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short report

Return to Play After Exertional Rhabdomyolysis

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Objective: To outline a 4-phase progressive program that safely and successfully enabled athletes to return to sport without recurrence of exertional rhabdomyolysis symptoms.

Background: In January 2011, a large cluster of National Collegiate Athletic Association Division I football athletes were evaluated and treated for exertional rhabdomyolysis. After the athletes were treated, the athletic trainers and sports medicine providers were challenged to develop a safe return-to-play program because of the lack of specific reports in the medical literature to direct such activities.

Treatment: A progressive 4-phase program based on existing recommendations, including guidelines for continued clinical and laboratory monitoring.

Conclusions: Although the actual process of reintegrating players will differ based on each athlete's unique circumstances, this program provides a safe and effective foundation that can be modified based on the response to activity and sport.

Key Words: athletes, football, reintegration program

Acute exertional rhabdomyolysis (ER) occurs when myoglobin and other intracellular contents are released into the systemic circulation because of skeletal muscle breakdown.[1] Although diagnostic criteria for ER are based on a constellation of symptoms and laboratory values described by several groups,[2–4] the medical literature largely lacks specific return-to-play protocols for high-level athletes returning after this ailment. A general guideline is available in the literature,[3] but no published reports have illustrated specific return-to-play programs for elite athletes to guide sports medicine providers and athletic trainers. The purpose of our article is to provide the sports medicine community with a proposed template to safely return athletes to play after ER.

O'Connor et al[3] described 2 cases of ER: 1 in an untrained athlete and 1 in a collegiate football player with sickle cell trait. They proposed first classifying the athlete's risk of ER recurrence. If the athlete is considered high risk, referral for expert (ie, nephrologist) evaluation before return to sport is recommended. If the athlete is considered low risk, a generalized guideline is offered to help return the athlete to sport.

Cleary et al[5] described a 16-year-old football player with mild ER. The authors suggested an individualized return-to-sport protocol based on the extent of the athlete's muscle breakdown. Additionally, they outlined a program with specific activities, environments (aquatic versus land, climate controlled versus outdoor), and training-intensity recommendations.

In January 2011, 10 members of a National Collegiate Athletic Association Division I football team were diagnosed and treated for ER.[6] This report outlined the 4-phase program implemented to successfully return each athlete to sport after an ER diagnosis requiring hospitalization. Our goal is to share specific program details to assist other athletic trainers and sports medicine providers. Although each athlete's return to sport will vary based on a number of individual factors, we propose this program as a guide to safely and effectively returning athletes to sport without ER recurrence.

REINTEGRATION PROGRAM

Phase I

Once each athlete was discharged from the hospital, he returned to activities of daily living for 2 weeks. During phase I, athletic trainers assessed the athlete daily for recurring muscle soreness, hydration status, and urine characteristics and ensured that the athlete was obtaining at least 8 hours of uninterrupted sleep nightly. Toward the end of phase I, the player was evaluated by the team physician, at which time creatinine kinase (CK) and serum creatinine levels were measured. The athlete progressed to phase II when the CK level was less than 5 times normal (1000 U/L), as previously recommended in the literature.[3] An overview of activities in each phase of the return-to-play program is provided in Table 1. Advancement to subsequent phases was allowed only if clinical symptoms remained absent and laboratory data remained within normal limits. The athlete's level of CK was checked at the beginning of each new phase to ensure that it remained below 5 times normal (1000 U/L).

Phase II

Once the athlete was allowed to progress from phase I, the reintegration program was based on a 5-day training week for phases II through IV. All phases were completed at controlled room temperature. The detailed training regimen each athlete adhered to in the remaining phases is shown in Tables 2 through 4. Athletes were able to initiate physical activity in phase II, focusing initially on

Table 1. Overview of Phased Return

Phase	Activities
I	Return to activities of daily living for 2 wk Regular monitoring by athletic training staff Screening for symptoms consistent with exertional rhabdomyolysis, sleep patterns, hydration, urine color, and class attendance Monitoring of creatinine kinase and serum creatinine by primary care physician
II	Daily monitoring of hydration status, muscle soreness, and swelling Initiation of physical activity: foam rolling, dynamic warm-up, aquatic jogging, and stretching
III	Daily monitoring of hydration status, muscle soreness, and swelling Progression of physical activity: body-weight resistance movements, resistance training with elastic band, core training, stationary bicycling, and stretching
IV	Daily monitoring of hydration status, muscle soreness, and swelling Initiation of resistance training at 20%–25% of estimated 1-repetition maximum, agility exercises, and running

stretching and aquatic aerobic conditioning. Of importance, the functional movements were started in chest-deep water and progressed to waist-deep water. Stationary bicycling was not introduced until the fourth day of phase II.

