

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

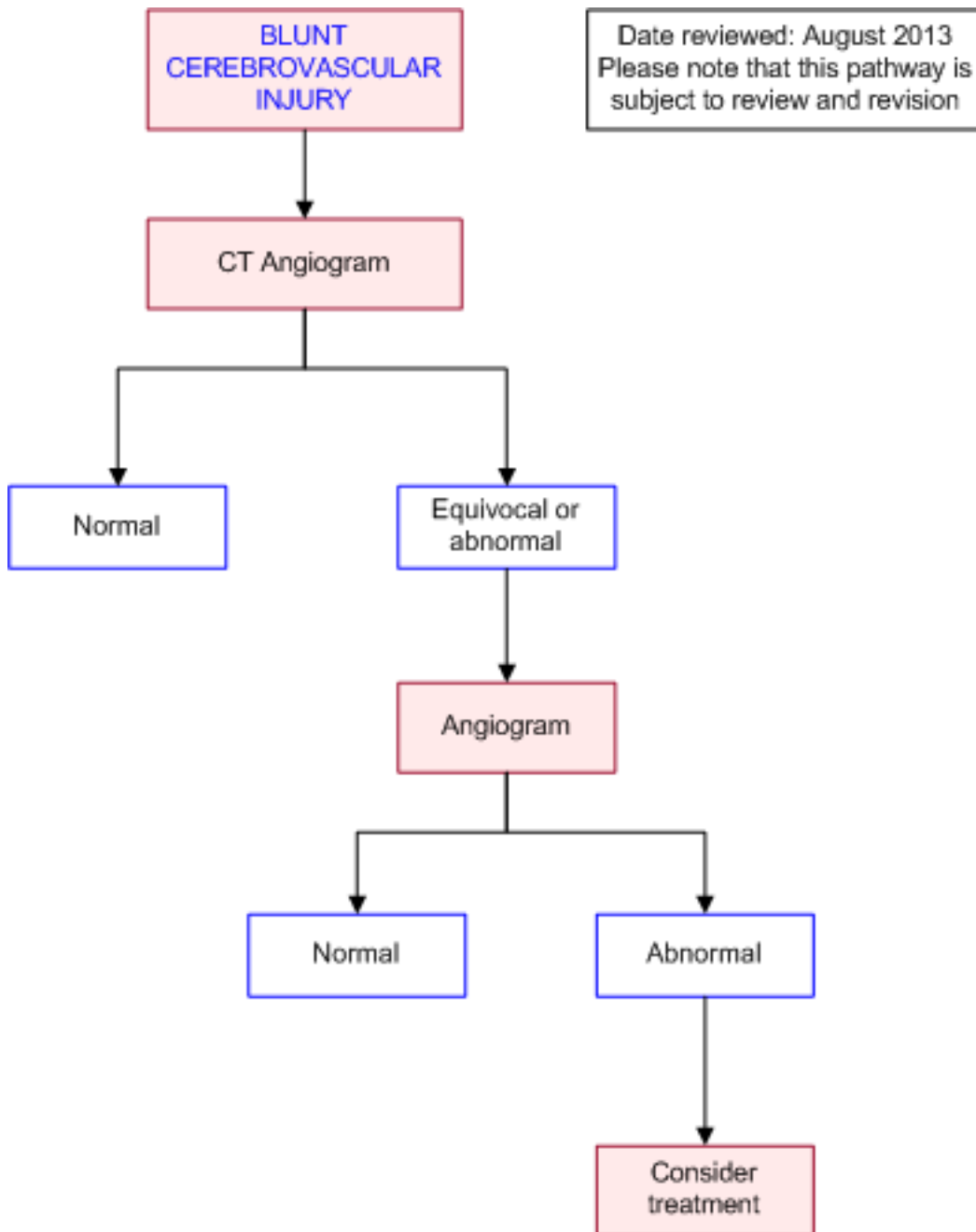


Image Gallery

Note: These images open in a new page

1a

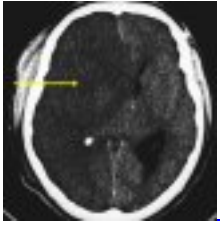


Blunt Cerebrovascular Injury

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 sequelae (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

References

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](#)

1. Burlew CC, Biffi WL, Moore EE, Barnett CC, Johnson JL, Bensard DD. **Blunt cerebrovascular injuries: redefining screening criteria in the era of noninvasive diagnosis.** J Trauma Acute Care Surg. 2012;72(2):330-5; discussion 336-7, quiz 539. (Level II evidence)
2. Franz RW, Willette PA, Wood MJ, Wright ML, Hartman JF. **A systematic review and meta-analysis of diagnostic screening criteria for blunt cerebrovascular injuries.** J Am Coll Surg. 2012;214(3):313-27. (Level II evidence)
3. Mutze S, Rademacher G, Matthes G, Hosten N, Stengel D. **Blunt cerebrovascular injury in patients with blunt multiple trauma: diagnostic accuracy of duplex Doppler US and early CT angiography.** Radiology. 2005;237(3):884-92. (Level IV evidence)
4. Biffi WL, Moore EE, Offner PJ, Brega KE, Franciose RJ, Elliott JP, et al. **Optimizing screening for blunt cerebrovascular injuries.** Am J Surg. 1999;178(6):517-22. (Level III evidence)
5. Bromberg WJ, Collier BC, Diebel LN, Dwyer KM, Holevar MR, Jacobs DG, et al. **Blunt cerebrovascular injury practice management guidelines: the Eastern Association for the Surgery of Trauma.** J Trauma. 2010;68(2):471-7. (Evidence based guideline)
6. Cothren CC, Moore EE, Biffi WL, Ciesla DJ, Ray CE, Jr., Johnson JL, et al. **Anticoagulation is the**

