SUBAXIAL CERVICAL SPINE TRAUMA - DIAGNOSIS AND MANAGEMENT
Anatomy

• 3 columns- Anterior, middle and Posterior
  • Anterior- ALL, Anterior 2/3 rd body & disc.
  • Middle- Posterior 1/3rd of body & disc, PLL
  • Posterior- Pedicle, lamina, facet, transverse process, spinous process, Ligaments-interspinous, lig.flavum
• Articulations- Disc-vertebral body, Uncovertebral, Zygapophyseal joints.
Cervical spine injuries

• Common cause of disability
• Incidence
  – Spine without cord injury- 3%
  – Cord without #- 0.7%
• Most commonly involves C5 and C6 levels.
• Primarily involves adolescents and young adults
• Males predominate.
• Most common causes-
  – RTA, Fall, Penetrating trauma, Sports
Clinical features

• Neck pain
• Restriction of neck movements
• Neck tenderness
• Varying degrees of neurological deficits
  – Complete cord syndrome
  – Incomplete cord syndrome
    • Central cord syndrome
    • Brown-Sequard syndrome
    • Anterior cord syndrome
    • Combination
Mechanisms of injury

A- Axial compression force
B- Hyperextension injury
C- Hyperflexion injury
By mechanisms of injury

• Flexion
  – Anterior subluxation
  – Unilateral facet dislocation
  – Bilateral facet dislocation
  – Wedge compression fracture
  – Flexion teardrop fracture
  – Clay Shoveler's fracture

• Extension
  – Hangman's fracture

• Compression
  – Jefferson fracture
  – Burst fracture

• Complex
  – Odontoid
• IMAGING

• Lateral view
  – Disc spaces, vertebral body, facet joints

• AP view- Spinous process, Uncovertebral joints

• Oblique view- Foramina, pedicles, facet joints, lateral mass, lamina
• Up to 20% of fractures are missed on conventional radiographs.
• The sensitivity and specificity of CSR to detect fractures around 31.6 and 99.2%, respectively.
• For radiographic clearance of the cervical spine- CT is a must.
• CT- Excellent details about the # morphology.
MR Imaging

- Excellent soft tissue detail
- To detect
  - spinal cord integrity/ spinal cord changes/ disc herniations/ epidural blood
- Supplementary to CT spine.
Classification

- **AO SPINE**
- **SLIC**
- Allen
AO spine classification

• Based on 2 column concept of Nicolle and Holdsworth.
• Similar to the ones of thoraco-lumbar injuries
• 3 types- based on fundamental injury patterns
  – A- vertebral body compression
  – B- anterior and posterior element with distraction
  – C- anterior and posterior element with rotation
• Each type has 3 groups with 3 sub groups
• Isolated spinous/ transverse process # not considered.
• Type B and type C injuries are the dominating cervical spinal injuries.
• The severity in terms of instability of the injuries as well as the rate of neurological deficits does not continuously increase from A to C in the cervical spine as it does in the thoracolumbar spine.
Type A (Compression) Fractures

• Axial compression with or without flexion.
• Height of vertebral body (anterior column) reduced.
• Shortening of the anterior column
• Posterior ligamentous complex intact (flexion/extension x-rays, MRI).
• Translation in sagittal plane does not occur.
• Rare in comparison to the thoracic and lumbar spine.
• Posterior elements’ disruption to be always ruled out so as to classify as type A injury.
Group A1- Impaction 

• Deformation of the vertebral body is due to compression of the cancellous bone rather than to fragmentation.
• Posterior column is intact.
• Narrowing of the spinal canal does not occur.
• Injuries are stable.
• Posterior vertebral body wall is intact.
• Neurological deficit is very rare
A1.1 end-plate impaction

A1.2- wedge impaction
  • Superior wedge impaction
  • Lateral wedge impaction
  • Inferior wedge impaction

A1.3-Vertebral collapse fracture.
  • Rare in cervical spine.
  • No subluxation.
  • Posterior elements remain intact.
Group A2- split #

- Vertebral body is split in the coronal or sagittal plane with a variable degree of dislocation of the main fragments.
- When the main fragments are significantly dislocated, the gap is filled with disc material which may result in a nonunion.
- Neurological deficit is uncommon.
- The posterior column is not affected.
A2.1- Sagital split #
A2.2- Coronal split#
A2.3- Pincer #

- Pincer #- Coronal fracture with dislocation of main fragments
Group A3- Burst #

