

13. (a) Management of open fractures

WOUND management

1. Photograph of the wound
2. Remove gross contamination (i.e. leaves, etc.)
3. Cover the wound with saline soaked gauze dressings but do not explore or irrigate.
4. Leave wound and dressing undisturbed thereafter.
5. Check Tetanus status
6. Give ASAP Antibiotics IV according to local guidelines. Leeds as follows:
 - a. **Co-Amoxiclav** 30mg/kg IV (max 1.2g) tds
 - b. **True penicillin allergy: Clindamycin** 6.25 mg/kg IV (max 600mg) qds and **Gentamicin** 2.5mg/kg
7. Continue Antibiotics IV for 72hrs or until definitive skin closure
8. At Induction: single doses of **Gentamicin** 2.5mg/kg and **Teicoplanin** 10mg/kg IV (max 400mg) for initial debridement and every secondary procedure until definitive skin closure

FRACTURE management

1. Neurovascular Examination & Documentation
2. Align and Splint the fracture
3. Repeat Neurovascular Examination
4. XRAYs – CT imaging as required
5. Document all findings

DEFINITIVE management

1. Decision balanced between oncall MTC Consultant, Plastic Surgery and Vascular Surgery consultants. Complex injuries, particularly those potentially requiring local or free tissue transfer, or with neurovascular injury should be immediately transferred (A&E to A&E) to the paediatric MTC offering these resources.
2. Timing depends on other injuries and available expertise.
3. Bone and soft tissue debridement, Wound coverage and fixation should be within 24hrs
4. Severely contaminated injuries, farmyard / aquatic involvement, compartment syndrome, remain a surgical Emergency and **MUST** be Debrided in Theatres **ASAP**
5. **Definitive soft tissue Coverage – Fixation** optimally within 72hrs



BOAST 4: THE MANAGEMENT OF SEVERE OPEN LOWER LIMB FRACTURES

Background and Justification:

The British Orthopaedic Association and the British Association of Plastic, Reconstructive and Aesthetic Surgeons have reviewed their 1997 guidance and now publish a review of all aspects of the acute management of these injuries using an evidence-based approach, leading to the "Standards for the Management of Open Lower Limb Fractures," which are free to download from www.boa.ac.uk and www.bapras.org.uk. This BOAST is derived from these standards. Contrary to traditional teaching, best outcomes are achieved by timely, specialist surgery rather than emergency surgery by less experienced teams.

Included Patients:

All patients with high energy open fractures as manifest by the following injury patterns:

- Fracture Pattern:
- Multifragmentary (comminuted) tibial fracture with fibular fracture at same level
 - Segmental fractures
 - Fractures with bone loss, either from extrusion or after debridement
- Soft tissue injury:
- Swelling or skin loss, such that direct, tension-free wound closure is not possible
 - Degloving
 - Muscle injury that requires excision of devitalised muscle via wound extensions
 - Injury to one or more major arteries of the leg
 - Wound contamination with marine, agricultural or sewage material

Standards for Practice Audit:

1. Intravenous antibiotics are administered as soon as possible, as per local antimicrobial guidelines, and are continued until wound debridement.
2. The vascular and neurological status of the limb is assessed systematically and repeated at intervals, particularly after reduction of fractures or the application of splints
3. Vascular impairment requires immediate surgery and restoration of the circulation using shunts, ideally within 3-4 hours, with a maximum acceptable delay of 6 hours of warm ischaemia
4. Compartment syndrome also requires immediate surgery, with 4 compartment decompression via 2 incisions (see overleaf)
5. Urgent surgery is also needed in some multiply injured patients with open fractures or if the wound is heavily contaminated by marine, agricultural or sewage matter.
6. A combined plan for the management of both the soft tissues and bone is formulated by the plastic and orthopaedic surgical teams and clearly documented
7. The wound is handled only to remove gross contamination and to allow photography, then covered in saline-soaked gauze and an impermeable film to prevent desiccation
8. The limb, including the knee and ankle, is splinted
9. Centres that cannot provide combined plastic and orthopaedic surgical care for severe open tibial fractures have protocols in place for the early transfer of the patient to an appropriate specialist centre
10. The primary surgical treatment (wound excision and fracture stabilisation) of severe open tibial fractures only takes place in a non-specialist centre if the patient cannot be transferred safely
11. The wound, soft tissue and bone excision (debridement) is performed by senior plastic and orthopaedic surgeons working together on scheduled trauma operating lists within normal working hours and within 24 hours of the injury unless there is marine, agricultural or sewage contamination. The 6 hour rule does not apply for solitary open fractures. Antibiotics as per local antimicrobial guidelines are administered at wound excision and continued for 72 hours or definitive wound closure, whichever is sooner
12. If definitive skeletal and soft tissue reconstruction is not to be undertaken in a single stage, then vacuum foam dressing or an antibiotic bead pouch is applied until definitive surgery.
13. Definitive skeletal stabilisation and wound cover are achieved within 72 hours and should not exceed 7 days.
14. Vacuum foam dressings are not used for definitive wound management in open fractures.
15. The wound in open tibial fractures in children is treated in the same way as adults

13. (b) Management of extremity compartment syndrome

Compartment syndrome is a severe time-dependent condition characterised by challenges to its diagnostics, straight forward therapeutic management, and detrimental irreversible consequences if it is neglected.

