

Spinal injuries



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Objectives



- ❧ The ability to demonstrate knowledge of the following:
 - ❧ Basic anatomy of the spine
 - ❧ Initial assessment and treatment of spinal injuries at the field
 - ❧ Principle of spinal stability
 - ❧ Understanding of neurologic syndromes caused by spinal trauma
 - ❧ Management of Cauda equina syndrome



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Spine Pathology Red Flag Conditions

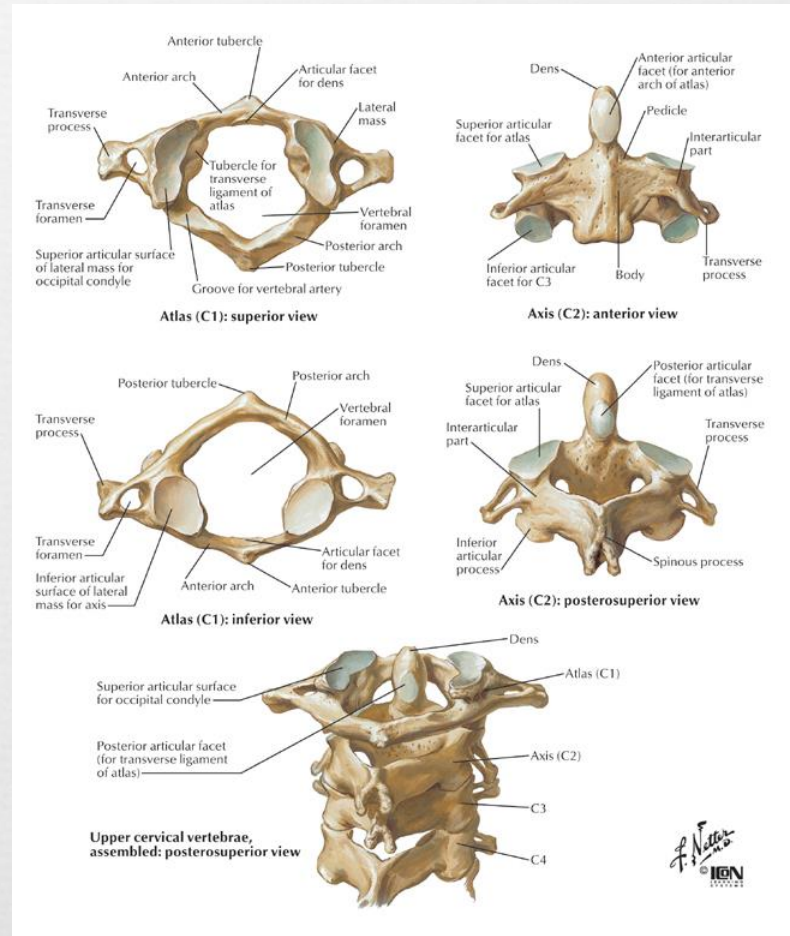
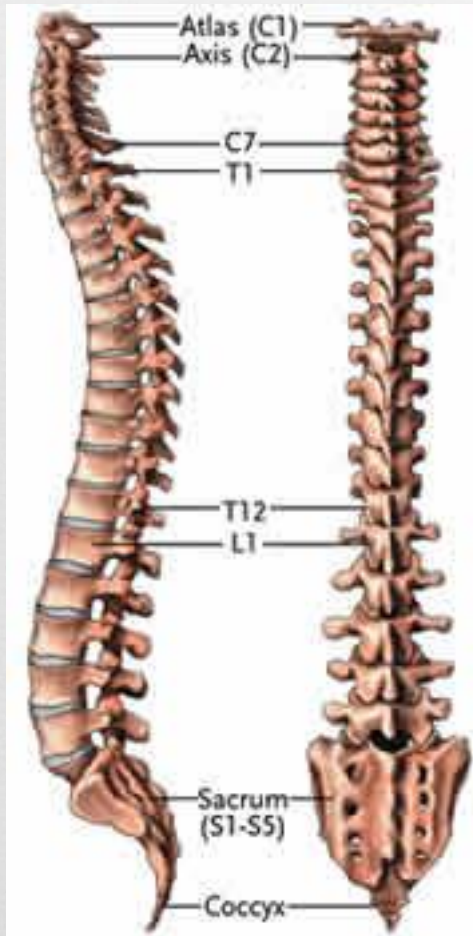
☞ Beware of:

- 1) Cauda Equina/severe neurologic injury (perianal numbness, decreased rectal tone, loss of movement in the extremities)
- 2) Tumour weakening the vertebrae (causing cord compression or vertebral fracture)
- 3) Infection weakening bone (causing disc/vertebral destruction or cord compression)
- 4) **Traumatic Spine Fracture** (causing vertebral angulation, pain, or neuro compromise)

