). There was not a significant time main effect for IR ($F_{2,36}$=1.73, P=.19, 1-β=.34) or TLLD ($F_{2,36}$=2.85, P=.07, 1-β=.52). There was not a significant group main effect for IR ($F_{1,18}$= 1.89, P=.19, 1-β=.26), TLLD ($F_{1,18}$=0.05, P=.83, 1-β=.06) or ALLD ($F_{1,18}$= 2.96, P=.10, 1-β=.37). **Conclusions:** MET demonstrated a decrease in VAS for worst pain over the past 24 hours, therefore MET may be advantageous to decrease SI joint pain in the short term. While the other measurements showed no significant differences, small changes did occur in the short term between both groups.

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**Jogging Gait Kinematics Following Fatiguing Lumbar Extension Exercise In Persons With Recurrent Low Back Pain**

Hart JM, Kerrigan DC, Fritz JM, Ingersoll CD: University of Virginia, Charlottesville, VA, and University of Utah, Salt Lake City, UT

**Context:** Isolated lumbar paraspinal fatiguing exercise causes deteriorated postural control, results in a more forward leaned posture during stance and results in lower extremity neuromuscular changes during gait. Persons with recurrent low back pain (rLBP) may experience different postural adaptations during gait due to muscle weakness and poor endurance. **Objective**: To compare changes in body position during gait following fatiguing lumbar extension exercise in persons with rLBP with healthy controls. **Design:** Experimental, 1x2 factorial, repeated measures design. **Setting:** Motion Analysis Laboratory **Patients or other participants:** Twenty-five subjects with a history of recurrent episodes of low back pain were matched to 25 healthy controls (N=50). **Interventions:** Subjects performed a set of fatiguing isometric lumbar extension exercise until we observed mild muscular fatigue indexed by lumbar paraspinal EMG spectral shifts. A 10% downward shift in EMG median frequency was used to define mild muscular fatigue. **Main Outcome Measures:** A 10-camera motion analysis system in

conjunction with a force plate imbedded in a custom-built treadmill measured joint angles of the ankle, knee, hip, pelvis lumbar spine and trunk while subjects jogged at a comfortable pace. Measurements from 5 consecutive stance phases (first 50% of each stance phase to represent a loading response) were recorded before and after exercise. A MANOVA compared angles between groups and over time. **Results:** Significant group by time interactions were observed for peak spine extension angles ($F_{1,36}$=4.7, P=0.04), peak trunk flexion angles ($F_{1,36}$=5.8, P=0.02), and peak abduction angles (lateral flexion), ($F_{1,36}$=6.0, P=0.02). After fatiguing exercise, control subjects experienced, on average, a 1.1-degree reduction (13.0±7.2-to-11.9±7.9°) in peak spine angle (lordosis) whereas persons with recurrent low back pain experienced, on average 0.2-degree increase in peak spine angle (12.6±5.7-to-12.8±5.5°). Peak trunk flexion angle increased following fatiguing exercise in control subjects by 0.8-degree (8.9±5.2-to-9.7±5.2°) but reduced by 0.4-degrees in persons with rLBP (10.9±4.7-to-10.8±4.5°). Control subjects experienced an increase in peak trunk abduction of 0.4-degrees, (3.5±1.0-to-3.9±1.2°) persons with rLBP experienced an increase of 0.1-degrees following paraspinal exercise (3.8±1.5-to-3.9±1.5). **Conclusions:** Forward flexed posture during jogging gait followed lumbar paraspinal fatigue in healthy persons but not in persons with rLBP. Small differences in jogging gait posture during exercise in persons with rLBP may represent a necessary adaptation to preserve gait function by preventing inappropriate intervertebral joint loading and reduce the demand on muscles that support the hips, pelvis and spine, which may be weak, unbalanced or poorly conditioned.

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**Development Of A Unified Core Stability Model**

Haak TL, Evans TA, Ragan BG, Williams RB: Athletic Training Outcomes Research Laboratory, University of Northern Iowa, Cedar Falls, IA

**Context:** The concept of core stability has transcended physical medicine as well as health and physical performance. It is now considered a fundamental component of general fitness programming and it is thought to have specific implications in low back pathology. However, despite widespread acceptance, there is currently no consensus on the definition, fundamental components, or the assessment techniques for core stability. **Objective:** The purpose of this project was to develop a comprehensive core stability model addressing its definition, components, and assessment techniques. **Design:** Delphi technique utilizing the paper-and-pencil and interview designs. **Setting:** Educational institutions and rehabilitation clinics. **Participants:** Fifteen content experts from the USA and Canada participated. Experts were identified from a literature review, professional presentations, and professional recommendations. Experts, several with dual credentials, represented a variety disciplines including: certified athletic trainers (8), physicians (1), physical therapists (10), strength and conditioning specialists (3), certified diagnostic therapists (1), and performance enhancement specialists (1). **Data Collection and Analysis:** An open-ended questionnaire pertaining to a core stability definition, components, and specific assessment techniques was distributed to each expert. Data was collected over two rounds of telephone interviews. In round one, feedback from each expert was collected. Round two involved a second telephone interview to gather changes experts made to their initial responses. Data collection was concluded after round two because a consensus was achieved. Descriptive data and frequency tables were used to consolidate the responses. **Results:** A working definition was developed as "the ability to achieve and sustain control of the trunk region at rest and during precise movement" after one round. Eighty-three percent of the experts considered the definition satisfactory and it was therefore accepted. A consensus was also achieved for the components of core stability. During round one, 13 components were identified. Twelve of the 15 (80%) experts identified specific muscles or muscles groups, and five of 15 (33%) identified neuromuscular control as a component. After reviewing the other author's responses during the second round, 14 of the experts (93%) identified specific muscles or muscle groups and eight of 12 (67%) identified neuromuscular control as components. Consistently identified muscles were the transverses abdominis, internal oblique, external oblique, rectus abdominis, and multifidus. Assessment techniques were identified, however no consensus was established. Although 38 techniques were identified, only five were identified by more than one expert. **Conclusions:** In conclusion, a consensus core stability definition was created and its components were identified. However, of the initial definition provided by the experts, no two were identical, which revealed the inconsistencies among expert and the importance of this study. Although a consensus for the assessment techniques could not be reached, it was a beneficial starting point to identify the inconsistencies among the content experts.

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**Clinical Characteristics, Outcomes, And Prognostic Factors For Adolescents With Low Back Pain Undergoing Rehabilitation**

Fritz JM, Clifford SN: Department of Physical Therapy, The University of Utah, Salt Lake City, UT; Intermountain Healthcare, Salt Lake City, UT; Physical Therapy Department, Chatham College, Pittsburgh, PA

**CONTEXT:** Although the problem of low back pain in adolescents has been recognized, little is known about the clinical presentation or outcomes of treatment in this age group. **OBJECTIVES:** 1) describe the clinical characteristics and treatment outcomes for a cohort of adolescents with low back pain undergoing rehabilitation, and 2) examine the prognostic importance in adolescents with low back pain of baseline variables suggested to be predictive of treatment outcome for adults with low back pain. DESIGN: Prospective case series. **SETTING:** Outpatient sports medicine rehabilitation facilities. **PATIENTS:** 29 adolescents (mean age = 15.1± 1.4 years, 48% female), referred for treatment of low back pain. **INTERVENTIONS:** A standardized baseline assessment including a physical examination and self-report questionnaires for pain and disability was performed with all patients before treatment. Questionnaires were repeated at the final treatment session. Because the purpose of this study was to describe outcomes under routine conditions, treatment decisions were left to the clinician's discretion. Statistical analyses included descriptive statistics for baseline and outcome variables including frequencies and percentages for categorical variables, means and standard deviations for continuous variables, or medians for continuous variables with skewed distributions. Potential prognostic variables, including symptom duration, presence of leg pain, sports participation, prior history of back pain, BMI, and fear-avoidance beliefs, were tested by examining univariate relationships between presence of the variable and outcome (change in disability) using independent-group t-tests. A median split was used to dichotomize continuous prognostic variables. A variable was considered prognostic if significant differences in outcome existed between patients with or without the variable. An alpha level of $p<0.05$ was used to establish significance. **MAIN OUTCOME MEASURES:** Primary dependent variable was the Modified Oswestry Questionnaire, a validated self-report measure of back pain-related disability. **RESULTS:** Baseline patient characteristics included median

symptom duration = 156 days, mean BMI = 21.0 ± 2.7, 4 patients (13.8%) had leg pain, 5 (17.2%) had a prior history of back pain, and 17 (58.6%) participated in organized sports. Mean score on the fear-avoidance beliefs questionnaire was 13.9 ± 5.0, mean Oswestry score was 22.8 ±10.2 points, and the mean pain rating was 4.7 (out of 10) ± 2.3. Patients attended a median of 4 treatment sessions (range 2-9). Significant improvements in disability (mean change = 7.0 ± 9.6 points, p<0.001) and pain (mean change = 1.2 ± 2.1 points, p=0.020) occurred with treatment. None of the potential prognostic variables examined reached significance. **CONCLUSIONS:** Adolescents with low back pain demonstrated improvement in pain and disability with treatment. Prognostic variables identified as significant for adults with low back pain were not significant in this cohort of adolescents. Further research is needed to identify important prognostic factors for adolescents with low back pain. *Funded by a grant from the NATA Research and Education Foundation.*

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**Effects Of A Muscle Energy Technique On Sacral Dysfunction In Patients With Acute Lumbosacral Pain**

O'Hara R, Van Lunen BL, Miller SJ, Vairo GL, Ismaeli ZC, Zirges SD, Oñate JA: Old Dominion University, Norfolk, VA, and Pennsylvania State University, State College, PA

**Context:** Traditionally, treatments for low back have focused on manual therapy along with stretching and strengthening exercises. Currently, no studies have been published on the effects of muscle energy technique (MET) on pelvic girdle dysfunctions in symptomatic or asymptomatic subjects. Research is required to understand the effects of MET in symptomatic patient populations. **Objective:** To examine the effects of treating patients with suspected acute iliosacral rotational dysfunction (IRD) with MET on disability, perceived pain during lumbar motion, lumbar range of motion (ROM) in flexion and extension, and sagittal innominate rotation. **Design:** Pre-test/post-test, repeated measures design. **Setting:** Athletic Training Rooms of local high schools and universities. **Patients or Other Participants:** Eight high school and college athletes (age = 17.8+2.4yrs; ht = 166.7+12.1cm; mass= 67.3+8.5kg) with acute(< 72 hours) lumbosacral pain and sacral dysfunction and clinical evaluation that demonstrated negative McKenzie mechanical lumbar assessments, two positive sacroiliac pain provocation tests, and sacroiliac joint specific pain referral patterns. **Interventions:** Subjects were randomly assigned to either the experimental group receiving MET treatments, or the placebo subjects receiving a stretching placebo treatment. The treatments consisted of the application of five seven-second anterior or posterior iliosacral MET isometric contractions. Subjects were treated four times over the course of one week and perceived disability, pain, ROM and innominate rotation were measured prior to each treatment. Repeated measures ANOVA were utilized to assess differences over time(5) between treatments(2) for each dependent measure with an alpha level of p<.05. **Main Outcome Measures**: Innominate rotation was measured with a Palpation meter, perceived pain during range of motion with a 10 cm visual analog scale (VAS), perceived disability was measured with the modified Oswestry Disability Questionnaire (mODQ), lumbar ROM with double inclinometer measurements. **Results:** Although the MET was successful in bringing the dysfunctional innominate into near neutral rotation ($p$= .042) (pre left/right difference= 2.5 ± .58cm,post left/right difference= .75 ± 50cm), it did not significantly improve VAS in neutral ($p$= .305)(pre= 3.13 ± 2.02,post= 3.25 ± 2.63), flexion ($p$= .311)(pre= 5.5 ± 1.29, post= 5.38 ± 2.12, or extension ($p$= .891)(pre= 7.00 ± 2.00, post= 5.50 ± 1.73), mODQ scores (p= .905)(pre= 15.25 ± 4.57,post= 11.75 ± 9.36) or lumbar ROM measurements in flexion ($p$=.509)(pre= 43.75 ± 16.35, post= 41.00 ± 6.97) or extension ($p$= .603) (pre= 27.33 ± 2.52,post= 20.67 ± 4.04) over time as compared to the control group. Power analyses indicate that in order to have 80% power approximately 7-24 subjects would be needed in each group. However, this increase in subjects would demonstrate that METs as applied to this patient population would show an increase in pain measurements following application. **Conclusions:** MET aimed at correcting IRD will not produce decreases in pain, disability, or improve lumbar ROM in the first week after onset of lumbosacral pain in patients with suspected IRD (in spite of correcting the innominate rotation). Appropriate patient classification and an increase in patient number may need to be more closely examined as to whether MET is effective in treating this specific condition. *Funded by a grant from the NATA Research and Education Foundation.*

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## Free Communications, Poster Presentations: Gait Adaptations And Overuse Injuries

Friday, June 20, 2008, 8:00AM-12:00PM, 2nd Floor Atrium; authors present 11:00AM-12:00PM

**The Effect Of Perturbed Gait On Selected Muscles In The Kinetic Chain**

McLoda TA, Csiszer VJ, Stanek JM, Hansen AJ: Illinois State University, Normal, IL

**Context:** An involuntary response to unexpected ankle inversion contributes to the ability for the body to avert injury or reduce the severity of the trauma. This response has previously been studied from the perspective of the peroneal muscles. **Objective**: The purpose of this investigation was to determine the activation of specific postural muscles of the kinetic chain during normal gait as compared to gait that includes unexpected inversion at the ankle. **Design**: Single factor repeated measures design **Setting:** University biomechanics laboratory. **Participants**: Thirty-two subjects (age 20±1.2 y; mass 71.9±12.4 kg; height 173.0±9.2 cm; 18 male, 14 female) with no lower extremity injuries. **Interventions**: Data were collected from each subject's dominant leg using surface electromyography (EMG). Electrodes were applied over the ipsilateral rectus femoris (RF), gluteus maximus (MA), gluteus medius (ME), and contralateral external obliques (EO). Reasonable procedures were applied to reduce movement artifact. Subjects walked a total of 15 randomized trials the length of a 6.1 m custom runway that is capable of releasing either the left or right side into 30 degrees of unexpected inversion. During 5 trials, perturbation of gait occurred on the dominant side. During the remaining trials, no perturbation occurred. **Main Outcome Measures**: Average, peak, and time to peak EMG were analyzed across the 4 muscles for 5 averaged trials of each condition. Normalization was not necessary as within muscle comparisons were used for analysis. **Results**: Significance was adjusted to .004 with a Bonferroni correction. A significantly higher peak muscle activity was noted for the perturbed condition for the RF (0.40±0.33 mV > 0.14±0.07 mV, $P$<.001), MA (0.48±0.45 mV > 0.19±0.11 mV, $P$<.001), ME (0.43±0.39 mV > 0.22±0.14 mV, $P$=.001), and EO (0.52±0.46 mV > 0.12±0.06 mV, $P$<.001). Average muscle activity was also higher for the perturbed gait for the RF (0.21±0.12 mV > 0.09±0.04 mV,

$P<.001$), MA (0.23±0.17 mV > 0.10±0.06 mV, $P<.001$), ME (0.23±0.19 mV > 0.13±0.09 mV, $P<.001$) and EO (0.23±0.16 mV > 0.08±0.04 mV, $P<.001$). Time to peak muscle activity was slower during perturbed gait for the MA (0.15±0.04 ms > 0.10±0.06 ms, $P<.001$) and ME (0.16±0.04 ms > 0.10±0.05 ms, $P<.001$) but faster for the EO (0.13±0.04 ms < 0.18±0.04 ms, $P<.001$). For the RF, time to peak activity was the same for both conditions. **Conclusions**: We concluded that the ability for the body to avert sudden, unexpected inversion may be partially conducted by involuntary contractions of the selected postural muscles of the kinetic chain. These results provide additional understanding of the recovery from an unexpected inversion moment.

