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case report

Unusual Mechanism of Injury Resulting in a Thoracic Chance Fracture in a Rodeo Athlete: A Case Report

Mikaela Boham, EdD, LAT, ATC; Kim O'Connell, MS, LAT, ATC

Human Performance, Dance, and Recreation Department, New Mexico State University, Las Cruces

Objective: To introduce the characteristics of a Chance fracture and increase awareness of the mechanism of injury that may occur during athletic activity.

Background: A T12 Chance fracture was diagnosed in an 18-year-old male rodeo athlete. The rider was forced into extreme lumbothoracic hyperflexion when the horse bucked within the chute, pinning the rider's legs to his chest.

Differential Diagnosis: Burst fracture, abdominal organ rupture, spinal dislocation, spinal cord injury, disk herniation, pars interarticularis fracture, spinal nerve injury, paralysis.

Treatment: The patient underwent an open reduction and fixation of the thoracic fracture. Posterior stabilization was obtained with nonsegmental instrumentation. Allograft and autografts were used for posterolateral arthrodesis at T11–T12 and T12–L1.

Uniqueness: Motor vehicle crashes with occupants wearing lap-type–only restraints account for nearly all previously reported Chance fractures. When only lap seatbelts are worn, the pelvis is stabilized, and the torso continues moving forward with impact. The stabilized body segment for this individual was reversed. Nearly 3 years after the initial surgery, fixation, and infection, the bareback rider has returned to full participation in rodeo.

Conclusions: To our knowledge, this is the first reported diagnosis of a T12 Chance fracture in a rodeo athlete. When animals buck, athletes can be forced into hyperflexion, exposing them to Chance fractures. Therefore, anyone treating rodeo athletes must suspect possible spinal fracture when this mechanism is present and must treat all athletes with early conservative management and hospital referral.

Key Words: sports, flexion-distraction injuries, spinal fractures, emergency medicine

Rodeo is considered an extreme sport, and subsequently, extreme risk is implied.[1] Horseback riding, including rodeo and recreational riding, has been identified as one of the most common activities resulting in injuries requiring visits to emergency departments.[2] The rough-stock events in rodeo include bareback riding, saddle bronc riding, and bull riding.[1] Other events, including steer wrestling, tie-down roping, team roping, and ladies' barrel racing, are considered timed events.[1] In rodeo events, participants most often are injured while participating in rough-stock events.[3] In an epidemiologic analysis of Canadian Professional Rodeo athletes, Butterwick et al[4] found bull riders (31.2% of all injuries) were injured most frequently, followed by bareback riders and saddle bronc riders (16.0% and 14%, respectively, of all injuries).

Intercollegiate rodeo is extremely competitive; the skill required and risk of injury are comparable with those seen in the professional ranks.[5] During a 7-month, 10-event rodeo season, nearly one-quarter of all collegiate rough stock competitors sustained injuries.[5] At the professional and collegiate ranks, competitors enter multiple rodeos each week and travel among towns to attend competitions. Depending on the event, the injury rate for rodeo participants ranges from 2.3 to 19.7 per 100 animal-exposures.[5,6] Rough-stock competitors are 3 to 4 times more likely to be injured than other rodeo competitors.[6,7]

Young athletes have an increased frequency of thoracolumbar spine injuries while participating in high-risk sporting activities, such as elite skiing, climbing, motorcycle racing, skydiving, and other extreme sports.[8] More than half (53%) of all trauma to the thoracic and lumbar spine seen in adolescents has been attributed to recreational or competitive athletic activities.[9] Chance[10] first described unusual spinal injury patterns with a hyperflexion mechanism, usually resulting in a splitting of the posterior lumbar spine and neural arch without spinal cord damage, in patients admitted to the hospital after automobile crashes. Denis[11] later postulated that the use of lap seatbelts in automobiles could explain these injuries because the restraints serve as an axis of rotation, subjecting the anterior spinal elements to compression during flexion and the posterior elements to distraction or tension.

