Axial and Subaxial Injuries of the Cervical Spine

Neurosurgery Resident Teaching

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Classification of Cervical Spine Injury

- Mechanism of injury: more appropriate element to divide c-spine injuries into classes.
- Force vectors:
  Flexion
  Extension
  Vertical compression (axial load)
  Lateral flexion
  Rotation
  Combination of forces

- Hyperflexion:
  Ligamentous injuries
  Subluxations
  Bilateral facet dislocations
  Compression fractures
  Avulsion fractures
- Flexion + Rotation: Unilateral facet dislocation.
- Hyperextension:
  Avulsion fractures of the anterior arch of atlas
  Posterior arch atlas fractures
  Teardrop fractures
  Laminar fractures
  Hyperextension fracture-dislocations Hangman's fract.

- Extension + Rotation: Pillar fractures.
- Vertical compression (axial load):
  Burst type of fractures
  Jefferson’s fracture
- Lateral flexion: Uncinate process fracture

Stability

Clinical definition

- The ability of the spine under physiological loads to prevent displacements which would injure or irritate neural tissue.

Cervical Spine Stability

Clinically, stability of the cervical spine implies:

- Absence of excessive displacement or deformity under physiologic loading.
- No development of deformity or abnormal displacement during the healing process.
- Compression or injury of the neural elements is not present and will not occur over time with the application of physiological loads.

Cervical Spine Stability

Goals in the management of spinal instability

- Prevention of secondary neurological injury
- Provision of an optimal environment for the recovery of any existing neurological injury.

Cervical Spine Stability

Stability at the occipitoatlantoaxial region is provided by

- Inner ligaments:
  Alar ligaments
  Apical ligament
  Cruciform ligament
  Tectorial membrane
- Outer ligaments:
  Articular capsules
  Anterior and posterior atlanto-occipital memb.
  Nuchal ligament

Stability in the lower cervical spine

- Disk
- Anterior and posterior longitudinal ligaments

Criteria for Instability of Lower Cervical Spine

Element	Points
Ant. elements damaged	2
Post. elements damaged	2
Relative saggital plane translation > 3.5 mm	2
Relative saggital plane rotation > 11 degrees	2
Positive stretch test (>1.7 mm)	2
Spinal cord damage	2
Nerve root damage	1
Abnormal disc narrowing	1
Dangerous loading anticipated	1

Total 5 or more = unstable lower c-spine

White, Southwick, Panjabi, 1976

Occipital Condyle Fractures

- Commonly associated to fractures of the atlas.
- Neurological deficit is uncommon.
- Most common presentation: occipitocervical pain.
- Classification:

Type I

•Minimal displacement of fragments into the foramen magnum.
•Mechanism of trauma: axial loading.
•Stable fractures.

Type II

•Occur as part of a skull base fracture
•Stable fractures.

Type III

•Avulsion from the alar ligament.
•Mechanism of injury: rotation, lateral bending or combination of the two.
•Potentially unstable fractures.

Atlanto-Occipital Dislocations

- Improvements in prehospital management have resulted in increased number of alive patients.
- Unstable fractures.
- Mechanism of trauma: distraction +/- other force vectors.
- Clinical presentation: quadriplegia and respiratory arrest to intact neurologically.
- Index of suspicion may be increased with the identification of prevertebral soft tissue swelling (retropharingeal hematoma) or SAH at the craniovertebral junction.
- Classification:

  - ❖ Ant. Displacement of the cranium with respect to the atlas.
  - ❖ Post. displacement of the cranium with respect to the atlas.
  - ❖ Longitudinal distraction with separation of skull from c-spine