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**Normative Database Of Common Anatomical Measures Related To Running Injuries**

Kendall KD, Sheerin K, Keshmiri E, Ferber R: Faculty of Kinesiology and Running Injury Clinic, University of Calgary, Calgary, Alberta, Canada, and Institute of Sport and Recreation Research New Zealand (ISRRNZ), AUT University, Auckland, New Zealand

**Context:** Various anatomical alignment measures have been attributed to running-related injuries such as Quadriceps angle (Q-angle) and leg length discrepancy (LLD). However, a comprehensive normative database of these variables does not exist in the scientific literature. **Objective:** The purpose of this study was to provide a comprehensive database from a large population of runners of selected anatomical alignment measures commonly associated with running injuries. Anatomical measures were chosen since, regardless of stage of rehabilitation or injury, these measures would not change unlike flexibility and/or strength variables. **Design:** Descriptive cohort study design. **Setting:** Running Injury Clinic at the University of Calgary. **Patients or Other Participants:** Two hundred and twenty one consecutive patients, presenting to the Clinic for various musculoskeletal running injuries (females: 95; males: 126; age: 32 years±9.3; weekly running mileage 32.8 km±7.3). Variables of interest included tibial torsion, Q-angle, LLD, resting subtalar neutral position, maximal rearfoot eversion range of motion (ROM), resting forefoot position, rearfoot-tibia standing angle, and rearfoot standing angle. **Data Collection and Analysis:** All measures were made by a single certified athletic trainer using a goniometer. **Results:** Average values (± 1 standard deviation (SD)) and percentage of patients above and below 1 SD are presented. Average tibial torsion was 14.59° (±2.40): only 6.33% of patients exhibited reduced and 15.83% exhibited increased amounts of tibial torsion. Average Q-angle was 17.00° (±3.58) and 15.84% exhibited greater and 11.76% demonstrated a reduced Q-angle. The average LLD was 0.45cm (±0.87) and only 3.17% of patients exhibited a LLD greater than 1.5cm. Resting subtalar neutral position was 0.69° everted (±1.57) and 66.74% exhibited a 0° or neutral resting position while 1.12% presented an inverted and 32.14% presented an everted resting position. The average maximal rearfoot eversion ROM was 9.36° (±3.32) and 15.16% exhibited greater while only 2.94% exhibited reduced eversion ROM. Average resting forefoot position was 3.36° (±3.72) with 67.42% exhibiting a varus alignment, 20.45% a neutral alignment, and 12.12% a valgus forefoot alignment. Average rearfoot-tibial standing angle was 6.10° (±2.58) and average rearfoot standing angle was 9.39° (±3.83). Only 14.71% of patients exhibited greater and 8.60% a reduced rearfoot standing angle and 78.13% exhibiting a valgus rearfoot alignment, 8.93% a neutral alignment, and 12.95% a varus rearfoot standing alignment. **Conclusions:** This database provides clinicians comparative measures to help determine if atypical anatomical alignment may be a factor contributing to a running-related injury.

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**Strengthening The Intrinsic Plantar Foot Muscles Decreases Navicular Drop And Decreases Muscular Fatigue**

Campbell EB, Frye JL, Gribble PA: University of Toledo, Toledo, OH, and James Madison University, Harrisonburg, VA

**Context:** Excessive pronation is often cited as a predisposing factor to several lower extremity overuse injuries. Previous research has focused on the cause rather than the treatment of excessive pronation. By focusing on strengthening the intrinsic foot muscles that support the medial longitudinal arch (MLA), in turn aiming to reduce navicular drop during fatiguing activities, this research may help in the treatment of various overuse injuries that often result from excessive pronation. **Objective:** This study assessed the effects of a strengthening program of intrinsic foot muscles on navicular drop and endurance of the intrinsic foot muscles become. **Design:** Pretest-posttest design. **Setting:** Athletic Training Research Laboratory. **Patients or Other Participants:** Twenty-five healthy subjects (12 males, 13 females; 21.23 ± 2.8yrs; 171.83 ± 8.6cm; 76.5 ± 13.21kg) volunteered to participate in this study. **Interventions:** The independent variable was muscle condition with two levels, pre- and post- strengthening. Sub-talar pronation was assessed using measurements of navicular drop taken with a digital height caliper. Navicular drop was measured prior to strengthening in a pre- and post-fatigue state as well as following strengthening in a pre- and post-fatigue state. Muscle activity of the abductor hallicus was measured using surface electromyography during the subject's initial maximum voluntary contraction (MVIC). Subjects performed 75 toe-curl repetitions with the foot stabilized in a custom fabricated pulley strengthening system followed by a MVIC measurement. This was repeated until a 10% shift in median frequency (MedF) of the EMG signal was seen during their MVIC, denoting a fatigued state. Subjects then completed a three-week modified DAPRE strengthening program for the foot intrinsics. Following completion of the strengthing program, navicular drop and fatigue measures were re-assessed in pre- and post-fatigue states. Paired sample t-tests determined statistical differences. Significance was set at $p<.05$. **Main Outcome Measures:** Dependent variables were navicular drop and MedF measures. **Results:** Navicular drop de-creased significantly following the three-week strengthening program of the intrinsic foot muscles. At baseline, subjects exhibited an initial navicular drop of 9.34±3.75mm prior to fatigue which decreased to 8.25±3.07mm following the strengthening program ($t$ = 4.606; $p<0.001$). Following fatiguing exercises prior to strengthening the subjects had a navicular drop value of 10.26 ± 3.74mm which decreased significantly to 9.11 ± 3.25mm following strengthening ($t$ = 5.501; $p<0.001$). The shift in MedF from pre- to post-fatigue decreased from 27.07±5.94Hz pre-strengthening to 19.03±11.78Hz post-strengthening ($t$ = - 3.183; $p<0.001$). **Conclusion:** This study demonstrates the ability of the intrinsic foot muscles to contribute to stability of the MLA. This study suggests that a 3-week strengthening program can effectively strengthen the intrinsic foot muscles making them more fatigue resistant and increasing their ability to support the MLA. This strengthening program may be useful for patients with overuse injuries in which their pronation is deemed problematic.

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**Shock Attenuation Characteristics For Children Running**

Mercer JA, Dufek JS, Bhanot K, Freedman JA, House AJ, Aldridge J, Rubley MD, Mangus BC: Sports Injury Research Center, University of Nevada Las Vegas, Las Vegas, NV

**Context:** Among many possible mechanisms leading to running injuries is how the body accommodates impact forces. Shock attenuation (SA) is the process by which the impact shock caused by the foot-ground collision is reduced. Although it is well understood that adult runners absorb about 80% of the impact shock during running, there are limited data on SA for children. **Objectives:** To determine SA characteristics for children 1) running on a treadmill at different speeds and 2) during running on a treadmill and overground. **Design:** Within-subjects design. **Setting:** Biomechanics Laboratory. **Patients or Other Participants:** Children (n=14; 10.5±0.9 yrs; 38.1±10.1 kg, 1.42±0.08 m) who were physically active and free from lower extremity injury. **Interventions:** Two experiments were completed by all subjects. Experiment 1: subjects completed two conditions: 1) treadmill (TM) running and 2) overground (OG) running. Running speed was identical for each condition. The speed used was self-selected while running on a treadmill. A subject was asked to select a speed that could be maintained for 15 minutes. This process was repeated three times with the test speed being the average of the speeds. During Experiment 2, subjects ran overground at speeds that were 0.5 m/s slower (SLOW) and faster (FAST) than the self-selected (SS) speed for a total of three speed conditions (SLOW, SS, FAST). During Experiment 2, OG running speed was monitored using infrared photo sensors placed along a 20-m runway. Two accelerometers (PCB Piezotronics, NY, 2 grams, sensitivity=100 mV/g, frequency range=0.3 Hz–12 KHz, fs=1000 Hz) were used. One was secured to the anterior-medial region of the distal aspect of right tibia; the second was secured at the frontal region of the head. A paired t-test was used to test dependent variables in Experiment 1, repeated measures ANOVA for Experiment 2. **Main Outcome Measures:** The peak acceleration (g) within the impact phase of stance was recorded for the leg (LgPk) and head (HdPk) acceleration profiles. SA was calculated using the formula: SA= [1-(HdPk/LgPk)]*100. **Results:** Experiment 1: SA (SLOW: 66.4±8.1%, SS: 70.6±6.7%, FAST: 72.4±6.9% p=.002) LgPk (SLOW: 3.64±1.3g, SS: 4.37±1.7g, FAST: 5.62±1.8g) and HdPk (SLOW: 1.11±0.27g, SS: 1.21±0.5g, FAST: 1.41±0.3g, p=.004) were each different across speeds. Experiment 2: SA and LgPk were each different between treadmill and overground running (SA: TM 70.6±6.7%, OG 81.8±4.7%, p<0.001; LgPk: TM 4.37±1.7g, OG 6.31±2.3g, p=.001). HdPk was not different between conditions (TM 1.21±0.5g, OG 1.12±0.42g, p=0.27). **Conclusions:** When children ran on the treadmill, SA increased as running speed increased. Furthermore, when children ran overground, SA was greater than when they ran on the treadmill. It appears that SA in children is dynamic and dependent on the impact shock, which varies with running speed and surface changes. *Funded by a grant from the NATA Research and Education Foundation.*

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# Free Communications, Poster Presentations: Foot and Ankle Orthotics

Friday, June 20, 2008, 1:00PM-5:00PM, 2nd Floor Atrium; authors present 2:00PM-3:00PM

**Effect Of Textured Insoles On Single Leg Balance Of Subjects With Functional Ankle Instability**

Arnold BL, Ross SE, Linens SW, Wright CJ, Massie L: Virginia Commonwealth University, Richmond, VA

**Context**: Balance deficits are associated with functional ankle instability (FAI), and these deficits may predispose individuals to ankle sprain. The application of vibrating textured insoles to the feet has improved balance in young healthy subjects. Textured insoles that do not vibrate may be one alternative therapy that enhances balance in individuals with FAI by providing sensory feedback to the plantar surface of the foot. **Objective**: The purpose of this study was to determine the effects of textured insoles on single leg balance. **Design**: Crossover trial. **Setting**: Research laboratory. **Patients or Other Participants**: Participants in this study included 15 subjects with FAI (172±10 cm, 74±10 kg, 23±3 yr) and 15 healthy subjects with stable ankles (166±9 cm, 65±15 kg, 23±5 yr). **Interventions**: While on a force plate and using an insole, subjects stood on a single leg with their eyes closed and remained as motionless as possible for 20 seconds. Three trials were performed for each treatment condition: 1) regular insole; 2) cushioned insole; and 3) textured insole. Testing order was counterbalanced. A repeated measures ANOVA with 1 within factor with 3 levels (insole: regular insole, cushioned insole, textured insole) was used for statistical analysis ($\alpha$=.05). **Outcome Measures**: The average center-of-pressure velocity (COPV) was calculated from the resultant vector of the anterior/posterior and medial/lateral center-of-pressure data from a force plate. Faster velocities were indicative of balance deficits. **Results**: No main effect for insole (p=0.88) or insole by group interaction (p=0.44) were found. A significant (p=0.03) main effect for group was found, indicating that subjects with FAI (7.45±2.27 cm/s) had faster velocity than subjects with stable ankles (5.96±1.28 cm/s). **Conclusions**: Subjects with FAI had impaired balance compared to subjects with stable ankles. Our non-vibrating textured insoles did not improve balance in subjects with or without FAI. Our textured insoles may not have provided adequate sensory feedback to enhance balance.

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**The Effect Of Three Foot Orthoses On Plantar Pressure Of Pes Planus Foot Type**

Nordsiden LA, Van Lunen BL, Walker ML, Cortes N, Oñate JA: Old Dominion University, Norfolk, VA

**Context**: Many styles of foot orthoses are commonly used to reduce pain and pressure under the foot; however, relative effectiveness in an athletic population has not previously been studied. Distribution patterns under the first metatarsophalangeal joint have not been identified using different orthoses. **Objective**: To examine the effect of three different foot orthoses on peak plantar pressure (PPP) and mean plantar pressure (MPP) under the first metatarsophalangeal (MTP) joint during standing and slow running. **Design**: A 2x4x4 repeated measures design. **Setting**: University athletic training clinic and fitness facility. **Patients or Other Participants**: A convenient sample of twenty physically active participants, 12 males (19.7±1.3 years, 181.5±6.3cm, 83.6±12.3kg) and 8 females (20.8±1.5 years, 172.7 ±11.2cm, 69.9±14.2kg) with navicular drop greater than 10mm, no history of surgery to the lower extremity, and no history of pain or injury to the first MTP joint in the past

six months volunteered to participate in the study. **Interventions**: PPP and MPP were evaluated under four areas of the foot: the rearfoot (RF), lateral forefoot (LFF), medial forefoot (MFF) and first MTP joint. Four orthosis conditions (no orthosis, metatarsal dome, U-shaped orthosis, and donut-shaped orthosis) were evaluated during standing and slow running. Standing measurements were recorded at three five-second intervals during free stance with feet shoulder width apart. Running measurements were recorded at three ten-second intervals during a 2-minute jog at a self-selected pace between 5.5-6.5 miles per hour. All measurements were taken on a standardized treadmill using the Pedar in-shoe pressure measurement system. Separate 2x4x4 repeated measures design, with an alpha level set *a priori* of $p<.05$, were utilized to assess significant differences. **Main Outcome Measures**: PPP and MPP under all areas of the foot during standing and the midstance phase of gait during slow running measured in kilopascal (kPa). **Results**: The metatarsal dome produced significant decreases in standing MPP (10.25±14.84), running MPP (163.07±49.46) and running PPP (228.73±63.41) when compared to no orthosis (MPP : 180.44 ± 53.77, PPP: 249.75 ±67.01) ($p<.001$). The U-shaped orthosis significantly decreased running MPP (168.68±50.26) when compared to no orthosis ($p<.001$). The donut-shaped orthosis (MPP:178.85 ±53.25,PPP: 258.53±72.31) produced no decreases and actually increased standing MPP and standing PPP compared to no orthosis ($p<.001$). The addition of orthoses produced an overall distribution throughout other areas of the foot. **Conclusions**: The metatarsal dome was most effective in reducing both peak and mean plantar pressure during standing and slow running in the MTP area. It was also shown that with the use of orthoses there was an overall distribution of pressure to various areas of the foot. Further research should be done on the applicability of foot orthoses to other foot types and symptomatic subjects. *Funded by a grant from the NATA Research and Education Foundation.*

# Free Communications, Poster Presentations: Lower Extremity Pathology Case Reports

Friday, June 20, 2008, 1:00PM-5:00PM, 2nd Floor Atrium; authors present 2:00PM-3:00PM

**Ankle Injury In A Division One Men's Ice Hockey Athlete**

Angus J, Fairbrother B, Norkus S: Quinnipiac University, Hamden, CT

**Background:** A 19 year old male, NCAA Division I ice hockey athlete with no previous known injury to the right ankle skated full speed into the boards during a contest. The athlete stated he was forced into dorsiflexion. He was immediately removed NWB from the ice. An initial evaluation revealed no obvious deformity, moderate swelling, 8/10 pain, strong dorsal pedis pulse, tenderness to palpation over the medial and lateral ligaments, and with palpation to the distal fibula and tibia. The squeeze test was negative. The evaluation was immediately stopped when active range of motion increased pain. The athlete was immediately treated with RICE, a posterior splint, and crutches. The following day he presented with localized pain, swelling in the ankle mortise, and a strong distal pulse. He was then referred to the team orthopedist. **Differential Diagnosis:** Grade 3 medial or lateral ankle sprain, distal anterior inferior tibiofibular sprain, distal tibia fracture, distal fibular fracture, tibiofibular fracture, talus fracture. **Treatment:** Radiographs revealed a Hawkins 2 talar neck fracture with 3-4 mm of displacement from the subtalar joint. There was additional evidence of a previous avulsion fracture of the medial malleolus. The athlete was kept in the posterior splint, treated with RICE, and given prescription pain medication for one week until an open reduction internal fixation repaired the talus, the deltoid ligaments, and removed the medial malleolar avulsion. Special consideration was taken to ensure the talar head and neck was maintained in a neutral position. A compression dressing and posterior splint were applied post-op. One week post surgery; the incision site was clear of infection and the athlete was placed in a well padded short leg NWB cast. At two weeks, the staples were removed and the athlete was casted in slight plantar flexion. The athlete complained of severe pain the following day due to excessive compression which resolved with recasting. Eight weeks S/P x-rays revealed Hawkins sign, identifying healing of the talus with no signs of avascular necrosis. Rehabilitation included ankle range of motion for plantarflexion and dorsiflexion, lower leg, knee, and hip strengthening exercises, and progressed as tolerated. Twelve weeks S/P, the fracture had healed and the athlete was cleared to lift weights and skate. He continued PWB in a walking boot for one week due to an antalgic gait. At this time, rehabilitation concentrated on supervised FWB activities, inversion and eversion strengthening, and joint mobilization. Skating caused minimal discomfort. Seventeen weeks S/P the athlete participated in a team run which caused mild discomfort which resolved quickly. He returned to all team workouts by 19 weeks. At 38 weeks, the athlete was pain free but still lacking approximately 4 degrees of dorsiflexion, 14 degrees of plantar flexion, and 14 degrees of inversion. Rehabilitation continues to focus on Mulligan's mobilizations and fibular glides to work on increasing the athlete's ankle ROM. **Uniqueness:** The force needed to fracture the talus is high, with fractures of the talar neck typically being the result of landing from a height or a motor vehicle accident. **Conclusion:** There is a high risk of avascular necrosis with talus fractures, therefore the Hawkins sign must be seen to identify bone healing. Also with the severity of the displacement there is a high chance of ankle osteoarthritis. The neutral alignment of the talus must be maintained during surgery and throughout recovery. The athlete still has decreased range of motion, but is working to regain this in order to return to normal function and play.

