Ain't that a kick in the head?: CT angiography in blunt head and neck trauma

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Authors: J. Siddiqui, T. Campion, J. Evanson; London/UK
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Learning objectives

- Describe indications for CT angiography in the setting of blunt craniocervical trauma

- Understand the spectrum of possible vascular injuries in blunt craniocervical trauma

- Recognise the signs of injuries on CT indicating subsequent CT angiography
Background

Blunt cerebrovascular injury (BCVI) is seen in up to 2.7% of blunt head and neck trauma patients, and in up to 29% of those screened as at risk patients (1,2). Associated morbidity and mortality rates lie in the range of 32-67% and 17-38% respectively (1).

Often clinical manifestations are delayed, making diagnosis difficult, but prompt treatment and intervention can reduce impact of sequelae such as stroke.

CT angiogram (CTA) is now seen as an appropriate screening tool in assessment of arterial injury in the head and neck following blunt trauma. It is able to identify vascular injury which can be treated; such injuries may require endovascular treatment.

Although CTA in blunt craniocervical trauma is advocated as standard in some centres (3,4), CTA of the head and neck is not routinely performed in this setting. Therefore, specific indications for performing CTA are crucial to avoid underdiagnosis of cerebrovascular injury, and prevent their consequences which may be critical.

In the UK, no national protocol or guideline on criteria justifying CTA in blunt craniocervical trauma is currently in standard use.
Findings and procedure details

We performed a literature search utilising Pubmed and Medline search tools to highlight the major clinical and radiological criteria used for risk stratification in blunt head and neck trauma, and selection for CT angiography.

A variety of screening tools exist in the literature. The Memphis screening criteria highlight a number of radiological and clinical factors deemed to warrant invasive arteriography (2), with up to 29% of patients screened using these criteria in this study sustaining vascular injury. The commonest sustained injury was cervical spine fracture.

Biffl et al developed the Denver criteria, identifying at risk patients using an alternative tool including clinical signs such as haemorrhage from mouth, nose, ears or wounds of presumed carotid arterial origin, as well as lateralising neurological deficits, and fractures of the cervical spine, mastoid, sphenoid, petrous bones or foramen lacerum. Such patients subsequently went on to undergo invasive arteriography, where arterial injuries are graded by severity (5). Table 1 shows this grading scale, which can equally be applicable to CTA.

This has later been modified slightly to include basal skull fractures through the carotid canal only and subsequent stroke on secondary CT imaging (6).

The Eastern Association for the Surgery of Trauma guidelines include all petrous bone fractures and patients with diffuse axonal injury, but refine the cervical spine fracture indications to include those involving C1-3, fractures through the foramen transversarium, or involving subluxation or rotation (7). This group did not believe that CTA confers sufficient sensitivity and specificity as a screening tool, at the time of publication.

The above criteria, although useful, are screening tools for subsequent invasive arteriography. Although initially some believed CTA to be inadequate as a screening investigation for cerebrovascular injury (8), improvement in diagnostic performance has led to its evolution and acceptance as the screening tool of choice in most centres (9-12). CTA is cheaper, faster and more accessible than invasive arteriography (1), however, there has been little update in criteria leading to its use in blunt cranocervical trauma.

The Memphis criteria have been modified by Ciapetti et al to include all patients sustaining petrous temporal bone fractures (13). In this study, those satisfying criteria underwent subsequent CTA with 2.2% diagnosed with vascular injury.
Löhrer et al (2012) have developed a screening tool which recommends CTA for all patients with basal skull fractures, diffuse axonal injury with GCS<6, and all cervical spine fractures involving the foramen transversarium, C1, odontoid peg, or atlantooccipital dislocation (14).

Delgado Almamdoz et al recently developed a simple and succinct scoring system with risk associated with three risk factors: 1) high impact mechanism of injury such as high speed motor vehicle collision, and fall from height; 2) cervical interfacetal subluxation or dislocation; 3) fracture line reaching an arterial surface (15) (see table 2).

Although this scoring system has yet to be fully validated, scores of 2 and 3 were associated with highest risk of arterial injury in the population surveyed.

However the lower scoring cases still have a not insignificant risk of vascular injury and CTA may still be appropriate.