A Chance fracture is a unique spinal hyperflexion-distraction injury occurring around a fulcrum, which most often is described in the literature as a seatbelt crossing the lap.[12] Ruptures are seen in the posterior ligaments, and the injury may include fractures to the pedicles or spinous process of the vertebrae.[10] Chance fractures are relatively uncommon among the general population with the exception of individuals injured in automobile accidents and high-velocity athletic activities.[13,14]

Denis[11] proposed classifying the spine into 3 columns. The anterior column comprises the anterior longitudinal ligament, anterior annulus, and anterior vertebral body.[11] The middle column comprises the posterior longitudinal ligament, posterior annulus, and posterior portion of the vertebral body. The posterior column comprises the spinal structures located dorsally to the posterior longitudinal ligament.[11] Chance fractures result in a failure of the bony or soft tissue structures of the posterior and middle columns as they are subjected to tension, whereas the anterior column remains largely intact and becomes a fulcrum for

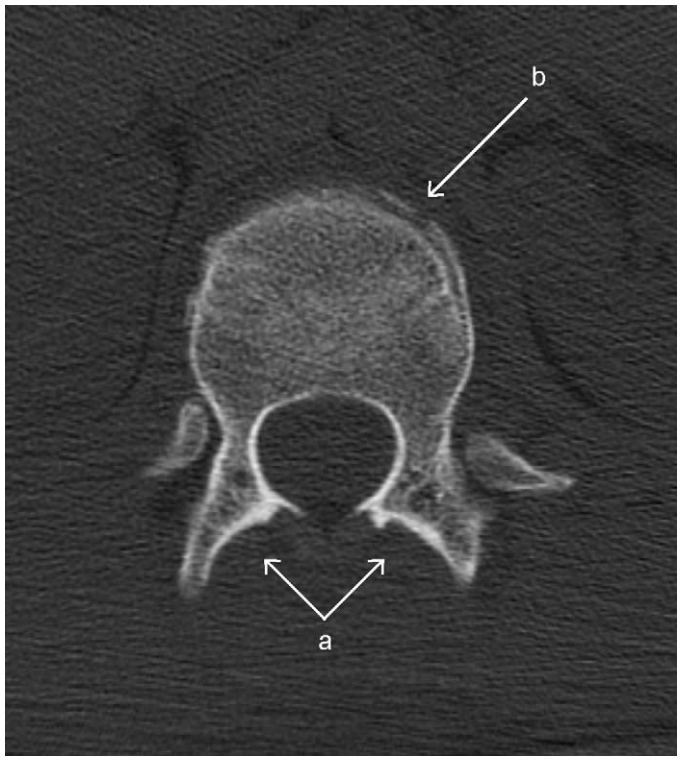

Figure 1. A Chance fracture in an 18-year-old male bareback rider. Transaxial computed tomography image of the T12 vertebral body shows the superior articular processes of the T12 are seen without their normal articulation with T11. a, Findings represent a "naked-facet" sign and signify distraction of the posterior elements. b, Anterior compression or "sandwich sign" of the vertebrae. The vertebra maintained only 30% of its original height. In addition, note the absence of the spinous process, which was fractured and cannot be seen in this image.

injury.[11] We present this case of a collegiate bareback rider who sustained a Chance fracture of the thoracic vertebra (T12). The mechanism of injury was the same as for other reported Chance fractures; however, the thoracic spine was stabilized in this patient, whereas most researchers have indicated the legs are typically the fixated segment during injury.[10–12,14,15] The athlete successfully underwent surgery; although he had medical complications, he eventually returned to bareback riding competition.

CASE REPORT

An 18-year-old male bareback rider was competing in a sanctioned National Intercollegiate Rodeo Association event during the spring of 2007 at a remote location in rural New Mexico when he sustained an unstable Chance fracture. The National Intercollegiate Rodeo Association rules require an ambulance or prehospital care professionals to be present at all rodeo events, allowing this athlete to receive immediate emergency care and referral.

The Rodeo Environment

Rough-stock animals (bulls and horses) are loaded into a small metal enclosure with a gate that opens out into the arena.[15] When prepared, the rider nods his head, the gate is pulled open, and the ride begins. Bulls or horses commonly become agitated in the chute, resulting in bucking or kicking. A rider can become trapped or pinned against the metal confines of the chute by the animal and, under the worst circumstances, may become trapped beneath the animal. Rodeo bulls and horses typically weigh 1500 lb (675 kg) or more and are selected for competition based on the ability to buck hard, have big powerful kicks, or spin fast.[1,5] A ride is scored based on the animal's athletic ability and the rodeo athlete's technique. Bareback riders commonly sustain injuries during the ride or while trying to dismount the animal; however, in this case, the rider was injured while the animal was still in the chute before the ride began.

