Exercise Rhabdomyolysis

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Introduction: Exercise Rhabdomyolysis, Discovery and Occurrence

With an incidence of approximately 29.9 per 100,000 patients (1), exercise rhabdomyolysis (ER) can pose a large threat to those diagnosed with side effects of dark, reddish urine, decreased urine, extreme fatigue. As well as this severe skeletal muscle damage can lead to potentially fatal results as the proteins from the breakdown of skeletal muscle enter the blood stream, and lead to effects as severe as kidney failure. The first depiction of rhabdomyolysis (meaning damage to skeletal muscle) in a medical setting dates back to early 1900's German medical literature, in which it was referred to as Meyer-Betz disease. Symptoms of myalgia, weakness, and myoglobinuria all contributed to this muscle breakdown being noticed, as well as the noticeable dark pigmented urine. (2). Later in 1940, it was identified and called "crush syndrome" as it was seen in patients whose limbs were crushed but died due to renal failure in the following several days. (3). While typically occurring due to traumatic injury, this condition can also arise as an effect of toxins, genetic disorders, myalgia and strenuous exercise. With these effects typically widely ranging in both origin and severity, this research review will incorporate the cause of exercise rhabdomyolysis and discuss exercise intervention which can in turn help individuals diagnosed recover, as well as prevent ER in future subjects. While there are no current evidence-based guidelines for post-ER return to sport; monitoring levels of circulating creatine kinase (CK) and physical presentation paired with intravenous fluid and therapeutic intervention are used by clinicians to determine a gradual safe return for a diagnosed patient.

"Too Much of a Good Thing is a Bad Thing:" Etiology of Exercise Rhabdomyolysis

With a wide variety of causes for rhabdomyolysis, the most common recorded tend to be drug/alcohol abuse, medicinal drug use, trauma, neuroleptic malignant syndrome, exercise exertion, and more. (2) With any of these situations, intracellular muscle components such as myoglobin, creatine kinase (CK), aldolase, lactate dehydrogenase, and electrolytes can be released into the bloodstream and extracellular space. (2). In the case of exercise rhabdomyolysis, the continuous exertion will raise the levels of CK in the blood, thus

exacerbating the effect of rhabdomyolysis. (3). The effects of this increased rhabdomyolysis can be both mild and unnoticed, however in severe cases can lead to fatal results

Topic #2: Pathophysiological Changes of Exercise Rhabdomyolysis

While the cause of different cases of rhabdomyolysis is typically known, there comes confusion when determining which pathways, the issues derive from. As it nears the end of its course, the final steps leading to rhabdomyolysis typically involve direct myocyte injury, or a failing energy supply within the muscle cells. (2). In the case of failing energy systems, the lack of sufficient ATP will not allow the muscle cells to contract through actin-myosin cross-linking, (2). This will cause a disruption in the intracellular electrolyte levels. As the decrease of ATP and injury to the muscle occurs, there appears to be an increase in the influx of Na^+ and Ca^{2+}, which draws water into the cell, hinders the structure of the cell. Additionally, this process causes a prolonged contraction which will deplete ATP and cause damage to other ion channels. All of these changes lead to the breakdown of muscle fibers, and the release of their contents into the blood stream. (2). This condition and final pathway can range in severity, as in some cases the contents of the skeletal muscle cells cannot inhibit or the effect the body, but in others it may seriously damage the kidneys and lead to renal failure. The most common testing tool to diagnose is elevated CK levels at 5 times the upper limit of normal., paired with symptoms of pain, tenderness, weakness, and swelling. (1)

Topic #3: Resistance vs. Endurance Exercise in the World of Exercise Rhabdomyolysis

Exercise Rhabdomyolysis is can occur in athletes who dramatically increase their training, shift muscle groups, or use motions and lifting techniques they are otherwise unfamiliar with. In untrained individuals this can occur during the beginning of a program and is seen in cases in which the trainer/program pushes overexertion. (3). In muscular contractions there is a strong link in movements in which a muscle is lengthening as it is attempting to contract, also referred to as the eccentric phase. These lengthening contractions will damage the muscle proteins and release them into the circulation, thus leading ot the irritation of ER symptoms. (4). In endurance exercise programs, cases of ER typically do not result in serious issues. While possible, the cases of ER typically are due to other factors such as dehydration/hyper hydration, and or hyponatremia (5). The result can still be renal failure; however, it may not be a direct link to an large increase in muscle proteins in the blood stream. Both training programs can lead to renal failure, and cases of ER, however it is typically seen in resistance training programs as the

breakdown of muscle proteins enter the blood stream and will begin to cause issues for the subject.

