Compartment syndrome

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How to use this handout?

This handout is part of the AO Trauma Course for ORP. The left column is the information as it may be given during the lecture. The column on the right gives you space to make personal notes.

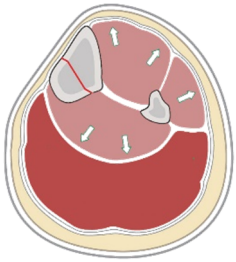
Learning outcomes

At the end of this lecture you will be able to:

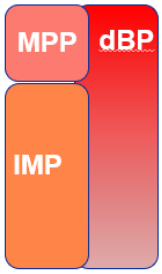
- Diagnose a compartment syndrome
  - Outline anatomy
  - Outline pathophysiology
  - Recognize as a surgical emergency
  - Interpret critical signs
- List causes
- Support correct management

What is compartment syndrome?

A compartment syndrome is an increase of the pressure in a muscular compartment that exceeds the pressure within the capillaries.
This syndrome occurs when the pressure within a closed osteo-fascial muscle compartment rises above the Muscle Perfusion Pressure (MPP) and so deprives the muscle of oxygen.



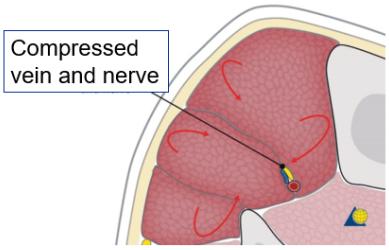
What's the normal Muscle Perfusion Pressure (MPP)?



The muscle perfusion pressure (MPP) is the diastolic blood pressure (dBP) minus the pressure in the muscle compartment itself (IMP)

If **MPP** is below 30mm mercury, muscle hypoxia will occur (acute compartment syndrome (ACS)).

Serious decrease in the MPP, over several hours, can result in irreversible damage to the muscle tissue, as well as the nerves and blood vessels traversing the affected muscle compartment.



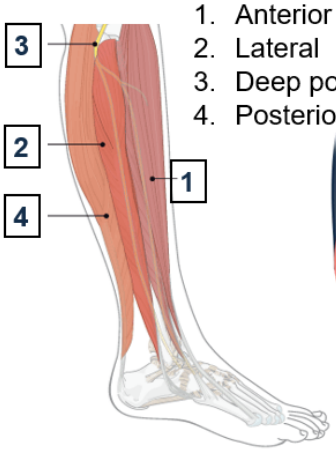
A compartment syndrome is a real orthopedic emergency.
Early recognition and treatment will save the affected limb.
Late diagnosis, or poor treatment, can end in disaster. Late diagnosis, or poor management of compartment syndrome, is a frequent cause for claims by lawyers for clinical negligence, in some societies.

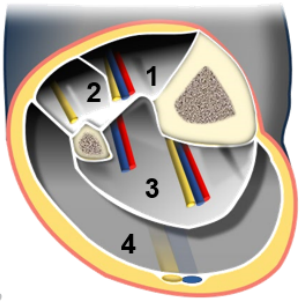
Anatomy

Compartments lower leg

The limbs have muscles that are regarded in groups that perform similar actions. Each of these groups has its distinct fascial, or osteofascial, compartment. Osteofascial compartments, or 'compartments', exist in all parts of the body. Each compartment contains muscles, nerves and blood vessels. As you can see from this pictures below, there are 4 separate osteofascial compartments in the lower leg. Often, all 4 are affected by compartment syndrome of the leg.

1. Anterior
2. Lateral
3. Deep posterior
4. Posterior

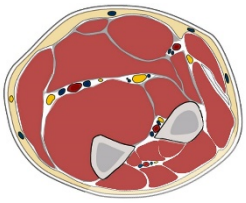




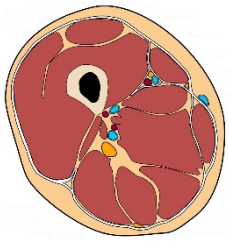
Compartments in other limbs

Similar to the leg, such muscle compartments exist in other limbs such as ….

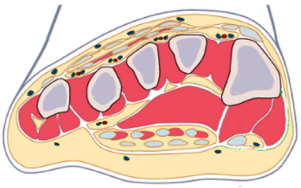
- Forearm



- Femur



- Foot



Pathophysiology

- Injury to muscles
- Reperfusion of injury
    - Return of blood flow after period of limb ischemia
- Bleeding into muscles
    - Edema
    - Swelling
- Increased pressure in compartment
    - Pressure on nerves and vein

Muscle death leads to fibrosis and ischemic contracture, as seen here in a neglected forearm flexor compartment syndrome—Volkmann's contracture.
This is a late consequence of delayed treatment.

Consequences

As muscle perfusion deteriorates, the muscle is deprived of oxygen. As this evolves, there is severe and increasing pain and, ultimately, the muscle fibres may die, leading to scarring and contracture. The early sign that must always be sought is pain in the muscle on passive stretching.
As veins become compressed, the blood cannot return which causes further muscle swelling.
When nerves are compressed, the patient often complains of pins and needles, and then, with prolonged compression, paralysis may occur.

Causes leading to compartment syndrome

There can be many causes of muscle compartment syndrome. These include

1. Open and closed fractures.

2. Tight dressings or casts, especially if pain, which is more than expected for the known pathology, increases the risk.

