A 41-Year-Old Man With Thigh Pain and Loss of Sensation in the Toes*

Rubin I. Cohen, MD, FCCP; and Ram Rao, MD

*(CHEST 1997; 111:810-12)*

A 41-year-old man was brought to the Emergency Department after family members found him on the floor of his living room. He was last seen 10 h earlier. He was lethargic but arousable. His chief complaints were bilateral thigh pain and loss of sensation in his toes on both feet. Further questioning revealed consumption of 20 tablets of an acetaminophen-codeine preparation (30 mg) over a period of 4 h. The medication had been prescribed following outpatient sinus surgery that he had undergone the previous day.

**Physical Examination**

He was afebrile with BP of 112/73 mm Hg and a heart rate of 108 beats per minute. Muscular membranes were dry and skin turgor was normal. Results of chest and cardiac examinations were normal. He demonstrated ½ muscle strength in both lower extremities, absent reflexes below the knees, and minimal sensation below the ankles. Elevation of both lower extremities and flexion of both knees were limited by severe pain. Both thighs were tender on palpation, but were neither tense nor firm. Peripheral pulses were intact in both lower extremities.

**Laboratory Findings**

Values were as follows: sodium, 132 mEq/L; potassium, 5.8 mEq/L; chloride, 100 mEq/L; bicarbonate, 20 mEq/L; creatinine, 3.2 mg/dL; BUN, 67 mg/dL. Creatine kinase was 116,800 U/L. Phosphate and calcium levels were normal. WBC count was $21 \times 10^9/L$, and hemoglobin value was 16.5 g/dL. Platelet count was within normal limits as were the prothrombin time and partial thromboplastin time. Urine was positive for hemoglobin but without red cells. The ECG was within normal limits. Toxicology screening was positive for opiates, and all preliminary culture reports were negative for organisms. No fractures were detected on radiologic examination of the pelvis or legs. A neurology consultant suspected lower spinal cord injury and recommended a CT scan. The CT scan through the level of the thigh muscles is shown in Figure 1.

*What are your diagnoses? In addition to aggressive hydration, what procedure may need to be performed if the neurologic findings progress?*
Diagnosis: Rhabdomyolysis resulting in nontraumatic compartment syndrome of the thigh. The procedure is bilateral fasciotomy of both thighs.

Rhabdomyolysis can occur in the setting of prolonged muscle ischemia generated either by external compression of muscle compartments or vascular events that decrease blood flow. Alcohol or drug overdoses can result in prolonged extreme positioning of the legs in an unconscious patient that may produce not only direct compression injury of muscle groups but also prolonged vascular “crimping” that results in diminished blood flow.

Once established, the most important complication of rhabdomyolysis is acute renal failure, the prevention of which requires the prompt initiation of aggressive volume replacement with up to 12 L/d. Maintenance of a brisk urine output in excess of 200 mL/h remains the single most important therapeutic intervention in this condition. The use of intravenously administered bicarbonate to alkalinize the urine and prevent the precipitation of myoglobin and urate in the renal tubules remains controversial. Human studies have lacked proper controls and alkalining the urine is difficult to achieve and may worsen hypocalcemia. Intravenous bicarbonate therapy, however, may be useful in managing patients who develop hyperkalemia from rhabdomyolysis. Benefits from the use of mannitol to preserve renal function in rhabdomyolysis remain similarly undocumented. Mannitol use may precipitate an osmotic diuresis with worsened hypovolemia. Loop diuretics may not provide significant benefit in preserving renal function and may acidify the urine, thereby promoting intratubular precipitation of myoglobin. In clinical practice, however, many clinicians utilize mannitol or loop diuretics in the management of rhabdomyolysis especially if urine flow is inadequate.

Compartment syndrome is another major complication of rhabdomyolysis that occurs in muscles that are enclosed by a fascial compartment. Myofibrillar proteins decompose into osmotically active particles that attract water from inflowing arterial blood. It is estimated that 1 mOsm exerts a pressure of 19.5 mm Hg. Thus, a relatively small increase in osmotically active particles in a closed compartment can attract sufficient fluid to cause a rise in intramuscular pressure.

