



Limb Injury

Source Document:	North West Children's Major Trauma Operational Delivery Network (ODN) Clinical Guidelines
Version:	4
Ratification Date:	10/11/2023

Limb Injury

Emergency Management of Open Fractures

Aims of treatment:

1. Control haemorrhage.
2. Minimise soft tissue injury.
3. Prevent infection, non-union, deformity and limb length discrepancy
4. Reduce / Treat pain

Treatment Algorithm

1. Initial primary survey assessment
2. Control external haemorrhage
3. Administer analgesia
4. Establish IV access and obtain samples for basic blood tests including group and save.
5. Assess and document Neurovascular status
6. Remove GROSS contamination from wound*
7. Photograph and cover wound
8. Straighten and align limb (if appropriate and indicated)
9. Splint fracture
10. Administer IV antibiotics +/- tetanus prophylaxis*
11. Obtain radiographs
12. Notify:
 - Orthopaedic Registrar
 - Plastics
 - +/- Vascular surgery"

*Please note there is a global shortage of immunoglobulin products and tetanus immunoglobulin should only be used when indicated in accordance with this guidance <https://www.gov.uk/government/publications/tetanus-advice-for-health-professionals>. Supply may be required from Pharmacy.

Post exposure management for Tetanus Prone Wounds

Immunisation Status	Immediate treatment				Later treatment
	Clean wound ¹	Tetanus Prone		High risk tetanus prone	
Those aged 11 years and over, who have received an adequate priming course of tetanus vaccine ¹ with the last dose within 10 years	None required	None required		None required	Further doses as required to complete the recommended schedule (to ensure future immunity)
Children aged 5-10 years who have received priming course and pre-school booster					
Children under 5 years who have received an adequate priming course					
Received adequate priming course of tetanus vaccine ³ but last dose more than 10 years ago	None required	Immediate reinforcing dose of vaccine		Immediate reinforcing dose of vaccine	
Children aged 5-10 years who have received an adequate priming course but no preschool booster <small>(Includes UK born after 1961 with history of accepting vaccinations)</small>					
Not received adequate priming course of tetanus vaccine ³ <small>(Includes uncertain immunisation status and/or born before 1961)</small>	Immediate reinforcing dose of vaccine	Immediate reinforcing dose of vaccine	One dose of human tetanus immunoglobulin ² in a different site	Immediate reinforcing dose of vaccine	

¹ Clean wounds are defined as wounds less than six hours old, non-penetrating with negligible tissue damage.

² If TIG is not available, HNIG may be used as an alternative.

³ At least three doses of tetanus vaccine at appropriate intervals. This definition of "adequate course" is for the risk assessment of tetanus-prone wounds only. The full UK schedule is five doses of tetanus containing vaccine.

Patients who are severely immunosuppressed may not be adequately protected against tetanus, despite having been fully immunised and additional booster doses or treatment may be required.

- Control haemorrhage with direct pressure, or as a last resort in torrential haemorrhage apply a tourniquet. If arterial injury is suspected early involvement of a vascular surgeon is essential to avoid irreversible tissue damage. Never try to clamp bleeding vessels blindly in ED.
- Palpate and mark dorsalis pedis +/- posterior tibial pulses in lower limbs and radial in upper limbs. If difficult to palpate use a handheld Doppler probe. Assessment of compartment syndrome should be part of this evaluation and should be considered in the presence of pain out of proportion to the injury, or on passive movement of the muscles of the associated compartment. Any concerns should warrant immediate involvement of the on call orthopaedic team
- Use a sterile saline-soaked gauze (**NOT** betadine) and cover with an adhesive dressing (e.g. tegaderm/opsite).
- REASSESS AND DOCUMENT NEUROVASCULAR STATUS**
- Administer IV/IO antibiotics as per local guidelines

Timely plastic surgery involvement is essential in severe soft tissue injury or the presence of peripheral nerve injury. Peripheral nerve injury is suspected when a wound is near a nerve or associated with objective neurological deficit.

BRITISH ORTHOPAEDIC ASSOCIATION & BRITISH ASSOCIATION OF PLASTIC, RECONSTRUCTIVE & AESTHETIC SURGEONS AUDIT STANDARDS for TRAUMA

DEC 2017

Open Fractures

Background and justification

Open fractures may require timely multidisciplinary management. The consequences of infection, can be great both for the individual patient and the community. Trauma networks and hospitals require the appropriate pathways and infrastructure, to manage these patients, to enable optimum recovery and to minimise the risk of infection.

Inclusions:

All patients with open fractures of long bones, hind foot or midfoot (excluding hand, wrist, forefoot or digit).

