

# Chronic exertional compartment syndrome

## Stopping runners in their tracks

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**Chronic exertional compartment syndrome (CECS) is a relatively common problem in runners. Recognising the clinical features of this painful condition is the first step towards avoiding delays in diagnosis.**

**C**hronic exertional compartment syndrome (CECS) is a debilitating problem for some individuals in the exercising population. This painful condition literally stops runners in their tracks, robbing them of a favoured exercise pursuit, but it continues to be under-recognised as a cause of exertional lower leg pain. Fortunately, clinical suspicion and recognition of the clinical features of this painful condition will enable clinicians to avoid diagnostic delays and to provide advice about appropriate management.

The anatomy of the compartments of the lower leg is described in the Box and Figure 1.<sup>1</sup>

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### The spectrum of exertional leg pain in runners

There are many causes of exertional lower leg pain in runners. Characteristics of CECS and other common causes are listed in the Table.

### What is CECS?

The distinguishing feature of CECS is elevated muscle pressure during and after exercise. The reason for this abnormal increase in muscle pressure is not completely known but possibly linked to reduced fascial compliance. With exercise, muscle volume normally expands by up to 20%,<sup>2</sup> but if this expansion is prevented then continued effort will force blood into the tight compartment and cause a rise in pressure. This may lead to collapse of the outflow vasculature (reduced venous drainage) and lymphatic vessels, further compounding the problem. Eventually, pain occurs as a result of the pressure itself or the retained products of exercise (e.g. lactic acid).

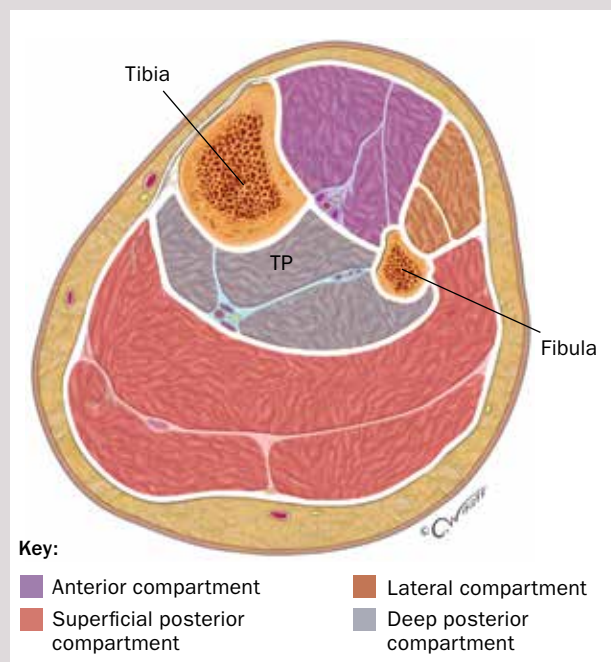
### Clinical features of CECS

The clinical history holds the key to unlocking a diagnosis of CECS. The classic presentation is a runner who has no pain at rest but develops aching pain in both legs after a set time, distance and intensity. The pain builds gradually and may become severe. Patients often mention that the affected area is 'rock hard' to palpation after exercise and may describe a developing 'tightness' in the muscle. Upon ceasing running, the pain slowly decreases – this may take 20 minutes or as long as a few hours.

In the majority of patients (about 90%), the symptoms of CECS are bilateral. Sometimes there is nerve involvement, with patients describing a sensation of 'pins and needles' (paraesthesia), often in the foot. There may be a tender lump (muscle hernia) in the anterior aspect after exercise. Some adult patients have experienced the problem since adolescence, whereas others have been running without pain for years before developing symptoms.

## COMPARTMENTS OF THE LOWER LEG

The muscles of the lower leg are organised into four well-defined compartments (the anterior, lateral, superficial posterior and deep posterior compartments) that exist within a relatively tight region and are bounded by bone and fascia (Figure 1). The tibialis posterior (TP) muscle has been proposed to have its own compartment deep in the posterior calf, but the existence of this so-called 'fifth compartment' is controversial.<sup>1</sup>



**Figure 1.** Cross-section of the lower leg showing the four well-defined fascial compartments and the proposed fifth compartment (tibialis posterior [TP] muscle).