The horse appeared restless in the chute as the bareback rider climbed onto it. His gloved hand was wedged into the rigging to keep him secured to the horse's back during the event, and as the horse's agitation increased, the rider called for the gate to be opened. As the gate opened, the horse bucked back, slamming the rider into the back of the metal chute and forcing his legs into his chest (lumbar spine hyperflexion). The rider felt a "pop" in his lower back followed by excruciating pain. The rider immediately attempted to free his hand from the rigging and struggled to dismount from the animal. After the hand was freed, the rider was launched off the back end of the horse and was kicked by the horse on his way to the arena floor. The rider immediately scrambled to his feet and motioned for medical assistance.

He walked out of the arena under his own volition. When he was behind the chutes, the rider dropped to his knees and could not return to a full upright position. The rider told the responding ambulance emergency medical technicians that he had broken his back. The on-site medical staff observed relatively few physical findings. He reported agonizing low back pain unaccompanied by any lower extremity neurologic symptoms. The patient had tenderness to palpation at the midline of the thoracolumbar junction. No obvious visible deformities or step-offs were noted. Manual muscle strength testing revealed normal (5/5) strength bilaterally for hip flexion, knee flexion, knee extension, dorsiflexion, plantar flexion, and toe extension. The sensory examination revealed normal findings.

Medical History

Given the remote location and extent of injury, the bareback rider was airlifted to a level I trauma center medical facility. Computed tomography (CT) scans were taken of the cervical, thoracic, and lumbar spine (Figures 1–3). The cervical spine scans and lumbar spine scans indicated no evidence of acute fracture or subluxation, maintained vertebral body heights and intervertebral disc spaces, and well-aligned vertebral bodies and posterior elements.

The computed tomography scan of the thoracic spine demonstrated an acute compression fracture of the T12 vertebra, indicating a Chance fracture. The T12 vertebra compression fracture was primarily anterior, with approximately 30% of vertebral body height maintained (Figure 1); the posterior height appeared within normal limits. (The final surgical report noted approximately 20° of kyphotic angulation in the T12 vertebral body.) The patient also had a transverse fracture passing through the bilateral pedicle lamina and spinous process at T12 (Figure 2). The fracture

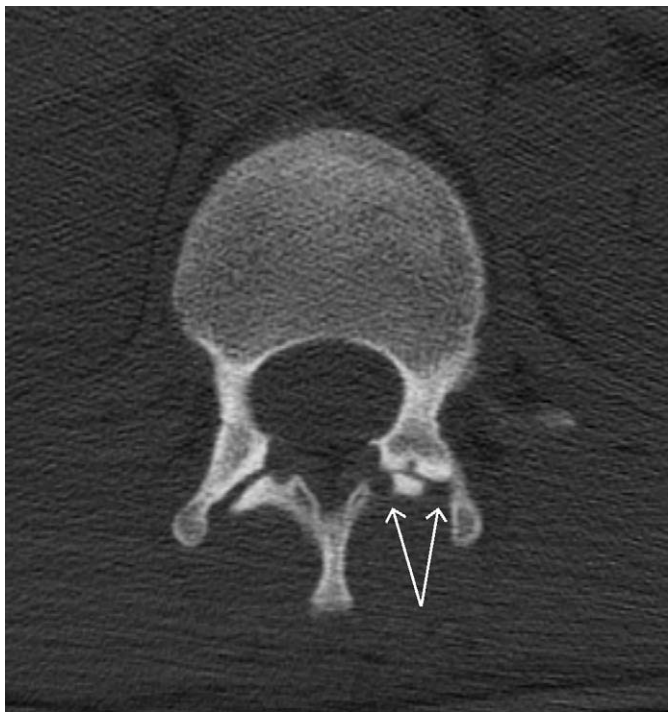

Figure 2. Fracture of the left transverse process and arch between the transverse and spinous processes of the vertebra at T12 (arrows).

extended into the posterior limits, which was consistent with a Chance fracture. The patient received the diagnosis of a highly unstable T12 Chance fracture but had no other neurologic injury and no spinal cord trauma (Figure 3). The treatment of choice was surgical stabilization.