**Proximal Tibiofibular Joint Sprain In A Female Basketball Player**

McGuire M, Moffit D, Driban J, Murata P: Department of Kinesiology, Temple University, Philadelphia, PA

**Background**: This unique case involves an 18-year-old female (body mass = 81.82 kg, height = 190.5 cm) NCAA Division I college basketball player with forefoot varus and tibial torsion who sustained a proximal tibiofibular joint sprain during competition. The athlete came down from a rebound and stepped on an opponent's foot. She reported a cramping sensation in her lateral lower leg which radiated down to her posterior-lateral ankle. No obvious deformity or edema noted. The tibiofibular squeeze and tap test were negative. Active range of motion and strength in the knee and ankle were within normal limits and equal bilaterally. Palpable point tenderness was evident over and around the fibular head. She was able to walk with a limp, but unable to finish playing in the game. **Differential Diagnosis:** Subluxation or dislocation of proximal tibiofibular joint, instability of the proximal tibiofibular joint, lateral meniscal tear, biceps femoris strain at the distal insertion. **Treatment**: The athlete was initially diagnosed by the physician at the

game with a possible biceps femoris strain at the distal attachment. When seen by the team physician the next day she was diagnosed with a proximal tibiofibular joint sprain and was advised to use crutches to rest the joint. The athlete had an MRI two days post-injury to confirm injury and it showed marrow edema of the fibular head and the distal posterior aspect of the lateral tibia plateau; both from presumed bone contusions secondary to the joint sprain. All ligamentous structures were intact. The athlete was able to practice as pain tolerated. A pad was fashioned from an orthoplast mold of the fibular head. An open cell memory foam donut-shaped pad was placed inside the mold with a layer of the foam covering the mold. It was applied with a compression wrap over the fibular head to deter movement, and to prevent pressure being placed on the fibular head and peroneal nerve. Initially, high voltage electrical stimulation (negative polarity, 15 minutes) was applied for edema control and the athlete was given a TENS unit to take home for pain. Before practice, treatment consisted of 3.3 MHz continuous ultrasound at 0.6W/cm$^2$ for 4 minutes over the area. Ice was applied 10-12 minutes after practice. **Uniqueness**: Proximal tibiofibular joint sprains are a very rare injury. Research is limited regarding assessment and recognition of proximal tibiofibular sprains. This injury is usually seen in acute trauma incidents such as a car accident. Due to this particular athlete's forefoot varus and tibial torsion she was predisposed to added stress to the proximal tibiofibular joint. The molded donut pad with compression wrap was beneficial because it decreased movement thereby decreasing pain in the athlete. **Conclusion**: Proximal tibiofibular joint sprains are rare however abnormal biomechanics of the lower extremity can make an athlete more susceptible to the injury. The risk of injury is greatly increased when athlete has forefoot varus and/or tibial torsion. This is important as the athlete injured the contralateral proximal tibiofibular joint later in the year. Due to the athlete's biomechanic predisposition concurrent with the landing of the jump, injury risk was increased. Application of a pad at the tibial head may be used to help alleviate symptoms of this injury.

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**A Tear Of The Infrapatellar Fat Pad In A High School Athlete**

Seiler BD, Jones CM, Litsinger KR, Sanford BL, Siple BJ: Slippery Rock University of Pennsylvania, Slippery Rock, PA

**Background:** The objective of this case study was to explore the rare occurrence of a tear to the infrapatellar fat pad. The infrapatellar fat pad is also known as Hoffa's Fat Pad. This case study focuses on an infrapatellar fat pad tear caused by knee hyperextension in a high school athlete. The athlete was a fifteen year old, white male who is the place kicker of a high school varsity football team. The athlete's previous medical history includes insulin-dependent diabetes, cold urticaria, and a first degree sprain to the lateral collateral ligament of the right knee. The injury occurred during practice in an attempt to kick a field goal. Missing the ball, the athlete hyperextended his right knee. Immediately following the injury, the athlete's chief complaint was discomfort in his right knee and the inability to fully flex the knee. He presented with minimal swelling, no ecchymosis, and no visual deformity over the lateral aspect of the knee. Upon palpation, there was point tenderness over the lateral collateral ligament and the lateral border of the patella. Hypermobility and discomfort of the patella was also evident during palpation. The athlete described a "tight" feeling in the knee during contraction of the quadriceps. Approximately twenty-four hours post-injury, further evaluation of the athlete displayed increased tissue temperature and an altered gait due to gross edema and effusion. Throughout the injury process, the athlete experienced no significant pain. There was a positive finding with the Stroke Test, also known as the Sweep Test. **Differential Diagnosis:** In this particular case, possible injuries included Hoffa's Disease (impingement of the infrapatellar fat pad), lateral collateral ligament sprain, patellar subluxation, infrapatellar bursitis, anterior cruciate ligament sprain, injury to the lateral retinaculum, and meniscal injury. **Treatment:** Directly following the injury, the athlete was instructed to rest, ice, and compress the knee. Upon presentation of the largely effused knee one day post-injury, the athlete was referred to a physician who aspirated fifty-four cubic centimeters (cc's) of frank blood from the athlete's knee. After aspiration, the athlete was sent for magnetic resonance imaging tests. Four days after initial aspiration of the knee, the athlete returned to the physician and consequently had twelve cc's of pink-tinted fluid drained. The athlete was instructed to continue ice and compression as well as to incorporate the use of over the counter non-steroidal anti-inflammatory drugs. The athlete returned to play one week following the initial injury. **Uniqueness:** This case deviates from the expected Hoffa's Disease because of the genuine lesion of the infrapatellar fat pad. While Hoffa's Disease is a fairly common occurrence, an actual tear to the fat pad is extremely rare. **Conclusions:** The diagnosis of this particular injury was difficult because of the similarity to multiple knee pathologies, especially Hoffa's Disease. An awareness of this occurrence is important to consider during knee injury evaluation because the infrapatellar fat pad is a structure that is often overlooked. Therefore, a Certified Athletic Trainer should become familiar with this pathology because of the established potential of a torn, rather than merely impinged, infrapatellar fat pad.

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**Foot And Ankle Pain In A High School Football/Baseball Player**

Blair DF, Dice SJ, Broberg MA, Schroeder SA, Hansen MS, Coston CL, Freed SD: Wenatchee High School, Wenatchee, WA

**Background:** Our subject is a 16-year-old male high school football quarterback/linebacker. He has also been a baseball catcher for the past ten years. On September 8, 2006, he complained of right 1st meta-tarsophalangeal (MTP) pain during a football game. The athlete had experienced a mild, acute inversion ankle sprain to the ipsilateral ankle one week earlier in football practice. He also had a history of chronic ankle sprains. The athlete did not continue in the game and was ultimately sidelined for the season. A physical examination of the right ankle revealed no gross deformity or ligament laxity, however, there was point tenderness along the anterior talus and over the 1st MTP joint. Physical examination of the foot and ankle revealed a restricted structural ankle and forefoot equinus that limited ankle dorsiflexion and prevented the athlete from properly loading the foot and ankle with squatting and walking. **Differential Diagnosis:** *Ankle*- arthro-fibrosis with anterior bony impingement, tight heel cord, osteochrondritis dissecans of the talus, ankle arthritis. *MTP*- turf toe (MTP sprain), metatarsal fracture, proximal phalangeal fracture, hallux limitus. **Treatment:** Radiographs showed osteo-phytes of the anterolateral talus and dorsal 1st metatarsal head and a fracture fragment of the base of the dorsal proximal phalanx. Final diagnoses: *Ankle*- Anterior talar osteophyte with bony impingement *MTP*: Hallux limitus with dorsal osteophyte and fracture fragment. The athlete underwent a course of rehabilitation that included exercises to regain full range of motion, flexibility, and strength in his foot and ankle. After a period of no significant improvement, the patient explored surgical opinions. Through consultation with both a podiatrist and an orthopedic surgeon, it was decided that, due to his limited progress, both joints should be simultaneously surgically addressed. On October 31, 2006, a cheilectomy with synovectomy of the right

1st MTP joint and a fracture fragment excision was performed along with an arthroscopic ankle synovial debridement and excision of the anterior talar osteophyte. Examination of the ankle under anesthesia revealed normal stability. At two weeks post-op, the athlete was able to ambulate on crutches with a cast boot. The athlete returned to rehabilitation to restore normal ROM and function. **Uniqueness:** The additive nature of the two injuries made the case unique. This structural foot and ankle type created functional challenges for the athlete to recover from the initial injury and ultimately be treated for symptoms that were a result of movement compensations creating impingement syndromes, limited mobility, loss of strength, function, and pain. Each injury alone may have responded to conservative treatment, however, the grouping of the injuries proved to be a limiting and painful combination. The athlete compensated for the structural sagittal plane deformity in the ankle by compensating in the frontal and transverse planes by excessively pronating the subtalar and midtarsal joints and internally rotating the tibia creating an anterior lateral ankle impingement with ankle dorsiflexion. This position of the foot abnormally tightened the plantar fascia and limited dorsiflexion of the 1st MTP, thus creating a dorsal impingement. **Conclusions:** The athlete's congenital foot type and ten-year history as a baseball catcher contributed to these foot and ankle conditions. Interestingly, the athlete has the same osteophytes and limitations on the contralateral foot/ankle and presently has mild symptoms. He was able to return to baseball in the spring of 2007 only as a designated hitter since he was not able to get into a catcher's stance at five months post-operatively. However, he was able to play catcher during the summer of 2007. During the 2007 football season, he was the starting varsity quarterback and led his team to the league championship.

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**A Discoid Meniscal Tear With An Associated Cyst: A Case Study**

Dlugos JR, Dover GC: University of Florida, Gainesville, FL

**Background:** This report discusses a case of a 19-year old Caucasian, division one female collegiate pole vaulter with multiple knee injuries. The athlete reported pain in the left knee during extension and internal rotation with no specific mechanism. She has a history of clicking in both knees but no diagnosed pathology. The initial exam revealed no swelling and no ligamentous laxity. She suffered from pain on the lateral side during Apley's compression and internal rotation, and clicking on the medial side during McMurray's test. Two MRI's over the next three months revealed nothing significant and conservative treatment was implemented. When pain persisted for 7 months, exploratory arthroscopic surgery was performed. A lateral tear was found and the affected portion of the meniscus was excised. The athlete underwent successful re-habilitation until the third month when she increased her running intensity and she began to feel pain on the lateral side of her left knee. After a brief consultation with a doctor an MRI was ordered. **Differential Diagnosis:** Lateral meniscal pathology, iliotibial band friction syndrome, popliteus tendonitis, local synovitis around osteophytes, or common peroneal nerve entrapment. **Treatment:** The third MRI identified a cyst had developed on the lateral side of the meniscus adjacent to a frayed, irregular edge where the previous surgery was performed. A second arthroscopic surgery was planned to express the cystic material out and shave down the irregular edge of the meniscus. The meniscus was saucerized to within 2 to 3 millimeters of the rim of the meniscus at the body. The doctor noted she had a lateral discoid meniscus. An unsuccessful attempt was made to express any material out of the cyst. Rehabilitation after the second surgery began the next day, with the main focus in the first week to be to decrease pain and swelling with cryotherapy. In addition exercises to regain strength in the quadriceps, and to restore flexion and extension range of motion was implemented. In the third week, pro-prioception exercises were added and by the fourth week, the athlete was able to perform light jogging on the track. At week four the rehabilitation program progressed slowly in an attempt to avoid further injury to the meniscus. The athlete began running 2 laps daily during the eighth week. Sport-specific activities continued to progress so that by the twelfth week she was performing the regular warm-up with the team and continued to progress to drills. Five months following surgery she was released to full practice with no limitations, although she continued to use cryotherapy as needed for some residual pain and swelling. The athlete completed a successful rehabilitation and reports no additional complaints associated with the left knee. A year later the athlete suffered a torn lateral meniscus in her right knee, and imaging and surgery revealed the athlete had a lateral discoid meniscus in the right knee as well. **Uniqueness:** Meniscal cysts accompanying a tear are rare, with one author reporting 0.27% of medial meniscal tears and 1.5% of lateral meniscal tears developing a cyst. Furthermore, a discoid lateral meniscus occurs in only about 5% of the Caucasian population, and only about 10% of discoid lateral menisci are bilateral. **Conclusion:** The presence of a discoid meniscus, while rare, predisposes the athlete to meniscal tears. Caution must be used when rehabilitating an athlete with a discoid meniscus tear, and the time frame of rehabilitation following a menisectomy may need to be lengthened in order to avoid further damage.

