Chronic Exertional Compartment Syndrome in a Collegiate Soccer Player: A Case Report and Literature Review

Derek Farr, DO, and Harlan Selesnick, MD

Abstract

Chronic exertional compartment syndrome is a relatively rare condition among running athletes. In those who engage in repetitive activity, it can cause severe, debilitating leg pain.

The diagnosis can be made with a thorough workup that includes history and physical examination, radiologic studies (x-rays, magnetic resonance imaging, bone scan), and compartment pressure monitoring.

Most patients do not respond well to nonoperative intervention. Fasciotomy provides satisfactory relief of symptoms and helps patients return to their sports.

We present the case of a high-level collegiate soccer player with chronic exertional compartment syndrome.

Case Report

A healthy male collegiate varsity soccer player in his early 20s presented to the orthopedic clinic with a complaint of right lower leg pain during running. Past history of leg pain was negative. The man's first episode of leg discomfort began 8 weeks earlier, while he was running on a treadmill. The pain developed after 15 minutes and radiated from the midportion of the anterior lower leg down to the foot. Another complaint was of associated numbness along the dorsum of the foot. Both symptoms dissipated 5 to 10 minutes after cessation of running. Elliptical training reproduced the pain. The patient had right tibial periostitis in the past but said that the present pain and discomfort were clearly different. Activity and shoe modification and a course of physical therapy failed to relieve this reproducible pain. The rest of the medical history was noncontributory.

On examination, there was no tenderness to direct palpation along any of the 4 four fascial compartments of the right lower leg. No pain was elicited with stress-testing the tibia, and no crepitus was noted. There was no tenderness to percussion. The patient had full range of motion (ROM) and no knee or ankle instability. Results of motor and sensory testing were normal. Reflexes were graded 2+ bilaterally. There was normal peroneal nerve sensation with a negative Tinel sign over the nerve. Flexor strength and extensor strength were graded 5/5. Pedal pulses were graded 2+. The patient stood with neutral alignment and well-preserved arches.

X-rays did not show any acute process or osseous abnormality. A right tibia magnetic resonance imaging (MRI) scan obtained to help delineate the underlying pathology showed no evidence of stress fracture or periostitis.

Some of the most common causes of chronic lower leg pain in athletes are medial tibial stress syndrome (MTSS), stress fracture, chronic exertional compartment syndrome (CECS), nerve entrapment, and popliteal artery entrapment syndrome (PAES). Given the findings from our patient's physical and radiographic examinations, and using the algorithm published by Edwards and colleagues,[1] we settled on CECS and PAES as working diagnoses. To distinguish these conditions, we had the patient run on a treadmill at a brisk pace for 15 minutes or until symptoms were reproduced. He complained of anterior leg pain radiating to the foot along with associated paresthesias to the dorsum of the foot. Examination revealed tightness in the distal third of the anterior and lateral compartments of the lower leg. Pain was exacerbated with passive flexion of the toes. The foot was warm and well perfused. Capillary refill was less than 2 seconds. Pedal pulses remained normal. There were paresthesias in the peroneal nerve distribution. Ten minutes after exercise, symptoms dissipated. The diagnosis of anterior and possibly lateral CECS was suspected.

To confirm this diagnosis, we measured compartment pressures

> "The gold standard for CECS diagnosis is compartment pressure measurement, an invasive method."

Dr. Farr is Orthopedic Sports Fellow, Orthopaedic Institute of South Florida, Baptist Doctors' Hospital, Coral Gables, Florida.

Dr. Selesnick is Director, Miami Sports Fellowship Program, Orthopaedic Institute of South Florida, Baptist Doctors' Hospital, Coral Gables, Florida, and Team Physician, Miami Heat, National Basketball Association.

Address correspondence to: Harlan Selesnick, MD, 1150 Campo Sano Ave, Suite 301, Coral Gables, FL 33146 (tel, 786-308-3384; fax, 305-667-8279; e-mail, jockdoc69@aol.com).

