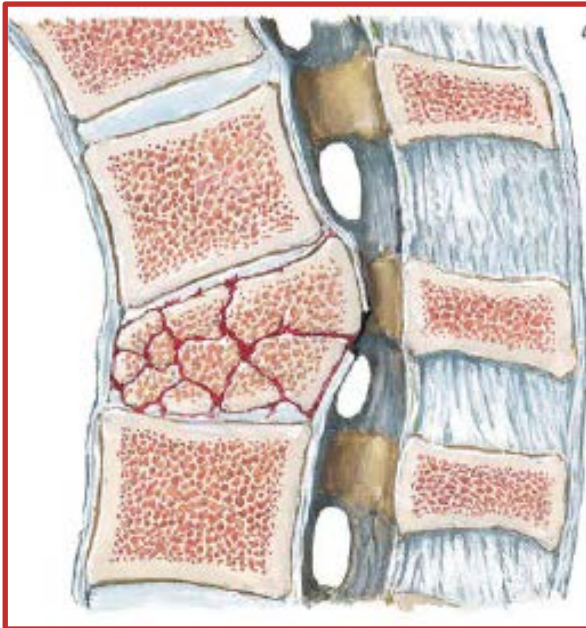
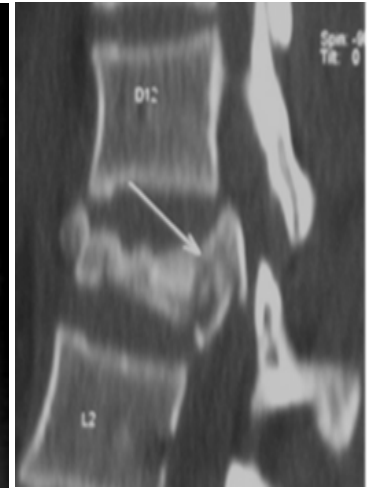
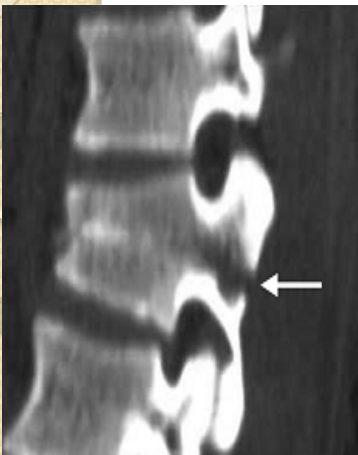



# Thoracolumbar fractures

Dr.Ajoy P Shetty





- 
- Introduction
  - Examination
  - Early /Emergency management
  - Classification
  - Definitive management

# Introduction

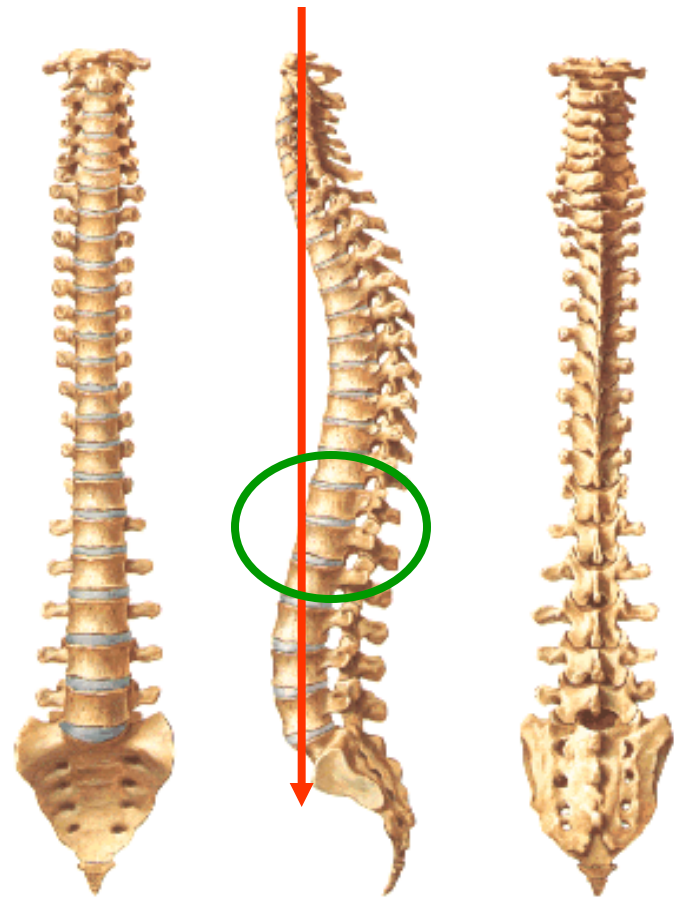
- Thoracic & Lumbar fractures
  - Thoracic spine – T1-T10
  - Thoracolumbar – T11-L1
  - Lumbar - L2-L5
- TL #s amounts to about 50% of fractures
- Neurological deficits in 20% of these



# Transitional zone (T11-L2)

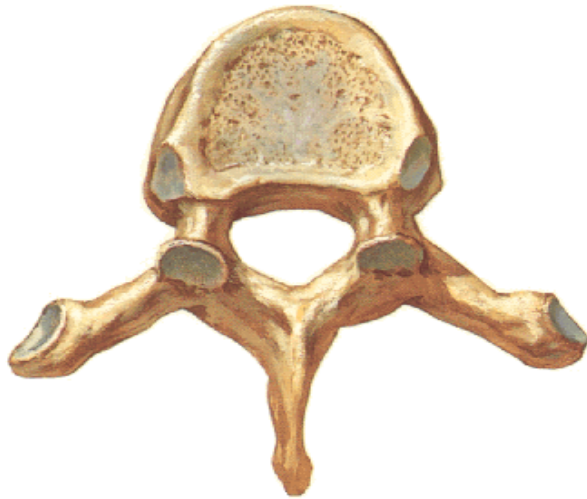
- Lies between rigid Thoracic spine and mobile Lumbar spine
- Sagittal contour changes from kyphosis to lordosis

Vertebral Column

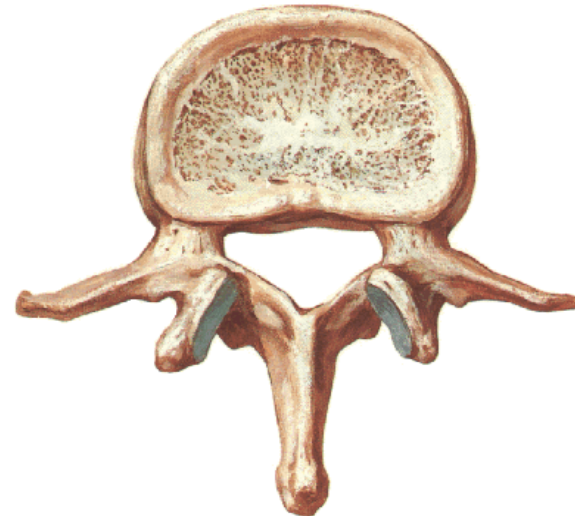


- Facetal joint gradually change from coronal to sagittal plane
- Increased transitional stiffness between T7- L4 with peak stiffness at T12- L2

**Thoracic Vertebrae [T6]**  
Superior View



**Lumbar Vertebrae [L2]**  
Superior View

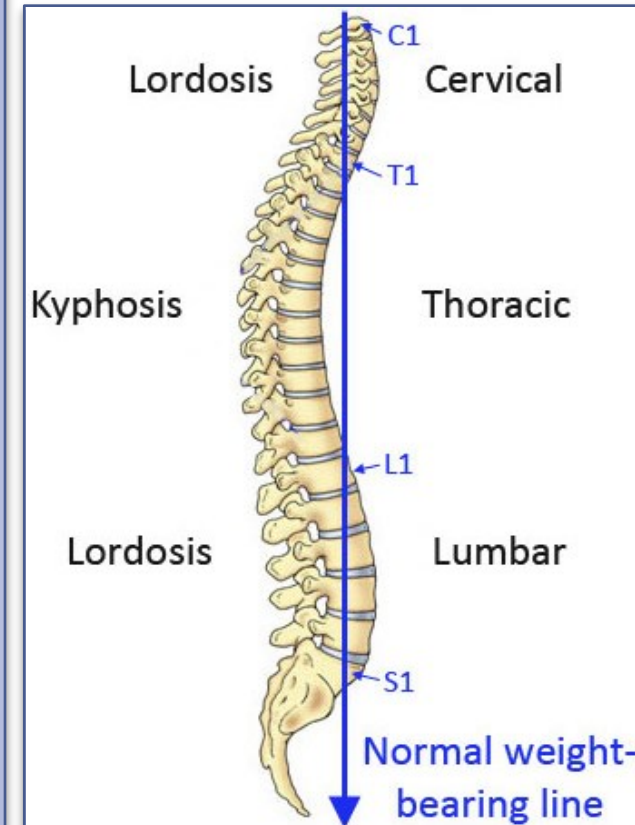


# Biomechanics

- Of load bearing & R.O.M
  - Basis of understanding & classification of TL #
  - Basis of understanding stability /instability
  - Basis of management

# Biomechanics

- Loading axis of spine
  - situated in front of spine
- Flexor loading on the Vertebral column
  - Ventral column -80% compressive load
  - Dorsal column - 20% as shearing force



# Biomechanics

- Muscles on back
  - Act like a tension band
  - Counteract flexor loading
- Tension band depends on
  - Functional state of muscles
  - Intact ligaments
- Unstable
  - Injury to posterior column & PLC

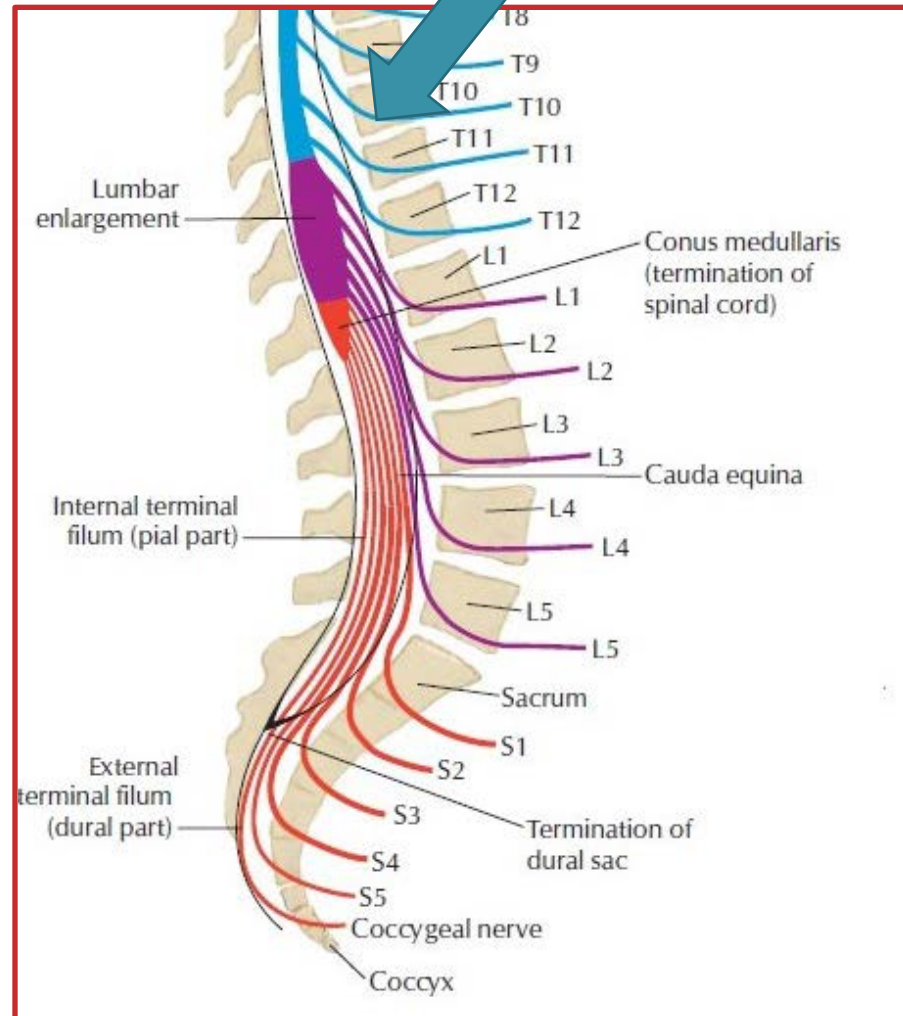


# Biomechanics

- Compression fractures & stable burst fractures
  - posterior columns intact
  - stable
- Unstable burst fractures, flexion distraction injury
  - 3 column injury
  - unstable



# Spinal cord injury



# PATHOPHYSIOLOGY

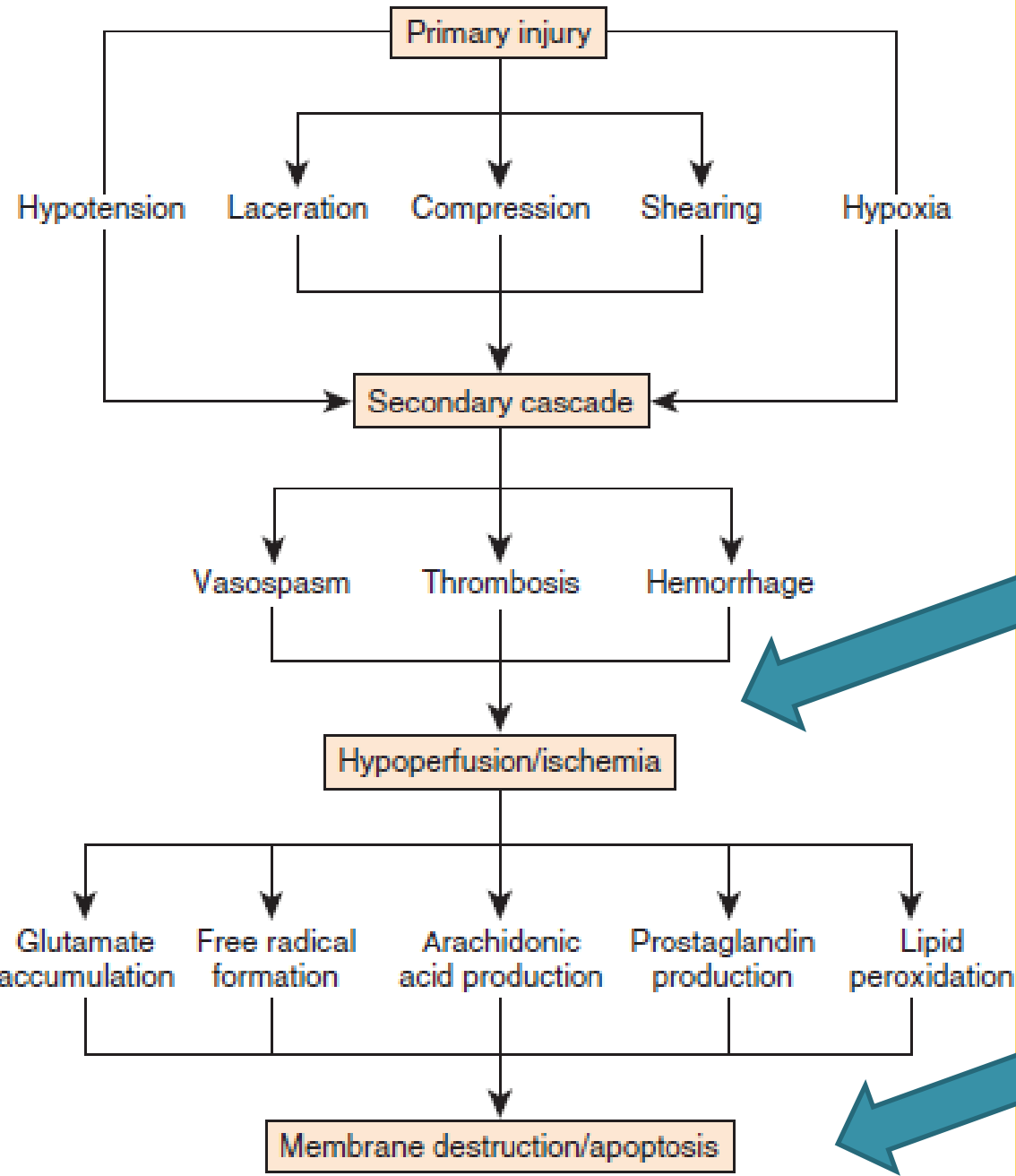
- **Neural injuries**

## **Primary injury**

physical tissue disruption caused by mechanical forces

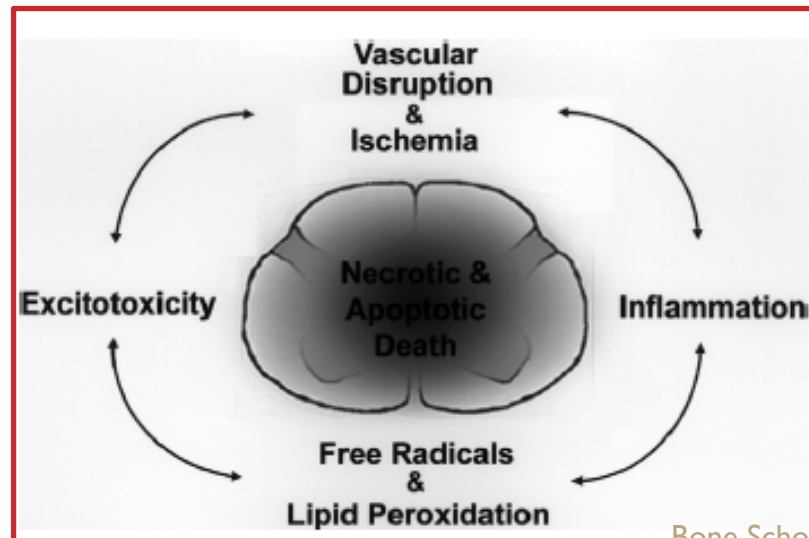
## **Secondary injury**

additional neural tissue damage resulting from the biologic response

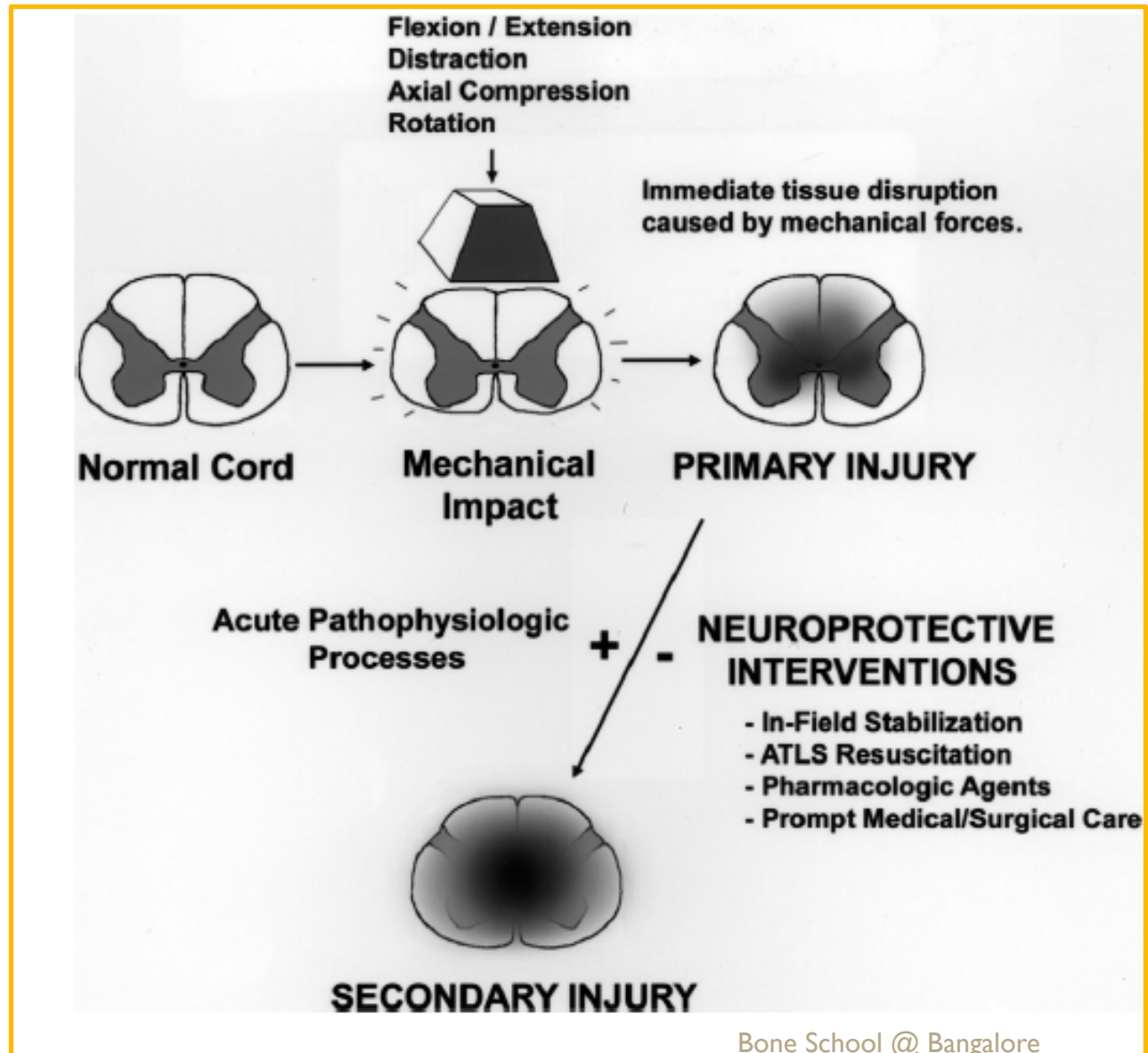


# Secondary injury

- Lack of autoregulation of bloodflow in spinal cord , hypotension and fall in SpO<sub>2</sub> contributes to delayed *secondary neuronal injury*