The increase in intramuscular pressure compresses the compliant veins, resulting in increased venous outflow resistance. This limits blood drainage from the compartment, causes ischemia, and begins a cycle of ischemia-swelling-ischemia. Theoretically, arterial vasodilation could compensate for increased venous resistance and maintain blood flow. A decrease in arterial resistance, however, would result in a smaller drop in pressure across arteries and a rise in capillary hydrostatic pressure. The increased filtration pressure in intramuscular capillary beds would aggravate edema formation and increase intramuscular pressure. Shrier and Magder questioned this traditional hypothesis for the pathophysiology of compartment syndrome and postulated that within muscle compartments there exists a critical closing pressure (similar to West zone II in the lung). They showed that it is the increase in this critical closing pressure, rather than an increase in resistance, that results in decreased flow. Regardless of the mechanisms involved, an unrelieved, severe compartment syndrome results in irreversible myoneuronal dysfunction and necrosis of soft tissue even though pulses may be initially maintained.

Compartment syndromes have most commonly been described in the calves or the forearms. A compartment syndrome is unusual in the highly compliant thigh that can accommodate significant volume expansion due to hematomas or third-spaced fluid. Furthermore, the fascial compartments of the thigh blend anatomically with the muscles of the hip providing a potential reservoir for decompressing fluid formations. Consequently, compartment syndromes of the thigh in the absence of severe soft-tissue injury or associated bone fractures are distinctly rare. A retrospective review revealed only 21 thigh compartment syndromes in 17 patients in a series of over 6,000 patients admitted to a trauma facility. In ten of the patients who had a thigh compartment syndrome, an ipsilateral femoral fracture was present. Nine patients had a vascular injury, coagulopathy, or severe blunt trauma. Two patients were unconscious due to drug or alcohol overdoses and had prolonged compression of their limbs. Of these two patients, one was hypotensive and the other was hypothermic with delirium tremens and was treated with military antishock trousers, all of which have been associated with rhabdomyolysis.

It is difficult to diagnose a compartment syndrome in the unconscious or stuporous patient who presents with a swollen and tense compartment. In this setting, the presence of elevated intracompartamental pressures above 35 mm Hg help to confirm the diagnosis. The decision to proceed to fasciotomy rests primarily on clinical judgment. Most orthopedic surgeons will perform a fasciotomy, however, if intracompartamental pressures exceed 60 mm Hg. Other surgeons may proceed to fasciotomy if pressures remain at levels above 40 mm Hg for 8 h or longer. It appears that no single pressure threshold provides sufficient diagnostic accuracy to clearly identify the need for surgery especially considering that irreversible muscle injury and nerve ischemia may depend on both the degree and duration of

CHEST / 111 / 3 / MARCH, 1997 811
pressure elevations. Therefore, patients should be closely observed for worsening neurologic function in spite of maximal medical management. Early fasciotomy (less than 8 h following onset) usually results in good functional recovery. Creatine kinase levels do not determine the potential for recovery.

The present patient developed acute renal failure and compartment syndrome of the thigh due to rhabdomyolysis. The compartment syndrome was not initially diagnosed because the neurologic deficits in the distribution of the sacral nerves suggested a spinal cord injury, which prompted a CT scan. Serendipitously, the CT scan revealed extensive myonecrosis in the thigh muscles compatible with a compartment syndrome. Because the neurologic deficits progressed during the next 6 h, the patient underwent bilateral thigh fasciotomies. Both vastus medial muscles were dusky but became pink on decompression. Despite aggressive hydration and furosemide administration, the patient required dialysis for anuria and hyperkalemia. He eventually recovered complete renal function and regained full ambulation after extensive and prolonged rehabilitation.

**Clinical Pearls**

1. **Rhabdomyolysis must be treated with prompt and aggressive volume hydration to prevent acute renal failure. The use of bicarbonate, mannitol, and loop diuretics remains controversial; if used, their potential risks should be considered.**

2. **Compartment syndromes of the thigh are uncommon and are usually associated with ipsilateral femoral fractures. Nontraumatic compartment syndrome of the thigh is distinctly rare but should be suspected in patients with prolonged lower extremity compression usually in the setting of drug or alcohol overdose.**

3. **In the proper clinical setting, a tender, tense, or swollen thigh area along with pain on passive stretching of the thigh muscles (flexing the knee) should alert the examiner to the possibility of a thigh compartment syndrome. Neurologic findings in the distribution of the sacral nerves further support the diagnosis.**

4. **Compartment syndrome must be treated early to avoid serious late morbidity. The treatment is surgical with conservative management playing a small role.**

5. **Compartmental pressures help to confirm the diagnosis, especially in the unresponsive patient. However, their routine measurement is unnecessary if both the medical history and the examination are adequate, especially in a patient with worsening neurologic findings.**

**Suggested Readings**


