MANAGEMENT OF THORACO-LUMBAR FRACTURES

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FINAL YEAR ORTHO PG
Anatomy:

- Cervical - 7 vertebrae
- Thoracic - 12 vertebrae
- Lumbar - 5 vertebrae
- Sacral - 5 fused vertebrae
- Coccyx - 4 fused vertebrae
Fig. 1 * indicates pain-sensing structures
Functional spinal unit

Functional spinal unit is composed of
• two adjacent vertebrae
• Facet joint
• inter vertebral disc and
• intervening ligaments

This unit is responsible for Movement of joint
Physiological Anatomy of the Thoracic Spine

- Facets lie in the frontal plane- allowing rotation
- Ribs resist rotation and add 3x the normal stiffness in lateral rotation
- Kyphosis of the T spine loads the anterior column
- Lower 2 vertebra have floating ribs and no costotransverse articulations
- Canal size in thoracic spine relatively small
Physiological Anatomy of the Lumbar Spine

- Large discs allow more ROM
- Facets prevent rotation as they are arranged in sagittal plane
- Spinal canal wider
- Lordosis loads the facets
Thoracolumbar Junction

The susceptibility of the thoracolumbar junction to injury is attributed mainly to the following anatomical reasons:

• The transition from a relatively rigid thoracic kyphosis to a more mobile lumbar lordosis occurs at T11–12.

• The lowest thoracic ribs (T11 and T12) provide less stability at the thoracolumbar junction region compared to the upper thoracic region, because they do not connect to the sternum and are free floating.
• The facet joints of the thoracic region are oriented in the coronal (frontal) plane, limiting flexion and extension.

• In the lumbosacral region, the facet joints are oriented in a more sagittal alignment, which increases the degree of potential flexion and extension.
THORACIC AND LUMBAR INJURIES

• Thoracolumbar injuries usually are the result of high-energy trauma, and often associated visceral injuries are present in patients who have sustained significant injuries in this region.

• CT of the chest, abdomen, and pelvis with contrast enhancement is routinely obtained in the same population at risk for thoracic or lumbar spine fractures to assess for visceral injury.

• The use of MRI remains controversial and has a limited role in the thoracic and lumbar regions.
Clinical presentation

History

• The history of a patient who sustained a thoracolumbar spinal injury is usually obvious.

The **cardinal symptoms are:**

• pain
• loss of function (inability to move)
• sensorimotor deficit
• bowel and bladder dysfunction
The history should include a detailed assessment of the injury, i.e.:

- type of trauma (high vs. low energy)
- mechanism of injury (compression, flexion/distraction, hyperextension, rotation, shear injury)
• In patients with **neurological deficits**, the history must be detailed regarding:

• time of onset
• course (unchanged, progressive, or improving)
Concomitant Non-spinal Injuries

- One-third of all spine injuries have concomitant injuries.
- Most frequently found concomitant injuries are:
  1. Head injuries (26%)
  2. Chest injuries (24%)
  3. Long bone injuries (23%)
CLASSIFICATION
Denis Three column theory:

• The vertebral column is divided into three columns

1. ANTERIOR

2. MIDDLE

3. POSTERIOR Columns
Anterior column:

- anterior longitudinal ligament,
- the anterior half of the vertebral body and
- the anterior portion of the annulus fibrosus.
Middle column

- posterior longitudinal ligament,
- the posterior half of the vertebral body and
- the posterior aspect of the annulus fibrosus.
posterior column:

• the neural arch,
• ligamentum flavum,
• the facet joint, and
• the interspinous ligaments
Denis Classification of Spinal Trauma

Major Injuries
- COMPRESSION
- BURST
- SEAT-BELT-TYPE
- FRACTURE-DISLOCATION

Minor Injuries
- transverse processes fx
- articular process fx
- pars interarticularis fx
- spinous process fx
AO/MAGERL CLASSIFICATION OF SPINAL INJURIES

• **A, Compression injuries:**
  A1, impaction;
  A2, split;
  A3, burst.

• **B, Distraction injuries:**
  B1, posterior ligamentous;
  B2, posterior, osseous;
  B3, anterior through disc.