Topic #4: Treatment and Recovery from exercise rhabdomyolysis

Under the notion that mild case of ER occurs, it is typically unnoticed, and its effects can be managed by hydration and rest of the athlete and may be passed off as muscle soreness & fatigue from exertion. However, if the appearance of dark red and decreased volume of urine appears, the athlete should seek medical testing. In the case of severe symptoms, and testing of elevated CK levels, the athlete is recommended to be hospitalized and administered intravenous hydration (IV). Once under care, CK levels, and kidney function will continuously be monitored to determine the severity or the prognosis. In severe cases, it is easier to monitor and intervene the symptoms in an inpatient setting. If CK levels continue to increase 48-72 hours after the injury occurs, a nephrologist or surgeon should be seen depending on the outlook of the patient, (1). As levels decrease towards normal, patient can be moved to an outpatient setting, however will need to still be monitored at the risk of symptoms worsening and causing renal failure. (6)

Topic #5: Return to exercise/exercise prescriptions for those who have been diagnosed with exercise rhabdomyolysis

As stated previously, there are no current evidence-based guidelines for returning to sports after ER. Being that severity of the episode can range drastically, it is important to monitor symptoms, and if an athlete is "high-risk" have them tested for myopathic disorders. (7) This testing may take place in the form of modalities ranging from electromyograms to muscle biopsies and will give the testing clinician a better idea of if, when, and how the athlete will be able to return to sport. If the diagnosis is deemed "low-risk" for the athlete, a return to sport is very accessible with the lack of symptoms, hydration, normal CK levels, lack of muscle pain, and no myoglobin presented in serum or urine of the subject, (8). The ability to return to sport is possible and attainable for those who experience less severe cases of ER, however these athletes must be monitored extremely closely, and the situations and sports available for them to play may change depending on clinician's evaluation.

Article Conclusion

Rhabdomyolysis is a condition with a wide variety of causes and prognoses, in which the skeletal muscle cell components such as myoglobin, creatine kinase (CK), aldolase, lactate dehydrogenase, and electrolytes are broken down and released into the blood stream. This

pathway causes effects of weakness, myalgia, and renal failure in serious cases leading to the death of some patients unless intervened. Within exertion from exercise, more commonly seen in resistance training, this physical stress can irritate the components responsible for this process through physical trauma on the musculoskeletal system. Through the testing of CK levels in the blood, clinicians can diagnose this issue, and must intervene depending on the severity with intravenous fluids, monitored rest, and physical therapy. While currently there are no evidence-based guidelines for returning to sport for those diagnosed with ER, possible recovery is possible in cases where the issue is caught early and remains at a low level of severity. It is crucially important to consistently monitor any signs and symptoms to not further stress the already degrading skeletal muscle cells, and if issues arise in an athlete, the testing of CK levels, and urine concentration may be necessary to determine a diagnosis.

4 Elements

Apply It

- The exercise professional will expect to learn the causes of Exercise Rhabdomyolysis (ER) and recognize the early signs and symptoms to be aware of.
- This article will provide critical information to help fitness professionals prevent exercise induced rhabdomyolysis, such as a gradual training program that provides recovery time, preserving fluid balance, and avoiding extreme
  eccentric exercise and exercise in high heat load
- With return to sport protocol being limited to none, the exercise professional will be informed of different techniques ranging from monitored bed rest, to simple hydration interventions paired with physical therapy and training program adaptions in order to allow safe return to play

Bridging the Gap

ER is a exertion induced variant of the condition known as Rhabdomyolysis. This condition breaks down the skeletal muscle cells, and leaks their contents into the blood stream, thus hindering kidney function at its highest severity. While extremely rare, it can still occur in populations of athletes, and must be monitored to prevent worsening cases.

Summary Statement

While extremely rare, ER can break down skeletal muscle cell components in those who engage in high exertion routines. This pathway can lead to muscle soreness, physical issues, as well as

kidney failure in serious cases. Testing for ER relies in the CK levels being 5 times the normal limit, and treatment must be started immediately if this condition is diagnosed. While return to play protocol is still being researched, suggestions rely in plenty of monitored rest, IV fluid intake, and physical therapy.

Pulled Text

With an incidence of approximately 29.9 per 100,000 patients (1), exercise rhabdomyolysis (ER) can pose a large threat to those diagnosed with the condition, as severe skeletal muscle damage can lead to potentially fatal results as the proteins from the breakdown of skeletal muscle enter the blood stream, and lead to effects as severe as kidney failure

BIO:

Maxwell Walker is currently pursuing his bachelors in Exercise Science at the University of New Mexico. From there he will continue on to the CU Denver Anschutz medical campus and pursue a master's degree in modern human anatomy. His interests include education, phycological changes, as well as the effects of disease and injury on the body.

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