

*clinical case study***Acute exertional anterior compartment syndrome in an adolescent female**

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Cambridge, MA***ABSTRACT**

FEHLANDT, A. JR. and L. MICHELI. Acute exertional anterior compartment syndrome in an adolescent female. *Med. Sci. Sports Exerc.*, Vol. 27, No. 1, pp. 3-7, 1995. Acute compartment syndromes usually occur as a complication of major trauma. While the chronic exertional anterior tibial compartment syndrome is well described in the sports medicine literature, reports of acute tibial compartment syndromes due to physical exertion, or repetitive microtrauma, are rare. The case of an adolescent female who developed an acute anterior compartment syndrome from running in a soccer game is described in this report. Failure to recognize the onset of an acute exertional compartment syndrome may lead to treatment delay and serious complications. Whereas the chronic exertional anterior compartment syndrome is characterized by pain that diminishes with the cessation of exercise, the onset of the acute exertional anterior compartment syndrome is heralded by pain that continues, or increases, after exercise has stopped. Compartment pressure measurement confirms the clinical diagnosis and helps guide treatment. True compartment syndromes require urgent fasciotomy.

ACUTE COMPARTMENT SYNDROME

Acute tibial compartment syndromes following macrotrauma, as in tibial fractures, are well described in the orthopedic literature (11). In addition, there are reports of minor trauma (15,17) and noncontact injury (3,19,24) being followed by the onset of acute lower leg compartment syndromes in athletes. Chronic exertional tibial compartment syndromes have been described in athletically active adults (18,22,31,33,35). Acute compartment syndromes due to repetitive microtrauma are uncommon, as reported in male military recruits (4,9,12,13,16,42) and male athletes (18,19,31,36); a review of the medical literature found few cases involving women or adolescents, and none in

children (44). We present the case of a 16-yr-old female with chronic anterior lower leg pain from running in soccer games and practices who developed an acute exertional anterior tibial compartment syndrome in the absence of any apparent macrotrauma; failure to rapidly diagnose and treat her condition resulted in significant complications.

CASE REPORT

An otherwise healthy 16-yr-old girl experienced what she and her coach thought were "shin-splints" for several weeks while playing soccer. Her bilateral anterior lower leg pain typically increased during persistent and intense activity and diminished over 10-30 min of rest, but occasionally increased for several minutes when resting immediately after such vigorous activity. The crescendo of pain was frequently accompanied by what she described as "tingling" in her feet and occasional "giving out and weakness" of her ankles. She was competitive and stoic, and continued playing soccer through her pain. She had no history of acute injury from twisting or direct blows to her leg. During a soccer game she experienced progression of pain and dysesthesias in her lower legs prior to her right ankle "feeling weak and giving out". Her right lower leg pain increased despite rest. She went to a hospital emergency department for evaluation.

The emergency physician documented her complaints of right anterior lower leg and ankle pain, and dysesthesias. There was no swelling and minimal tenderness over the right lateral malleolus. Pedal pulses, capillary refill, and sensory exam were described as "normal"; the motor exam was recorded as "decreased strength and range of motion in plantar flexion and dorsiflexion of the right ankle due to pain." There was no instability on drawer testing. The remainder of her exam as documented in the chart was otherwise unremarkable, with normal resting

temperature, pulse, respirations, and blood pressure recorded. Radiographs of the ankle in anteroposterior, lateral, and mortise views were negative for fracture or other bony abnormality. She was discharged with the diagnosis of an ankle sprain and given an air-cast splint, crutches, and acetaminophen with codeine.

She returned to the emergency department the following morning with unrelenting pain, increased swelling, and marked tenderness along the right anterolateral leg. A compartment syndrome was suspected. The medical record reflects that an orthopedic consultation was rapidly obtained. The consulting orthopedist recorded right lower extremity pain in the region of the tibialis anterior and extensor hallucis longus muscles with passive plantar flexion and active, resisted dorsiflexion of the foot and ankle. Decreased sensation in the "peroneal nerve distribution" was noted. The patient was treated with narcotic analgesics, Naprosyn, elevation, compression, ice, rest, and discharged.

She returned later that same day with progressive, unrelenting pain, and physical findings of tense swelling, firmness, and marked tenderness over her right anterior lower leg. She complained of dysesthesias and weakness in her foot and ankle; the examining physician's note commented on a progression of sensory and motor deficits. She had normal dorsalis pedis and posterior tibial pulses in her right leg. Her physical exam was otherwise unremarkable, including normal blood pressure for her age. The examining physician made the diagnosis of incipient compartment syndrome. Compartment pressures were obtained, measuring 54 mm Hg in the anterior, and 25 mm Hg in the deep posterior compartment. The patient was taken to the operating room where, under general anesthesia, an anterior tibial compartment release of the right leg through proximal and distal skin incisions was performed. The surgeon stated in the operative report that "prompt return to normal compartment pressures" were observed in the operating room after the fasciotomy. Actual numbers were not, however, recorded in the chart.

