

Vertebral Column Injury (GENERAL)

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VCT – vertebral column trauma.
SCI – spinal cord injury.

- VCT causes ≈ 6% TRAUMATIC HOSPITALIZATIONS.

ETIOPATHOPHYSIOLOGY

Causes (most commonly *indirect severe force* applied to vertebral column → sudden flexion, hyperextension, vertebral compression, or rotation):

- 1) motor vehicle accidents 30-50% (declining)
- 2) violence 5-29% (increasing)
- 3) falls 17-21% (esp. in elderly)
- 4) recreational activities 7-16% (esp. diving)
- 5) birth trauma (esp. cervical spine – breech delivery, “shaken baby”)

Evolutional aspects:

- *prehistoric humans suffered little spinal injury* - semierect posture, with shoulders hunched well forward, combined with well-developed posterior cervical muscles that extended head against pull of gravity, protected cervical spine against day-to-day trauma.
- in evolution, people assumed upright posture (so that hands could be used more effectively), *shoulders dropped* away from newly elevated head and previously hypertrophied *paraspinous muscles atrophied* - this provided head with tremendous range of motion but decidedly diminished protection of spine.

REGIONAL ASPECTS

Vertebral trauma:

50% - cervical (30% occur at C₂, 50% occur at C₆₋₇)

50% - thoracic ÷ sacral (60-70% occur in T₁₂-L₂)

N.B. trauma most often affects junctions between fixed and mobile segments

Cervical segment (very mobile segment that joins two large body masses – head with trunk) – *CLOSED SPINAL INJURIES* by *hyperextension* or *flexion*, etc.

- 39% cervical fractures give *neurologic deficit*.

Thoracic spine (longest segment) – high percentage of *MISSILE INJURIES*

- T₁₋₁₀ region has *high stability* (stabilizing effects of **rib cage**, almost-vertical orientation of **articulating processes**, shingle-like oblique arrangement of **spinous processes**) - significant force is required to cause fracture / dislocation.
- **laminae** are also protective – broad, sloping, overlapping.
- thoracic spinal canal is narrow, cord has poor vascular supply – vertebral injuries have *high incidence of SCI* (90% dislocations above T₁₀ result in complete paraplegia!!!)

Thoracolumbar union (rigid thoracic area transitions to mobile lumbar spine) – *CLOSED SPINAL INJURIES* by *vertical compression with flexion* (→ compression fractures with anterior wedging), or *rotation* (→ fracture dislocations), etc.

- *lower mechanical stability* - no stabilizing effect of rib cage (T₁₁₋₁₂ region has false ribs), spinous processes are more horizontal, disc height↑.
- injuries to T₁₁-L₁ can result in significant paralysis (conus medullaris).

Mid ÷ low lumbar spine - injuries are more forgiving - *roots of cauda equina* are smaller, more flexible, and more resistant to injury (as they are PNS) compared with conus medullaris (as it is CNS).

STABILITY and spinal cord injury

Holdsworth's concept:

ANTERIOR COLUMN (80% of vertical strength) - *vertebral bodies* and *intervertebral disks* - held in alignment by *anterior & posterior longitudinal ligaments*.

POSTERIOR COLUMN - *articulating facets* (provide remaining 20% of vertical strength), *pedicles*, *transverse processes*, *laminae*, *spinous processes* - held in alignment by *nuchal ligament complex* (supraspinous, interspinous, infraspinous ligaments), *capsular ligaments*, *ligamentum flavum*.

If **BOTH COLUMNS** are traumatically disrupted at one level (spine moves as two separate pieces) - **MECHANICALLY unstable** injury - great risk of vertebral canal misalignment (→ spinal cord injury) from even slight motion.