There are no distinguishing examination findings of CECS at rest, although a muscle hernia may be present. Nevertheless, a physical examination should be conducted to rule out other conditions that may mimic or accompany CECS. Some runners present without the classic presentation. Symptoms and signs frequently overlap, but there are typical features that may assist in making the correct diagnosis (see Table). More than one condition may be present. A common example is the runner with diffuse bilateral posteromedial pain due to medial tibial stress syndrome combined with additional features suggesting coexistent CECS.

### Posterior lower leg pain

Posterior pain in the lower leg is a greater challenge to diagnose accurately than anterior or lateral pain because there is a greater likelihood of an alternative diagnosis, especially entrapment of the

popliteal artery behind the knee. The artery runs a variable course in relation to the medial gastrocnemius,<sup>3</sup> and an accessory muscle or a tight band can contribute to potential compression. Popliteal artery entrapment is an increasingly recognised condition in patients with posterior exertional pain in the lower leg. A rapid onset of posterior calf pain with exercise and a rapid improvement on ceasing activity should alert the clinician to its possible existence and relevance.

A patient with suspected popliteal artery entrapment needs to be referred for specialised vascular studies with exercise to determine if significant arterial compression is occurring. However, many individuals in the general population who compress their popliteal artery with active plantar flexion have no symptoms at all. A diagnosis of popliteal artery entrapment requires consideration of the patient's presentation, results of vascular studies and careful exclusion of other pathology.

## Investigations

### Compartment pressure testing

A runner presenting with suspected CECS will need to undergo muscle pressure testing in an exercise setting, which involves passing a needle attached to a manometer into the muscle (Figure 2). It requires the use of specialised equipment and should be conducted by a doctor who is experienced in the use of the test (usually a sports physician or an orthopaedic surgeon). Access to a treadmill or an area suitable for running (such as local footpaths or a park) is required because the patient must be able to replicate the usual pain.

Measurements of compartment pressure are taken at the symptomatic sites both before and after exercise. Some devices can remain strapped in place while the patient undertakes exercise. The patient needs to run for long enough to bring on symptoms (often 15 minutes). The usual protocol for post-exercise testing involves pressure measurement either one minute or five minutes after running. At rest, the pressure is usually low (<15 mmHg) but it is usually higher in patients with CECS. A clearly positive test for CECS would be higher than 40 mmHg at the one-minute post-exercise test.

A positive compartment pressure test is important for making a diagnosis of CECS, but false-negative results can occur. To maximise the accuracy of a planned compartment test, a runner should be advised to undertake a number of runs in the days prior to the test to induce symptoms. A recent systematic review has indicated that measurements taken one minute after exercise may have higher diagnostic reliability than measurements taken after five minutes.<sup>4</sup>

Compartment pressure testing is well tolerated and very safe. The risk of complications (including infection) is very low. Pain at the site of testing often persists for 24 hours (rarely much longer) as a sensation of bruising and with some tenderness, which will resolve.

**TABLE. COMMON CAUSES OF CHRONIC EXERTIONAL LOWER LEG PAIN IN RUNNERS**

Diagnosis	Structure affected	Location of symptoms	Symptoms	Signs
Medial tibial stress syndrome (periostitis)	Bone and soft tissue	Tibia (medial border)	Diffuse pain along inner edge of tibia, pain that improves with running and worsens after running	Tenderness along medial tibial border (approximately 10 to 15 cm)
Muscle tear (chronic)	Muscle–tendon unit	Mid to upper calf (usually)	Recurrent, localised pain that is worsened by calf activity	Longitudinal tenderness
Stress fracture	Bone	Tibia (mostly) or fibula	Sharp, localised pain on bone; pain that worsens with running	Focal tenderness on bone
Chronic exertional compartment syndrome	Muscle	Anterior, lateral or posterior lower leg	Slow build-up of pain, pain that improves with rest	Tense muscle after running, with or without muscle hernia (anterior)
Popliteal artery entrapment	Artery (muscle pain)	Posterior calf (usually)	Claudicant pain, rapid onset, posterior calf pain, rapid improvement with rest	Often nil at rest
Nerve entrapment	Peripheral nerve	Anterolateral lower leg and foot	Low anterior muscle pain (often ‘burning’) associated with paraesthesia and/or numbness	Tenderness over exit point of nerve through fascia (approximately 15 cm of anterior compartment), with or without muscle hernia

In some states and territories, relatively few centres offer compartment pressure testing, and unfortunately patients from regional areas may have to travel large distances to access the service. Furthermore, there is no Medicare item number for the test so it is relatively expensive, given the time required and fixed costs of disposable equipment.

