



Spinal Cord Injuries

2nd Orthopaedics and Traumatology
Dept.

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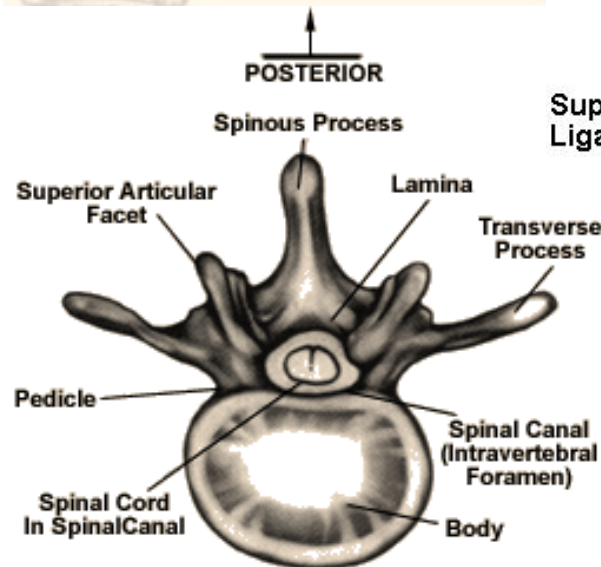
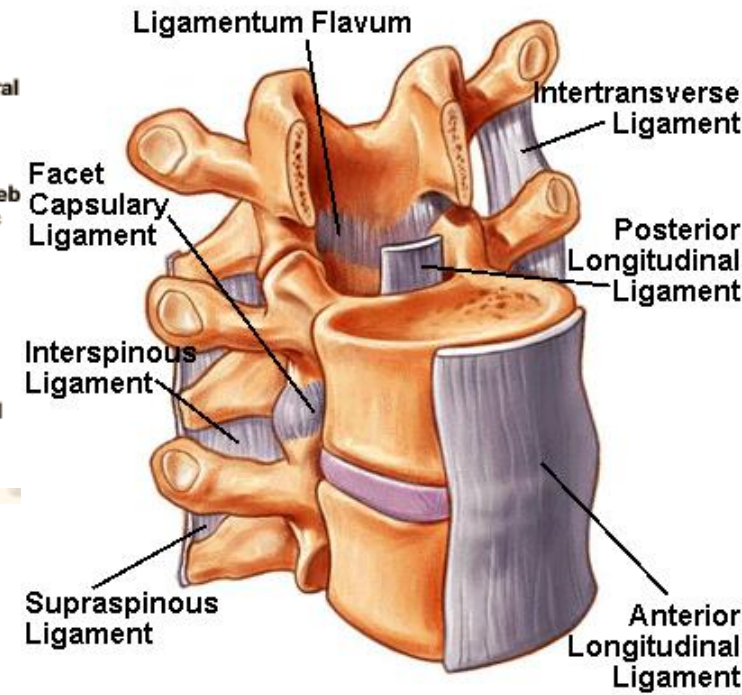
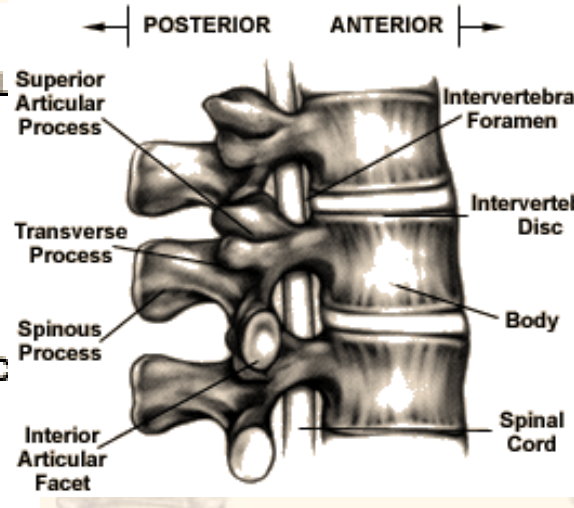
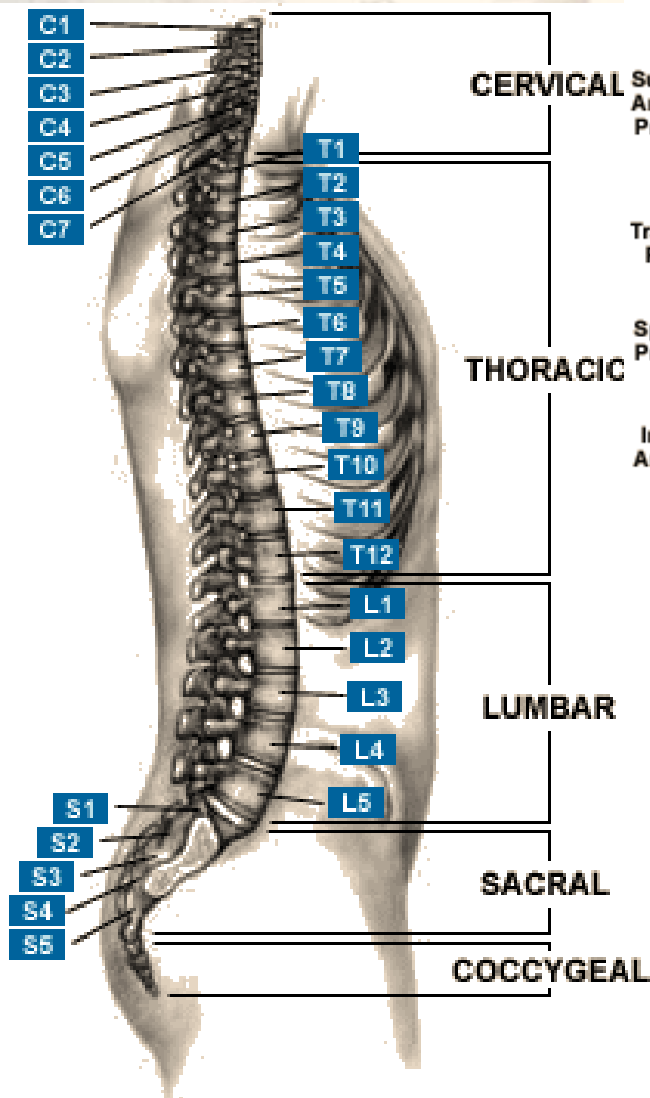
Spinal column fractures

The background of the slide features a detailed anatomical illustration of the human spine. A central column of vertebrae is shown, with several individual vertebrae and intervertebral discs depicted around it, some in cross-section and others in side view. The illustration is rendered in a light, sketchy style with some shading to indicate depth and structure.

Incidence:

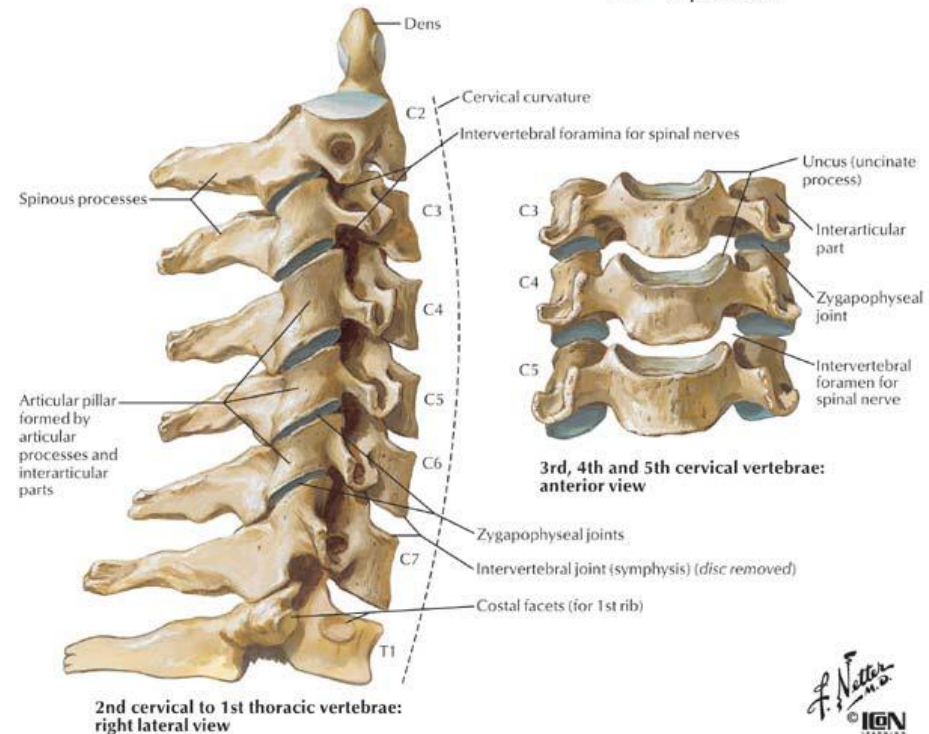
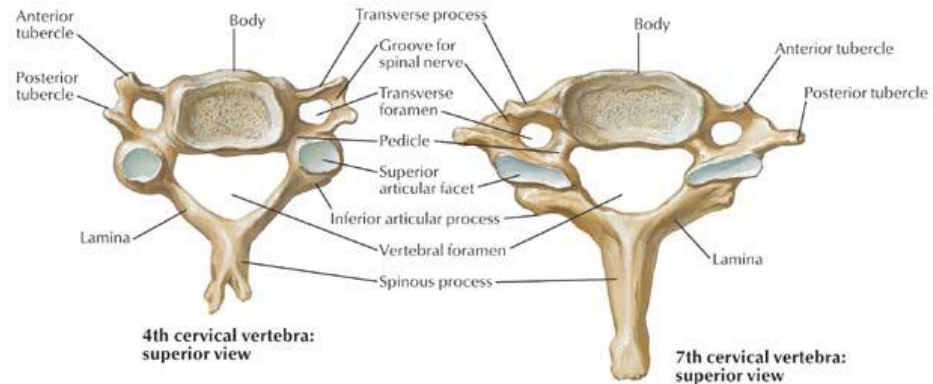
- Neurological deficit may occur in 10–25% of patients with spinal trauma
- The common causes of spinal trauma include
 - Road traffic accidents
 - Falls
 - Sports
- The male to female ratio is 4:1.
- The overall survival rate for patients with spinal injuries is 86% at 10 years
- Incidence of non-contiguous, multilevel vertebral injuries is approximately 20%

Anatomy of spinal column

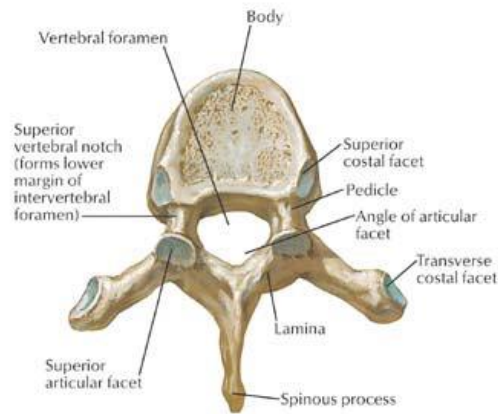


Cervical vertebrae

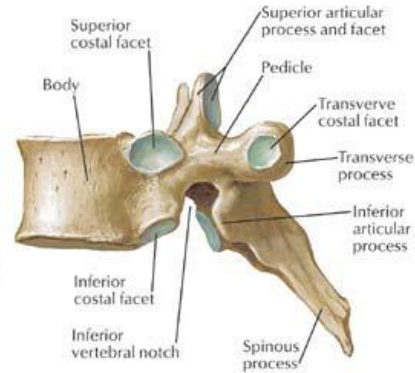
- Small vertebral bodies
- Large surfaces of facet joints
- Physiologic lordosis



