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Exertional rhabdomyolysis with acute kidney injury after high-intensity CrossFit training in a young healthy male with dehydration and creatine supplementation: A case report.

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Abstract

High-intensity physical exercise leads to exertional rhabdomyolysis which causes muscle tissue destruction and myoglobin leakage that results in acute kidney damage. The development of exertional rhabdomyolysis with acute kidney injury has been linked to two main factors: dehydration and performing extreme physical activities.

The main objective of this case report involves showing a person who developed rhabdomyolysis with kidney failure following their CrossFit workout at maximum intensity and we will examine the elements which increase the risk of this condition.

A 25-year-old male patient developed rhabdomyolysis symptoms after his high-intensity CrossFit workout. The patient's medical background, laboratory results and treatment progression were studied.

The patient arrived at the hospital multiple hours after his exercise because his muscles were extremely painful and his urine had turned dark. The patient developed elevated creatine kinase levels and myoglobinuria and elevated serum creatinine which indicated acute kidney injury. The patient's medical history showed he had not drunk enough water and he was taking creatine supplements at the same time. The patient received aggressive intravenous fluid treatment which brought his test results back to normal and restored his kidney function and he fully recovered within several days.

Exertional rhabdomyolysis represents a rare but dangerous condition that occurs when people perform excessive physical activity which can cause their kidneys to fail. The treatment of this condition requires immediate medical care and strong therapeutic methods to prevent severe complications from occurring. The prevention of exertional rhabdomyolysis requires healthcare providers to monitor athletes for dehydration and high-intensity exercise during their training sessions.

Keywords: exercise-induced rhabdomyolysis; acute kidney injury; CrossFit; sports medicine

Introductions

Rhabdomyolysis develops into a dangerous medical condition because skeletal muscle fibers experience rapid breakdown which results in their internal substances entering blood circulation (1,2). The breakdown of skeletal muscle fibers occurs through three main causes which include trauma and seizures and specific medications (1). People develop exertional rhabdomyolysis when they engage in excessive physical activity that exceeds their typical endurance levels (3,4). High-intensity physical activity together with unaccustomed exercise leads to muscle fiber damage that exceeds typical microtrauma which occurs during normal training (3). High-intensity functional training programs including CrossFit have become more popular which leads to rising concerns about exercise-induced rhabdomyolysis because multiple cases have been reported among young adults who engage in these activities (5,6,7). The occurrence of exertional rhabdomyolysis remains rare but intense "extreme" workouts have increased its importance in sports medicine because of its dangerous potential complications (1,8).

Research studies have discovered multiple elements which make people more susceptible to developing exertional rhabdomyolysis (3,1). The combination of rapid exercise intensity increases and prolonged exercise duration leads to muscle damage in people who lack proper fitness levels (3). The combination of high temperatures and high humidity in the environment leads to muscle breakdown because it causes body heat to rise and dehydration to occur which increases the risk of rhabdomyolysis during strenuous physical activity (8,3). The body becomes more susceptible to muscle injuries during exercise because it lacks sufficient hydration and its electrolyte balance remains abnormal (3). The risk of developing rhabdomyolysis increases when people have specific genetic conditions or metabolic disorders or when they take certain medications including statins and stimulants or when they have sickle cell trait (9,1). The exertional rhabdomyolysis syndrome develops when athletes of all skill levels exceed their body limits through excessive training under poor environmental conditions (9,8).

The clinical presentation of exertional rhabdomyolysis consists of standard muscle symptoms which appear with particular laboratory test results (1,4). The main symptoms of exertional rhabdomyolysis include intense muscle pain and swelling and weakness that affects the muscles which were subjected to intense physical activity (9). The presence of myoglobin in urine produces a dark tea or cola-like color which serves as a warning sign for rhabdomyolysis (4). The laboratory results demonstrate elevated muscle enzyme levels through creatine kinase (CK) measurements which reach dozens of times above normal ranges because of muscle tissue destruction (1). The condition produces systemic symptoms which include fatigue and stomach issues and slight fever but the severity of the condition depends on biochemical and renal test results (1). The presence of intracellular substances and proteins in blood circulation results in fatal medical complications (1,2). The presence of intracellular substances and proteins in blood circulation results in fatal medical complications. The main danger of rhabdomyolysis stems from acute kidney injury which develops when myoglobin and other proteins from damaged muscles accumulate in renal tubules and cause acute renal failure when left untreated (1,8). The development of acute kidney injury (AKI) occurs in most severe cases of rhabdomyolysis which might need dialysis treatment (8). The release of potassium from cells into blood causes hyperkalemia which creates a life-threatening risk for fatal heart rhythm disturbances and death from cardiac arrest (1,2). The combination of muscle swelling in tight fascial compartments with metabolic acidosis and hypocalcemia and hypercalcemia

