

T.I.G.E.R.



#1 Compartment Syndrome

Acute compartment syndrome of a limb is due to raised pressure within a closed fascial compartment causing local ischaemia and hypoxia. This is most often seen after tibial or forearm fractures and crush injuries. Other cause may include: restrictive dressings, prolonged immobilisation or reperfusion of ischaemic limbs. Early diagnosis and treatment is vital to avoid severe disability. Pulses are usually present in compartment syndrome. Absent pulses are usually due to systemic hypotension, arterial occlusion or vascular injury.



Situation

- Trauma patient in the Emergency Department Resuscitation Area.
- Clinician trained in the recognition of compartment syndrome.
- Senior Orthopaedic (+/- Plastic Surgery) support available.
- A confirmed compartment syndrome should be escalated to the duty consultant responsible for the patient.



Patient

Trauma patients at risk of compartment syndrome:

- Long bone fracture.
- Soft tissue injury of a limb.
- Crush injury of a limb.
- Restrictive plaster cast or dressings.
- Circumferential burn to a limb.
- Reperfusion after tourniquet / REBOA or other restriction to blood flow.
- Reperfusion following repair of vascular injury or management of an arterial thrombosis to a limb.
- Whilst compartment pressure monitoring can be helpful the mainstay of decision making is a clinical diagnosis.

This TIGER is based on BOAST Guidance for the Management of Compartment Syndrome – see Appendix for the original document.

PROCEDURE

Measurement of Limb Compartment Pressures



Assessment

- There must be a low threshold for considering compartment syndrome in trauma patients.
- Important information that should be recorded:
 - Time and mechanism of injury (not the time the patient arrived in the ED)
 - Time evaluated, name, grade & specialty.
 - Level of pain (when considered a risk a pain chart should be started), pain may be out of proportion to the initial injury, may be worse on passive movement of the muscles.
 - Level of consciousness.
 - Response to analgesia
 - Capillary refill & presence of distal pulses (NOTE: Pulses are usually present in compartment syndrome).
 - Whether regional anaesthesia has been given (when considered a risk, regional anaesthesia should not be used)
- Routine limb observations must be commenced and recorded hourly, with senior medical review if pain scores are not reducing.
- Remove all circumferential dressings and elevate limb to the 'level of the heart'.
- Re-assess at 30mins.



Measurement of Compartment Pressure

- Set up the arterial line transducer and tubing in the normal way.
- Attach the 3-way tap to the tubing and attach the needle and syringe to the 3-way tap.
- Flush the system with saline from the pressure bag and 'Zero' the monitor.
- Insert the needle into the desired compartment. Using the 3-way tap inject 0.1ml saline from the syringe then switch the 3-way tap to the monitor.
- Record the reading.

Normal compartment pressures are 0-8mmHg.

Pressure >30mmHg indicates compartment syndrome & is an indication for fasciotomy.

A difference between diastolic BP & compartment pressure of <30mmHg indicates an increased risk of compartment syndrome. A decision over the need for surgical decompression or further monitoring for this group of patients should be made at Consultant level.

EQUIPMENT



Measurement of Limb Compartment Pressures

- Bedside monitor with arterial line transducer setting.
- Arterial line transducer set.
- 3-way tap.
- 10mls syringe with sterile saline.
- 20G needle.
- Sterile field inc. gown & gloves for operator.
- Skin prep (Chlorhexidine 2%)
- Local anaesthetic (1% Lidocaine)
- Small dressing

CHECKLIST



Measurement of Limb Compartment Pressures

This is designed as a challenge-response checklist in which the operator should be responding to the questions.

- | | |
|---|-------|
| • Correct patient (Give name & MRN) | CHECK |
| • Correct limb & side (State location) | CHECK |
| • Pressure monitoring device set up correctly | CHECK |
| • Sterile field and skin prep available | CHECK |

Anatomy



Measurement of Limb Compartment Pressures

Lower Limb Anterior Compartment

Position the patient supine.

Palpate the anterior border of the tibia at the junction of the proximal and middle thirds of the lower leg.

Insert the needle 1 cm lateral to the anterior border of the tibia (the most lateral part of the tibia), perpendicular to the skin.

Advance the needle to a depth that allows a rise in pressure when you press with your finger over the anterior compartment just proximal or distal to the needle insertion site, or with plantarflexion of the foot or dorsiflexion of the foot.

Lower Limb Deep Posterior Compartment

Position the patient supine with the lower leg slightly elevated.

Palpate the medial border of the tibia at the junction of the proximal and middle thirds of the lower leg.

Insert the needle just posterior to the medial border of the tibia.

Advance the needle perpendicularly to the skin toward the posterior border of the fibula to a depth of 2 to 4 cm.