Standards for Practice

1. Patients with open fractures of long bones, hind foot or midfoot should be taken directly or transferred to a specialist centre that can provide Orthoplastic* care. Patients with hand, wrist, forefoot or digit injuries may be managed locally following similar principles.
2. Intravenous prophylactic antibiotics should be administered as soon as possible, ideally within 1 hour of injury.
3. There should be a readily accessible published network guideline for the use of antibiotics in open fractures.
4. The examination of the injured limb should include assessment and documentation of the vascular and neurological status. This should be repeated systematically, particularly after reduction manoeuvres or the application of splints. Management of suspected compartment syndrome should follow [BOAST guidelines](#).
5. The limb should be re-aligned and splinted.
6. Patients presenting with arterial injuries in association with their fracture should be treated in accordance with the [BOAST for arterial injuries](#).
7. In patients where an initial "Trauma CT" is indicated there should be protocols to maximise the useful information and minimise delay:
 - The initial sequence should include a head to toes scanogram. This should be used with clinical correlation to direct further specific limb sequences during that initial CT examination.
 - There should be a local policy on the inclusion of angiography in any extremity CT related to open fractures.
8. Prior to formal debridement the wound should be handled only to remove gross contamination and to allow photography, then dressed with a saline-soaked gauze and covered with an occlusive film. 'Mini-washouts' outside the operating theatre environment are not indicated.
9. All trauma networks must have information governance policies in place that enable staff to take, use and store photographs of open fracture wounds for clinical decision-making 24 hours a day.
10. Photographs of open fracture wounds should be taken when they are first exposed for clinical care, before debridement and at other key stages of management. These should be kept in the patient's records.
11. The formation of the management plan for fixation and coverage of open fractures and surgery for initial debridement should be undertaken concurrently by consultants in orthopaedic and plastic surgery (a combined orthoplastic approach).
12. Debridement should be performed using fasciotomy lines for wound extension where possible (see overleaf for recommended incisions for fasciotomies of the leg)
 - Immediately for highly contaminated wounds (agricultural, aquatic, sewage) or when there is an associated vascular compromise (compartment syndrome or arterial disruption producing ischaemia).
 - within 12 hours of injury for other solitary high energy open fractures
 - within 24 hours of injury for all other low energy open fractures.
13. Once debridement is complete any further procedures carried out at that same sitting should be regarded as clean surgery; i.e. there should be fresh instruments and a re-prep and drape of the limb before proceeding.
14. Definitive soft tissue closure or coverage should be achieved within 72 hours of injury if it cannot be performed at the time of debridement
15. Definitive internal stabilisation should only be carried out when it can be immediately followed with definitive soft tissue cover.
16. When a decision whether to perform limb salvage or delayed primary amputation is indicated, this should be based on a multidisciplinary assessment involving an orthopaedic surgeon, a plastic surgeon, a rehabilitation specialist, the patient and their family or carers.
17. When indicated, a delayed primary amputation should be performed within 72 hours of injury.
18. Each trauma network should submit appropriate data to the TARN, monitor its performance against national standards and audit its outcomes.
19. All patients should receive information regarding expected functional recovery and rehabilitation, including advice about return to normal activities such as work and driving.

*The BAPRAS/BOA group recommend that for clarity the narrative description of an Orthoplastic Service by NICE is broken into its component parts as follows: a combined service of Orthopaedic and Plastic Surgery Consultants; sufficient combined operating lists with consultants from both specialties to meet the standards for timely management of open fractures; scheduled, combined review clinics for severe open fractures; specialist nursing teams able to care for both fractures and flaps. In addition, an effective orthoplastic service will also: submit data on each patient to the national trauma database (TARN) and hold regular clinical audit meetings with both orthopaedic and plastic surgeons present. Please note: the definition of an Orthoplastic Centre was updated in November 2019.

Evidence base:

NICE Complex fracture guideline <https://www.nice.org.uk/guidance/NG37/chapter/recommendations>