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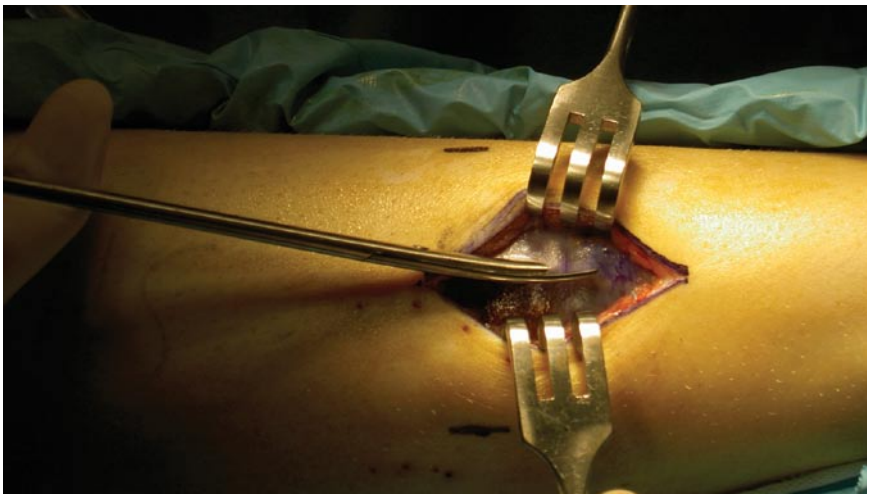

Figure 1. Release of the lower leg anterior compartment fascia with Mayo scissors. Care is taken to avoid the superficial peroneal nerve.

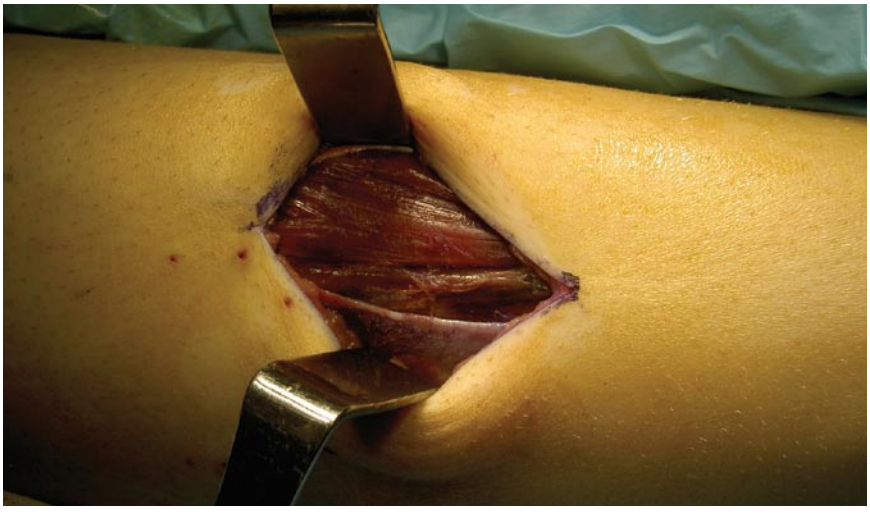

Figure 2. Complete release of the lower leg anterior compartment fascia.

(with the patient lying in the supine position) and recorded them with the Stryker Compartment Monitor (Stryker, Kalamazoo, Mich) per the protocol of Pedowitz and colleagues[2] (Table). Pressure in the anterior compartment was 17 mm Hg at rest, 63 mm Hg 1 minute after exercise, and 20 mm Hg 5 minutes after exercise. All other pressures were within the normal limits set by the guideline. These results confirmed the diagnosis of isolated anterior CECS.

Our patient, a high-level collegiate soccer player, did not want to stop running or engaging in other repetitive athletic activity, so an anterior fasciotomy was recommended and performed.