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**Lateral Knee Sprain With Associated Avulsion Fracture Of The Fibular Head In A High School Football Player: A Case Report**

Vaughn PD, Dover GC: University of Florida, Gainesville, FL

**Background:** This case report discusses a fourteen year old, male varsity high school football player who suffered a right knee injury during a regular season game as he was making a tackle on special teams. The patient was able to walk off the field, where he was then evaluated by the ATC onsite. The athlete stated he suffered a direct blow from opponent's helmet to lateral side of his knee while he was involved in a "pile up" tackle. His initial chief complaint was global knee pain with point tenderness along the medial and lateral joint lines. No swelling or ecchymosis was observed and the neurovascular exam was normal. Knee range of motion was normal but painful through flexion and extension. Ligamentous testing revealed pain and minimal joint laxity with both varus and valgus testing at 30°, while both tests were negative at 0°. Pivot-shift, anterior and posterior drawer, and Lachman's tests were all negative. Ice was applied and the athlete did not return to the game. The patient was evaluated by an orthopedic resident after the game with the same physical findings. Ice was applied and patient was instructed to keep compression wrap on during the weekend and continue to ice while staying off of his feet whenever possible. The patient was re-evaluated by another ATC two days later and referred to a physician for imaging and follow-up. The athlete had no significant previous injuries to his right knee. **Differential Diagnosis:** LCL sprain, MCL sprain, or lateral knee contusion. **Treatment:** During the physicians' exam one week post-injury, his medial knee pain had subsided, and his pain, although minimal, was localized to the head of the fibula and there was minimal swelling. X-rays taken one week post injury indicated an avulsion fracture of the fibular head. MRI exam without contrast was conducted twelve days post-injury and revealed increased joint fluid and a non-displaced fracture of the medial femoral condyle which the doctor also referred to as a

bone bruise. There was bone marrow edema within the fibular the head due to an avulsion of the LCL and biceps femoris tendon. The physician's diagnosis was an avulsion of the fibular head and non-displaced fracture of the medial femoral condyle. The patient was seen for a surgical consult by another orthopaedic surgeon but non-operative management was recommended. Six weeks of immobilization and non-weight bearing with crutches was prescribed, with gentle rehabilitation exercises being supervised by the ATC at his high school. **Uniqueness:** The uniqueness of this case is the rare mechanism and combination of pathologies involved. Isolated damage to the LCL is rare, and an associated avulsion fracture is even more uncommon. Additionally, the avoidance of surgical intervention due to epiphyseal plate concerns is unique to this age group. Also, the immobilization period of six weeks to judge the non-operative management strategy is unique in that most surgical repairs are done much earlier in the process. Further complicating the treatment of this and other injuries to the posterolateral corner of the knee is the variable and anatomy of that area. **Conclusions:** Clinicians should be aware of the complex signs and symptoms regarding posterolateral corner injuries. A full assessment is required when the signs and symptoms do not correlate with the mechanism of injury.

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**Unexplainable Lateral Malleolus Laceration Accompanying An Ankle Injury In A Collegiate Volleyball Player**

Hoffman JJ: James Madison University, Harrisonburg, VA

**Background:** A 19 year old female collegiate volleyball player sustained an inversion injury to the left ankle. This was the athlete's first injury sustained to either ankle. Upon primary survey, the athletic trainer observed blood visible through the athlete's ankle taping which was coming from a 3-centimeter laceration just inferior to the lateral malleolus. The athlete was fully coherent. Bleeding was controlled and the athlete was splinted and transported to the local emergency room. The athlete received four stitches, was placed in a walking boot and given crutches for ambulating. **Differential Diagnosis:** Ankle subluxation/dislocation, fibular fracture, medial ankle sprain, lateral ankle sprain, talar dome fracture. **Treatment:** Radiographic imaging done at the emergency room proved negative. Three days post-injury the athlete was seen by the team physician and diagnosed with a second-degree lateral ankle sprain. Treatment consisted of modalities to control pain and edema, range of motion exercises and stretching. Nineteen days post-injury point tenderness remained at the ATF, CF, PTF, base of the lateral calcaneus, and medial malleolus. An MRI was ordered revealing a Grade I osteochondral injury to the medial talar dome, contusion of the medial malleolus, talar body, and calcaneus and ruptured ATF ligament. Light strengthening exercises were initiated at 39 days post-injury, and at 43 days walking boot use was discontinued. Light volleyball activities began at 48 days post-injury, with complaints of mild point tenderness at both malleoli. At 56 days post-injury the athlete was cleared for full return to play. After continuing with rehabilitation, the athlete returned from winter break with an antalgic gait due to pain at the medial talus and malleolus. A second MRI 17 weeks post-injury revealed healed osteochondral and ATF injuries, but fluid in the posterior tibialis tendon sheath**.** The athlete was referred to a foot and ankle specialist. Evaluation revealed gross laxity with inversion stress which was comparable bilaterally. Posterior tibialis strength was excellent and a single leg calf raise was successfully performed, however the arch was compromised. Consequently posterior tibialis tendinitis was diagnosed. The athlete was fitted for custom orthotics, and told only to participate in pain-free activity, avoiding excess loading. No change in symptoms were reported after six weeks of iontophoresis, ultrasound, massage and use of prescription NSAID's. At 28 weeks post-injury, the athlete underwent a partial synovectomy, tenolysis of the posterior tibialis tendon, tightening of the deltoid ligament, and a modified Brostrom technique. Return to play was cleared at 13 weeks post-operatively, or 41 weeks post-injury. **Uniqueness:** Although the athlete was initially diagnosed with a second-degree ankle sprain, a medial subtalar subluxation/dislocation (which account for less than 1 percent of all dislocations) would explain the laceration seen. Medial subtalar dislocations occur by an inversion mechanism and also yield damage to the lateral ankle ligaments, but are almost always accompanied by deformity, subtalar ligament injury and fracture of the bilateral malleoli, tarsal bones, or fifth metatarsal as well; none of which were present in this case. The condition of the posterior tibialis was also unique, as strength and single leg calf raise ability were excellent yet the integrity of the patient's arch was compromised and all other symptoms were consistent with tendinitis. **Conclusion:** This case should make athletic trainers aware that many ankle injuries can be masked as just sprains. After initial diagnosis, the athlete's continued signs and symptoms warranted subsequent MRI's which revealed the osteochondral defect and fluid at the posterior tibialis tendon sheath. Also, following long periods of inactivity tendinitis is quick to develop secondarily as in this case.

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**Bilateral Compartment Syndrome With Complex Regional Pain Syndrome: A Case Study**

Wilson L, Perkins SA, Hart K, Sullivan, RJ: Marist College, Poughkeepsie, NY

**Background:** A 17-year-old female involved in dance, figure skating, and track and field first experienced sharp pain in the anterior compartment of the right lower leg at the age of 15. There was no known mechanism of injury or significant changes in running surfaces or footwear at the time of the pain. The athlete presented with palpable tightness and swelling in the lower leg, paresthesia over the L4 dermatome, and drop foot. The Certified Athletic Trainer (ATC) determined that the injury was an acute onset of anterior compartment syndrome of the right lower leg. The athlete was advised to avoid activity and referred to an orthopedist. **Differential Diagnosis**: Medial tibial stress syndrome, Tenopathy, Nerve entrapment, Stress fracture, Periostitis, Deep venous thrombosis, Tenosynovitis, Fasciitis, Fracture **Treatment:** The orthopedist ordered pre-exertion and post-exertion compartment pressure readings. Pre-exertion readings in both the anterior and lateral compartments bilaterally were less than 6mm Hg, but the post-exertion readings ranged from 40-56mmHg. Normal compartment pressure reading values are less than 15mm Hg pre-exertion and less than 30mm Hg post-exertion. Ten weeks after the initial onset, the athlete underwent a surgical fasciotomy for bilateral releases of the anterior and lateral compartments of the right lower leg. Nine days post-surgery, the surgical incisions showed no signs of infection and the athlete had good resistive ankle range of motion. Seven weeks after surgery, the athlete informed the physical therapist that she was having constant pain bilaterally in her lower legs, numbness, hypersensitivity, tenderness, and swelling distally around the surgical incisions. In addition, the athlete had decreased range of motion, shiny skin, and an antalgic gait. A Magnetic Resonance Imaging (MRI) and a Triple Bone Scan were ordered by the orthopedist which were normal, but upon evaluation the athlete was diagnosed with Complex Regional Pain Syndrome (CRPS) Type I. The orthopedist prescribed exercises and physical therapy to increase endurance and decrease edema. The athlete was also prescribed a series of lumbar sympathetic blocks, epidural infusions, and intravenous

Ketamine treatments in order to manage her pain. The Ketamine treatments were the most successful and offered a 50% decrease in pain and hypersensitivity surrounding the scar sites. Upon completion of the treatment, the athlete was able to bear full weight on the affected legs without significant pain. **Uniqueness:** Anterior compartment syndrome affected the athlete's lateral compartments in both legs which only occurs in 3 to 12% of cases. The athlete experienced the onset of CRPS at age 15 and although CRPS can affect adolescents, the age of most patients is between 36 and 42 years old. In this case, the athlete had sympathetically independent pain and derived only short term relief from sympathetic blocks and local injections. Ketamine is not typically used to treat CRPS, instead, it is reserved for severe cancer pain. It reaches its full effect within minutes and often replaces opioids in cancer treatments. As a blocker of NMDA (N-methyl d-aspartate) receptors, Ketamine has recently been used as a club drug for hallucinogen effects. Despite chronic pain during the two year course of treatments, the athlete remained very active in sports. **Conclusion:** The athlete hasn't experienced any recurrent signs or symptoms since surgery. The symptoms of CRPS are still present, but hypersensitivity to pain has decreased. The onset of CRPS may occur following surgery and the pathophysiological causes are still unknown. Although pain management treatments may offer relief, patient response will vary. **Key Words:** Compartment syndrome, surgical fasciotomy, CRPS, Ketamine.

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**A 22-Year Old Female Gymnast Diagnosed With Chronic Inflammatory Demyelinating Polyneuropathy**

Middlebrooks MG, Warren AJ: Oklahoma State University, Stillwater, OK

**Background**: A 22 year old female gymnast with no previous history of lower extremity injuries complained of bilateral strength decreases in her lower extremities. When performing manual muscle tests she presented with right dorsiflexion strength of 2-/5 and a left of 2+/5. Her plantar flexion strength was 1+/5 on her right ankle and 2/5 on her left ankle. Inversion strength revealed 3-/5 on her right ankle and 2-/5 on her left. Strength of eversion on the right leg was 4-/5 and 4/5 on the left. Her active dorsiflexion was limited to forty degrees less than neutral in her right ankle and thirty degrees less than neutral in her left ankle. She had limited active eversion with zero degrees in her right ankle and twenty five degrees in her left ankle. When performing a pupil dilation reaction and a rapid alternating movement test, which are upper motor neuron reflex tests, her signs were normal. When analyzing her gait she also had a decrease in balance with drop foot in her right foot and also in her left foot with fatigue. **Differential Diagnosis**: Tibial nerve injury, compartment syndrome, tibialis anterior weakness, and herniated disc. **Treatment**: Patient under went a nerve biopsy. The test came back inconclusive. The final diagnosis of her injury was chronic inflammatory demyelinating polyneuropathy (CIDP). She then proceeded to start physical therapy. She would begin nerve stimulation and resistive exercise bands on her ankle to improve strength. We also worked to improve her balance and gait with exercises directed toward improving those two areas. She also conducted proprioceptive neuromuscular facilitation work. With this regiment she has improved her strength and balance considerably. **Uniqueness**: CIDP is a unique pathology characterized by the decrease in nerve function. It is an autoimmune disorder where the body is attacking its own nerves. It is estimated that about 80 people in million are diagnosed with CIDP. It can occur across all ages while it is more likely to occur in young adults. Men are also more likely than women to be diagnosed with it. It is thought to the chronic form of Guillain-Barré syndrome. **Conclusions**: The patient showed a decrease in strength and innervation consistent with the symptoms of CIDP. She also showed that with proper treatment CIDP symptoms can be decreased helping improve the patients' activities of daily living.

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**Chronic Lower Leg Pain In A Collegiate Basketball Player**

Yakuboff MK, Dodge TM, Spak SF: A.T. Still University, Mesa, AZ; Boston, University, Boston, MA; Massachusetts Institute of Technology, Cambridge, MA

**Background:** This case involves an 18-year old collegiate male basketball player who presented with episodes of exquisite pain over the mid-diaphysis of the left tibia when participating in basketball (height = 201 centimeters, weight = 85 kilograms). Functional testing revealed pain during activities that involved excessive running and jumping. **Differential Diagnosis:** Medial tibial stress syndrome, osteoid osteoma, insufficient bone density, endocrine disease, osteal cysts, anterior mid-shaft tibial stress fracture. **Treatment:** Radiographs taken in June 2004 revealed the presence of a small stress fracture in the tibia. No sign of osteoma was found, and both MRI and CT scans were normal. The athlete was removed from activity and slowly progressed to weight-bearing activities over three months. A follow-up radiograph in August revealed cortical thickening within the anterior tibial shaft consistent with a healed stress fracture. One month later, the athlete returned to full playing status. Pain returned by October, prompting additional diagnostic imaging. Radiographs were negative and MRI revealed increased marrow edema within the intramedullary canal of the distal two-thirds of the left tibia, suggesting a mild stress reaction. The athlete was restricted from activity, and then progressed back to full participation over two weeks. By November, pain returned once again and the athlete was removed for four weeks from activities that might forcefully load the tibia. He began bone-growth stimulation using an Exogen Bone Healing System and consulted a nutritionist to evaluate any relationship between his diet and bone health. In December, MRI revealed bone marrow edema and an increase in metabolic activity in close proximity to the previous stress fracture, indicative of a new stress fracture. However, the athlete was asymptomatic at that time and was permitted to slowly return to activity. In January, an MRI revealed cortical thickening of the anterolateral third of the distal tibia consistent with a healed stress fracture and osseous edema in the intramedullary cavity consistent with a new stress injury. Bone density testing and endocrine values were determined to be normal. The athlete was withheld from basketball for six weeks in a final attempt to resolve all symptoms. Exquisite pain returned upon resuming full activity and the athlete was withdrawn from basketball for the remainder of the season. Because intramedullary nailing has been shown to have favorable outcomes with chronic stress fractures that are recalcitrant with non-operative treatment, a decision was made to perform this surgery. A reamed intramedullary nail was inserted just medial to the patellar tendon of the left knee. Initial rehabilitation consisted of using a CPM machine to increase knee ROM and reduce joint effusion. Ankle ROM was also implemented to reduce post-surgical inflammation and friction massage was performed to reduce adhesion formation under the incision. As edema was reduced, rehabilitation was aimed at increasing the ranges of motion at the knee and ankle, and returning the athlete to full weight-bearing activity. The athlete returned to full basketball participation three months after surgical intervention and roughly a year after initial presentation. **Uniqueness:** Chronic stress fractures unresponsive to conservative treatment are not typical of collegiate male basketball athletes. While most stress fractures involve the posteromedial and distal tibia, mid-anterior stress fractures are far less common, representing only 2.4% of all stress

fractures and 4.6% of tibial stress fractures. **Conclusions:** Conservative treatment is the accepted course for chronic stress injuries. However, conservative treatment did not ultimately produce the desired outcomes, and a more aggressive treatment was necessary. Consistent with recent research, the intramedullary nailing procedure was effective for returning this athlete with a recurrent stress fracture back to full playing status.

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**Freiberg's Disease In 20-Year Old Male Collegiate Cross Country Runner**

Rudasill D, Konz SM: Oklahoma State University, Stillwater, OK

**Background**: A 20 YO, male, NCAA division I cross country runner, specializing in the 5K and 1 mile runs, presented complaining of pain in his left foot over the past year. The athlete had been diagnosed with Freiberg's Disease during high school, but had not received any treatment as the pain was never enough to inhibit his running. After beginning collegiate training, the athlete increased his running mileage causing an increase in repetitive stress to the foot. The increase in mileage elevated the pain level in the second left metatarsophalangeal (MTP) joint causing him to alter his gait. He also began experiencing referred pain in the lateral left foot and lower back, in addition to tightness in the quadriceps and hamstrings of the affected limb. He categorized the pain as moderate to severe and indicated that the pain increased when he exerted himself. **Differential Diagnosis**: Metatarsal head fracture, metatarsal head luxation, stress fracture (March fracture), Morton's neuroma, Freiberg's disease. **Treatment**: A radiograph confirmed the previous diagnosis of Freiberg's disease, or Freiberg's infarction. The surgeon decided that a cheilectomy with an open reduction and pinning of the second MTP joint would be the most appropriate procedure for this athlete's situation. During the procedure, the dorsal MTP capsule was opened revealing "significant synovial fluid" and a "huge dorsal osteophyte." This osteophyte was removed along with a large area of avascular bone and several other osteophytes from the dorsal medial head of the second metatarsal. The dorsal exostosis was removed from the second proximal phalanx and the crater was cleared of bone debris in order to allow for a 0.62K wire to be placed through the joint to hold it in a straightened position. The capsule and extensor retinaculum were closed and the wound was sutured with 3-0 nylon. The athlete was given a walking boot to restrict movement in the foot and ankle. A pin removal procedure was scheduled for approximately one month later. One week before the pin removal, the athlete presented at a local medical center complaining of increased pain. The incision site was visibly red and warm to the touch. The physician diagnosed the condition as cellulitis and prescribed antibiotics. The removal procedure was successfully carried out as scheduled. The athlete soon began a rehabilitation regiment of calf raises, Active Release Technique, and eventually a walking/jogging program. Strength and range of motion returned to 100% in about three and a half months and the patient returned to participation, with the only lingering side effect being minimal medial arch pain which resolved with time. **Uniqueness**: Freiberg's disease is rare disorder. So rare, no established incidence rate is available. Other considerations that make this case particularly unique is the gender of the patient and the type of surgery performed. The patient was a male. Freiberg's disease is one of the few osteochondroses more likely to occur in females. Of those diagnosed with the disorder, the incidence of male to female cases is 1:5. The cheilectomy procedure is usually performed on the first MTP joint to correct hallux rigidus and not on the second MTP joint. **Conclusions**: A cheilectomy and fairly minimal rehabilitation plan were an effective means to treating Freiberg's disease in this male collegiate cross country runner and returning him to training and competition in a reasonable about of time.