The patient experienced progressive pain and swelling in the right lower leg at the operative site within hours of surgery. Right tibial compartment pressures were recorded at 52 mm Hg anterior, 26 mm Hg lateral, 17 mm Hg deep posterior, and superficial posterior at 14 mm Hg. She was taken to the operating room where a long longitudinal skin incision was used for direct visualization of the anterior compartment and extension of the previous fascial release. Massive muscle swelling from the anterior compartment prevented primary skin closure. In the weeks following this surgery the patient required extensive debridement of necrotic muscle from the anterior and lateral compartments, in addition to drainage of hematoma deep to the anterior tibial musculature. Split thickness skin grafts were required for delayed wound closure. She was left with deep and superficial peroneal

nerve motor and sensory deficits, minimal ability to extend her toes, and inability to effectively invert or evert the foot.

The patient presented to our sports medicine clinic over 3 months after her initial surgery for evaluation and another opinion concerning her right lower extremity functional deficits. She also expressed concern about pain she experienced in her left leg during physical therapy—pain similar to the "shin splints" she had experienced playing soccer and in her right leg prior to developing an acute compartment syndrome.

Examination of her left leg was unremarkable except for firmness and fullness over her anterior tibialis muscle. She developed progressive pain in her left anterior leg during walking, but denied dysesthesias. Active resisted dorsiflexion and passive plantar flexion of the toes immediately after exercise produced anterior lower leg pain; her sensory-motor exam was otherwise normal. Her general exam was also unremarkable, including normal blood pressure readings for her age. Her resting anterior compartment pressure measured 17 mm Hg. After 15 min of vigorous walking, it increased to an opening pressure of 79 mm Hg, dropping steadily over 5 min to 29 mm Hg, and 21 mm Hg after 7 min. With the diagnosis of a chronic exertional anterior tibial compartment syndrome confirmed, a subcutaneous anterior compartment release was performed, utilizing a technique of small (1 cm) proximal and distal incisions over the anterior compartment for access to the crural fascia. One year following the surgery she has no exertional pain in her left lower extremity, and continues to tolerate vigorous conditioning exercises. Her right lower extremity has permanent functional deficit, and has required multiple reconstructive procedures for improved function and appearance.

DISCUSSION

This case illustrates the progression of a chronic exertional anterior tibial compartment syndrome to an acute exertional compartment syndrome in an adolescent female athlete, and emphasizes the occurrence of an acute lower leg compartment syndrome in the absence of any obvious macrotrauma. The acute exertional compartment syndrome was initially recognized in fit, young adult male military recruits subjected to long marches (4,12) and recently reemphasized (9,16,42). Development of an acute exertional compartment syndrome in the absence of antecedent trauma is unusual in sports (18), as illustrated in a report of an adult male tennis player (36). Beall et al. (3) noted, in a case of noncontact acute anterolateral compartment syndrome of the leg, that lower extremity compartment syndromes were receiving more emphasis in the orthopedic and trauma literature because of improved diagnostic techniques and the recognition that major complications occurred from failure to perform early surgical decompression. Continued emphasis is

warranted: acute compartment syndromes require early recognition and surgical intervention to prevent limb-threatening complications (12,15).

The 16-yr-old girl in this report had symptoms of a chronic exertional anterior tibial compartment syndrome prior to developing, in the absence of acute trauma, an acute compartment syndrome. Almost twenty years ago, in distinguishing the acute and chronic compartment syndromes, Reneman (31) reviewed 52 cases of lower leg compartment syndromes due to intensive use of muscles. He found 17% of these cases had documented symptoms suggestive of a chronic exertional compartment syndrome prior to development of the acute form. Leach et al. (18) warned of the possibility of progression of the chronic form of anterior compartment syndrome to the acute form in their case presentations. As with Shrier's case report (36), our patient complained of "shin splints" prior to developing an acute compartment syndrome. Patients who complain of "shin splints" require the inclusion of the chronic exertional anterior tibial compartment syndrome in their initial differential diagnosis.

The acute compartment syndrome, whether due to major trauma, minor trauma, or simply exertion, is primarily a clinical diagnosis. The pattern of exertional pain this girl experienced is typical of the chronic exertional compartment syndrome, while the unrelenting pain out of proportion to her injury and increased pain with passive stretching of the muscles in the involved compartment (35) all heralded an acute compartment syndrome (44). The transient, activity-related dysesthesias and ankle weakness that accompanied her pain were also clues to her condition. Fascial defects and compartment tenderness and firmness have also been described in association with the chronic compartment syndrome (7). Direct compartment pressure measurements are useful in confirming clinical suspicions and guiding treatment. (6,20,21,23,25,28).

The initial treating orthopedist remarked in retrospect that the patient's stoicism and high pain tolerance led to an underestimation of the severity of the pathology until compartment pressures were obtained. As with other potentially catastrophic stress-related sports injuries, such as femoral neck stress fractures (14), the highly motivated athlete, with her high pain tolerance, may minimize her subjective complaints, requiring the physician to pay extra attention to eliciting objective physical findings; in this clinical setting we have found compartment pressure measurements helpful in diagnosing the problem.