Surgical Fixation

The risks associated with an unstable Chance fracture include, but are not limited to, bleeding, infection, abdominal organ injury, pneumothorax, complete paraplegia, loss of bowel and bladder function, loss of sexual function, spinal instability, pseudoarthrosis, the need for future surgical procedures, adjacent segment spine degeneration in the future, spinal fluid leakage, and death.[16] Surgical procedures performed on this patient consisted of open reduction, fixation, and short-segment fusion of the thoracic fracture from the T11–L1 level bridging the Chance fracture at T12 and posterior stabilization with bilateral pedicle screws and Harrington rod fixations at T11 and L1 (Figure 4). During a surgical procedure 2 days later, posterior arthrodeses of T11–T12 and T12–L1 were completed with autograft and allografts, including bone harvested from the right iliac crest of the patient.

After a normal hospital course and routine discharge, the patient returned to the hospital's emergency department at 3 weeks postsurgery reporting fever, chills, increased pain, and purulent drainage from the wound. The patient was readmitted to the hospital with a postoperative wound infection. Wound re-exploration, irrigation, and debridement were deemed necessary. During surgery, the patient was found to have necrotic tissue and seropurulent drainage that extended to the level of the hardware. Approximately 1 week later, the patient was instructed in home self-care for continued antibiotic administration and discharged from the hospital. His recovery proceeded without further incident.

Criteria for Return to Competition

The patient was discouraged from returning to competition based on the severity of injury and high potential risk of further damage or reinjury. The patient engaged in general rehabilitation treatments for approximately 3 months after surgery. In addition, he completed nearly 1 year of intensive functional training, agility drills, and core strengthening exercises to prepare his body for return to rodeo activities. After multiple physical examinations and radiographs to ensure the hardware and surgical fixation were secure, the patient was granted a medical clearance to return to unrestricted participation in rodeo activities.

It is extremely common to see rough-stock athletes wearing leather flak jackets because they offer protection against hoof kicks and being gored by animals. A condition of this bareback rider's return to rodeo activities was that he be required to wear a padded vest during all practices and competitions. Shock Shield (Econoline, Charlotte, NC) padding that was 22 in (5.88 cm) high, 12 in (30.48 cm) long, and 0.5 in (1.27 cm) thick was placed in the posterior aspect of the rider's vest. This extra padding weighed approximately 4 lb (1.8 kg), and the athlete reported frequently losing his balance while riding, resulting in the rider being bucked off the horse and landing on his back, which is contraindicated after spinal surgery, fixation, and stabilization. The original Shock Shield padding was replaced with a thinner version of the product (0.31-in [0.79-cm] thickness), which offered slightly less protection but was about half the weight (approximately 2.2 lb [0.99 kg]). He has rigorously maintained a core stabilization program because the hardware fixation and bone grafts alone do not possess the tensile strength to protect him from further injury.

DISCUSSION

Athletes rarely sustain thoracolumbar fractures, and encountering a Chance fracture in a rodeo athlete is even rarer. The only other diagnosed Chance fracture reported in athletics occurred in an adult snowboarder who had a similar mechanism of injury.[9] The snowboarder fell backward, and the legs were forced into the chest in much the same manner as the bareback rider being slammed into the chute with his back against metal poles and his legs forced into his chest by the horse. Forced hyperflexion of the spine is not uncommon in athletic events. Consider a high jumper or pole vaulter in track and field landing on his or her back while the legs come into the chest in a forceful gravity-induced hyperflexive manner. This mechanism is particularly pertinent for rodeo athletes who may be slammed into the chutes by animals, who may land on their backs during dismounts, or who may be stepped on by animals, resulting in a hyperflexion injury to the spine.

The injury to this bareback rider is unique because he sustained an unstable Chance fracture at the last thoracic (T12) level due to participation in a rodeo event. The unstable spinal fracture required surgical intervention,