Methods to identify AOD

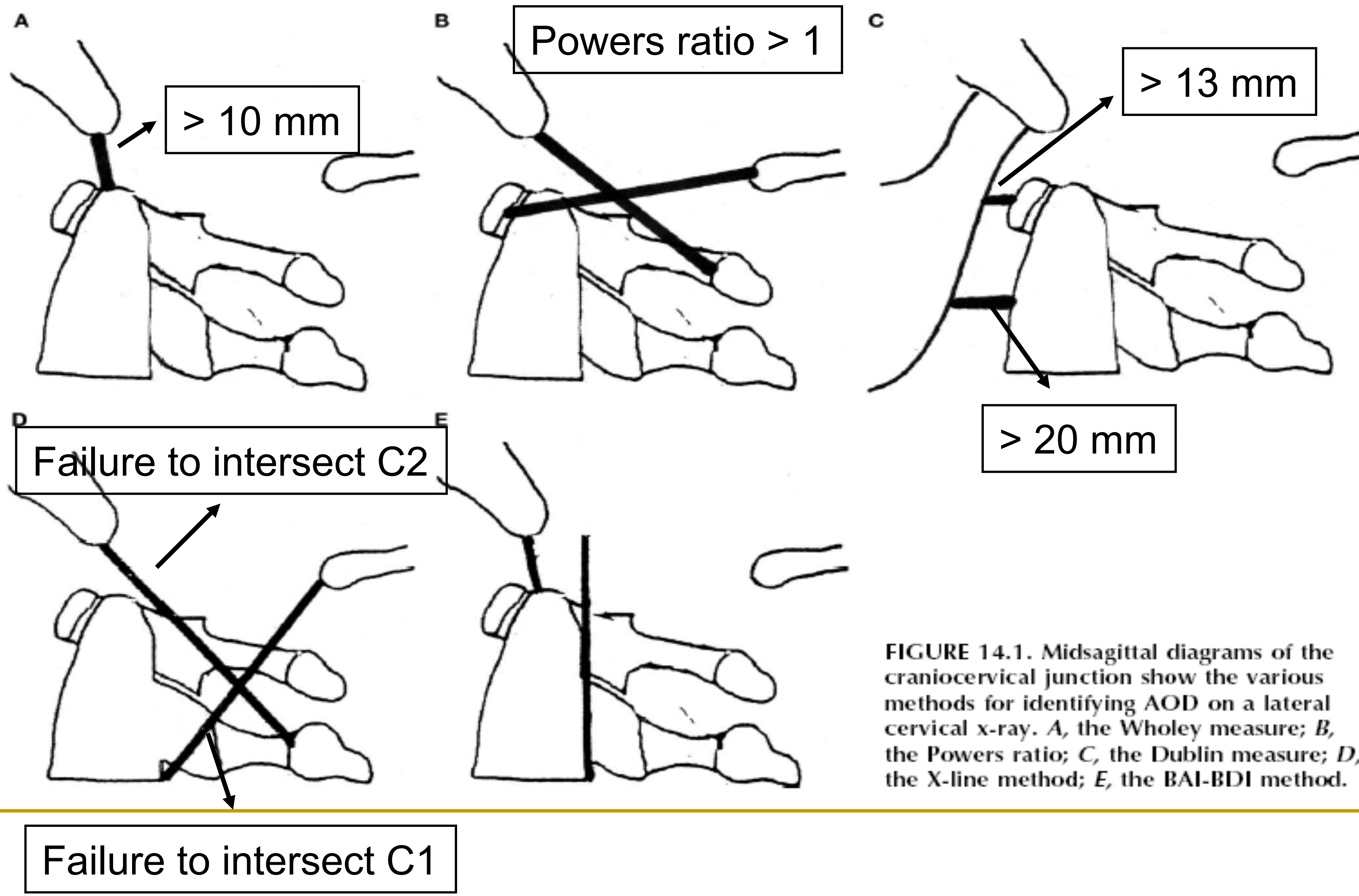


FIGURE 14.1. Midsagittal diagrams of the craniocervical junction show the various methods for identifying AOD on a lateral cervical x-ray. *A*, the Wholey measure; *B*, the Powers ratio; *C*, the Dublin measure; *D*, the X-line method; *E*, the BAI-BDI method.

AOD: Treatment

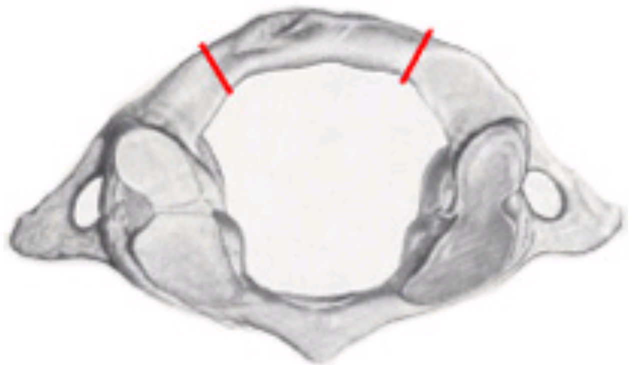
- All patients with AO should be treated.
- Without treatment, nearly all patients develop neurological worsening, and some do not recover.
- Traction and external immobilization: Association to transient or permanent neurological worsening and late instability.
- Craniocervical fusion with internal fixation: best treatment.