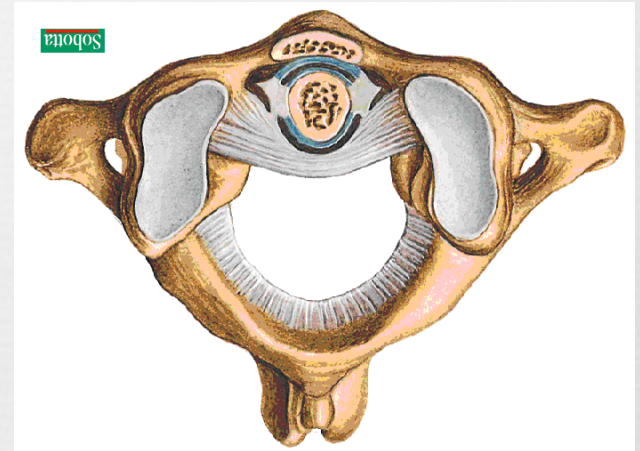
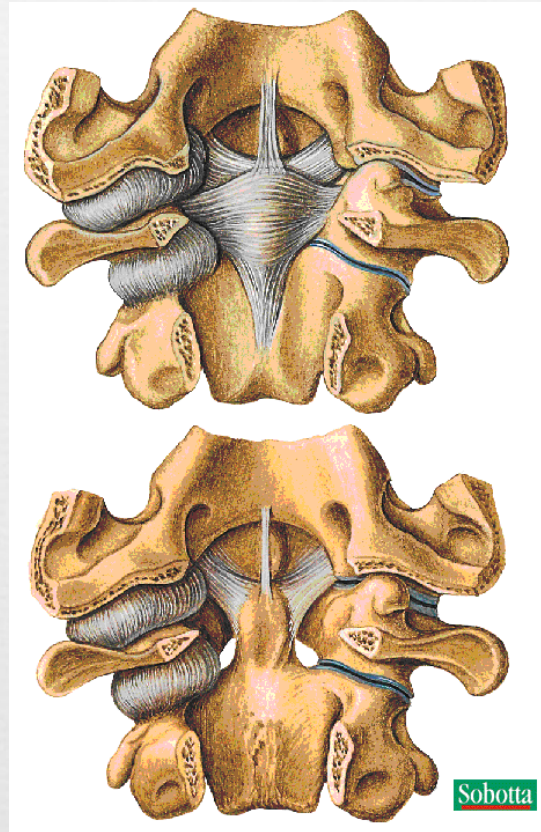
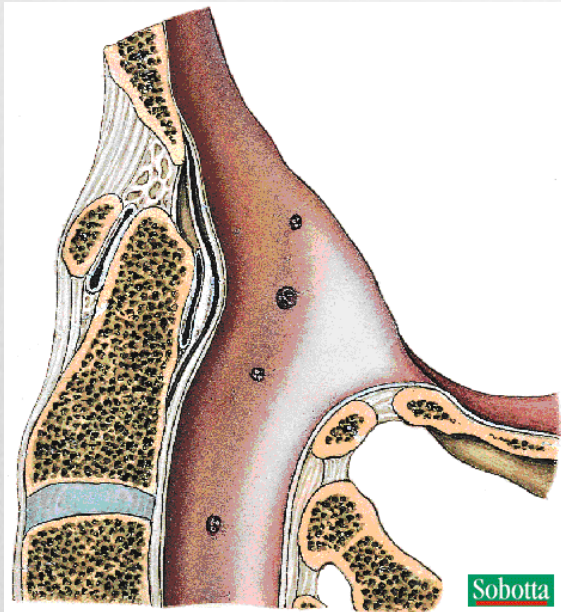
Remember that spine fracture can occur without trauma