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**Insidious Onset Of Swelling In A 12 Year Old Female Cheerleader**

Ullery LR, Hosey R, Milbrandt T, Royalty B: University of Kentucky Department of Orthopaedic Surgery and Sports Medicine, Lexington, KY

**Background:** A 12 year old female cheerleader presented to clinic with anterior knee pain. Her past medical history included a visit to another local clinic who diagnosed her with Osgood - Schlatter disease. The patient visited our clinic because of worsening symptoms. She had complained of intermittent knee pain throughout the day which was made worse while participating in cheerleader activities. Her knee had not improved despite conservative therapy and NSAIDS. Of note, the knee had become red, swollen, and even more painful in the last three weeks. She was unable to stand for any length of time and had considerable discomfort with kneeling. Pain was generalized over the entire knee without specific points of tenderness appreciated. Range of motion was limited to 90 degrees due to the amount of swelling. There was no significant intraarticular swelling present. She had significant soft tissue swelling, redness, and warmth over the area of the pes bursa on the medial aspect of the proximal tibia that was very tender to palpation. There was some surrounding erythema although no significant spreading of the erythema above the knee or down towards the ankle. She had all normal pulses. All ligament tests were negative. X-rays revealed a well circumcised cystic area in the proximal tibia just inferior to her physis. This corresponded to the area of tenderness on physical exam. The patient was then presented to the physician for evaluation. **Differential Diagnosis**: Ostomyelitis, fibroma, ewing's sarcoma, bone cyst, osteosarcoma **Treatment:** X-ray report from her previous office visit was obtained and there was no mention of tibial lucency or cystic lesion. MRI was obtained and showed a large abcess of the proximal tibia that crossed the physis. Her blood work also showed an elevated white blood count. The patient was taken to the operating room where she underwent an irrigation and debridement of the proximal tibia. She was also placed on six weeks of IV antibiotics and instructed to be non weight bearing until her next visit. At one month post - surgery, she was taken off of the IV antibiotics by the treating physician and instructed to begin weight bearing as tolerated. At that time she was instructed in range of motion exercises and quad sets. She returned to full cheerleader activities at 2 months post – surgery without tumbling exercises. She will progress to more tumbling exercises as tolerated. She will have continued follow-up over the next year to evaluate for growth plate arrest, limb shortening and/or malalignment. **Uniqueness**: This case is unique because it illustrates the importance of continued follow - up in any patient not improving from a typically benign injury or illness. Osgood – Schlatter is usually self limiting and responds to rest and analgesics or anti-inflammatory medications. While the original diagnosis makes "complete sense" the abscess is fairly rare. They are very rarely seen in athletics. These are most often seen in females and in the tibia and are typically difficult to diagnose due to their mild nature. **Conclusions**: In this case, the patient's regression, along with changing symptoms required further work – up. The discovery of the abscess is significant because it represents subacute osteomyelitis. She has returned to full cheerleader activities, and will be closely monitored by radiographs over the next year for any growth plate arrest which would require further surgical intervention.

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**Traumatic Knee Injury In A High School Basketball Player**

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**Background:** A 15 year-old female basketball player sustained an acute knee injury during an attempt to block a lay-up in February 2007. The athlete landed in a position of knee valgus. An immediate on-field assessment was conducted and the athlete presented with moderate effusion in her joint, and the knee was positioned in slight flexion. The athletic trainers were mostly concerned with the severe amount of swelling. There was no obvious deformity and her neurovascular systems were intact. The athlete reported her pain level was high (8/10), and lacked full active range of motion due to muscle guarding. She was assisted off the floor by three athletic trainers, non-weight bearing, to be further evaluated. Past medical history revealed no previous knee injuries. A valgus stress test revealed increased opening, bilaterally, with a firm end-feel. Also, a Lachmans was performed however due to pain and muscle guarding, it was unknown if there was sufficient translation of the tibia to be a positive test. Varus stress test and anterior/posterior drawers were negative. The athlete was tender to palpation over her anterolateral joint line. **Differential Diagnosis:** Anterior cruciate ligament sprain; Medial collateral ligament sprain; Patella subluxation; Osteochondral lesion, Fracture. **Treatment:** Ice and compression were applied however a knee immobilizer was not available. Crutches were provided to assist in non-weight bearing gait, and the athlete was placed in the care of her parents, as the injury did not appear to be a medical emergency. The parents were instructed to seek immediate physician referral the following morning. Plain radiographs at that time were unremarkable, but subsequent magnetic resonance imaging (MRI) revealed a non-displaced lateral tibial plateau fracture with no associated ligamentous involvement. The athlete's knee was aspirated, and a straight-leg immobilizer and crutches were provided. The athlete remained in the immobilizer with non-weight bearing, assisted gait for a total of 6 weeks, with progressive weight-bearing beginning thereafter. At 3 weeks post-injury, quadriceps isometrics and controlled range of motion exercises up to 45° were initiated. At 4 weeks, straight-leg raises and terminal knee extension strengthening exercises were initiated, and at the sixth week, hip exercises were initiated. Eight weeks post-injury, the athlete was cleared by the physician to begin proprioceptive training, and continued strengthening and conditioning, as allowed based on pain tolerance. The athlete was fully cleared in June 2007. **Uniqueness:** Tibial plateau fractures have not been commonly reported in this age level in sports. The most common mechanism of injury is high-energy impact, such as a motor vehicle accident or in elderly individuals with osteoporotic bone. Traumatic injuries of this type can be severe enough to require internal fixation in order to properly heal the bone. Initial plain radiographs can be negative in non-displaced fractures of this type, making MRI a helpful tool to diagnose these fractures early and appropriately. **Conclusions:** Early recognition of the severity of this injury and proper rehabilitation allowed for this injury to be managed without incident. Conservative treatment was appropriate due to the non-displaced nature of the fracture, and consisted of prolonged immobilization and controlled rehabilitation as outlined above. Bony injuries must always be considered as a potential differential diagnosis when immediate swelling is present following a joint injury.

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**Bilateral Femur Shaft Stress Fractures In A High School Football Player: A Case Study**

Goins JM, Torres-McGehee TM, Laursen RM, Guy JA: University of South Carolina, Columbia, SC

**Background:** We present a case of an injury involving a high school junior football player. A 16 year old (body mass=77.1 kg , height=175.3 cm) male football player reported to the Athletic Trainer two weeks into practice before a preseason scrimmage complaining of bilateral quadriceps pain. This was the first time the athlete reported any pain, but stated it had started earlier in the week. Pain increased when the quadriceps were placed in a stretched position, and he stated feeling weak while running and practicing. The athlete was well conditioned, and had participated in an off-season exercise program for the entire spring semester and summer. The athlete acknowledged having a stress fracture in his lower back during the previous football season. The athlete's symptoms did not improve within the next two weeks, so the athlete was referred to an orthopedic physician. **Differential Diagnosis:** Quadriceps muscle strain, delayed onset muscle soreness, regional rhabdomyolisis, pathologic legion of bone or muscle, and/or femur stress fracture. **Treatment:** Upon evaluation we first treated with ice, rest, and light stretch of the quadriceps. Once, the symptoms did not improve, the athlete was referred to an orthopedist. The athlete's previous history of a spinal stress fracture caused the physician to anticipate a stress fracture injury. A bone-scan revealed bilateral femur shaft stress fractures. The athlete was encouraged to rest with no physical activity, and his return was based on symptoms, which included pain and strength during functional movement. The athlete was recommended to take a calcium supplement and was instructed to rest and limit any weight-bearing activities until pain subsided. The athlete performed minimal exercises in the pool in maintain cardiovascular fitness levels, and to retain strength and range of motion. These exercises included: running, pivot and run, high knees, butt-kicks, skipping, and swimming. As pain diminished, athlete slowly progressed into sport-specific weight-bearing activities. He was instructed to stop if any pain occurred during any point in the activity. The athlete had to stop progression twice due to pain during week 2 and 3 and was held out of activity for approximately 6 weeks. **Uniqueness:** Bilateral stress fractures in the shaft of the femur are uncommon injuries. Reports state that the majority of stress fractures seen at this age are of the tibia and metatarsals, or femoral neck of those in the military. Due to the athlete's previous history, he seemed susceptible to bone stress fractures. **Conclusion:** The primary signs and symptoms the athlete complained of included: quadriceps muscle pain, chronic pain that increased with stretch, and complaints of not being able to run full speed. The pain did not decrease with time, so a physician referral was suggested. This is important due to the fact that most injuries would heal with time, unless there was an underlying cause that was not being treated. Stretching of the muscles caused a sharp pain more than the dull achy pain previously noted. After results revealed bilateral femur stress fractures, rest was the most optimal treatment for the athlete with a slow progression into activity based on symptoms.

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**Juvenile Rheumatoid Arthritis In A Collegiate Softball Player: A Case Study**

Lustbader J, Perkins SA, Sullivan RJ, Hart K: Marist College, Poughkeepsie, NY

**Background**: A 19-year-old female Division I softball player began having pain in her fingers, wrists, and knees at age 16. There was a gradual onset of symptoms that included minor sleep disturbances and weight loss of approximately five to six pounds. She had no personal or familial history of autoimmune diseases. The athlete sought treatment from her primary care physician, who ordered laboratory tests. The results of the laboratory tests were abnormal. **Differential Diagnosis**: Tenopathy, Lyme Disease, Sjogren's Syndrome, Systemic Lupus **Treatment**: The athlete was referred to a rheumatologist by her primary care physician, who performed a physical assessment to find the cause of the athlete's pain and joint swelling. Slight synovial joint thickening was noted at her left second metacarpophalangeal (MCP) joint and at the right second and third MCP joints on x-ray. She experienced pain at the end ranges of motion in her second and third MCP joints, as well as in her shoulder. The rheumatologist ordered laboratory tests which included a rheumatoid factor and sedimentation rate. The rheumatoid factor level was 470 units, normal is less than 30, and the sedementation rate was 50 mm/hour, normally 0-20. All radiographs were negative for decreased joint space. The athlete was diagnosed with Juvenile Rheumatoid Arthritis (JRA), confirmed by laboratory test findings, after excluding similar conditions. The athlete was prescribed non-steroidal antiinflamatory drugs (Ibuprofen), Cox-2 inhibitors (Celebrex), and disease-modifying antirheumatic drugs (Enbrel and Methotrexate), to control swelling and pain. She continues to take these medications, depending on the severity of her symptoms, and has x-rays periodically to assess the progression of the disease. **Uniqueness**: Juvenile Rheumatoid Arthritis is an autoimmune disease, which causes one's own white blood cells (WBC) to lose the ability to distinguish between "self" and "invaders". As a result of the inability of the WBC to distinguish between types of cells, there is a destruction of a person's healthy cells rather than destroying "invaders" such as bacterial and viral cells. This destruction of healthy cells affects the chondrocytes in cartilage throughout the body, including synovial joints. Rheumatoid Arthritis has been shown to affect 25-50 per 100,000 people per year, but the juvenile form of the disease affects about 50,000 children each year. Overall, only 0.5-1.0% of the population have some form of Rheumatoid Arthritis. This athlete faces a unique challenge by playing collegiate softball, while having a disease that involves inflammation and deterioration of joints. The demands on joints from playing an intercollegiate sport are immense, coupled with a disease such as Juvenile Rheumatoid Arthritis makes participation very challenging and painful. Juvenile Rheumatoid Arthritis is a unique childhood disease that will require continuous care throughout her life. Because it is an autoimmune disease, she must maintain a healthy lifestyle in order to prevent other illnesses. **Conclusion**: The athlete continues to take medication to control the symptoms, and occasionally experiences an increase in joint pain and stiffness. She continues to be examined by a physician every few months to monitor any changes in her condition. Currently, she is playing Division I intercollegiate softball despite pain, joint stiffness and swelling.

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**Acute Abdominal Pain In A Collegiate Football Player**

Harkins KR, Harkins TH, Drake JB, Keller BK: Charleston Southern University, Charleston, SC

**Background:** We present the case of an 18 year-old male collegiate football player with a traumatic abdominal injury. The athlete had no previous history of abdominal pain or trauma prior to this event. On September 15, 2007, the athlete participated in a kickoff-return during the first quarter of the game. During the play the athlete was struck by a helmet in the right flank region by a player on the opposing team. The athlete did not remain on the field, but returned to the sideline under his own volition where he sought out the athletic training staff. The athlete complained of pain in his right side and upper right quadrant. At this point, the team general medical practitioner, team orthopedist, and an orthopedic resident whom were all attending the contest collectively evaluated the athlete. Palpation over the abdomen and back revealed only minimal, diffuse pain in the right upper quadrant, with no muscle guarding or rigidity. The athlete had no positive signs of rebound tenderness. There was no noticeable discoloration or nausea and vomiting. The team general practitioner did not report any lack of peristalsis via auscultation or any positive percussion testing. The athlete had normal respirations, pulse, and blood pressure immediately following the injury and at recurrent intervals throughout the game. Noticeable symptoms did include a change in demeanor and lethargy. **Differential Diagnosis:** Abdominal contusion, rectus sheath hematoma, tear/rupture of the ligament of Treitz, kidney contusion/laceration, and or liver contusion/laceration. **Treatment:** The athlete was closely monitored by the medical staff throughout the remainder of the competition. There were no changes noted in respirations, pulse, or blood pressure. Upon the athlete reporting to the Athletic Training Center following the competition a standard Urinalysis was performed using a Multistix 10 SG Reagent Strip. This test identified a large amount of blood in the athlete's urine as there was no obvious hematuria to the unaided eye. The athlete was immediately transported to the local emergency facility where a contrast enhanced CT of the abdomen demonstrated hepatic contusion and active extravasation from the hepatic arteries of the right lobe. At that time the local emergency facility staff decided to transport the athlete to the Medical University of South Carolina where the athlete underwent interventional radiology. Three separate branches of the right hepatic artery were embolized using embolization coils and Gelfoam. During the course of this procedure the athlete received 4 units of packed red blood cells and 3 units of fresh frozen plasma. Most of the right hepatic lobe was infarcted. This region measured approximately 10.9 x 9.8 x 11.0 cm. The athlete left the Agiography Suite in stable condition and was then transported to the Intensive Care Unit. **Uniqueness:** The extremely low incidence of liver lacerations in athletics makes this case unique. An extensive research of the literature revealed only one previously reported case involving laceration of the liver in an athlete. In addition, the severity of injury to the liver in this case is most commonly observed in vehicular traumas, instead of sport-related collision. **Conclusions:** In this case, a grade 5 liver laceration, which is clinically defined as a global destruction or devascularization of the liver, was sustained during the normal play of a collegiate football game. It is imperative that clinicians realize that the initial signs and symptoms of an injury do not always demonstrate the severity of a particular injury. Therefore, the importance of closely monitoring each incidence is magnified.