Surgical Technique

Our preferred technique for release of the anterior compartment is to make a 4- to 5-cm longitudinal incision midway between the tibial crest and the anterior fibula border. After the skin is incised, blunt dissection is taken down to the level of the fascia, and the intermuscular septum is identified. A small (1-cm) incision is made 1 cm anterior to the intermuscular septum to avoid the superficial peroneal nerve. Long curved Mayo scissors (common in laparotomy cases) are used to release the anterior compartment fascia (Figures 1, 2). Care is taken to release proximally toward the center of the knee and distally to the center of the ankle, again to avoid injury to the superficial peroneal nerve. The wound is then copiously irrigated. Subcutaneous tissue is approximated with 2.0 absorbable sutures, and skin margins are approximated with skin clips. A sterile soft dressing is then applied.

Weight-bearing as tolerated is encouraged, and crutches are used as needed in the immediate postoperative period. After surgery, our patients begin a physical therapy program designed to help them achieve and maintain full active ROM and strength. Light jogging and other cardiovascular exercise are implemented 2 to 3 weeks after surgery. A full return to sports is permitted 6 to 8 weeks after surgery.

We followed up with our patient 2 weeks, 4 weeks, 6 weeks, and 3 months after surgery. He progressed through a physical therapy program, and his right leg (compared with the left) regained full ROM and strength. The patient returned to jogging after 3 weeks and to running and sprinting after 6 weeks. His return to full collegiate soccer participation occurred 2 months after surgery. At his most recent follow-up, 6 months after surgery, he was still asymptomatic.

Table. Leg Compartment Pressure Testing

Compartment	Compartment Pressure (mm Hg)		
	At Rest	After Exercise (1 min)	After Exercise (5 min)
Anterior[a]	17	63	20
Lateral	9	21	16
Posterior	8	14	8
Deep posterior	10	15	13

[a]Abnormal values based on criteria of Pedowitz and colleagues.[2]

Discussion

In compartment syndrome, increased interstitial pressure in a closed fascial compartment leads to microvascular compromise. As this condition progresses, myoneural function is impaired, and muscle and soft tissue eventually undergo myonecrosis. Compartment syndrome can be classified as acute or chronic (exertional).

Acute compartment syndrome has various causes (eg, trauma, fracture, reperfusion of ischemic limb, burn, improper casting). It often presents as severe pain that occurs with passive stretch of muscles and remains unimproved with rest, and it represents an orthopedic emergency. Fasciotomy is the standard treatment for reducing the interstitial pressure.

CECS is not an orthopedic emergency, but it is debilitating for high-level athletes. During exercise, repetitive muscle exertion can result in elevated compartment pressure and then microvascular compromise, formation of tense, swollen compartments, and pain. Pain often leads these athletes to stop exercising; it usually dissipates with rest but can linger up to 24 hours. In 1962, French and Price[3] described elevated pressure as the cause of CECS of the lower leg.[3,4]

Nonoperative treatment, including rest, physical therapy, use of anti-inflammatory medication, and stretching, usually fails to relieve this chronic condition. Fasciotomy of the involved compartments has been found to provide successful relief of symptoms and return to full activity.[5] Mavor[6] in 1956 described a successful CECS treatment in which he widened the fascia of the anterior compartment of the lower leg.

CECS most often affects the lower leg, which has 4 compartments: anterior, lateral, posterior, and deep posterior. Of these compartments, the anterior and the lateral are most commonly involved.[4] CECS can also affect the shoulder, upper arm, forearm, hand, thigh, and foot.

Pathogenesis

During repetitive exercise, muscle fibers can swell up to 20 times their resting size and gain weight.[7] This increase in muscular volume, along with increased blood flow and interstitial fluid, leads to increased pressure within a nonexpansile muscular compartment, which in turn can cause a decrease in arteriolar blood flow. When blood flow is insufficient to meet muscular demands, the patient feels pain. Pain continues until pressure normalizes and blood flow is restored.

Clinical Presentation

Athletes with CECS of the lower extremity are usually asymptomatic at rest and in the off-season. With activity, they experience a painful ache along the involved compartment. This pain is usually not relieved by immediate rest and can persist for a day or so.[8]

Findings from an at-rest physical examination can be negative. Given their history of exercise-induced pain, athletic patients should be evaluated immediately after exercise, when they may complain of lower extremity paresthesias, localized compartment pain, and a tense, swollen lower leg. Pulses are usually not affected, as the microvascular circulation is involved.