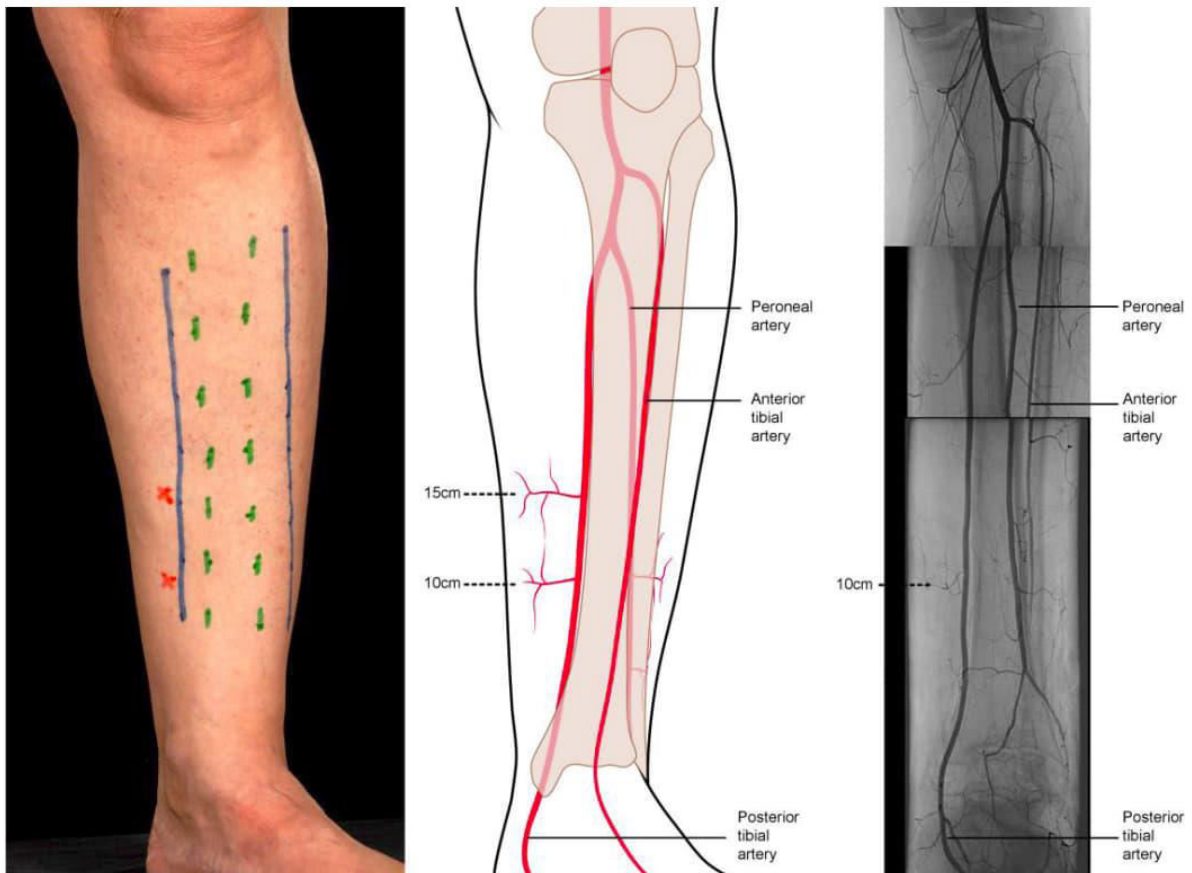


Figure showing recommended incisions for wound debridement and fasciotomies in the leg. The medial incision alone is usually sufficient for debridement and preserves the perforators arising from the posterior tibial vessels, which form the basis of local fasciocutaneous flaps. It also provides access 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.

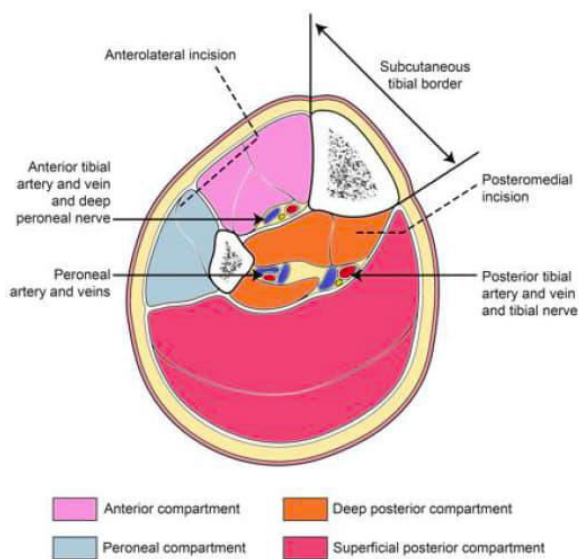


Figure showing cross section through leg showing incisions to decompress all four compartments

Version 2.0

Background and justification

All clinicians undertaking musculoskeletal care may be involved in the management of peripheral nerve injury, either as a complication of surgery or as the result of primary trauma. The consequences of a missed peripheral nerve injury carry considerable impact for the patient. Achieving the best result will require that first the injury is identified and then that the management is directed and delivered by the right clinician at the right time. Establishing pathways which lead to early identification and timely management of injured nerves is key to optimal patient outcome.

Inclusions:

All patients with musculoskeletal trauma and surgery where there is the potential for peripheral nerve injury.

Exclusion:

Birth injuries.

