

Imaging of Cervical Spine Trauma

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General Considerations

Most spinal fractures are due to a single episode of major trauma. Fatigue fractures of the spine are unusual except in the pars interarticularis of children. Insufficiency fractures typically involve cancellous bone in the axial skeleton and are common in the spine, particularly in patients with osteoporosis. Pathologic fractures are common in the spine and are usually due to metastatic disease.

Spinal trauma is categorized by the location of the injury, its presumed mechanism and by the presence or absence of instability. The most common locations of injury include the lower cervical and thoracolumbar regions. The most common mechanisms are flexion and axial loading.

Cervical Spine

Soft-tissues:

>5 mm at anterior-inferior margin of C2 is abnormal.

>14 mm below arytenoid cartilages is abnormal (3/4 vertebral body).

Any focal bulge is abnormal (except adenoids and arytenoids).

Assess for prevertebral gas and assess position of the larynx.

Lines to Assess Alignment

Line 1: Anterior vertebral bodies

-difficult if osteophytes

Line 2: Posterior vertebral bodies

-very useful

Line 3: Spinolaminar line

-very useful

Line 4: Spinous processes

-unreliable due to normal variability

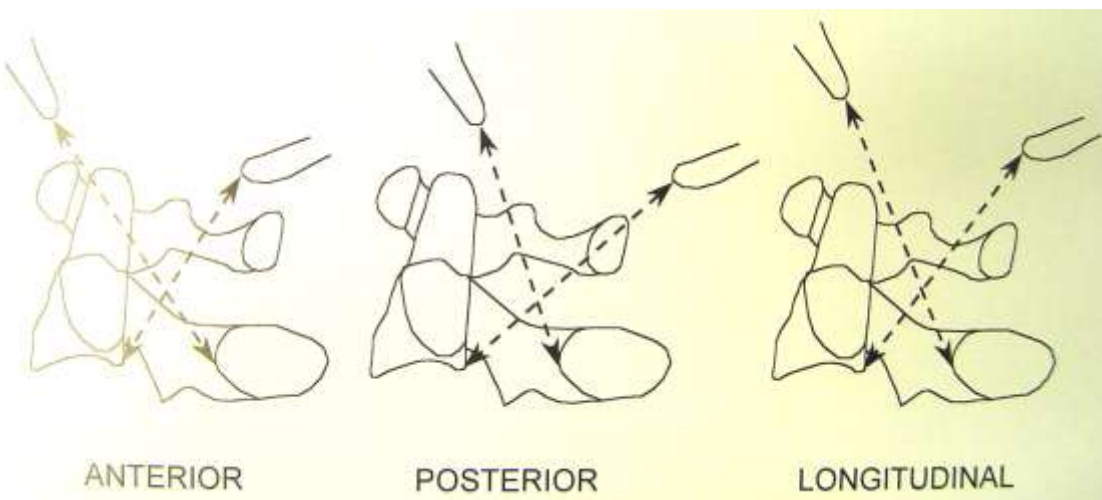
Mechanisms:

Mechanism of Injury		Unstable
Flexion:	Ligamentous Instability	+
	Wedge Fracture	
	Flexion teardrop fracture	+
	Clay-shoveller's fracture	
	Bilateral facet lock	+/-
Flexion-Rotation:	Unilateral Facet Lock	+/-
Extension:	Hangman's Fracture	+
	C1 posterior arch fracture	
	Extension teardrop	+/-
	Hyperextension dislocation	+
Extension-Rotation:	Pillar Fracture	
Axial Compression:	Burst Fracture	+/-
	Jefferson Fracture (C1)	+/-

Cervical spine: Specific injuries

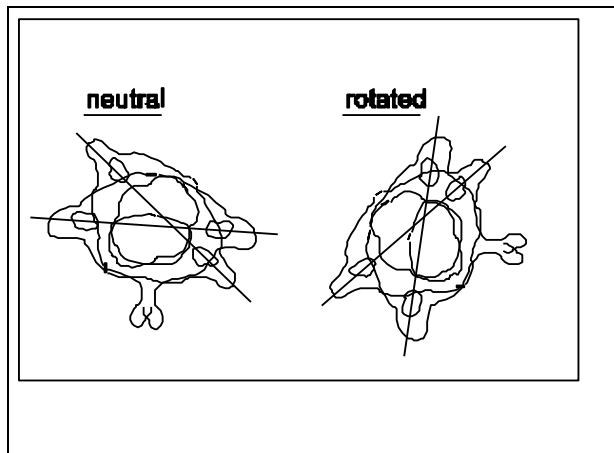
Occipito-Atlantal Dislocations:

This injury is almost always fatal at the time of impact. There is a higher incidence in children. Survivors with minimal deficit are not common. Xrays show soft tissue swelling. The Power's ratio is abnormal. There is displacement of the anterior rim of the foramen magnum (basion) anterior to the dens. There is displacement of the posterior rim of the foramen magnum anterior to the posterior arch of C1. The clival line fails to intersect the dens. There is widening of the occipitoatlantal articulations. Anterior dislocations of the occipital condyles occur with respect to the superior articular facets of C1.



