Midlands Critical Care, Trauma and Burns Networks
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1. General principles

Vascular injuries are common in trauma and are associated with other injuries. Control of catastrophic external haemorrhage should be performed with direct pressure or by tourniquet. When using a tourniquet, the time of application should be recorded. Vascular injury should be suspected according to the presence of hard and soft signs (table 1). Hard signs mandate urgent surgery, or immediate transfer to a major trauma centre (MTC).

Suspicion of arterial injury warrants further investigation. The investigation of choice is computed tomography angiogram (CTA). These images should be transferred at the same time as the patient transfer. If damage control surgery (DCS) is indicated, this should be undertaken locally. Where this is not possible, a critical transfer should be arranged and the MTC consultant trauma leader should be notified.

Hard Signs	Soft Signs
Active arterial bleeding	Proximity of injury to vascular structure
Rapidly expanding or pulsatile haematoma	History of arterial bleeding at scene
Absent pulses	Major single nerve deficit
Bruit or thrill	Reduced (but present) unilateral pulses

Hard Signs	Soft Signs
Signs of limb ischaemia/compartment syndrome	Posterior knee or elbow dislocation

Table 1: Hard and soft signs of vascular injury

2. Management of Extremity Vascular Injury

Patients with hard signs of vascular injury (table 1) will usually require urgent surgery and should be critically transferred to the nearest MTC. Soft signs of vascular injury (table 1) warrant further investigation with an urgent CTA. If this cannot be provided locally within one hour then the patient should be sent to the MTC. An ankle-brachial pressure index (ABPI) of <0.9 in a patient with no previous history of peripheral vascular disease suggests vascular injury and a CTA is indicated. A normal ABPI (>0.9) does not exclude vascular injury.

Surgical exploration can be performed in the trauma unit (TU) if the patient presents with an isolated injury. If the patient is haemodynamically unstable and DCS is indicated, this should be performed in the TU within 30 minutes, otherwise the patient should be sent as a critical transfer to the MTC. If external haemorrhage is present this should be controlled with direct pressure, if this fails a tourniquet should be applied. Tourniquets applied in the pre-hospital environment should have their location and time of application recorded and communicated to the trauma team.

Emergency primary limb amputation should only be undertaken in cases where attempts to preserve the limb pose an unacceptably high risk to the patient's life and where the limb is deemed unsalvageable (a two-consultant decision taken in conjunction with a consultant orthopaedic surgeon).

3. Management of Cervical Vascular Injuries

a. Penetrating Cervical Vascular Injuries

Penetrating injuries of the neck are conventionally evaluated according to three zones relating to the relevant vascular structures. The description of injuries according to zone is only a guide and the possibility of injury to structures outside their conventional zone should be appreciated.

An expanding haematoma with associated airway compromise mandates immediate anaesthetic assessment. If damage control surgery is required this should be performed in the TU within 30 minutes, otherwise the patient should be sent as a critical transfer to the MTC. If the superficial fascia of the neck is not breached then a significant vascular injury is excluded. If it is not possible to determine this or there are any soft signs of vascular injury a CTA should be performed immediately at the TU, or failing this the patient should be transferred to the MTC. Exploration of neck injuries should not be performed in the TU without imaging unless damage control surgery is required.

Where CTA demonstrates a vascular injury, the patient should be transferred as an immediate transfer to the MTC along with CTA images. The duty trauma leader should be informed of the specific vascular injuries and the relevant surgical teams should be notified accordingly.

b. Blunt Cervical Vascular Injuries (BCVI)

BCVI are frequently missed during the primary survey. The presence of risk factors for BCVI (table 2) should raise the suspicion of an unidentified vascular injury. Suspicion of BCVI should be investigated with a CTA. If a BCVI is detected in a TU that is not a vascular hub then the patient should be transferred to the MTC and the vascular team notified. The severity of BCVI can be divided into five categories: 1. Dissection (grade I-II), 2. Pseudo-aneurysm (grade III), 3. Occlusion (grade IV) and 4. Transection (grade V). Grades I, II, and IV can be managed conservatively. Grade III injuries require surveillance and may require interventional treatment. Grade V injuries require urgent surgery and should be managed for penetrating injuries.

Signs	**Mechanism of Injury**
Arterial haemorrhage from ears, mouth or nose	Head-on/side-on high speed RTC
Evidence of acute infarct on head CT	Ejected from vehicle
GCS less than 6	Unrestrained occupant
Incongruous neurology/imaging	Significant intrusion into vehicle
Horner's syndrome	Significant crush of vehicle
Petrous bone fracture	Falls from >3 meters
Base of skull fracture	Head injury with significant chest injury
Lefort II/III fracture	Direct signs of great vessel injury
Cervical spine fracture involving the transverse foramen/lateral process	Death on scene of other victims

Table 2: Risk factors for BCVI

4. Management of Blunt Thoracic Vascular Injury (BTVI)

Blunt injuries to the major vessels of the thorax most commonly occur following road traffic collisions or falls from height. The most common type of injury is a false aneurysm, followed by dissection and intimal tear. Physical signs are not reliable in the diagnosis of BTVI. Plain film chest x-ray features suggestive of BTVI include aorto-pulmonary window opacification, left displacement of trachea/oesophagus, left main bronchus displaced downwards, left apical cap, left haemothorax and fractures of the 1st rib, scapula, sternum, or vertebrae. The absence of these features does not exclude vascular injury.

Hypotension in the presence of a widened mediastinum should prompt a search for an extra-thoracic haemorrhage, as a complex injury of the aorta often leads to rapid exsanguination. Blunt chest injury associated with hypovolaemia, a high-speed deceleration injury or chest x-ray signs raise the possibility of BTVI and an urgent CTA should be performed. Direct and indirect features of BTVI on CTA are summarised in table 3. A normal CTA effectively excludes BTVI.

Direct Features	**Indirect Features**
Pseudoaneurysm	Mediastinal haematoma

Direct Features	Indirect Features
Intramural haematoma	Isolated intimal flap
Dissection flap	
Contract extravasation	

Table 3: CTA features of BTVI. Direct features are more specific for aortic injury.

Patients with BTVI diagnosed in a TU should be transferred to the MTC as critical transfers, CTA images should be transferred and the duty trauma team leader informed of the injuries and the vascular and cardiothoracic teams informed. If possible, fluid resuscitation should be performed with invasive blood pressure monitoring. Aggressive fluid resuscitation should be avoided.