- gold standard therapy for blunt carotid injuries to reduce stroke rate.** Arch Surg. 2004;139(5):540-5; discussion 545-6. (Level II evidence)
7. Cothren CC, Moore EE, Biffl WL, Ciesla DJ, Ray CE, Jr., Johnson JL, et al. **Cervical spine fracture patterns predictive of blunt vertebral artery injury.** J Trauma. 2003;55(5):811-3. (Level IV evidence)
 8. Cothren CC, Moore EE, Ray CE, Jr., Johnson JL, Moore JB, Burch JM. **Cervical spine fracture patterns mandating screening to rule out blunt cerebrovascular injury.** Surgery. 2007;141(1):76-82. (Level IV evidence)
 9. Berne JD, Cook A, Rowe SA, Norwood SH. **A multivariate logistic regression analysis of risk factors for blunt cerebrovascular injury.** J Vasc Surg. 2010;51(1):57-64. (Level II evidence)
 10. Liang T, Plaa N, Tashakkor AY, Nicolaou S. **Imaging of blunt cerebrovascular injuries.** Semin Roentgenol. 2012;47(4):306-319. (Review article)
 11. Delgado Almandoz JE, Schaefer PW, Kelly HR, Lev MH, Gonzalez RG, Romero JM. **Multidetector CT angiography in the evaluation of acute blunt head and neck trauma: a proposed acute craniocervical trauma scoring system.** Radiology. 2010;254(1):236-44. (Level II evidence)
 12. Roberts DJ, Chaubey VP, Zygun DA, Lorenzetti D, Faris PD, Ball CG, et al. **Diagnostic accuracy of computed tomographic angiography for blunt cerebrovascular injury detection in trauma patients: a systematic review and meta-analysis.** Ann Surg. 2013;257(4):621-32. (Level II evidence)
 13. Goodwin RB, Beery PR, 2nd, Dorbish RJ, Betz JA, Hari JK, Opalek JM, et al. **Computed tomographic angiography versus conventional angiography for the diagnosis of blunt cerebrovascular injury in trauma patients.** J Trauma. 2009;67(5):1046-50. (Level II evidence)
 14. Eastman AL, Chason DP, Perez CL, McAnulty AL, Minei JP. **Computed tomographic angiography for the diagnosis of blunt cervical vascular injury: is it ready for primetime?** J Trauma. 2006;60(5):925-9; discussion 929. (Level II evidence)
 15. Malhotra AK, Camacho M, Ivatury RR, Davis IC, Komorowski DJ, Leung DA, et al. **Computed tomographic angiography for the diagnosis of blunt carotid/vertebral artery injury: a note of caution.** Ann Surg. 2007;246(4):632-42; discussion 642-3. (Level II/III evidence)
 16. Kaye D, Brasel KJ, Neideen T, Weigelt JA. **Screening for blunt cerebrovascular injuries is cost-effective.** J Trauma. 2011;70(5):1051-6; discussion 1056-7. (Level II/III evidence)
 17. Deng K, Liu C, Ma R, Sun C, Wang XM, Ma ZT, et al. **Clinical evaluation of dual-energy bone removal in CT angiography of the head and neck: comparison with conventional bone-subtraction CT angiography.** Clin Radiol. 2009;64(5):534-41. (Level II/III evidence)
 18. Winklehner A, Karlo C, Puipe G, Schmidt B, Flohr T, Goetti R, et al. **Raw data-based iterative reconstruction in body CTA: evaluation of radiation dose saving potential.** Eur Radiol. 2011;21(12):2521-6. (Level III evidence)
 19. Miller PR, Fabian TC, Croce MA, Cagiannos C, Williams JS, Vang M, et al. **Prospective screening for blunt cerebrovascular injuries: analysis of diagnostic modalities and outcomes.** Ann Surg. 2002;236(3):386-93; discussion 393-5. (Level II evidence)
 20. Biffl WL, Ray CE, Jr., Moore EE, Mestek M, Johnson JL, Burch JM. **Noninvasive diagnosis of blunt cerebrovascular injuries: a preliminary report.** J Trauma. 2002;53(5):850-6. (Level II evidence)
 21. Berne JD, Reuland KS, Villarreal DH, McGovern TM, Rowe SA, Norwood SH. **Sixteen-slice multi-detector computed tomographic angiography improves the accuracy of screening for blunt cerebrovascular injury.** J Trauma. 2006;60(6):1204-9; discussion 1209-10. (Level IV evidence)
 22. Willinsky RA, Taylor SM, TerBrugge K, Farb RI, Tomlinson G, Montanera W. **Neurologic complications of cerebral angiography: prospective analysis of 2,899 procedures and review of the literature.** Radiology. 2003;227(2):522-8.
 23. Nunez DB, Jr., Torres-Leon M, Munera F. **Vascular injuries of the neck and thoracic inlet: helical CT-angiographic correlation.** Radiographics. 2004;24(4):1087-98; discussion 1099-100. (Review article)



24. Nunez DB, Jr., Berkmen T. **Imaging of blunt cerebrovascular injuries.** Eur J Radiol. 2006;59(3):317-26. (Review article)
25. Miller PR, Fabian TC, Bee TK, Timmons S, Chamsuddin A, Finkle R, et al. **Blunt cerebrovascular injuries: diagnosis and treatment.** J Trauma. 2001;51(2):279-85; discussion 285-6. (Level IV evidence)

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