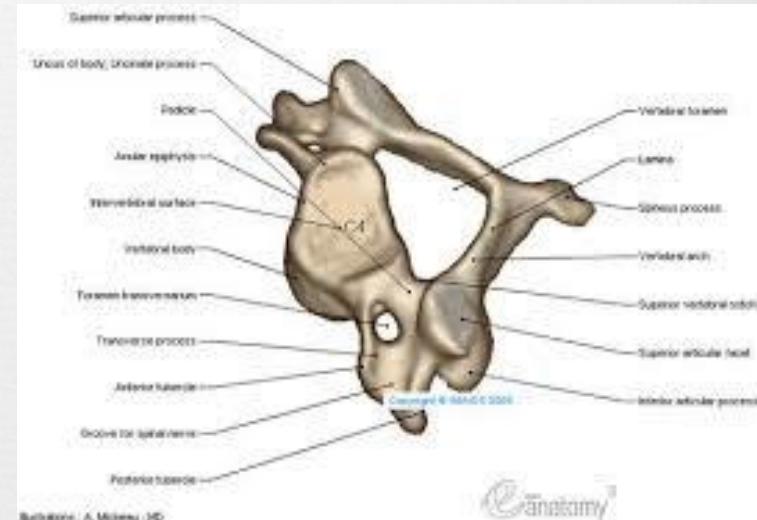
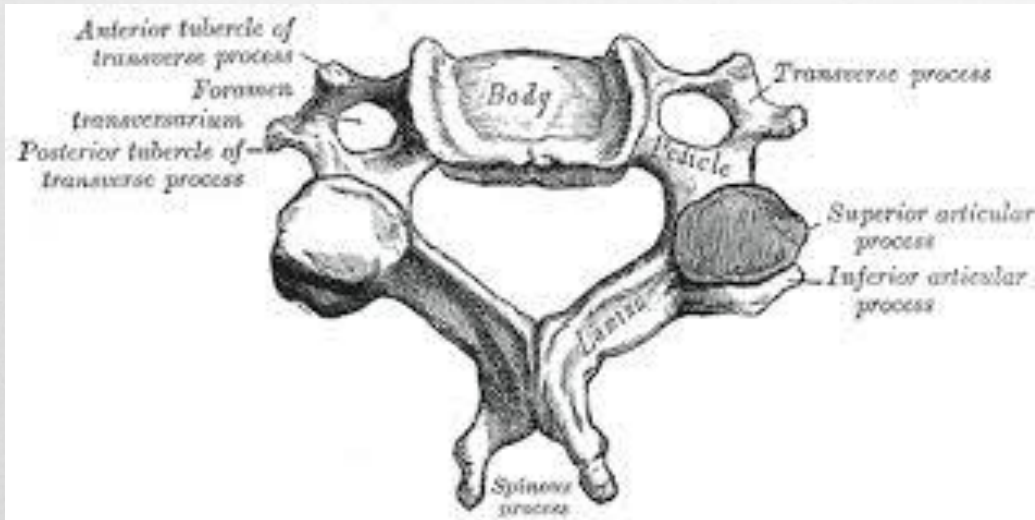
Anatomy



