**RCH Trauma Guideline**

Management of the Mangled Limb

**Trauma Service, Division of Surgery**

**Mangled Limb Guideline**

**See also:**

[Trauma – Primary Survey](https://www.rch.org.au/clinicalguide/guideline_index/Major_paediatric_trauma_The_primary_survey/)

[Trauma – Severe Vascular Injury in Children](https://www.rch.org.au/policy/policies/Trauma_-_Severe_Vascular_Injury_in_Children/) (RCH Intranet only)

[Massive Haemorrhage and Critical Bleed Procedure (MHP)](https://www.rch.org.au/policy/policies/Massive_Haemorrhage_and_Critical_Bleeding_Procedure/) (RCH Intranet only)

**Purpose**

This guideline is to assist staff in the assessment and management of patients with massive extremity trauma, based on the best available evidence for prompt recognition, resuscitation and management of the mangled limb (upper or lower limb).

**Key Points**

1. All life-threatening limb trauma requires activation of the Trauma Team
2. Management of the mangled limb require a multidisciplinary approach including plastic surgery, orthopaedics and, on occasion, vascular surgery. Discuss with the vascular service at RMH early if required.
3. Control of bleeding may require direct pressure or tourniquet and rapid transit to theatre may be needed for haemorrhage control and/or limb salvage
4. Definitive decision making regarding amputation or limb salvage should involve at least two consultants, where possible from different specialties, directly involved in the patient’s care.

**Definitions**

A mangled limb can be defined as

* Any extremity which has sustained severe traumatic injury to at least three of the four systems of a limb - soft tissue (muscle, fascia, skin), skeletal structures, nerves and vascular supply or
* Any extremity which has sustained an injury to a combination of the four systems and that results in subsequent concern for viability of the limb

.

**Background**

A mangled limb can pose as an immediate life threat and the management involves resuscitation and complex timely decision making requiring a multidisciplinary approach including emergency, trauma, plastics, orthopaedics and, on occasion, vascular surgery. Injuries are often accompanied by other significant life-threatening injuries to head, chest abdomen or pelvis resulting from high force mechanisms. Common mechanisms include motor vehicle collisions, farm machinery, lawn mower accidents, explosions (fireworks). Outside of Australia, other common causes include landmine explosions or gunshot wounds.

**Initial Assessment**

Assessment of the mangled limb is prioritised a part of the primary survey, recognising the need to control catastrophic haemorrhage as an immediate life threat. In the multi-trauma patient haemorrhage elsewhere (concomitant head/neck/torso injury) must also be considered.

**Key priorities of treatment**

1. Wounds should be exposed and bleeding controlled by
   1. Direct pressure to wound with gauze and hand or finger on the bleeding source
   2. Tourniquets can be used if failing to control by direct pressure. Apply a CAT tourniquet above the bleeding point (5cm above) and tighten until the bleeding has stopped. Always record the time of application on the patient or tourniquet and in the medical notes. The decision to remove the tourniquet should be done with discussion of the senior treating clinicians/surgeons.

Tourniquets are painful and the child should be adequately analgised.

Tourniquets should be applied for the least amount of time possible (ideally less than 2 hours) and increased duration may impact limb salvage. However, the risk of exsanguinating haemorrhage outweighs tourniquet related morbidity.

1. The Major Haemorrhage Procedure should be activated if required
2. Splinting and/or reducing open fractures can assist in haemorrhage control, pain control, improve perfusion and facilitate better assessment of the limb
3. Protruding embedded objects should not be removed in the ED unless they present an imminent threat to staff safety (removal could lead to further uncontrolled bleeding).
4. IV access or IO access if delay to IV. IO should only be placed in a non-injured limb.
5. Tranexamic acid 15mg/kg IV
6. Initial fluid resuscitation should be with blood (packed red blood cells) and as per the MHP if ongoing transfusion requirements. If blood is delayed or unavailable, a 10-20ml/kg crystalloid bolus can be given whilst acknowledging that this may worsen acidosis and traumatic coagulopathy.
7. IV antibiotics should be commenced

|  |  |  |
| --- | --- | --- |
|  | Empiric antibiotic regimen | Penicillin allergy / Alternative regimen |
| Bite (animal/human)  Land injury | Amoxicillin/clavulanate PO | Ciprofloxacin ***and***  Clindamycin |
| Severe, penetrating injury | Amoxicillin/clavulanate IV |
| Severe sepsis/toxic shock syndrome | 3rd gen cephalosporin  ***and***  Vancomycin ***and***  Clindamycin  Consult Infectious Diseases | Meropenem ***and***  Vancomycin ***and***  Clindamycin  Consult Infectious Diseases |
| Aquatic exposure | Add Ciprofloxacin to above |  |

1. Tetanus vaccination status should be confirmed and consideration for booster vaccine and/or tetanus immunoglobulin as per [tetanus guidelines](https://www.rch.org.au/clinicalguide/guideline_index/Management_of_tetanusprone_wounds/).