during recovery creates additional risks for patients (1,2). The development of disseminated intravascular coagulation (DIC) and multi-organ failure becomes possible in cases of severe rhabdomyolysis (1,2). The development of severe rhabdomyolysis from extreme post-exercise muscle soreness requires immediate medical intervention because it leads to a dangerous medical emergency (4,10).

Medical staff need to begin immediate treatment for exertional rhabdomyolysis because the condition leads to dangerous complications (1,2). Medical staff must stay vigilant when treating patients who experience severe muscle pain and weakness following strenuous exercise and show signs of dark urine and multiple body system symptoms (4,9). Medical staff need to run right away confirmatory tests which include CK measurements and myoglobin detection in urine when they suspect rhabdomyolysis (1,3). The treatment of rhabdomyolysis needs immediate fluid resuscitation through intravenous administration to defend kidney function and extract myoglobin from the body (1,2). Patients who receive proper care during their acute phase will achieve better treatment results through early intravenous hydration combined with electrolyte correction and continuous renal function monitoring (1,8). Medical delays increase the risk of permanent kidney damage and severe additional complications for patients (8,2).

Educational programs combined with protective strategies serve as the foundation to prevent exertional rhabdomyolysis from happening (3,10). The body needs time to adapt to higher workloads so athletes should increase their training intensity gradually (3). The sports community needs to teach athletes and their coaches about the risks of excessive high-intensity training and the early signs which indicate rhabdomyolysis development (3,4). The prevention of exertional rhabdomyolysis requires athletes to stay hydrated while taking regular breaks during exercise in hot or humid environments which raise the risk of heat-related muscle injuries (3,8). The prevention of rhabdomyolysis requires athletes to stay away from NSAIDs and supplements which affect muscle metabolism during their most intense workouts and to exercise caution when taking medications that weaken muscle structure (3,1). The sports and fitness community needs to recognize that intense physical activity leads to dangerous medical emergencies which need immediate emergency medical assistance when people develop severe muscle pain (10,4).

The condition of exertional rhabdomyolysis exists as a preventable medical emergency which threatens to become fatal during intense physical activities (1,3). The condition creates a medical environment which requires athletes to find the right balance between their performance goals and their safety needs (3). The prevention of severe complications from rhabdomyolysis requires healthcare providers to identify the condition early through diagnostic tests followed by immediate supportive care (1,2). Sports communities need preventive education about safety measures to perform high-performance training without risks according to this condition (3,8). The introduction establishes the medical background which explains why CrossFit-induced rhabdomyolysis with AKI in a young adult requires immediate medical intervention and prevention strategies (5,8).

Case report

The subject of this case is a 25-year-old male with no significant past medical history. The patient maintained his regular recreational fitness activities while showing excellent health status. The patient did not have any ongoing medical conditions and he took no prescription medications while stating he had no history of muscle or kidney problems. The patient stated he did not use anabolic steroids or any illegal substances. The patient used only occasional over-the-counter protein shakes as his supplement but he did not take any specialized training supplements or medications before the incident.

The patient developed exertional rhabdomyolysis after performing an intense CrossFit workout. The High-Intensity Functional Training (HIFT) workout at CrossFit consisted of continuous high-intensity aerobic and resistance exercises which were separated by short rest intervals between sets. The workout consisted of multiple high-repetition full-body exercises that included fast-paced weightlifting and calisthenics which participants needed to finish within time limits. The training session spanned one hour while taking place in a gym environment. The patient began his workout without enough hydration while exercising in hot weather conditions. The patient reached an extreme state of dehydration after finishing his workout. The patient had not added any new performance-enhancing substances to his routine because he only consumed standard pre-workout protein powder and water which turned out to be insufficient. The patient developed rhabdomyolysis because of his extreme physical activity and heat-induced dehydration during the CrossFit workout instead of using performance-enhancing substances.