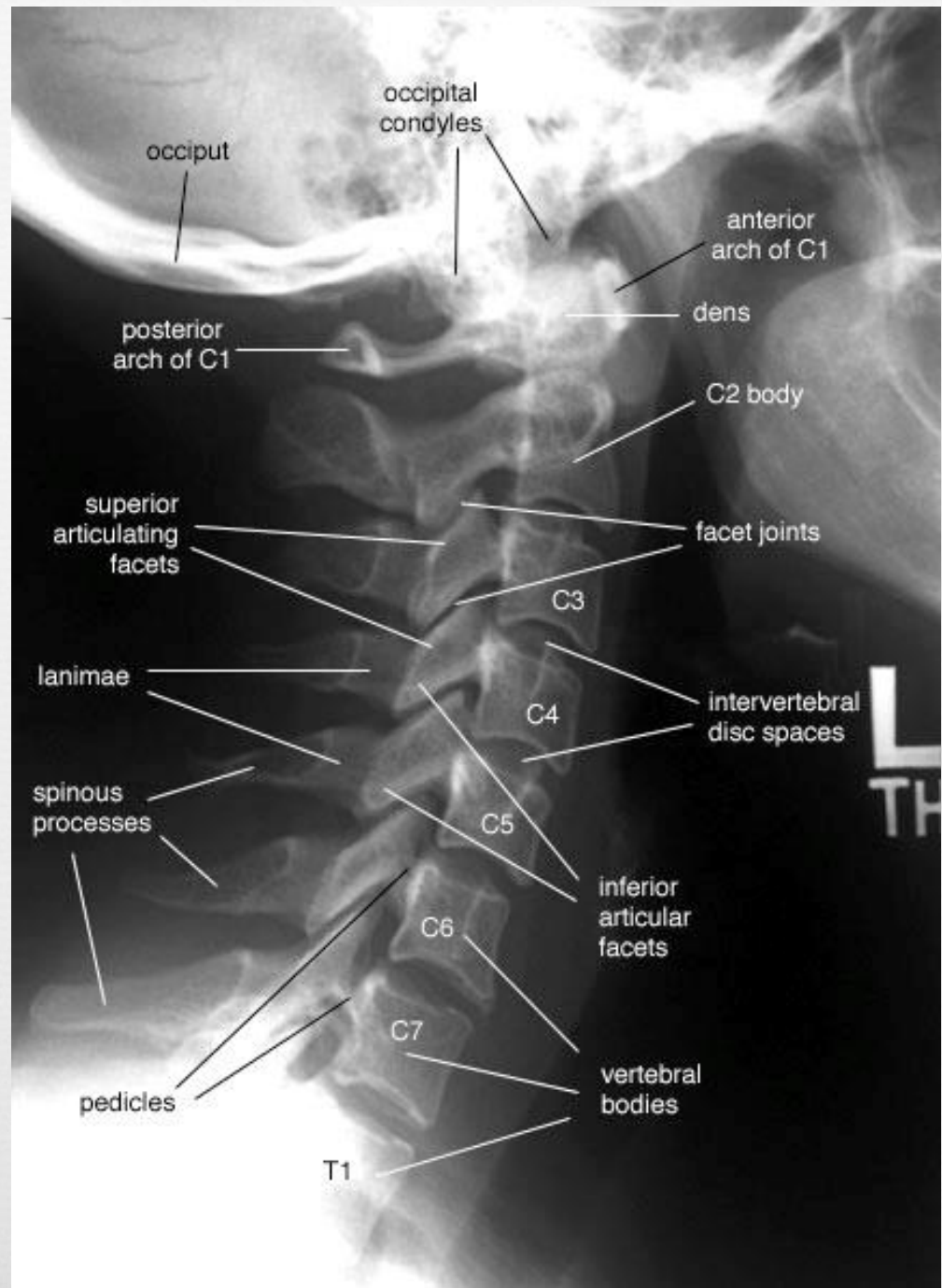
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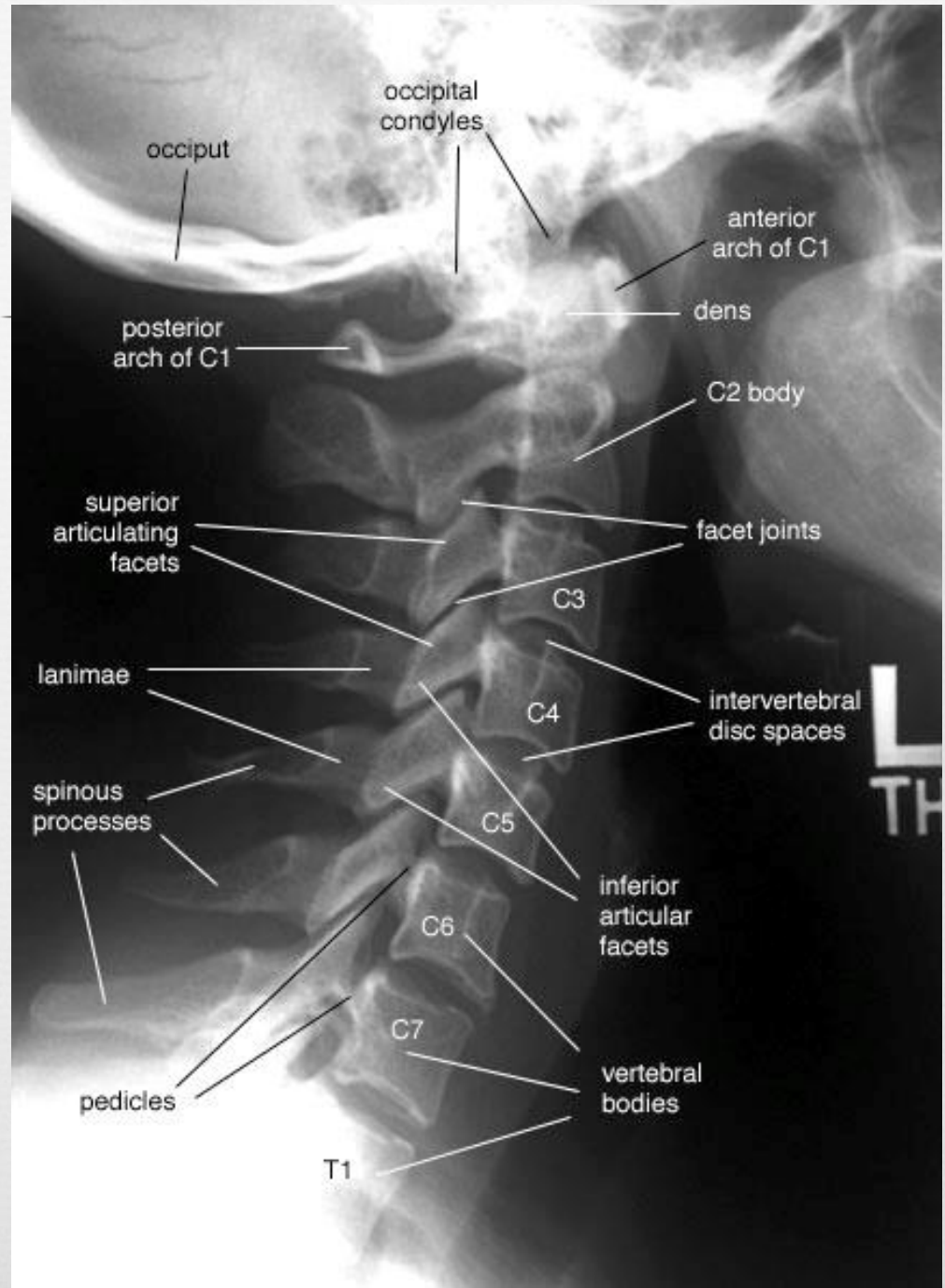