# Primary and secondary cord injury



# Emergency evaluation

- Early management

- PRIMARY SURVEY
- RESUSCITATION
- SECONDARY SURVEY
- DIAGNOSTIC TESTS
- SPECIFIC MANAGEMENT



# RESUSCITATION

- **Spinal evaluation is concurrent with resuscitative measures**
- **Oxygenation and maintenance of B.P**
- **Minimize secondary cascade of injury caused by hypoperfusion**

# Neurogenic and Hypovolemic Shock

## Neurogenic Shock

As the result of loss of sympathetic outflow

Hypotension

Bradycardia

Warm extremities

Normal urine output

## Hypovolemic Shock

As the result of hemorrhage

Hypotension

Tachycardia

Cold extremities

Low urine output

# Pharmacological agents

- Minimize secondary cascade of events
  - inflammatory response and oxidative cell injury
  - Limit excitotoxicity and membrane break-down
- High dose steroids
- GM-1 gangliosides
- Sodium channel modulators
- Glutamate receptor- blockers

-methyl prednisolone(NASCIS II&III trials)

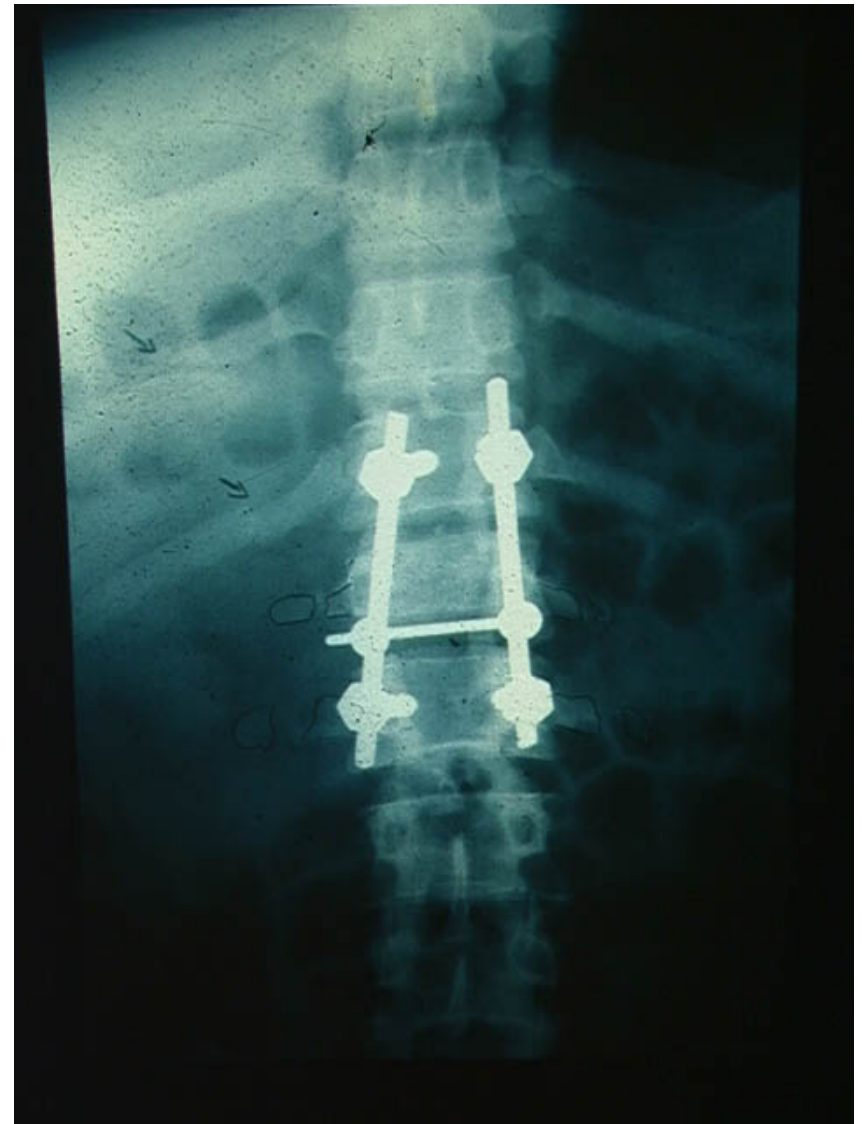
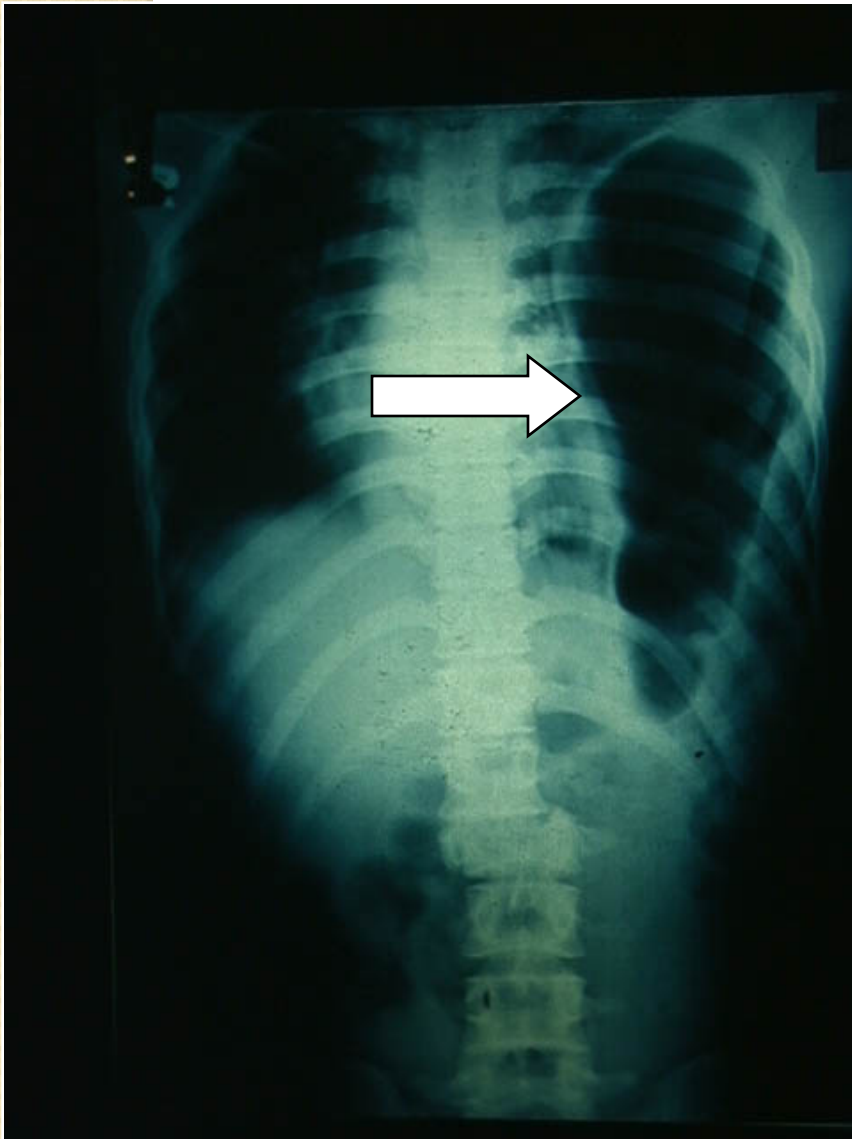
bolus of 30 mg/kg, followed by a 5.4 mg/kg/hour infusion for 23 hours if therapy is initiated within 3 hours of injury or 48 hours if initiated at 3 to 8 hours after injury

# Examination

- Prevent second accident
- Rule out other injuries
- 3 – 5% have spinal injury at other level !!

# Spine board





**22 y male, partial neurology with open injuries of both lower and upper limbs.**



# Physical examination

- Spine examination-
- Inspection and palpation of the spine with proper log rolling
- Pain ,tenderness , deformity
- Interspinous gaps
- Skin condition

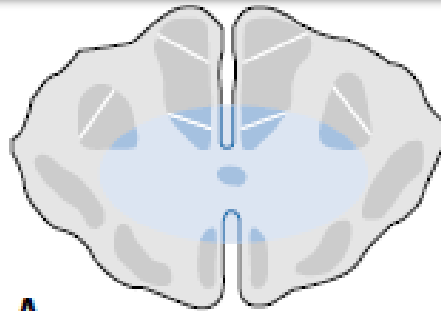
# Determine

- Complete or incomplete neurologic injury?
- Patient in spinal shock?
- Other injuries

# Incomplete injury syndromes

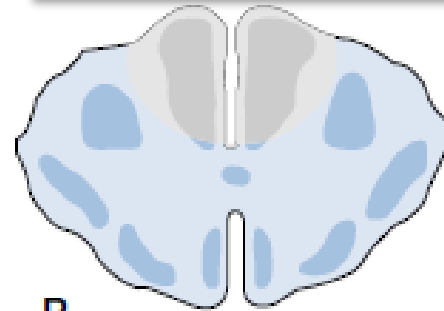
- Incomplete injury patterns, depend on the location of cord damage-central, anterior, posterior cord syndromes, Brown-Séquard syndrome, conus medullaris , cauda equina syndrome

Central cord syndrome

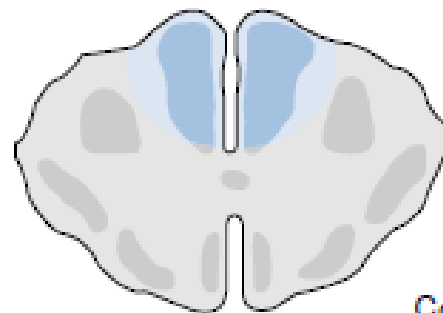


A

Anterior cord syndrome

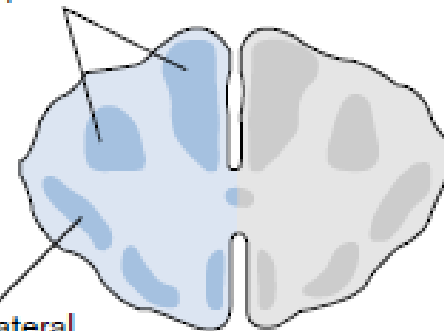


B



Posterior cord syndrome

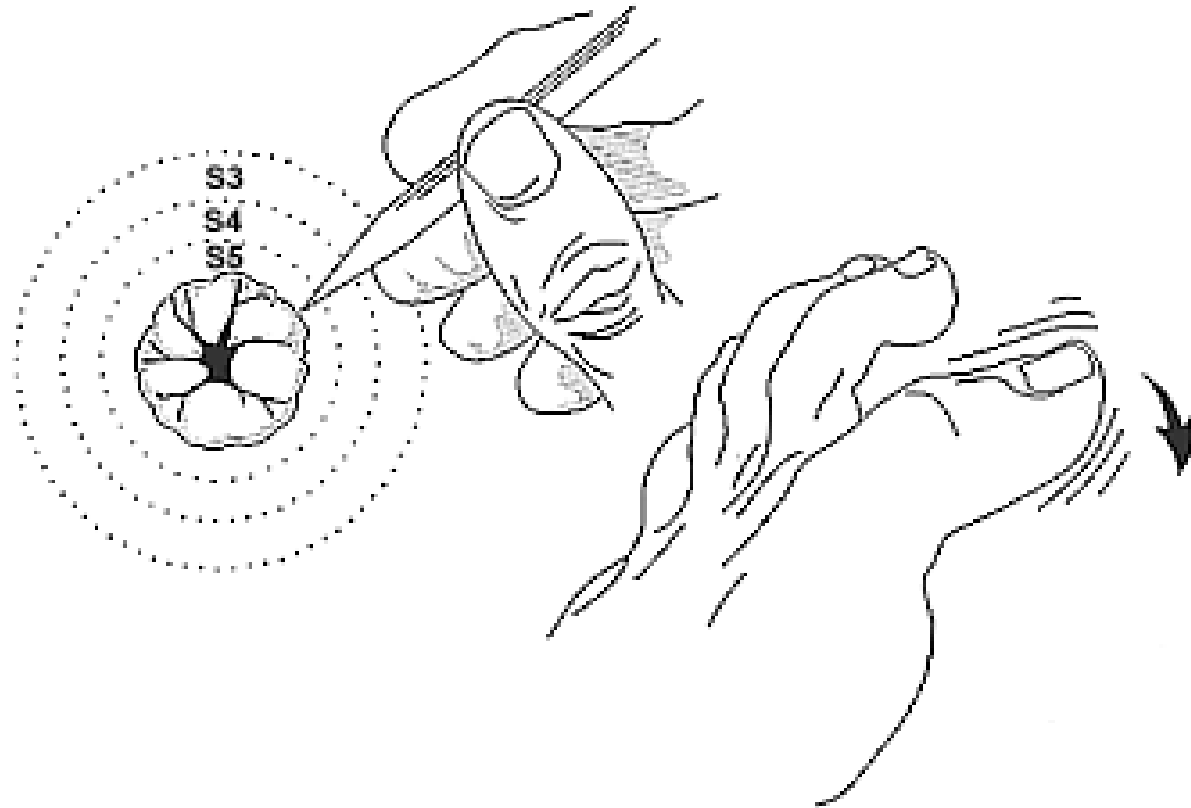
Ipsilateral



Contralateral

Brown sequard syndrome

# Indicators of incomplete injury

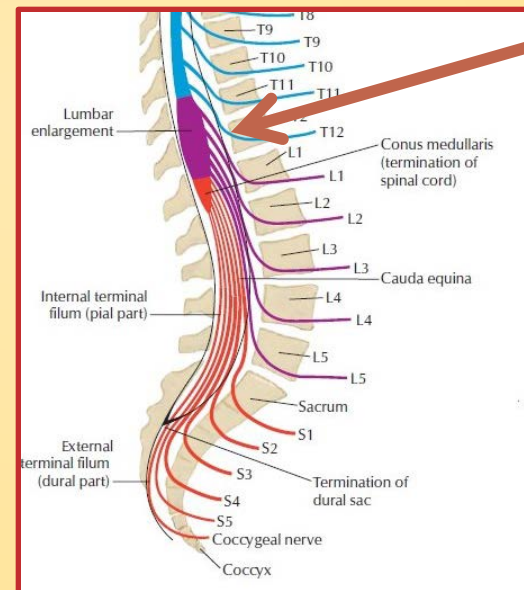
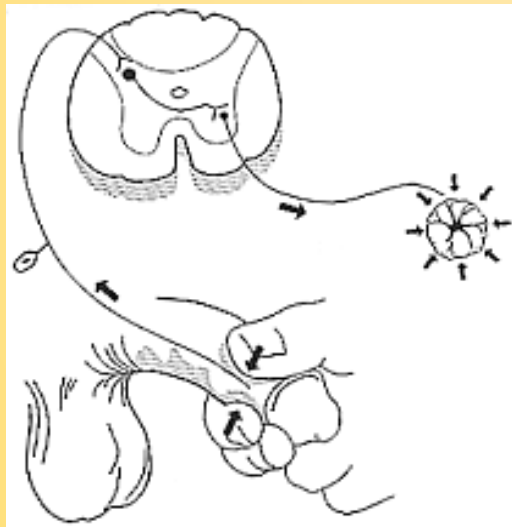


# Spinal shock

- Spinal shock is a state of transient physiological (rather than anatomical) reflex depression of cord function below the level of injury with associated loss of all sensorimotor functions
- Recovery is apparent within 24 – 48 hours but may last as long as 1 week

# End of spinal shock

- Heralded by the return of spinal cord–mediated reflexes below the level of injury
- Return of bulbocavernosus reflex - end of spinal shock



