

Case Report

Effort-Related Chronic Compartment Syndrome of the Lower Extremity

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Effort-related chronic compartment syndrome (ERCCS) of the lower extremity is often misdiagnosed, requiring repeated visits to the physician and subsequent delay in definitive treatment. The most significant causes of chronic leg pain in physically active individuals are stress fractures, shin splints, and "exercise-induced" or effort-related chronic compartment syndrome. In patients susceptible to ERCCS, the fascial compartments are too small to accommodate the associated 20% increase in muscle mass that typically occurs with heavy exercise. The increased pressure within a small unyielding compartment limits circulation and subsequent muscle function. The only appropriate conservative treatment is cessation of the offending activity. Early suspicion of the condition is paramount, because the definitive treatment is fasciotomy. ERCCS has only recently been recognized, and therefore it may be underdiagnosed. Family physicians and general medical officers caring for otherwise healthy soldiers and athletes should be aware of ERCCS so that prompt orthopedic referral for evaluation and definitive treatment will not be delayed.

Introduction

The first reports of effort-related acute compartment syndrome were military in origin and were described as "march gangrene" by Horn¹ in 1945. Later, a chronic variant of the compartment syndrome was identified by Mavor² in 1956, but it was not until 1975 that Reneman³ described the clinical manifestations of effort-related chronic compartment syndrome (ERCCS) and confirmed the observation that the symptoms are caused by an elevated compartment pressure. At present, the incidence of ERCCS is unknown. ERCCS occurs predominantly in physically active individuals, especially military personnel and athletes, and should be considered in the initial differential diagnosis of effort-related lower leg pain. The diagnosis of ERCCS dictates a specific treatment plan.⁴ Therefore, the military family physician or general medical officer must consider an orthopedic referral for compartment pressure monitoring in the evaluation of effort-related lower leg pain.

Case Report

The patient was a 22-year-old white male, an active duty Army specialist who presented complaining of a year-long history of pain in both lower extremities brought on by running.

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This manuscript was received for review in October 1998. The revised manuscript was accepted for publication in January 1999.

The pain was described as a bilateral "tightening" or "tense" sensation over the anterior aspect of the lower leg. Initially, the patient had pain 3 to 4 miles into his run, but this progressed to pain occurring at the 0.5- to 1-mile mark over a 6- to 7-month period. The patient noted that the tense sensation seemed to limit his ankle range of motion. Rest improved the symptoms over a few hours, but the patient never received complete resolution, maintaining a dull "pressure sensation" within the extremity. Other activities, including biking and extended walking, were also found to aggravate his symptoms. Previous treatment consisted of stretching exercises, physical therapy, oral anti-inflammatory agents, and orthotics. Previous evaluations with plain film radiography and bone scintigraphy were unremarkable and depicted no evidence of stress fracture.

Physical examination of the lower extremity was unremarkable before exercise. Immediately after exercise, examination revealed significant tenseness of the entire anterior compartment bilaterally. Pain was elicited on palpation of the anterior compartments and on active and passive plantar flexion of the ankles. Strength with dorsiflexion of the left ankle was graded 3/5 and dorsiflexion of the right ankle was graded as 4/5. Decreased superficial and deep sensation of the first interspace of the left foot was also noted.

Bilateral pressure measurements were obtained and are summarized in Table I. The diagnosis of bilateral chronic anterior compartment syndrome brought on by exercise was subsequently established. Bilateral anterior compartment fasciotomies were performed, and 4 weeks later the patient was walking without symptoms. Four months after surgery, the patient was participating in desired athletic activities without limitation.

Discussion

Initial studies on chronic compartment syndrome emphasized the importance of a thorough clinical evaluation and concluded that invasive diagnostic studies were unnecessary.⁵ More recent studies, however, stress the vital role of intracompartmental pressure measurements. Black and Taylor⁶ state that "the physical examination is rarely helpful in confirming the diagnosis. . . particularly if the patient is asymptomatic on presentation." This suggests that history and physical examination alone are insufficient in establishing a definitive diagnosis. Although a presumptive diagnosis may be made based on the initial clinical presentation, physicians must understand the need for compartment pressure measurement to confirm the diagnosis.

TABLE I
COMPARTMENT PRESSURES MEASURED VIA THE WICK
CATHETER TECHNIQUE

	Compartment Pressure (mm Hg)		
	Anterior (Right/Left)	Lateral (Right/Left)	Deep Posterior (Right/Left)
Resting	14/20	<10/<10	<10/<10
During exercise	110/116	66/74	54/49
5 minutes after exercise	48/50	<10/<10	<10/<10
15 minutes after exercise	24/26	<10/<10	<10/<10

Patient History

The patient's historical presentation is critical, for effort-related pain is the typical complaint indicating an effort-related chronic compartment syndrome.⁷ Patients may have experienced pain for months to even years that is induced by exercise and relieved with rest. Some patients can go so far as to predict the exact distance or duration of activity needed to elicit their symptoms. Patients describe the character of pain as aching, burning, cramping, gnawing, squeezing, sharp, or stabbing. Merely continuing through the pain is not possible for patients with ERCCS. When the runner attempts to "push through," the pain may persist through the next day. When the patient promptly ceases the offending activity, symptoms gradually resolve over 10 to 15 minutes.⁷ Additional complaints may include extremity weakness with an inability to control the extremity or dysesthesias in the sensory distribution of an entrapped nerve.⁸ Interestingly, there are usually no complaints of swelling in the affected extremity, but patients are able to localize the pain with reference to the involved compartment.⁷ Bilateral involvement is reported approximately 60% to 90% of the time.^{7,8}