Standards for Practice

Identification of peripheral nerve injury

1. An examination to assess and document all the functions of a peripheral nerve:
 - 1.1. should be carried out and recorded:
 - 1.1.1. at the first opportunity after injury
 - 1.1.2. after any intervention to the limb such as injection, manipulation or application of cast
 - 1.1.3. pre-operatively, by the operating surgeon prior to any procedure where nerve injury is a recognised risk
 - 1.1.4. post-operatively, by the operating surgeon following any procedure where nerve injury is a recognised risk
 - 1.1.5. in accordance with any written management plan
 - 1.2. the examination should:
 - 1.2.1. be sufficiently general to elucidate unexpected nerve deficit
 - 1.2.2. be specific enough to identify deficit likely with the nature of the injury or procedure
 - 1.2.3. be expanded to greater detail if concern over nerve injury is raised
 - 1.2.4. be recorded in sufficient detail to allow confident comparison with preceding and subsequent examinations
2. Every unit receiving injured patients should maintain a policy in which training in and assessment of competence in the above examination standards is contained. This should be integrated with the wider regional trauma network referral processes.

Response to identification of peripheral nerve injury

3. There should be a clear and accessible pathway for suspected peripheral nerve injuries including a single point of contact to guide further management.
4. The single point of contact should provide a consistent route into a network approved pathway of management and must be accessible twenty-four hours a day.
5. When a nerve injury is associated with a dislocation, the joint should be reduced immediately. In an unstable fracture, reduction and provisional stabilisation should be carried out as soon as it is safe to do so.
6. Formal advice should be sought:
 - 6.1. Within twenty-four hours when a laceration or penetrating injury is associated with a neurological deficit.
 - 6.2. Immediately when a nerve is seen to be damaged during surgery.
 - 6.3. Prior to surgery when internal fixation of a fracture associated with a nerve injury is to be performed, as part of multidisciplinary care.
 - 6.4. Within twenty-four hours for any peripheral nerve injury if operative management of the associated fracture is not indicated.
 - 6.5. Immediately when a new nerve deficit is identified following surgery and appropriate measures such as loosening of bandages, splitting Plaster of Paris splints to the skin and gentle repositioning of the limb have proved ineffective.
7. When a nerve is exposed during fracture surgery, this should be clearly documented in the operation note including a description of the nerve's relationship to any internal fixation device.
8. When a damaged nerve is found at surgery and the single point of contact is unavailable, the operation should be completed and the nature of nerve injury clearly documented. The patient should then be discussed with the single point of contact at the first opportunity.

Audit

9. The local network should collate data on the number and nature of nerve injuries referred to the service. Delayed diagnosis or iatrogenic nerve injury should be the subject of documented local network review. Feedback and case discussion should be used to further build best practice in nerve injury management.



The North West Children's
Major Trauma Network

Diagnosis & Management of Arterial Injuries Associated With Extremity Fractures and Dislocations

Version 2.1*

Background and justification

Rapid, accurate diagnosis of arterial injuries to the extremities is crucial for optimum outcome with immediate referral to, and joint management with, a surgeon capable of performing vascular repair.

Inclusions

Patients of all ages with vascular injuries to the extremity associated with musculoskeletal trauma.

Standards for Practice

1. All hospitals and networks that are responsible for the management of injured patients must have clear emergency referral and transfer protocols that should include a single point of contact.
2. Centres providing definitive care must have an agreed protocol and pathway standardising the management of these complex injuries.
3. This protocol should include combined review and decision making in person by Consultant surgeons skilled in vascular repair and skeletal trauma on reception of the patient.
4. Haemorrhage should be controlled immediately by direct pressure or tourniquet. Blind clamping should not be undertaken.
5. A pulseless, deformed limb should be re-aligned, splinted and the vascular examination repeated and documented at the time of diagnosis and prior to transfer.
6. Neurological examination must be documented as a timed entry in all patients with extremity trauma; associated nerve injury should be presumed until disproven.
7. Any patient undergoing CT scan following major trauma should have a head to toe scanogram.
8. CT angiography of the extremity should occur immediately following the scanogram, without requirement for patient repositioning.
9. The ischaemic limb should be revascularised within four hours from injury.
10. Where rapid definitive restoration of arterial flow cannot be achieved, arterial shunts should be used to restore flow (eg while skeletal stabilisation is placed).
12. Definitive repair or direct interposition grafts are preferred to bypass grafts.
13. Where cognition allows, patients must be made aware of the possibility of amputation. Any decision to perform early amputation must be made by two consultants and clearly documented.
14. Fasciotomies should always be considered. They should either be performed or the decision not to perform documented with the name of the senior decision maker. There is a low threshold for fasciotomy in these cases.
15. Post-operative care should be delivered in an appropriate area with nursing and medical staff competent in the assessment of the critically injured limb.

Evidence base

Studies with level-1 evidence are lacking. Predominantly retrospective series, with some good prospective studies, meta-analyses, reviews and expert opinion

* On 30th April 2021, the BOAST was updated to remove bullet point 11 that had appeared in the earlier version in error. We have preserved the numbering on all other bullet points for consistency with the previous version



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BAPRAS
British Association of Plastic
Reconstructive and Aesthetic Surgeons



BOAST 10: 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.

Inclusion Patients of all ages.

Standards for practice audit:

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