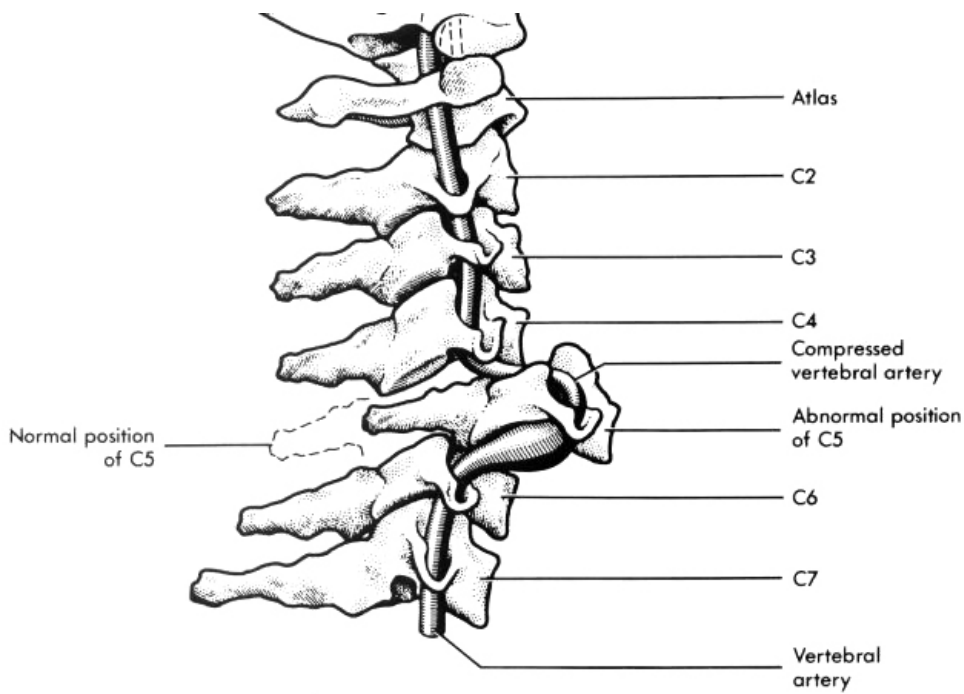
If **only ONE COLUMN** is disrupted (other column resists further movement) - likelihood of spinal cord injury resulting from normal motion depends on integrity of ligaments supporting involved column.

- failure of any one of columns may involve *compression effect* (failure of vertical strength) or *failure of ligamentous strength* (incapability to oppose distraction).
- spinal canal compromise is more frequent when anterior column is involved.
- *any degree of subluxation* must be treated as potentially unstable!!! (ligamentous disruption allows cord compression at moment of impact, but vertebral bodies return closer to their original stations afterward).

MECHANICALLY stable - fragments are not likely to move and cause neural damage when spine is physiologically loaded.

N.B. **MECHANICALLY stable** injuries may be **NEUROLOGICALLY unstable** - result in spinal cord damage from:

- 1) fracture fragments (bone splintering)
- 2) herniated intervertebral disks
- 3) epidural hematoma
- 4) spinal cord vascular compromise:

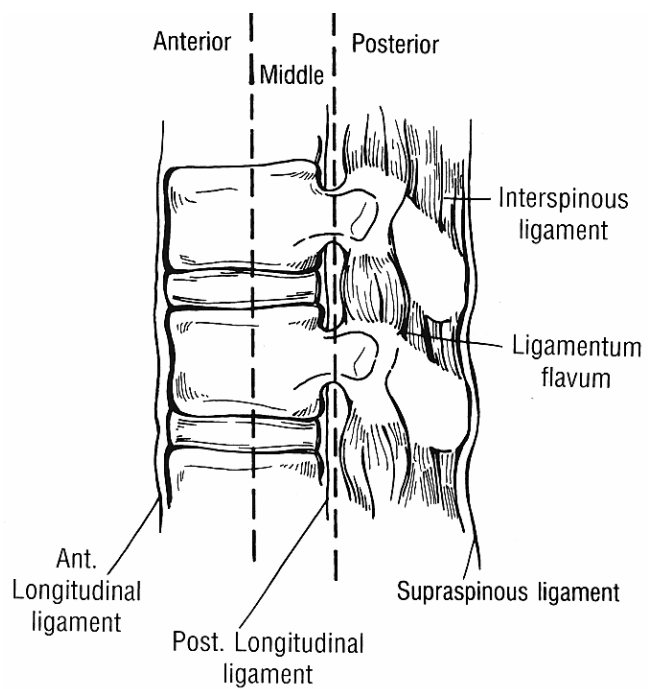


Denis (1983) divided ANTERIOR COLUMN of Holdsworth into two segments:

ANTERIOR SEGMENT - anterior halves of vertebral bodies with intervening disks, anterior longitudinal ligament.