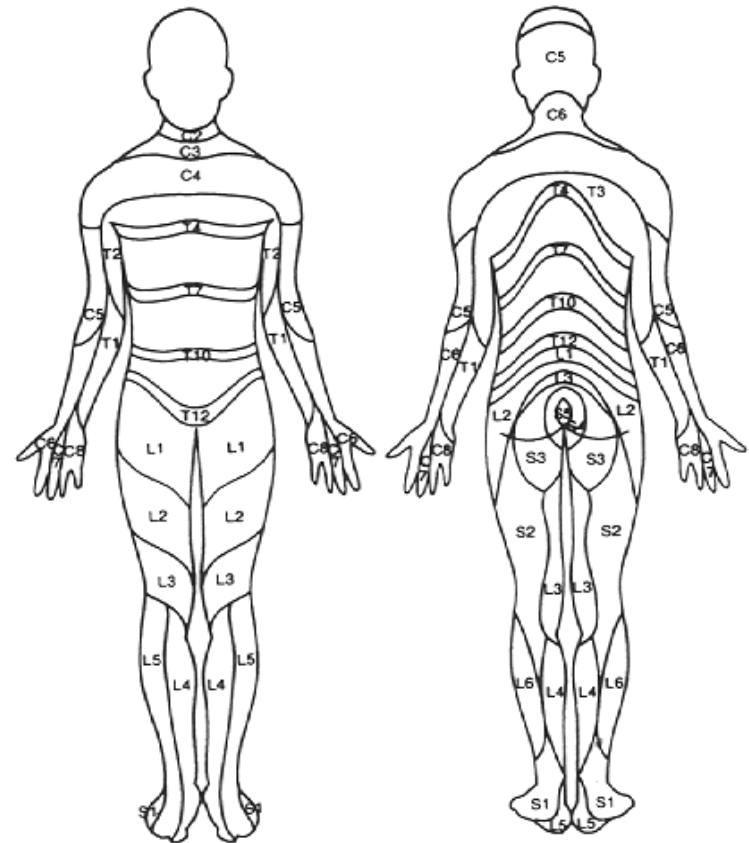
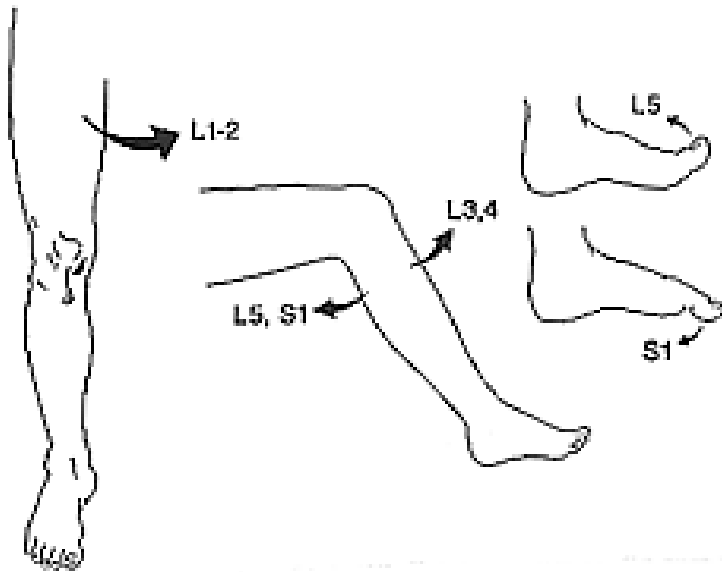


# Conus medullaris syndrome

- The conus medullaris - anatomic transition from the upper motor neurons of the spinal cord to the lower motor neurons of the cauda equina
- usually at T12-L1 level
- May be complete or incomplete
- The conus medullaris injury-
  - flaccid paralysis, loss of reflexes, and sensory loss of the lower extremities with bowel, bladder, and sexual dysfunction
- Prognosis is poor

- Injury to the cauda equina below the conus medullaris is a purely LMN injury and presents with the same types of findings as with conus medullaris injury, except - higher incidence of asymmetric involvement
- Prognosis good in cauda equina injury

# Quick neurological examination



## STANDARD NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY

### MOTOR

KEY MUSCLES

	R	L	
C2			
C3			
C4			
C5			Elbow flexors
C6			Wrist extensors
C7			Elbow extensors
C8			Finger flexors (distal phalanx of middle finger)
T1			Finger abductors (little finger)
T2			
T3			
T4			
T5			
T6			
T7			
T8			
T9			
T10			
T11			
T12			
L1			
L2			Hip flexors
L3			Knee extensors
L4			Ankle dorsiflexors
L5			Long toe extensors
S1			Ankle plantar flexors
S2			
S3			
S4-5			Voluntary anal contraction (Yes/No)

0 = total paralysis  
 1 = palpable or visible contraction  
 2 = active movement, gravity eliminated  
 3 = active movement, against gravity  
 4 = active movement, against some resistance  
 5 = active movement, against full resistance  
 NT = not testable

LIGHT TOUCH

	R	L
C2		
C3		
C4		
C5		
C6		
C7		
C8		
T1		
T2		
T3		
T4		
T5		
T6		
T7		
T8		
T9		
T10		
T11		
T12		
L1		
L2		
L3		
L4		
L5		
S1		
S2		
S3		
S4-5		

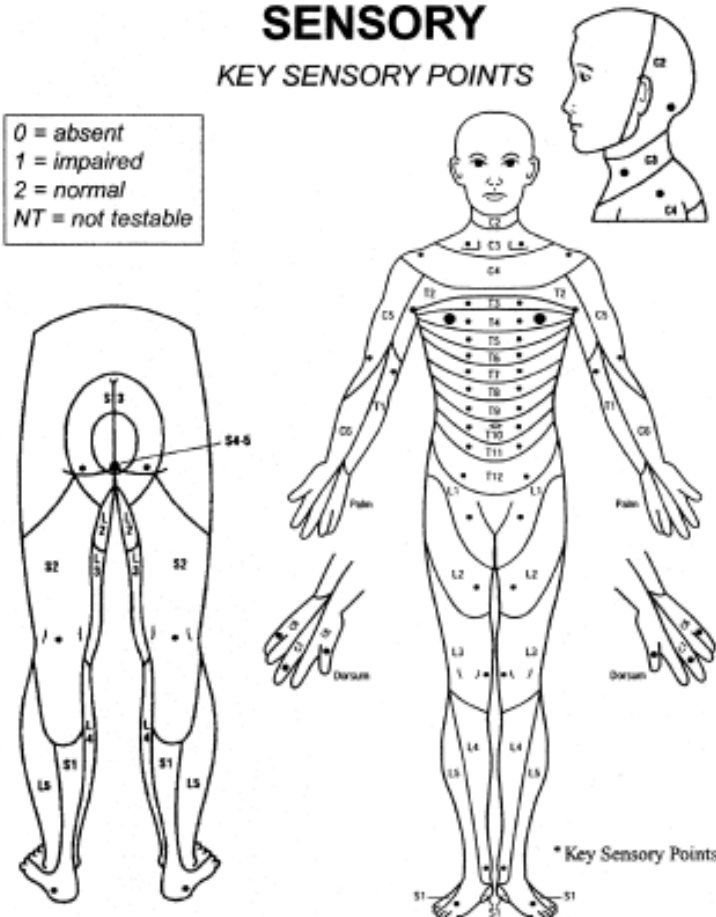
PIN PRICK

	R	L
C2		
C3		
C4		
C5		
C6		
C7		
C8		
T1		
T2		
T3		
T4		
T5		
T6		
T7		
T8		
T9		
T10		
T11		
T12		
L1		
L2		
L3		
L4		
L5		
S1		
S2		
S3		
S4-5		

0 = absent  
 1 = impaired  
 2 = normal  
 NT = not testable

### SENSORY

KEY SENSORY POINTS



\* Key Sensory Points

TOTALS  +  =  **MOTOR SCORE**  
 (MAXIMUM) (50) (50) (100)

TOTALS  +  =  **PIN PRICK SCORE\*** (max: 112)  
 +  =  **LIGHT TOUCH SCORE** (max: 112)

**NEUROLOGICAL LEVEL**

The most caudal segment with normal function

	R	L
SENSORY	<input type="checkbox"/>	<input type="checkbox"/>
MOTOR	<input type="checkbox"/>	<input type="checkbox"/>

**COMPLETE OR INCOMPLETE?**

Incomplete = Any sensory or motor function in S4-S5

**ASIA IMPAIRMENT SCALE**

**ZONE OF PARTIAL PRESERVATION**

Caudal extent of partially preserved segments

	R	L
SENSORY	<input type="checkbox"/>	<input type="checkbox"/>
MOTOR	<input type="checkbox"/>	<input type="checkbox"/>

# Radiological evaluation

- Xray- AP & Lateral
- CT
- MRI

Primary goal - to detect spine injury

Secondary goal-determine the stability

# Imaging

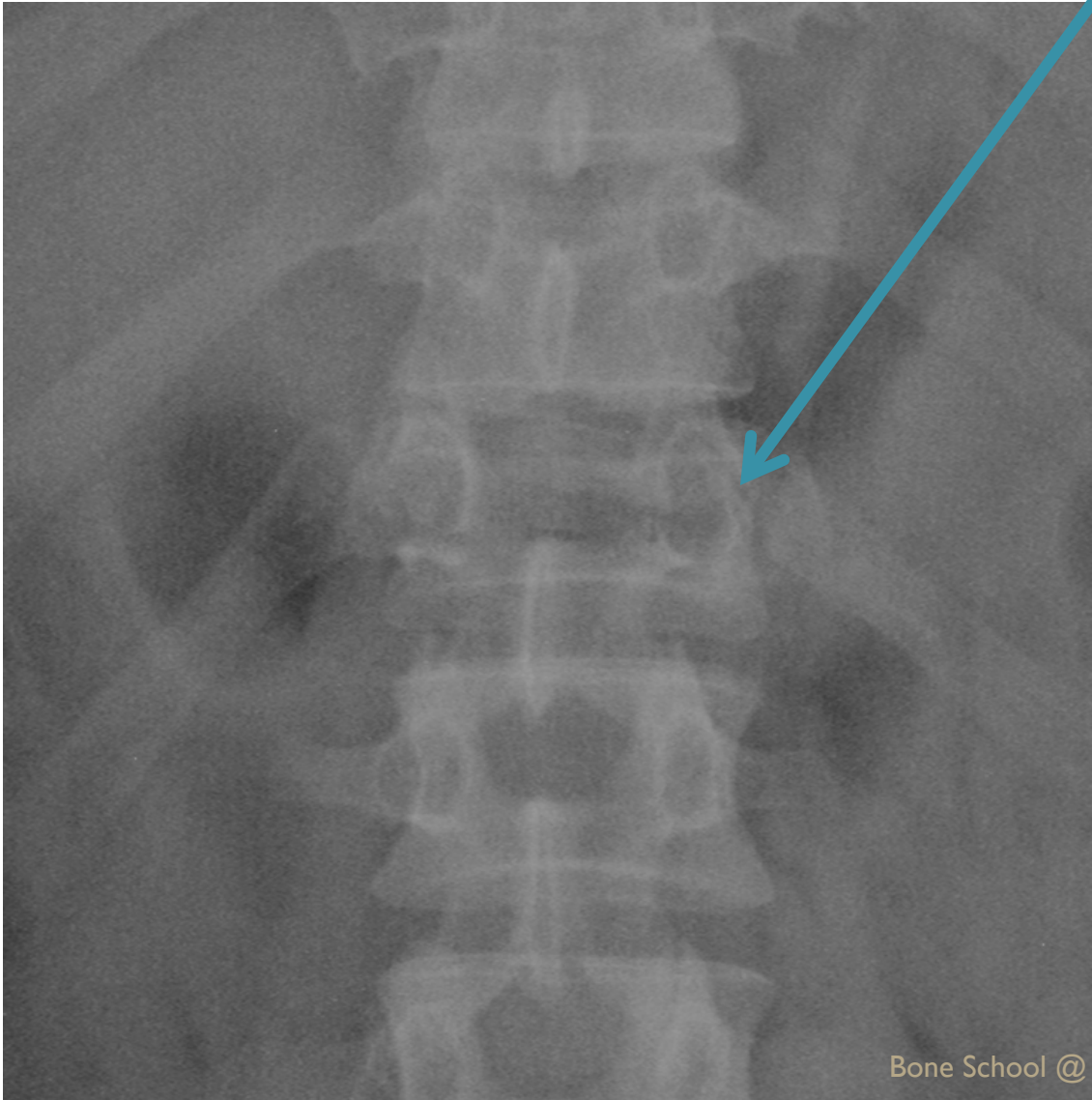
- Xray
- CT
- MRI
  - Progressive deficit
  - Neurological level not coinciding with the recognised injury

# AP view



- Alignment
- Vertebral height
- Interpedicular distance
- Spinous process
- Ribs & transverse process

# # through the pedicle





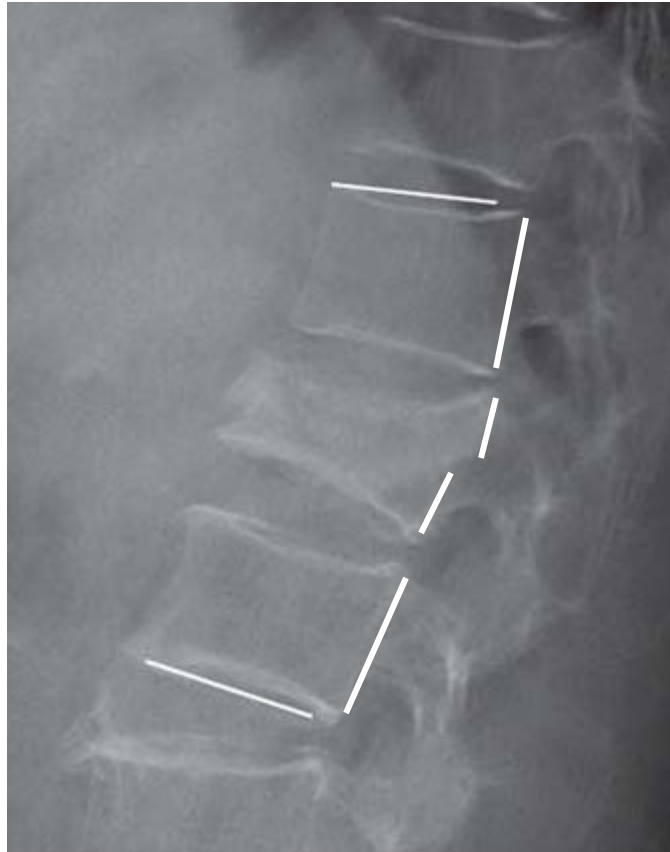


# Lateral view



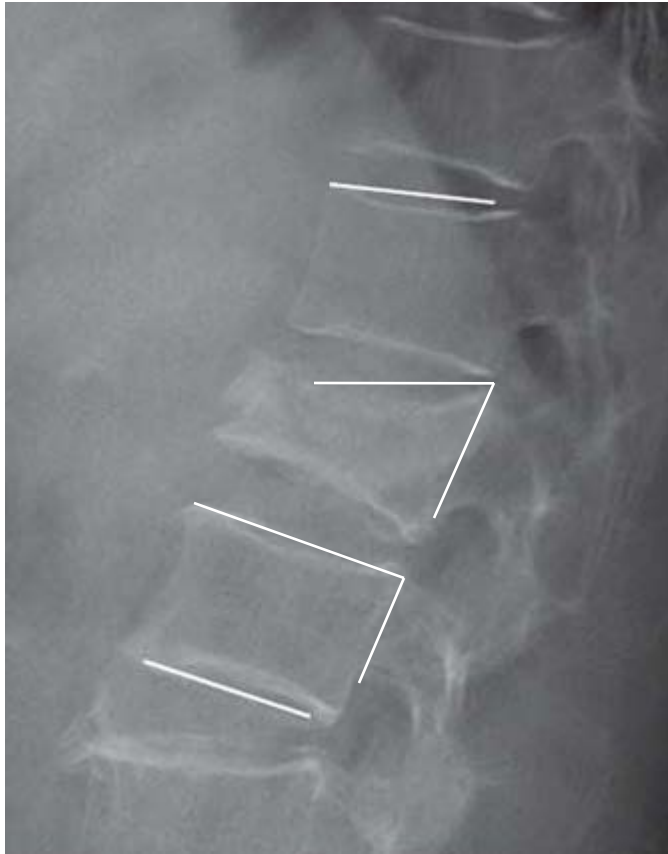
- Alignment
- Vertebral bodies
- Posterior vertebral line & angle
- Interspinous distance

# Lateral view

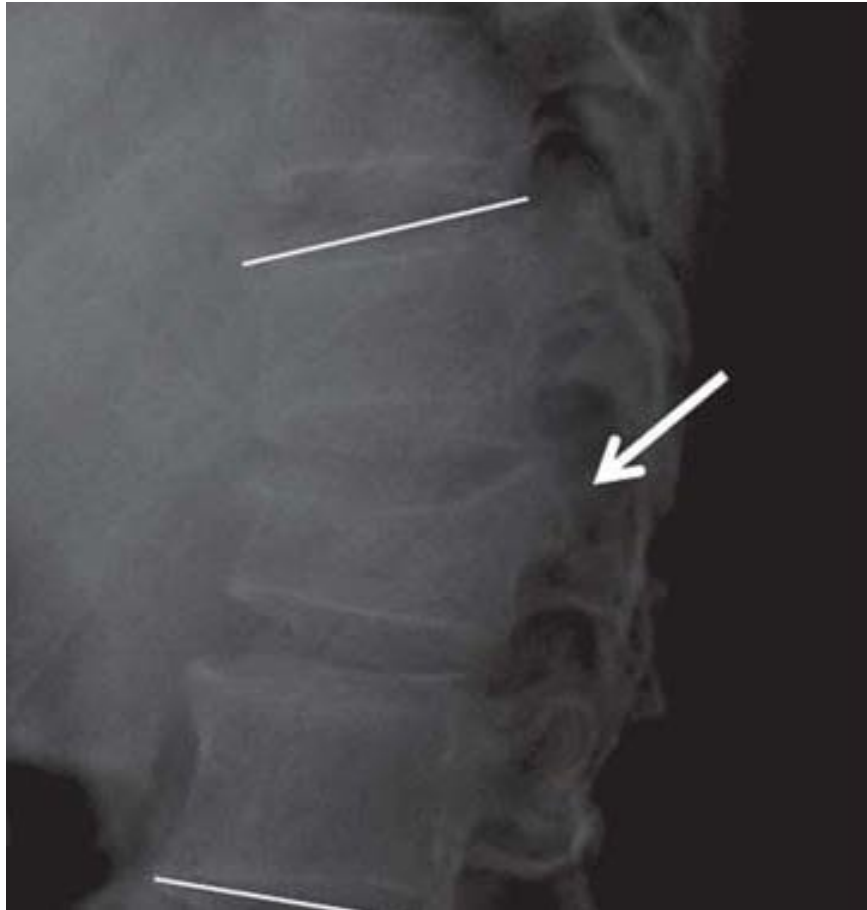


- Alignment
- Vertebral bodies
- Posterior vertebral line & angle
- Interspinous distance

# Lateral view



- Alignment
- Vertebral bodies
- Posterior vertebral line & angle
- Interspinous distance



# CT Scan

- Better differentiation of compression fractures from burst fractures
- Screening CT scans
  - Decreases the incidence of missed, delayed, or incorrect diagnoses
- Dedicated spine CT protocol
  - 2- to 3-mm axial images with sagittal and coronal reconstructions



# MRI Scan

- High-resolution imaging of soft tissues
- Neural elements can be visualized
- PLC can be reliably evaluated
- Whole spine MRI
- Complementary to CT not a substitute  
**Definitely indicated**
  - Progressive neurological deficit
  - Neurological level do not correspond to the fracture level

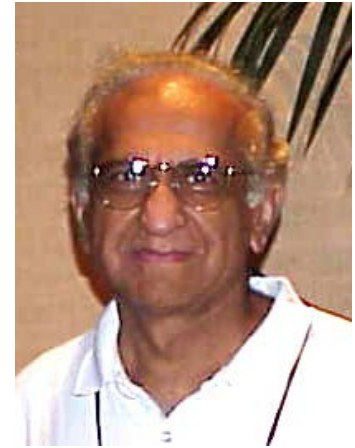




# Classification

- No universally accepted classification
- Based on spinal mechanical & neurologic stability
- Spinal neurologic stability
  - -The presence or absence of a neurologic deficit