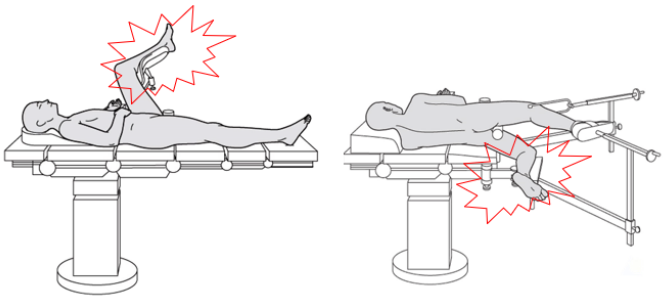
3. Reperfusion injury. If there has been an arterial disruption and a period of warm ischemia of the distal limb, the reestablishment of the circulation can cause muscle oedema, swelling and a compartment syndrome. For this reason, after vascular repair, prophylactic fasciotomy may be considered.

4. Burns will cause swelling, and in the presence of stiff burned skin and fat, which acts like a hard dressing, the pressure beneath, especially in the muscle compartments, may rise.

5. Envenomation, particularly by snake bite, can result in deep swelling.

6. Injudicious repair of a fascial defect has been known to cause a rise in pressure in the affected compartment.

7. Positioning on the OR table can also cause acute compartment syndrome by prolonged surgery in certain positions. Acute compartment syndrome of the uninjured leg can occur after prolonged surgery on a fracture table if there has been local muscle pressure as a result of muscle compression due to improper positioning. You can see how, on the picture on the left, prolonged surgery on the right leg can cause swelling to the normal left leg by direct pressure on the calf. Similarly, on the picture on the right, you can get ACS of the normal left leg after prolonged surgery in this position.



ACS in the lower extremities is a well-known complication of prolonged spinal surgery in the knee-chest position, or of prolonged surgery in the lithotomy position.

Symptoms and diagnosis

ACS is usually a clinical diagnosis, at least initially.

The first is pain out of proportion to the known injury, and especially pain on stretching the affected muscle group.

A later symptom is tingling along the nerve distribution, because of nerve compression due to swelling within the compartment that the nerve traverses.

If the nerve compromise is prolonged, it can lead to paralysis as a late feature.

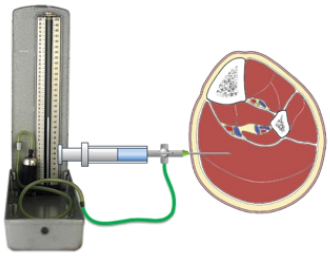
If the patient has two pain signs, ACS will be the diagnosis in 60% of the cases. If the patient has three signs, ACS will be the diagnosis in 95% of the cases. But, that may be too late.

Objective diagnosis

Measure the diastolic blood pressure, then the intramuscular pressure, to calculate the muscle perfusion pressure.

To measure the IMP, you can use a standard syringe, a three-way tap and a blood pressure manometer, or you can use the arterial pressure transducer in the anesthetic room to set up a device like this.

There are also available ready-made pressure measuring devices.

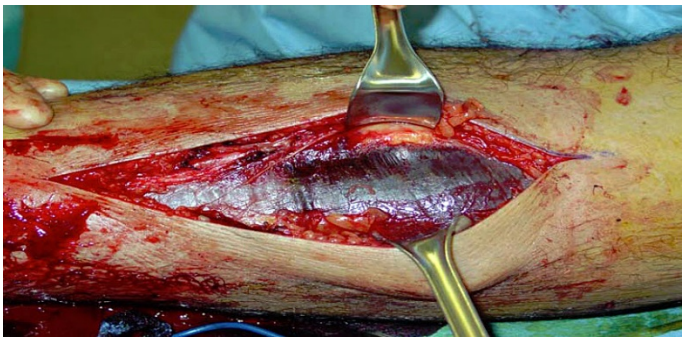


Treatment

The surgical release of the affected muscle compartments, by incising the skin and fascia over the whole length of the compartment is known as dermatofasciotomy (or fasciotomy, for short).

This is the only treatment for a confirmed, or strongly suspected, muscle compartment syndrome.

It is essential to perform this as an emergency procedure, and certainly no later than 6 hours from the onset of the condition. Basically, as soon as possible–it is a true surgical emergency.



What to do while waiting to start emergency surgery?

We all know that setting up an emergency surgical procedure takes time, so simple things help while we await surgery.

- A tight plaster must be split right down to skin and spread.
- Tight dressings must be removed.
- Elevation of the limb, but not too much, will help to reduce swelling. Too much elevation can reduce blood flow!!!
- Dealing with any hypotension will improve muscle perfusion by normalising the diastolic BP.
- Oxygen always helps.

Summary

You should now be able to

- Recognize an ACS as a surgical emergency by interpreting clinical signs
- List causes
- Support correct management

Questions

The most important clinical symptom in compartment syndrome is?

- ☐ Firm hard limb
- ☐ Muscle pain on passive stretch test
- ☐ Pulselessness

If a patient complains about pain referring to the cast on a fractured leg, you

- ☐ Document it carefully
- ☐ Give them lots of painkillers
- ☐ Inform surgeon immediately

Reflect on your own practice:

What is the procedure to follow in your hospital when a compartment syndrome is diagnosed?

Which content of this lecture will you transfer into your practice?