It arises from an increase in intra-fascial pressure in the compartments. It can affect all regions of the extremities, primarily the tibial region. Causes include direct trauma, burns and compression as a result of prolonged positioning (eg. lying on leg in an unconscious state).

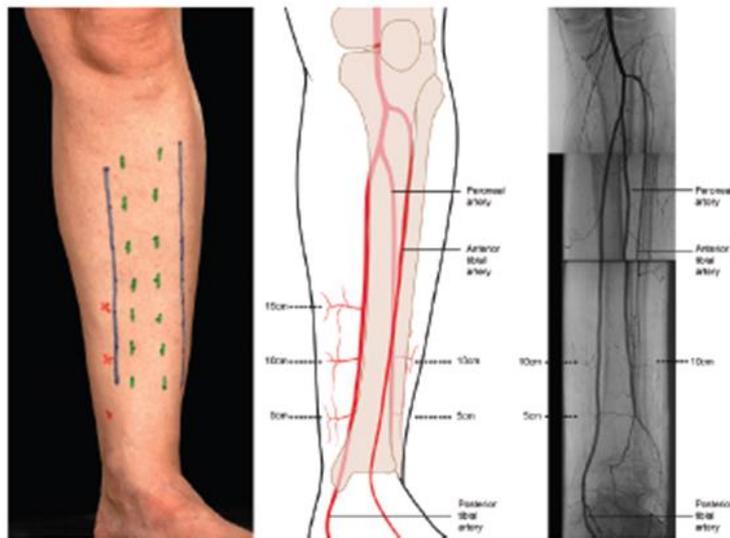
Recommended standards (adaptation of BOAST 10)

- Assessment for compartment syndrome must be part of the routine evaluation of patients who present with significant limb injuries, OR after surgery for limb injuries, AND after any prolonged surgical procedure which may result in hypo perfusion of a limb.
- Clear documentation should include:
 - Time and Mechanism of injury
 - Time of evaluation
 - Level of Pain
 - Level of Consciousness
 - Response to Analgesia
 - Whether a Regional Anaesthetic is given.
- The key clinical findings are
 - Pain out of proportion to the associated injury
 - Pain on passive movement of the muscles of the involved compartments
 - Tense compartments painful to press
 - Limb neurology and perfusion, including capillary refill and distal pulses, should be clearly documented but do not contribute to early diagnosis of the condition.
- Patients documented to be AT RISK for 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 i.e. ONCALL MTC / ORTHOPAEDIC CONSULTANT or ONCALL SENIOR REGISTRAR is mandated.
- 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.
- 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.

- Compartment syndrome is a surgical emergency and surgery should occur within an hour of the decision to operate. If the patient is in a Trauma Unit and the local expertise allows and when other life-threatening injuries are not present, then the decompressive surgery should be undertaken in the trauma unit rather than enforcing a delay with a transfer to the MTC.
- FOR PATIENTS WITH DIAGNOSTIC UNCERTAINTY and those with risk factors where clinical assessment is not possible (e.g. patients with reduced level of consciousness):
 - Intra-fascial pressures should be measured objectively and documented without delay
 - Compartment pressures exceeding 40 mmHg, OR, in the case of hypotension, exceeding a difference between the DBP (diastolic) and the intra-fascial chamber pressure of <30 mmHg are classed as critical values and are an indication for fasciotomies in the unconscious patient
 - It must be noted that the accuracy of the compartment pressure measurement depends on the examiner and can be false-positive/negative.
 - Following measurement - should either proceed to surgical decompression or continue to be monitored. This decision should be made by an orthopaedic / plastic surgical or vascular consultant.

Surgery

- 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.
- In the presence of a fracture skeletal stability should be provided, such as with monolateral external fixation.
- 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.
- For lower leg fasciotomies it is recommended to perform a two-incision four-compartment decompression (BOAST 4).
- 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.
- In case of vascular reconstruction the indication for fasciotomies should be considered and applied early; if necessary it should be carried out even before the vascular reconstruction.
- Postoperatively the patient should be covered with antibiotics as per the paediatric open fracture guidelines.



Recommended incisions for fasciotomy and wound extensions. (a) Margins of subcutaneous border of tibia marked in green, fasciotomy incisions in blue and the perforators on the medial side arising from the posterior tibial vessels in red. (b) line drawing depicting the location of the perforators. (c) montage of an arteriogram. The 10cm perforator on the medial side is usually the largest and most reliable for distally-based fasciocutaneous flaps. In this patient, the anterior tibial artery had been disrupted following an open dislocation of the ankle; hence the poor flow evident in this vessel in the distal 1/3 of the leg. The distances of the perforators from the tip of the medial malleolus are approximate and vary between patients. It is essential to preserve the perforators and avoid incisions crossing the line between them.