• **C, Torsion injuries:**
  C1, type A with torsion;
  C2, type B with torsion;
  C3, torsion shear.
# Thoracolumbar Injury Classification and Severity Score

<table>
<thead>
<tr>
<th>Fracture Mechanism</th>
<th>Points</th>
</tr>
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<tbody>
<tr>
<td>Compression fracture</td>
<td>1</td>
</tr>
<tr>
<td>Burst fracture</td>
<td>1</td>
</tr>
<tr>
<td>Translation/rotation</td>
<td>3</td>
</tr>
<tr>
<td>Distraction</td>
<td>4</td>
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</table>

<table>
<thead>
<tr>
<th>Neurological Involvement</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intact</td>
<td>0</td>
</tr>
<tr>
<td>Nerve root</td>
<td>2</td>
</tr>
<tr>
<td>Cord, conus medullaris, incomplete</td>
<td>3</td>
</tr>
<tr>
<td>Cord, conus medullaris, complete</td>
<td>2</td>
</tr>
<tr>
<td>Cauda equina</td>
<td>3</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Posterior Ligamentous Complex Integrity</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intact</td>
<td>0</td>
</tr>
<tr>
<td>Injury suspected/indeterminate</td>
<td>2</td>
</tr>
<tr>
<td>Injured</td>
<td>3</td>
</tr>
</tbody>
</table>

*Score of $\leq 3$—nonoperative treatment; score of $\geq 5$—operative treatment; score of 4—either nonoperative or operative treatment, depending on qualifiers such as comorbid medical conditions and other injuries.*
COMPRESSION FRACTURES

• They cause isolated failure of the anterior column and result from forward flexion.
• They rarely are associated with neurological deficit except when multiple adjacent vertebral levels are affected.
4 subtypes on basis of end plate involvement

- # of both end plates
- # of superior end plate
- # of inferior end plate
- both end plates intact
BURST FRACTURES

- **In stable burst fractures**, the anterior and middle columns fail because of a compressive load, with no loss of integrity of the posterior elements.
- **In unstable burst fractures**, the anterior and middle columns fail in compression and the posterior column is disrupted.
- The posterior column can fail in compression, lateral flexion, or rotation.
- There is a tendency for posttraumatic kyphosis and progressive neural symptoms because of instability.
- If the anterior and middle columns fail in compression, the posterior column cannot fail in distraction.
BURST FRACTURES

5 subtypes on basis of end plate involvement

- # of both end plates
- # of superior end plate
- # of inferior end plate
- both end plates intact
- Burst lateral flexion
FLEXION-DISTRACTION OR SEAT-BELT-TYPE INJURY or CHANCE #

• They are flexion-distraction injuries; horizontal avulsion injuries of the vertebral bodies caused by flexion around an axis anterior to the anterior longitudinal ligament.

• The entire vertebra is pulled apart by a strong tensile force.
FLEXION-DISTRACTION OR SEAT-BELT-TYPE INJURY or CHANCE #
FLEXION COMPRESSION INJURIES

• The flexion axis is posterior to the anterior longitudinal ligament.

• The anterior column fails in compression, whereas the middle and posterior columns fail in tension.

• This injury is unstable because the ligamentum flavum, interspinous ligaments, and supraspinous ligaments usually are disrupted.
FLEXION COMPRESSION INJURIES
TRANSLATIONAL/ROTATIONAL INJURIES

• They are characterized by mal alignment of the neural canal, which has been totally disrupted.
• Usually all three columns have failed in shear.
• At the affected level, one part of the spinal canal has been displaced in the transverse plane.
• This injury pattern is the most severe and is usually associated with a significant neurological injury.
TRANSLATIONAL/ROTATIONAL INJURIES
EXTENSION INJURIES

• Extension injuries are identified by anterior spinal lengthening most commonly occur in the thoracic spine.
• They almost always fractures in patients with ankylosing spondylitis or disseminated idiopathic skeletal hyperostosis.
• These injuries are very unstable, and translation, usually retrolisthesis, can cause spinal cord injury.
• It is critical to avoid placing the patient in a horizontal supine position.
SPINAL STABILITY

• Spinal injury is considered **unstable** if normal physiological load cause further neurological damage, chronic pain & deformity.

• Instability exists if any of two columns are disrupted.

• In T-L stability if middle column is intact, # is usually stable.
Three Degrees of instability:

First degree: (Mechanical instability):
  Severe compression #
  Seat belt injury

Second degree: (Neurological instability)
  Burst # with out neurological deficit

Third degree: (Both)
  Burst # with neurological deficit
  Fracture dislocation
Investigations:

- plain X-rays,
- CT and
- MRI studies

X-RAYS

- A-P &
- Lateral views
X-RAYS A-P view

- Alignment
- Symmetry/ Shape of pedicles
- Interpedicular distance
- Position of spinous process
- Contour of bodies
X-RAYS Lateral View

- Alignment.
- Contour of bodies.
- Disc spaces.
- Angulation.
- Encroachment on canal.
- Loss of vertebral body height.
CT Scan

- Accurate assessment of bone.