The commonest injuries found in this study were the vertebral artery injury, 61% of vascular injuries, with risk highest when associated with C5-fractures. This was seen to be more common than internal carotid injuries, occurring in 34% of vascular injuries. Injuries to more than one vessel made up the remaining 5% of injuries seen (15).

Table 3 summarises features of the main scoring systems for invasive angiography and CTA in blunt craniocervical trauma.

A range of cerebrovascular injuries are possible following blunt head and neck trauma. Below are a series of examples of injuries identified following initial non-contrast CT head examination, and subsequent CTA.

Figures 1-5 demonstrate cerebrovascular injuries seen on CT angiography of the intracranial vessels following blunt craniocervical trauma.
Table 1 adapted from Biffl et al, 1999 (5): a grading scale for blunt cerebrovascular injury.

Table 1

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<table>
<thead>
<tr>
<th>Parameter</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MOI</strong></td>
<td></td>
</tr>
<tr>
<td>Low Impact</td>
<td>0</td>
</tr>
<tr>
<td>High impact</td>
<td>1</td>
</tr>
<tr>
<td><strong>Cervical interfacetal subluxation/dislocation</strong></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>0</td>
</tr>
<tr>
<td>Yes</td>
<td>1</td>
</tr>
<tr>
<td><strong>Fracture line reaching an arterial structure</strong></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>0</td>
</tr>
<tr>
<td>Yes</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 2, adapted from Delgado Almanoz et al (2010), showing the proposed scoring system for CTA following blunt head and neck trauma (15).
<table>
<thead>
<tr>
<th>Type of injury</th>
<th>Radiological criteria</th>
<th>Clinical criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bony</td>
<td>Basal skull fracture involving carotid canal, basisphenoid, anterior clinoid processes</td>
<td>Le Fort II or III facial fracture</td>
</tr>
<tr>
<td></td>
<td>Cervical spine fracture, involving foramen transversarium</td>
<td></td>
</tr>
<tr>
<td>Neurological</td>
<td>Stroke on secondary CT scan</td>
<td>Horner’s syndrome</td>
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<tr>
<td></td>
<td></td>
<td>Unexplained neurological deficit</td>
</tr>
<tr>
<td>Soft tissue</td>
<td>Cervical haematoma</td>
<td>Hanging injury</td>
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<td></td>
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<td>Seatbelt sign</td>
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The commonest criteria justifying CTA are summarised in table 3, above

**Table 3**

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Figure 1a) axial bone windows demonstrating fracture of left basisphenoid. At subsequent CTA, a left-sided traumatic aneurysm of the cavernous portion of the carotid is identified b) axial view, c) magnified axial view, d) sagittal view, and e) magnified sagittal view.

Fig. 1

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Fig. 2

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Figures 3 a) and b) axial bone windows demonstrating fracture of lateral wall of right sphenoid sinus extending into the right carotid canal. Figures 3 c) and d) show subsequent CTA shows early right caroticocavernous fistula sagittal views, and e) and f) axial views. Figures 3 g) and h) show late right caroticocavernous fistula at second CTA examination.

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Figure 4 a) shows second unenhanced CT head following normal initial unenhanced CT head, performed due to persistently low GCS. Hypodense area in left frontal lobe suggestive of ischaemia. Subsequent CTA shows bilateral extracranial carotid artery dissections seen in coronal plane b) and c) magnified. Axial CTA d) shows right sided carotid dissection.

**Fig. 4**

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Figure 5 a) axial bone windows demonstrating fracture through left foramen transversarium. On coronal and axial views (b) and (c)), there is no flow in the left vertebral artery below the fracture. Appearances are suggestive of traumatic vertebral artery dissection (Biffi grade V (5)).

**Fig. 5**

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Conclusion

Unenhanced CT head examination following blunt head and neck trauma can highlight specific injuries which may warrant subsequent CT angiography of the intracranial vessels.

A standard protocol based on current evidence would aid the radiologist in rationalising the need for CTA, and hence increase diagnostic yield of frequently life-threatening cerebrovascular injury.
Personal information

Dr Juveria Siddiqui: Radiology Specialty Trainee, Bart's Health NHS Trust, London, UK
Dr Tom Campion: Radiology Specialty Trainee, Bart's Health NHS Trust, London, UK
Dr Jane Evanson: Consultant Neuroradiologist, Bart's Health NHS Trust, London, UK
References