The patient's first surgical intervention, a subcutaneous fasciotomy through limited skin incisions, was initially effective in lowering compartment pressures, but subsequently failed by clinical and objective assessment. Gaspard and Kohl (8) observed this problem occurring after partial skin incision fasciotomy for acute compartment syndromes, and emphasized that the "skin may

become the limiting boundary in extremity swelling, producing significantly increased pressure and tissue damage within its confines." Generous skin incisions and intraoperative compartment pressure measurements are recommended in treating acute compartment syndromes in the lower leg (5).

The chronic exertional compartment syndrome is characterized by increased compartment pressures and associated pain, dysesthesias, and paresthesias that occur with exercise and reverse with the cessation of exercise (39). The acute exertional compartment syndrome is distinguished from the chronic syndrome (18,31). We hypothesize that a continuum exists from the chronic exertional compartment syndrome to the acute exertional compartment, where continued exercise at critically high compartment pressures results in global intracompartmental ischemia, triggering a pernicious cycle of tissue damage and inflammation that makes progression to an acute compartment syndrome inevitable. Patients with the chronic exertional compartment syndrome may be at greater risk of developing an acute exertional compartment syndrome (18,31,36); we agree with Shrier's prudent recommendation that these patients should be warned to seek immediate medical attention if their pain increases with rest, instead of decreasing (36). The girl in our case presentation may have avoided tragedy had she been diagnosed as having the chronic exertional anterior tibial compartment syndrome (not "shin splints"), and given appropriate advice and treatment.

Measurement of compartment pressures confirms the diagnosis of both the chronic exertional compartment syndrome and the acute compartment syndrome, and helps guide treatment (10,17,21,26,27,29,32-35,37-39,43). There is no single threshold compartmental pressure that determines the need for fasciotomy in the acute compartment syndrome (10,43). The intracompartmental pressure measurement criterion that is most logical for determining the need for fasciotomy in the acute compartment syndrome is described by Whitesides et al. (43), and elegantly supported by Heppenstall et al. (10). Development of these guidelines is based on the observation that systemic central perfusion pressure plays a critical role in determining the tissue pressure at which muscular metabolic compromise is manifest in compartment syndromes (10). Whitesides et al. recommended performing fasciotomy in clinically symptomatic individuals with compartment pressures within 10-30 mm Hg of diastolic blood pressure. Heppenstall et al. (10) observed that differences of 40 to 30 mm Hg or less between the mean arterial pressure and the compartment pressure were found to be critical values for cellular metabolic derangement in skeletal muscle. In light of the clinical history and physical examination, these serve as guidelines for the performance of fasciotomy in the acute compartment syndrome.

Fasciotomy is effective in the treatment of the exertional compartment syndrome (33,40). Different techniques for measuring compartment pressures in the chronic exertional anterior compartment syndrome have been presented in the literature; findings by these methods include higher resting, exercise, and post-exercise compartment pressures in individuals with chronic exertional compartment syndrome symptoms when compared with asymptomatic individuals (20,23,30,33,34,37-39, 40,41). The most relevant parameters are an elevated immediate post-exercise pressure and a sluggish return to preexercise levels. Post-exercise pressures in excess of the insertion pressure, or pressures in excess of 15 mm Hg persisting for longer than 15 min are useful signs of chronic compartment syndrome likely to benefit from surgical fasciotomy (32). Good results have been achieved in the surgical treatment of lower leg exertional compartment syndromes diagnosed with the aid of direct compartment pressure measurements (33,41). Good long-term results have also been achieved in the surgical treatment of lower leg chronic exertional compartment syndromes diagnosed without the aid of compartment pressure measurements (1,2). Our clinical experience mirrors that of the literature, where symptomatic individuals cannot continue their desired intensity of activity if

not treated by fasciotomy, and where fasciotomy is safe and effective in relieving symptoms in most individuals (unpublished data). We obtain preexercise, immediate post-exercise, and 5-15 min post-exercise compartment pressures in individuals with suspected chronic exertional compartment syndromes. These data are weighed relative to the severity of the patients symptoms in choosing to recommend surgical intervention over a trial of conservative treatment, or to reevaluate our diagnosis.

In summary, the acute exertional compartment syndrome requires early diagnosis and surgical intervention to prevent the type of irreversible and profound tissue damage experienced by the 16-yr-old girl in this report. Patients who complain of activity-related "shin splints" or anterior lower leg pain must be evaluated for the presence of a chronic exertional compartment syndrome, and advised to seek immediate medical attention if their pain increases after the cessation of exercise. The diagnosis of both the chronic exertional compartment syndrome and acute exertional compartment syndromes are primarily clinical, with diagnostic confirmation provided by, and subsequent treatment guided by direct compartment pressure measurement.

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