1- Comminution.

2- Canal compromise.

3- Dislocation.
• **Sagittal and** coronal 2D or 3D reconstructions are helpful for determining the fracture pattern
MRI

• Accurate assessment of soft tissue.

1- Neurological deficits.
2- Cord lesion.
3- Ligament injury.
4- Disc herniation.
5- Hematoma.
• MRI can be helpful in determining the integrity of the posterior ligamentous structures and thereby differentiate between a stable and an unstable lesion.
INITIAL MANAGEMENT OF SPINAL INJURY

• Evaluation and management of the patient begin at the scene of the injury, and proper transport of the patient is very important.
• The deterioration was attributed primarily to poor immobilization and improper initial handling of the patients.
• Total spine immobilization is recommended for all patients with a potential spinal injury.
• A hard collar with supports beside the head on an appropriately sized spine board for the age of the patient is used. This allows the patient to be moved and tilted as needed for transport.
HARD COLLAR ON A SPINE BOARD
INITIAL SPINE ASSESSMENT

• After the ABCs (airway, breathing, and circulation) of the Advanced Trauma Life Support (ATLS) protocol have been completed, a thorough orthopaedic history should be obtained and full physical examination should be done.

• The initial spinal assessment of a trauma patient is to determine if the patient has a spinal cord injury.

• CT imaging
National Emergency X-Radiography Utilization Study (NEXUS)
Criteria for Patients To Be Considered Asymptomatic

- No posterior midline cervical spine tenderness
- No evidence of Intoxication
- A normal level of Alertness
- No focal neurological Deficit
- No painful distracting injuries
SPINE PRECAUTIONS

• Even if a significant spinal injury at any level is found, the patient can be moved to a bed but maintained with a cervical collar in place on a pillow as needed to avoid cervical extension.

• Patients with unstable thoracic or lumbar injuries, such as fracture-dislocation or other injuries that will be treated with internal stabilization, are maintained flat in bed and log-rolled side-back-side every 2 hours while awake until the spine is stabilized.

• The head of the bed elevated.

• Therapeutic air mattress.
NEUROLOGICAL ASSESSMENT

• Assessment of mental status using the Glasgow Coma Scale determines the level of consciousness.

• The American Spinal Injury Association (ASIA) form is used to record the neurological findings.
**Muscle Function Grading**

0 = total paralysis
1 = palpable or visible contraction
2 = active movement, full range of motion (ROM) with gravity eliminated
3 = active movement, full ROM against gravity
4 = active movement, full ROM against gravity and moderate resistance in a muscle specific position
5 = (normal) active movement, full ROM against gravity and full resistance in a functional muscle position expected from an otherwise unimpaired person
5* = (normal) active movement, full ROM against gravity and sufficient resistance to be considered normal if identified inhibiting factors (i.e., pain, disease) were not present
NT = not testable (i.e., due to immobilization, severe pain such that the patient cannot be graded, amputation of limb, or contracture of > 50% of the normal ROM)

**Sensory Grading**

0 = Absent
1 = Altered, either decreased/impaired sensation or hypersensitiveness
2 = Normal
NT = Not testable

**When to Test Non-Key Muscles:**

In a patient with an apparent AIS B classification, non-key muscle functions more than 3 levels below the motor level on each side should be tested to most accurately classify the injury (differentiate between AIS B and C).

**Movement**

| Shoulder: Flexion, extension, abduction, adduction, internal and external rotation |
| C5 |
| Elbow: Flexion |
| C6 |
| Finger: Flexion at proximal joint, extension |
| C7 |
| Thumb: Flexion, extension and abduction in plane of thumb |
| C8 |
| Finger: Flexion at MCP joint |
| Thumb: Opposition, adduction and abduction perpendicular to palm |
| T1 |
| Hip: Adduction |
| L2 |
| Hip: External rotation |
| L3 |
| Hip: Extension, abduction, internal rotation |
| L4 |
| Knee: Flexion |
| Ankle: Inversion and eversion |
| Toe: MP and IP extension |
| Hallux and Toe: DP and PIP flexion and abduction |
| L5 |
| Hallux: Adduction |
| S1 |

**ASIA Impairment Scale (AIS)**

A = Complete. No sensory or motor function is preserved in the sacral segments S4-5.