# Instability



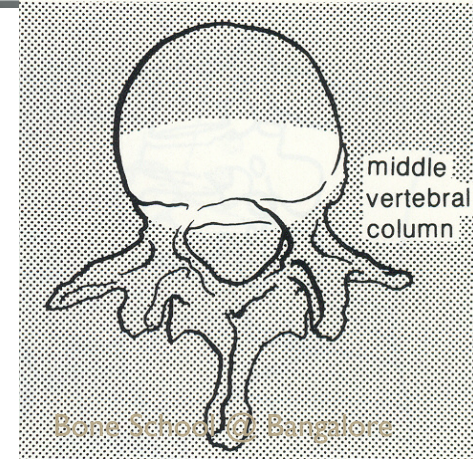
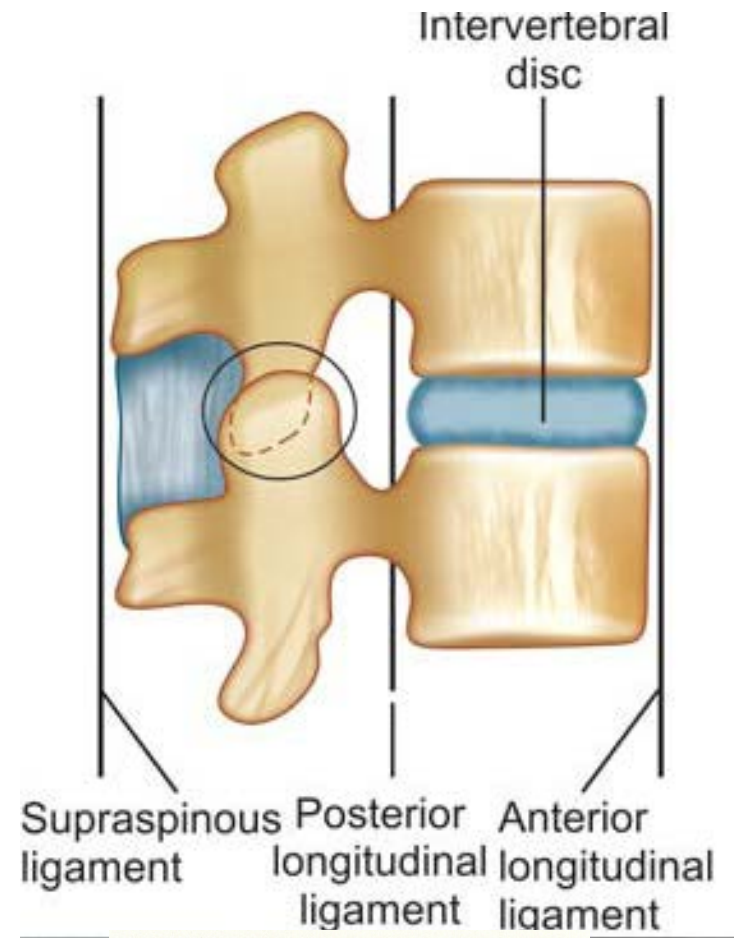
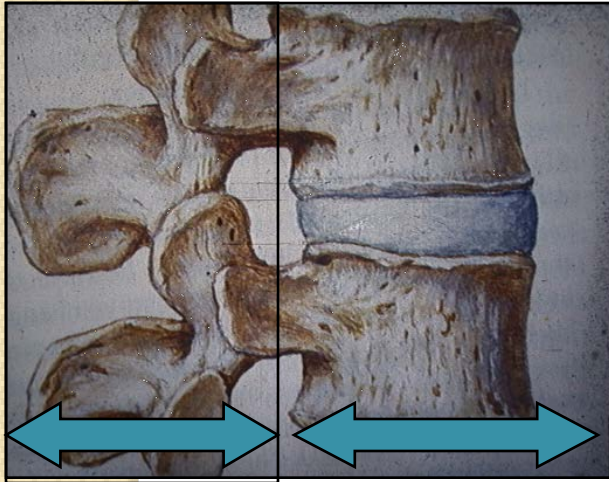
***White and Panjabi (1978, 1990)***

***“ Inability to maintain Structural integrity under physiological load, prevent progression of neurological deficit & pain.”***

# Column concept

- Holdsworth -2 column
- Denis -3 column
- Berg's concept -4<sup>th</sup> column in thoracic injury

# column concept



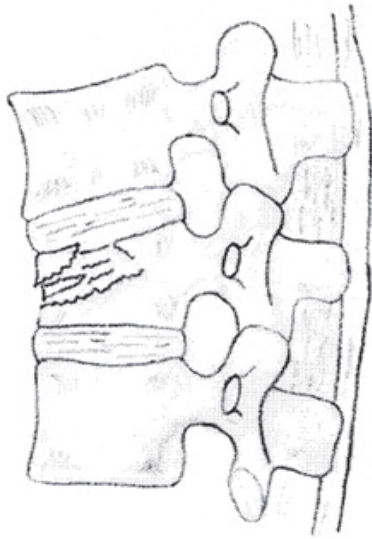
# Classification systems

- Holds worth
- Denis
- McCafee
- Load sharing classification  
( McCorack)
- AO classification (Magerel)
- TLICS

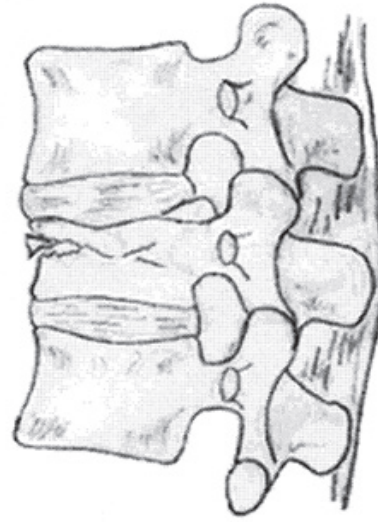
# Mcafee classification

- CT Scan based
- Six basic injury patterns were proposed
  1. Wedge –compression
  2. Stable Burst
  3. Unstable Burst
  4. Chance
  5. Flexion Distraction
  6. Translational

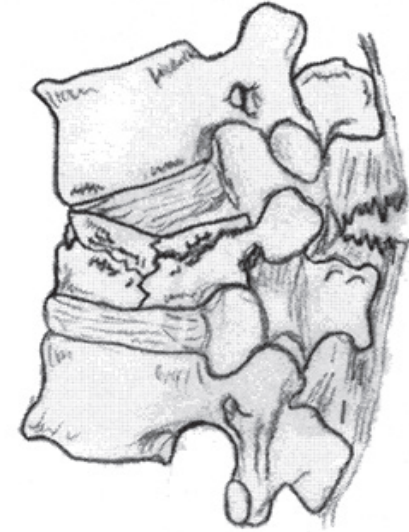




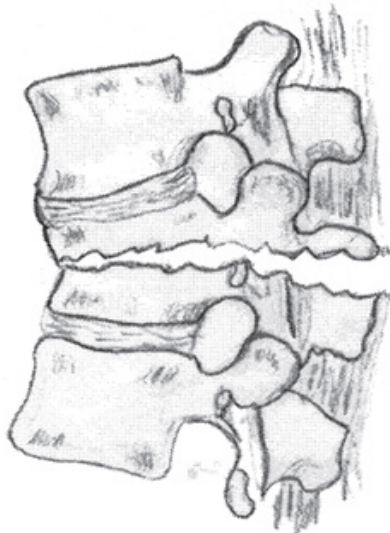
Compression fracture



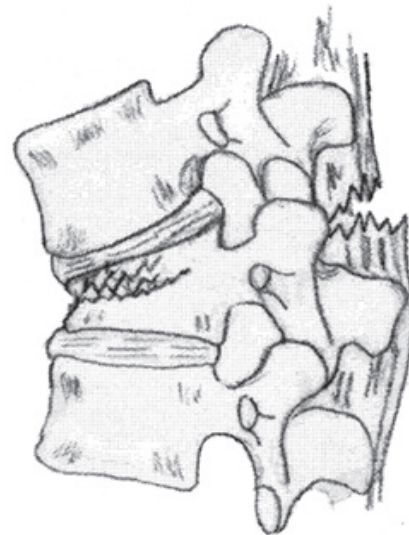
Stable Burst fracture



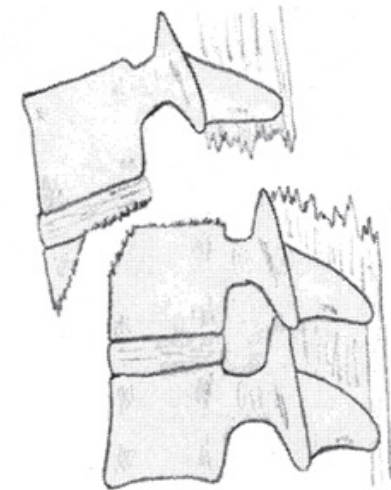
Unstable Burst fracture



Chance fracture



Flexion distraction injury



Translational



# Difference between Compression fracture and Burst fracture

*“ Presence of comminution of Posterior vertebral wall with retropulsion of fragment.”*

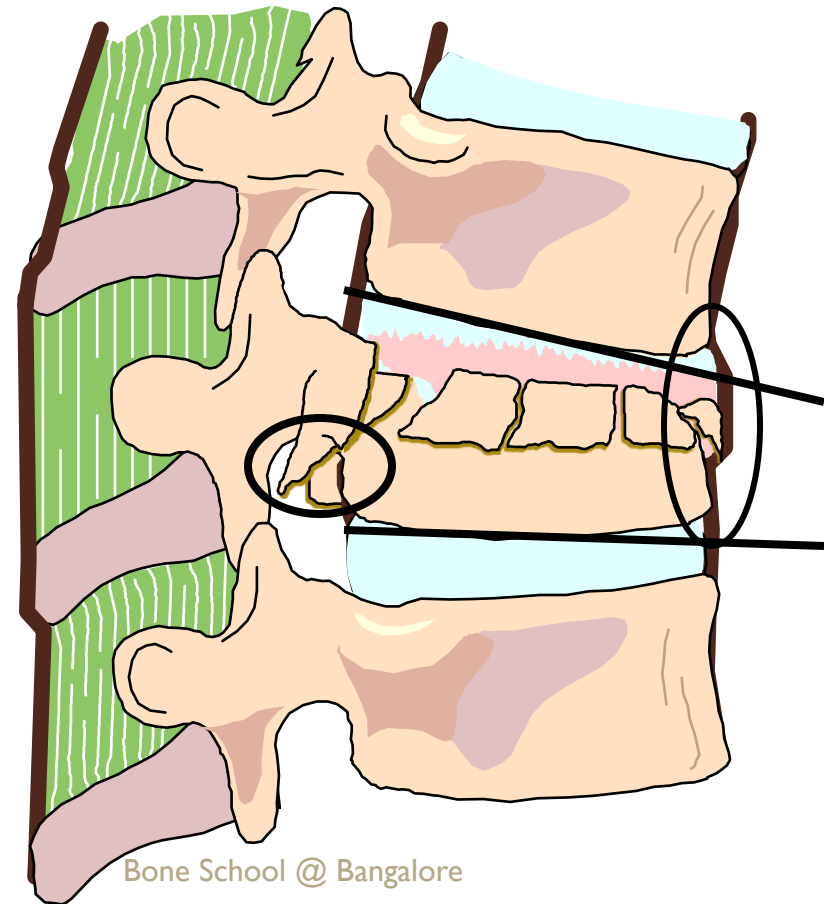


# Stable vs unstable burst #

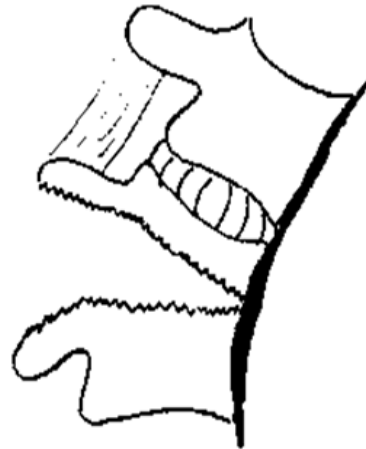


# Unstable Burst Fracture

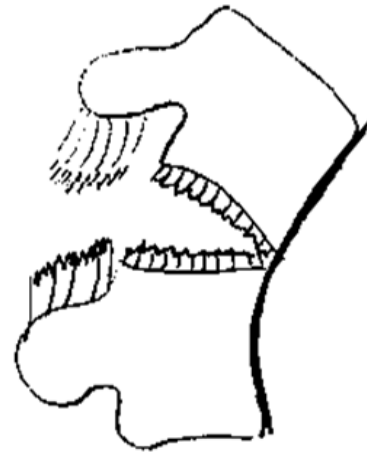
- **Burst fractures** –
  - a) Loss of Anterior vertebral body height  $> 50\%$  .
  - b) Kyphosis of  $> 30^\circ$
  - c) 50% canal compromise.
  - 4) Neurological deficit



# Chance Fracture



Bony Chance



Ligamentous



Osseoligamentous

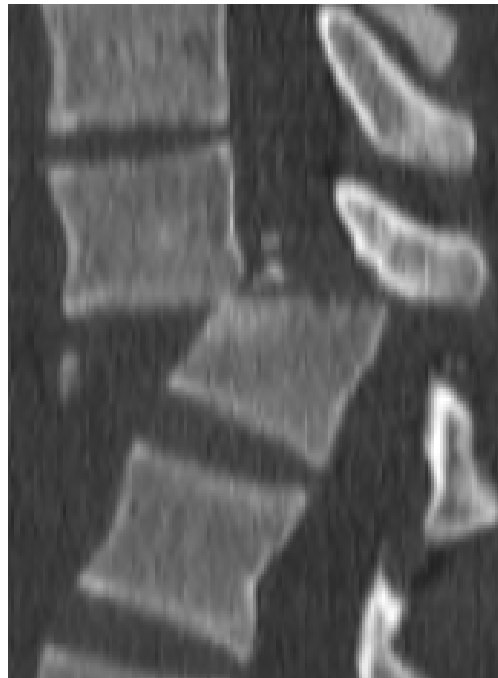
# Flexion distraction injury

- Due to distractive force on the spine
- Flexion axis - posterior to the anterior longitudinal ligament
- The anterior column fails in compression, whereas the middle and posterior columns fail in tension.

# T12-L1 Flexion distraction injury



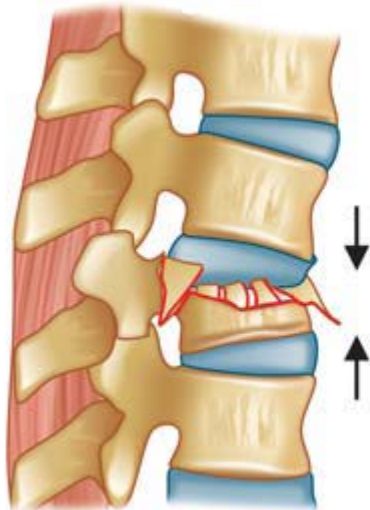
# T11-T12 fracture dislocation



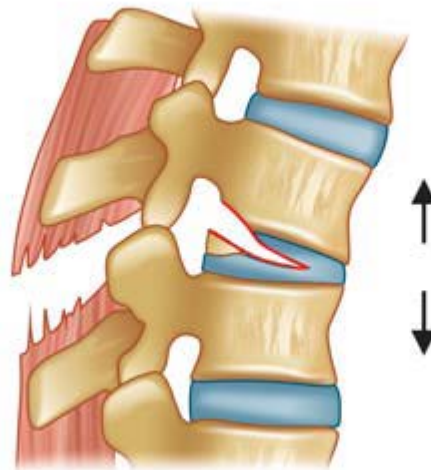


# AO classification

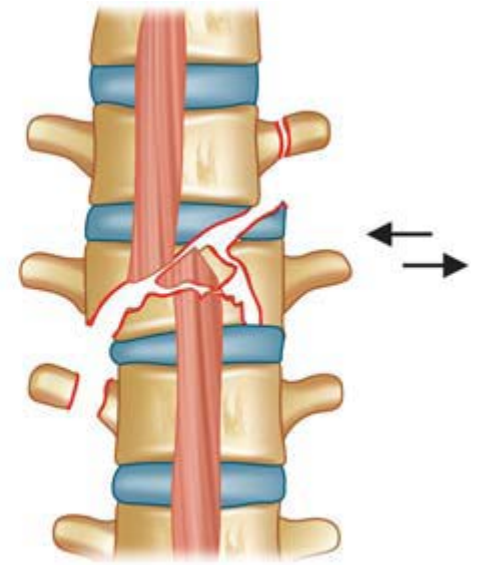
- Type A : Compression injuries- stable
- Type B : Distraction injuries-unstable
- Type C : Rotational injuries-unstable




Type A



Type B



Type C

- 
- Stable vs unstable fracture .
  - How to decide ?