Phase III

Phase III built upon the activities started in phase II but also introduced a number of ground-based movements. Band walking, ground-based dynamic warm-ups, and a variety of functional movement exercises were added. Functional movement exercises were performed, using the athlete's body weight and the Swiss ball, only if no muscle soreness occurred. The time spent on the stationary bicycle was gradually increased, as were resistance levels and maximum heart-rate goals.

Phase IV

Phase IV began with the initiation of resistance training at 20% to 25% of the estimated 1-repetition maximum weight, with each exercise being directly supervised by the strength and conditioning coach. Phase IV was also the first time the athlete was allowed to participate in agility training and complete 55-yd (49.5-m) runs. Under usual circumstances, the athletes complete the runs in a prespecified time period that is correlated with their position (7, 8, or 9 seconds). The untimed runs were to be run at a slower than usual pace, and the +1 runs were to be completed at a pace that was 1 second slower than the usual pace. Agility box drills were completed at 70% to 80% of the athlete's maximal effort.

Return to Play

Upon completion of phase IV, the athlete continued to increase strength and conditioning with lifting, agility work, speed development, and resistance training under the supervision of the strength and conditioning staff. Once the player returned to regular out-of-season training, he underwent another reintegration period to help prevent injury. In the first return session, the athlete completed one-half of the repetitions during drills, without attempting 7-on-7 drills. In the second session, he completed all repetitions during drills, again without attempting 7-on-7 drills. During the third session, he was allowed to return to full drills and completed a full week of strength and conditioning activities.

The final reintegration period occurred during spring practice, which began 9 weeks after the initial diagnosis of ER. Spring practices were scheduled for 145 minutes. The athlete was allowed to participate in only 51 minutes of the first practice and 95 minutes of the second practice; he was fully integrated into the third practice, with the exception of being allowed to perform only one-half of the contact repetitions. The athlete was fully integrated into all activities of the fourth practice. If at any time throughout the reintegration process, ER symptoms recurred, he was to be held out of participation until symptoms fully resolved and then was to repeat the same activity or practice that triggered the symptoms. None of our athletes developed recurrent symptoms during the reintegration process.

DISCUSSION

We would be negligent not to address the fact that ER is a preventable condition that should not occur in the absence of training errors. However, if an athlete does develop ER, the program laid forth in this report is intended as a tool that can help return him or her to sport. We have provided the specific training program our athletes completed under the supervision of athletic trainers, including recommendations for laboratory monitoring intervals.

Each athlete's return-to-play timeline will vary, depending on the maturation of the athlete, severity of the ER, previous fitness level, and training experience. Because of these

Table 2. Return-to-Play Training Program, Phase II: Aerobics

	Day				
Activity	1	2	3	4	5
Foam rolling	Upper and lower body	Upper and lower body	Upper and lower body	Upper and lower body	Upper and lower body
Dynamic warm-up, 5 min	Pool	Pool	Pool	Pool	Pool
Functional movements, ie, pool jog	10 min, chest-deep water	15 min, chest-deep water	15 min, waist-deep water	15 min, waist-deep water	15 min, waist-deep water
Stationary bicycle	Not introduced	Not introduced	Not introduced	10 min steady-state cycling at 70% maximum heart rate	15 min steady-state cycling at 70% maximum heart rate
Stretching	In-place cord	In-place cord	In-place cord	In-place cord	In-place cord

Table 3. **Return-to-Play Training Program, Phase III: Initial Resistance Training**