### Other investigations

Other investigations may be indicated for patients who present with chronic exertional lower limb pain. The selection will depend on the clinical likelihood of coexistent conditions or differential diagnoses.

X-ray is almost never useful for patients with lower leg pain on exertion. The vast majority of patients present with bilateral diffuse symptoms. Even in patients with suspected stress fracture, the sensitivity of x-ray is too low to justify its use in this situation.

Bone scanning is still widely used for investigating patients with exertional leg pain. However, a bone scan subjects a patient to unnecessary high doses of radiation, often at a young age, and has well-documented long-term risks.<sup>5</sup> Although bone scanning will readily diagnose a stress fracture, the radiation dose is hard to justify. A stress fracture is a clinical diagnosis, but in the occasional situation where this diagnosis needs to be

confirmed MRI is a safe and sensitive alternative. Bone scanning is not useful for diagnosing CECS.

MRI can readily diagnose and clinically grade stress fractures. Pain site locations can be marked by the radiographer, which makes interpretation easier. Post-exercise MRI scanning can increase sensitivity. MRI is also useful for finding chronic tears



**Figure 2.** Anterior compartment pressure testing.



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**Figures 3a and b.** Fasciotomy for CECS. a (left). Fasciotomy involves an incision into the skin and fascia, which allows muscle to expand more freely. b (right). The positions of fasciotomy incisions for treating CECS in the anterolateral and posterior compartments.

and nerve entrapments, especially when these are clinically suspected.

Ultrasound performed by an experienced operator is very helpful for showing muscle hernias and nerve entrapments. The utility of ultrasound is highly user-dependent.

Vascular studies are indicated in some situations. Older patients with suspected claudication due to intrinsic arterial disease should be referred for Doppler ultrasound or arteriogram. Patients with suspected popliteal artery entrapment will need specific screening with Doppler ultrasound to show whether the artery is compressed or occluded during activity. Typically, blood flow and vessel diameter are measured at rest and with active plantar flexion. If the result is positive (or if an alternative test is required), dynamic CT angiography (rest and active) can confirm popliteal entrapment.

### Management of CECS

There is only low level evidence to show that treatment other than surgery is likely to sufficiently relieve symptoms of CECS such that can runners can return to their sport.<sup>6</sup> Therefore, most patients are referred to a surgeon for fasciotomy, which involves dividing the fascia lengthways in the affected areas to allow muscle to expand more freely and relieve pressure in the compartment (Figures 3a and b). Surgical techniques differ slightly.

Problems that occasionally occur after fasciotomy include infection, excessive scar formation, and nerve injury or entrapment. Recurrence of CECS symptoms can occur after surgery, and may be due to inadequate surgical release of the compartment or to excessive scar tissue developing at the site of the fasciotomy.

This situation may necessitate repeat compartment testing and, if results are positive, further surgery.

There is no agreed approach to rehabilitation following surgery, and little advice is available in the literature.<sup>7</sup> In my opinion, early return to exercise (including strengthening exercise) is advisable once the skin wounds are healed sufficiently and the risks of bleeding and infection are minimal.

The success of fasciotomy for treating CECS is variable.<sup>7,8</sup> Higher success rates are achieved for anterior fasciotomy (75% to 80%) compared with posterior fasciotomy (50%). The lower success rate for CECS in the posterior compartment may be related to surgical challenges in achieving a sufficient release (including not releasing the 'fifth compartment', the tibialis posterior muscle);<sup>1</sup> the risks of bleeding and scarring are also increased. There are also greater diagnostic challenges (such as excluding popliteal entrapment syndrome) and a higher likelihood of a coexisting condition.

### Conclusion

CECS is a common cause of lower leg pain in runners. Other conditions can mimic CECS, so the diagnosis rests on a good history, confirmed by clearly positive results on compartmental pressure testing after exercise. Recognising the distinctive features is the key to a correct diagnosis and appropriate management. CECS in the posterior compartment is more challenging to diagnosis and manage compared with in the anterior and lateral compartments. Fasciotomy, despite having success rates that are lower than ideal, still offers patients with CECS the greatest likelihood of a return to pain-free running. **MT**

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