The anterior compartment is most often involved in CECS. In anterior CECS, symptoms include variable weakness with toe extension, pain on the anterior leg with passive toe flexion, and diminished sensate in the first web space. In posterior CECS, symptoms include weakness with toe flexion and ankle inversion, pain along the posterior leg with passive toe extension, and decreased plantar sensate. The signs and symptoms of lateral CECS are similar to those of anterior CECS but with the peroneals involved; however, lateral CECS lacks the anterior pain associated with the anterior condition.

Diagnosis

A thorough history and physical examination are helpful in the diagnosis of CECS, as the differential of leg pain in running athletes includes periostitis, stress fracture, MTSS, muscular tears, PAES, tibiofibular synostosis, and peripheral nerve entrapment. In addition, x-rays, MRI, bone scan, and electromyography can be helpful in establishing or excluding a diagnosis.

CECS is often associated with 1- to 2-cm^2 fascial defects near the intramuscular septum between the anterior and lateral compartments (incidence, 39%-46%).[4] These defects are often palpable with exercise.

The gold standard for CECS diagnosis is compartment pressure measurement, an invasive method. According to Pedowitz and colleagues,[2] the diagnostic criterion for CECS is pre-exercise pressure of 15 mm Hg or higher, 1-minute postexercise pressure of 30 mm Hg or higher, or 5-minute postexercise pressure of 20 mm Hg or higher. The criteria of Whitesides and colleagues[9] have also been applied to CECS; compartment ischemia occurs when compartment pressure increases to within 20 mm Hg below diastolic blood pressure (normal resting compartment pressures, 0-4 mm Hg). MRI, laser Doppler flow, and near-infrared spectroscopy are being studied as methods for confirming CECS diagnosis, and results are encouraging.

"Fasciotomy, the treatment of choice, allows athletes to return to full participation in sports."

Treatment

The only effective nonoperative treatment for CECS is avoidance of the offending activity. Micheli and colleagues[10] examined several modalities, including rest, ice, electrical stimulation, and stretching, and concluded that only rest was effective.

The mainstay of treatment for this condition is surgical, consisting of a fasciotomy. This surgery is often performed endoscopically or through small subcutaneous incisions. Endoscopic techniques to release the anterior and lateral compartments have been found safe and effective.[11] Regardless of technique, full fascial release of the compartment is critical to a good outcome.

Although fasciotomy is the treatment of choice, it is not without risk. Its potential complications (incidence, 4.5%-13%[3]) include infection, neurovascular compromise, hemorrhage, nerve entrapment, seroma formation, deep vein thrombosis, lymphocele, and symptom recurrence.

Outcomes

Most patients who undergo fasciotomy for CECS do very well (81%-100% improvement).[4] Fasciotomy for release of the deep posterior compartment has been less successful (50%-65%).[4] Foster and colleagues[12] found that patients with isolated anterior CECS treated solely with anterior fasciotomy versus combined anterior and lateral fasciotomy had a significantly faster recovery (8.1 vs 11.4 weeks) and 93% good and excellent results. Given their findings, they recommended single anterior fasciotomy alone in the setting of isolated anterior CECS. After fasciotomy, most patients return to light activity within 2 to 4 weeks and full participation in sports within 6 to 8 weeks.

Summary

CECS is a relatively rare condition among running athletes. In those who engage in repetitive activity, it can cause severe, debilitating leg pain. The diagnosis can be made with a thorough workup that includes history and physical examination, radiologic studies (x-rays, MRI, bone scan), and compartment pressure monitoring. Nonoperative management, with the exception of avoiding the offending activity, has not been shown to relieve symptoms of this chronic condition. Fasciotomy, the treatment of choice, allows athletes to return to full participation in sports. Recognizing the signs and symptoms of CECS allows the orthopedic surgeon to make the correct diagnosis and form a surgical treatment plan so that the athlete can return to preinjury level of activity relatively quickly and avoid potential permanent disability.

Authors' Disclosure Statement

The authors report no actual or potential conflict of interest in relation to this article.

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