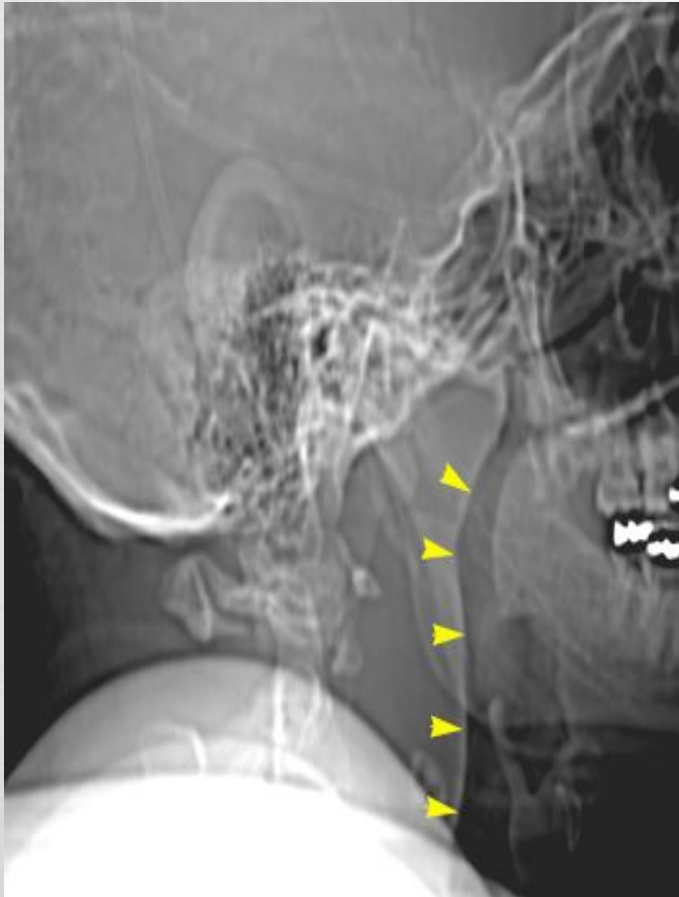
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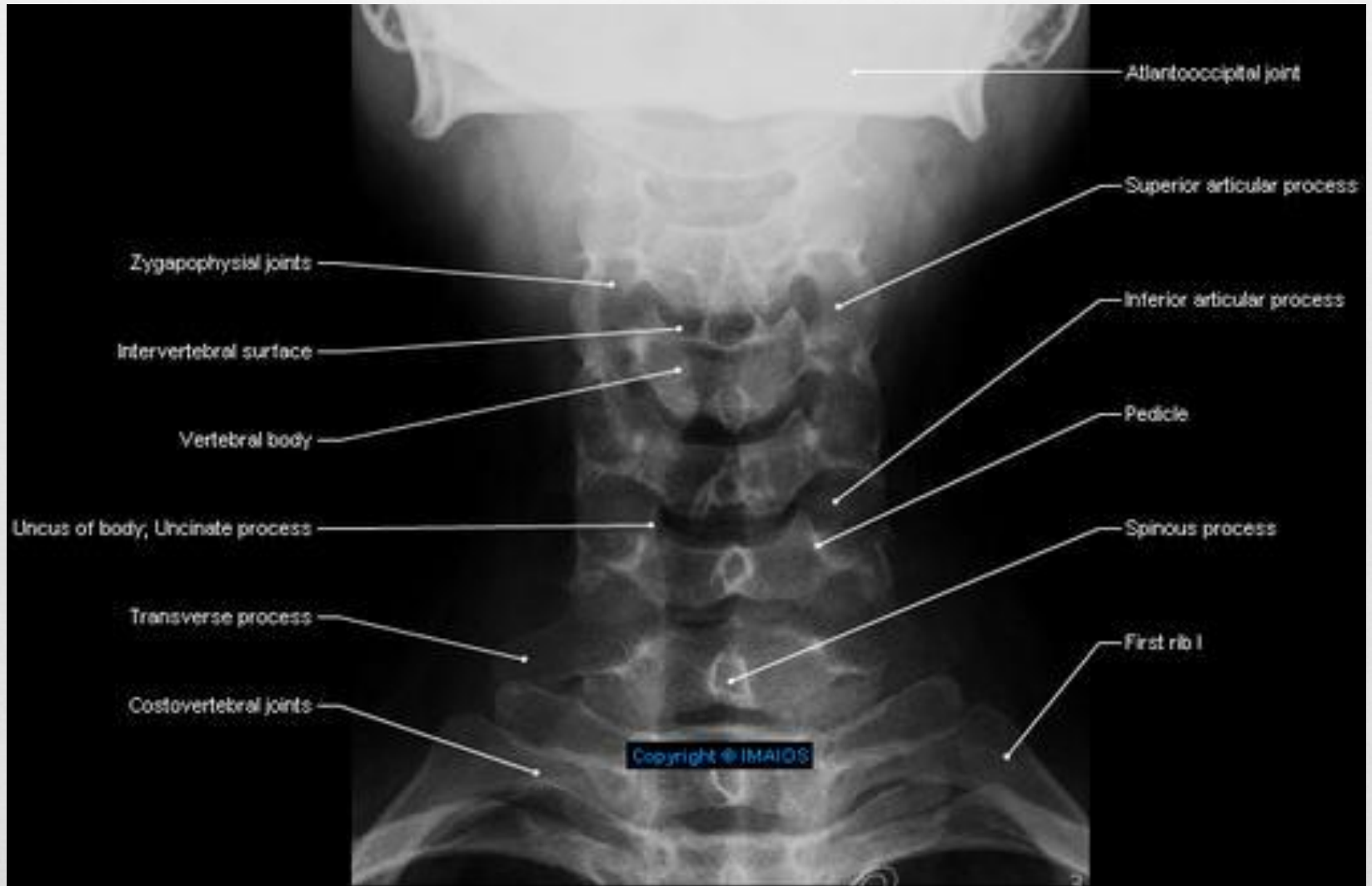
