Diagnostic Imaging Pathways - Cerebrovascular Blunt Trauma

Population Covered By The Guidance

This pathway provides guidance for cerebrovascular imaging of blunt trauma patients who are at increased risk of cerebrovascular injury following their trauma.

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Quick User Guide

Move the mouse cursor over the PINK text boxes inside the flow chart to bring up a pop up box with salient points.
Clicking on the PINK text box will bring up the full text.
The relative radiation level (RRL) of each imaging investigation is displayed in the pop up box.

SYMBOL	RRL	EFFECTIVE DOSE RANGE
	None	0
	Minimal	< 1 millisieverts
	Low	1-5 mSv
	Medium	5-10 mSv
	High	>10 mSv

Pathway Diagram

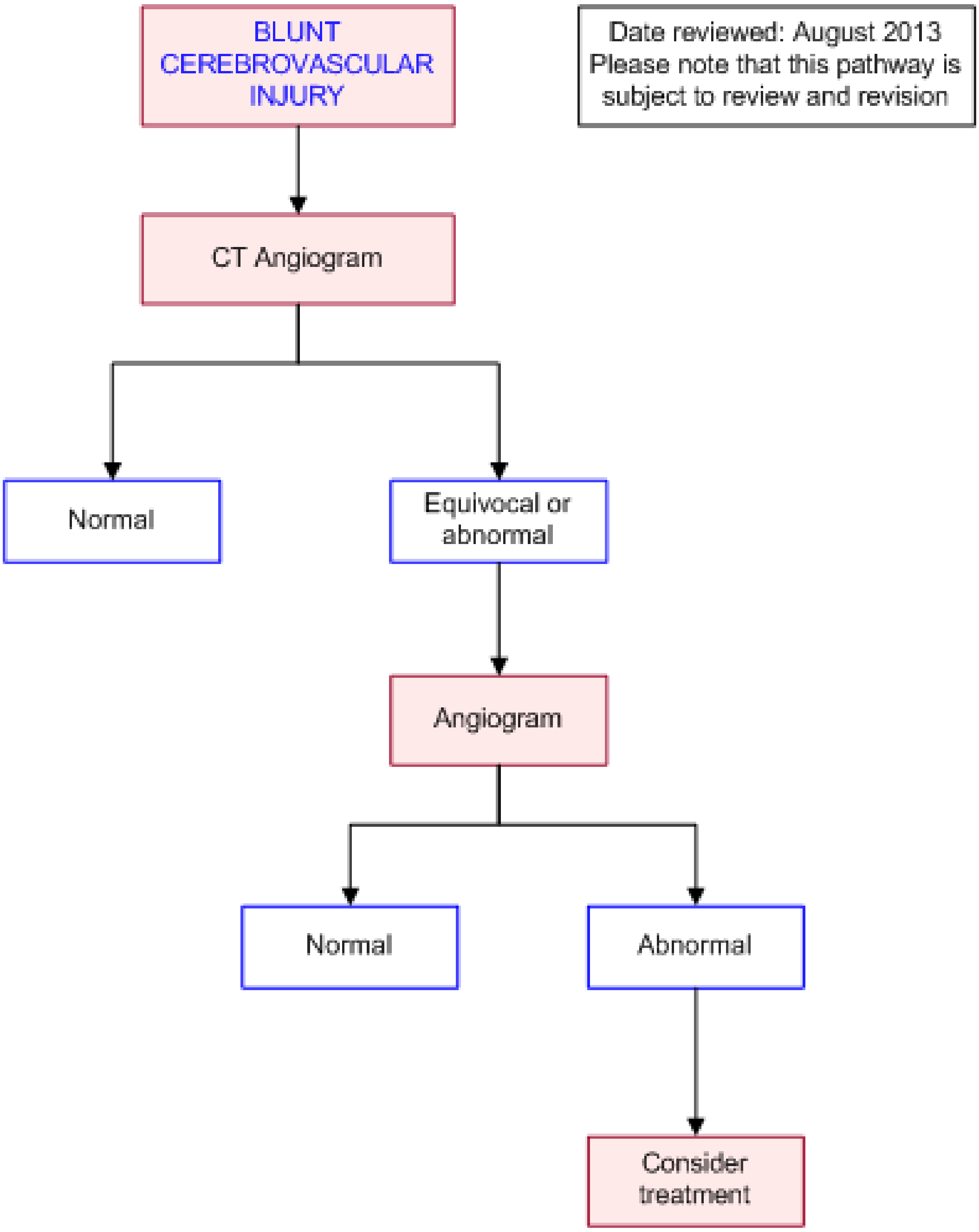
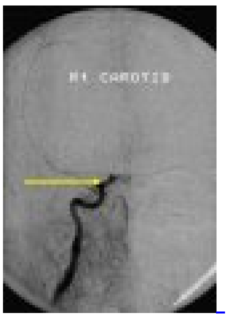