B = Sensory Incomplete. Sensory but not motor function is preserved below the neurological level and includes the sacral segments S4-S5 (light touch or pin prick at S4-5 or deep anal pressure) AND no motor function is preserved more than three levels below the motor level on either side of the body.

C = Motor Incomplete. Motor function is preserved in the most caudal sacral segments for voluntary anal contraction (NAC) OR the patient meets the criteria for sensory incomplete status (sensory function preserved at the most caudal sacral segments (S4-S5) by LT, PP or DAP) AND has some sparing of motor function more than three levels below the collateral motor level on either side of the body. (This includes key or non-key muscles to determine motor incomplete status.) For AIS C – less than half of key muscle functions below the single NL having a muscle grade ≥ 3.

D = Motor Incomplete. Motor incomplete status as defined above, at least half (half or more) of key muscle functions below the single NL having a muscle grade ≥ 3.

E = Normal. If sensation and motor function as tested with the ISNCSCI are graded as normal in all segments, and the patient had prior deficits, then the AIS grade is E. Someone without an initial SCI does not receive an AIS grade.

**Steps in Classification**

The following order is recommended for determining the classification of individuals with SCI.

1. Determine sensory levels for right and left sides.
   The sensory level is the most caudal, intact dermatome for both pin prick and light touch sensation.

2. Determine motor levels for right and left sides.
   Defined by the lowest key muscle function that has a grade of at least 3 (an supine testing), providing the key muscle functions represented by segments above that level are judged to be intact (graded as a 5).
   Note: in regions where there is no myotome to test, the motor level is presumed to be the same as the sensory level, if testable motor function above that level is also normal.

3. Determine the neurological level of injury (rNI)
   This refers to the most caudal segment of the cord with intact sensation and antigravity (3 or more) muscle function strength, provided that there is normal (intact) sensory and motor function rostrally respectively.
   The NLI is the most cephalad of the sensory and motor levels determined in steps 1 and 2.

4. Determine whether the injury is Complete or Incomplete.
   (i.e. absence or presence of sacral sparing)
   If voluntary anal contraction = No AND all S4-5 sensory scores = 0 AND deep anal pressure = No, then injury is Complete. Otherwise, injury is Incomplete.

5. Determine ASIA Impairment Scale (AIS) Grade
   Is injury Complete?
   If YES, AIS=A and can record
   ZPP (lowest dermatome or myotome on each side with some preservation)
   If injury Motor Complete?
   If YES, AIS=B
   (No voluntary anal contraction OR motor function more than three levels below the motor level on a given side, if the patient has sensory incomplete classification)
   Are at least half (half or more) of the key muscles below the neurological level of injury graded 3 or better?
   AIS=C
   If sensation and motor function is normal in all segments, AIS=E
   Note: AIS E is used in follow-up testing when an individual with a documented SCI has recovered normal function. If at initial testing no deficits are found, the individual is neurologically intact; the ASIA Impairment Scale does not apply.
### Reflex Testing in Thoracolumbar Injuries

<table>
<thead>
<tr>
<th>Reflex</th>
<th>Level Tested</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superficial abdominal (above umbilicus)</td>
<td>T7-T10</td>
</tr>
<tr>
<td>Superficial abdominal (below umbilicus)</td>
<td>T11-L1</td>
</tr>
<tr>
<td>Cremasteric reflex</td>
<td>T12-L1</td>
</tr>
<tr>
<td>Knee jerk</td>
<td>L3-L4</td>
</tr>
<tr>
<td>Ankle jerk</td>
<td>S1</td>
</tr>
<tr>
<td>Anal wink</td>
<td>S2-S4</td>
</tr>
<tr>
<td>Bulbocavernosus reflex</td>
<td>S3-S4</td>
</tr>
<tr>
<td>Plantar response</td>
<td>Brain/cord continuity</td>
</tr>
</tbody>
</table>
SPINAL CORD INJURY

SPINAL SHOCK

• *Spinal shock refers to a* temporary dysfunction of the spinal cord, with a loss of reflexes and sensorimotor function caudal to the level of injury. It is manifested by absence of anal wink and bulbocavernosus reflexes and by flaccid paralysis. It is a temporary phenomenon and recovers usually in 24 to 48 hours even in severe injuries. There is no specific treatment for spinal shock.
SPINAL CORD INJURY TREATMENT

