Radiological Evaluation of Cervical Spine Trauma

18

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Recommendations

Level I

Data are insufficient to support Level I recommendations for this subject.

Level II

A 3D CT of the cervical spine is far superior to plain X-ray (Holmes and Akkinepalli 2005).

Level III

MRI scan reveals damage to soft tissue that often isn't visible on a CT scan.

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18.1 Overview

CT should be the examination of choice, as it has a very high sensitivity and specificity for detecting injuries. Supplemental MRI for ligamentous or disc injuries should be reserved to cases with persisting neurological disability.

Particularly, multiplanar reconstruction and 3D reconstructions are valuable to visualize fractures and bone fragments.

Fractures of the cervical spine can be divided based on the mechanism of injury into *flexion*, *extension* or *compression* fractures or according to stability into *stable* or *unstable* fractures, using the three-column model (Fig. 18.1). There are multiple classification and scoring systems for spine injuries, some based on their anatomical location and others based on the osseous and ligamentous injuries.

Description/classification of injuries should be systematic and reflect a consensus between radiologist and treating physicians in regard to the classification systems used.

Tips, Tricks and Pitfalls: Cervical Spine Traumas

- Always do reconstructions and evaluate sagittal and coronal images.
- Be systematic when evaluating cervical images; look for:

T. Sundstrøm et al. (eds.), *Management of Severe Traumatic Brain Injury*,
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  - Maintained height of the vertebral bodies.
  - Alignment.
  - Normal distances and parallel surfaces between endplates in disc spaces, facet joints and spinous processes.
  - Continuous cortical margins.
  - Paraspinal haematomas and disruption of the architecture of the muscles of the posterior neck.
- Alignment is evaluated along the lines of the anterior and posterior longitudinal ligament, the posterior margin of the spinal canal and along the posterior margin of the spinous processes.

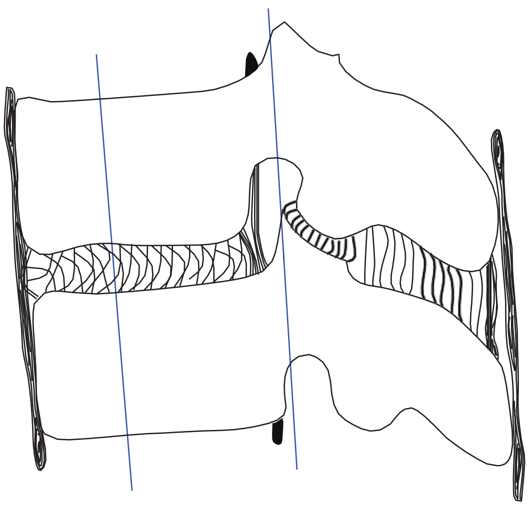

Fig. 18.1 The three-column model. Instability occurs when two of the three columns (anterior, middle or posterior) are injured

18.2 Background

18.2.1 Atlanto-occipital Dislocation

Atlanto-occipital dislocation in anterior-posterior or longitudinal direction results in increased distance between the basion and the odontoid. This injury can be associated with odontoid or condylar fractures and results often in severe soft tissue damage and brainstem injury.

18.2.2 Atlanto-axial Distraction

Atlanto-axial distraction causes widening of the distance between C1 and C2 with concomitant prevertebral soft tissue swelling and ligamentous tears. Dislocation in the transverse plane with rupture of the transverse ligament and associated fractures results in increased distance between the anterior surface of the odontoid and the posterior surface of C1.

18.2.3 Jefferson's Fracture

Jefferson's fracture is a compression "burst" fracture of C1 and involves disruptions of the anterior and posterior arches of the atlas. Tears of the transverse ligament are associated. More often, a hyperextension injury is seen with compression of the posterior arch of C1, resulting in a stable posterior arch fracture (Fig. 18.2).