Image Gallery

Note: These images open in a new page

1a

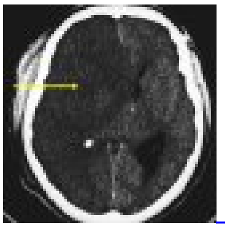


Blunt Cerebrovascular Injury

Image 1a (Angiogram): A carotid angiogram in a 33 year old male involved in a motor bicycle accident reveals complete occlusion of the right internal carotid artery in its supraclinoid portion (arrow).

1b

Image 1b (Computed Tomography): Large right middle cerebral artery



territory infarct with mass effect (arrow).

Teaching Points

- Blunt cerebrovascular injury (BCVI) occurs in approximately 1% (0.18 – 2.7%) of all blunt trauma victims
- It is often asymptomatic initially, though its detection is crucial to avoid long-term neurological sequelae
- Clinical screening criteria with a sensitivity approaching 100% are yet to be defined. The most commonly used modified Denver screening criteria miss ~20% of BCVI
- CT angiogram is a useful screening tool for BCVI in selected patients
- Digital subtraction angiogram is the 'gold standard' and enables therapeutic interventions

Blunt Cerebrovascular Injury (BCVI)

- Incidence ranges between 0.18% - 1.63% of blunt trauma admissions, and is reportedly as high as 2.7% in patients with an Injury Severity Score (ISS) of 16 2, 3
- They are often asymptomatic initially, with delayed onset of neurological sequelae. This presents an opportunity for early identification and avoidance of potentially significant morbidity and mortality within this typically young cohort
- The modified Denver screening criteria have been developed to select patients who should undergo screening for BCVI 4-6
- Signs/symptoms of BCVI
  - Arterial haemorrhage
  - Cervical bruit in a patient < 50
  - Expanding cervical haematoma
  - Focal neurologic deficit
  - Neurologic examination incongruous with head CT scan findings
  - Stroke on secondary CT scan
- Risk factors for BCVI: high-energy transfer mechanism with
  - Cervical spine fracture patterns: subluxation, fractures extending into the transverse foramen, and fractures of C1–C3 have been shown to correlate with vertebral artery injury (VAI) 7,8
  - Basilar skull fracture with carotid canal involvement
  - Diffuse axonal injury with GCS score <6
  - Leforte II or III fracture
  - Petrous bone fracture
  - Near hanging with anoxic brain injury
- Approximately 20% of patients with BCVI have no conventional screening criteria. 1 Of these patients, mandible fracture, basilar skull fracture (any) or occipital condyle fracture were the most common injury patterns 1,9
- A recent metaanalysis found cervical spine injury and thoracic injury were associated with a significantly increased chance of BCVI 2

- Unfortunately no validated diagnostic criteria to select patients in which to screen for BCVI exists that approaches 100% sensitivity. 10 Another promising scoring system has been developed. Prospective validation is awaited 11

Computed Tomography Angiogram (CTA)