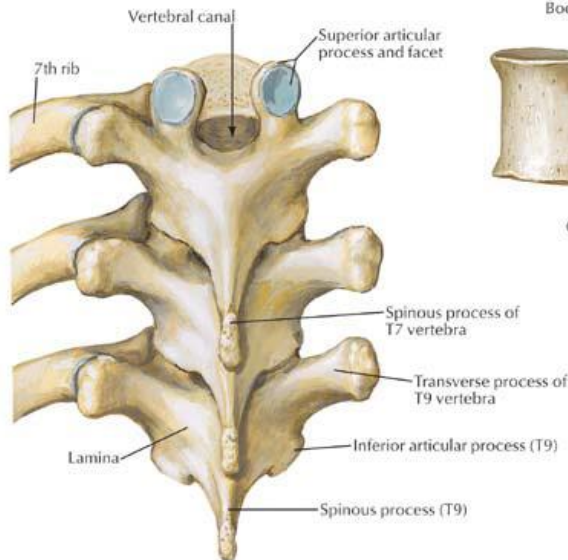
Thoracic vertebrae



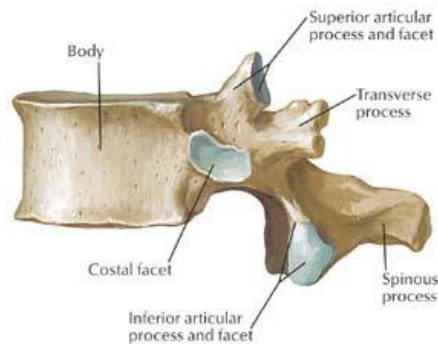
**T6 vertebra:
superior view**



**T6 vertebra:
lateral view**



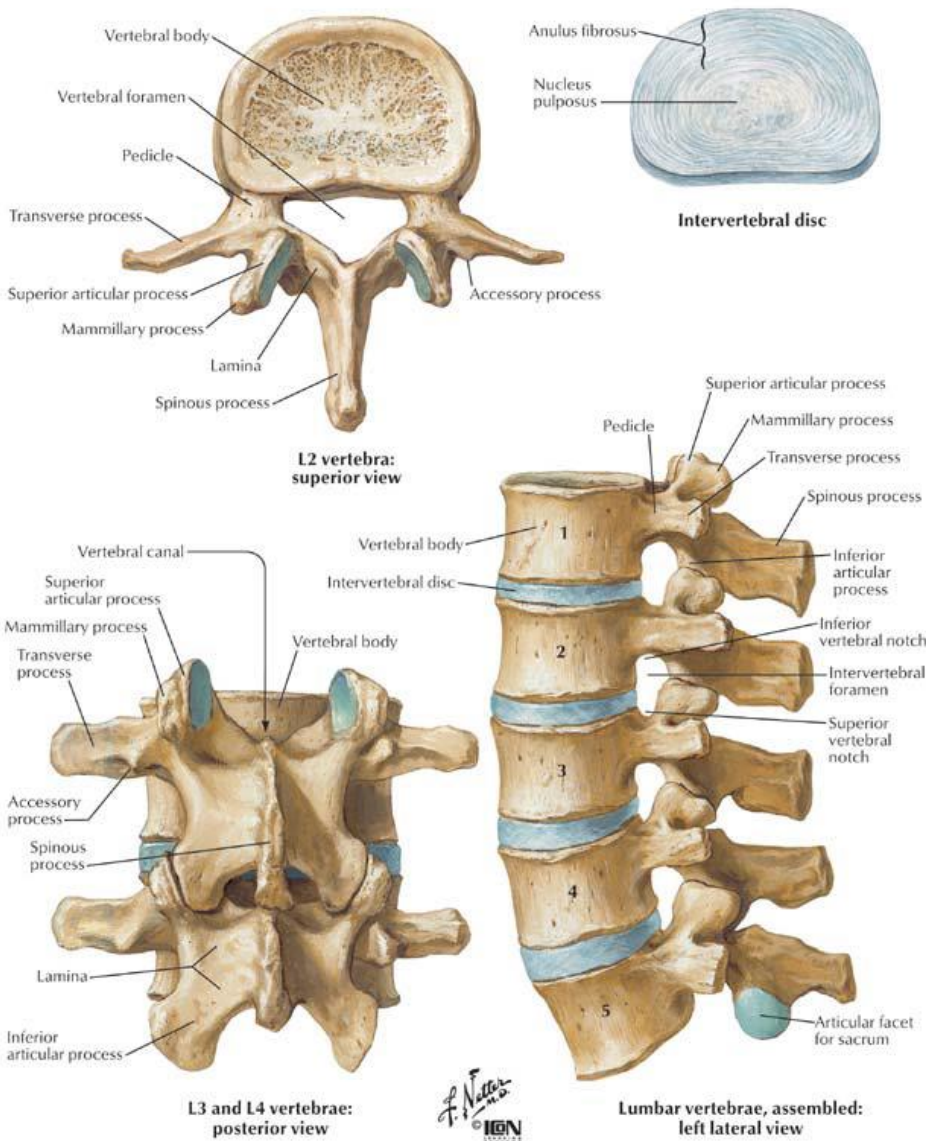
**T7, T8 and T9 vertebrae:
posterior view**



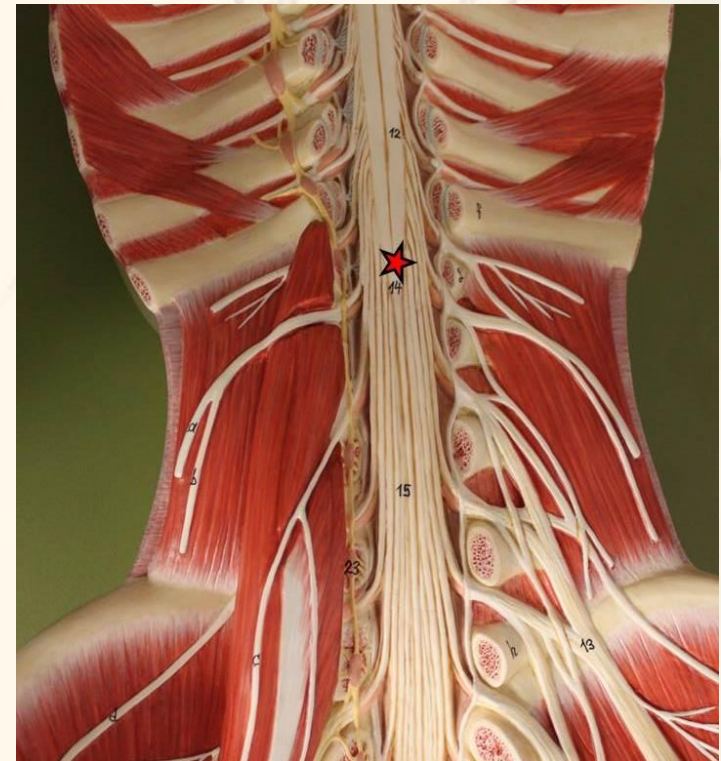
**T12 vertebra:
lateral view**

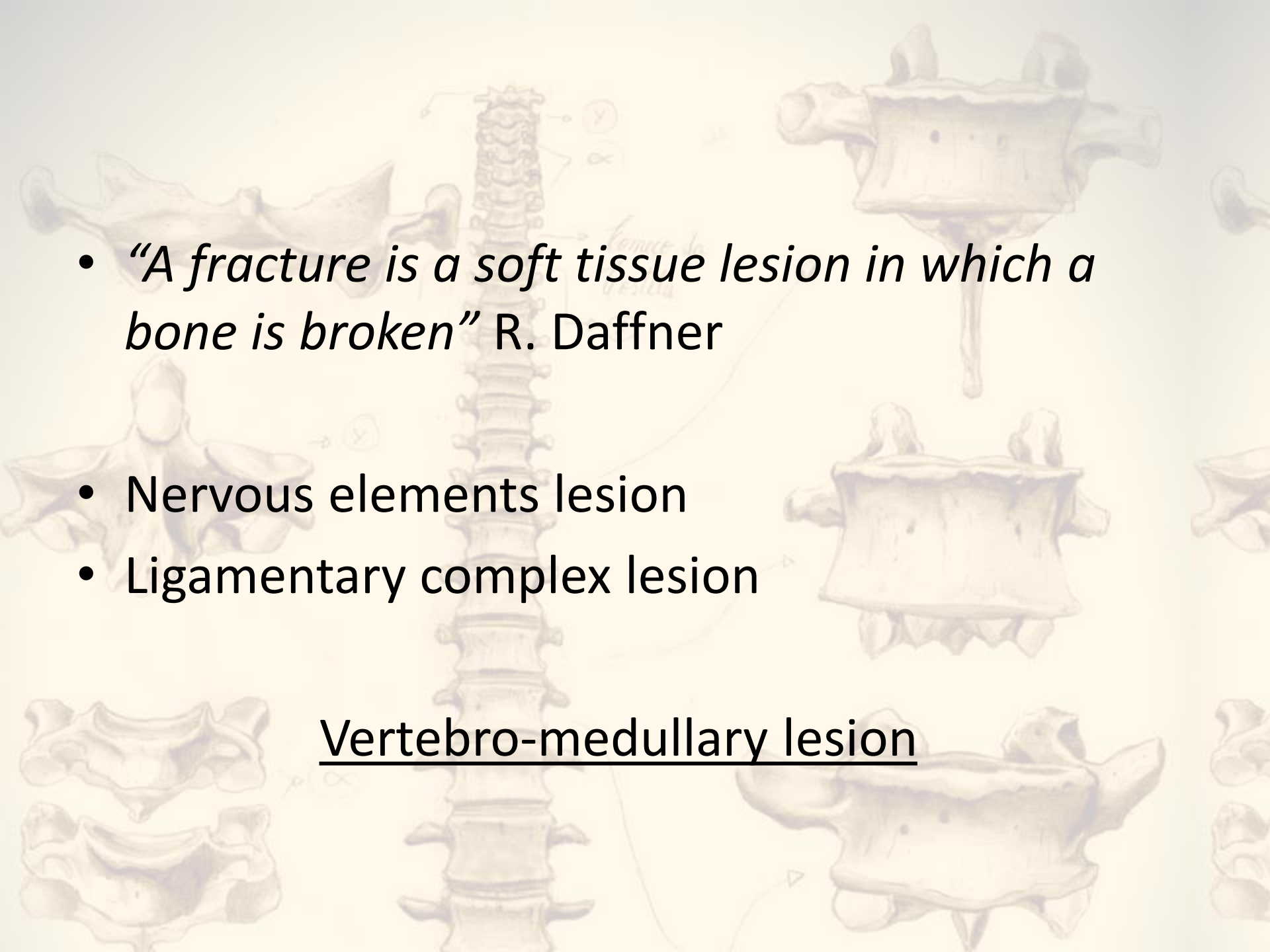
- Limited movement
- Supplementary articulation with ribs
- Small vertebral canal
- Physiologic kyphosis

Lumbar vertebrae



- Vertebral bodies that can withstand heavy weights
- Physiologic lordosis
- L1 (L2) conus medullaris



- 
- *“A fracture is a soft tissue lesion in which a bone is broken”* R. Daffner
 - Nervous elements lesion
 - Ligamentary complex lesion

Vertebro-medullary lesion

Types of lesional mechanisms

Traumatic force → lesion model

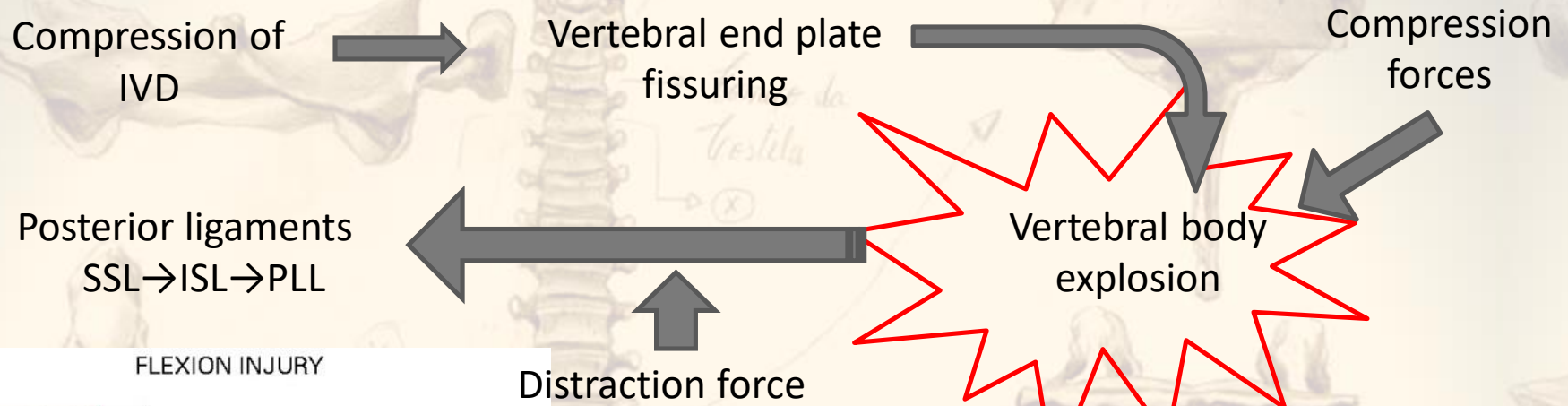
light soft tissue lesions

Important disco-ligamentary lesions

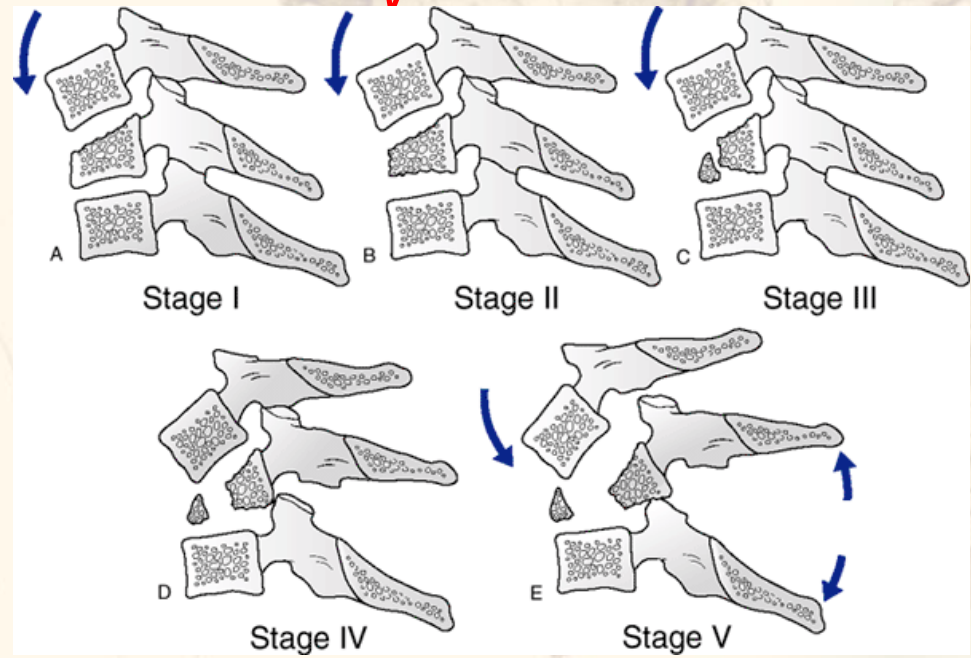
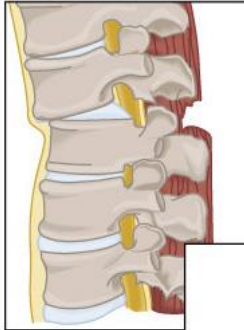
Spinal column fractures: -myelic
-amyelic

- Basic mechanisms:
 - flexion
 - hyperextension
 - rotation (torsion)
 - shearing

Flexion lesions



FLEXION INJURY

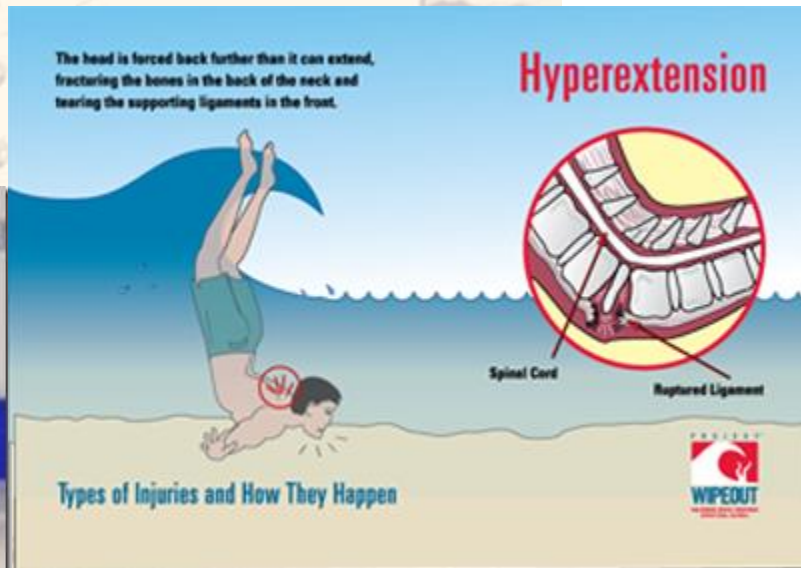
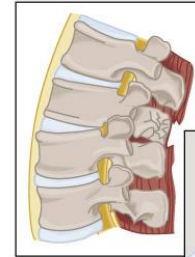


Extension lesions

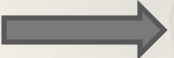
More frequent in cervical area

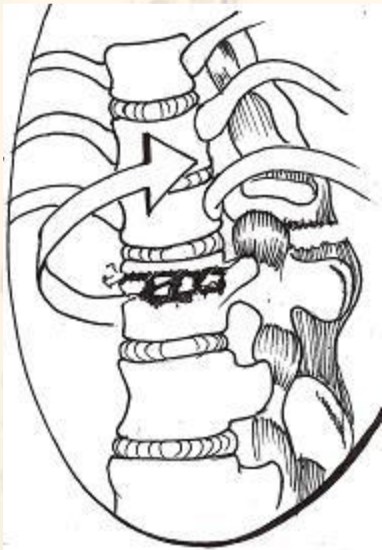
Falling with the back on an object

!!Increased discal space!!