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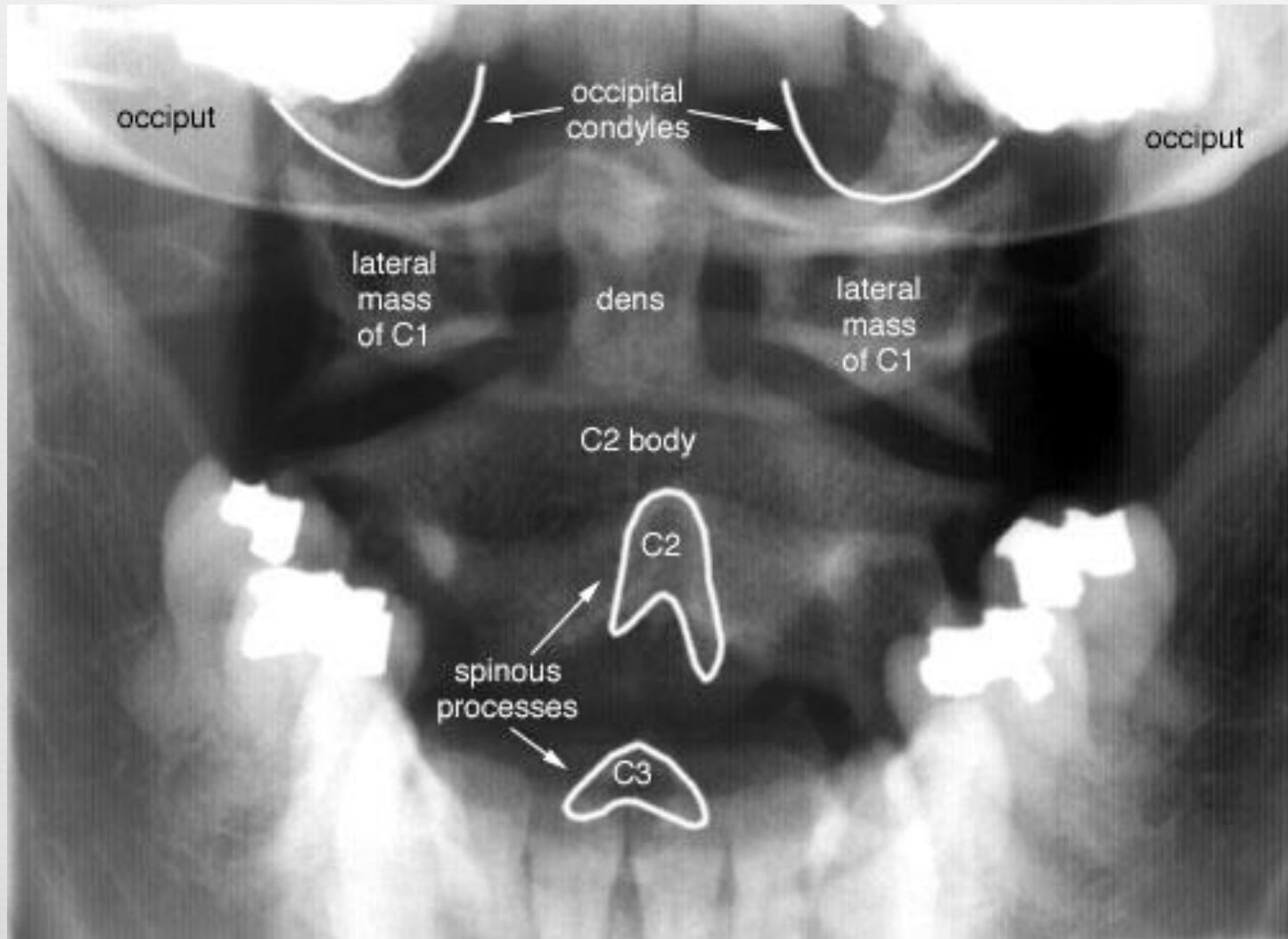
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Anatomy