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**Nail-Patella Syndrome In A High School Wrestler**

Polubinsky RL, Plos JM: Western Illinois University, Macomb, IL

**Background:** This case report involves a unique condition known as Nail-Patella Syndrome (NPS) in a 16 year-old high school athlete. The young man was seen for injuries sustained during his participation in wrestling. He reported to the ATC after he experienced knee pain and an elbow sprain during wrestling. Nail-Patella Syndrome is a rare genetic disorder that causes individuals to be born with several skeletal deformities and abnormalities within the body. Due to the NPS, this athlete had patellae the size of a quarter and dislocated each time he straightened and bent his knee. The NPS causes tight muscles in both the upper and lower extremities. One incident that occurred during wrestling was the gradual onset of knee pain as a result of frequent kneeling without the protection of the patellae in the proper aligned position on the anterior knee. Another injury was an elbow hyperextension injury from having the arm pulled behind his back. Because of the NPS, this athlete's elbow lacks full extension, has a radial head that protrudes about half inch and dislocates off of the capitullum, and has limited pronation/supination of the forearm. **Differential Diagnosis:** Patellar contusion, abrasion, and elbow dislocation. **Treatment:** Upon arrival to the athletic training room during the wrestling season for knee pain the athlete was treated with ice and rest for 3 days along with additional padding applied to the knees. He then was limited in his practice time in the following 3-5 days. The athlete recovered nicely due to the limited time spent in a four-point position which was causing the repeated stress (due to little size and misaligned patellae) placed on the anterior knees. The elbow presented the ATC with much more difficulty in treatment due to his condition-related limited extension, limited supination, and the dislocating radius. The athletic trainer suggested the use of a protective brace with padding to keep the athlete within his normal limits (-15° of extension, -75° of supination). However, the athlete felt too restricted in this brace and refused to be compliant. All of the injury conditions resolved without complication and the athlete returned to play. He understands the risk involved with participation in the various activities and is determined to compete in the same manner as the other athletes on the teams. **Uniqueness:** It is estimated that 1 in 50,000 persons worldwide have characteristics of the NPS condition. It is rare that a child would go undiagnosed with NPS but the possibility exists that athletic trainers may have an athlete with the condition under their immediate care. This athlete has an uncle with the condition who has successfully played professional soccer in Europe. **Conclusions:** Athletes with NPS demonstrate changes in their structural and physical function. However, these athletes still posses a competitive desire, normal cognitive and emotional functions, and a commitment to participate in athletics. Treatments of the musculoskeletal injuries follow similar guidelines for athletes who do not have the NPS condition. However, special consideration must be given to the physical restrictions in his range of motion and shortening demonstrated in both the upper and lower extremities.

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**Management Of Skin Ulcers In A Paralympic Athlete With Buerger's Disease**

Nadler B, Chang CJ: United States Olympic Committee, Lake Placid, NY

**Background:** The athlete was a 46 year old male Paralympic Seated Volleyball player with a left leg amputation and a diagnosis of Buerger's Disease. The initial injury to the left leg was a popliteal artery perforation from a gunshot wound in 1979. A failed arterial bypass in 1979 resulted in a second bypass in 1980. In 1985, a peripheral circulation specialist recommended amputation. During this procedure he was diagnosed with Buerger's Disease, or thromboangiitis obliterans. Buerger's Disease is a chronic inflammation and thrombosis of the peripheral vascular bodies causing tissue breakdown and pain, and often leading to skin ulcerations and gangrene. Buerger's Disease is strongly associated with tobacco use. This athlete smoked since 1985 but had not used tobacco for several months. The athlete presented to the Medical Clinic at the Parapan American Games in Rio de Janeiro, Brazil in September 2007 with skin ulcerations on the toes, dorsum of foot and lateral ankle of his right lower extremity. These ulcerations were over a year old. The athlete was unable to ambulate, reported his pain as 7/10, and used oxycodone for pain control. **Differential Diagnosis:** Skin ulcerations as a complication of Buerger's Disease. **Treatment:** The athlete had been self treating the wounds with bacitracin and gauze wraps. Wound measurements taken during first visit were: dorsum of foot - 4.5 cm in length, 5 cm in width. Extensor tendons of the 3rd and 4th digits were visible and green-tinged. The athlete refused to uncover his toes during the initial evaluation. The athletic trainer suggested and the physician agreed to use polymeric membrane dressing on the ulcers. The athlete reluctantly consented to try this on his foot and ankle. Dressings were applied twice daily and athlete stated a decrease in pain to 5/10 during the 2 weeks of the Games, and decreased his use of oxycodone. He also expressed pleasure that the dressing did not adhere to the wounds. At the conclusion of the Games, the athlete returned home with supplies to ensure consistent treatment of ulcers. Weekly pictures and measurements were sent to the authors. After one month his pain was 1/10 and he had discontinued use of all medications. However, it was noted in the photos that the foot wound was not diminishing from the outside edges. Wound care consultants suggested creating cell migration across the surface of the wound by applying a thicker dressing and gentle outward pressure on the rolled edges. Measurements at 2 months were: dorsum of foot – 6 cm in length and 4.5 cm in width. Although the longitudinal measurement increased new tissue granulation was significant. Changes were especially noticeable on the dorsal foot wound as the forth extensor tendon was no longer clearly visible. However, pain had increased in this wound to 4/10 at night. It is unknown if the increase in pain results from the regranulation of tissue or the pressure from the dressing. Measurements for the ankle ulcer were: initial – 1.5cm, 1 month - 1cm and completely closed at two months. **Uniqueness:** Ulcerations from thrombo-angiitis obliterans are extremely difficult to heal and uncommon in the athletic population. This case demonstrates the effective use of polymeric membrane dressings for this disease. **Conclusions:** The ankle ulcer has resolved and the dorsal foot wounds have shown remarkable improvement. Athletic trainers and other sports medicine professionals should consider the use of polymeric membrane dressings for significant wounds as a result of ulceration, surgery or abrasions.

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**Anaphylaxis By Hornet Stings In A Cross Country Collegiate Athlete**

Sakurai T, Yeargin SW, Yeargin BE: Indiana State University, Terre Haute, IN

**Background:** A 22-year-old Caucasian male NCAA Division I cross country athlete was found on running trails during an afternoon practice in August. Environmental conditions that day included: Dry bulb 26.7°C (80.1 °F) and relative humidity 76%. During the middle of the workout, his teammates reported that he was stung by a hornet one half mile away from campus and was not feeling well. The athlete continued to run after the sting for approximately one mile in order to arrive at

the water break point where athletic training personnel were stationed. Seven minutes after the sting; he initially complained of hives and itching on his palms and feet. His face was red and hot, and he was profusely sweating. An initiation of hives forming on the entire body was present, but they were only slightly recognizable at this time. Nine minutes after the sting; difficulty breathing, coughing, additional hives on his body, swelling of the throat and lips, elevated pulse, and nausea feeling presented. Ten minutes after the sting; vomiting, advanced progression of hives, and swelling of eyes presented. Twelve minutes after the sting disorientation set in. He had no previous history of an anaphylactic reaction to bee stings prior to this incident. **Differential Diagnosis:** Heat stroke, heat exhaustion, allergic reaction, asthma attack, and seizure. **Treatment:** EMS was activated when the athlete's throat started swelling and having difficulty breathing approximately nine minutes after the sting. The athlete was kept in a supine position and made as comfortable as possible. His vital signs were monitored. The athlete was turned to a recovery position as he started to vomit. Ambulance arrived at the site approximately seventeen minutes after the sting. The patient received an epinephrine shot, benedryl shot, and IV fluids on the ambulance. Once the patient arrived at the hospital, he received an additional liter of IV fluids. The second shot of epinephrine and benedryl was given to the athlete approximately 45 minutes after the first shots. **Uniqueness:** The uniqueness of this case is the athlete had experienced bee stings before and after this incident and did not have any reaction to them. Therefore, people could have reactions to different allergens by the same stimulus (different kinds of insect stings). Additionally, the athlete was stung by the hornet during practice and still kept running. The exercise after the sting may have influenced the reaction time since the symptoms appeared rapidly. Scarlet (2006) explained that 70% of those who have an anaphylactic reaction begin to see signs and symptoms within 20 minutes and another 20% of them start to have reaction in 40 minutes. A rapid onset of anaphylaxis is associated with greater severity. **Conclusions:** In this case, the athlete initially did not know he was allergic to bee stings. Recognizing that athletes are allergic to certain allergens is necessary during preseason. However, based on this incident, people could be allergic to a certain allergen without knowing it or have no previous history. As an athletic trainer, it is important to recognize the signs and symptoms of anaphylaxis and to manage the situation appropriately.

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**Partial Thickness Burns To The Lower Extremity In A Collegiate Distance Runner**

Pirog KB, McCarthy TJ, Manwaring PN, Waskowitz RS: Central Connecticut State University, New Britain, CT

**Background:** A 20 year old Division I female long distance runner suffered a scalding liquid burn to approximately thirty percent of the distal one-third of her anterior lower leg and foot. This non-athletic injury occurred when she accidentally spilled boiling water onto her lower leg, entrapping the fluid in her athletic shoe. The athlete sustained four distinct areas of superficial partial thickness burns: 6.5cm x 5 cm intact bulla superior and anterior to the medial malleolus, 2 cm x 5 cm broken blister superior to the medial longitudinal arch, 1cm x 2cm intact blister medial to the first metatarsal and a 5 cm x 8.5 cm area with small vesicles to the anteromedial distal one-third of the lower leg. Erythema was visible along the anterior lower one-third of the leg, to the dorsum of the foot, and to the first and second toes. Slight edema was present to the medial aspect of the ankle joint and an increased local skin temperature was noted. Subjective pain was rated as 5/10. **Differential Diagnosis:** Superficial thickness burn (1st degree), superficial partial thickness & deep partial thickness burn (2nd degree), full thickness burns (3rd, 4th, & 5th degree). **Treatment:** Acute care focused on pain management and prevention of secondary complications common to partial thickness burns. Initially, the bullae were left undisturbed and allowed to desiccate without intervention. The affected areas were cleansed with an antiseptic solution, lubricated with an antimicrobial ointment, and covered with a sterile non-adhesive bulky dressing. An elastic compression wrap was then applied from the distal foot to the proximal aspect of the lower leg to prevent edema. The athlete was prescribed oral antibiotic therapy, acetaminophen with codeine for pain management, and a non-steroidal anti-inflammatory agent. Tetnus prophylaxis was not warranted upon verification of a tetanus booster within the past two years. Two days post trauma, the four major blisters underwent debridement by a soft tissue specialist (MD). Daily treatments in the athletic training facility included antiseptic hydrotherapy followed by minor debridement of devitalized tissue and the application of a sulfa-based topical cream using sterile technique. Six days post injury, the athlete began formal rehabilitation to increase range of motion and maintain tissue mobility. Non-impact cardiovascular conditioning began by day eight and progressed to low impact training over the course of two weeks. The supervised cardiovascular phase progressed with a pain free walk-to-run program on the treadmill during week three. Twenty–seven days post injury, hydrotherapy, range of motion exercises, and cardiovascular training concluded. The athlete demonstrated normal ankle/foot motion, performed pain free functional activity, and the affected areas revealed complete re-epithelialization. The athlete returned to her sport with no limitations. **Uniqueness:** Superficial burns (1st degree) in the athletic population are typically a result of sun exposure. Superficial partial thickness burns (2nd degree), including their recognition, management, and the establishment of rehabilitation protocols are an athletic rarity. **Conclusion:** The depth, location, and percentage of surface involvement are critical in determining the medical care and rehabilitation time frame. Infection, loss of tissue, and joint mobility due to eschar formation may lead to the development of adhesions or contractures. Maintenance of skin integrity is the focus in treating an athlete who sustains partial thickness burns. The potential complications of cellulitis, extremity edema, and tissue loss due to infection or skin necrosis can be avoided. In this case, the athlete returned to competition in less than four weeks.

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**Herpes Simplex Keratitis In The Eye Of A Male Intercollegiate Tennis Player**

Neumann MR, Bryant S, Brown CN, Ferrara MS: University of Georgia, Athens, GA

**Background:** The patient is an 18-year-old male intercollegiate tennis player who reported during his pre-participation physical exam with 20/15 vision in his left eye, but 20/50 in his right eye. He reported he had "right eye issues" for more than 3 years. He stated a doctor from his home country diagnosed a virus, which caused corneal scarring, and that glasses will not help the problem. He stated that his vision does not get blurry, but he has something which blocks his vision in certain areas. The spots tend to come and go; there are times when they are minimal and he can see very well and others where they are very bad and he has difficulty seeing with that eye. He also reports that the worse periods tend to follow cold sore appearances on his face around his mouth. **Differential Diagnosis:** Past corneal laceration or abrasion, Herpes Simplex keratitis, Syphilis, Varicella Zoster Virus. **Treatment:** The athlete initially presented with this problem in January of 2007. He stated it was not currently a problem. Thus, we waited to receive his

medical records from his home country before referring him to a local ophthalmologist. We received the medical records in late February. He began having problems in early March and was referred to a local ophthalmologist. The medical records indicated that the athlete had been diagnosed and treated for Herpes Simplex keratitis of the right eye starting in 2003. Herpes Simplex keratitis is a viral infection, which tends to affect the cornea causing lesioning and vision problems. It is not a curable disease, however, it is treatable. Initially the athlete was treated by his home doctor with topical Acyclovir, which usually promptly decreased symptoms. At one stage in 2005, the patient developed a severe hypersensitivity response and Fluorometholone drops were used with topical Acyclovir, again improving symptoms. The patient traveled with Acyclovir and used it when symptoms returned. He was instructed to see an ophthalmologist immediately if this occurred. During this process the athlete also developed slight scarring of the cornea. The team ophthalmologist noted corneal scarring in the right eye through the use of a slit lens and corneal topography, and confirmed this diagnosis, giving similar recommendations emphasizing the importance of protecting the "good" left eye and immediately seeking treatment if the right eye worsened. The athlete's current vision problems are believed to be due to the corneal scarring with a possible recurrence of symptoms from the disease. Corneal scarring cannot be treated with glasses or laser eye surgery. A corneal transplant is a possibility but was ruled out given the subject's age and level of functioning. **Uniqueness:** Herpes simplex viruses are common in the U.S. and develop into keratits in about 700,000 people each year. The virus will cause corneal scarring in only a small percentage of those infected. It is unusual to observe such scarring in a high-level athlete exhibiting superior hand-eye coordination. **Conclusions:** Topical Acyclovir and Fluorometholone drops can help control the symptoms of Herpes Simplex keratitis. While the virus cannot be eliminated and the scarring cannot be fixed, this case demonstrates that with careful monitoring, an athlete can still continue to compete at a high level in athletics, even in a sport emphasizing hand-eye coordination.