# Posterior ligamentous complex(PLC)

- **Disruption of PLC indicates instability**
- PLC includes supraspinous ligaments , interspinous ligaments , ligamentum flavum and facet joint capsules
- Clinically: tenderness , swelling , palpable gap between spinous processes
- X-Rays & CT: increase interspinous interval , perched facets/facet dislocation
- MRI: T2 weighted images, increase in intensity

*‘Diagnosis of a stable injury is made by excluding PLC injury’*

## Stable fractures

- Compression fracture
- Stable burst fractures

*'Posterior ligamentous complex and neurology is intact'*

# Unstable fractures

- Unstable burst fractures
- Chance fractures
- Flexion distraction injuries
- Translational and rotational injuries

*‘Posterior ligamentous complex injured, neurological and structural instability’*

# Treatment goals

- Stable well aligned spine
- Neurological stability
- Early functional recovery

# Treatment of thoracic and lumbar fractures depends

- Patho-morphology of the fracture
- Neurological deficit
- General condition of health
- Presence or absence of polytrauma



# Treatment based on fracture morphology

## Conservative

Wedge compression fracture (A1)

Bony chance (B2)

## Grey zone

Burst fractures

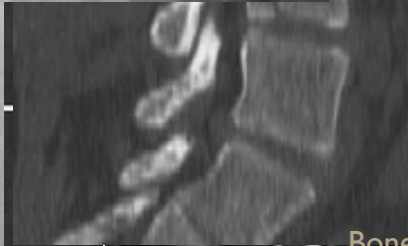
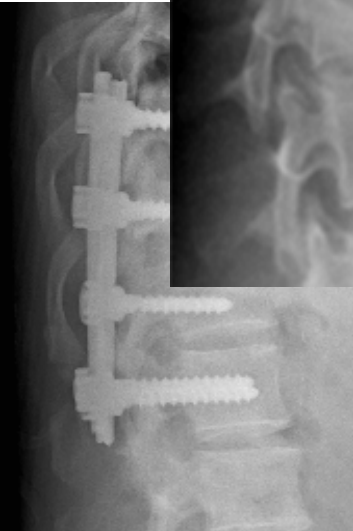
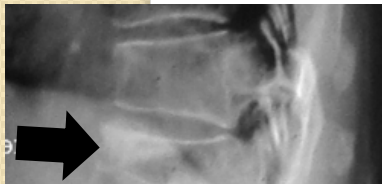
## Surgery

Ligamentous chance (B1)

Flexion distraction (B3)

Fracture dislocations (C)

Injury with rotational component (C)





# Burst fracture - Conservative Vs Surgery

- **Unstable burst fractures**
- **Presence of neurological deficits**
- **Multiple contiguous fractures**

Surgery is preferred in these situations,

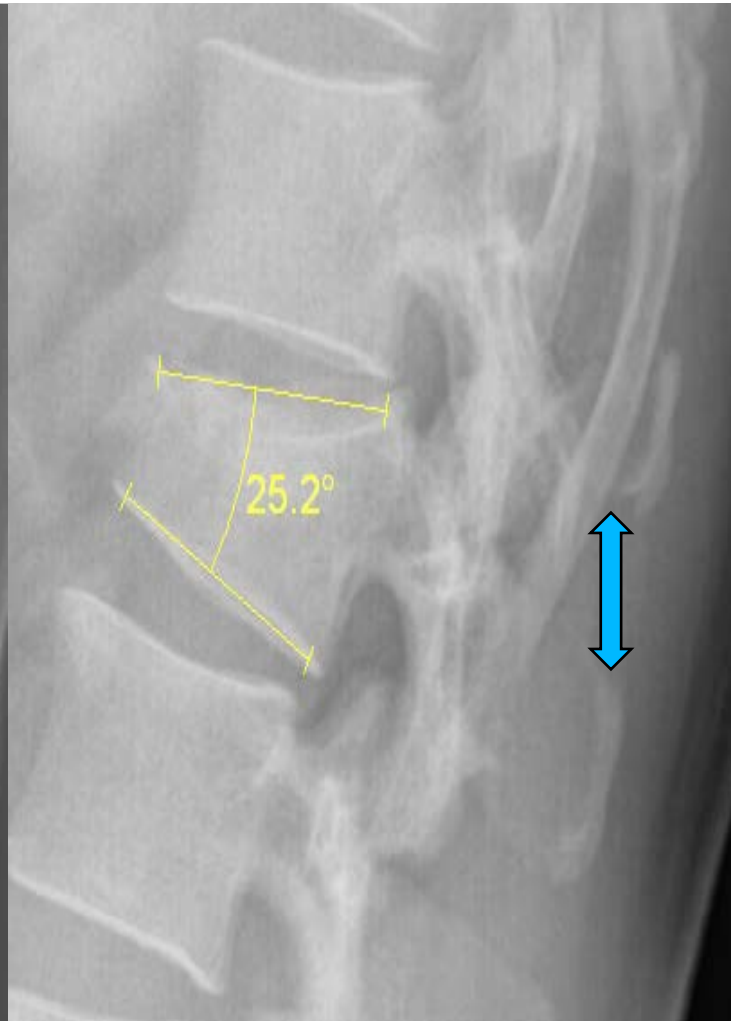
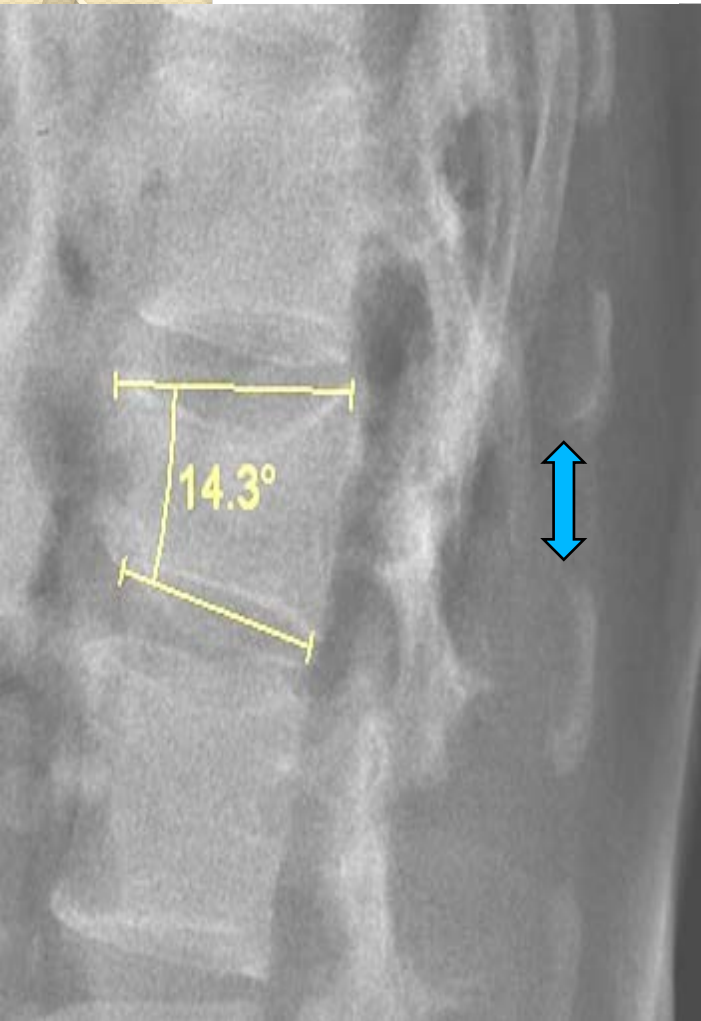
# Non operative treatment Methods

- Initial short period of rest 5-7 days, Analgesics
- Once pain is reduced- standing & walking
- On standing-if pain increases significantly
  - radiculopathy/ neural deficits
  - increased collapse & deformity on Xray

Fracture is considered unstable- surgery

- If stable on standing- Brace Mobilisation

# Weight bearing radiographs



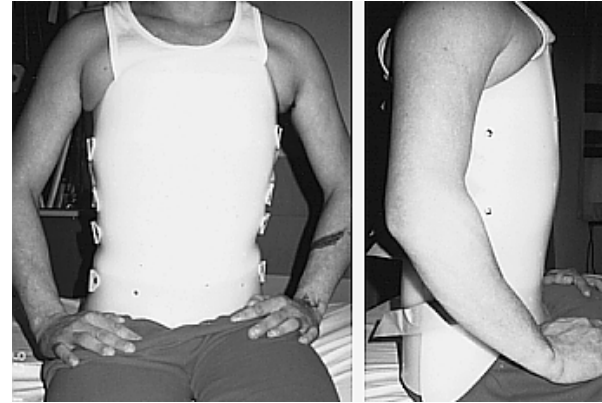
COIMBATORE PH: 2485000

Weight bearing

Diagnosis – unstable burst fracture

# Conservative

- Brace
- Molded orthosis
- Hyperextension cast



# Problems with casting

- Cannot be applied in
  - abdominal injury, prolonged ileus
  - chest trauma,
  - multiple extremity trauma
  - psychological disease, venous disease or previous DVT, obesity, bronchopulmonary diseases
- Cannot maintain sagittal alignment
- Poor patient compliance

# Indications of surgery

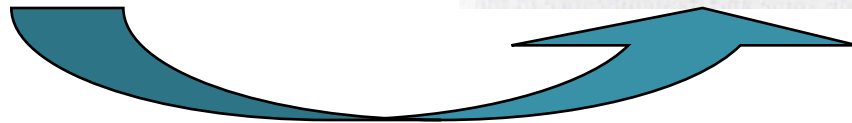
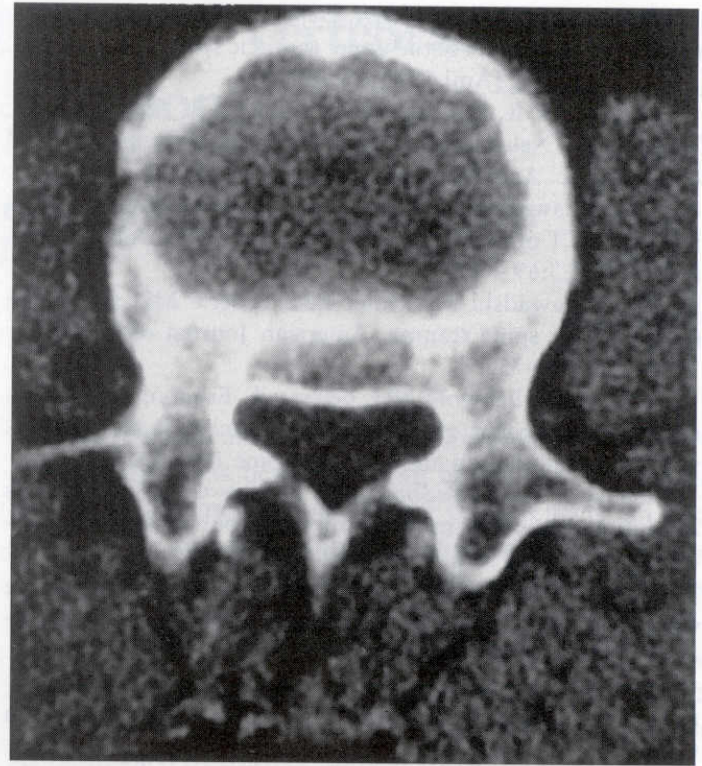
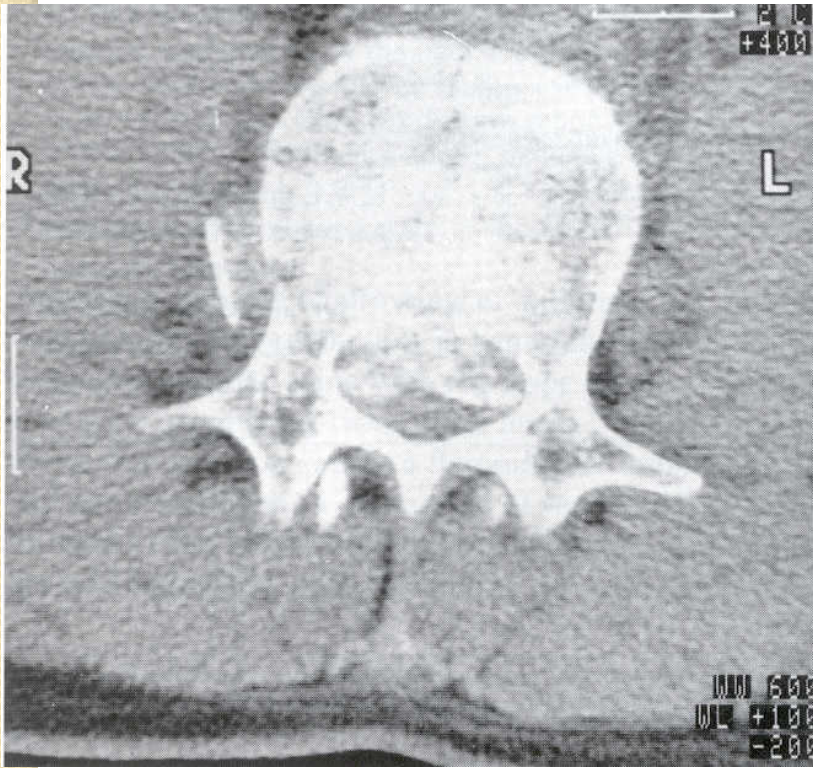
- Neurological instability
- Mechanical instability
- Canal compromise ?

# Indications of surgery

## Canal compromise

- Canal compromise from retropulsed bone fragments- not an absolute indication for surgical decompression.
- Remodeling and reconstitution of the spinal canal occurs within the first 12 months after injury.
- Accepted indication for surgery is canal compromise >50% or associated with neural deficit







# Timing of surgery

- Most TL fractures can be surgically stabilized on a priority basis , need not be an emergency.

# Indications for emergent stabilization

- Severe associated chest trauma/pulmonary contusion
- Poly trauma with multiple injuries systems/ long bones
- Progressive neurological deficit (very rare)
- **Presence of neurological deficit - controversial**

Does canal decompression and its timing actually influence neurological recovery?

## Conclusions from literature !

- “Although surgical removal of bony fragments may restore the spinal canal, it may not improve the chances of neurological recovery”
- “Decompression within 3 hours of injury influences neurological recovery” – lab studies

# Surgical approach

- Posterior
- Anterior
- Anterior+Posterior

*‘ Posterior approach is most common ‘*

- Chance fractures (B)
- Flexion distraction injuries (B3)
- Fracture dislocations (C1,C2,C3)
- Burst fracture without deficits (A2,A3)

Posterior

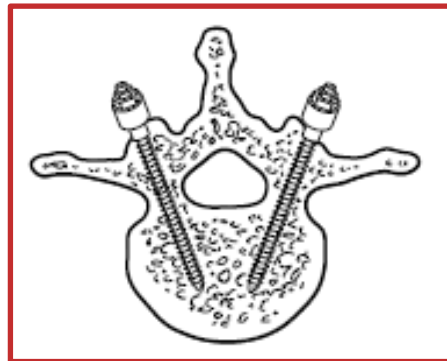
- Burst fracture with deficits (A2,A3)

Anterior /Posterior/ 360

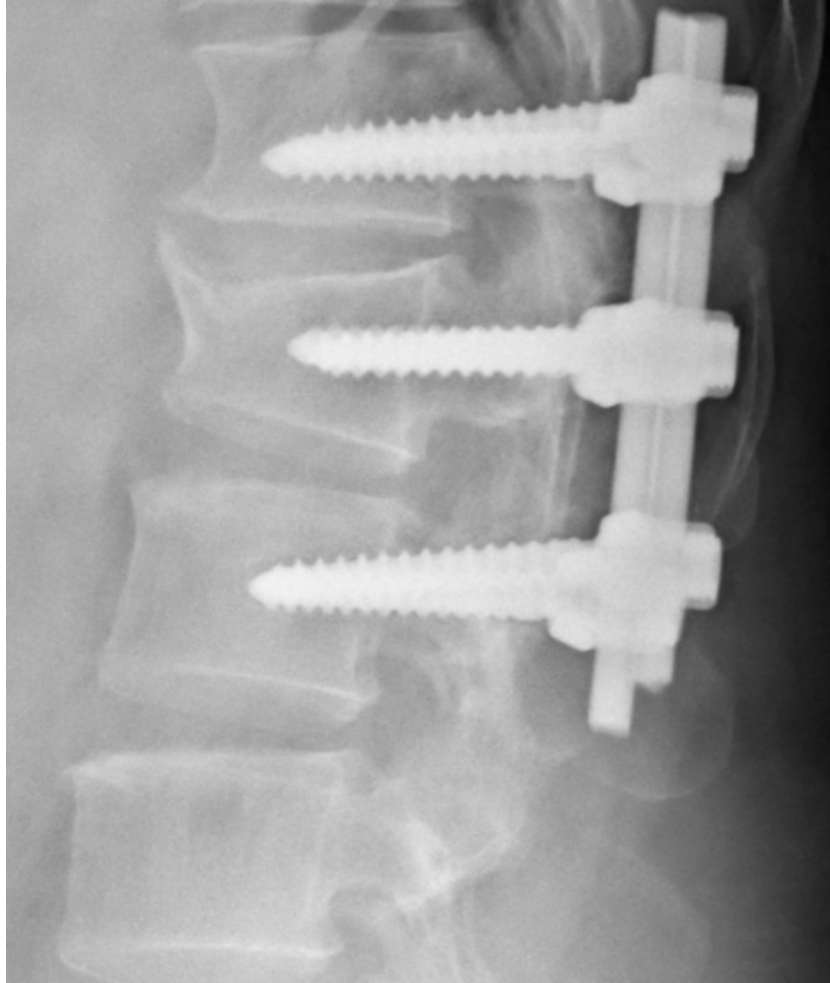
# Surgical options

# Posterior approach

- Done in type B & C fractures with PLC injuries to restore posterior tension band and alignment of spinal column
- Pedicle screw instrumentation with connecting rods – more rigid than anterior construct



# Pedicle screw fixation



# Length of construct

- **Short segment construct-**
  - one level above and below the injury
  - burst fractures
  - chance fractures
- **Long construct-** two level above and below injury
  - significant osteoporosis
  - fracture dislocations



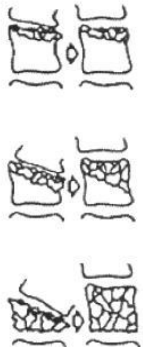


# Anterior approach

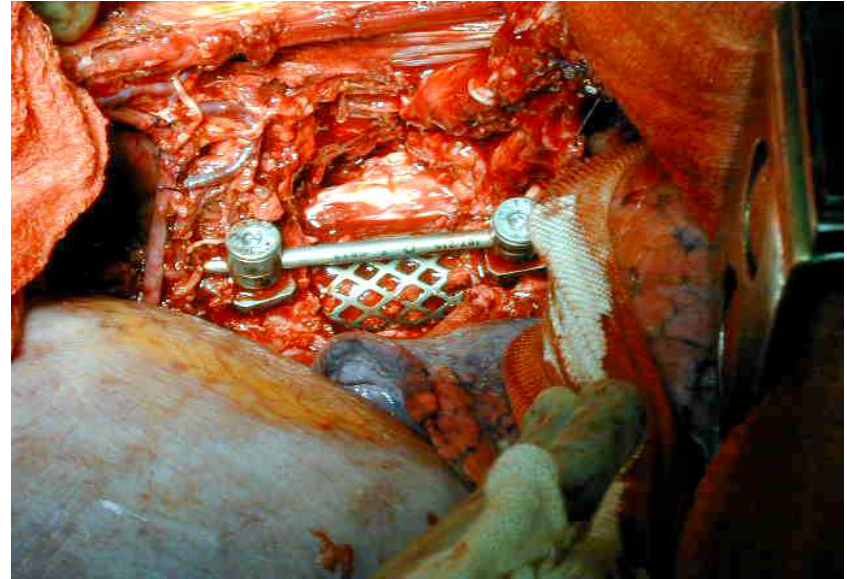
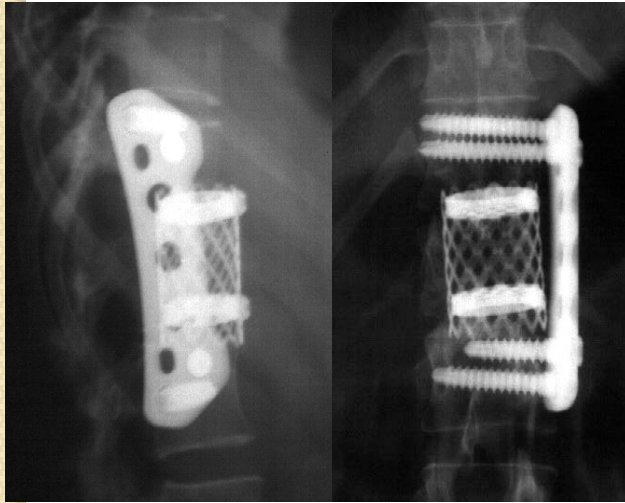
- Severe collapse of anterior column
- Gaines score > 6 (Load sharing classification)
- Split variant of Type A fracture with disc migration in fracture site

- Corpectomy + reconstruction of anterior column (cage fixation)
- Kaneda anterior instrumentation
- Anterior Plate fixation