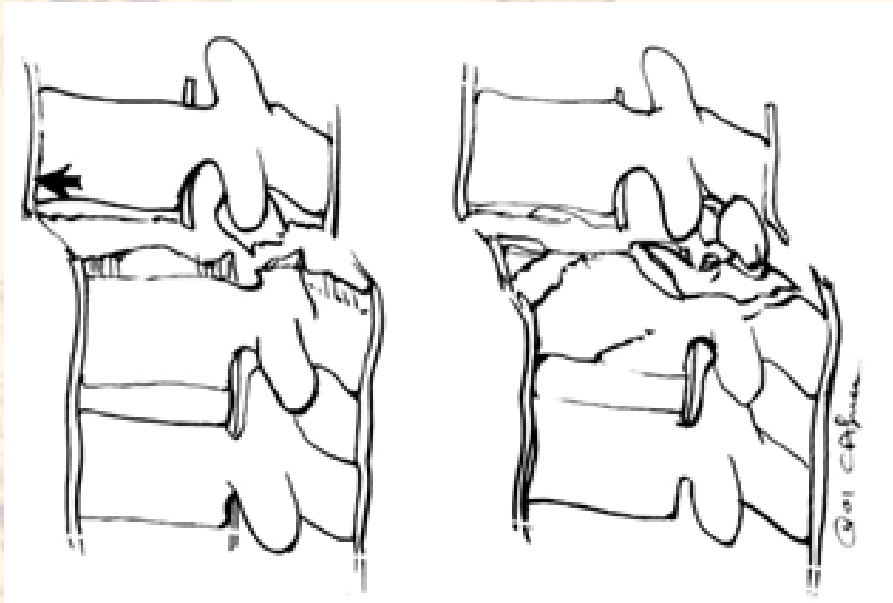
Rotation lesions

- The junctions from rigid segments to more flexible ones 
Cranio-vertebral and thoraco-lumbar junction
- Usually at thoraco-lumbar junction a compression or flexion component is associated
- Can lead to pulverization of the vertebral body - “*rotary grinding mechanism*” R. Daffner
- Can be mistaken with burst fractures



Shearing lesions

- Horizontally directed forces, without flexion
- Can be combined with the rest of the mechanisms
- Lead to severe neurological injuries
- Very great forces that can lead to distractions
- “Windblown” vertebral column



Classification

Controversies

Watson-Jones '38: 7 types

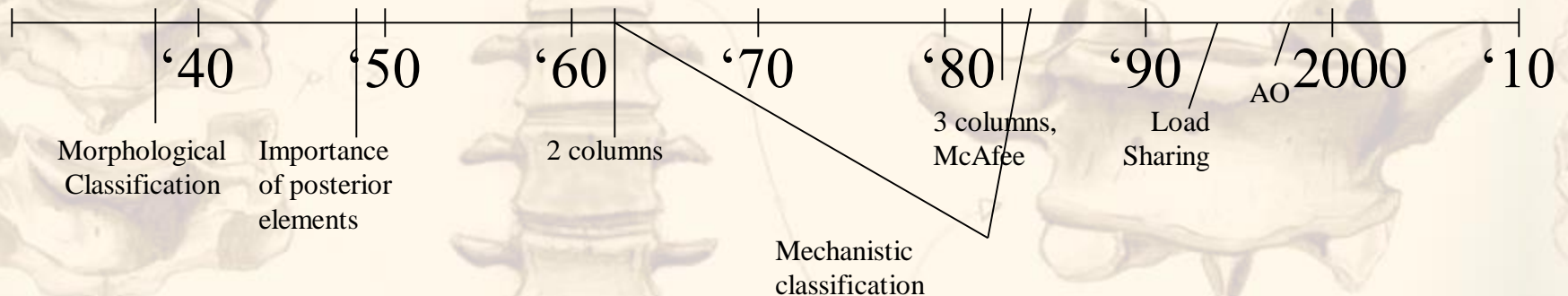
Nicoll '49: 4 types

Holldsworth '62: Theory of 2 columns

Denis '83: **3 columns theory**

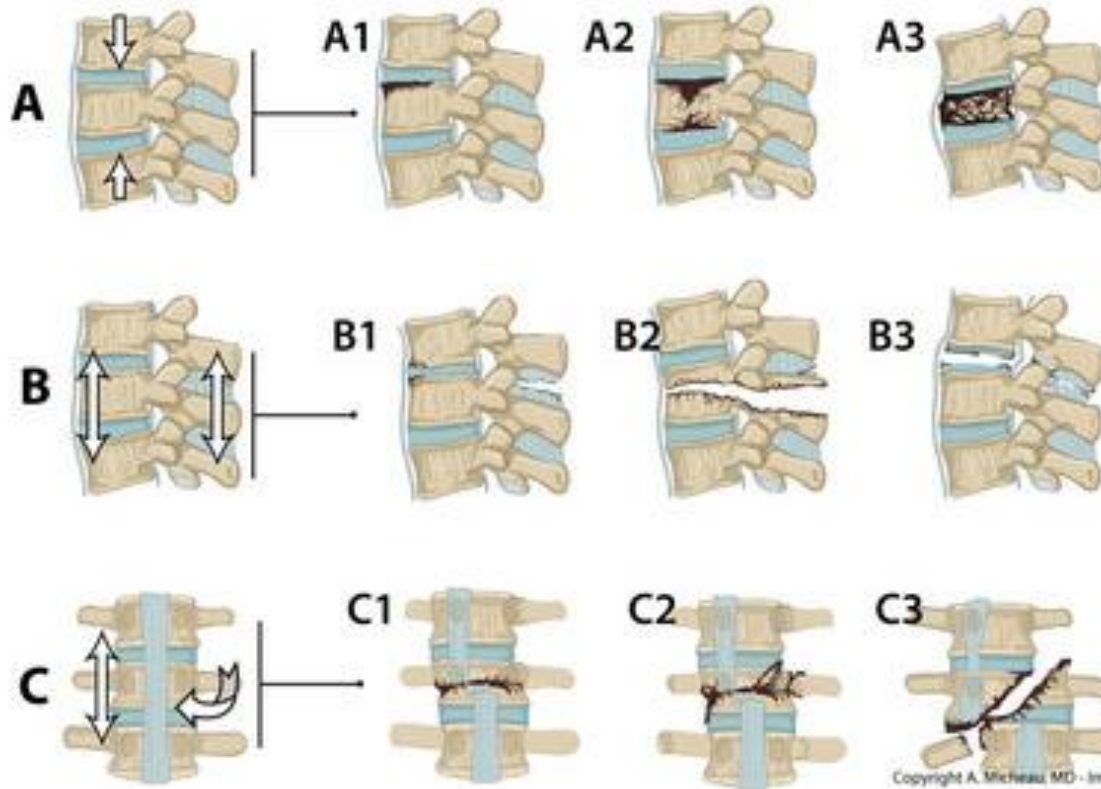
McCormack '94: load sharing *little/more/gross*

AO/Magerl & Denis '94: **vector of forces**



AO/Magerl & Denis

Types	Groups	Subgroups	Specifications
A compression	A1 impaction	A1.1	A1.2.1, A1.2.2, A1.2.3
		A1.3	
		A1.3	
		A2.1	
	A2 split	A2.2	A3.1.1, A3.1.2, A3.1.3 A3.2.1, A3.2.2, A3.2.3 A3.3.1, A3.3.2, A3.3.3
		A2.3	
		A3.1	
		A3.2	
		A3.3	
B distraction	B1 post ligamentous	B1.1	B1.1.1, B1.1.2, B1.1.3 B1.2.1, B1.2.2, B1.2.3
		B1.2	
	B2 post osseous	B2.1	B2.2.1, B2.2.2 B2.3.1, B2.3.2 B3.1.1, B3.1.2
		B2.2	
		B2.3	
	B3 anterior	B3.1	
		B3.2	
		B3.3	
	C1 A with rotation	C1.1	C1.2.1, C1.2.2, C1.2.3, C1.2.4 C2.1.1, C2.1.2, C2.1.3, C2.1.4 C2.2.1, C2.2.2, C2.2.3 C2.3.1, C2.3.2, C2.3.3
		C1.2	
B rotation	C2 B with rotation	C2.1	
		C2.2	
		C2.3	
	C3 shear	C3.1	
		C3.2	



Spine Trauma Study Group Thoracolumbar Injury Classification and Severity Scale (TLICS)

Three descriptive components:

- Injury morphology : compression, distraction, rotation
- Integrity of posterior ligamentary complex : torn, tensioned
- Neurological Status : Intact, radicular injury, cauda equina injury, medullary injury complete-incomplete

Diagnostic

An anatomical illustration of the human spine, showing a central column of vertebrae with several individual vertebrae shown in detail to the left and right. A handwritten label 'Cone de Vestibulo' with an arrow points to a specific vertebra in the central column. Another arrow points from a vertebra on the right towards the central column. The background is a light, textured grey.

Obtain history from
Patient

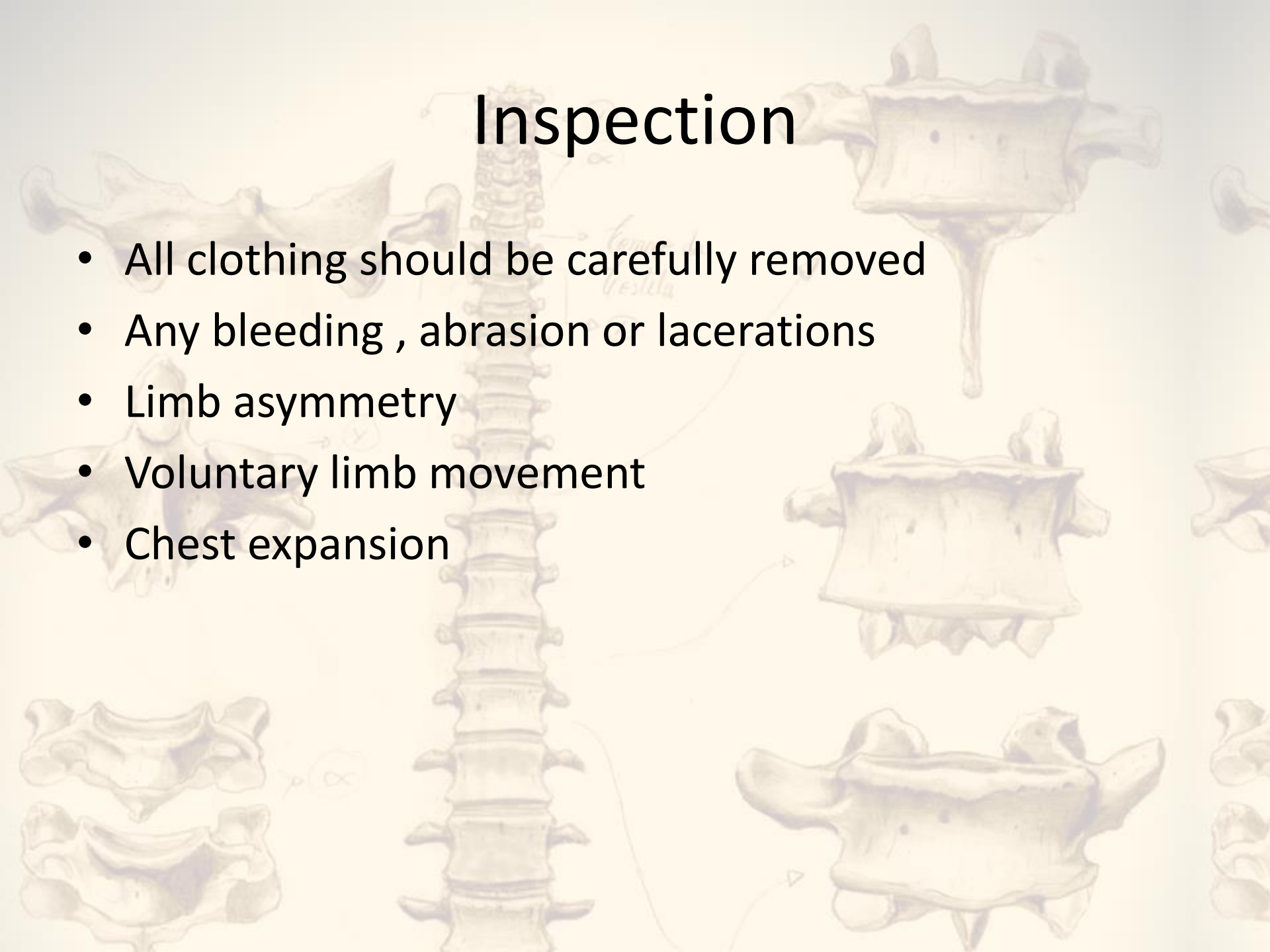
Family members

Paramedical personnel

- Mechanism of injury
- Position of the patient when found
- Transient motor or sensory loss
- Paradoxical breathing
- Seat belt