Confirm needle placement by a rise in pressure during toe extension and ankle eversion.

Lower Limb Superficial Posterior Compartment

Position the patient prone.

Visualize a transverse line at the level of the junction between the proximal and the middle thirds of the lower leg.

Insert the needle at this level, 3 to 5 cm on either side of the anatomic midline of the lower leg.

Advance the needle perpendicular to the skin and direct it toward the centre of the lower leg to a depth of 2 to 4 cm.

Confirm needle placement by a rise in pressure when you press with your finger over the posterior compartment just inferior or superior to the needle insertion point and with dorsiflexion of the foot.

Lower Limb Lateral Compartment

Position the patient, usually supine, on the stretcher. Elevate the lower leg slightly.

Palpate just anterior to the midline in the sagittal plane.

Insert needle just anterior to the posterior border of the fibula, on the lateral aspect of the leg.

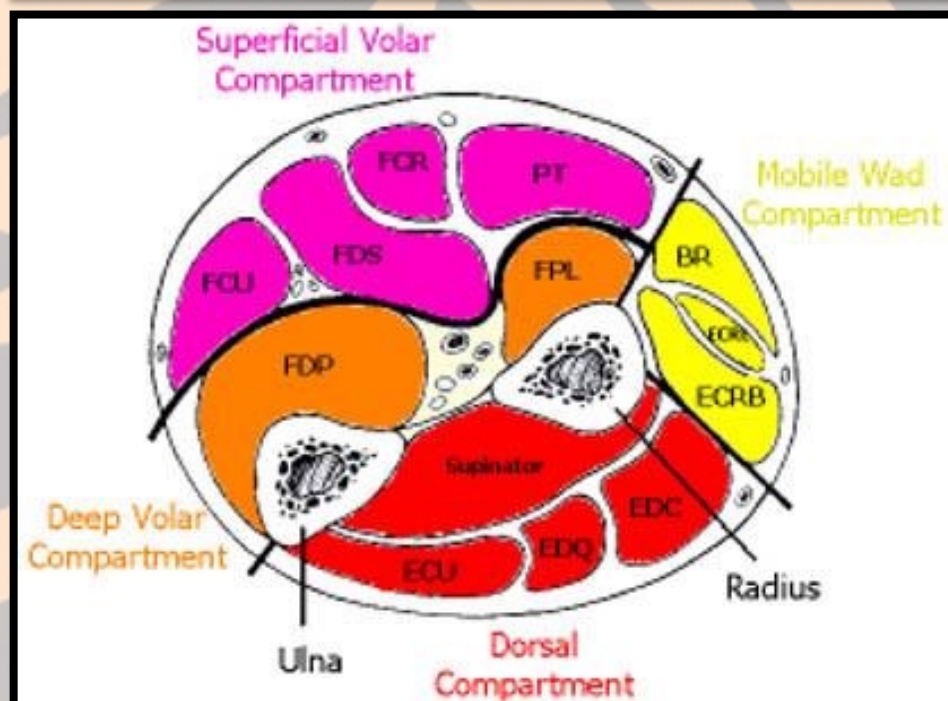
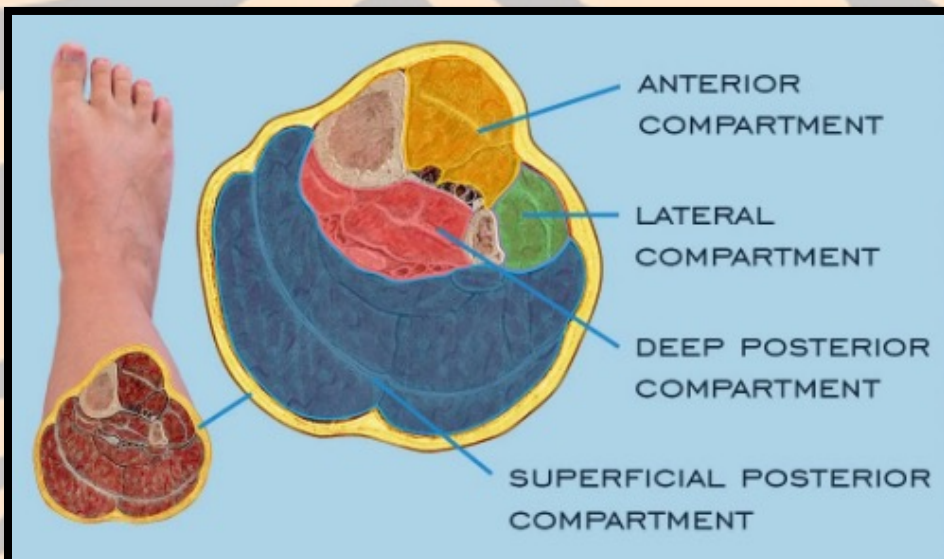
Advance the needle perpendicularly to the skin and direct it toward the fibula to a depth of 1 to 1.5 cm. If the needle contacts bone, withdraw it 0.5 cm.