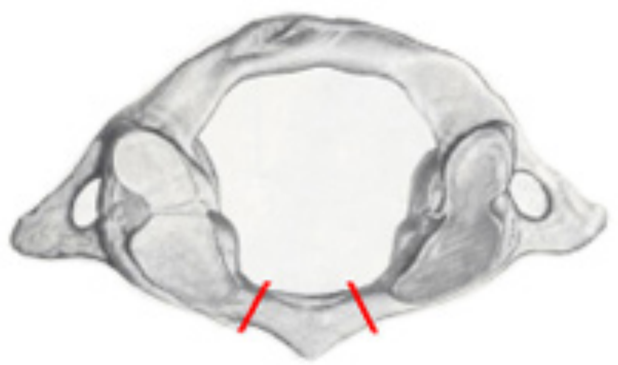
Atlas Fractures

- Posterior arch fractures.
- Anterior arch fractures.
- Jefferson’s fractures.
- Lateral mass fractures.

Atlas Fractures

- Posterior arch fractures: Most common. Hyperextension-compression forces. Differential diagnosis: congenital anomalies of the posterior arch. Stable fracture
- Anterior arch fractures: Avulsion of the tuberculum anterius by the longus colli muscle. Stable fracture.

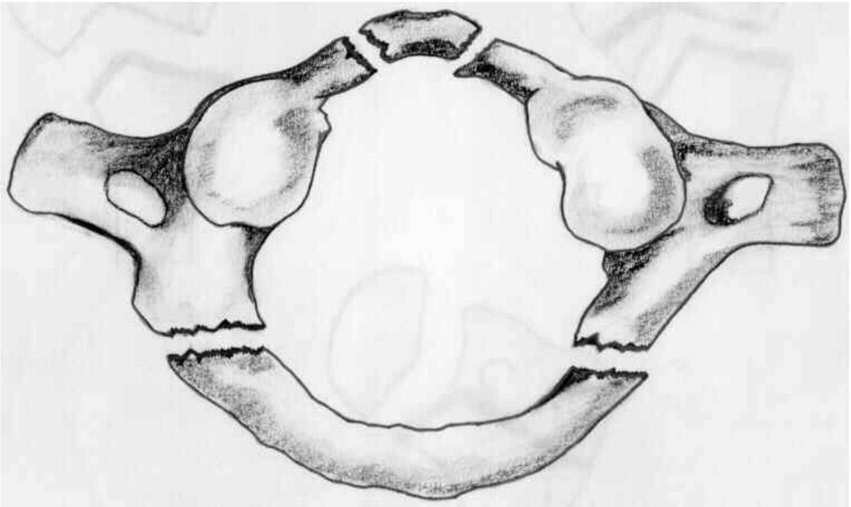




Atlas Fractures

Jefferson's fractures

- Axial compression forces.
- Bilateral spreading of the lateral masses.
- Failure of both the anterior and posterior arches.



Jefferson's fractures

- Spence's rule: If, on open mouth radiographs, the distance of excursion of lateral masses is 7 mm or more, there likely is a transverse ligament rupture.

Atlas Fractures

Lateral Mass Fractures

- Axial loading + lateral bending.
- Diagnosed on open - mouth view.
- Associated to condyle fractures and lateral mass fractures of C2.
- Minimal lateral displacement (< 2 mm): cervical orthosis.
- Greater displacement or comminution: halo orthosis or recumbent traction.

TABLE 16.2. Treatment Options for Atlas Fractures

Atlas Fracture Type	Treatment Options
Anterior or posterior arch fractures	Collar
Anterior and posterior arch (burst):	
Stable (transverse atlantal ligament intact)	Collar, halo
Unstable (transverse atlantal ligament disrupted)	Halo, C1–C2 stabilization and fusion
Lateral mass fractures:	
Comminuted fracture	Collar, halo
Transverse process fractures	Collar