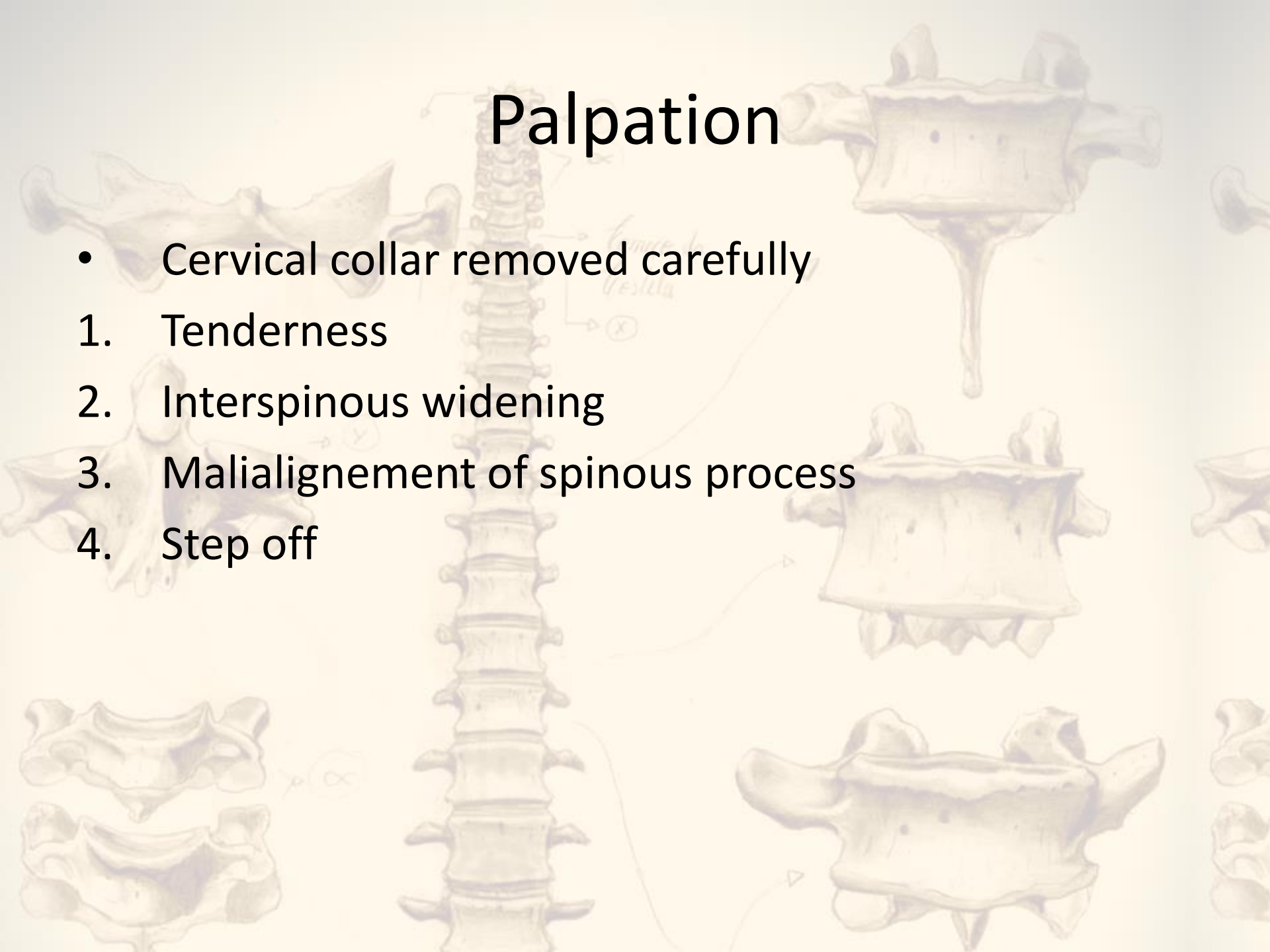
Inspection

- All clothing should be carefully removed
- Any bleeding , abrasion or lacerations
- Limb asymmetry
- Voluntary limb movement
- Chest expansion



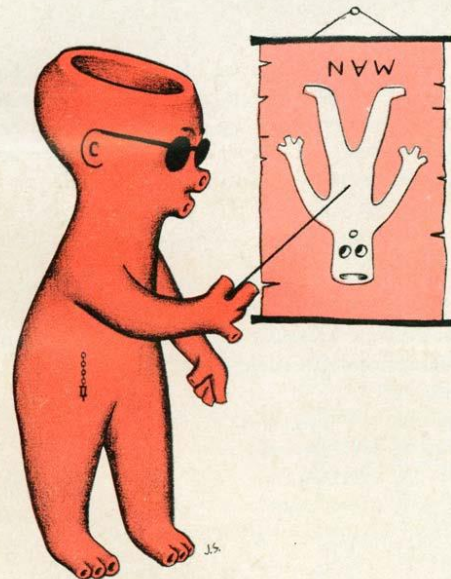
Palpation

- Cervical collar removed carefully
 1. Tenderness
 2. Interspinous widening
 3. Malalignment of spinous process
 4. Step off



Neurological examination

- Utilizing ASIA scale
- Sensitivity
- Motor Function
- Reflexes



"The trouble with doctors is not that they don't know enough, but that they don't see enough."

SIR DOMINIC J. CORRIGAN, 1853

Patient Name _____

Examiner Name _____ Date/Time of Exam _____



STANDARD NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY



MOTOR

KEY MUSCLES
(scoring on reverse side)

R L

- | | | | |
|----|--------------------------|--------------------------|--------------------------------------------------|
| C5 | <input type="checkbox"/> | <input type="checkbox"/> | Elbow flexors |
| C6 | <input type="checkbox"/> | <input type="checkbox"/> | Wrist extensors |
| C7 | <input type="checkbox"/> | <input type="checkbox"/> | Elbow extensors |
| C8 | <input type="checkbox"/> | <input type="checkbox"/> | Finger flexors (distal phalanx of middle finger) |
| T1 | <input type="checkbox"/> | <input type="checkbox"/> | Finger abductors (little finger) |

UPPER LIMB
TOTAL ☐ + ☐ = ☐
(MAXIMUM) (25) (25) (50)

Comments:

- | | | | |
|----|--------------------------|--------------------------|-----------------------|
| L2 | <input type="checkbox"/> | <input type="checkbox"/> | Hip flexors |
| L3 | <input type="checkbox"/> | <input type="checkbox"/> | Knee extensors |
| L4 | <input type="checkbox"/> | <input type="checkbox"/> | Ankle dorsiflexors |
| L5 | <input type="checkbox"/> | <input type="checkbox"/> | Long toe extensors |
| S1 | <input type="checkbox"/> | <input type="checkbox"/> | Ankle plantar flexors |

Voluntary anal contraction
(Yes/No) ☐

LOWER LIMB
TOTAL ☐ + ☐ = ☐
(MAXIMUM) (25) (25) (50)

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

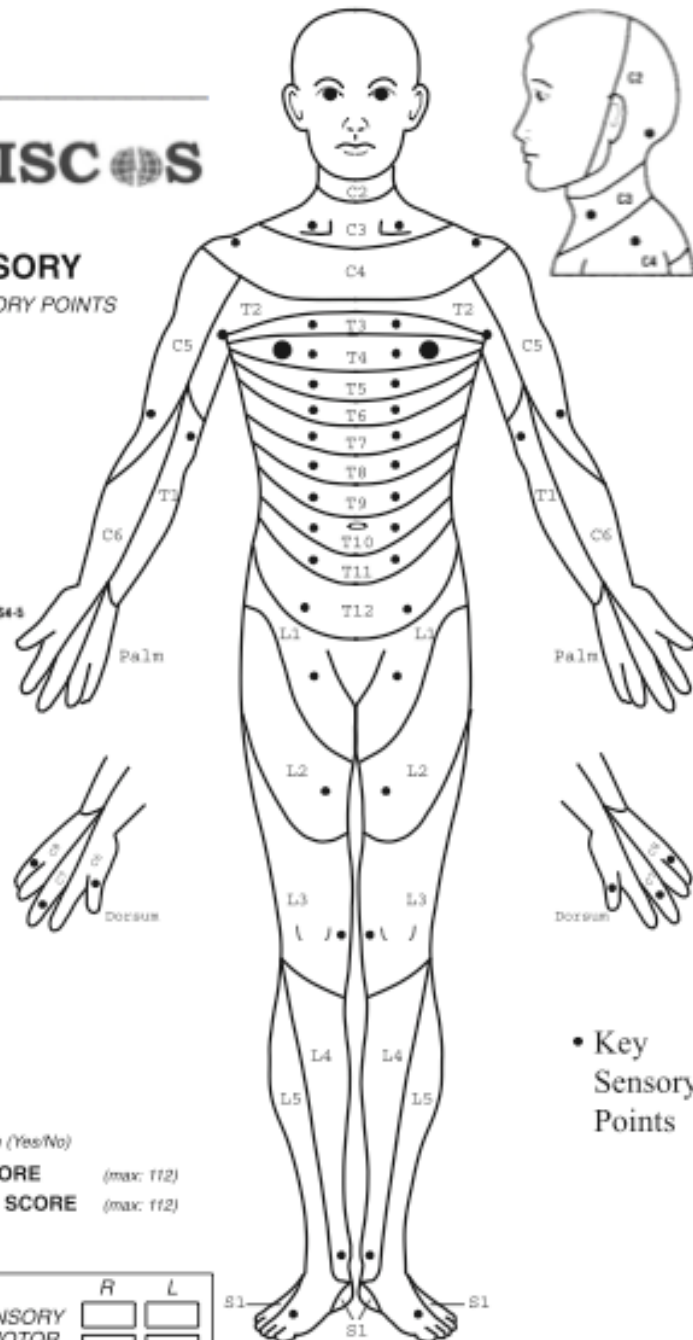
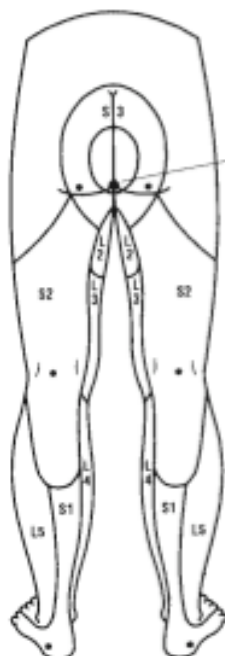
R L

TOTALS ☐ + ☐ = ☐
(MAXIMUM) (56) (56) (56) (56)

SENSORY

KEY SENSORY POINTS

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



• Key
Sensory
Points

NEUROLOGICAL
LEVEL

The most caudal segment
with normal function

SENSORY ☐ R ☐ L
MOTOR ☐ R ☐ L

COMPLETE OR INCOMPLETE?

Incomplete = Any sensory or motor function in S4-S5

ASIA IMPAIRMENT SCALE

ZONE OF PARTIAL
PRESERVATION

Caudal extent of partially
innervated segments

SENSORY ☐ R ☐ L
MOTOR ☐ R ☐ L

Sacral Sparing



1. Perianal/perineal sensation
2. Rectal tone
3. Big toe flexion
 - Implies partial structural continuity of white matter long tracts
 - May be only evidence of incomplete injury → higher chance of recovery
 - Essential to check and document

ASIA IMPAIRMENT SCALE

- A=Complete.** No sensory or motor function is preserved in the sacral segments S4-S5.
- B=Incomplete.** Sensory but not motor function is preserved below the neurological level and includes the sacral segments S4-S5.
- C=Incomplete.** Motor function is preserved below the neurological level, and more than half of key muscles below the neurological level have a muscle grade less than 3.
- D=Incomplete.** Motor function is preserved below the neurological level, and at least half of key muscles below the neurological level have a muscle grade greater than or equal to 3.
- E=Normal.** Sensory and motor function is normal.

Pathophysiology



- **Primary Neurological damage**

Direct trauma, hematoma & SCIWORA < 8yrs old

In 4hrs - Infarction of white matter occurs

In 8hrs - Infarction of grey matter and irreversible paralysis

- **Secondary damage**

Hypoxia

Hypoperfusion

Neurogenic shock

Spinal shock

Medullary injury

- Contusion
 - Similarly to brain concussion
 - Temporary loss of spinal cord functions
 - Can associate soft tissue injuries
- Compression
 - Secondary to:
 - vertebral column distraction
 - IVD herniation
 - movement if a bony piece in the spinal canal
 - tumefaction of adjacent soft tissue
- Laceration
 - Causes
 - Bony fragments pushed into the spinal canal
 - Tensioning until the rupture of the spinal cord
 - Intramedullary bleeding, edema and spinal impulses transmission loss
- Hemorrhage
 - Associated to contusions or tensioning of the spinal cord



Neurogenic shock

- Lesions above Th6
- Minutes – hours (fall of catecholamines may take 24 hrs)
- Disruption of sympathetic outflow from Th1 - L2
- Unopposed vagal tone
- Peripheral vasodilatation
- Hypotension, Bradycardia & Hypothermia
- BUT consider hemorrhagic shock if – injury below Th6, other major injuries, hypotension with spinal fracture alone without neurological injury.

Spinal shock

- Transient physiological reflex depression of cord function – **‘concussion of spinal cord’**
- Loss anal tone, reflexes, autonomic control within 24-72hr
- Flaccid paralysis bladder & bowel and sustained Priapism
- Lasts even days till reflex neural arcs below the level recovers.