Confirm needle placement by a rise in pressure when you press with your finger over the lateral compartment just inferior or superior to the needle entry with inversion of the foot and ankle.

Fasciotomy



- Should occur in theatres.
- Should open all compartments in the affected part of the limb.
- Obviously necrotic tissue should be debrided.
- Dressing with paraffin gauze and bandage, or topical negative pressure.
- Post-fasciotomy limbs should be nursed in the elevated position.
- Relook and closure at 24-48hrs.
- Closure may include suturing or skin grafting.
- Measure Creatine Kinase as a marker of muscle injury and breakdown.



BRITISH ORTHOPAEDIC ASSOCIATION STANDARDS for TRAUMA

Diagnosis and Management of Compartment Syndrome of the Limbs

Background and justification

Acute compartment syndrome of a limb is due to raised pressure within a closed fascial compartment causing local tissue ischaemia and hypoxia. In clinical practice, it is most often seen after tibial and forearm fractures, high-energy wrist fractures and crush injuries. Other important causes include restrictive dressings or casts, prolonged immobilization and reperfusion of ischaemic limbs. Early diagnosis and treatment is vital to avoid severe disability. Pulses are normally present in compartment syndrome. Absent pulses are usually due to systemic hypotension, arterial occlusion or vascular injury.

Inclusions

Patients of all ages.

Standards for Practice

1. Assessment for compartment syndrome should be part of the routine evaluation of patients who present with significant limb injuries, after surgery for limb injuries, and after any prolonged surgical procedure which may result in hypoperfusion of a limb.
2. Clear documentation should include: the time and mechanism of injury, time of evaluation, level of pain, level of consciousness, response to analgesia and whether a regional anaesthetic has been given.
3. The key clinical findings are pain out of proportion to the associated injury and pain on passive movement of the muscles of the involved compartments. Limb neurology and perfusion, including capillary refill and distal pulses, should be clearly documented but do not contribute to early diagnosis of the condition.
4. Patients documented to be at risk of compartment syndrome should have routine nursing limb observations for these early signs and these should be recorded. These observations should be performed hourly whilst the patient is deemed still to be at risk. If pain scores are not reducing, then senior clinical review is mandated.
5. In high-risk patients, regional anaesthesia should be avoided as it can mask the symptoms of compartment syndrome. In addition patient-controlled analgesia with intravenous opiates can also mask the symptoms. When evaluating these patients, the rate and dose of opiates and other analgesics must be taken into consideration and recorded in the medical records.
6. Patients with symptoms or clinical signs of compartment syndrome should have all circumferential dressings released to skin and the limb elevated to heart level. Measures should be taken to maintain a normal blood pressure. Patients should be re-evaluated within 30 minutes. If symptoms persist then urgent surgical decompression should be performed. Alternatively, in situations where the clinician is not completely convinced by the clinical signs, compartment pressure measurements should be undertaken. All actions should be recorded in the medical records.
7. Compartment syndrome is a surgical emergency and surgery should occur within an hour of the decision to operate.
8. For patients with diagnostic uncertainty and those with risk factors where clinical assessment is not possible (e.g. patients with reduced level of consciousness), hospitals should have a clear, written management policy.
9. All hospitals treating patients with significant injuries should have the capability to perform intracompartmental pressure monitoring. The pressure sensor should be placed into the compartment(s) suspected of being abnormal or at risk.
10. All patients having compartment pressure measurements should have their diastolic blood pressure recorded; a difference between the diastolic blood pressure and the compartment pressure of less than 30 mmHg suggests an increased risk of compartment syndrome. It is recommended these should either proceed to surgical decompression or continue to be monitored depending on the consultant decision.
11. If the absolute compartment pressure is greater than 40 mmHg, with clinical symptoms, urgent surgical decompression should be considered unless there are other life-threatening conditions that take priority.
12. Surgery should involve immediate open fascial decompression of all involved compartments, taking into account possible reconstructive options. Necrotic muscle should be excised. The compartments decompressed must be documented in the operation record. All patients should undergo re-exploration at approximately 48 hours, or earlier if clinically indicated. Early involvement by a plastic surgeon may be required to achieve appropriate soft tissue coverage.
13. For lower leg fasciotomies it is recommended to perform a two-incision four-compartment decompression (BOAST 4).
14. There is no consensus for the management of foot compartment syndrome.
15. Patients with late presentation or diagnosis (greater than 12 hours) have a high risk of complications with surgery. Decision-making is difficult and should involve two consultants. Non-operative management is an option.