Axis Fractures

- Odontoid fracture.
- Hangman’s fracture.
- Lateral mass fracture

Axis Fractures

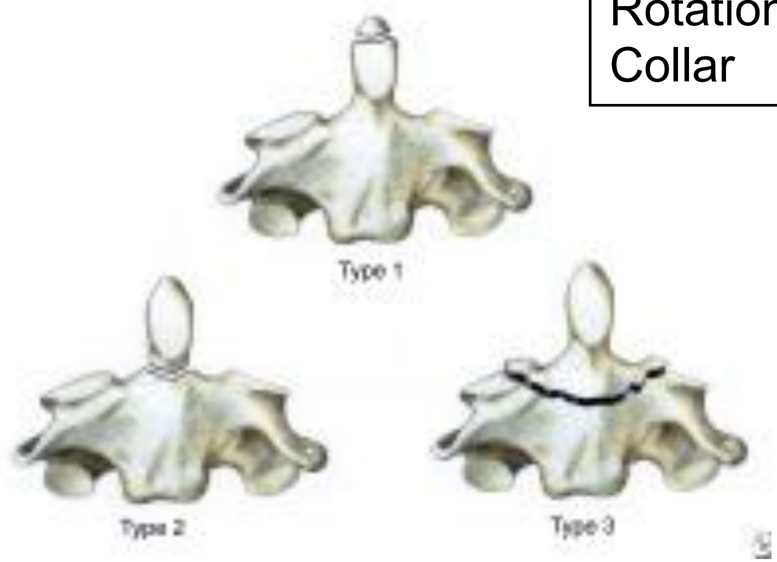
Odontoid Fractures

- 7% - 14 % of c-spine fractures.
- Mechanism:
  Falls in pts > 60 years of age.
  MVC in pts < 40 years of age.
  Most are due to hyperflexion – ant. displacement
- Clinical findings: neurological deficit is uncommon.

Anderson and D'Alonzo Classification

Avulsion of distal tip
Uncommon
Rotation + lat flex
Collar

Fracture through the base
Most common:60-90%
High non-union rate:
Age
Displacement > 6 mm
Post displacement.



Fracture passes into the body
Halo-vest for 12 weeks

Hangman's Fracture

- AKA traumatic spondylolisthesis of C2.
- The fracture line passes through the neural arch.
- It may or may not result in ant. displacement of C2 on C3.
- Most commonly caused by a MVC and a fall.
- Current classification (Levine & Edwards) is based on radiological findings: 4 types are described and each category has different mechanism of trauma.

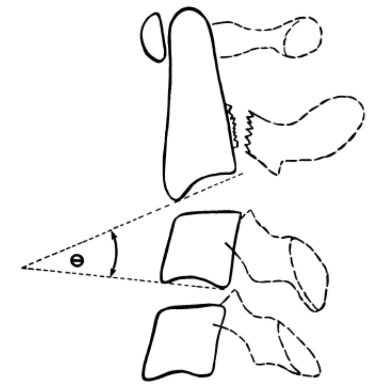


FIG. 1

Angulation is calculated as the angle between the inferior end-plate of the second cervical vertebra and the inferior end-plate of the third cervical vertebra.

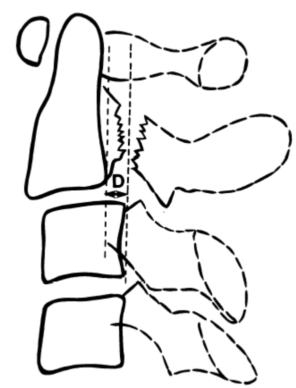


FIG. 2

Anterior translation is measured as the distance between a line drawn parallel to the posterior margin of the body of the third cervical vertebra and the posterior margin of the body of the second cervical vertebra at the level of the disc space between the second and third cervical vertebrae.