Medullary injury

- Complete
 - Cervical region
 - Tetraplegia
 - Urinary incontinence
 - Respiratory muscles paralysis
 - Beneath T-1
 - Urinary incontinence
 - Paraplegia

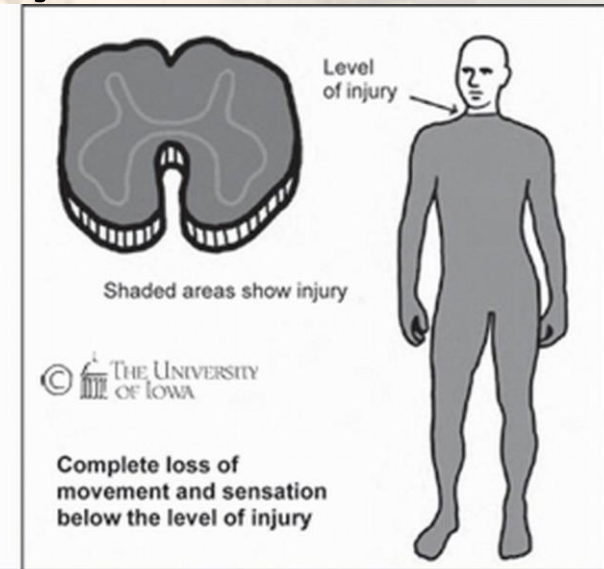


Figure 9. Complete Spinal Cord Injury

Medullary injury

- Incomplete
- Syndromes: anterior/posterior cord, Brown Sequard, cauda equina

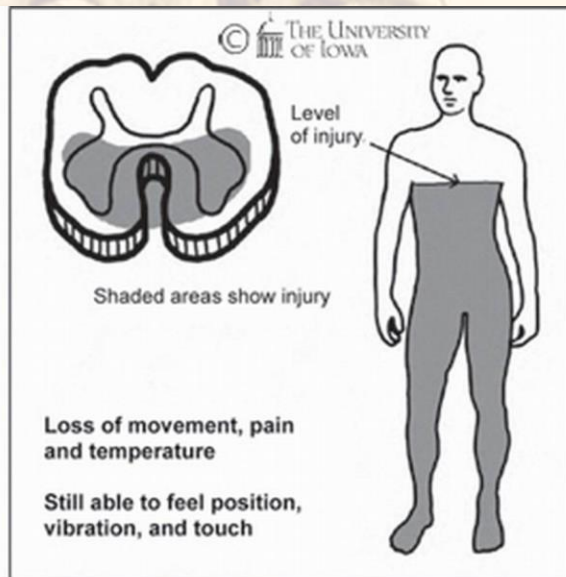


Figure 10. Anterior Cord Syndrome

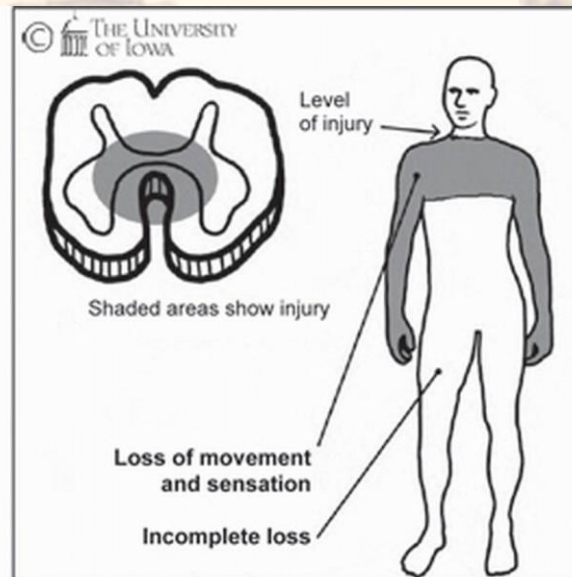


Figure 11. Central Cord Syndrome

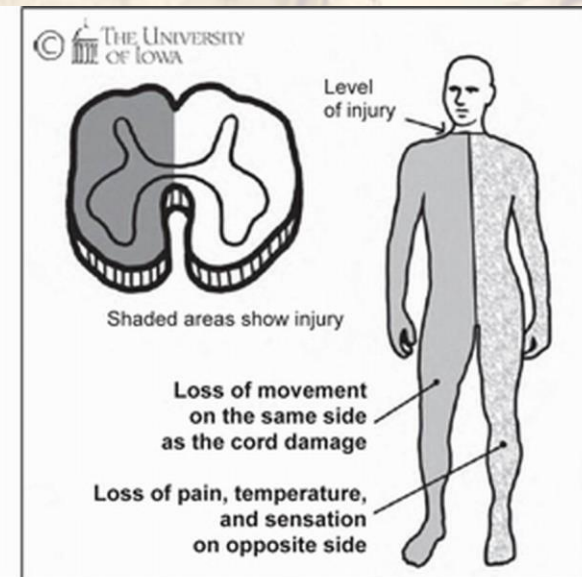


Figure 12. Brown-Séquard Syndrome

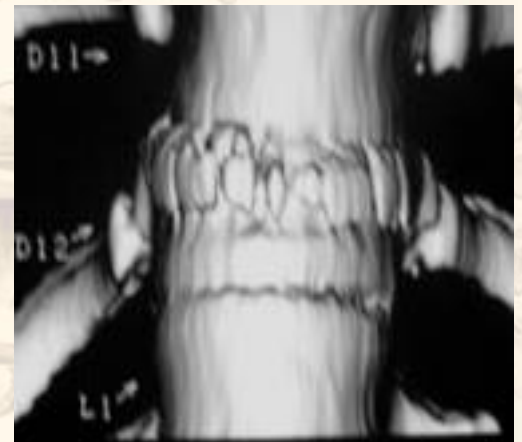
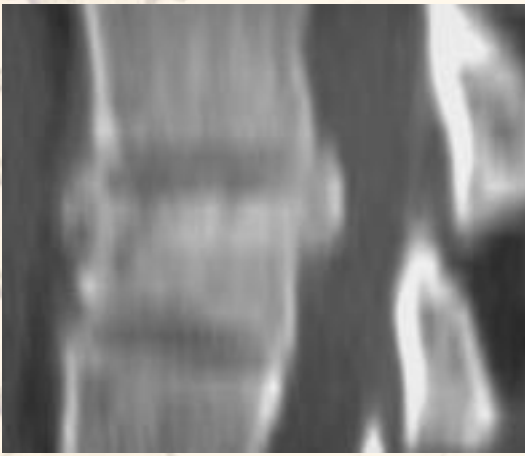
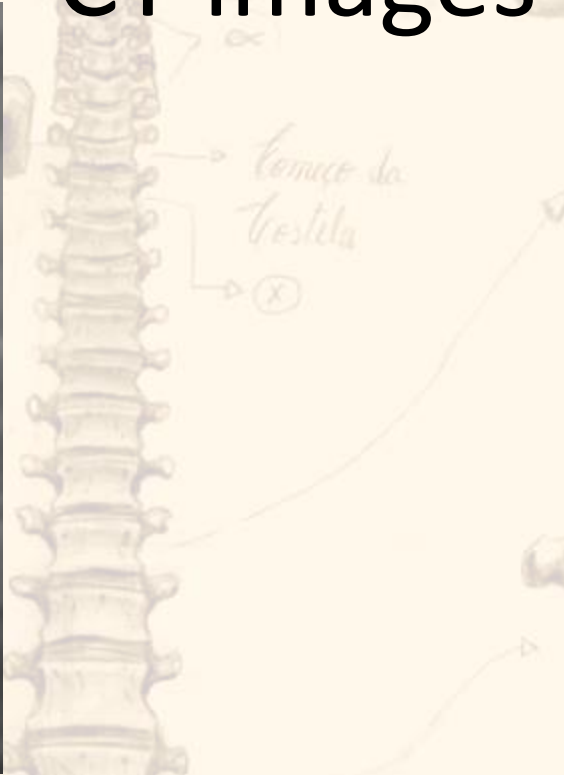
Diagnostic



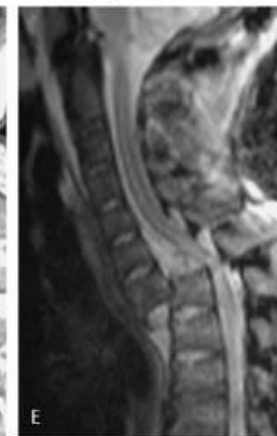
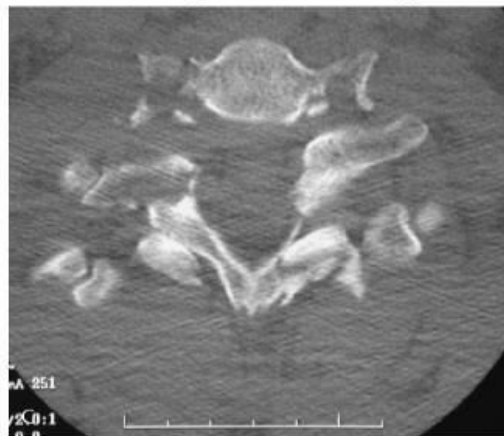
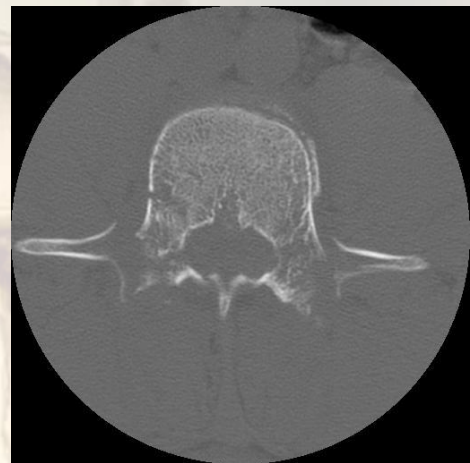
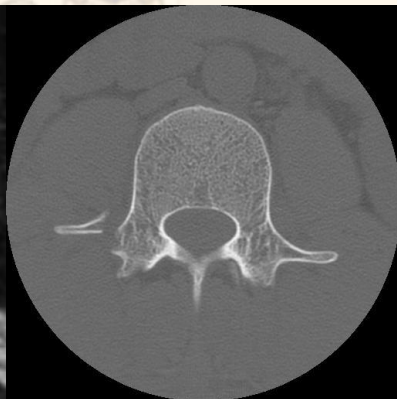
Golden standard for diagnosing vertebral column injuries is the CT scan, and this is a must do for every patient that is suspect of a vertebro-medullary injury.

- Injury suspected on plain films
- Better visualize fracture (specificity and sensitivity)
- Unable to adequately assess on plain films
- Fracture or soft tissue injury in the plane of the CT can be missed

CT images



CT Images



Plain X-ray

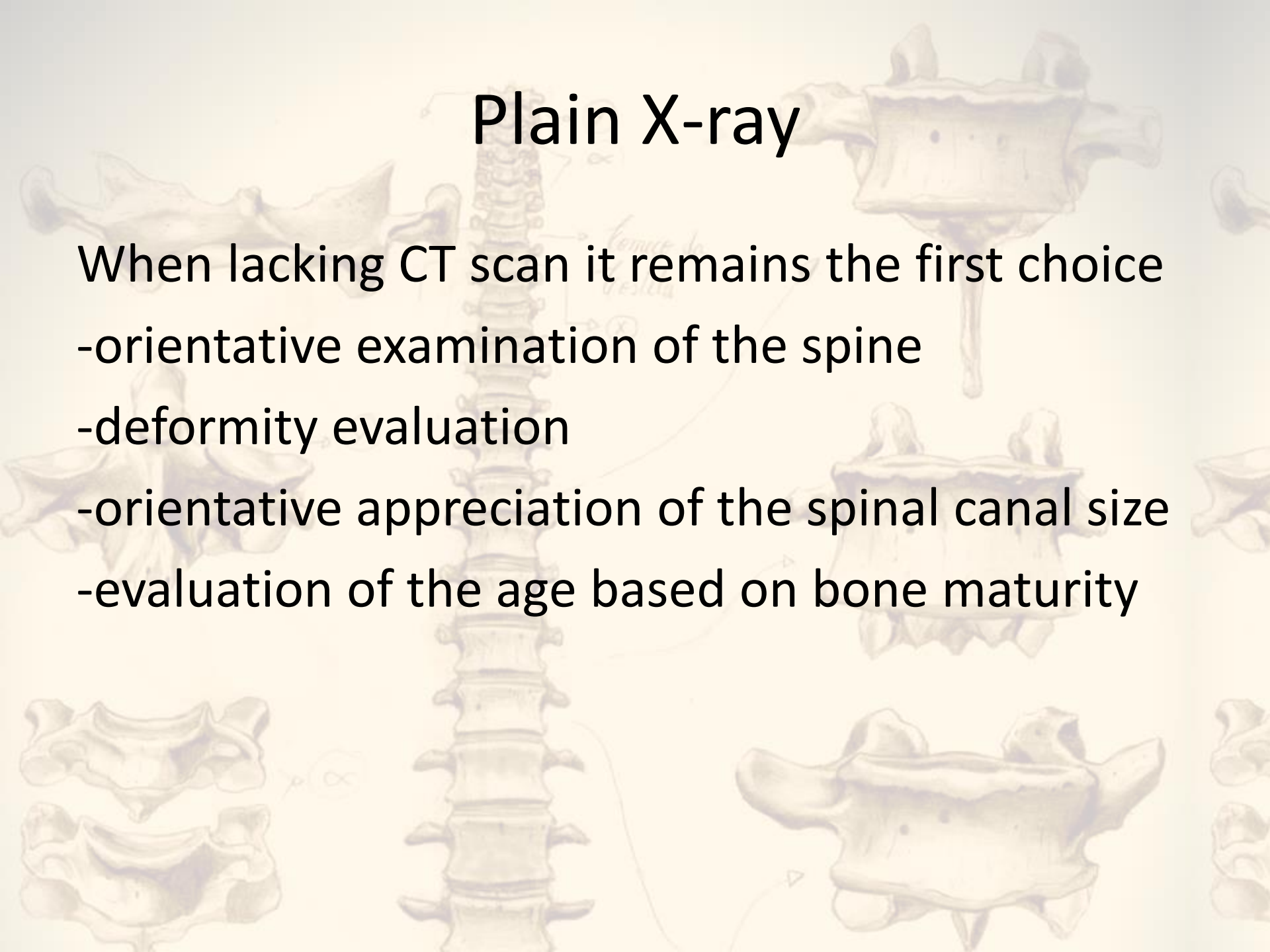
When lacking CT scan it remains the first choice