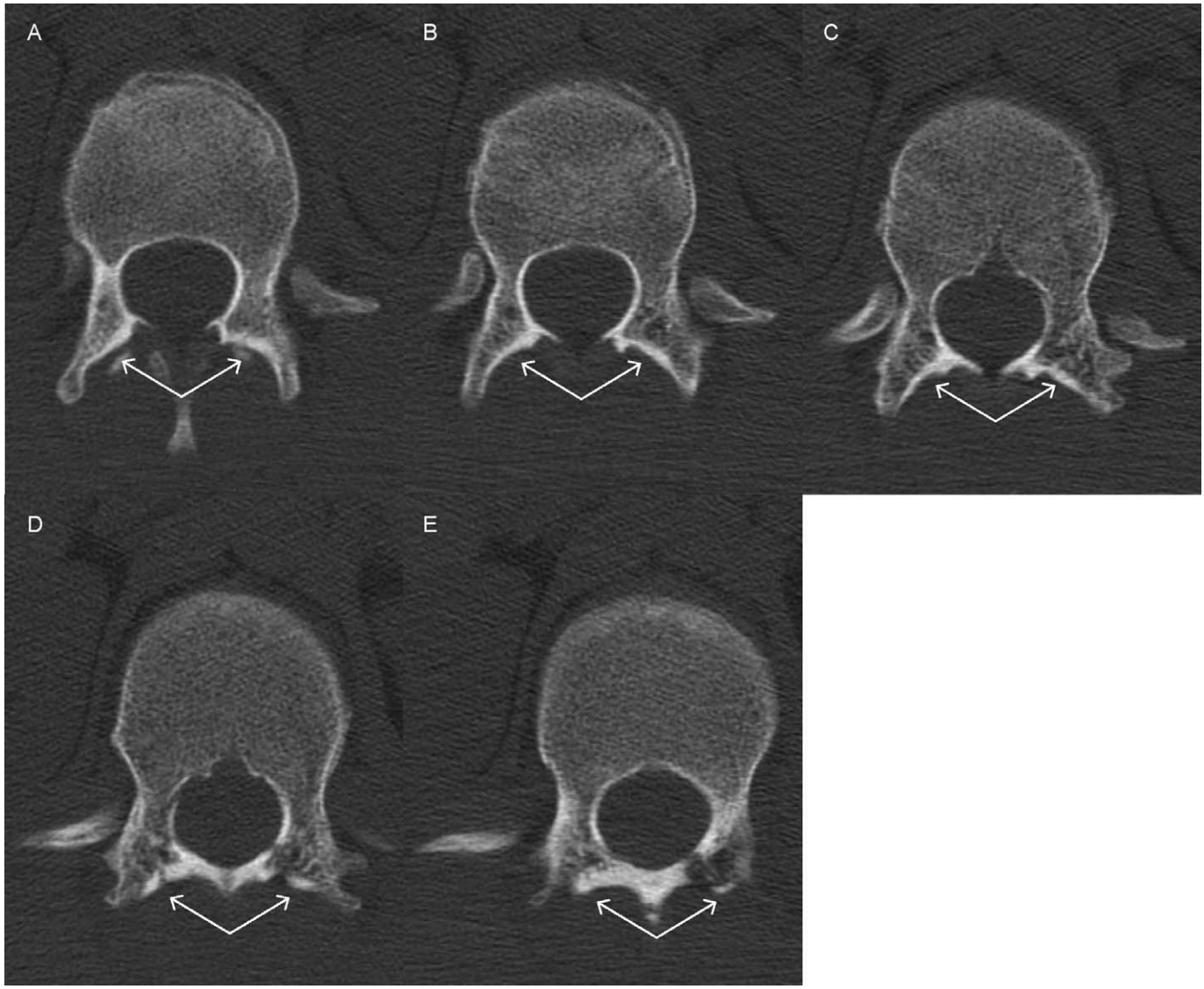

Figure 3. A–E, Bilateral "dissolving pedicle" sign in the bareback rider at T12. The loss of definition of the pedicles in computed tomography images is a common diagnostic feature for a Chance fracture. Five serial transaxial computed tomography images of thoracic spine reveal fracture through the pedicles and into the vertebral body with loss of pedicle definition (arrows), which is more pronounced on the left. B–D, Note the absence of a spinous process, indicating splitting of the spinous process into inferior and superior segments due to posterior spinal distraction.

fixation, and stabilization before the athlete could return to activity. Although the bareback rider sustained a serious unstable fracture, he presented few physical symptoms of a spinal injury. Medical professionals must use early conservative treatment and management protocols, such as early spinal stabilization and referral to medical services, when treating participants whose mechanism of injury may result in spinal fractures. The bareback rider in this case was treated conservatively at the time of injury by the emergency medical personnel despite the lack of physical cues to indicate a serious unstable spinal injury. This early conservative treatment and timely medical referral may have preserved the integrity of the spinal cord, allowed for successful surgery, and enabled the athlete to walk and ride again (Figure 5).