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**Knee Injury And Infection In A High School Basketball Player**

Williams SJ, Hosey R: University of Kentucky Orthopaedic Surgery and Sports Medicine, Lexington, KY

**Background:** A 17 year old male basketball player sustained a direct blow to his left knee during a scrimmage. He presented to the certified athletic trainer the next day. He had mild swelling on the medial side of his knee where he took the blow and a small cut on the medial border of his patella which he claimed was not related to the injury. He claimed he did not hear or feel a pop at the time of the injury. He felt no instability and had a normal gait. His only complaint was the swelling and point tenderness over his medial femoral condyle. He had full range of motion and full strength when compared bilaterally. His knee was stable to ligamentous examination. He was instructed to ice the injured area 2-3 times per day and use a compression wrap over the weekend. On the following Monday, the mother called the coach to inform him that he could not walk due to extreme pain and swelling in his knee. The coach contacted the certified athletic trainer and he was referred to the Emergency Department. **Differential Diagnosis:** Possible explanations could include a medial femoral condyle bone bruise, ACL tear, patellar subluxation, or prepatellar bursitis with infection. **Treatment:** The athlete was admitted to the Emergency Department with a grossly swollen knee that was red and warm to the touch. The emergency department physician consulted with Orthopaedics. He had full range of motion and was neurovascularly intact. He did have a draining lesion on his anterior knee. The x-rays were negative. White count was 22,000 (normal 4,000-10,800). C reactive protein was 17.7 (normal 0-0.9) which is appropriate for assessment of infection. Fluid samples were taken and the orthopaedic doctor decided it seemed unlikely that this infection involved the joint. Fluid was aspirated and sent for cultures. The lab results returned three days later stating a heavy growth of Methicillin-resistant Staphylococcus aureus. He was placed on a double dose of Bactrim for seven days. After five days, his swelling had increased, so he returned to the Emergency Department. He underwent irrigation and debridement at bedside. The wound was packed and the mother was instructed on how to change the dressing. His prescription of Bactrim was extended for five more days. He reported to the Sports Medicine Clinic three days later for a wound check. The wound was healing adequately and he was instructed to start performing lower body strengthening exercises to return to play. **Uniqueness:** It is unusual for an athlete to have a knee injury and infection that developed simultaneously. There was no link found between the two incidents. The athlete initially thought he had a knee injury due to his direct blow from another player. He applied ice for the first three days and started to use heat on the fourth day because he said he remembered the certified athletic trainer talking about how to use ice first then heat later. In most cases, this would be the appropriate treatment, but he did not know the signs of infections and did not realize the heat was making the infection worse. **Conclusions:** A basketball player with a left knee contusion later developed a knee infection diagnosed as MRSA. Seventeen days after the initial injury, the athlete was able to return to practice and played in his first game four days later.

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**Fifty-Three-Year-Old Male Develops MRSA In Knee Joint Post Arthroscopic Knee Surgery**

Weatherford RW, Warren AJ: Oklahoma State University, Stillwater, OK

**Background:** A 53-year-old male initially injured the right knee by falling in a hole in a storm drainage area. He received treatment and therapeutic exercise at that time, but had a progressive increase in pain and a locking sensation in the right knee. The patient subsequently underwent a right knee arthroscopic debridement, and reported for therapeutic exercise sessions two days post-operatively. Upon arrival for treatment and exercise, the patient presented with extreme amounts of swelling and localized heat around the right knee. The patient was referred back to the physician for suspicion of infection. **Differential Diagnosis:** Differential diagnosis of signs and symptoms include chondromalacia patella, synovitis, patellar tracking problems, meniscal complications, and presence of methicillin-resistant staphylococcus aureus (MRSA). **Treatment:** Initial surgical intervention consisted of an arthroscopic debridement to treat for synovitis and chondromalacia patella in the knee from the initial injury onset. A subsequent surgery was performed to irrigate the area and debride for possible infection. The patient continued to experience local heat, fever, and extreme swelling around the knee. A third surgical procedure revealed the presence of MRSA in the right knee joint. The patient received intravenous antibiotics for treatment of the infection and underwent a fourth surgery for drainage of the infection. Initial therapeutic exercise consisted of increasing strength and range of motion.

Electric muscle stimulation was used for muscle contracture and pain control. A stationary bike was used for range of motion with partial revolutions, because the patient was unable to flex the knee beyond 90°. Passive stretching was used to normalize joint mobility and progressive resistance exercises and patellar mobilizations were performed to stimulate quadriceps muscle activity and decrease contraction and possible joint adhesions. **Uniqueness:** MRSA, or methicillin-resistant staphylococcus aureus, is a staph infection that is resistant to most antibiotics. In hospitals, patients with open wounds or weakened immune systems are at greater risk than the general population. Researchers found that only 2.9% of orthopedic trauma surgical admissions and 0.2% of elective orthopedic surgical admissions developed MRSA post-operatively. Unfortunately, the prevalence of this infectious disease is on the rise. The Center for Disease Control estimates that the number of MRSA cases in 2001 (31,440) nearly tripled in 2005 (94,360). This once very rare form of staphylococci bacteria is now posing a serious threat to many healthcare settings. **Conclusious:** The patient responded well to treatment. Range of motion is almost completely restored and signs of infection, such as pitting edema and localized heat, no longer exist. The patient was able to return to work but continues with therapeutic exercise to regain strength.

# Free Communications, Poster Presentations: Postural Control

Friday, June 20, 2008, 1:00PM-5:00PM, 2nd Floor Atrium; authors present 2:00PM-3:00PM

**What Impairments In Football Players Contribute To Poor Movement Patterns During Functional Movement Analysis?**

Dunn JC, Tillman SM, Lentz TA, Indelicato PA, Moser MW, Chmielewski TL: Department of Physical Therapy, University of Florida, Gainesville, FL; Shands Rehabilitation, UF&Shands Orthopaedic and Sports Medicine Institute, Gainesville, FL; Department of Orthopaedics and Rehabilitation, University of Florida, Gainesville, FL

**Context**: Pre-participation screenings assess musculoskeletal impairments thought to increase sports injury risk, but the predictive ability is equivocal. A current trend in sports medicine is to observe athletes for poor movement patterns during functional tests that may result from musculoskeletal impairments and lead to injury. It is unknown what impairments underlie poor movement patterns, which is needed to inform injury prevention programs. **Objective:** The purpose of this study was to determine, in football players, what musculoskeletal impairments discriminate poor and good movement patterns during 2 functional tests. **Design:** A cohort study design. **Setting:** Testing was performed in a controlled laboratory setting. **Participants:** Division I collegiate football players (n=74) without activity restrictions. **Interventions:** Independent variables were musculoskeletal impairment measures collected during a preparticipation screening. Joint motion (hip internal/external rotation) was assessed with a goniometer, and flexibility was assessed with a goniometer (iliopsoas, quadriceps) or inclinometer (iliotibial band, hamstrings, soleus); all recorded in degrees. Strength was assessed with hand-held (gluteus medius) or isokinetic (quadriceps, hamstrings; 60°/sec) dynamometers and normalized to body weight (BW). Functional tests were also administered. After practice, subjects performed an overhead parallel squat (OS) and right/left lateral heel taps (HT) off a step (15-25 cm), while digital camcorders captured frontal and sagittal views. Video data were visually analyzed for adherence to technique criteria using previously published methods. The criteria for OS were neutral lumbar spine, upright trunk, and neutral hip rotation. The criteria for HT were level pelvis, femur aligned over 2nd toe, and foot flat on step. One point was given for proper technique on each criterion, for a minimum score of 0 (poor) and a maximum score of 3 (good). Statistical testing included separate stepwise discriminant analyses for each functional test. Impairment measures were averaged between sides for OS. **Main Outcome Measures:** Dependent variables were poor and good groups for each functional test. **Results**: For OS, there were 30 poor ratings, 4 good ratings, and average illiopsoas flexibility was a discriminating factor (p=.05; poor=18.2 ±6.9°, good=10.9±2.7°; Thomas test position). For HT, there were 22 and 25 poor ratings (right and left, respectively), and 5 and 3 good ratings (right and left, respectively). Right soleus flexibility was a discriminating factor for right HT (p=.036; poor = 30.5 ± 4.8°, good=36.6±8.6°; standing lunge position), whereas left soleus flexibility (poor= 31.8 ± 5.0°, good= 40.7 ± 8.3°) and hamstrings strength (poor= 65.62 ± 27.11%BW, good= 94.97 ± 47.84%BW) were discriminating factors for left HT (p=.004). **Conclusions**: Around 30-40% of the sample performed these functional tests with poor technique indicating a high prevalence of movement dysfunction. Decreased soleus and illiopsoas flexibility and hamstring weakness were discriminating impairments on these functional tests, suggesting potential focus areas for football injury prevention programs.

**A Lack Of Correlation Between Static And Dynamic Measures Of Postural Stability**

Sell TC, House AJ, Huang HC, Abt JP, Lephart SM: Neuromuscular Research Laboratory, Department of Sports Medicine and Nutrition, School of Health and Rehabilitation Sciences, University of Pittsburgh, Pittsburgh, PA

**Context:** Static balance has been used to assess postural stability (PS) and potential predisposition to injury; yet, female athletes, who are at greater risk for noncontact anterior cruciate ligament injury (ACL), demonstrate better single-leg static balance than male athletes. A dynamic functional assessment of balance seems indicated although the relationship between dynamic and static measures of PS has yet to be quantified. **Objective:** To determine if a relationship exists between static and dynamic single-leg measures of PS in physically active females. It is hypothesized that no relationship exists. **Design:** Descriptive, correlational study. **Setting:** University sports medicine laboratory. **Participants:** A total of eight physically active females (age: 21.5±0.8yrs, mass: 62.3±7.9kg, height: 165.6±5.4cm) volunteered. Subjects reported no history of lower extremity surgery and no lower extremity injury within six months prior to testing. **Interventions:** Postural stability was assessed using two static single-leg balance tasks (eyes open and eyes closed), and two dynamic balance tasks (anterior-posterior (AP) and medial-lateral (ML) jump). Static balance included right leg stance with hands on hips. Dynamic balance included a double-leg jump, single-right leg land, and attempt to stabilize quickly on one leg. Once stabilized subjects placed their hands on their hips and maintained single-leg balance for an additional 10s. Jumps were performed over a 12" (AP jump) or 6" (ML jump) hurdle placed halfway between the force plate and a jump distance normalized to % subject height,

40% for AP and 33% for ML. Vertical, AP and ML ground reaction forces (GRFs) were collected using a force plate. For static balance, standard deviation (stdev) for each GRF was averaged across three 10 s trials. For five dynamic balance trials, mean postural stability indices were calculated using GRFs identified within the first three seconds post initial contact. Index calculations are as follows: AP stability index (APSI) = $[\sqrt{(0\text{-}GRFx_i)^2})]$/ body weight, ML stability index (MLSI) = $[\sqrt{(0\text{-}GRFy_i)^2})]$/body weight, vertical stability index (VSI) = $[\sqrt{(\text{body weight-}GRFz_i)^2})]$/ body weight. A series of 12 bivariate correlations were computed between the vertical, AP, and ML measures across dynamic and static balance assessments. An alpha level of 0.05 was set a priori to determine significant correlations. **Main Outcome Measures:** Dependent variables for the dynamic balance tasks included APSI, MLSI, and VSI and for the static balance tasks included AP stdev, ML stdev, and vertical stdev. **Results:** None of the 12 computed Pearson correlation coefficients achieved statistical significance (p-value range=.06 to 0.937, correlation coefficient range= - 0.44 to 0.69). **Conclusions:** The results of this study indicate that no relationship exists between the static and dynamic measures of PS tested suggesting that a dynamic assessment of PS may be a more functional assessment for risk of ACL injury.

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**Functional Ankle Instability Effects On Balance Error Scoring System And Modified Agility Hop Test**

Mitchell JC, Onate JA, Ross SE, Arnold BL, Van Lunen BL: Old Dominion University, Norfolk, VA, and Virginia Commonwealth University, Richmond, VA

**Context:** Functional ankle instability (FAI) has been shown to influence clinical measures of postural control. **Objective:** To examine the effect of FAI on two clinical tests of postural control. **Design:** Single-session experimental design **Setting:** Sports Medicine Research Laboratory **Participants:** A total of twenty-four subjects (male n=9, female=15; FAI (n=12): age=21.67±1.72 yrs, height = 177.17 ±15.30cm, mass=85.78 ±18.71kg; Control (n=12): age=23.92±1.00 yrs, height= 172.93 ±10.41cm, and mass=76.08 ±15.31kg) volunteered to participate in this study. Subjects within the FAI group had self-reported a history of multiple (>2) lateral ankle sprains, at least one of which required protected weight bearing (e.g. use of crutches), along with reports of affected ankle "giving way." **Interventions:** The Balance Error Scoring System (BESS) test consists of six twenty-second trials performed on two surfaces (firm and foam) across three stances (double-leg, single-leg, tandem). An error was recorded by an experienced investigator (blinded to group) via videotape analysis if the subject; opened their eyes, stepped out of the test position, removed their hands from the hips, moved the hip more than 30 degrees of flexion or abduction, lifted the toes or heels, or remained out of the test position for longer than five seconds. The Modified Agility Hop (MAH) test consists of four 12"squares placed in a single row pattern with two additional lateral squares placed at the second and last squares. Separate one-way ANOVAs were used to determine group differences for all tests with alpha level of p <.05 set *a priori*. **Main Outcome Measures:** BESS test was evaluated across one trial of each of the six categories and total score (errors). MAH test was scored for errors and total time for completion of each trial (seconds). **Results:** Participants with FAI committed approximately 1.5 times (p=.009) the amount of MAH errors (4.08± 1.68) as compared to the control group (2.42±1.14). The FAI group showed a statistically significant ($p$=0.01) increase in MAH time to completion (46.29±2.31 s) as compared to the control group (43.44±2.97 s). There were statistically significant increases in BESS errors in subjects with FAI as compared to the control ; Firm/ Single-Leg (p=0.02) (2.50±1.97 vs. 0.83±1.3), Foam/Single-Leg (p=0.031) (6.0±2.04 vs. 4.33±1.43), Tandem/Foam (p=0.01) (2.92±1.08 vs. 1.42±1.51), and Total Errors (p=0.003) (11.58±4.12 vs. 6.67±2.90) . Conclusions: Individuals with FAI committed more errors than control subjects in the BESS and MAH tests, along with taking longer to complete the MAH test. The results of this study support the use of both BESS and MAH testing as methods to evaluate postural control in individuals with FAI. In the absence of computerized postural stability measures, the BESS and MAH tests can distinguish between individuals with FAI as compared to a control group.

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**Postural Control Does Not Change Following Two Different Eight Week Exercise Programs In A Military Training Population**

Zirges SD, Oñate JA, Ringleb S, DeMaio M, Carr D: Old Dominion University, Norfolk, VA, and Naval Medical Center Portsmouth, Portsmouth, VA

**Context:** Improvements in postural control measurements are important to achieving a higher level of physical competence. It is important to understand how two different regimented eight week exercise programs affect balance measurements in a highly trained military population. **Objective:** To assess the improvement in postural measurement scores on the Sensory Organization Test (SOT) and the head shake (HS-SOT) ratios on a fixed and a sway referenced platform following two different eight-week exercise programs. **Design:** Experimental repeated measures design. **Setting:** Sports medicine research laboratory **Patients or Other Partici-pants:** Twenty nine physically active participants from a university Reserve Officers Training Corp [ROTC (15 males, 25.81±2.83yrs, 69.23±2.88in, 175.71± 22.28lbs, 14 females 25.8±2.52yrs, 65.66±3.07in, 145.64±20.95lbs)] participated in the study. **Interventions:** The participants were tested on the Neurocom Smart Balance master® (Neurocom, Clackamas, Oregon) for the SOT (three trials per stance) and the HS-SOT (four trials per stance) pre- and post-eight week exercise regiment. The SOT consists of six conditions of a combination of fixed/sway platform or reference combinations. During the HS-SOT, a head mounted accelerometer was utilized to monitor horizontal velocity at 120 degree/sec on a fixed and sway referenced platform. The participants were randomly assigned to either a crossfit exercise regimen, an on-line program emphasizing power, core stability and endurance through a variety of tasks, or a sequential exercise regimen based on percentage of maximum lift across isolated and functional strength exercises for the upper and lower extremity combined with self-selected aerobic/anaerobic activities. A 2(group) X 2(session) multivariate analysis of covariance (MANCOVA: pretest as the covariate) with an alpha level of p<.05 set *a priori* was conducted. **Main Outcome Measures:** Pre and Post scores; SOT, HS-SOT fixed platform and sway referenced scores (0-100 scale), fixed surface ratio (fixed surface on SOT divided by fixed surface on HS-SOT) and sway referenced ratio (sway referenced on SOT divided by sway referenced on the HS-SOT) scores. **Results:** The relationship between the covariate, prescores and the training groups were not significant, $p$=.38. The results also indicated that there were no significant improvements in the SOT scores (Pre = 80.9±5.50, Post = 85.4±5.14), HS-SOT scores (Pre-Fixed=90.2±4.3, Post-Fixed=90.6±3.6; Pre-Sway =24.8±25.6, Post-Sway = 44.7±23.3), $p \leq 0.05$. There also was not a significant improvement in the fixed surface or sway referenced ratio scores (Pre-Fixed ratio=.97±.03, Post-Fixed ratio= .67±.33, Pre-Sway ratio=.98±.03, Post-Sway ratio=.73±.19), $p$=.174 to .814. **Conclusions:** Neither of the eight week programs demonstrated a significant effect on the outcome of the postural control measures. A

lack of postural control improvement likely occurred due to the emphasis of the exercise programs were muscular strength, aerobic endurance, and anaerobic power. Future research should focus on specific postural control exercises and their effect on postural control measures in a healthy military population.