- orientative examination of the spine

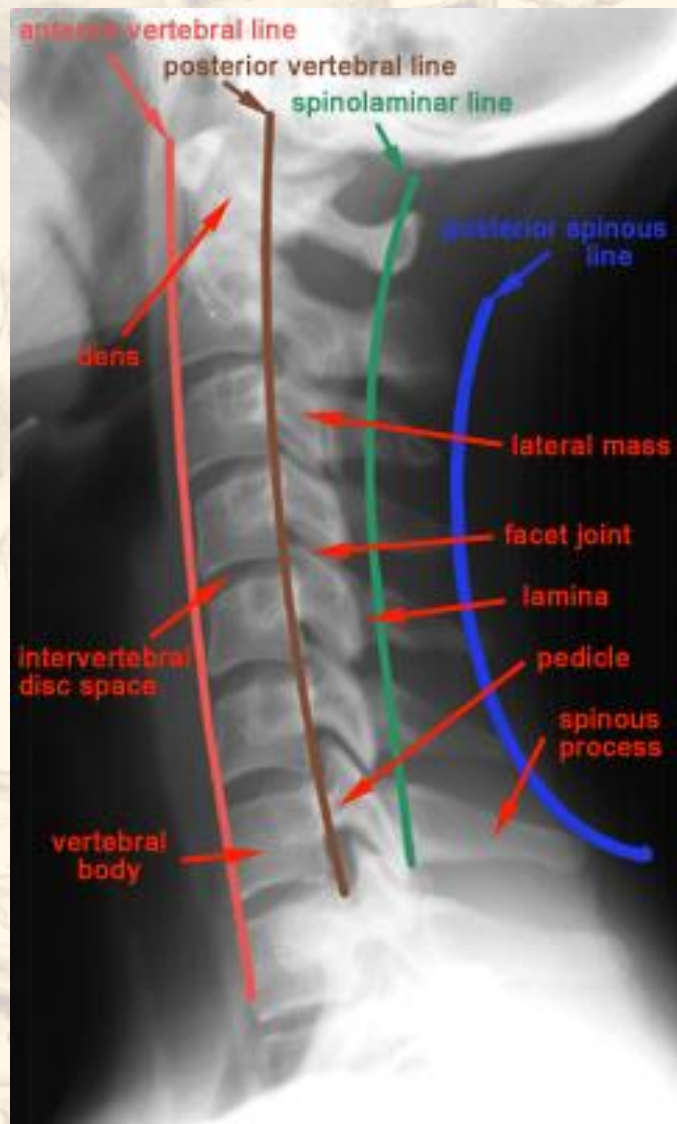
- deformity evaluation

- orientative appreciation of the spinal canal size

- evaluation of the age based on bone maturity



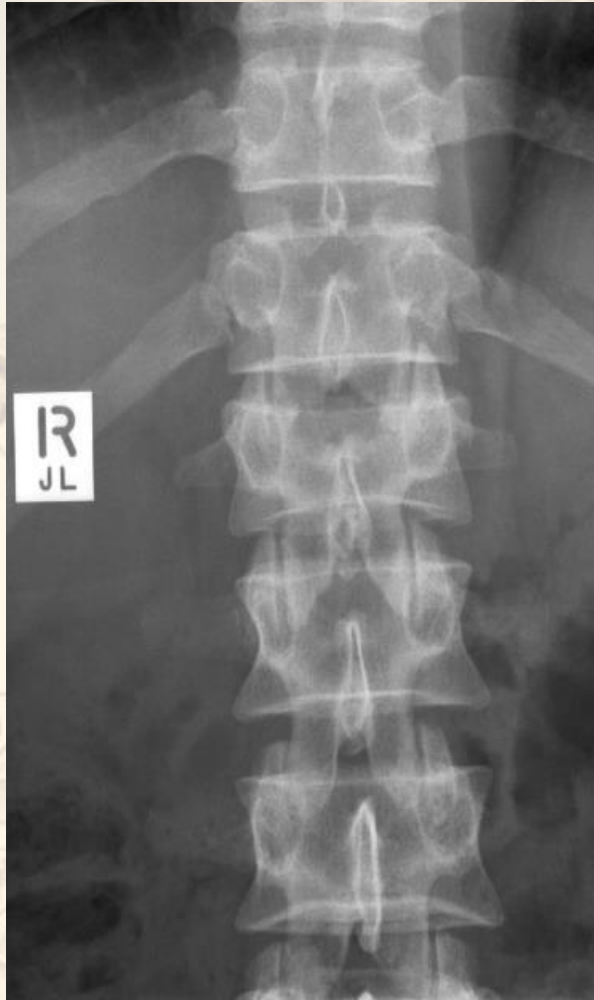
Cervical spine X-ray



Thoracic Spine X-ray



Lumbar spine X-ray



MRI

- Invaluable for assessing cord and soft tissues
- R/O associated disc herniation (facet dislocations)
- Hemorrhage vs edema in soft tissues ????
- Ligamentous tears and facet capsule disruptions visualized with fat suppression
- May allow prognostic assessment of final motor function
 - Intraspinal hematoma

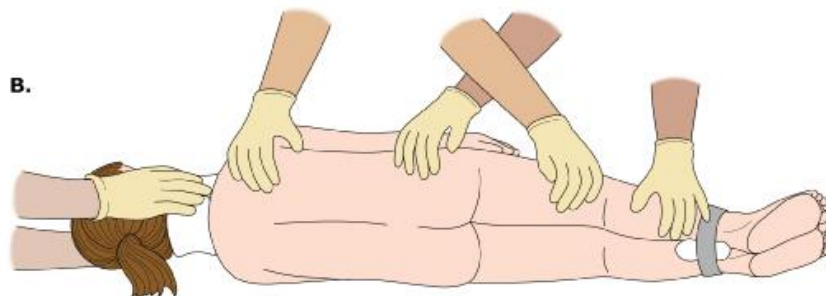
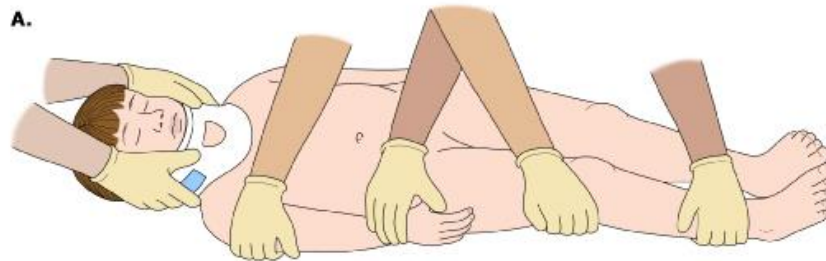
Outcome

- Better in incomplete injuries at any level
- Complete injuries: 1-2% significant rehab



First AID

- **PRE HOSPITAL CARE**
- **THE AIM IS TO RETRIEVE THE PATIENT FROM THE SITE OF INJURY SAFELY AND RAPIDLY**
- **TRANSFER TO A SUITABLE FACILITY.**
- **SPINAL TRAUMA SHOULD BE SUSPECTED IN**
 - 1. ALL UNCONSCIOUS PATIENTS**
 - 2. HIGH ENERGY TRAUMA**
 - 3. EVIDENCE OF NEUROLOGICAL DEFICIT**
 - 4. MULTIPLE INJURIES**



- **ATLS**
- **INTUBATION**
- **IMMOBILIZATION**
- **CERVICAL COLLAR, SAND BAG, TAPE,**
- **? NECK POSITION**
- **?PEDIATRICS**



Treatment

The background of the slide features a detailed anatomical illustration of a human spine. The central focus is a vertical column of vertebrae. Several individual vertebrae are shown in detail around this central column, some from a superior view and others from an inferior view, illustrating the complex structure of the spine. The illustration is rendered in a light, sketchy style with some shading to indicate depth.

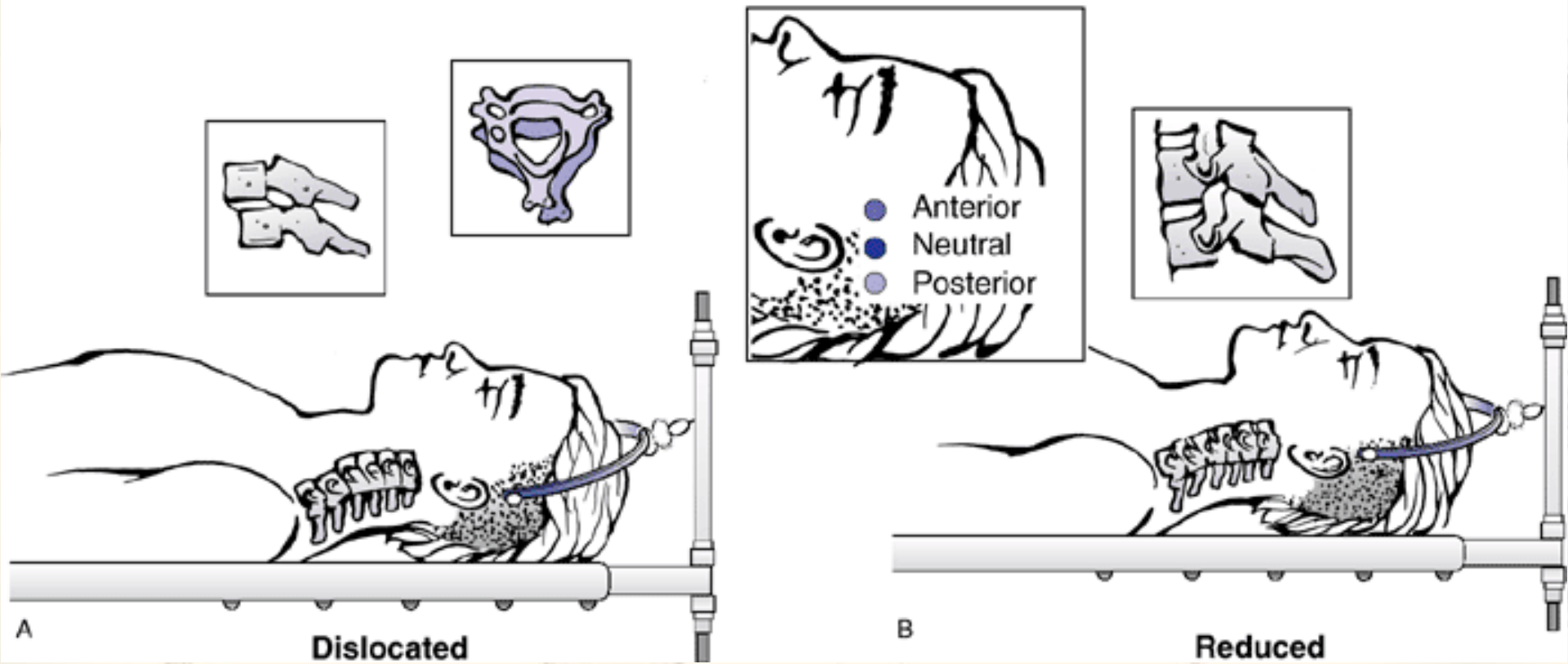
- Aims of the treatment are:
 - creating optimal conditions for a neurological recovery
 - fracture reduction
 - fracture stabilization
 - early mobilization and rehabilitation

Conservative treatment

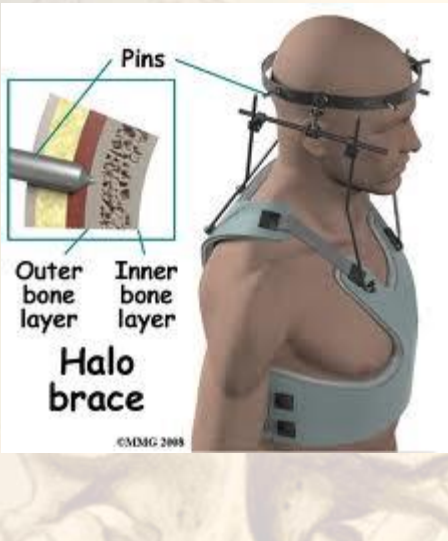
- Election treatment for type A fractures(AO Magerl) with intact posterior wall
- Isolated fractures of the posterior arc
- Stable fractures with a small potential for progression to kyphosis
- Initially bed rest and pain medication
- Immobilization

Conservative treatment

Cervical spine fracture dislocation treatment
Using Gardner-Wells or Crutchfield tongs