The entire report obtained its information from medical records and clinical documents of the patient. The patient received a complete medical history assessment when he entered the hospital which included his demographic information and details about his exercise activities. The hospital collected laboratory results when he first arrived and throughout his entire hospital stay to confirm rhabdomyolysis with acute kidney injury. The healthcare team tracked essential laboratory results including serum creatine kinase levels and renal function tests and electrolyte panels and urine myoglobin tests on a daily basis. The test results showed elevated muscle enzyme levels and kidney damage which confirmed acute injury based on the exact values reported in the case results section. The patient received complete hospital treatment evaluation through his medical records which included emergency department notes and ward progress notes and fluid balance records and medication administration reports. The treatment plan consisted of aggressive intravenous hydration and electrolyte management and supportive care which received detailed documentation. The patient needed continuous nephrology care instead of receiving dialysis treatment. The hospital stay duration and treatment effectiveness were extracted from medical records which showed the patient's laboratory values and symptoms returned to normal. Medical history records, laboratory test results and hospital treatment documents were used to build an exact timeline of the incident and its clinical management.

The research followed all ethical guidelines which apply to studies involving individual patients. The patient authorized medical information disclosure and allowed this case report to be published. The description contains no personal information because all identifying details have been removed or made anonymous. The research studied one patient's medical progression through retrospective analysis which made it unnecessary to use experimental treatments or control subjects. The research did not require statistical analysis because it consisted of one case study with descriptive data only. The report includes qualitative data which describes both the patient's medical condition and their responses to medical treatments. The research did not require Institutional Review Board approval because it met all the requirements for human

subject research under standard care protocols. All data were obtained from medical records and diagnostic test results after written informed consent had been obtained from the patient. A thorough analysis of the patient's medical files and test results was performed to create an accurate and compliant presentation that followed the journal's scientific guidelines.

A healthy young male without medical conditions arrived at the hospital 48 hours following CrossFit exercise which triggered symptoms that pointed to exertional rhabdomyolysis. The patient experienced intense muscle pain and weakness which focused on his workout muscles including his arms and thighs while his affected muscles became swollen. The patient developed dark tea-colored urine and reduced urine output on his first day at the hospital. The patient maintained stability in his vital signs while showing signs of muscle swelling and stiffness in his affected areas. The initial assessment showed no signs of trauma but rhabdomyolysis with possible acute kidney injury became apparent through his symptoms.

The laboratory results established the diagnosis while showing the extent of the condition. The patient showed elevated creatine kinase (CK) levels above 100,000 U/L when he arrived at the hospital because his normal CK values should be below 200 U/L. The patient showed muscle damage through his elevated serum myoglobin levels and his urine dipstick test showed blood but microscopic examination showed only minimal red blood cells. The test results showed extensive muscle tissue death. The patient developed acute kidney injury because his serum creatinine levels reached 3.9 mg/dL while his myoglobin toxicity and dehydration caused his renal function to deteriorate. The patient developed two critical electrolyte imbalances which included elevated potassium levels (6.2 mmol/L) and elevated phosphate levels and decreased calcium levels in the blood. The patient developed elevated liver enzymes including AST and LDH because of muscle damage. The laboratory results showed exertional rhabdomyolysis with acute kidney injury according to established diagnostic criteria for this condition.