MIDDLE SEGMENT - posterior halves of vertebral bodies and their intervertebral disks, posterior longitudinal ligament.

Injuries involving 2 or 3 columns are unstable!



INCIDENCE of spinal cord injury

Overall, only 10-15% VCTs result in neurologic deficits.

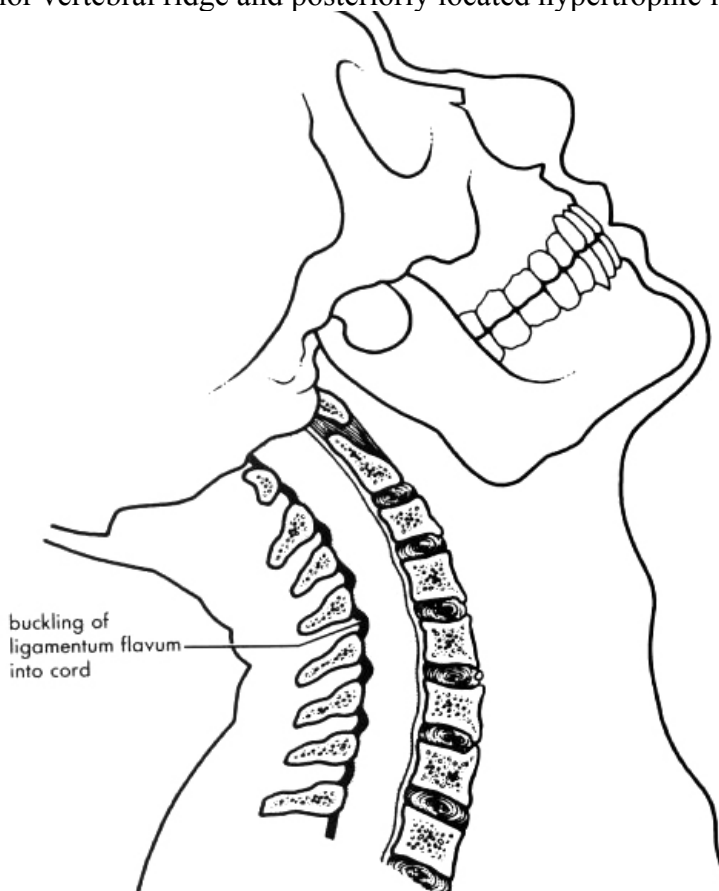
Type of injury	Percent with neurologic deficit
Fracture of vertebral body	3
Fracture of posterior element	19
Fracture of posterior elements and vertebral body	11
Dislocation only	17
Dislocation + fracture of posterior elements	27
Dislocation + fracture of vertebral body	56
Dislocation + fracture of posterior elements and vertebral body	61

PREDISPOSING FACTORS to spinal cord injury

- preexisting vertebral column pathology (may allow SCI even without fracture or dislocation!!!):

- 1) **instability of apophyseal joints** (e.g. [rheumatoid arthritis](#)).
- 2) **atlantoaxial instability** (e.g. Down syndrome*, rheumatoid arthritis) → severe SCI after minor injury. *laxity of transverse ligaments
- 3) **decreased spinal canal** - [spondylosis](#) (elderly predisposition to cervical SCI**), [spinal stenosis](#), [ligamentum flavum hypertrophy](#).

**forcible cervical extension → cord compression between arthritically enlarged anterior vertebral ridge and posteriorly located hypertrophic ligamentum flavum:



BIBLIOGRAPHY for ch. "Spinal Trauma" → follow this [LINK >>](#)