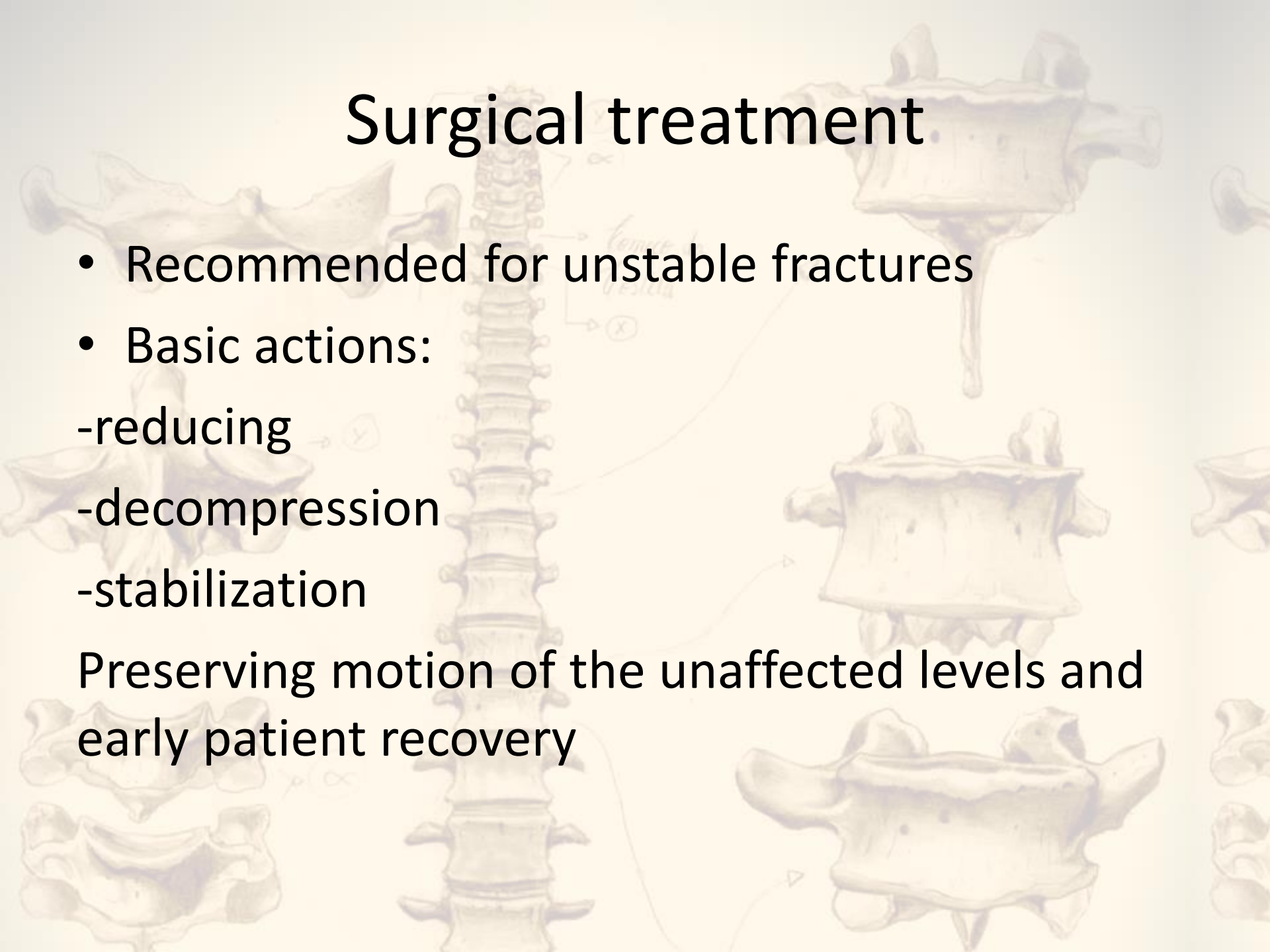
Immobilization types



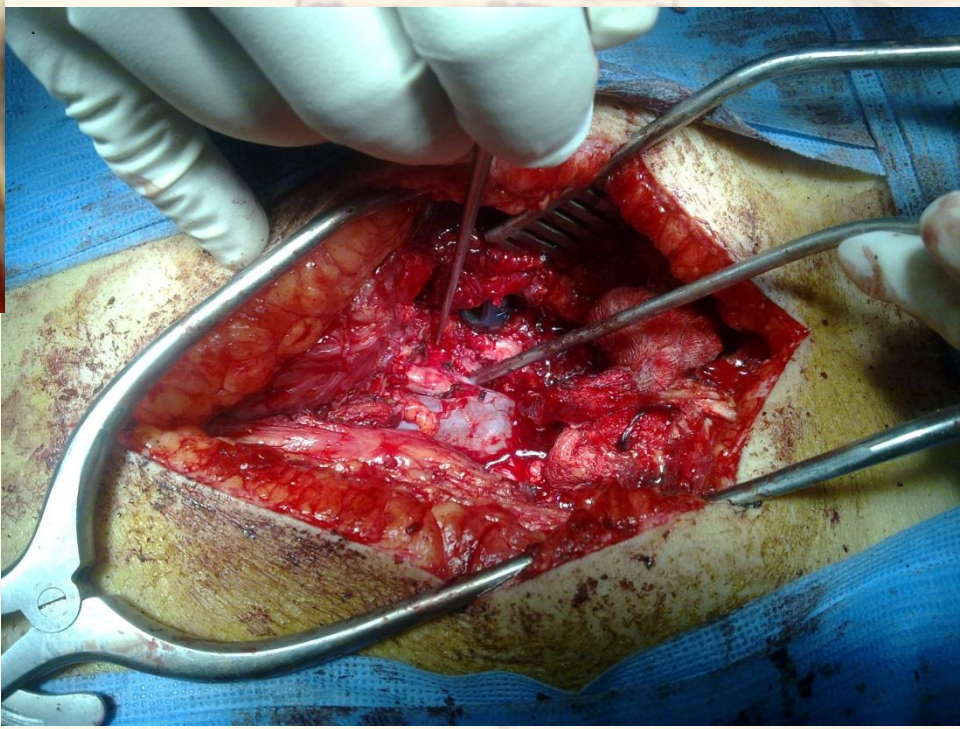
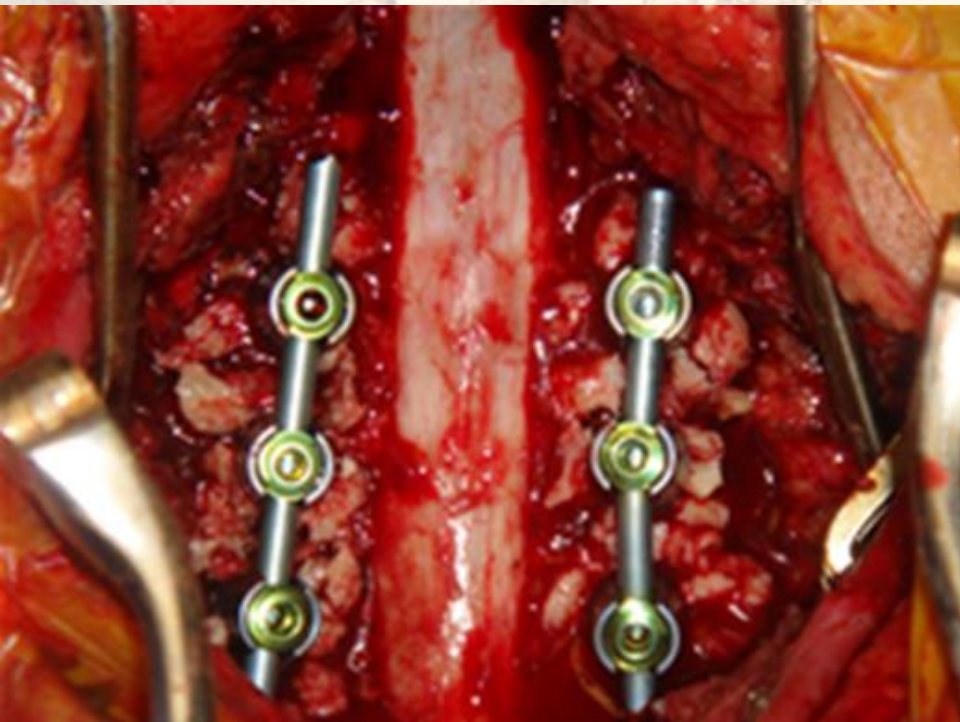
Surgical treatment

- Recommended for unstable fractures
- Basic actions:
 - reducing
 - decompression
 - stabilization

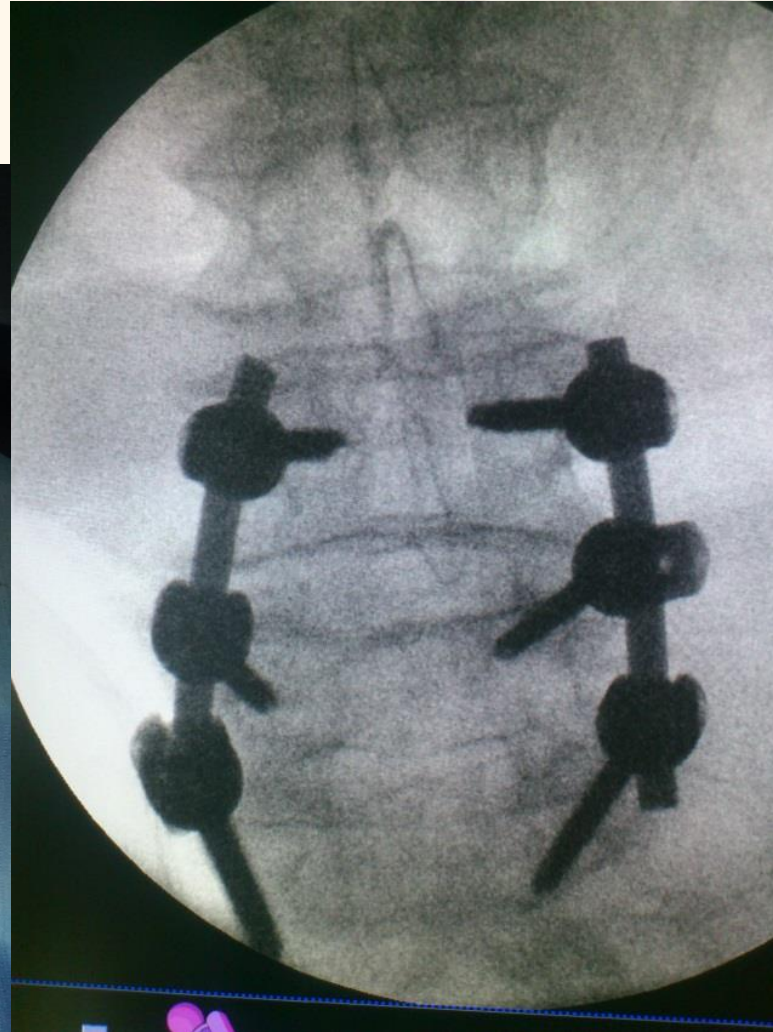
Preserving motion of the unaffected levels and early patient recovery

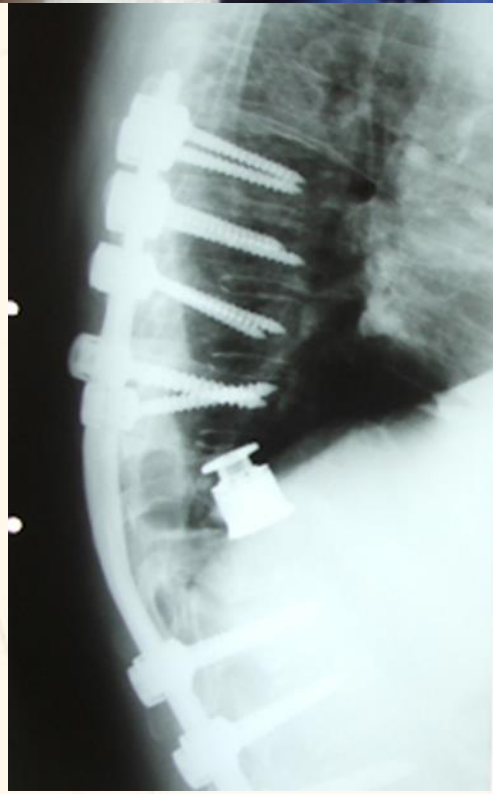
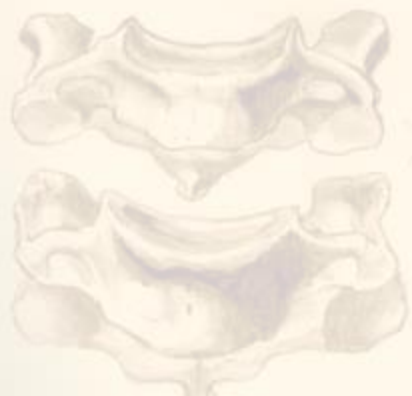
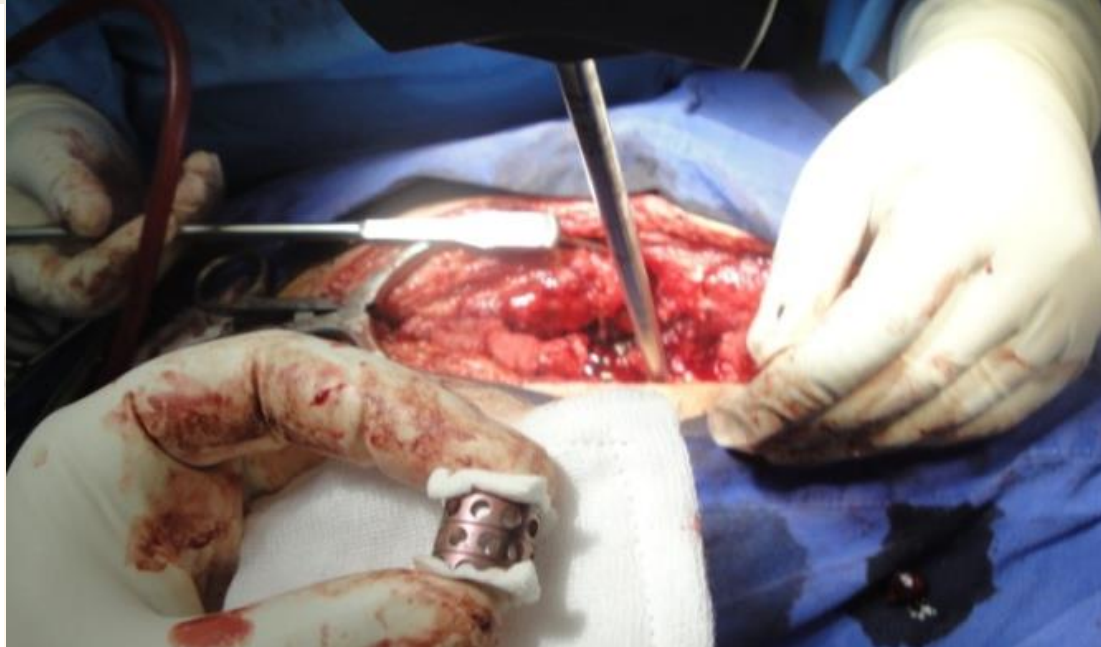


Decompression



Stabilization





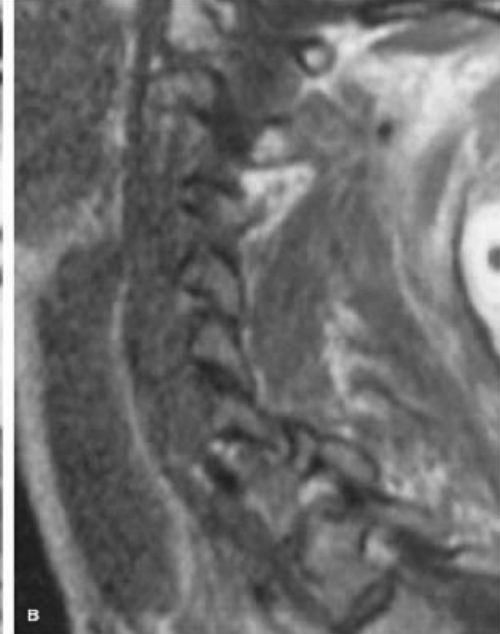
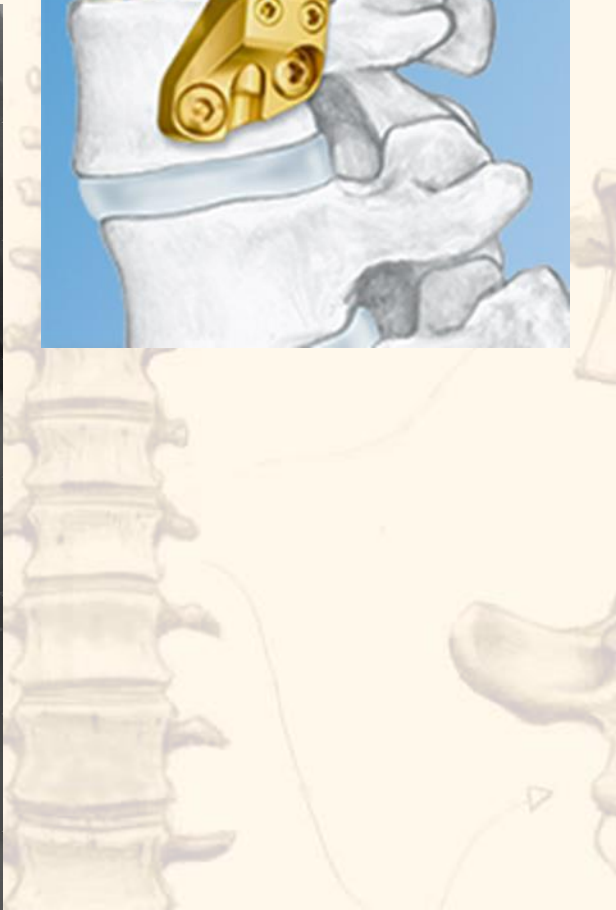
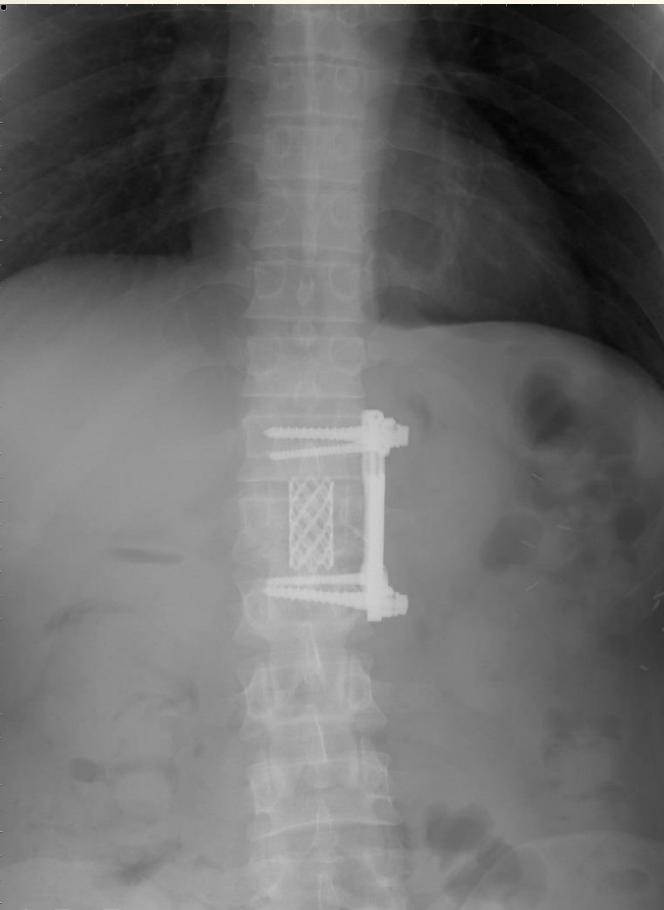


FIGURE 1. A and B, MR image showing a DF injury stage 3 at C6–C7. C, Radiograph 6 weeks postoperatively. Lateral view shows dislocation. D, Postoperative radiograph after reoperation with posterior pedicle screw and rod fixation.

