An unfit man with painful leg swelling after exertion

Commentary by
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A 44-year-old unfit man has worsening painful tense swelling in his thighs and legs and dark urine four days after participating in a one-day boot camp. What is the diagnosis and treatment?

Case scenario

Colin, a 44-year-old normally healthy but unfit man, presented in the surgery two days after participating in a day-long boot camp as a bonding exercise with his workmates. He said he had done more squats than all his workmates, and won the prize for enthusiasm. Over the day or so after the camp he had developed worsening leg cramps that affected his sleep, and by 48 hours he was hobbling due to the pain. He was prescribed anti-inflammatories for five days and advised to work from home. Two days later (four days after the camp), he has returned for review because he has noticed increasing tense swelling in his calves and thighs and that the pain is worsening. On questioning he has dark urine, which he thinks is due to dehydration.

- What features would you expect to find on clinical examination in this patient?
- What investigations, if any, are indicated for diagnosis of compartment syndrome?
- What are the indications for incision for decompression of compartment syndrome?
- How should Colin's urinary signs be investigated and managed?

Commentary

This case highlights many typical features of acute compartment syndrome, although this patient's insidious presentation is unusual. Failure to diagnose acute compartment syndrome can result in significant morbidity, including permanent muscle and/or nerve damage, limb amputation and sometimes death, and it is therefore important to recognise the early signs of the condition and refer patients to hospital as soon as the diagnosis is suspected.

Clinical presentation

Acute compartment syndrome classically presents with an acute injury resulting in an increase in the pressure within a muscle compartment, due to either an ischaemic event or trauma and haemorrhage into the compartment (Figures 1a and b). It is rapidly progressive and patients often develop irreversible ischaemia if a diagnosis is not made and treatment commenced within hours. In contrast, chronic exertional compartment syndrome is a more transient form of compartment syndrome where patients complain of similar early symptoms of acute compartment syndrome without any history of acute injury or trauma; it is a common cause of lower leg pain in runners.

Acute compartment syndrome can, as in this rare case, result from muscle injury caused by acute exertion rather than direct muscle trauma, and manifest days after the initial injury.

Patients with acute compartment syndrome typically present with pain that seems out of proportion to the initial injury, as the nerve fibres are very sensitive to ischaemia. As the compartment syndrome progresses, patients start to show signs of increased tension within the muscle compartments, with the anterior and lateral compartments of the lower leg usually being affected first. Tenderness on palpation of the muscle compartment develops, and significant pain is experienced on passive stretching of the muscles. Decreased capillary refill and diminished distal pulses are late signs and signify severe compartment syndrome.

Pathophysiology

Tissue perfusion within the muscle compartment is dependent on the arteriovenous pressure gradient across the capillary bed in relation to the compartment pressure. As the tissue pressure rises, flow across the capillary bed is impaired until the critical closing pressure is reached (around 25 to 30 mmHg), at which point the postcapillary venules collapse (Figure 2). This sets up a vicious

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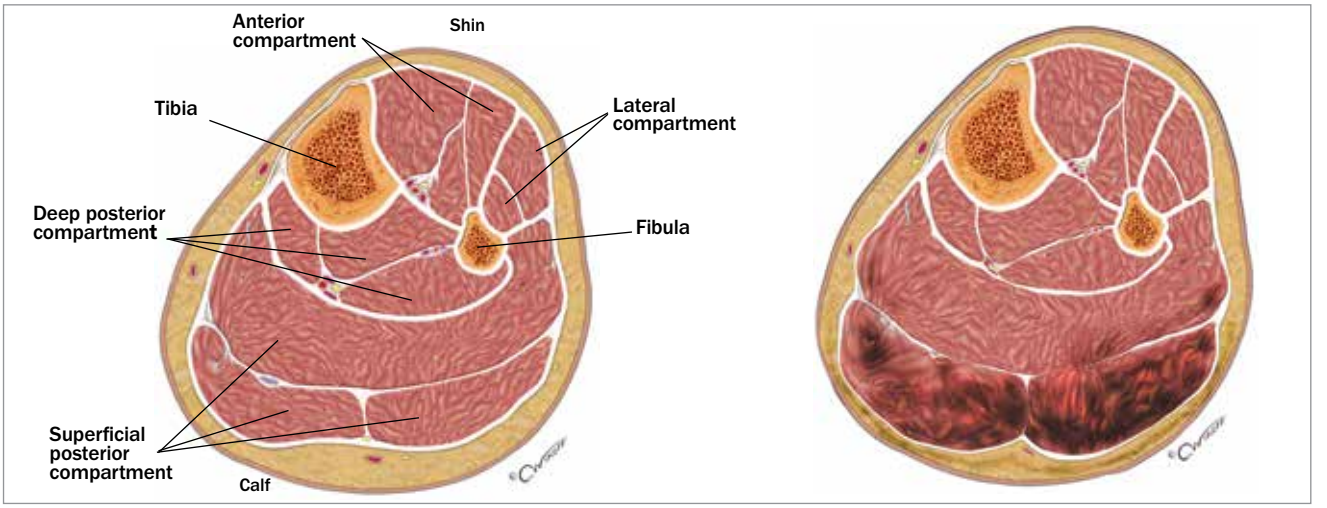

