Denis Classification

A widely used model for thoracolumbar spine stability is the 3-column model of Denis. See also the more recent TLICS system. Note: these systems are for trauma, see the Spine Instability Neoplastic Score (SINS) for stability assessment in metastatic spine disease.

Denis' 3-column model of the spine attempts to identify CT criteria of instability of thoracolumbar spine fractures. This model has generally good predictive value; however, any attempt to create "rules" of instability will have some inherent inaccuracy.

Description

According to Denis' system, spinal traumas are classified to minor and major injury, based on their potential risks to cause instability.

This is a spinal injury classification system based on radiological findings (and proposed tissues affected). US orthopedic surgeon Francis Denis devised the concept from a retrospective review of 412 thoracolumbar spine injuries and observations on spinal instability [1].

Denis divided the spinal motion segment into three columns. With the author's own words "The posterior column consists of what Holdsworth described as the posterior ligamentous complex. The middle column includes the posterior longitudinal ligament, posterior annulus fibrosus, and posterior wall of the vertebral body. The anterior column consists of the anterior vertebral body, anterior annulus fibrosus, and anterior longitudinal ligament".

see Three column model.

Denis classification of spinal trauma

Classification into major and minor injuries

Minor injury

The minor injuries represented by fractures of transverse processes, articular processes, pars interarticularis, and spinous processes involve only a part of the posterior column and do not lead to acute instability.

Major injury

The McAfee classification describes 6 main types of fractures [2].

Major spinal injuries are classified into four categories, all definable in terms of the degree of involvement of each of the three columns, namely: COMPRESSION, Thoracolumbar burst fracture, SEAT-BELT-TYPE , and FRACTURE-DISLOCATION type fractures. Each type of fracture also may be divided some subclasses based on severity of the damage.

COMPRESSION FRACTURE: It is a failure under compression of the anterior column. The middle column is intact and acts as a hinge. There may be a partial failure of the posterior column, indicating the tension forces at that level. Competent middle column prevents the fracture from subluxation or compression of the neural elements by retropulsion of the fragments of the posterior wall into the canal.

Four subtypes of compression fractures can be identified:

Type A - involvement of both end plates

Type B - involvement of superior end plate

Type C - inferior end plate

Type D - buckling of anterior cortex w/ both end plates intact.

BURST FRACTURE: The burst fracture results from failure under axial load of both the anterior and the middle columns originating at the level of one or both end-plates of the same vertebra. Five different types of burst fractures can be described (see the picture below).

Type A: Fracture of both end-plates. The bone is retropulsed into the canal.

Type B: Fracture of the superior end-plate. It is common and occurs due to a combination of axial load with flexion.

Type C: Fracture of the inferior end-plate.

Type D: Burst rotation. This fracture could be misdiagnosed as a fracture-dislocation. The he mechanism of this injury is a combination of axial load and rotation.

Type E: Burst lateral flexion. This type of fracture differs from the lateral compression fracture in that it presents an increase of the interpediculate distance on anteroposterior roentgenogram.

Denis' burst fracture subtypes

SEAT-BELT-TYPE INJURY: Both posterior and middle columns fail due to hyper-flexion and subsequent tension forces. The anterior part of the anterior column may partially damaged under compression, but still functions like a hinge. There is no subluxation, and spine is maily unstable in flexion. Seat-belt injuries may be divided to two subtypes.

One-level injury: It present as a simple Chance fracture going through bone, or as a ligamentous disruption passing through posterior ligamentous complex and the intervertebral disc.

Two-level injury: The middle column is ruptured either through the bone or the disc. This injusy pattern is comparable to the condition presented in hangman’s fracture.

FRACTURE-DISLOCATIONS: Presents with failure of all three columns under compression, tension,

rotation, or shear. It is similar to seat-belt-type injury. However, the anterior hinge is also disrupted and some degree of dislocation is present. There are three subtypes of fracture-dislocations based on mechanism of injury: flexion rotation, flexion distraction, and shear.

Flexion-rotation type fracture-dislocation.There is a complete disruption of the posterior and middle columns under tension and rotation. The anterior column may fail in rotation or compression and rotation. The failure at the level of the middle and anterior columns may occur through the vertebral body or purely through the disc.

Flexion-distraction type fracture-dislocation. This injury resembles the seat-belt type of injury with disruption of both the posterior and middle columns under tension. However, in addition, it presents tear of the anterior annulus fibrosus, and subsequent stripping of the anterior longitudinal ligament during subluxation or dislocation.

Shear type fracture-dislocation. This injury results from an extension type of mechanism in which the anterior longitudinal ligament is disrupted. The disc is first torn anteriorly to posteriorly until the continued shearing force translates the upper segment on top of the inferior segment, or vice versa. It has 2 subtype:

(1) In the posteroanterior shear subtype, the segment above is sheared off forward on top of the segment below. The posterior arch of the last one or two vertebrae of the upper segment is usually fractured in the translation, leaving a floating posterior arch behind. The frequency of dural tear and complete paraplegia is very high in this type of fracture.

(2) In the anteroposterior shear, the segment above shears off on the segment below in a posterior direction. Its posterior arch has nothing to clear during its posterior displacement; therefore, no free-floating laminae exist.

Stability

Although individual characteristics of the fractures are important, the order of fracture types in terms of their instability risk as follows (from the most stable to the most instable): wedge fracture < burst fracture < seat-belt-type fracture < fracture dislocation.

References

Denis F. Updated classification of Thoracolumbar spine fractures. Orthop Trans 6: 8-9, 1982

Denis F. Spinal instability as defined by the three-column spine concept in acute spinal trauma. Clin Orthop Relat Res. 1984 Oct;(189):65-76.

Dennis F., Armstrong G. W. D., Searls K., Matta L. Acute thoracolumbar burst fractures in the absence of neurologic deficit ; a comparison between operative and non-operative treatment. Clin. Orthop., 1984, 189, 142-149.

1)

Denis F. The three column spine and its significance in the classification of acute thoracolumbar spinal injuries. Spine (Phila Pa 1976). 1983 Nov-Dec;8(8):817-31. PubMed PMID: 6670016.

2)

Chedid MK, Green C. A Review of the management of lumbar fractures with focus on surgical decision

making and techniques. Contemp Neurosurg 1999;21(11):1-12.