- Vertebral body is partially or completely comminuted with a centrifugal extrusion of fragments.
- Fragments of the posterior wall are retropulsed into the spinal canal and may be the cause of neural injury.
- The posterior ligamentous complex is intact.
- Injury to the arch, if present, is always a vertical split through the lamina or spinous process.
• A3.1 incomplete burst fracture
  – 1. superior incomplete burst fracture
  – 2. lateral incomplete burst fracture
  – 3. inferior incomplete burst fracture
• A3.2 burst-split fracture
  – 1. superior burst-split fracture
  – 2. lateral burst-split fracture
  – 3. inferior burst-split fracture
• A3.3 complete burst fracture
  – 1. pincer burst fracture
  – 2. complete flexion burst fracture
  – 3. complete axial burst fracture
• Pathognomonic feature-
  – Broken, shortened posterior wall and
  – Subsequent narrowing of the spinal canal often combined with a neurological deficit.
  – Disc also usually involved.
TYPE B INJURIES—ANTERIOR AND POSTERIOR ELEMENT INJURY WITH DISTRACTION

- Account for almost half of all injuries
- B component of an injury has to be looked carefully because it changes the prognosis dramatically
- Typical features:
  - Transverse disruption of one or both spinal columns initiated by flexion-distraction (posterior) or hyperextension (anterior).
  - Translation dislocation in the **sagittal direction**.
- The main criterion is a transverse disruption of one or both spinal columns.
- Flexion/distraction initiates posterior disruption and elongation (B1 and B2)
- Hyperextension with or without anteroposterior shear causes anterior disruption and elongation (B3).
- In B1 and B2 injuries, the anterior lesion may be through the disc or a type A fracture of the vertebral body.
Group B1- Posterior disruption primarily ligamentous (Flexion distraction injuries)

- Leading feature is disruption of the posterior ligamentous complex with bilateral subluxation, dislocation, or facet fracture.
- Pure flexion-subluxations are only unstable in flexion, whereas pure dislocations are unstable in flexion and shear.
- Neurological deficit is frequent and caused by translational displacement and/or vertebral body fragments retropulsed into the spinal canal.
• B1.1- With transverse disruption of the disc
  – 1. Flexion subluxation
  – 2. Anterior dislocation
  – 3. Flexion subluxation/ anterior dislocation with # of articular process

• B1.2- With type A # of vertebral body
  – 1. Flexion subluxation with type A # of body
  – 2. Anterior dislocation with type A # of body
  – 3. Flexion subluxation/ anterior dislocation with # articular process and type A # of body
Group B2- Posterior disruption primarily osseous (flexion-distraction injuries)

• B2.1 transverse bi-column fracture (channel fracture)

• B2.2 with disruption of the disc
  – .1 disruption through the pedicle and disc
  – .2 disruption through the pars interarticularis and disc (flexion spondylolysis)

• B2.3 with type A fracture of the vertebral body
  – .1 fracture through the pedicle and type A fracture
  – .2 fracture through the pars interarticularis (flexion spondylolysis) and type A fracture
Group B3-anterior disruption through the disc (hypertension-shear injuries)

- B3.1 hyperextension-subluxation
  - .1 without injury of the posterior column
  - .2 with injury of the posterior column
- B3.2 hyperextension spondylolysis
- B3.3 posterior dislocation
Type C- Anterior and posterior element injury with rotation

• Rotational displacement.
• Translational displacement in the coronal plane (pathognomonic).
• Unilateral fractures of articular and transverse processes.
• Lateral avulsion fractures of the end plate.
• Account for 40% of all injuries in the lower cervical spine.
• Therefore have a significant clinical importance.
Group C1: type A (compression) injuries with rotation

- Very rare injuries.
- C1.1 rotational wedge fracture
- C1.2 rotational split fracture
  - .1 rotational sagittal split fracture
  - .2 rotational coronal split fracture
  - .3 rotational pincer split fracture
- C1.3 vertebral body separation (rotational burst fracture)
  - .1 incomplete rotational burst fracture
  - .2 rotational burst-split fracture
  - .3 complete rotational burst fracture
Group C2: Type B injuries with rotation

• C2.1- B1 injury with rotation (flexion-distraction injury with rotation)
• C2.2- B2 injury with rotation (flexion-distraction injury with rotation)
• C2.3- B3 injury with rotation (hyperextension-shear injury with rotation)
• Flexion-rotation dislocation, unilateral facet interlocking, or dislocation are other commonly used terms for these—in most cases relatively stable—injuries.
• Radiologic signs:
  – 3–4 mm subluxation of the vertebral body
  – Abrupt change in the width of the interlaminar space.
  – Alignment of the spinous processes may be impaired.
Group C3- Rotation shear injuries

• Most unstable injuries.
• C3.1 slice fracture
• C3.2 oblique fracture
• C3.3 Complete separation
Table 1. Subaxial Injury Classification (SLIC) Scale