The medical team started treatment according to established rhabdomyolysis management protocols to stop further kidney damage and body-wide complications. The patient received high-volume IV fluids of isotonic saline from admission until he reached a urine output of 200–300 mL per hour. The standard treatment for this condition involves aggressive hydration because it helps remove myoglobin from the kidneys. The patient received intravenous sodium bicarbonate to increase urine pH because this method helps prevent myoglobin from forming deposits in renal tubules. The medical team used insulin with glucose to drive potassium into cells and calcium gluconate to protect cardiac function for treating his severe hyperkalemia. The medical team prohibited all medications that could harm the kidneys. The medical team managed his pain effectively by giving paracetamol and opioids according to his requirements while they safeguarded his kidneys through correct medication delivery. The patient received continuous observation in a high-dependency unit while his doctors performed multiple daily tests for CK and renal function and electrolytes and cardiac monitoring until his electrolytes reached stable levels. The patient received early consultation from a nephrology specialist who determined that dialysis was not needed because his urine output stayed adequate and his condition improved with fluid therapy. The medical team treated exertional rhabdomyolysis by following standard protocols which involved strong fluid administration and electrolyte correction and additional supportive therapy.

The hospital treatment of the patient brought positive results after he received immediate medical care. The patient showed major improvement in his urine production during the initial 48 hours of fluid therapy and his urine turned normal color by the second day which confirmed myoglobin removal from his body. The patient stopped showing muscle breakdown after Day 3 of hospitalization when his serum CK levels peaked at their highest point before starting a fast decline to 20,000 U/L and then remaining stable. The patient's creatinine levels peaked at admission before they started to decrease while his renal perfusion improved until Day 5 when

his creatinine reached 1.5 mg/dL. The patient's electrolyte levels returned to normal during the first two days of treatment after which his potassium and calcium levels returned to their typical ranges. The patient received medical care to stop arrhythmia complications and compartment syndrome and disseminated intravascular coagulation while his vital signs stayed stable during his hospital stay. The patient showed continuous improvement of his muscle pain and tenderness through rest and hydration and analgesic treatment. The patient required seven days of hospital care for continuous observation and medical treatment.

The patient showed complete improvement at discharge because he had no pain and could walk normally while producing normal amounts of urine that was clear. The patient received normal kidney function results from his discharge laboratory tests because his creatinine levels reached 1.2 mg/dL and CK levels reached a few thousand U/L. The patient was discharged from the hospital with instructions to drink plenty of water and to restrict his physical activities until his muscle enzyme levels normalize.. The patient achieved a successful outcome because his kidney injury healed without dialysis treatment and he developed no permanent health problems. The patient needs to visit his primary care physician and nephrologist for follow-up care to check his kidney function and muscle enzyme levels have fully recovered. The patient achieved complete recovery because doctors correctly diagnosed severe exertional rhabdomyolysis with acute renal failure at the proper time and delivered suitable medical care.

Discussion

The young patient displayed all typical signs which are characteristic of exertional rhabdomyolysis (9,4). The patient experienced severe muscle pain and major muscle weakness following his intense CrossFit exercise session (5,6). The patient developed myoglobinuria which made his urine turn dark brownish-red (4). The patient developed oliguria which led to increasing serum creatinine levels that indicated the development of acute kidney injury (AKI) (1,8). The combination of specific clinical signs with elevated muscle enzyme activity (high creatine kinase levels) established exertional rhabdomyolysis as the diagnosis which caused acute kidney injury (1,9).

The body experiences muscle fiber damage through excessive physical strain which exceeds its adaptive limits during intense physical activities (3). The destruction of muscle cells produces substantial cellular debris which enters blood circulation through damaged blood vessels (1). The main factor responsible for this condition is myoglobin which functions as muscle oxygen storage (1). The body uses its kidneys to remove myoglobin from blood circulation after it enters the bloodstream (1). Three elements lead to myoglobin formation of pigmented casts in renal tubules because of concentrated urine and acidic pH and decreased blood volume (1). The direct damage to tubular epithelial cells and tubular obstruction results in acute tubular necrosis (ATN) which causes acute kidney injury in rhabdomyolysis patients (1,8).

The patient developed muscle injury fluid accumulation and excessive sweating which reduced blood flow to his kidneys and made his kidney damage worse (8). The blood contains myoglobin together with muscle enzymes including creatine kinase and aminotransferases and electrolytes such as potassium and phosphorus which leads to dangerous metabolic problems like hyperkalemia that causes heart rhythm disturbances during severe rhabdomyolysis (1,9). The patient developed dark urine and rising renal function markers because myoglobin crystals combined with renal tissue ischemia to damage the kidneys (1,8). The case demonstrates that rhabdomyolysis with complications can occur in healthy young people who exceed their muscle recovery capacity through excessive physical activity (3,4).