Physical Examination

Physical examination before exercise reveals few distinctive signs of effort-related chronic compartment syndrome.⁷ Lower extremity muscle herniations resulting from fascial defects were observed in 40% of patients with ERCCS. Tenderness and increased tension in the involved compartment was appreciated in 35% of patients who had been exercising before the examination.^{8,9} Because of the scarcity of reliable physical findings, a trial attempt to reproduce the pain through exercise, preferably the exact exercise that causes the pain, is suggested by some authors.⁶ Sensory and, less commonly, motor defects may be detected at this point secondary to nerve ischemia.¹⁰

Differential Diagnosis

Exercise-induced lower extremity pain is a commonly encountered complaint for the military family physician. The differential diagnosis should include common as well as uncommon causes. Common causes include tendinitis, stress fracture, muscle strain or cramp, and tibial stress syndrome, more commonly referred to as shin splints. One must also consider the less frequent causes of pain, such as vascular disorders, osteomyelitis, and ERCCS.

Differential diagnosis and the relative frequency of various causes of exercise-induced lower extremity anterior compartment pain have been presented by Styf.¹¹ Of 98 patients evaluated in his research series, 26 were noted to have findings

suggestive of ERCCS. Styf noted the importance of intracompartmental pressure monitoring and other technical examination methods, such as bone scintigraphy and plain radiography, in establishing a definitive diagnosis.

Pathophysiology

The pathophysiology of ERCCS is not fully understood at this time. However, muscle volume is known to increase up to 20% with exercise. This increase in muscle volume in a relatively noncompliant fibro-osseous space leads to abnormally elevated intracompartmental pressures, which may interfere with blood flow to the muscle. If blood flow to the muscle is reduced to the level at which metabolic needs can no longer be sustained, functional abnormalities ensue and an exercise ischemia or effort-related compartment syndrome results.⁶

Diagnostic Testing and Criteria

Plain film radiographic studies will usually rule out stress fracture in most patients who have experienced effort-related lower extremity pain for 4 to 6 weeks. Those individuals with symptoms characteristic of a stress fracture and negative radiographs should be evaluated with bone scintigraphy.

The most beneficial evaluation, however, is the recording of intracompartmental pressures before, during, and after exercise. There is no consensus regarding the best measurement technique¹¹ or which quantitative measurements constitute a definitive diagnosis.^{6,8-10} There is, however, a consensus on the criteria needed to confirm the diagnosis. These include elevated resting pressure before exercise, increased intracompartmental pressure during exercise, increased pressure after exercise, and prolonged return to pre-exercise resting pressure levels.^{6,8-10}

Elevated resting pressure before exercise is a diagnostic marker for ERCCS, but it is insufficient for definitive diagnosis. Normal resting pressure has been reported to be 0 to 8 mm Hg, and a pressure greater than 10 to 15 mm Hg is considered abnormal⁶ and suggests a diagnosis of ERCCS.

Increased intracompartmental pressure at rest, after 15 minutes of symptom-producing exercise, is a reliable finding for the definitive diagnosis of ERCCS. Within 15 minutes of exercise, the compartment pressure increases to more than 75 mm Hg. At 5 minutes after exercise, a normal individual will have a pressure of 13 ± 6 mm Hg, whereas the compartmental pressure of an individual with ERCCS will remain greater than 25 mm Hg for up to 30 minutes.

Prolonged time to normalization of compartment pressures is also a definitive diagnostic marker for ERCCS. In normal individuals, intracompartmental pressures will normalize within 6 minutes of exercise, whereas the ERCCS-affected individual may require more than 30 minutes to return to pre-exercise levels.⁶

Recent studies indicate that magnetic resonance imaging may be a reliable, safe, noninvasive, and reproducible alternative to intracompartmental pressure measuring in individual suspected of having ERCCS, but additional studies are needed to substantiate this claim.¹¹

Treatment

There is general consensus that conservative nonsurgical treatment of ERCCS is successful only if the patient gives up the

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activity that brings on the symptoms. For some individuals seeking evaluation by a family physician, this may be all that is needed. For most individuals who seek medical attention for such complaints, however, there is a strong desire to continue their exertional activities. For these individuals, the treatment of choice is surgical fasciotomy.^{6,8-11} Multiple surgical techniques have been reported,¹⁰ and all are reported to yield good results. Of the 85 patients with ERCCS prepared for fasciotomy by Moeyersoons and Martens⁷ in their 1992 study, 84% obtained an "excellent or good" result with no further complaints at their presymptomatic levels of activity. Of those with only "fair or no" improvement, 50% were found to have multiple compartment involvement with incomplete fascial release and a subsequent affected compartment without decompression. In most studies, the patient was walking independently within 7 to 10 days. At that point, they are instructed to bike ride as tolerated until they begin a gradual running program at 4 weeks postoperatively. At 8 weeks, they are allowed to increase activities as tolerated.^{7,10}

Conclusion

ERCCS should be considered in the initial differential diagnosis of effort-related lower extremity leg pain in physically active individuals, especially soldiers and athletes. The primary role of the military family physician is early and accurate diagnosis of this condition. The diagnosis of ERCCS dictates a special treatment plan, which may differ significantly from the treatment of other causes of exercise-induced lower extremity leg pain. A presumptive diagnosis can be established based on a thorough history and physical examination, but referral for compartment pressure measurements are needed to confirm the diagnosis. In most cases, definitive treatment of patients with ERCCS is surgical, and appropriate fasciotomy by the orthopedic surgeon is curative and allows the individual to return to full activities in a relatively short time.

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