Diagnostic Imaging Pathways - Cerebrovascular Blunt Trauma

Population Covered By The Guidance

This pathway provides guidance on the imaging of blunt trauma patients who are at increased risk of cerebrovascular injury.

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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.

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Pathway Diagram
SUSPECTED BLUNT CEREBROVASCULAR INJURY

New Denver Screening Criteria

Signs/symptoms of BCVI:
- Potential arterial haemorrhage from neck/nose/mouth
- Cervical bruit in a patient <50 yrs
- 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:
- C-spine fractures, subluxation or ligamentous injury
- Basilar skull fracture with carotid canal involvement
- Diffuse axonal injury with GCS score ≤8
- Leforte II or III fracture
- Mandible fracture associated with high-energy transfer mechanism
- Occipital condyle fracture associated with high-energy transfer mechanism
- Petrous bone fracture associated with high-energy transfer mechanism
- Near hanging with anoxic brain injury
- Clothesline type injury or seat belt abrasion with significant swelling, pain, or altered mental state
- Scalp degloving associated with high-energy transfer mechanism
- Major thoracic injuries, including vascular injuries and blunt cardiac rupture, associated with high-energy transfer mechanism

Also consider BCVI in high-risk injury mechanisms without high-energy transfer, including:
- Non-fatal strangulation
- Near hanging

CT angiogram if any criterion present

No vascular injury
- Stop
- New/persistent neurological deficit
  - MRI/MRA

Carotid or vertebral artery injury
- Manage appropriately
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) is a rare but serious sequela of trauma that occurs in approximately 1% of all blunt trauma victims.
- Morbidity and mortality is due to stroke which occurs in 10-21% of cases. Although some cases present with stroke, a number cases are initially asymptomatic and may have a delayed neurological event 10-72 hours after trauma.
- Symptoms relate to the vascular territories of the carotid and vertebral arteries. Vertebral artery injuries can result in posterior circulation strokes which may present as motor or sensory deficits, vertigo, ataxia, visual field deficits, dysarthria, dysphagia or loss of consciousness.
- There is evidence that anticoagulation or use of antiplatelet agents reduce the rate of stroke in BCVI, so there may be benefit from screening asymptomatic patients who are at increased risk. The exact optimal medical treatment regimen is yet to be determined.
- Clinical screening criteria with a sensitivity approaching 100% are yet to be defined. The most commonly used modified Denver screening criteria may miss 20-37% of BCVI. The New Denver Criteria are broader and identify more BCVIs, however the trade-off is that more patients will have unnecessary investigations. 5% of BCVIs may not fit into the listed New Denver Criteria.
- The New Denver Criteria identify injuries that are associated with BCVI if they are associated with a high energy mechanism.
- CT angiogram is the non-invasive screening tool of choice for BCVI in selected patients.
- MRI/MRA may be indicated as a second-line investigation for patients with new or persistent neurological signs concerning for BCVI, but a normal CTA.
- Invasive angiography (or digital subtraction angiography, DSA) is generally only indicated for therapeutic intervention. It is considered the gold standard diagnostic test for BCVI, but it has a number of disadvantages including cost, availability, and 1% risk of adverse events including stroke.
Blunt Cerebrovascular Injury (BCVI) Screening

- BCVI is an injury to the carotid and vertebral arteries, often secondary to direct trauma
- 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
- Stroke occurs in 10-21% of cases. 3-7 Although some cases present with stroke, a number of cases are initially asymptomatic, and may have a delayed neurological event 10-72 hours after trauma. 8-10 This presents an opportunity for early identification and avoidance of potentially significant morbidity and mortality within this typically young cohort
- Introducing screening criteria has led to increased detection of BCVI 11 and is associated with a reduction in mortality and delayed stroke rate following the use of antiplatelet agents or anticoagulants. 12-15 However, the exact optimal medical treatment regimen is yet to be determined 16,17
- A meta-analysis found cervical spine injury and thoracic injury were associated with a significantly increased chance of BCVI. 1 Mandibular fractures, when associated with a high-energy transfer mechanism, were also linked to an increased risk of BCVI 18
- Unfortunately no validated diagnostic criteria to select patients in which to screen for BCVI exists that approaches 100% sensitivity. 19 More liberal screening criteria may be indicated to enhance detection rates. 20-22 The modified Denver screening criteria have been developed to select patients who should undergo screening for BCVI 15,23-25 however, these may miss 20-37% of BCVI
- The New Denver Criteria 26 are broader and identify more BCVIs, 21 however the trade-off is that more patients will have unnecessary investigations. 5% of BCVIs may not fit into the listed New Denver Criteria 21
- Non-fatal strangulation is an uncommon injury that may be missed on history taking, especially when the injury is part of domestic violence or sexual assault. There have been cases of stroke presenting up to six months after the initial injury due to carotid dissection. 29 Some BCVI from strangulation will have no clinical signs 30,31
- Case series suggest that if there is a history of strangulation, CTA should be considered if there is: loss of consciousness, visual changes, facial, intra-oral or conjunctival petechial haemorrhage, incontinence, dysphonia/aphonia, dyspnoea, subcutaneous emphysema or neurological signs or symptoms, even if the presentation is delayed 32

Computed Tomography Angiogram (CTA)

- CT Angiography (CTA) is the recommended screening test for BCVI. 24,25 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). 33 Pooled sensitivity remained >80% among studies using >16 slice scanners 33
- 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 34-37
- There is a false positive rate associated with CTA 38-39 which precludes 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 40
- Invasive angiography (or digital subtraction angiography, DSA) is generally only indicated for
therapeutic intervention. It is considered the gold standard diagnostic test for BCVI, but it has a number of disadvantages including cost, availability, and 1% risk of adverse events including stroke so it is not recommended for screening.

**Magnetic Resonance Imaging/Angiography (MRI/MRA)**

- Magnetic Resonance Angiography may be used as a second-line investigation for BCVI in patients with a normal CTA but ongoing or new neurological signs that are concerning for BCVI.
- Sensitivity of 47-75% has been reported. 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 for initial screening.

**References**

**Date of literature search:** April-May 2018

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


27. Jacobson LE, Ziemba-Davis M, Herrera AJ. The limitations of using risk factors to screen for blunt cerebrovascular injuries: the harder you look, the more you find. World Journal of


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