Anatomy



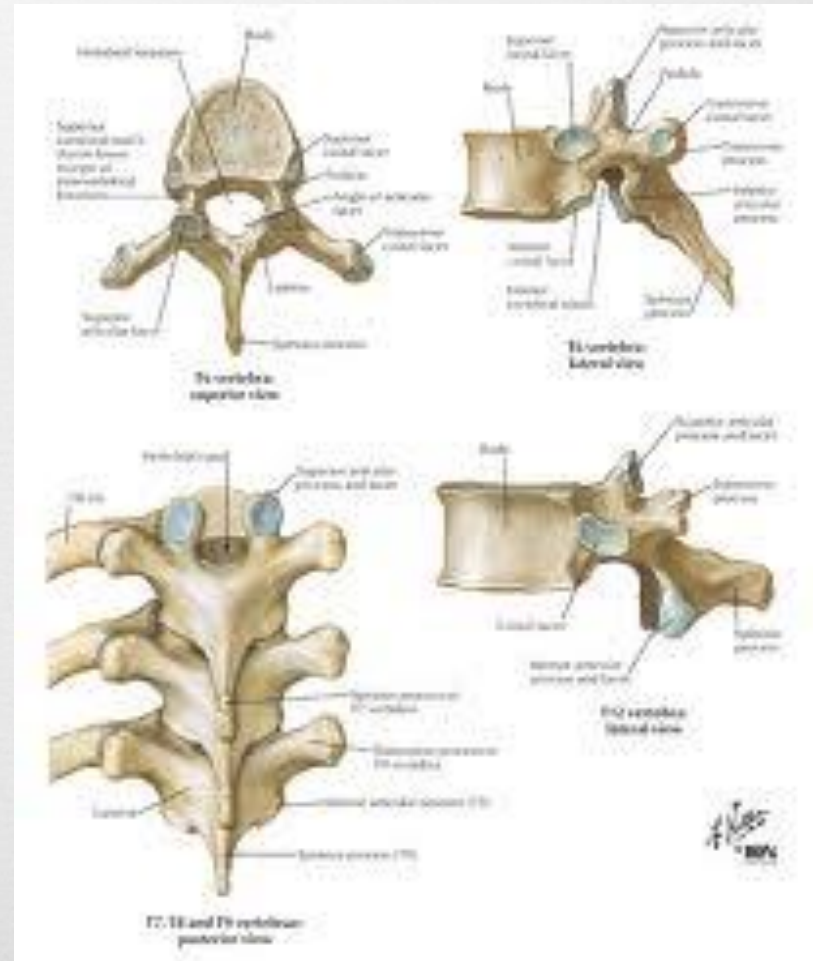
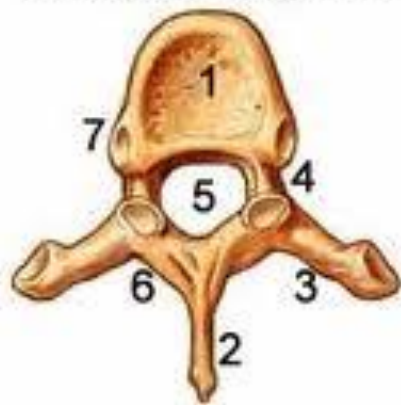
Anatomy