# Load sharing classification

 <p>Little 1</p> <p>More 2</p> <p>Gross 3</p>	<p style="text-align: center;"><b>COMMUNITION</b></p> <ol style="list-style-type: none"> <li>1 Little = &lt; 30% Comminution on sagittal plane section CT</li> <li>2 More = 30%–60% Comminution</li> <li>3 Gross = &gt; 60% Comminution</li> </ol>
 <p>Minimal 1</p> <p>Spread 2</p> <p>Wide 3</p>	<p style="text-align: center;"><b>APPOSITION of FRAGMENTS</b></p> <ol style="list-style-type: none"> <li>1 Minimal = Minimal displacement on axial CT cut</li> <li>2 Spread = At least 2mm displacement of &lt; 50% cross section of body</li> <li>3 Wide = At least 2mm displacement of &gt; 50% cross section of body</li> </ol>
 <p>Little 1</p> <p>More 2</p> <p>Most 3</p>	<p style="text-align: center;"><b>REDUCIBILITY of SAGITTAL DEFORMATION</b></p> <ol style="list-style-type: none"> <li>1 Little = Kyphotic correction <math>\leq 3^\circ</math> on lateral plain films</li> <li>2 More = Kyphotic correction <math>4^\circ</math>–<math>9^\circ</math></li> <li>3 Most = Kyphotic correction <math>\geq 10^\circ</math></li> </ol>

# Anterior stabilization



- Technically demanding - high morbidity
- Should be delayed until the patient is stable
- Usually reserved in cases with severe comminution of the body – Anterior compression

# Anterior + Posterior approach

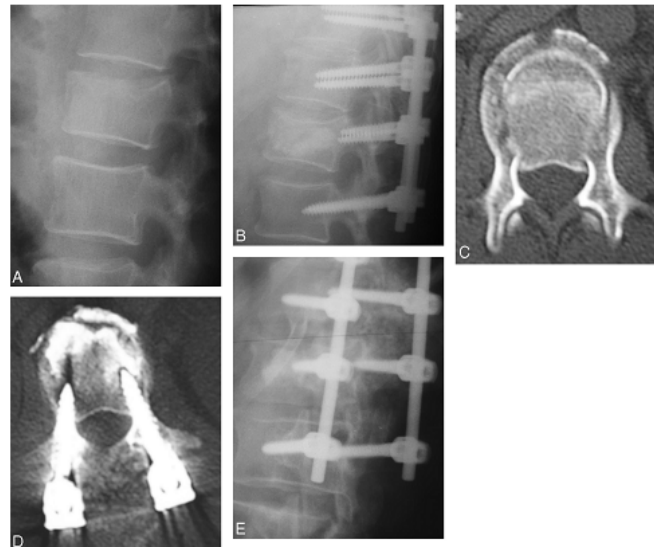
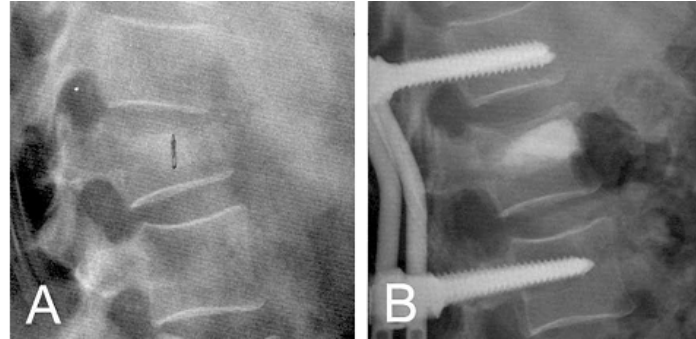
- Severe instability with disruption of all 3 columns
- Significant loss of anterior column height with deformity
- More stable construct
- More surgical morbidity



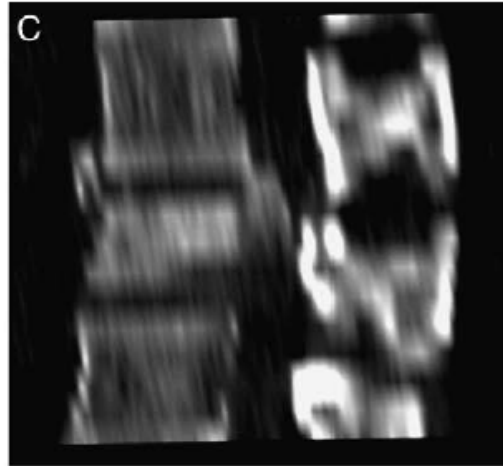


# Recent advances

# Newer techniques – Cement augmentation

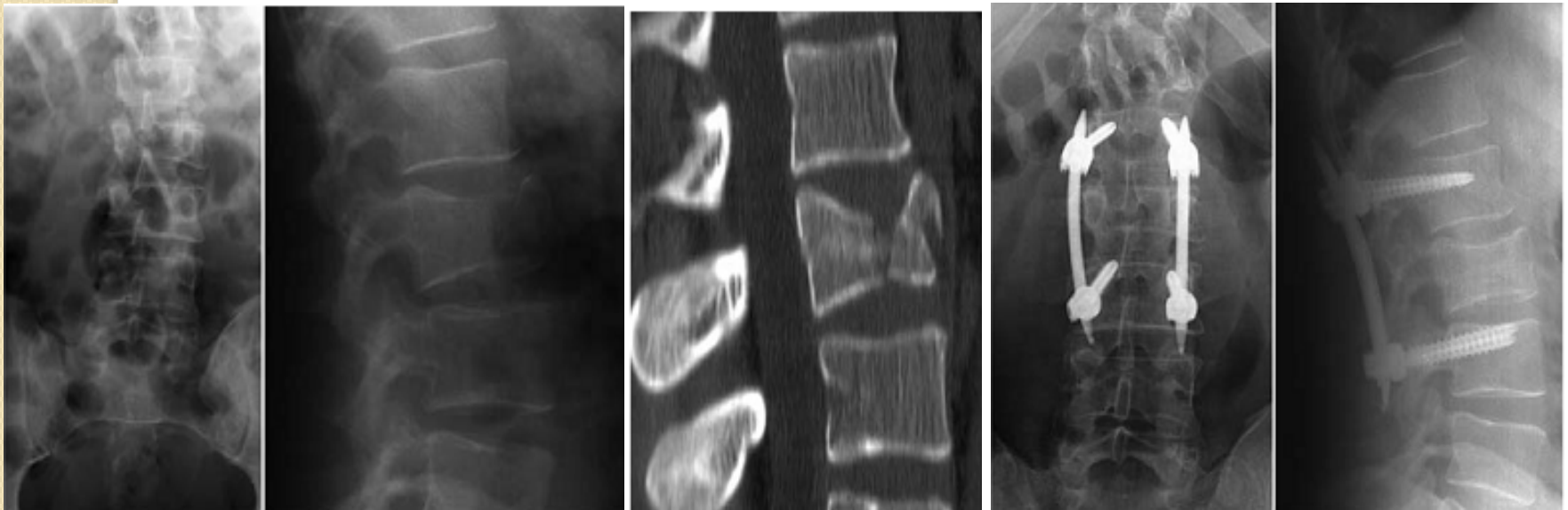


# mono segmental fixation





# Minimally invasive percutaneous fixation in the treatment of thoracic and lumbar spine fractures





# Conclusion

- Comprehensive initial evaluation
- See the patient as a whole
- Hemodynamically stable patient
- Classify # & formulate Rx plan



# Enhancement of stability using posterior only approach

- Anterior reconstruction from posterior approach-vertebrectomy , cage fixation
- Transpedicular bone grafting
- Pedicle screws at the level of fracture
- Kyphoplasty at fractured level
- Vertebral shortening – closing wedge osteotomies and deformity correction

# Complications

- Dural tears
- Iatrogenic neural injury
- Infection
- Pseudoarthrosis
- Instrumentation failure
- Iatrogenic flat back

# Spinal cord injury

- Site of spinal cord injury

cervical region            50- 64%

lumbar region            20% to 24%

(conus medullaris or cauda equina)

thoracic cord            17% to 19%

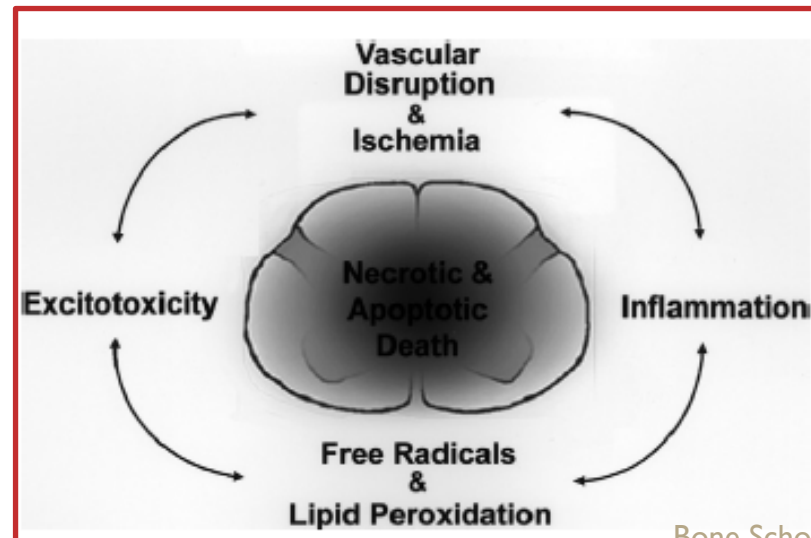
- Cervical injuries - incomplete neurologic common
- Thoracic injuries -complete deficits common

# Mechanics of Neural Injury

- The spinal cord can withstand considerable axial displacement without sustaining structural or neurologic deficit
- Spinal cord does not slide up and down in the spinal canal during spinal flexion and extension, as nerve roots.
- Rather, the cord appears to deform like an accordion
- As physical displacement of the spinal cord damages neural tissue, the innermost regions of the spinal cord sustain the most severe injury

# Secondary injury

- Changes in local blood flow, tissue edema, metabolite concentrations, and chemical mediators accumulation
- Ischemia and inflammation
- Lack of autoregulation of bloodflow in spinal cord , hypotension and fall in SpO<sub>2</sub> leads to delayed *secondary neuronal injury*



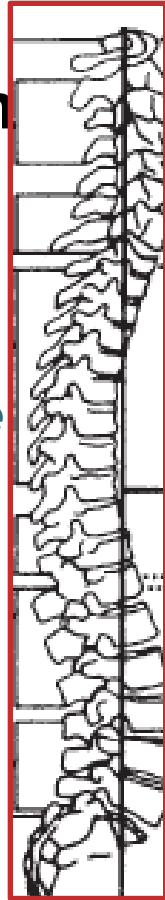
# Why Common ?

## Thoracolumbar junction - Transitional region

- *Rigid Thoracic spine to Mobile Lumbar spine*

- *Kyphotic Thoracic spine to the Lordotic Lumbar spine*

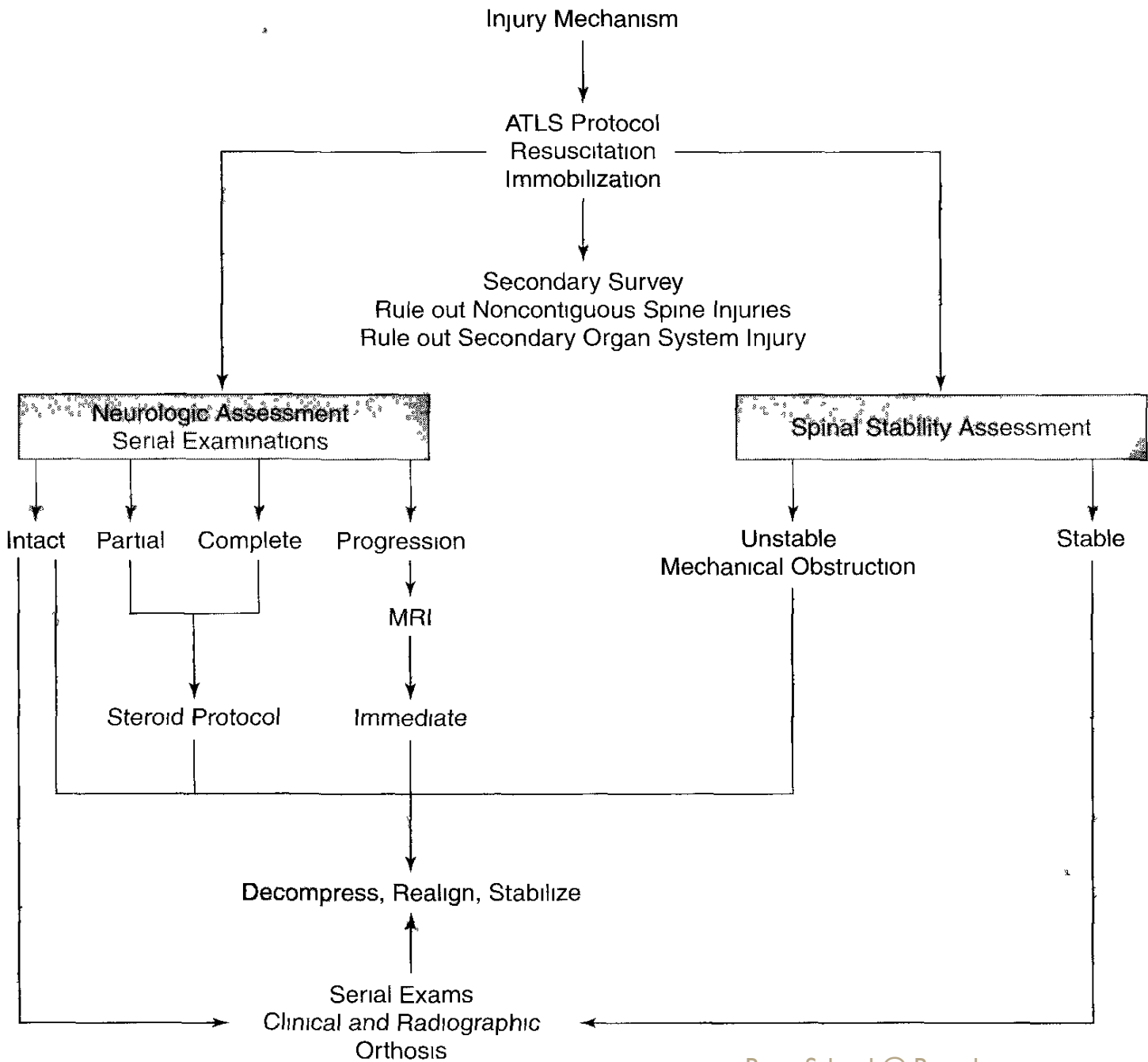
- *Coronally oriented Thoracic facet joints change to Sagittally orientated Lumbar facet joints.*





# PRINCIPLES OF EVALUATION

- All trauma patients need to be fully investigated for spinal injury
- Even mild complaints of pain or posterior midline tenderness in trauma patients should not be dismissed without full evaluation
- Persistent symptoms despite normal initial imaging studies require upright x-rays or flexion-extension x-rays ,CT , MRI
- ATLS principles are to be followed



# Field care

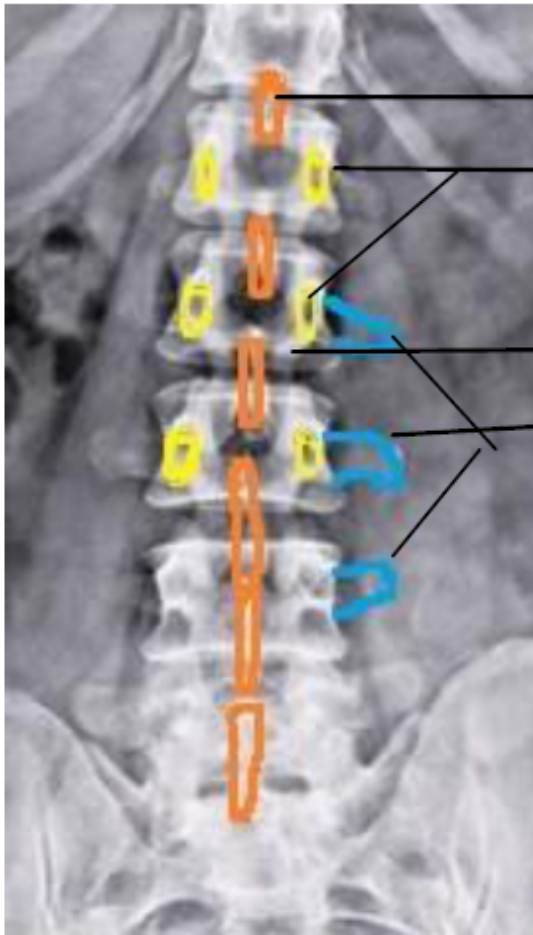
- Proper extrication of the patient and immobilization of cervical spine
- Secure airway ,breathing ,circulation
- Spine board immobilisation and proper log rolling maneuvers while transportation
- Preliminary assessment of neurologic status in the field helps prioritize subsequent treatment

# Emergency department care

- Primary and secondary survey as per ATLS protocol
  - A- advanced
  - T- trauma
  - L- life
  - S- support

# X-ray

## AP View



SPINOUS PROCESS

PEDICLES

INTERVERTEBRAL SPACE

TRANSVERSE PROCESS

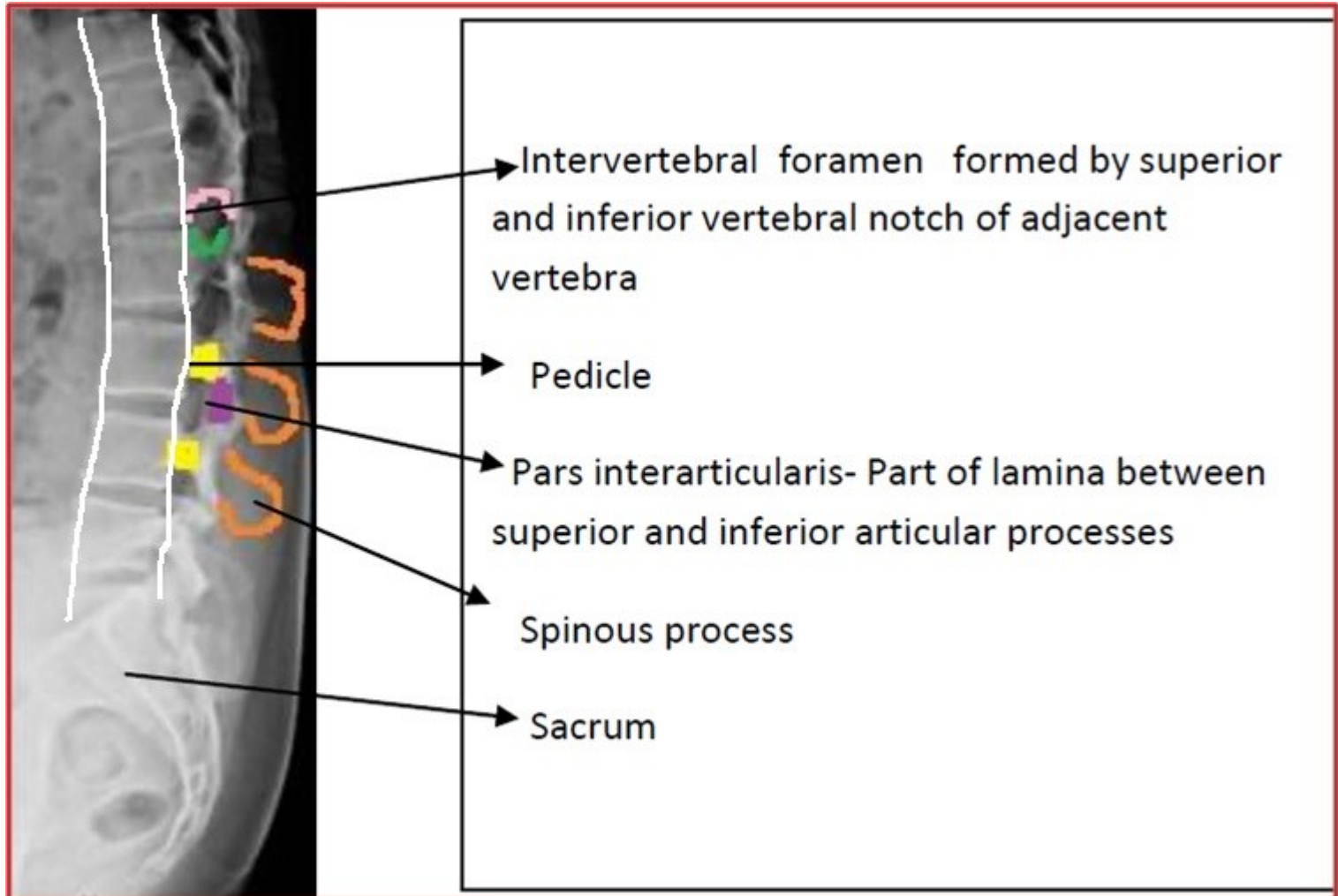
Each vertebra looks like a face , with pedicles predicting eyes, spinous process as nose and transverse processes as ears.

