CLINICAL VIGNETTE

Severe Exertional Rhabdomyolysis without Acute Kidney Injury

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Case Presentation

A 19-year-old male with no past medical history presented to the emergency room with severe arm pain. Two days earlier, he had done an intensive arm workout for the first time, performing bicep curls and back exercises for one and a half hours. He had never worked out before that. Over the next two days, he developed severe bilateral arm pain mainly in his biceps and had difficulty fulling extending his shoulders. He denied pain anywhere else. He had no recent viral symptoms, no darkening of his urine, no history of thyroid disease. He denied alcohol or illicit drug use. His only medication was melatonin and had no statin use. He presented to urgent care where a creatine kinase (CK) resulted at 152,490 U/L, and he was told to go to the emergent room for further evaluation.

The patient's initial vitals were temperature of 36.9°C, heart rate of 89 beats per minute, blood pressure of 154/88 mmHg, respiratory rate of 17, and oxygen saturation of 99% on room air. Physical exam was notable for mild tenderness over his bilateral shoulders and biceps without any edema or erythema. He had normal strength in his bilateral upper extremities and his exam was otherwise normal. Laboratories included a normal basic metabolic panel (BMP) including normal creatinine (Cr) 0.84 mg/dL and normal complete blood count. The aspartate aminotransferase (AST) and alanine aminotransferase (ALT) were elevated at 1691 U/L (normal range 13-62 U/L) and 382 U/L (normal range 8-70 U/L), respectively. CK was markedly elevated at 759,350 U/L (normal range 63-473 U/L). Thyroid stimulating hormone (TSH) was 3.9 mcIU/mL. Acute hepatitis panel was negative. Urinalysis showed light-yellow urine, specific gravity 1.018, pH 6.0, 3+ blood, trace protein, 2 RBC per HPF and 1 WBC per HPF. Urine drug screen was negative. Electrocardiogram (ECG) showed normal sinus rhythm without any ST changes.

The patient was diagnosed with exertional rhabdomyolysis. His transaminitis was thought to be secondary to rhabdomyolysis. He was admitted to the hospitalist service and started on IV fluids initially, 2 liters of lactated Ringer's solution (LR) followed by a maintenance infusion at 250 mL/hour. He was also given 1 liter of sodium bicarbonate. The CK level was monitored closely and decreased to 108,475 U/L on the next day. Given high risk of kidney injury, his Cr was monitored every 8 hours and remained stable. On hospital day 2, his CK decreased to 44,400 U/L, AST decreased to 759 U/L, ALT decreased to 295 U/L, and Cr was 0.80 mg/dL. His arm pain improved and he did not show any signs of compartment syndrome. He was able to drink at least 2 liters of fluids a day and was discharged with close follow-up. Four days after discharge, he was asymptomatic and CK decreased to 2,760 U/L, AST 100 U/L, ALT 159 U/L, and Cr 0.91 mg/dL.

Discussion

Exertional rhabdomyolysis is characterized by extreme physical activity that causes skeletal muscle damage leading to the release of intracellular toxins into the systemic circulation. Adenosine triphosphate (ATP) is depleted during prolonged heavy exercise, leading to calcium channels shutting down which increases levels of intracellular calcium. This activates protease and phospholipase A2, which break down intracellular structures leading to cell death.[1,2] The classic clinical triad of rhabdomyolysis consists of myalgia, weakness, and myoglobinuria (tea-colored urine). The hallmark laboratory finding is an elevated CK value >1,000 U/L (a 5-fold increase above normal physiologic levels). Aminotransferases are also present in skeletal muscle and are released in rhabdomyolysis. Elevated AST levels are observed in 95% of rhabdomyolysis cases and elevated ALT in 73% of cases.[3]

This patient's CK level of 759,350 U/L is one of the highest reported CK levels. Most exertional rhabdomyolysis literature consists of case reports, with the highest reported CK level of 1,454,952 U/L.[4] Various activities have been identified as precipitating causes, including marathons and rigorous gym-based workouts. Risk factors causing the high CK level in this case include exercise done by an untrained person, male sex, eccentric muscle lengthening (such as bicep curls), and prolonged exercise time. Other predisposing factors for exertional rhabdomyolysis include extreme heat, high altitude, statin use, genetic metabolic disorders such as McArdle's disease, and sickle cell trait.[5] The incidence of exertional rhabdomyolysis may be increasing, with the promotion of intensive workout regimens on social media as a possible culprit.[6]

AKI is one of the most common and serious complications of rhabdomyolysis but did not occur in our patient despite his extremely high CK level. The incidence of acute renal failure in patients with exercise-induced rhabdomyolysis is reported between 10-30%.[7] The primary cause is the release of muscle's intracellular contents, mostly myoglobin, which is freely filtrated through the glomerular basement membrane and accumulated into tubules, leading to acute kidney injury. Studies have

only shown a significant trend of increasing AKI with increasing CK levels in rhabdomyolysis secondary to prolonged surgery, trauma, and vascular occlusions.[8] Patients with exertional rhabdomyolysis have a low incidence of AKI despite having higher elevations of CK than those who develop rhabdomyolysis from other etiologies.[9] Other protective factors for this patient include young age, no substance use, and adequate oral hydration.

The treatment of rhabdomyolysis is directed at preventing AKI. A high rate of isotonic intravenous (IV) fluids are given with a urine output goal of 200-300 cc/hr. IV fluids relieve the obstruction of myoglobin casts by improving blood flow and glomerular filtration rate to prevent AKI. Sodium bicarbonate is frequently given to alkalinize the urine and counteract heme pigment precipitation to prevent AKI, though evidence is limited that this provides clinical benefit.[10] Dialysis can be used after AKI develops, although there is no evidence that it improves the clinical course or prevents AKI.[11] The CK levels in this patient decreased rapidly with IV fluids, and he was discharged with CK level of 44,400 U/L. There are no clear guidelines, but experts have proposed safe discharge at CK thresholds of 20,000 to 50,000 U/L.[12] Four days after discharge, his CK level decreased to 2,760 U/L without AKI.

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