- CTA has emerged as a promising screening tool. It also enables the visualisation of the vertebral column and spinal canal, the aerodigestive tract and associated soft tissues of the neck
- Metanalyses of reported trials (conducted on machines ranging from older single slice helical CT scanners to 64 slice MDCTs) report a pooled 66% sensitivity and 97% specificity compared to digital subtraction angiography (DSA). 12 Pooled sensitivity remained 80% among studies using 16 slice scanners 12
- Sensitivities and specificities of recent prospective studies using 16 slice CTAs compared to DSA as the gold standard range from 41-97.7% and 86-100% respectively 13-15
- The inconsistency of reported sensitivities and specificities preclude its replacement of DSA as the diagnostic gold standard in BCVI at present, but its non-invasiveness, rapidity and availability make CTA a popular screening modality in the trauma setting
- Screening high-risk populations for blunt cerebrovascular injuries appears cost-effective 16
- Prospective multicentre trials that compare new generation CT scanners with diagnostic angiography in the same cohort of patients are awaited
- Advances such as dual energy bone removal CT (DECT) angiography can be helpful in carotid artery injuries, 17 and iterative reconstruction in CTA can reduce the dose exposed to patients 18

Ultrasound

- Ultrasound has been well validated in the detection of extracranial atherosclerotic occlusive disease. Several small trials have explored its use in BCVI with poor results. A sensitivity of 38.5% has been reported. The problem with ultrasound is the injury to the vessel is often at the skull base, which is unable to be visualised with the probe. There is also interference from osseous structures, with vertebral artery injury, the technique is highly operator dependant and may be difficult in a haemodynamically unstable patient 3

Magnetic Resonance Angiography (MRA)

- MRA has also been advocated as a non-invasive screening tool in BCVI
- Sensitivity of 47-75%% has been reported. 19,20 However, in many cases ventilatory and monitoring equipment are often incompatible with MRI machines. Likewise the time required to perform the scan, and inability to gain access to an acutely unwell patient, preclude the widespread use of this technique

Digital Subtraction Angiography (DSA)

- DSA is the ‘gold standard’ in the diagnosis of BCVI, by providing flow analysis and a high sensitivity and specificity compared with CTA and MRA 10
- However, as a screening test it has a number of weaknesses
    - Invasive procedure
    - Requires extensive resources, including interventional neuroradiological expertise, theatre personnel and specialised equipment

    - 1% risk of adverse outcomes, including groin site complications, contrast nephropathy and cerebrovascular accident (including arterial dissection, vascular spasm, thrombosis with or without embolisation) 21,22
- There are a continuum of injuries that are recognised on angiography. This includes an irregularity of the vessel wall, through to vessel transection 23
- Angiography also affords therapeutic opportunities for certain injuries. Endovascular stenting may be carried out for symptomatic dissections and pseudoaneurysms 24

Treatment of Blunt Cerebrovascular Injury

- In parallel with ongoing work as to the most effective screening criteria and diagnostic strategies for BCVI, research continues into effective treatment. A gold standard protocol has not been established 10
- Delayed neurological sequlae (cerebrovascular accident) is the feared outcome of not recognising and appropriately managing BCVI
- Since its recognition, treatment has focussed on reducing the atheroembolic tendency of the disrupted vessel wall. Anticoagulation with heparin and anti-platelet agents has been trialled. However in a multi trauma patient, the risks of bleeding and surgery must be taken into account
- The use of anticoagulation and anti-platelets has been shown to reduce the risk of stroke and death associated with BCVI 6,25
- Certain injuries to cervical vessels may be amenable to endovascular therapy. 24 Therefore care in the setting of a multi-disciplinary team consisting of emergency physicians, trauma surgeon/neurosurgeon, radiologists and intensivists is recommended. Furthermore ongoing research into optimal treatment strategies is warranted

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Date of literature search: May 2013

The search methodology is available on request. Email

References are graded from Level I to V according to the Oxford Centre for Evidence-Based Medicine, Levels of Evidence. Download the document

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