# Lateral view

- Height, width, and alignment of the vertebral bodies, pedicles, spinal canal, neural foramina, facets, and spinous processes.
- Anterior vertebral body line-along anterior border of vertebral bodies
- Posterior vertebral line-along posterior border of vertebral bodies
- Posterior vertebral height and angle at injured level
- Interspinous distance

# X-ray

## Lateral view



## Ferguson and Allen classification

- Proposed a mechanistic classification
- Combined three-column theory with forces causing injury .
- Fracture types: compressive flexion  
distractive flexion  
lateral flexion  
translational  
torsional flexion  
vertical compression  
distractive extension  
isolated transverse process fractures



# The Thoracolumbar Injury Classification system and severity score (TLICS)

- By Spine Trauma Study Group
- Based on injury morphology, integrity of the posterior ligamentous complex, and neurologic status
- Type Points
- **Compression** 1
- **Burst** 2
- **Translational/rotational** 3
- **Distraction** 4
  
- Integrity of posterior ligamentous complex
- **Intact** 0
- **Suspected/indeterminate** 2
- **Injured** 3
  
- Neurologic status
- **Intact** 0
- **Nerve root** 2
- **Cord, conus medularis, complete** 2
- **Cord, conus medularis, incomplete** 3
- **Cauda equine** 3

## The Thoracolumbar Injury Classification system and severity score (TLICS)

- More severe injuries receive higher injury scores
- The scores in each category are added to yield the overall severity score, ranging from 1 to 10.
- Score of 3 or less – nonoperative
- Score of 5 or greater-operative
- Score of 4 - indeterminate-gray zone. Depends on other patient factor

# Load sharing classification

- By McCormack
- Based on 3 fracture characteristics
  - (1) Degree of vertebral body comminution
  - (2) Apposition of vertebral body fracture fragments
  - (3) Amount of kyphotic deformity.

Score - 6 points or less- Short segment

posterior approach

Score - 7 or higher - poor candidates for short-segment posterior-only fixation

## COMMUNITION



Little  
1



More  
2



Gross  
3

- 1 Little = < 30% Comminution on sagittal plane section CT
- 2 More = 30%–60% Comminution
- 3 Gross = > 60% Comminution

## APPOSITION of FRAGMENTS



Minimal  
1



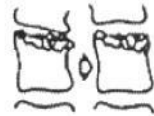
Spread  
2



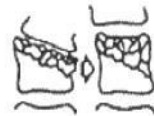
Wide  
3

- 1 Minimal = Minimal displacement on axial CT cut
- 2 Spread = At least 2mm displacement of < 50% cross section of body
- 3 Wide = At least 2mm displacement of > 50% cross section of body

## REDUCIBILITY of SAGITTAL DEFORMATION



Little  
1



More  
2



Most  
3

- 1 Little = Kyphotic correction  $\leq 3^\circ$  on lateral plain films
- 2 More = Kyphotic correction  $4^\circ$ – $9^\circ$
- 3 Most = Kyphotic correction  $\geq 10^\circ$

McCormack and Gaines classification depends

on

a scoring system based on the degree of comminution, and

spread of fracture fragments as noted from sagittal and axial CT

scans respectively, and the angle of kyphosis in lateral radiograph.

On each factor, the score can vary from 1 to 3 and the

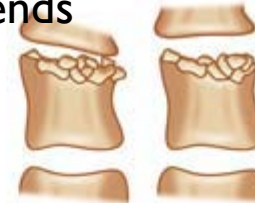
maximum total score can be nine. Burst fractures with score six

or more indicate significant comminution and need for surgical restoration of anterior column.

COMMINUTION

APPOSITION

KYPHOSIS

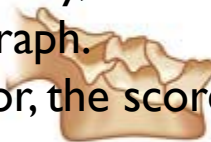


Score from 3 to 9

1. Little  
< 30%  
comminution

1. Minimal spread

1. Little  
< 4° correction

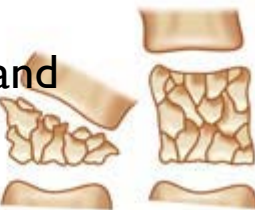


< 6 =  
posterior  
surgery

2. More  
30-60%  
comminution

2. Spread  
in anterior  
of vertebra  
> 50%

2. More  
4-9° correction



≥ 6 =  
anterior  
surgery

3. Gross  
> 60%  
comminution

3. Wide  
> 2 mm of  
of vertebra  
> 50%

3. Most  
> 9° correction

### COMMINUTION



1. Little  
< 30%  
comminution



2. More  
30–60%  
comminution



3. Gross  
> 60%  
comminution

### APPOSITION



1. Minimal  
Minimal spread



2. Spread  
< 2 mm of < 50%  
of vertebra

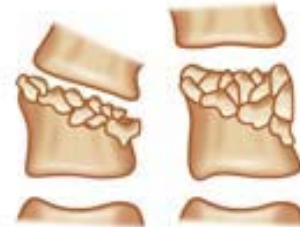


3. Wide  
> 2 mm of > 50%  
of vertebra

### KYPHOSIS



1. Little  
< 4° correction



2. More  
4–9° correction



3. Most  
> 9° correction

Score from  
3 to 9

< 6 =  
posterior  
surgery

≥ 6 =  
anterior  
surgery



**A: compression injuries**

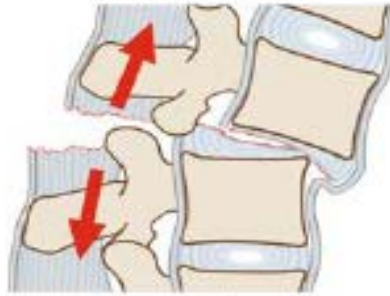
**B: distraction injuries  
(ant/post column)**

**C: rotational injuries**

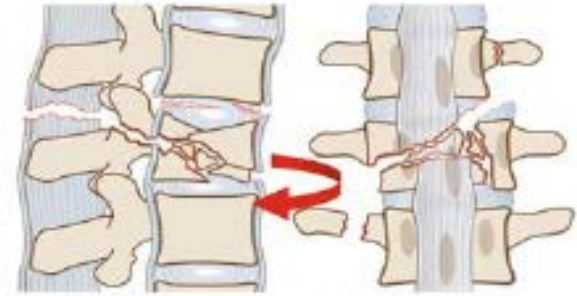
1



impaction fractures

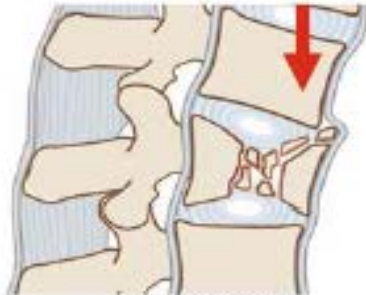


with post. lig. disruption

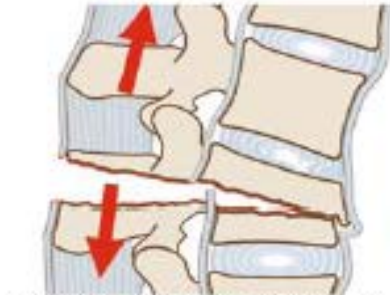


Type A injury with rotation

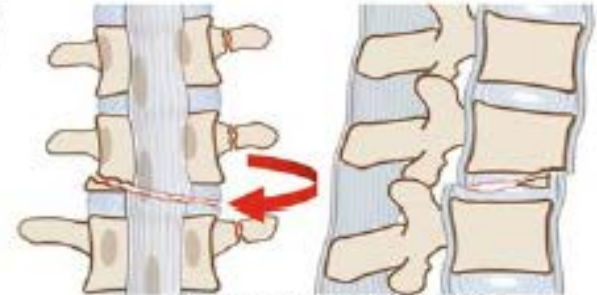
2



split fractures  
(pincer fracture)

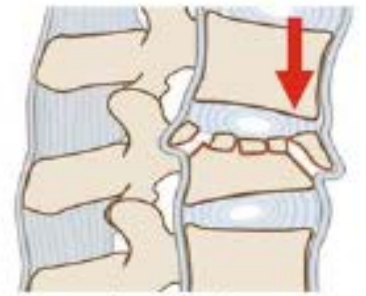


with post. transoss. disruption  
(chance fracture)

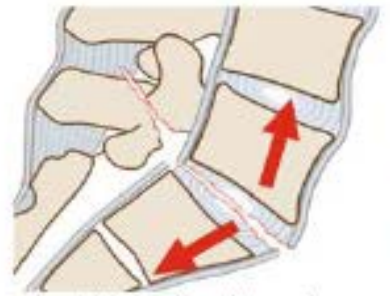


Type B injury with rotation

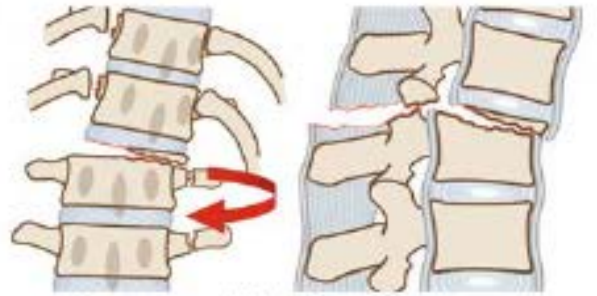
3



burst fractures

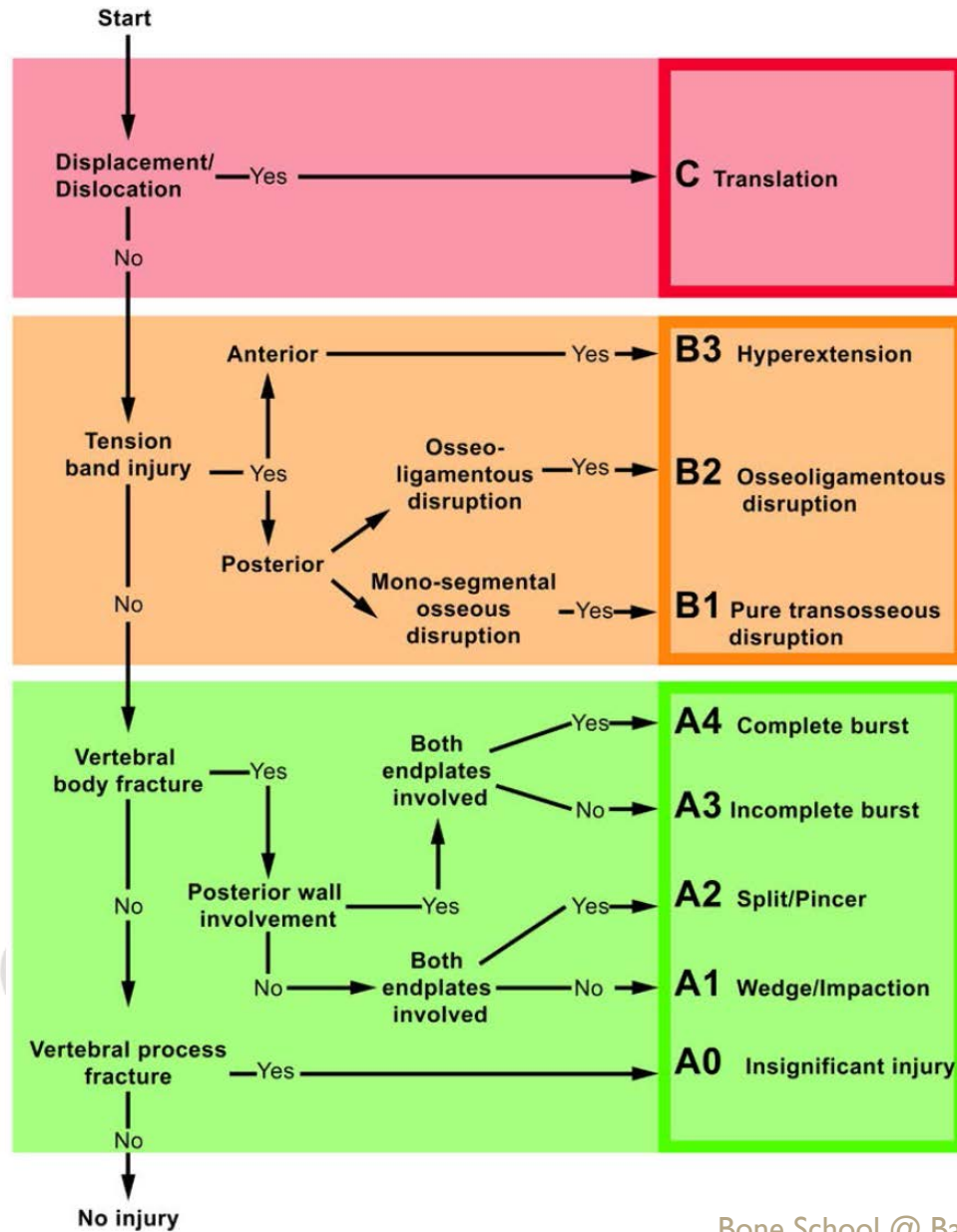


with ant. disc disruption



rotation/shear injuries

# AO Latest Fracture Classification algorithm





# Specific injury patterns

## Sprain

- Injuries to the spinal column involving the ligaments and musculotendinous units
- Do not cause facet joint subluxation, fracture, or listhesis
- Diagnosis of exclusion
- Stable

# Traumatic disc herniation

- Relatively rare as an isolated injury
- Fractures often associated with disc disruption, and displaced disc may contribute to neurologic injury
- Diagnosis with MRI

# Minor Fractures

- Transverse process fractures and spinous process fractures
  - Isolated pars fractures, lamina fractures, and articular process
  - These fractures are stable provided they are not associated with significant ligamentous injury
- indirect trauma- avulsion injury
- direct trauma

# Compression Fractures

- Result from axial compression through the vertebral body
- failure of the anterior column, middle column is intact
- May involve the superior or inferior endplate alone, both endplates, or buckling of the anterior cortex with endplate preservation
- Plain radiographs are usually diagnostic
- CT scan -to confirm the diagnosis

*Extension into the middle column may be subtle and burst fractures may be misdiagnosed as compression fractures*

# Stable burst fracture

- Caused by axial compression through the vertebral body
- Involvement of middle column
- The posterior column not involved
- Differentiation between compression and burst fractures occurs at the middle column, which is spared in compression fractures and involved with burst fractures
- Transition from compression fracture to burst fracture represents a continuum of injury rather than distinct injury patterns because the same force vector is responsible.

# Unstable burst fracture

- Anterior & middle column fail in compression
- Posterior column can fail in compression, lateral flexion, or rotation, but not distraction
- Retropulsion of cortex and canal compromise
- Tendency for posttraumatic kyphosis
- Neurological instability

# Fracture dislocations

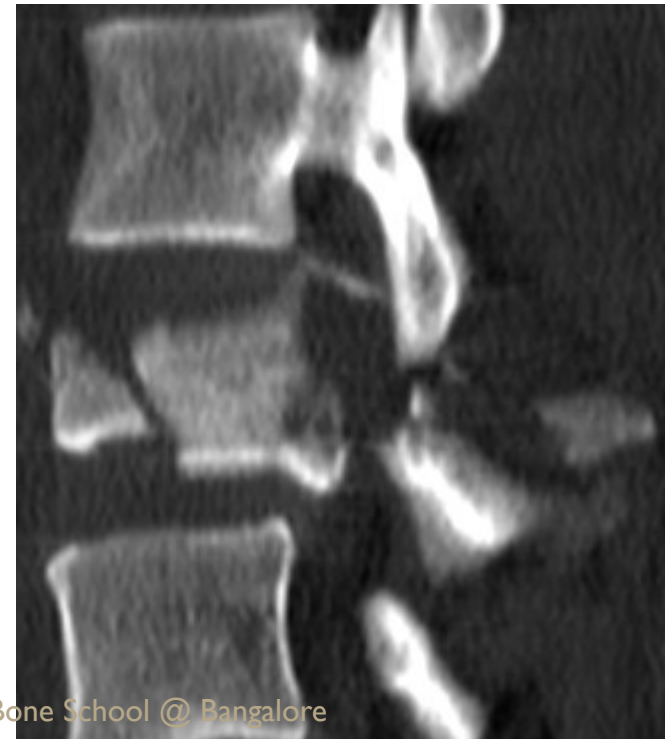
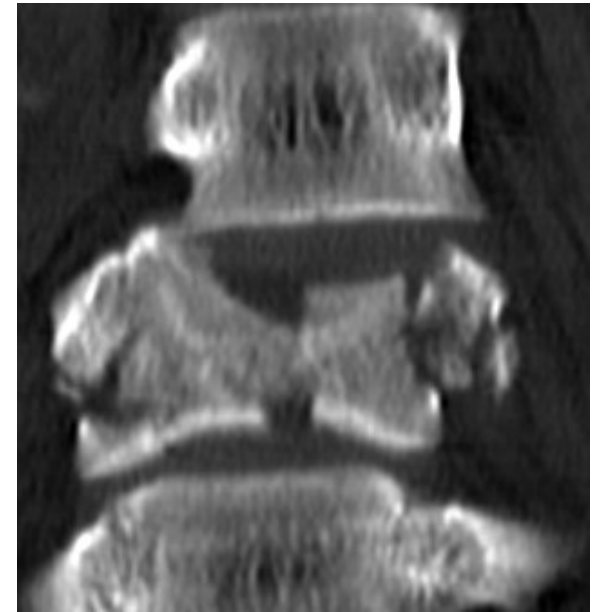
- Variety of mechanisms including shear, rotation, distraction, flexion, and extension.
- Usually involves a combination of these force vectors
- All three spinal columns are disrupted
- Unilateral or bilateral facet disruption
- The Xray AP view -lateral translation,  
lateral view- anterior or posterior  
translation

# Rotational injury

- Failure of all 3 columns
- Always unstable
- Xray- asymmetric fractures of body, transverse process , adjacent ribs, unilateral facet dislocation