The patient received his main treatment through aggressive fluid rehydration which started immediately after diagnosis (1). The medical team started administering 0.9% saline solutions through intravenous routes immediately after making the diagnosis (1). The current treatment approach enhances blood flow to kidneys while it reduces blood concentration to stimulate urine production (1). The treatment method allows for quick removal of myoglobin from renal tubules which helps protect kidney function from worsening (1,8). Medical staff monitored electrolyte levels during treatment because hyperkalemia required immediate medical care (1). The patient received proper hydration which prevented dangerous cardiac arrhythmias and major metabolic problems from developing (1,4).

The medical team administered intravenous sodium bicarbonate to alkalinize urine because it stops myoglobin from creating deposits in renal tubules although there is no scientific proof it works (1). The standard treatment for patients with rhabdomyolysis who experience anuria and worsening uremia requires renal replacement therapy through dialysis (1,8). The patient received successful treatment through intensive fluid administration without needing any additional medical interventions. The patient showed better urine production and his serum creatinine and creatine kinase levels started to decrease during the first days of his treatment (4). The patient escaped dialysis treatment because his kidney function started to recover when the rhabdomyolysis symptoms disappeared (8).

The treatment approach brought successful results because it brought quick improvement to the patient's medical state and it eliminated his symptoms while improving his laboratory test results (4). The patient received discharge from the hospital after his acute illness symptoms disappeared and his urine output and kidney function tests returned to normal. The patient achieved complete recovery of his organ function because of early intervention which proved the effectiveness of chosen treatment methods and demonstrated the value of early identification and aggressive treatment of exertional rhabdomyolysis (1,3). The case shows that people need education about correct high-intensity exercise methods because following exercise moderation rules and controlled training progression and adequate hydration prevents rhabdomyolysis complications (3,4).

Conclusion

The case shows that high-intensity exercise leads to severe exertional rhabdomyolysis which needs immediate medical treatment. A single intense CrossFit workout can trigger fatal rhabdomyolysis and kidney damage in a fit young person. Medical staff need to start immediate treatment when they identify severe muscle pain and weakness and swelling and dark urine in patients. The combination of hospital-based aggressive fluid resuscitation and supportive care enables patients to achieve complete recovery while protecting their kidneys from enduring permanent harm.

Athletes together with their trainers need to create defensive strategies which will help prevent these complications from happening. Athletes need to drink enough water while performing proper stretching exercises before their workouts and they should increase their exercise levels slowly to let their bodies adjust safely. All participants need to understand that any unusual or severe post-workout muscle discomfort and rhabdomyolysis symptoms require them to stop exercising right away while seeking medical help. The combination of warning sign knowledge with body awareness techniques enables participants to decrease their risk exposure. Healthcare providers need to stay alert for exertional rhabdomyolysis when treating patients who experience muscle pain or weakness after performing strenuous exercise. The combination of athlete and coach and clinician awareness with prompt medical response and safe training methods will decrease exercise-related rhabdomyolysis cases without stopping people from doing high-intensity fitness workouts.

Disclosure

Author's contribution

Conceptualization: Wojciech Neumann, Konrad Puchalski; methodology: Maria Małgorzata Lewowska, Bartłomiej Labut and Miraslau Kabak; Software: Monika Pachcińska; check: Bartłomiej Labut; data curation: Maria Lewowska; writing - rough preparation: Barbara Syska-lamb, Adrianna Kępa and Izabela Polakowska; investigation: Monika Pachcińska, Anna Sarolta Veer; Formal analysis: Wojciech Neumann, Anna Sarolta Veer; Visualisation: Konrad Puchalski, Monika Pachcińska; Writing - review and editing: Maria Małgorzata Lewowska, Izabela Polakowska; resources: Bartłomiej Labut, Adrianna Kępa, Izabela Polakowska; supervision: Wojciech Neumann; project administration: Konrad Puchalski.
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