Activity	Day 1	Day 2	Day 3	Day 4	Day 5
Foam rolling	Upper and lower body	No activity	Upper and lower body	No activity	Upper and lower body
Muscle activation	Band walking Forward Backward Lateral In place Hip abduction	No activity	Band walking Forward Backward Lateral In place Hip abduction	No activity	Band walking Forward Backward Lateral In place Hip abduction
Dynamic warm-up, 5 min	Ground based	Ground based and stick	Ground based	Ground based and stick	Ground based
Functional movements	8 squats × 3 reps, 5 lunges × 2 reps, 8 Romanian dead lifts × 3 reps, 5 Swiss ball bridges × 2 reps, 5 Superman movements × 2 reps, 8 push-ups × 3 reps, 5 dips × 2 reps	No activity	8 single-legged squats × 3 reps, 5 lateral lunges × 2 reps, 8 Swiss ball hamstrings curls × 3 reps, 15-s lateral planks × 4 reps, 5 Russian twists × 2 reps, 3 push-up box walkovers × 3 reps, 8 inverted rows × 2 reps	No activity	10 step-ups × 3 reps, 5 lunges × 3 reps, 10 Romanian dead lifts × 3 reps, 6 Swiss ball bridges × 2 reps, 6 Swiss ball prayers × 2 reps, 8 Swiss ball push-ups × 3 reps, 5 dips × 3 reps, 8 ladder movements
Stationary bicycle (% maximum heart rate)	20 min, steady-state cycling (80%)	15 min, hill intervals (80%)	15 min, steady-state cycling (70%)	20 min, hill intervals (80%)	20 min, steady-state cycling (80%)
Stretching	In-place cord	In-place cord	In-place cord	In-place cord	In-place cord

Abbreviation: reps, repetitions.

factors, it is not feasible to recommend a one-size-fits-all return-to-play program; however, what we have laid forth follows general periodization principles shown to be effective in our 10 athletes. The return-to-play progression must take into account the mode of exercise, intensity, volume, and frequency of training. The protocol should start with low-impact, aerobic activities that involve primarily concentric contractions and advance toward higher-impact, anaerobic, resistance, and eccentric exercises. Aquatic environments minimize the effects of gravity and, thus, encourage concentric-concentric contractions rather than potentially harmful concentric-eccentric movements.[5]

The immediate complications and long-term sequelae associated with ER have the potential to be life threatening.

Table 4. **Return-to-Play Training Program, Phase IV: Increase Resistance Training and Begin Running**

Activity	Day 1	Day 2	Day 3	Day 4	Day 5
Foam rolling	Upper and lower body	Upper and lower body	Upper and lower body	Upper and lower body	Upper and lower body
Muscle activation	Band walking Forward Backward Lateral In place Hip abduction	No activity	Band walking Forward Backward Lateral In place Hip abduction	No activity	Band walking Forward Backward Lateral In place Hip abduction
5-min dynamic warm-up	Ground based	Ground based and stick	Ground based	Ground based and stick	Ground based
Functional movements	Lift 20%–25% of 1-RM 8 ladder movements Agility box	No activity	Lift 20%–25% of 1-RM 8 ladder movements Agility box	No activity	Lift 20%–25% of 1-RM 8 ladder movements Agility box
Running	2 untimed 55-yd (49.5-m) runs 8 +1 55-yd (49.5-m) runs	No activity	2 untimed 55-yd (49.5-m) runs 10 +1 55-yd (49.5-m) runs	No activity	2 untimed 55-yd (49.5-m) runs 10 regular-time 55-yd (49.5-m) runs

Abbreviation: 1-RM, 1-repetition maximum.

None of the athletes involved in this cluster required hemodialysis, and all had serum creatinine values that were less than 1.2 mg/dL at the start of the reintegration period. Additionally, no players were readmitted to the hospital for similar symptoms during reintegration, and all athletes' creatine kinase levels remained below 1000 U/L. The laboratory values for each athlete in this cluster analysis can be found in the original report.[6]

Although we believe the program used for our athletes was successful because all athletes safely returned to play without recurrent symptoms, we must stress the importance of modifying the regimen based on each athlete's response to reintegration. The cluster of rhabdomyolysis cases occurred in the off-season workout period, allowing the reintegration to take place away from the pressures of the competitive season. However, we speculate that an athlete's return could be expedited if necessary: for example, recommending activities of daily living for 1 week rather than 2 weeks. Further, this return-to-play program used a 5-day training week, whereas a 6- or 7-day training week could be feasible and could decrease the reintegration time.

CONCLUSIONS

We provided a specific return-to-play program that successfully returned 10 Division I football athletes to play within 9 weeks of experiencing ER and without recurrence of symptoms. Although the process of reintegrating each athlete will differ based on his or her unique circumstances, this program provides a safe and effective foundation that can be modified based on the response to activity and sport. Our goal in sharing this program was to educate the sports medicine community about safe return to play and to raise the awareness of ER. We advocate for safe and effective training programs that protect athletes from the complications of ER. Further study is necessary to help guide return-to-play decisions for athletes with ER.

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