Lee C, AJNR 1987;8:19-26

Atlantoaxial rotary fixation:



AARF may be due to trauma or follow an upper respiratory tract infection. C1 is fixed in rotation relative to C2. The AP odontoid view shows asymmetry in the sizes of the C1 lateral masses and in the distance between the dens and the lateral masses of C2. CT is performed in the resting position and with maximal head rotation to see if the C1-C2 axis is fixed.

Fracture of the Odontoid Process:

The fracture line occurs at the tip of the dens in Type 1, at the base of the dens in Type 2 and extends to the body of C2 in Type 3. Anterior or posterior displacement of the dens and C1 may occur. In severe injury distraction may be present. A "step-off" configuration of the spinolaminar line at C1 and C2 indicates that C1 has subluxed either anteriorly or posteriorly on C2. If you can't get an adequate view, get tomos in the AP plane or reformatted CT. Axial CT alone misses over 50% of Type 2 fractures.

Jefferson Fracture:

This injury of C1 is due to axial loading. There are ipsilateral anterior and posterior arch fractures. It may be unilateral or bilateral. The AP odontoid view shows lateral displacement of the lateral masses of C1 with respect to the articular pillars of C2. Unilateral lateral displacement of a lateral mass of C1 if there is no compensatory medial movement of the opposite lateral mass. The fracture lines may or may not be directly visualized on routine radiographs. CT shows the fracture lines optimally. Suspect transverse ligament injury if there is more than 7 mm of displacement or if there is an avulsion fracture at the C1 lateral mass at the ligament insertion site. This injury is very rare in children. Pseudo-Jefferson fractures are misdiagnosed because of earlier growth of C1 relative to C2.

Hangman's Fracture:

This injury, also known as traumatic spondylolisthesis is best seen on the lateral view. There is a fracture of the pars of C2 and anterior displacement of C2 relative to C3. Disruption of the C1-C2 spinolaminar line and the C2-C3 posterior vertebral body line are seen. The occipito-atlantal joints and odontoid process are intact. The bilateral pars fractures of C2 are anterior to the inferior articular facets, 20% extend into the C2 vertebral body. The injury is due to hyperextension. In 20% of Hangman's fractures the mechanism of injury is flexion and these have more significant displacement, angulation and may have bilateral C2-C3 facet lock.

Flexion instability:

Flexion instability is due to isolated rupture of the posterior ligaments. No fracture is seen so the injury may be missed unless delayed flexion views are obtained. In severe injuries, the initial lateral film shows posterior ligament disruption.

Clay Shoveler's Fracture:

These spinous process fractures are best seen on the lateral view. The fractures are most common at T1 and C7. The injury is caused by avulsion by the supraspinous ligament. The tip of the fractured spinous process is frequently displaced inferiorly. An abnormal contour and position of the spinous process may be noted on the AP view. Associated ligamentous tears may accompany this fracture and may permit malalignment of the apophyseal joint.

Teardrop Fracture:

A triangular piece of vertebral body is seen in the soft tissue anterior to the vertebral body. This unstable fracture is associated with ligamentous tears and possible spinal cord compression. The anteroinferior vertebral corner is involved. Hyper-extension teardrop involve C2 and C3. The more serious hyper-flexion teardrop fracture involves C5, C6, or C7.

Burst Fracture:

Best seen on lateral view, recognized by the loss of vertical body and prevertebral soft tissue swelling. Often has a sagittal component extending to inferior end plate which may be seen on the AP view. This fracture may result either from flexion of the cervical spine or from compression forces applied to the long axis of the cervical spine. Serious injury to the spinal cord may occur if there is encroachment of the canal by displaced vertebral body or disc fragment or by associated hemorrhage. Suspect encroachment if there is loss of definition of the posterior vertebral body margin at the fracture level. This fracture may be associated with widening of the apophyseal joints and with fracture of the posterior vertebral arches.

Interlocking of the Articular Facets:

Both unilateral and bilateral facet lock are best assessed on the lateral view. On this view, there is anterior displacement of the affected vertebra (50% in bilateral, 25% in unilateral). Bilateral facet lock is due to flexion and is easy to recognize. Unilateral facet lock is due to flexion combined with rotation and may be very subtle. Careful analysis of the facet joints is necessary to avoid missing this injury. The AP view shows rotation of the spinous processes. Oblique views are very helpful. CT shows a "naked" facet or shows the abnormal reversed position of the dislocated facet joint. In both injuries, the ligaments are disrupted. The soft tissue injury is much more severe in

bilateral facet lock.

Hyperextension dislocation:

Hyperextension places the cord at high risk for neurologic deficit, particularly in the spondylitic or stenotic spine. The xray may be completely normal following a hyperextension cervical injury. MR can assess the cord in patients with central cord syndrome following hyperextension.