Evidence Base

Studies with level-1 evidence are lacking. Predominantly retrospective series, with some good prospective studies, meta-analyses and reviews. Review date: December 2016. For correspondence, contact: policy@boa.ac.uk

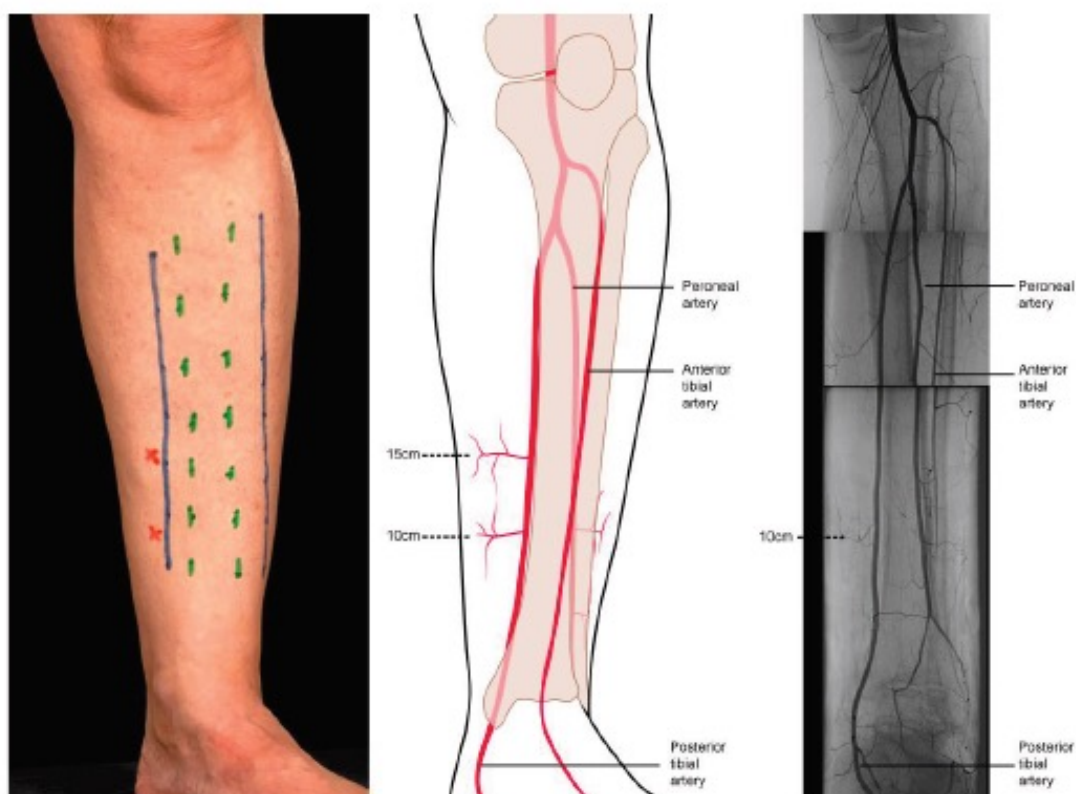


Figure showing recommended incisions for wound debridement and fasciotomies in the leg. The medial incision alone is usually sufficient for debridement and preserves the perforators arising from the posterior tibial vessels, which form the basis of local fasciocutaneous flaps. It also provides access to the posterior tibial artery and venae comitantes when required as recipient vessels for free flaps. The lateral incision is used for decompression of the anterior and peroneal compartments in patients with compartment syndrome. (A) Margins of subcutaneous border of the tibia marked in green, access incisions marked in blue and perforators arising from the medial side as red crosses. (B) Line drawing depicting the location of the perforators, with approximate indicative distances from the tip of the medial malleolus. (C) Montage of arteriogram.

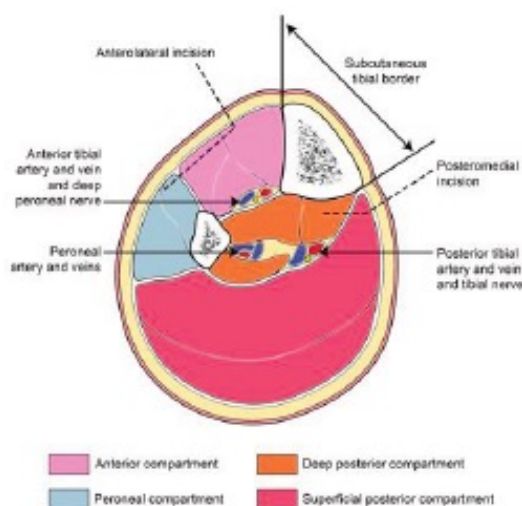


Figure showing cross section through leg showing incisions to decompress all four compartments