• The goal for optimal blood pressure management is a mean arterial pressure of 85 to 90 mm Hg with maintenance of 100% oxygen saturation.
• Rapid realignment of the spine when appropriate.
• High-dose methylprednisolone:
  Most benefit occurs in the first 8 hours, and additional effect occurs within the first 24 hours
  • Methylprednisolone bolus 30 mg/kg, then infusion 5.4 mg/kg/h
  • Infusion for 24 hours if bolus given within 3 hours of injury
  • Infusion for 48 hours if bolus given within 3 to 8 hours after injury
  • No benefit if methylprednisolone started more than 8 hours after injury
• However, studies claimed no benefits of corticosteroid use. Significant complications are associated with these very high corticosteroid doses, which may outweigh any proven benefit.
TREATMENT OF THORACO-LUMBAR FRACTURES

The treatment of thoracic and lumbar fractures is determined primarily by:

- the neurological status of a patient,
- a determination of spinal column functional integrity based on specifically injured structures, and
- the type and magnitude of deformity present.

Most patients with thoracic or lumbar injuries do not have neurological compromise, and most of these patients are treated non operatively.

A relatively small portion of these patients have injury patterns that necessitate operative treatment.
NON-OPERATIVE TREATMENT OF THORACO-LUMBAR FRACTURES

Indications:

• Ant. vertebral height loss < 40%.
• Canal compromise < 40%.
• Kyphosis < 25 degrees.

Bed Rest

• Strict bed rest for 3-4 weeks.
• Avoid flexion, sit-ups, & spinal rotation.
• Avoid weight bearing.
• Bed rolling encouraged.
NON-OPERATIVE TREATMENT OF THORACO-LUMBAR FRACTURES

• **Analgesics**
• **Orthosis:**
  • Thoracolumbosacral orthosis (TLSO)
  • Jewett-type braces
• **physiotherapy**
Thoracolumbosacral orthosis

Jewett-type braces
OPERATIVE TREATMENT OF THORACO-LUMBAR FRACTURES

Indications:
• Ant. vertebral height loss > 40%.
• Canal compromise > 40%.
• Kyphosis > 25 degrees.
• Neural compression.

Aim
• Neural Decompression.
• Stabilization.
• Solid fusion.
Treatment Overview

THORACOLUMBAR FRACTURE

A Evaluation for associated injuries Complete neurologic examination
Specific fracture pattern identified

C Compression
<40% anterior compression <20° angulation
TLSO

POSTERIOR INSTRUMENTATION AND FUSION

D Burst fracture
>40% anterior compression >20° angulation Contiguous fractures
CT scan
Through bone
Through ligaments or disc space

POSTERIOR COMpressive INSTRUMENTATION

E Anterior decompression with instrumentation and fusion
<30% canal compromise
TLSO

F >40% canal compromise
>50% loss of body height

POSTERIOR INSTRUMENTATION AND FUSION

G Flexion-distraction

H Fracture-dislocation
Isolated spinous or transverse process fractures

POSTERIOR REDUCTION, INSTRUMENTATION, AND FUSION WITH MULTIPLE HOOK SYSTEM

I Symptomatic Treatment

B AP and lateral radiographs

Through bone
Through ligaments or disc space
Surgical options

Posterior Fixation

Anterior Fixation
Posterior Surgery: primarily for realignment and stabilization

• Advantages:
  
  avoids the morbidity of anterior exposure in patients who potentially have concomitant pulmonary or abdominal injuries.
  
  shorter operative times
  
  decreased blood loss
  
  functional outcomes are similar to those following anterior surgery

• Disadvantages: no direct approach to site of pathology
Posterior realignment and fixation
Anterior decompression and stabilisation

- Indicated for decompression of the neural elements.
- It provides direct visualization of the anterior thecal sac and is the most reliable method of spinal canal decompression.
- Higher morbidity
- Decompression followed by void filling with autograft/ allograft / cage insertion
- Fixation by plates and screws/ rods - screw-staple construct.
Anterior decompression and stabilisation
Combined approach

• Advantages:
  maximization of canal clearance,
  immediate circumferential stability
  optimized fusion rates.

• Disadvantage
  superadded morbidity of two
  procedure

• Usually opted as 2 stage procedure: post
  CT scan shows increased deformity or has
  residual neurological deficit
Rehabilitation

• Physiotherapy.

• **Bladder dysfunction**: Intermittent cath.
  Supra-pubic cath.

• **Bowel dysfunction**: high fluids, fibers, Prokinetic.

• **Spasticity**: Stretching exercises, Baclofen, surgical.

• **DVT prevention**.

• **Chest physiotherapy**.

• **Bed sore prevention**: Postural change/2h, Air mattress,
  High protein diet.
THANK YOU