**Assessment of the Mangled Limb**

Once the multi-trauma assessment is complete and the child is stable, a full assessment of the mangled limb should be performed and documented. This should include:

1. Vascular assessment, examining the colour, warmth and presence of a pulse and capillary refill along with assessing the effect of tourniquet if used, noting potential or actual ischaemia. Doppler assessment should be undertaken if the pulse is weak or absent. Rapid transfer to theatre should be considered in a patient with hard signs of vascular injury (active haemorrhage, rapidly expanding haematoma, absent pulses, palpable bruit/thrill) in consultation with the vascular, orthopaedic and plastic surgery teams, without further radiology. Otherwise CT angiogram should be considered.
2. Skeletal assessment, clinical assessment of deformity as well as radiological – x-ray +/- CT.
3. Soft tissue assessment, assessing the degree of skin and soft tissue deficit as well contamination and degree of debridement required.
4. Neurological assessment – assessing sensory and motor function, paying particular attention to height of injury using the ASIA chart. Ideally this should be completed early, as ischaemia induced nerve palsy can occur within 20 minutes of tourniquet application. If the neuro examination is not completed in this timeframe and a tourniquet is applied, it should be noted that the examination may be unreliable.

All specialties should be notified early – general surgery/trauma, plastic surgery, orthopaedic surgery and, when required, vascular surgery (RMH). Clinical photography via EPIC on hospital ASCOM devices can be useful if time and resources permit.

**Transport of the Completely Amputated Limb**

The part should be washed thoroughly in in isotonic solution e.g. Hartmann’s Solution and wrap it firstly in moist sterile gauze, then a moistened sterile towel, then placed in a plastic bag and transported in a cooler chest or bag with crushed ice. Care should be taken to ensure the limb is not frozen or in direct contact with ice.

An amputated limb part can also be considered as a potential donor site for reconstruction of other coexisting injuries and should be not be removed/discarded to pathology prior to discussion with the plastic surgery team.

**Definitive Management and Decision Making**

Rapid transfer to theatre for limb salvage and/or haemorrhage control may be required prior to obtaining CT and the decision should be made between the surgical, plastics, orthopaedics, and, on occasion, vascular teams in agreement with the trauma Team Leader.

Scoring systems to aid decision making in adults about limb salvage have been developed, such as the Mangled Extremity Severity Score (MESS). However, such scores have not been validated for use in children. Compared to adults, children have better healing capacity of soft tissue and a greater capacity to form bone which means limb salvage may be more feasible in children. Decisions regarding limb salvage or amputation need to be individualised and will depend on the experience and judgement of the surgical teams involved. Nevertheless, certain factors related to mechanism and presentation may assist with prognostication.

These include:

1. the degree of tissue injury and

2) the degree to which ischemia is present in the effected limb.

Consideration should also be given to:

1. Pre-injury health and functional status or co-morbidities.

The loss of a limb presents an ongoing significant psychological and functional lifestyle change for patients. Where possible, the child and family should be included in the decision-making process. Limb salvage should only be attempted where there is a reasonable expectation that limb is salvageable with a meaningful functional outcome.

1. Other associated injuries and physiological severity of illness:

An example could be a severe head injury that makes it unlikely the limb will be used if salvage is successful, though such prognostication may be difficult in the early stages of assessment.

1. Patient and parent/guardian preference and available personnel and resources.
2. Injury factors:

* Limb factors including the fracture pattern, level of vascular injury, warm ischaemia time (>6 hours is associated with poorer outcome, extent of soft tissue injury, the grade of nerve injury and the status of the contralateral limb
* Circumferential tissue loss is less attractive to salvage as more soft tissue is required for coverage and the salvaged distal limb is prone to lymphoedema.
* Poor outcomes have been associated particularly with injuries at or proximal to the tibial nerve especially with high grade injuries and in proximal (above elbow injuries of the median, ulnar and radial nerves).
* Degree of contamination and debridement required should also be considered.

**Disposition and ongoing care**

A haemodynamically stable patient with a non-immediately life-threatening limb injury may be safe to proceed for imaging including X-ray and CT/ CT angiography with decision for operative management after imaging.

Limb salvage or complete amputation should occur as soon as possible as delayed amputation can increase risks of complications such as wound infection, non-union and longer hospital stay.

Decision making should involve at least two consultants from different specialties directly involved in the patient’s care. If amputation is planned, pre-amputation consultation should include prosthetics when possible, to optimise residual limb and prosthetic management outcomes.

Early referral to allied health (physio, occupational therapy, psychology, prosthetics) and referral to the rehabilitation team is recommended to assist with long term functional outcomes and psychosocial care. Involving the pain service is also recommended to assist in management of early and long-term pain.

**References**

1. Schiro GR, Sessa S, Piccioli A et al. Primary amputation vs limb salvage in mangled extremity: a systematic review of the current scoring system BMC Musculoskelet Disord. 2015 Dec; 16:372. Available from: <https://doi.org/10.1186/s12891-015-0832-7>
2. Charlton NP, Goolsby CA, Zideman DA et al. Appropriate Tourniquet Types in the Pediatric Population: A Systematic Review. Cureus 2021 Apr; 13(4): e14474. Available from: https://doi.org/10.7759%2Fcureus.14474
3. Scalea T, Dubose JJ, Moore E , et al. Western Trauma Association Critical Decisions in Trauma: Management of the Mangled Extremity Journal of Trauma. 2012;71(1):86
4. Patel M, Richter K, Shai S. Mangled Extremity: Amputation Versus Salvage. Curr Trauma Rep. 2015;1:45-4992
5. Stewart, DA., Coombs, CJ., Kerr Graham, H. Application of lower extremity injury severity scores in children. J Child Orthop 2012 Oct; 6(5):427-31