Type I

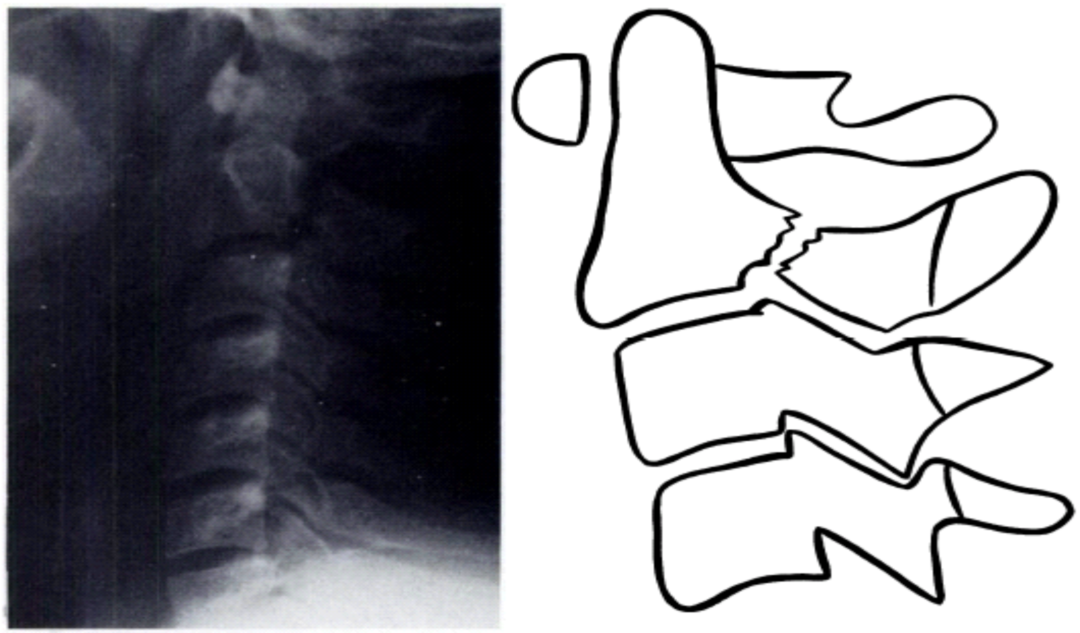
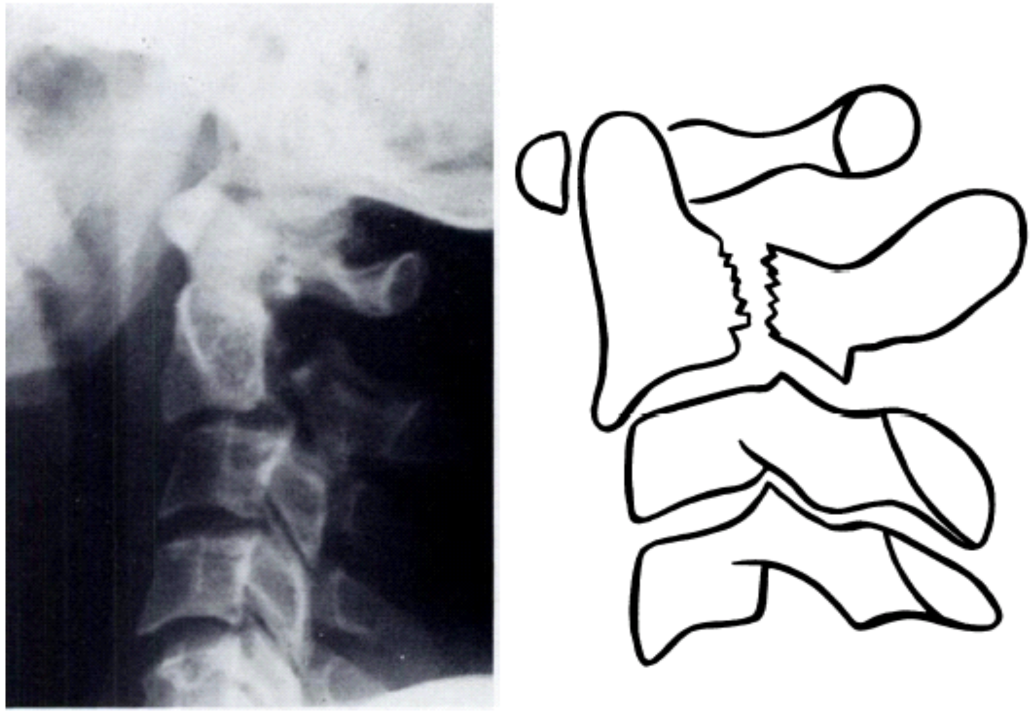


FIG. 3

Type-I injuries have a fracture through the neural arch with no angulation and as much as three millimeters of displacement.