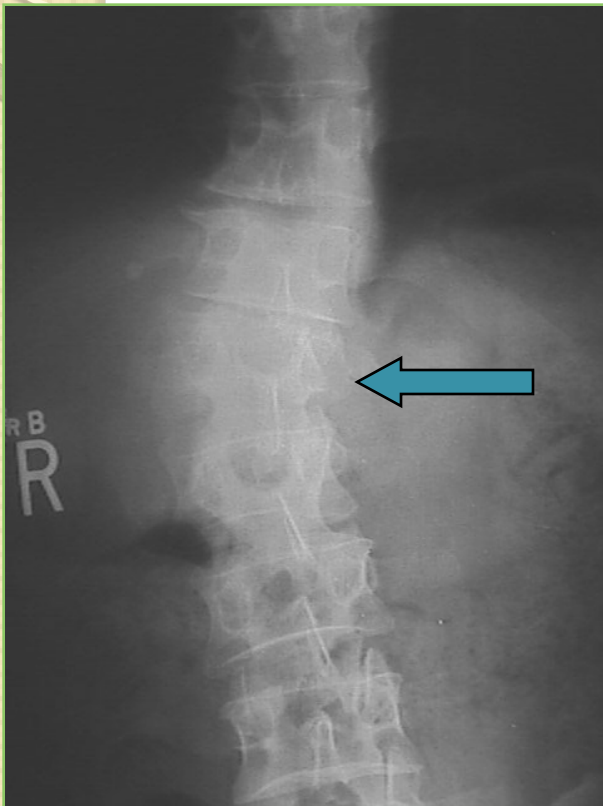
# Rotational injury



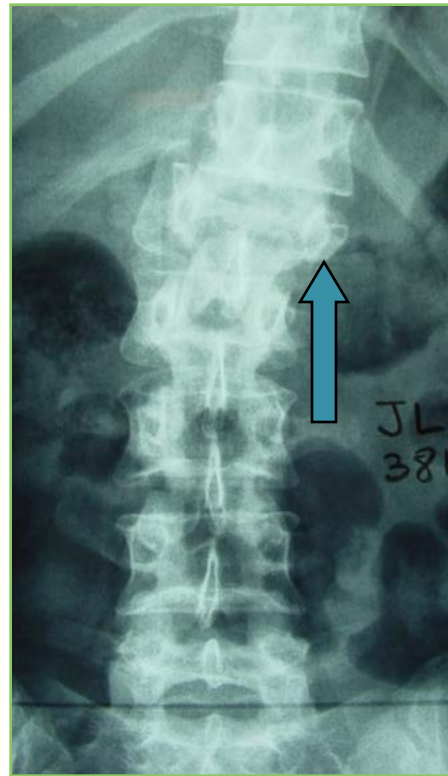
# Extension injuries

- Seen in ankylosed spine- ankylosing spondylitis (AS) or diffuse idiopathic skeletal hyperostosis (DISH).
- Do not follow typical patterns and resemble long-bone fractures
- Usually unstable
- CT scans- identify and characterize the injury
- MRI - to visualize neural elements
  - detecting epidural hematomas, which is more common in this group of patients

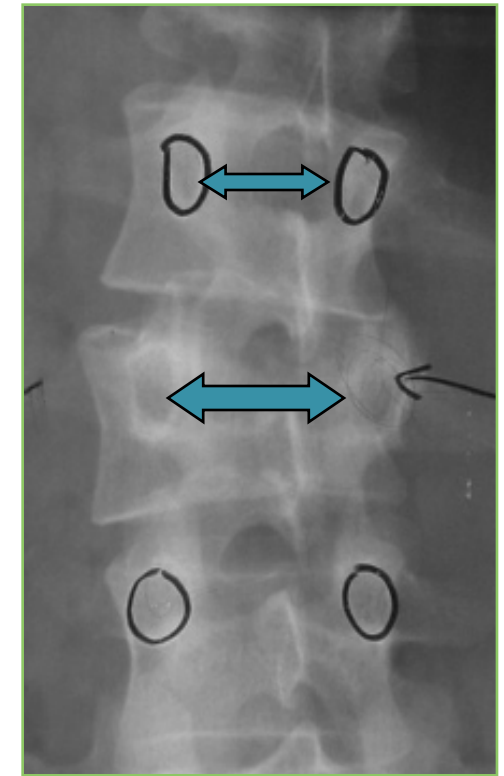
# Radiological evidence - Instability



**Lateral wedging**

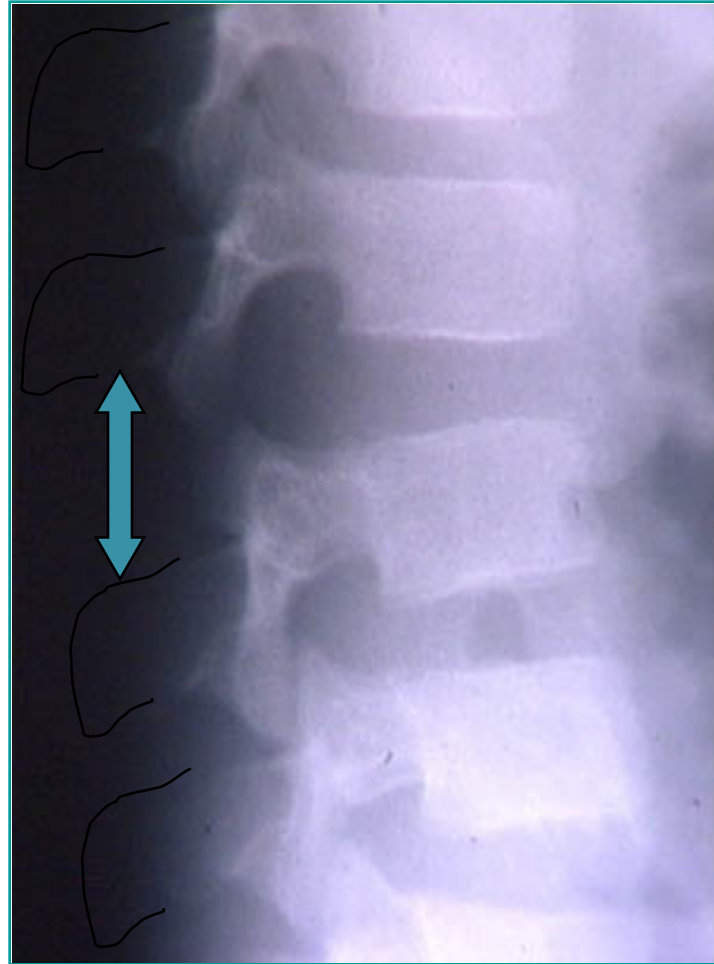


**Translation**



**Pedicle fracture/Widened interpedicular distance**

# Radiological evidence - Instability



**Widened Interspinous distance**

# Physical examination

## Neurological

- Neurologic examination is performed concurrently with resuscitation and hemodynamic stabilization of the patient
- motor and sensory examination

# STANDARD NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY

## MOTOR

### KEY MUSCLES

	R	L
C2		
C3		
C4		
C5		
C6		
C7		
C8		
T1		
T2		
T3		
T4		
T5		
T6		
T7		
T8		
T9		
T10		
T11		
T12		
L1		
L2		
L3		
L4		
L5		
S1		
S2		
S3		
S4-5		

- Elbow flexors
- Wrist extensors
- Elbow extensors
- Finger flexors (distal phalanx of middle finger)
- Finger abductors (little finger)

- 0 = total paralysis
- 1 = palpable or visible contraction
- 2 = active movement, gravity eliminated
- 3 = active movement, against gravity
- 4 = active movement, against some resistance
- 5 = active movement, against full resistance
- NT = not testable

- Hip flexors
- Knee extensors
- Ankle dorsiflexors
- Long toe extensors
- Ankle plantar flexors

Voluntary anal contraction (Yes/No)

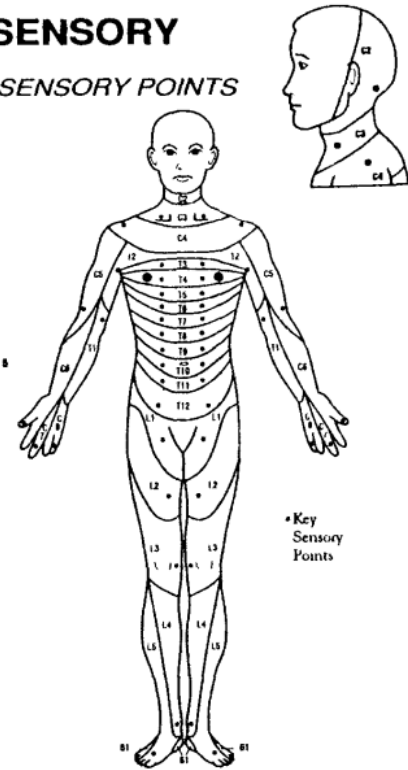
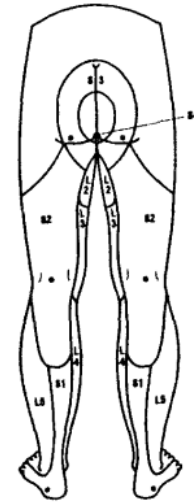
TOTALS  +  =  **MOTOR SCORE**  
(MAXIMUM) (50) (50) (100)

## SENSORY

### KEY SENSORY POINTS

	R	L
C2		
C3		
C4		
C5		
C6		
C7		
C8		
T1		
T2		
T3		
T4		
T5		
T6		
T7		
T8		
T9		
T10		
T11		
T12		
L1		
L2		
L3		
L4		
L5		
S1		
S2		
S3		
S4-5		

- 0 = absent
- 1 = impaired
- 2 = normal
- NT = not testable



Key Sensory Points

TOTALS  +  =  **PIN PRICK SCORE** (max. 112)  
(MAXIMUM) (56) (56) (56) (56)

TOTALS  +  =  **LIGHT TOUCH SCORE** (max. 112)

## SCALE

or sensory in the 5.  
but not served  
l level and  
ents S4-S5.  
unction is  
eurological  
half of key  
urological  
rade less

unction is  
eurological  
of key  
urological  
rade of 3

ensory

## MEMES

## NEUROLOGICAL LEVEL

The most caudal segment with normal function

	R	L
SENSORY	<input type="checkbox"/>	<input type="checkbox"/>
MOTOR	<input type="checkbox"/>	<input type="checkbox"/>

## COMPLETE OR INCOMPLETE?

Incomplete = presence of any sensory or motor function in lowest sacral segment

## ZONE OF PARTIAL PRESERVATION

Partially innervated segments

	R	L
SENSORY	<input type="checkbox"/>	<input type="checkbox"/>
MOTOR	<input type="checkbox"/>	<input type="checkbox"/>

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Version 4d  
GHC 1992

# Complete and incomplete injuries

Complete neurologic injuries- about 20%,

Incomplete neurologic injuries- about 15%

- A complete neurologic injury - total lack of sensory and motor function below the level of injury once spinal shock has resolved
- Incomplete injuries - partial preservation of sensory or motor function in the lowest sacral segment
- Sacral sensation - sensation at the anal mucocutaneous junction and deep anal sensation. Sacral motor function is voluntary anal sphincter contraction on digital examination

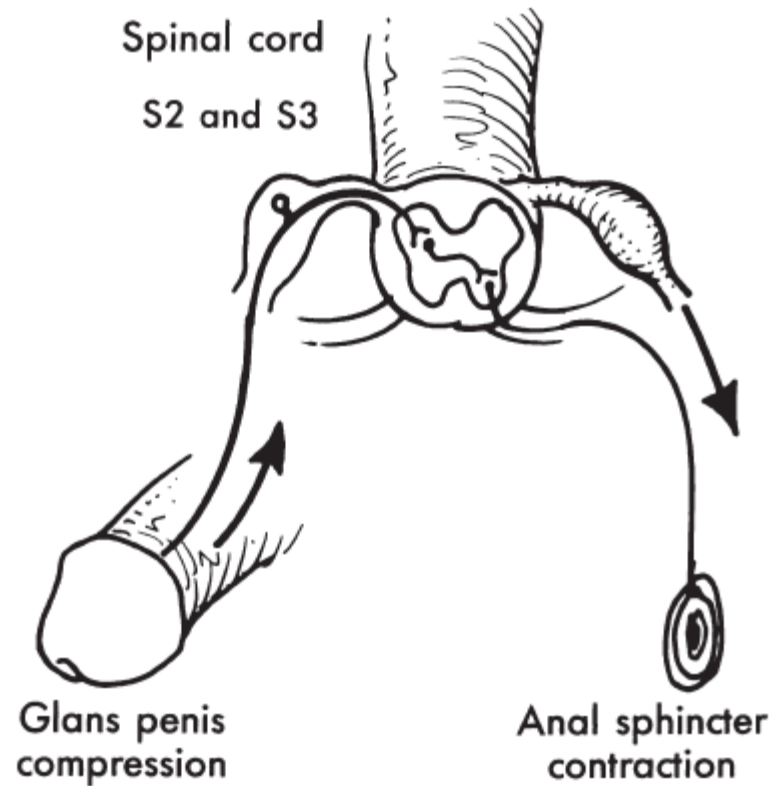


# Spinal shock

- Absent spinal function caudal to spinal cord injury
- Due to immediate depolarization of the axonal membranes from kinetic energy of the injury .
- Disrupts all cord function distal to injury, including reflexes
- Spinal shock usually resolve within 24 -48hours of injury



# Bulbo cavernosus reflex



# Brace mobilisation

- TLSO Brace
- Serial X-rays at 1,3,6,12 weeks
- Back strengthening exercises once pain is relieved
- The typical brace duration is approximately 3 months
- Brace weaning is initiated once there is clinical and radiographic evidence of fracture healing
- Once the brace is discontinued, flexion and extension radiographs are obtained to rule out instability



# Indications of surgery

- Neurological instability
- Type B & C unstable fractures
- Type A injury with neurological deficit
- Loss of height >50%
- Kyphosis >30°
- Canal narrowing > 50%

# Indications of surgery

## Neurologic instability

- Incomplete spinal cord injury, cauda equina syndrome-urgent surgery

Early decompression- improve circulation / oxygenation and recovery of somatosensory evoked potentials-hence promote neurological recovery

- In complete neurological deficits(ASIA A) – surgery aimed for early rehabilitation

# Indications of surgery

## Canal compromise

- Canal compromise from retropulsed bone fragments- not an absolute indication for surgical decompression.
- Remodeling and reconstitution of the spinal canal occurs within the first 12 months after injury.
- Late spinal stenosis has not been shown to be a problem provided there is maintenance of spinal alignment
- Accepted indication for surgery is canal compromise >50% or associated with neural deficit

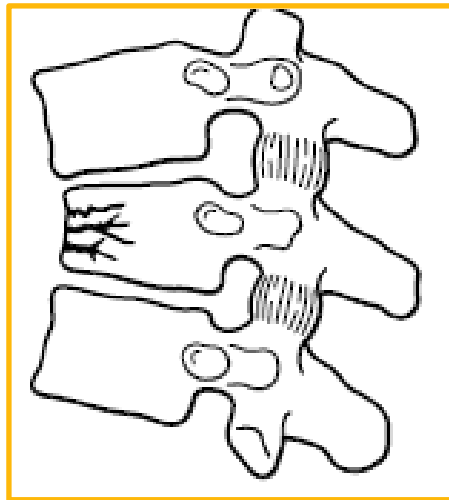
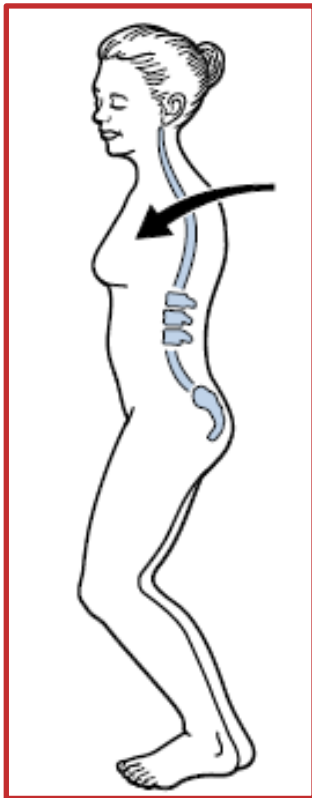
# Surgical principles

- Maintain anatomic reduction
- Minimize construct length while providing sufficient stability
- Neural element decompression
- Avoid complications

# Surgical principles

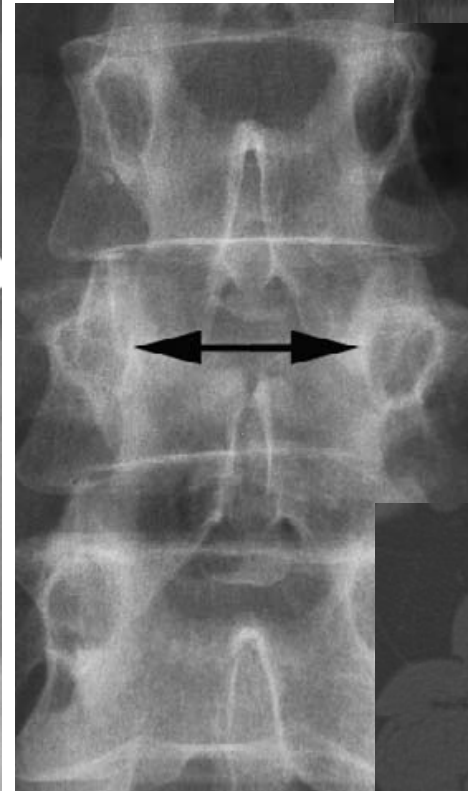
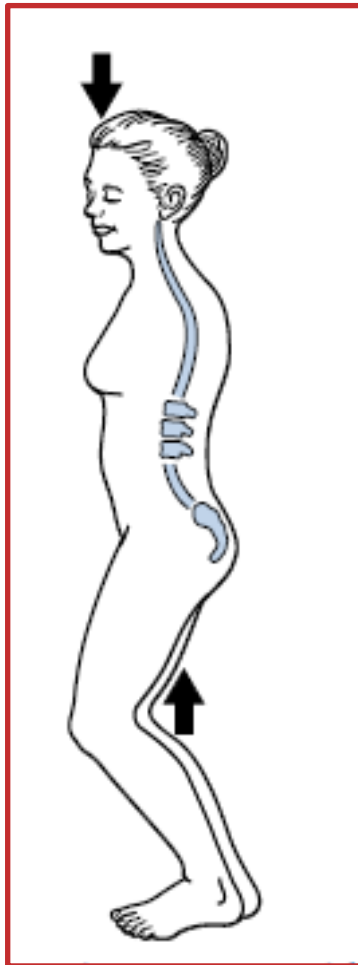
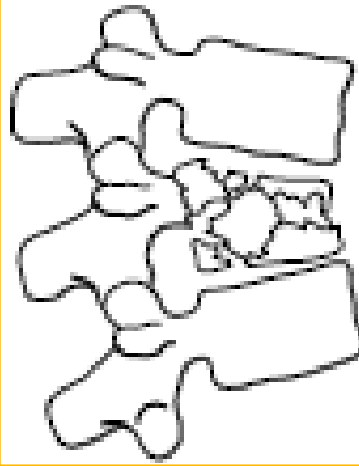
- Maintain anatomic reduction
- Minimize construct length while providing sufficient stability
- Neural element decompression
- Avoid complications

# Compression fracture





# Burst fracture



# Unstable Burst