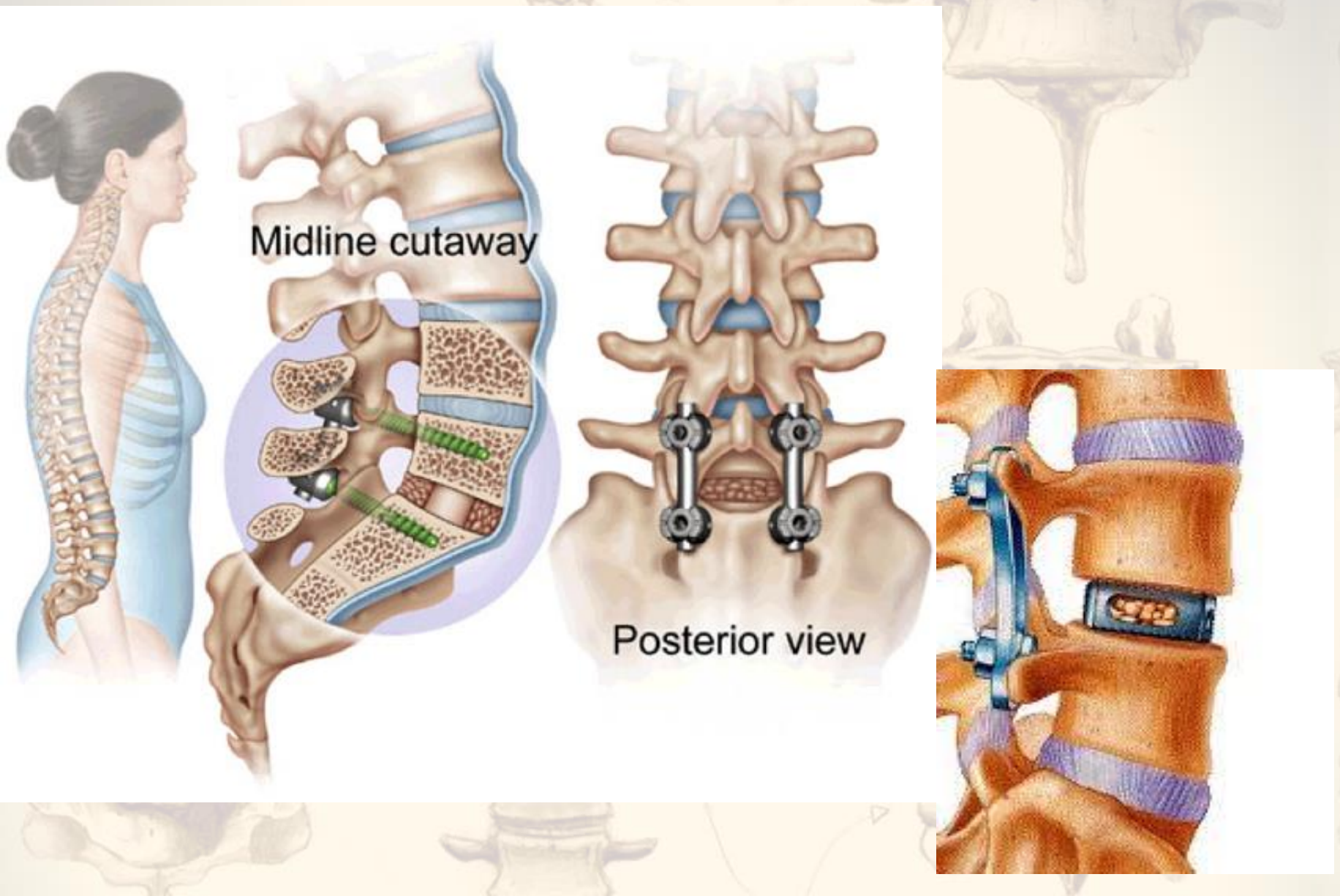


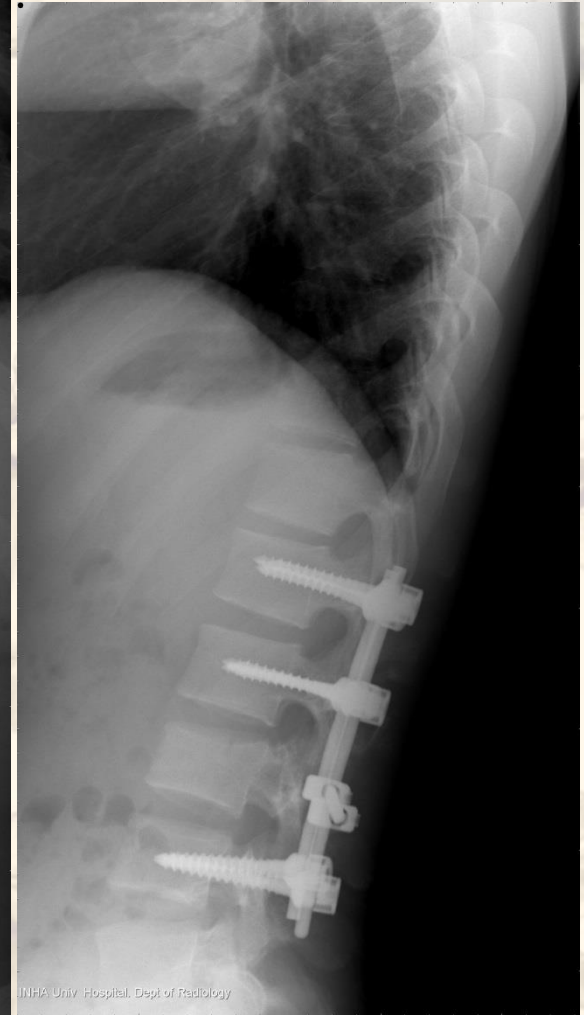
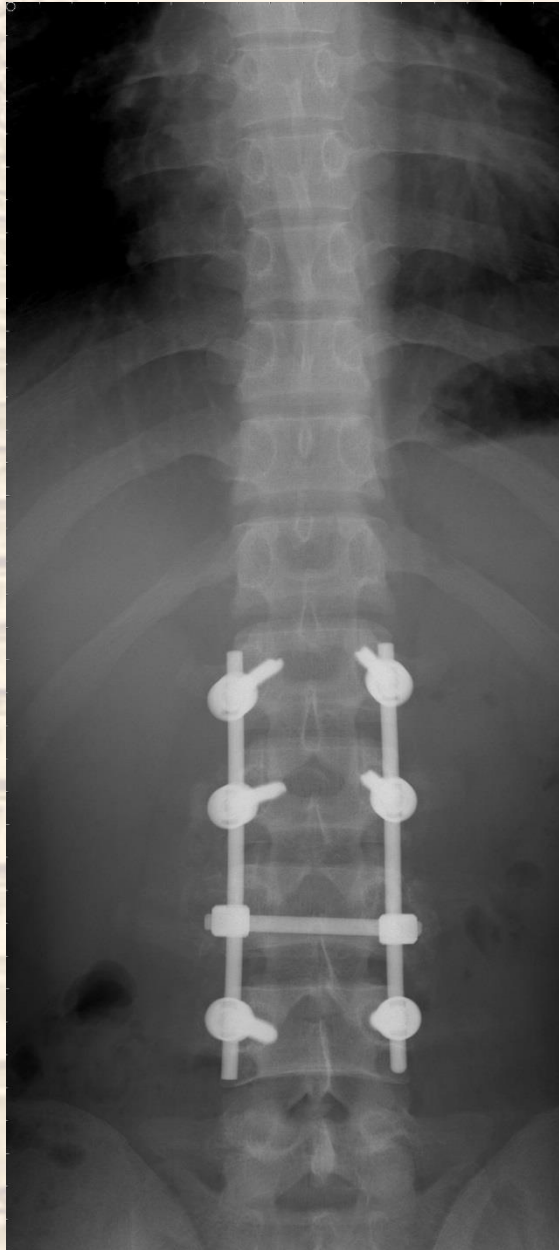
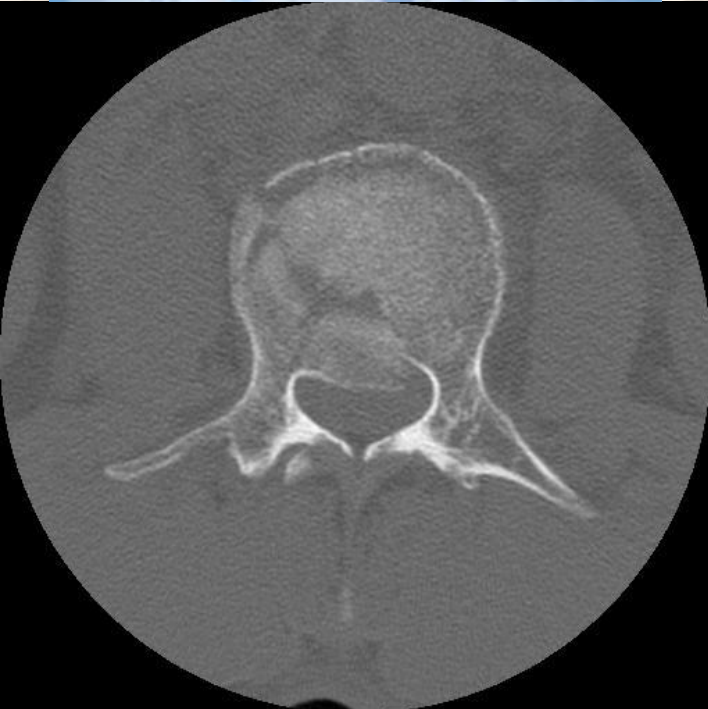
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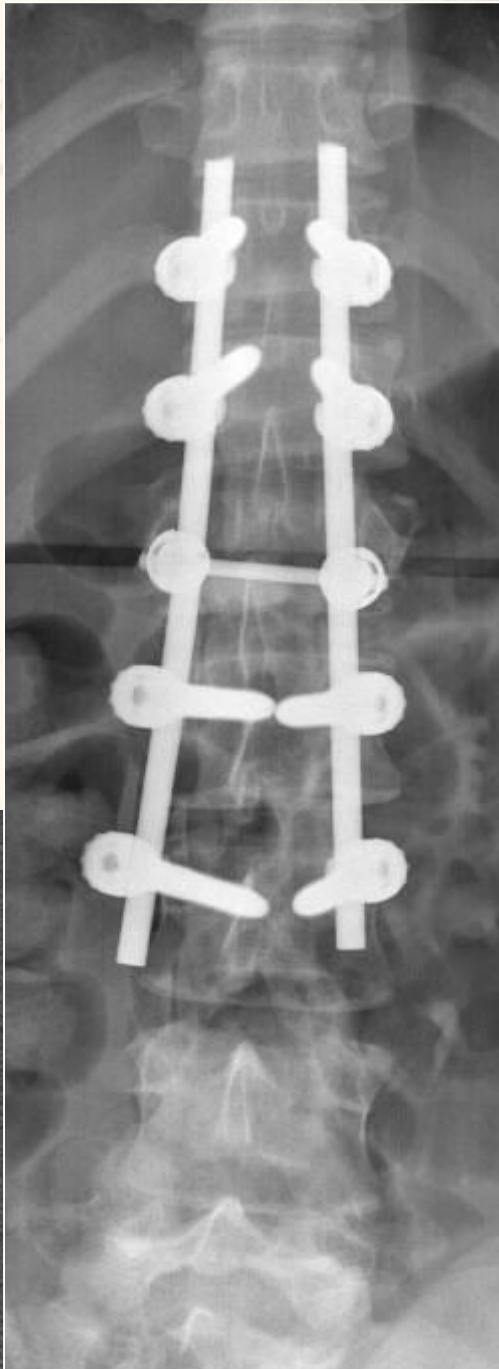
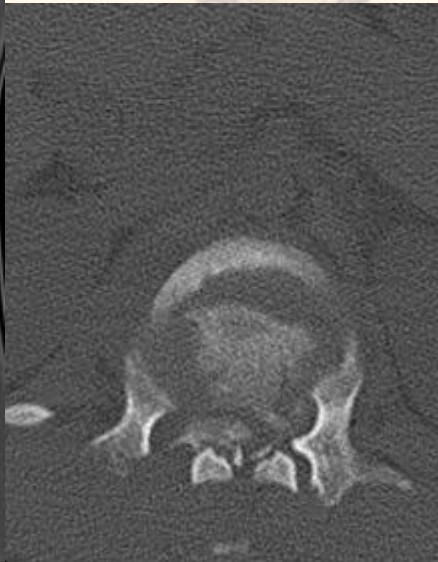




Posterior Instrumentation







Vertebroplasty/kyphoplasty

- Minimal invasive techniques used in osteoporotic fractures
- Quick recovery