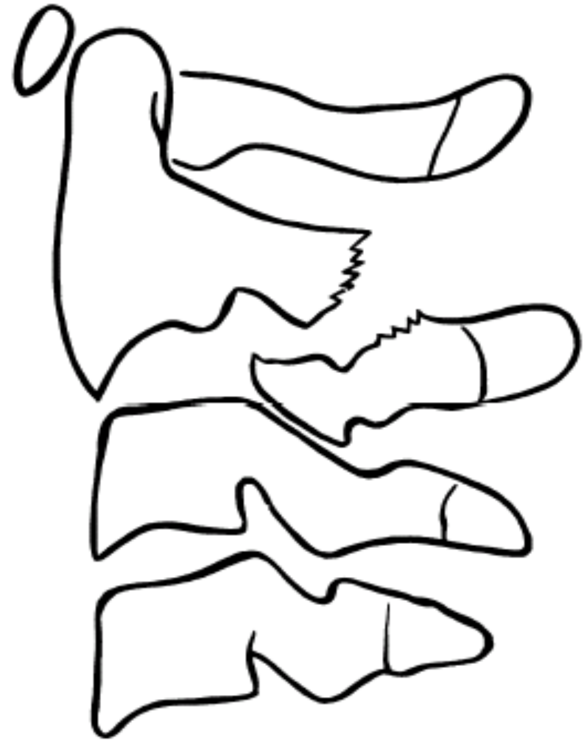
Mechanism: hyperextension – axial loading
Integrity of ALL, PLL, and Disc
No angulation.
Displacement < 3 mm
Stable fracture: Collar.

Type II



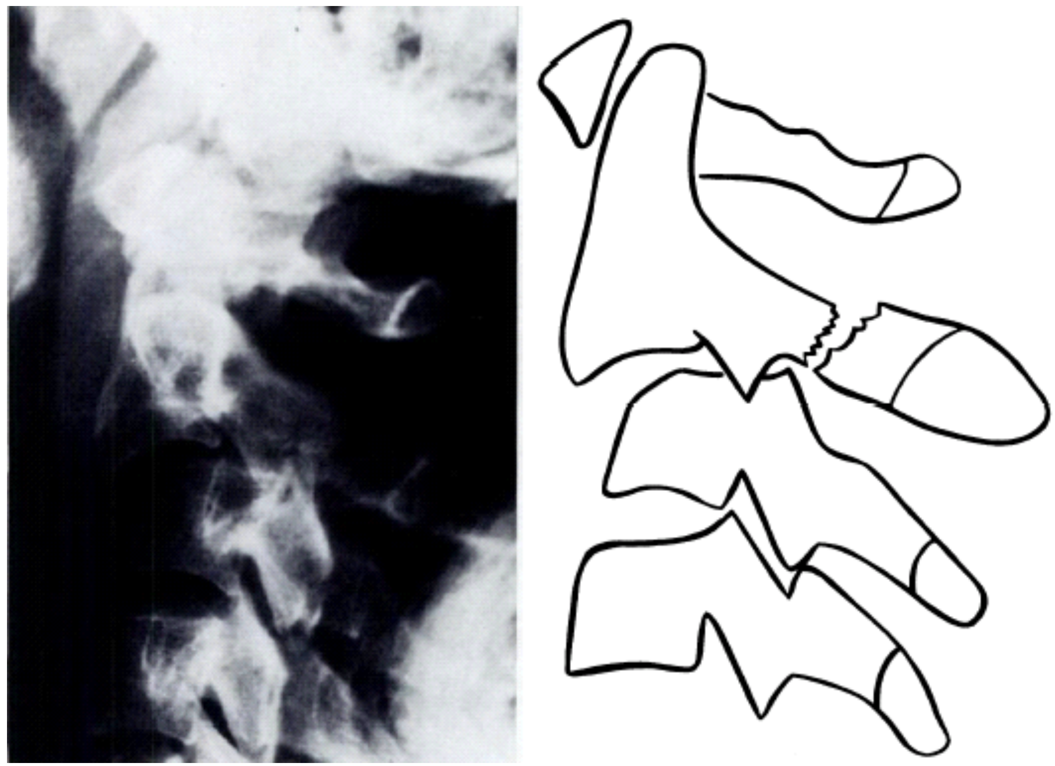
Significant angulation and translation.
Extension – axial loading followed by flexion.
Most common type
Unstable: halo vest.

Type IIA



Significant angulation
No translation
Flexion – distraction
Unstable: Halo vest

Type III



Severe angulation and translation + unilateral or bilateral C2-3 facet dislocations.
Flexion – compression.
Unstable fractures: Surgical reduction and fixation.

Subaxial Fractures and Dislocations

- Fractures below C2 have similar patterns.
- The most common levels affected are C5 and C6.
- More common injury patterns include:

  - ❖Compression fractures
  - ❖Burst fractures
  - ❖Teardrop fractures
  - ❖Unilateral and bilateral locked facets
  - ❖Hyperflexion injuries
  - ❖Clay shoveler's fractures