<table>
<thead>
<tr>
<th>Points</th>
<th>SLIC&gt;5</th>
<th>SLIC&lt;3</th>
<th>SLIC=4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Morphology</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>No abnormality</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compression, burst</td>
<td>1,+ 1= 2</td>
<td></td>
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<tr>
<td>Distraction (e.g., facet perch, hyperextension)</td>
<td>3</td>
<td></td>
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<tr>
<td>Rotation or translation (e.g., facet dislocation, unstable teardrop or advanced stage flexion compression injury)</td>
<td>4</td>
<td></td>
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<tr>
<td><strong>Discoligamentous complex</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Intact</td>
<td>0</td>
<td></td>
<td></td>
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<tr>
<td>Indeterminate (e.g., isolated interspinous widening, MRI signal change only)</td>
<td>1</td>
<td></td>
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<tr>
<td>Disrupted (e.g., widening of anterior disk space, facet perch or dislocation)</td>
<td>2</td>
<td></td>
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<tr>
<td><strong>Neurological status</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Intact</td>
<td>0</td>
<td></td>
<td></td>
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<tr>
<td>Root injury</td>
<td>1</td>
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<td></td>
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<tr>
<td>Complete cord injury</td>
<td>2</td>
<td></td>
<td></td>
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<tr>
<td>Incomplete cord injury</td>
<td>3</td>
<td></td>
<td></td>
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<tr>
<td>Continuous cord compression (neuro modifier in the setting of a neurologic deficit)</td>
<td>+1</td>
<td></td>
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</tbody>
</table>
Which ones to be operated?

Type A 2 injuries
Type A 3 injuries
Type B injuries
Type C injuries
Management

- Assess ABC
- Initial neck immobilization in a hard collar.
- Assess neurological status.
- Check for associated injuries.
- Role of steroids - Not a guideline (Only Class III evidence)
- Imaging - Digital X ray C-spine, NCCT spine +/- MRI
- Conservative v/s surgical management
Goals of treatment

- A pain free patient with normal spinal function and a clinically stable spine
- The maintenance or recovery of neurological function by reduction and decompression of neural elements.
- Restoration of a physiological spinal alignment.
- A definite bony healing of a surgically fused spinal segment.
- An as short as possible stabilization and fusion
- Number of segments involved in surgical management to be kept to a minimum.
Conservative treatment

- Can be done in less severe deficits (ASIA D,E)
- Cervical traction
- Early mobilization (to prevent chest infections and bedsores)
- Physiotherapy (Limb and chest)
SURGICAL TREATMENT

• Timing of surgery
• Type of surgery (Anterior/Posterior/Combined)
Timing of surgical intervention

• No clear consensus yet.

• Currently no standards regarding the role and timing of decompression in acute SCI.

• For injuries of the cervical spine there is some evidence that neurological recovery improved when the dislocation was reduced as early as possible
  – Indication, surgical technique and surgical results of 100 surgically treated # and #-dislocations of cervical spine. *Clin Orthop Relat Res; (203):244–257.*

• Currently no standards regarding the role and timing of decompression in acute SCI.

• Role of surgical decompression in patients with SCI is only supported by Class III and limited Class II evidence.
• Early treatment in acute central cord injuries
  – Reasonable and safe to consider early surgical decompression (<24 hrs) in patients with profound neurologic deficit (ASIA = C) and persistent spinal cord compression due to developmental cervical spinal canal stenosis without fracture or instability.
  – Surgical intervention consisting of Open door expansile cervical laminoplasty can be safely applied in the subset of patients with ATCCS without instability who have significant cervical spondylosis/stenosis. 29 cases. Average delay from injury to surgery was 3 days.
    • Surg Neurol. 2005 Jun;63(6):505-10
  – Surgical decompression, however, was associated with immediate neurologic improvement, faster recovery of neurologic function, early mobilization, better long-term neurologic outcome, briefer hospital stays, and fewer complications related to long confinements in bed than was nonoperative treatment. 13/16 showed improvement.
• Recommended- Urgent decompression of bilateral locked facets in a patient with incomplete tetraplegia or in a patient with SCI with neurologic deterioration. Urgent decompression in acute cervical SCI remains a reasonable practice option and can be performed safely. There is emerging evidence that surgery within 24 hours may reduce length of intensive care unit stay and reduce post-injury medical complications.

• 66 articles were reviewed including 1 RCT
Anterior approaches

- Discectomy and fusion.
- Corpectomy
- Anterior cervical plating
Posterior approaches

• Posterior wiring technique and bone grafting approach
  – Injuries of the posterior complex involving predominantly soft tissue with insignificant damage to the vertebral body.
  – Enhancement of other posterior fusion techniques.

• Lateral mass fixation
  – Posterior stabilization of the cervical spine from C3 to C7.
  – Biomechanically stronger than posterior wiring techniques and anterior plating
  – Risks of injury to the vertebral artery and segmental nerve.

• Others- not generally performed nowadays
  – Interlaminar clamps
  – Sublaminar wiring