18.2.4 Hangman's Fractures

Hangman's fractures are fracture dislocations of C2 caused by hyperextension injuries. If there are bilateral neural arch fractures, anterior displacement of C2 on C3 occurs. The posterior ring is usually fixed by the inferior articular process, unless there is accompanying facet disloca-

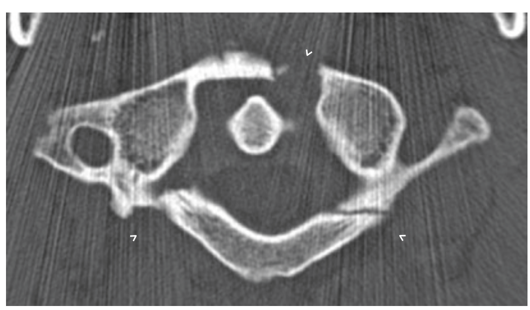

Fig. 18.2 Jefferson's fracture. *Arrow heads* indicate fractures disrupting anterior and posterior arches of C1

Fig. 18.3 Hangman's fracture: *Arrow heads* mark bilateral fracture through the posterior arch of C2

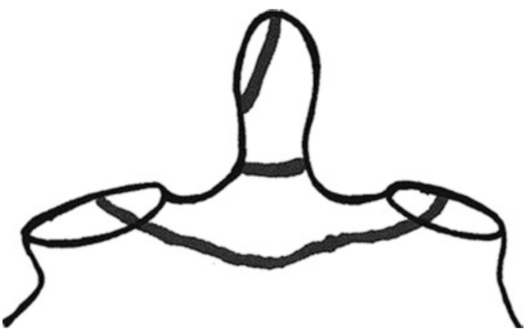

Fig. 18.4 Odontoid fractures. Type I: upper portion of the dens. Type II: junction of the dens with the body. Type III: through the body of the axis

tion. However, most Hangman's fractures result only in minimal translation and angulation (Fig. 18.3).

18.2.5 Odontoid ("Dens") Fractures

Odontoid ("dens") fractures are divided into three types according to Anderson and D'Alonzo with type II being unstable and type III relatively stable unless significantly displaced (Figs. 18.4 and 18.5).

Fig. 18.5 Odontoid fracture, type II

18.2.6 Associated Vascular Injury

Due to the anatomy of the vertebral artery, high cervical injuries (predominantly C1 and 2) can be associated with vascular injury (including both dissection and transection). In cases with significant dislocation or high injury, a supplemental CT-angio should be considered.

18.2.7 Compression Fractures

Compression fractures of a vertebral body can involve one or both endplates. Most are wedge-shaped without involving the posterior cortex. Burst fractures also affect the posterior cortex of the vertebral body, and fragments can be displaced into the spinal canal.

18.2.8 Teardrop Fractures

Teardrop fractures can be caused by hyperflexion or hyperextension injuries (Fig. 18.6).

In hyperflexion injuries, a triangular fragment can be found at the anterior-inferior border of the vertebral body with reduction of the anterior body height and soft tissue swelling. Disruption

Fig. 18.6 Teardrop fracture C6 (*arrow*)

Fig. 18.7 Locked facets. Anterior displacement of inferior articular process is marked by the (*arrow*). Note the concomitant fracture of the articular process

of the anterior part of the disc and the posterior ligament complex results in posterior displacement of the fractured vertebra and diastasis of the interfacetal joints. These fractures are unstable.

Hyperextension injuries may also result in an avulsion of the anterior-inferior corner of the vertebral body, but leave the posterior columns intact and are stable.

18.2.9 Locked Facets

Locked facets are the result of anterior displacement with interfacetal dislocation and the articular mass of the vertebra above lying anterior to the articular mass of the vertebra below.

This occurs uni- or bilaterally. The facet capsule is the strongest part of the cervical ligamentous complex, and so dislocation of the facet joint is often associated with severe ligamentous injuries with disruption of the interosseous ligaments and discs (Fig. 18.7).

18.3 Imaging of Intraspinal Injuries

MRI is the modality of choice to visualize spinal soft tissue lesions such as spinal cord haemorrhage and oedema, transections, ligamentous tears, epidural haematomas, disc herniations, nerve root avulsion and cord compression and also visualizes subluxations and fractures. Be aware that most of these lesions may occur without fractures or dislocations. Spinal cord oedema and ligamentous or disc lesions will appear bright on T2-weighted images (Fig. 18.8). Bright signal on T1-weighted images is related to acute haemorrhage. Medullary haemorrhage is associated with poor prognostic outcome.

18.4 Specific Paediatric Concerns

In children under the age of 8 years, distraction and subluxation injuries (such as atlanto-occipital dislocation and rotatory subluxation of the atlas upon the axis) are more common than fractures

Fig. 18.8 T2-weighted STIR image. Cervical fracture and dislocation with oedema of the spinal cord and posterior soft tissue laceration (*bright areas posterior*)

and often involve the occipito-atlanto-axial segment. Keep the congenital variants in mind including the absence of the posterior arch of C1 and the os odontoideum arising from the secondary ossification centre of the odontoid.

Suggested Reading

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