Many Chance fractures are associated with intra-abdominal injuries because the bowel or internal organs may become entrapped above or below the fulcrum and the level of associated flexion, causing damage.[16] The rodeo athlete did not sustain any abdominal trauma due to the hyperflexion of his legs into the chest, which could be attributable to the thoracic spine and not the lower extremities being stabilized. Whereas the mechanism of injury of extreme flexion with the fulcrum occurring on the anterior column is the same across all Chance fractures, the segment of spinal stabilization may have prevented further injury to this individual. In automobile accidents, the seatbelt creates an anterior fulcrum that locks the hips and pelvis in a static position while the upper body and head continue in a forward trajectory after impact.[10] In the case of the bareback rider, his upper torso was held in a static position by the metal rodeo chute, and his legs were forced into a hyperflexed position when the horse bucked backward. The mechanism of injury for this athlete may have changed the fulcrum of impact and

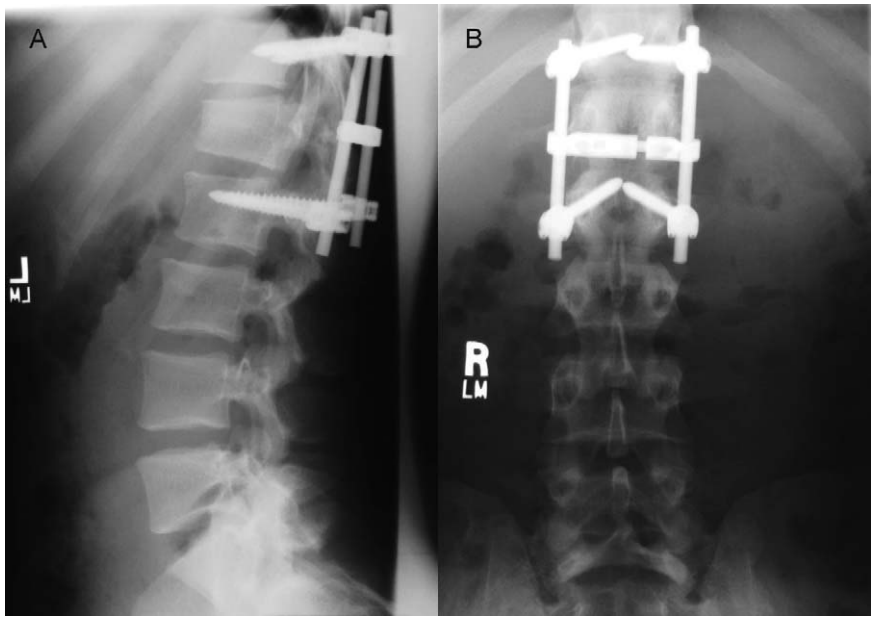

Figure 4. Radiographs of the Harrington Rods and pedicle screws. A, Lateral view. B, Posterior view.

prevented him from sustaining an associated intra-abdominal injury.

The risk of injury or death resulting from participation in activities involving livestock is high; some researchers[4,7,17] have claimed it is higher than the risk associated with American football, automobile racing, or motorcycle sports. Most rodeo injuries occur while the rider is dismounting the animal, either through his or her own volition or due to being bucked off.[7,17,18] Collisions between the rider and the animals or the arena are difficult to prevent or avoid.[19] In addition, rodeo athletes are extremely likely to continue participating even when injured. The culture of rodeo breeds machismo behavior, and many times a severely injured rodeo athlete refuses medical assistance when leaving the arena and does not report the injury to the medical staff on site.[8] However, this athlete did not follow this behavior.

Figure 5. The injured bareback rider at a rodeo competition after returning to participation postinjury.

CONCLUSIONS

Major fractures resulting in spinal instability are rare in athletic activity because the vertebrae are well supported by muscles and ligaments. Anytime either the legs or spine are stabilized and the other body segment is forced into hyperflexion, the risk of a Chance fracture should be considered. Understanding the mechanism of injury may bring awareness to athletic trainers or medical professionals of the possibility of a Chance fracture occurring in an athletic environment. Whereas the signs and symptoms may not initially present as a typical traumatic spinal injury with possible neurologic involvement, a Chance fracture could exist and should be treated with all the precautions and immediate care protocols warranted for any spinal column injury.

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Address correspondence to Mikaela Boham, EdD, LAT, ATC, Human Performance, Dance, and Recreation Department, New Mexico State University, MSC 3FAC, PO Box 30001, Las Cruces, NM 88003-8001. Address e-mail to mboham@nmsu.edu.