CASE REPORT

Rhabdomyolysis after Prolonged Suspension in a Cave

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A 29-year-old man was caving and could not ascend his rope. He was rescued after 4+ hours of hanging after which he could not feel his legs and could not move one of them. He was shivering but still alert. In the field, he received calcium chloride, normal saline, and bicarbonate. At the hospital, he was found to have elevated creatine phosphokinase levels that resolved after continued intravenous fluid. Suspension trauma can include early syncope and late rhabdomyolysis. Persons suspended passively must be rescued immediately and given intravenous fluid to prevent rhabdomyolysis and renal failure.

Key words: rhabdomyolysis, suspension trauma, cave

Introduction

Caving and other outdoor sports require attachment to a rope for progression in caves, cliffs, or canyons, and to ensure safety in case of a fall. Remaining suspended on a rope is almost always preferable to falling but also has risks. A person may sit in a harness for hours at a time without detriment as long as the person remains active. If someone hangs limply from injury or exhaustion, however, the person may be subject to great morbidity.

Case Report

In 2005, 3 men entered a Tennessee cave for exploration.¹ The cave was accessed by a 140-ft (42-m) rappel through a pit in the ground to reach the main 750-ft (225-m) horizontal section. The 3 men descended uneventfully and explored the cave as intended. On return, the first person ascended the rope without incident. The second experienced difficulty with his climbing system and became stuck on the rope 12 ft (3.6 m) off the floor of the cave. The third caver climbed up to him to help him climb back down but failed. The first person left the cave to summon help. The stuck second caver continued to try to move on the rope but eventually became exhausted.

A cave rescue team arrived 4 hours after the second man had started his climb. They found him hanging in a sit harness in the spray of a small waterfall, shivering

uncontrollably, nauseated and dizzy, without feeling in either leg, and incapable of moving his left leg. The rescuers decided to raise the patient to the top of the pit and treat him there, rather than lower him to the floor and bring the response down to him. By the time he was raised, his shivering had stopped. He was alert and oriented. Rescuers established an IV line within a minute of arriving at the top of the pit. The subject was given 10 ml of 10% calcium chloride for presumed hyperkalemia along with 50 ml of 7.5% sodium bicarbonate and a 500 ml bolus of normal saline. He was packaged in a litter with heat packs around the neck, groin, and axillae for hypothermia prevention and treatment. He was raised up the slope above the pit then down to an ambulance. Transit time to the hospital was 20 minutes.

At the hospital, the patient had a temperature of 98.4°F (36.9°C). He was found to have rhabdomyolysis with a serum myoglobin elevated at 1622 ng/ml. Initial creatine phosphokinase (CPK) level was 9030 units/L. He was fluid resuscitated and CPK declined to 2506 units/L by day 3 when he was discharged. Creatinine was initially 0.9 mg/dl, peaked the next morning at 1.3, and returned to 1.0 by discharge. Initial potassium was low at 3.1 mmol/L but normalized for the rest of his stay. Other electrolytes and blood counts were normal. He achieved a complete recovery after several weeks.

Discussion

The patient experienced suspension trauma, described as a pooling of blood in the lower extremities of a subject

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passively suspended on rope. Passive hanging disables the venous return system. Arterial flow continues, however, leading to accumulation of volume and pooling of increasingly deoxygenated blood in the legs. The lack of venous return leads to hypovolemia in the central circulation. This can be rapidly fatal if someone has a syncopal response to the hypovolemia but remains upright instead of falling down and restoring cerebral blood flow.² Instead of increasing cerebral blood flow, the fainting response decreases it even more by decreasing heart rate and further decreasing blood pressure. After 2 to 3 hours in a suspended position, muscle damage from hypoxia ensues leading to rhabdomyolysis with hyperkalemia and potential renal failure.

In this case, the patient was immobilized on rope due to difficulty with equipment. Similar cases in which someone died on rope without sufficient trauma to explain the death or who developed renal failure after prolonged suspension have been reported. This may occur after falling during rock climbing, becoming hypothermic while climbing a rope hung in water, running into a tangle of rope, or simply hanging limp for a training exercise.^{2–4} These cases are not simply the result of hanging in a harness. Climbers and cavers can be suspended in harnesses for hours at a time in many wilderness settings without incident. The causative factor is likely hanging passively without moving the legs to return blood to the body's core.

Rescuers at the scene did not believe that the patient was hypothermic because of his alert mental status and resolved shivering, but hypothermia has been attributed as a cause of rhabdomyolysis, especially when severe.^{5,6} Experimental series of mild hypothermia have not, however, demonstrated CPK changes.^{7,8} A trial of induced hypothermia down to 33°C after cardiac arrest found no difference in CPK levels compared to the control group.⁹ Two controlled trials of induced hypothermia found no evidence of renal failure, a complication of rhabdomyolysis.^{9,10} Given his normal mental status in the field and normal temperature on hospital arrival with only external rewarming, hypothermia would have been mild at best and not the cause of his rhabdomyolysis.

Excessive muscle use as in extreme exercise or involuntary use seen in some seizures may also cause rhabdomyolysis.^{11,12} Shivering has been implicated, but shivering-associated muscle damage has been more commonly seen in hyperthermic syndromes such as malignant hyperthermia, neuroleptic malignant syndrome, and serotonin syndrome.^{11,13}

We believe that this person's rhabdomyolysis was likely caused by deoxygenated blood in the lower limbs secondary to being passively suspended in a harness for a prolonged time. Rhabdomyolysis has been described in other

victims immobilized on rope.^{14,15} Risk increases as suspension time increases. In suspension cases, the person must be removed from the rope as soon as possible to restore circulation. Intravenous fluid and bicarbonate are indicated as soon as possible to restore volume and prevent renal failure. In cases in which hypothermia is likely, early fluid resuscitation should be implemented in anticipation of acidosis and hyperkalemia on rewarming.⁸

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