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**Single Leg Squat As A Functional Assessment Of Hip Strength**

Nguyen A, Schmitz RJ, Perrin DH, Shultz SJ: University of North Carolina at Greensboro, Greensboro, NC

**Context:** While injury prevention programs have been developed to target the posterior-lateral hip musculature, functional screening tools to identify those with decreased hip muscle strength are not well established. The single leg squat (SLS) is a controlled functional task that is commonly used to clinically assess hip muscle strength, but limited research has quantified the relationship between hip muscle strength and lower extremity motion during this task. **Objective:** To determine if greater hip and knee motions during a SLS predict decreased hip abduction, external rotation, and extension strength. **Design:** Descriptive cohort study design. **Setting:** Controlled, laboratory setting. **Patients or Other Participants:** Sixty (30M, 30F) healthy collegiate aged participants (23.1±3.2 yrs, 170.5±11.6 cm, 71.2±17.8 kg) with no current lower extremity injury, or any previous history that would detract from the ability to perform a SLS. **Interventions:** All measures were performed on the dominant leg (stance leg when kicking a ball). SLS trials were performed to a depth of 60º of knee flexion. Hip abduction (standing, hip abducted 5°), external rotation (semi-reclined, hip flexed 40°, knee flexed 90°) and extension (supine, hip flexed 90°) torques were measured during maximal isometric voluntary contractions using an instrumented dynamometer. The average hip and knee excursions over 5 SLS trials and the highest peak torque over 3 trials for each strength measure were used for analyses. Step-wise linear regressions determined the extent to which hip and knee excursions during the SLS predicted each hip strength measure. **Main Outcome Measures:** Joint excursion (degrees) was calculated as the final (joint positions at 60° of knee flexion) minus initial (joint positions during quiet single leg stance) joint angles for each trial. Hip abduction, external rotation and extension torques were measured in Newton-meters and normalized to body weight (Nm/kg). **Results:** Means±SDs for hip adduction, hip internal rotation, knee valgus and knee external rotation excursions were 11.4°±10.4°, -2.3°±5.9°, -0.1°±8.0°and 2.7°±6.1°, respectively. Normalized hip abduction, external rotation and extension torques were .69±.19 Nm/kg, .80±.26 Nm/kg and 3.46±1.05 Nm/kg, respectively. Knee external rotation excursion had the highest zero order correlation with hip abduction torque (R= -.369) explaining 13.6% of the variance (P=.004). Knee valgus excursion had the highest zero order correlation with hip external rotation (R= -.275) and extension (R= -.382) explaining 7.5% (P=.03) and 14.6% (P=.003) of the variance, respectively. **Conclusions:** Greater hip and knee joint motions during a SLS were predictive of decreased posterior-lateral hip strength. Further work is needed to determine 1) if these greater joint motions during a SLS are clinically useful to accurately identify those with decreased hip strength and 2) whether the joint motion patterns during a SLS are predictive of joint motion patterns during more dynamic activities which place the knee at greater risk for injury. *Funded by a grant from the NATA Research and Education Foundation.*

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# Free Communications, Poster Presentations: Stress and Strain Issues in Athletic Training

Friday, June 20, 2008, 1:00PM-5:00PM, 2nd Floor Atrium; authors present 2:00PM-3:00PM

**Retention And Attrition Factors Of Female Certified Athletic Trainers In The National Collegiate Athletic Association Division-I Football Bowl Subdivision Setting**

Goodman A, French KE, Jay M, Mitchell M, Mensch JM: University of South Carolina, Columbia, SC

**Context:** A high amount of attrition can adversely influence organizational effectiveness and the continuity of patient care. Female certified athletic trainers (ATs) working in the National Collegiate Athletic Association Division-I Football Bowl Subdivision (NCAA D-I FBS) setting not only deal with the pressure and demands of a highly competitive work environment, but may also deal with the demands of pregnancy, childbearing, and/or stereotypes regarding the "traditional" woman's role in American society. While research exists on the socialization, job satisfaction, and work-family conflict of ATs, little to no research exists on the retention and attrition of ATs in certain settings. **Objective:** The purpose of this study was to gain insight and understanding into the factors and circumstances affecting a female AT's decision to persist at, or leave the NCAA D-I FBS setting. **Design:** Grounded theory was the primary mode of qualitative inquiry. **Setting:** The setting included the 12 NCAA D-I FBS institutions within the Southeastern Conference (SEC). **Patients or Other Participants:** Twenty-three females who were current full-time ATs (n = 12), or former full-time ATs (n = 11) at SEC institutions were recruited via criterion and snowball sampling strategies. One current and one former SEC AT were recruited from each SEC institution, with the exception of one institution which had no female former full-time AT. **Data Collection and Analysis:** Data were collected via in-depth, semi-structured interviews, transcribed verbatim, and analyzed via a grounded theory approach and NVivo 7® software. Trustworthiness was ensured using member checks and peer review methods. **Results:** Results re-vealed the decision to persist involved four main factors: 1) enjoyment of job aspects/fitting the NCAA D-I mold, 2) kinship responsibility, 3) social support, and 4) increased autonomy. Two sub-factors of persistence, the NCAA D-I atmosphere and positive athlete dynamics emerged under the main factor of "enjoyment and fit". The decision to leave the setting included three main factors: 1) life-balance issues, 2) role conflict/role overload, and 3) kinship responsibility. Two sub-factors of leaving, supervisory/coach support issues and decreased autonomy, emerged under the main factor of role conflict/role overload. The participants' experiences also reflected well on a Causal Model of Turnover which depicts determinants of voluntary turnover. **Conclusions:** A comprehensive review of the study's results suggest that when addressing retention/attrition of female AT's in the NCAA D-I FBS setting, the following characteristics should be considered: 1) an understanding of certain aspects of the athletic training profession such as increased opportunity and general training, 2) the social support paradigm relative to the AT's position, and 3) attributes and personal obligations of the individual. Future research should include qualitative inquiries of administrators and male ATs, and quantitative

research on the Causal Model of Turnover's relation to the athletic training profession. *Student Poster Award Finalist*

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**Predicting Factors Of Work Stress In Secondary School Athletic Trainers**

Stemmans CL, Harada N, Huxel KC: Indiana State University, Terre Haute, IN

**Context:** There are two main employment categories for secondary school athletic trainers (ATs): direct employment through school district (DE), and outreach from hospital or clinic (CO). Differences between work stress, gender, and employment category as well as predicting factors of work stress in these populations are not established. **Objectives:** (1) To determine whether work stress levels differ between employment category and gender for ATs in the secondary school setting; (2) Identify predicting factors of work stress in each employment category. **Design:** Cross-sectional design. **Setting:** Web-based survey. **Participants:** Certified members of NATA identified as full-time employees and working in secondary schools were obtained using the membership database. The NATA randomly selected 1000 ATs from this database and distributed e-mail invitations to participate. Of the 1000 recruits, 435 responses (M=207, F=227, CO ATs=160, DE ATs=275, age=34.7±8.7, years in profession=10.9±7.9) were usable and included in statistical analyses. **Interventions:** A 39-item survey consisted of 3 demographic items, 18 Work-Related Strain Inventory (WRSI) questions, and 18 questions from five predicting factors of work stress. The WRSI has been shown to be both valid and reliable (ICR range = 0.85 - 0.90). Questionnaires of five predicting factors of work stress were created based on a comprehensive literature review and used to identify significant predicting factors of work stress. The contents of the questionnaires were 4 experience-related, 6 workload-related, 2 reward-related, 2 control-related and 4 community-related questions. Data were analyzed using a 2 x 2 ANOVA to answer the first study objective. Separate standard regression analyses were used to answer the second study objective. **Main Outcome Measures:** The WRSI measure is based a score from 18 questions answered using a 4-point Likert scale. Questionnaires of five predicting factors were all "select the best answer" questions. Responses to these questions were coded for analytical reason and calculated in each factor. **Results:** Results found no significant difference in work stress level between employment category (CO = 37.2±8.1, DE = 38.0±7.8, $P$ =.329), gender (M = 37.7±7.9, F = 37.7±7.9, $P$ =.979), or an interaction effect ($P$ = .514). Significant predictors of work stress in CO ATs included reward ($P$ =.044), control ($P$ <.001), and community ($P$ =.001). Factors that significantly predicted work stress in DE ATs were workload ($P$ =.016), reward ($P$ =.001), control ($P$ <.001), and community ($P$ =.001). **Conclusions:** Identifying factors that contribute to work stress is imperative to improve a workplace environment. We found that work stress is comparable between employment category and gender for secondary school ATs. Significant predicting variables identified control, community, and reward for both CO and DE ATs; workload was also a factor for DE ATs. Stress reduction strategies should focus on predicting factors within each employment category.

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**Burnout Levels In Athletic Training Students Across A Semester**

Lopez SJ, LaRue MJ, Janot JM: University of Wisconsin-Eau Claire, Eau Claire, WI, and Indiana State University, Terre Haute, IN

**Context:** Burnout is a common, but important, phenomenon in service professions such as athletic training. **Objective:** Determine burnout levels and uncover sentiments towards the athletic training education program (ATEP) in athletic training students (ATSs) at various points throughout the fall semester. **Design:** Longitudinal. **Setting:** Two CAATE accredited undergraduate ATEPs. **Participants:** Sixty-two (20 males, 41 females, one undisclosed) responded from 68 possible ATSs (92% response rate). ATSs averaged 2.9±0.11 years in the program and 87% were 18 to 22 years old. **Interventions:** The independent variable was time (beginning of semester, during season overlap, end of semester). The Maslach Burnout Inventory (MBI) was used to determine burnout levels. To gather additional data (demographics, rotation and job information, concerns regarding daily lives, etc.), a self-made questionnaire was employed. Both instruments were hard documents. Validity for the MBI has been demonstrated in a variety of ways and reliability coefficients for the emotional exhaustion, depersonalization, and personal accomplishment subscales are reported as 0.90, 0.79, and 0.71 respectively. The supplemental questionnaire was pilot tested for face validity and modified as necessary. MBI data was analyzed using two-way ANOVAs (school and time) and Tukey HSD post-hoc testing. Measures of central tendency were used to describe supplemental information. **Main Outcome Measures:** MBI subscale scores and supplemental information. Multiple scoring methods were utilized. **Results:** Overall, emotional exhaustion was moderate (19.15±10.27). Scores increased ($p$=.024) from low (16.19±8.86) at the beginning of the semester to moderate (20.95±11.25) at season overlap. At the end of the semester, scores were still moderate (20.36±10.03) but not significantly different from the beginning of the semester ($p$=.060) or season overlap ($p$=.993). Depersonalization was low (4.40±4.79) overall and for all administrations (3.02±3.63, 5.16±5.05, 5.08±5.31 respectively). Although scores were categorized as low, differences were found between the beginning of the semester and season overlap ($p$=.033) as well as between the beginning and end of the semester ($p$=.045), but not between season overlap and the end of the semester ($p$=.996). Personal accomplishment scores were high overall (39.08±6.28), for the beginning (39.79±6.23), and the end of the season (39.42±5.58). Moderate scores (38.02±6.89) were reported during season overlap. Despite the difference in categories, scores were not significantly different between administrations ($p$=.208, .384, .934). Analysis showed no interaction between administration and school. For each administration, ATSs reported receiving sufficient support from other ATSs and from athletic training staff (93% and 83% of respondents respectively). **Conclusions:** Although ATSs reported some degree of burnout, they felt they had sufficient support from the athletic training staff and other students. Levels of burnout were highest during season overlap. ATEPs need to be aware of the degree of burnout among ATSs, understand when burnout levels are increased during the semester, and work to minimize feelings of burnout.

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**Occupational Stress, Burnout, Engagement, And Health Complaints In The AT Profession: Results From A Nationwide Random Sample Of Certified Athletic Trainers**

Giacobbi P: University of Florida, Gainesville, FL

**Context:** Burnout has been a concern in the athletic training (AT) profession for two decades largely because of relationships with attrition, health complaints, and absenteeism (Capel, 1986). Clearly, the physical, psychological, and human costs associated with burnout in the AT profession warrant systematic research efforts. More recent efforts to explore occupational experiences of other human service workers have focused on the logical antipode of burnout: engagement. **Objective:** To estimate the

prevalence of burnout and engagement experienced by full-time certified athletic trainers (ATC's) and identify group differences based on gender, years of experience, and occupational setting. **Design:** A stratified-proportionate random sample of 3,998 ATC's were invited to complete a battery of validated surveys. **Setting:** Public and private US schools, universities and colleges, and industrial/clinical settings. **Participants:** With a response rate of 24%, the participants were 480 female and 454 males (M = 33.84, SD = 8.29) full-time ATC's that were proportionate to NATA membership demographics. **Interventions:**. All participants completed the measures via the World Wide Web. **Main Outcome Measures:** The measures included demographic assessments, the Maslach Burnout inventory (Maslach & Jackson, 1981), the occupational engagement scale (Schaufeli et al., 2002), and somatic health complaints (Derogatis, 1994). **Results**: All analyses were conducted with SPSS 15.0 software and sampling weights were applied to the strata. Results showed that participants scored one standard deviation below published norms for emotional exhaustion (M=16.94, SD=10.44) and depersonalization (M=6.35, SD=5.20) subscales of the MBI, one standard deviation above norms for personal accomplishment (M=36.77, SD=7.06); 16.2% of the participants were in advanced stages of burnout. The participants also scored approximately one standard deviation above norms on the vigor (M=4.59, SD=1.89), dedication (M=4.71, SD=1.89), and absorption (M=3.80, SD=2.57) scales measuring facets of occupational engagement. Reliability analyses (alpha) for all measures exceeded .70.The results revealed significant gender differences on emotional exhaustion ($p < .001$, $\eta^2 = .013$), vigor ($p < .001$, $\eta^2 = .018$), dedication ($p < .01$, $\eta^2 = .008$), and health complaints ($p < .001$, $\eta^2 = .025$): females scored higher on emotional exhaustion and health complaints while those in college university settings scored significantly higher on depersonalization ($p<.000$, $\eta^2=.03$) and emotional exhaustion subscales ($p<.000$, $\eta^2=.02$). Also, males scored significantly higher on vigor ($p < .001$, $\eta^2 = .02$) and dedication than females ($p < .001$, $\eta^2=.01$). **Conclusions:** The majority of the sample was engaged but a sub-sample of individuals was burned out. Females, and those working in college/university settings, were more burned out than males and ATC's in the other work settings; females also experienced greater somatic health complaints than males. Finally, males scored higher on the vigor and dedication scales. *Funded by a grant from the NATA Research and Education Foundation.*

# Author Index

## H



## I



## J



## K



## L



## M

## N



## O



## P



## R



## S

## T



## U



## V



## W



## Y



## Z



# Subject Index

## A

## B

## C

## D

## E

## F

## G



## H

## I

## J

## K



## L

## M

## N



## O



## P

## Q



## R

## S

## T

## U



## V



## W



## Y