Figures 1a and b. Acute compartment syndrome in the lower leg. a (left). Normal calf showing muscle compartments. b (right). Acute compartment syndrome, showing swelling of muscles causing compression of nerves and blood vessels.

cycle where impairment of venous outflow from the compartment causes further swelling until arterial inflow is also affected and tissue death and rhabdomyolysis result (Figure 3).

Diagnosis

The diagnosis of compartment syndrome is largely a clinical one, and GPs should have a very high index of suspicion in patients with a predisposing presentation. Measuring intracompartment pressures with needle manometry can aid diagnosis, but false-positive and false-negative results limit the usefulness of this measurement in the acute setting. Performing blood or urine tests or any imaging studies in the general practice setting is rarely useful in patients with suspected acute compartment syndrome, and simply delays making a diagnosis; these investigations are, however, important in the initial hospital assessment of such patients.

The most crucial consideration in the general practice setting is that if there is any clinical reason to suspect a patient has a compartment syndrome then the patient should always be referred immediately to the emergency department for complete assessment and management as missing the diagnosis can have disastrous consequences.

With regard to the described case, the presence of dark urine indicates severe compartment syndrome with rhabdomyolysis and Colin clearly requires urgent admission to hospital for decompression fasciotomy and management of complications.

Management

Fasciotomy

The mainstay of treatment for acute compartment syndrome is the release of pressure within the affected compartments by

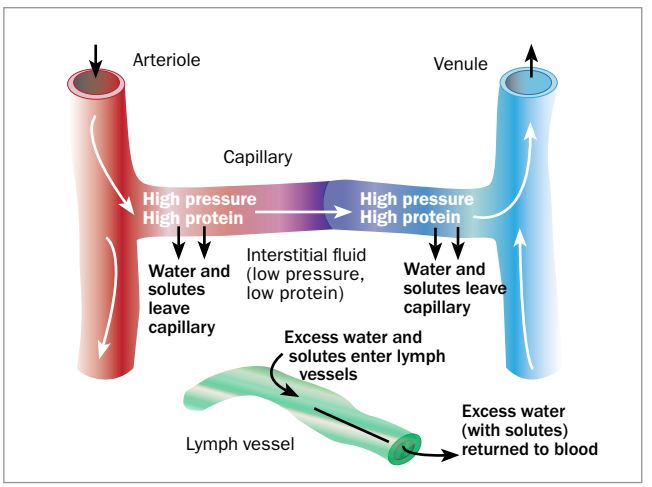

Figure 2. Tissue perfusion in acute compartment syndrome.

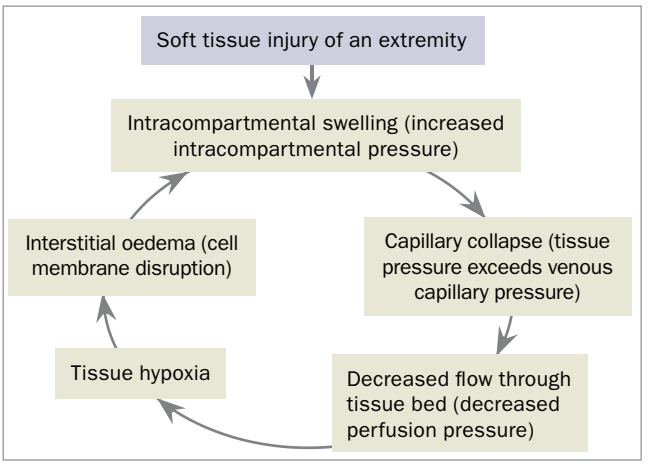

Figure 3. Acute compartment syndrome; the vicious cycle leading to further swelling and ischaemia and rhabdomyolysis if not treated.

fasciotomy to re-establish venous and arterial flow. In the lower leg, this is performed via lateral and medial incisions to release the anterior and lateral and the deep and superficial posterior compartments, respectively (Figure 4). In the thigh, the anterior and posterior compartments are decompressed via a lateral incision, and the medial compartment, which is rarely involved, by a medial incision. Compartment syndrome can also rarely affect the buttocks, feet and upper limbs.

Once the acute injury and inflammation settles, it is often possible to perform primary closure of the fasciotomy wound. If this is not possible within five to seven days, split skin grafting is often required. If there has been extensive rhabdomyolysis, debridement of the compartments may be required, and rarely amputation. In most patients, however, provided diagnosis and management have occurred promptly then these issues are avoided, although persistent neurological deficit is common as the nerves recover poorly following an ischaemic event. The common peroneal nerve is particularly vulnerable to damage because it courses through the anterior compartment; foot drop and associated numbness of the foot often occur with compartment syndrome in this muscle compartment.

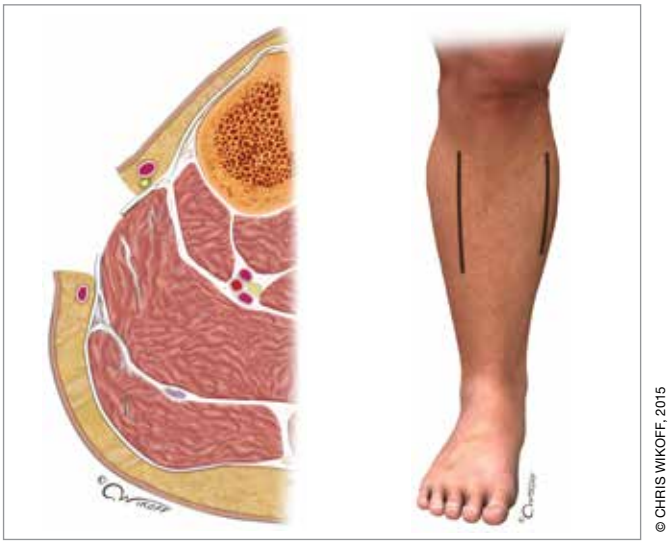

Figure 4. Fasciotomy incisions for acute compartment syndrome in the lower leg. a (left). Medial incision for release of the posterior compartments. b (left). Fasciotomy incisions for release of anterior and lateral compartments (lateral incision) and posterior compartments (medial incision).

Managing the complications of compartment syndrome

After surgical decompression, it is important to manage the complications of acute compartment syndrome, especially if rhabdomyolysis has occurred, as it has in this patient.

In rhabdomyolysis, myoglobin is released from the ischaemic muscle and is excreted in the urine, giving it a dark rust/brown appearance. Myoglobin is detected on biochemical assay, and tests positive for haemoglobin on dipstick urinalysis. Myoglobinaemia can also be detected in blood by measurement of creatine kinase, elevated levels of this enzyme being associated with the release of myoglobin from muscle cells. Myoglobin is toxic to the renal tubules, and acute renal failure can result. It is therefore essential to ensure that patients maintain with a urine output of at least 100 mL/h to flush the myoglobin through the kidneys. Alkalinisation of the urine with intravenous sodium bicarbonate can improve the solubility of myoglobin in urine and aid excretion. Haemodialysis is of limited value in patients with myoglobinaemia due to the large size of the myoglobin molecule preventing it readily passing across the dialysis membrane.

In addition to myoglobin, other toxic metabolites and electrolytes (such as potassium) can be released during rhabdomyolysis, and careful monitoring is required to ensure myocardial toxicity is not missed. Hyperkalaemia can be treated with binding agents such as resonium, insulin and dextrose infusions, or haemodialysis in severe cases.

Chronic exertional compartment syndrome

As mentioned earlier, chronic exertional compartment syndrome is a more transient form of compartment syndrome than the acute form. The symptoms are reproducible and brought on by exercise, and relieved after several minutes of rest; the patient has no symptoms when not exercising, and there are no abnormalities on clinical examination. Compared with the acute form, the diagnosis of chronic exertional compartment syndrome is much more difficult to make, and other causes of exertional leg pain such as claudication and neurogenic causes need to be excluded. Measuring compartment pressures before exercise, immediately after exercise and after several minutes of rest (delayed pressure) can be useful in making a diagnosis. Treatment is once again fasciotomy, although this can usually be performed remotely via small skin incisions.

Chronic compartment syndrome has been discussed in detail in a previous article published in *Medicine Today* (December 2015 issue).

Conclusion

The presented case scenario highlights the very rare case where exertional compartment syndrome has progressed to full-blown acute compartment syndrome with progressive swelling and pain over several days. The presence of dark urine indicates severe compartment syndrome with rhabdomyolysis and the patient requires urgent decompression fasciotomy and management of complications. Fortunately, this is a very rare presentation to encounter in the general practice setting, but it does emphasise the need for a high index of suspicion for compartment syndrome. MT

Further reading

Burne S. Chronic exertional compartment syndrome: stopping runners in their tracks. Medicine Today 2015; 16(12): 65-68.

COMPETING INTERESTS: None.