Thoracic Vertebrae

Axial (Overhead) View

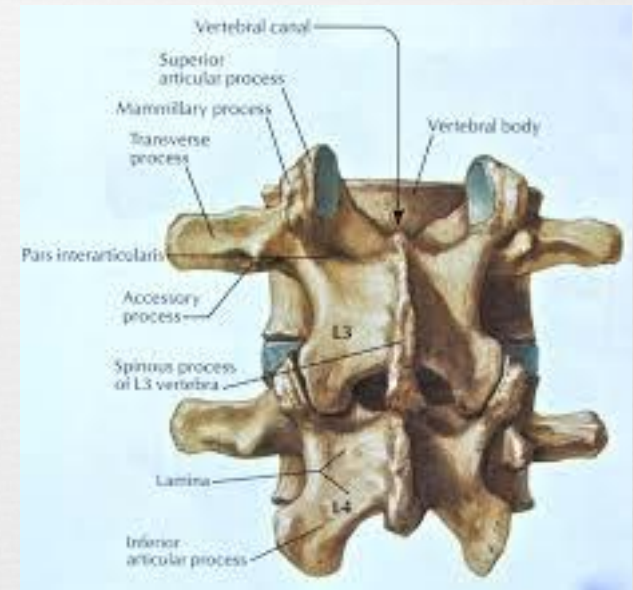
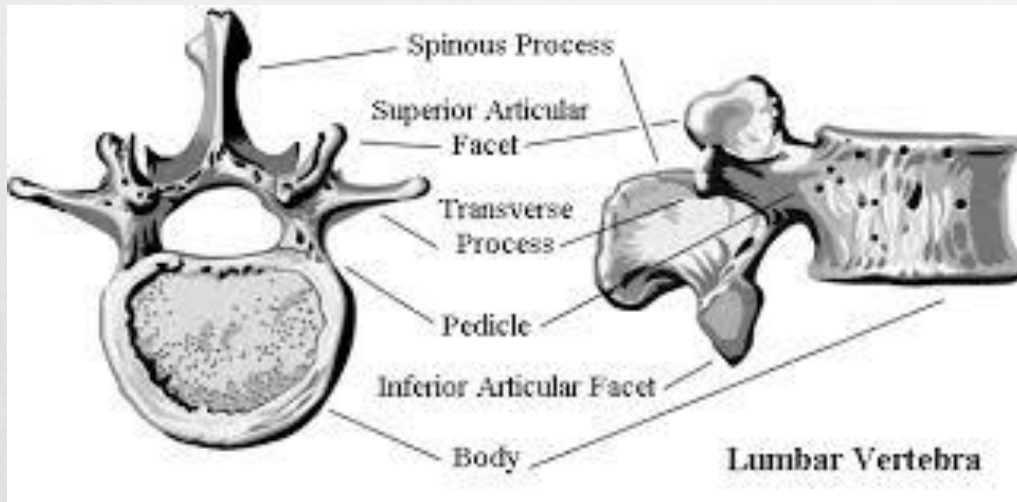
Lateral (Side) View



Anatomy



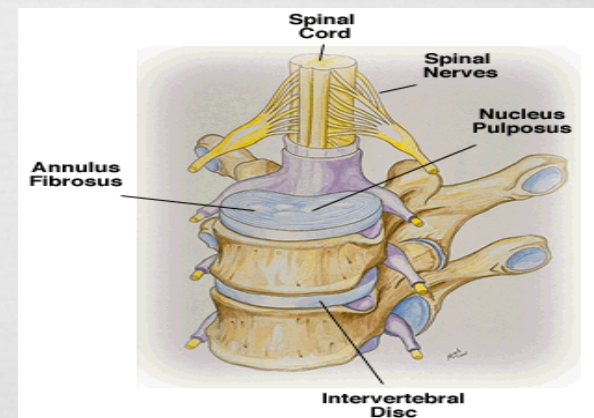
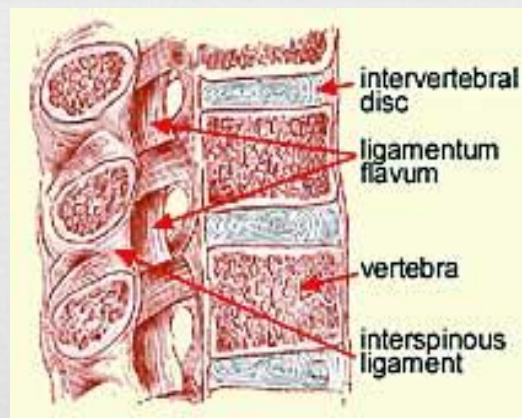
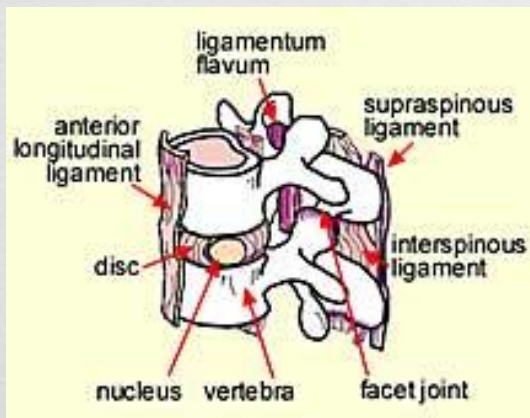
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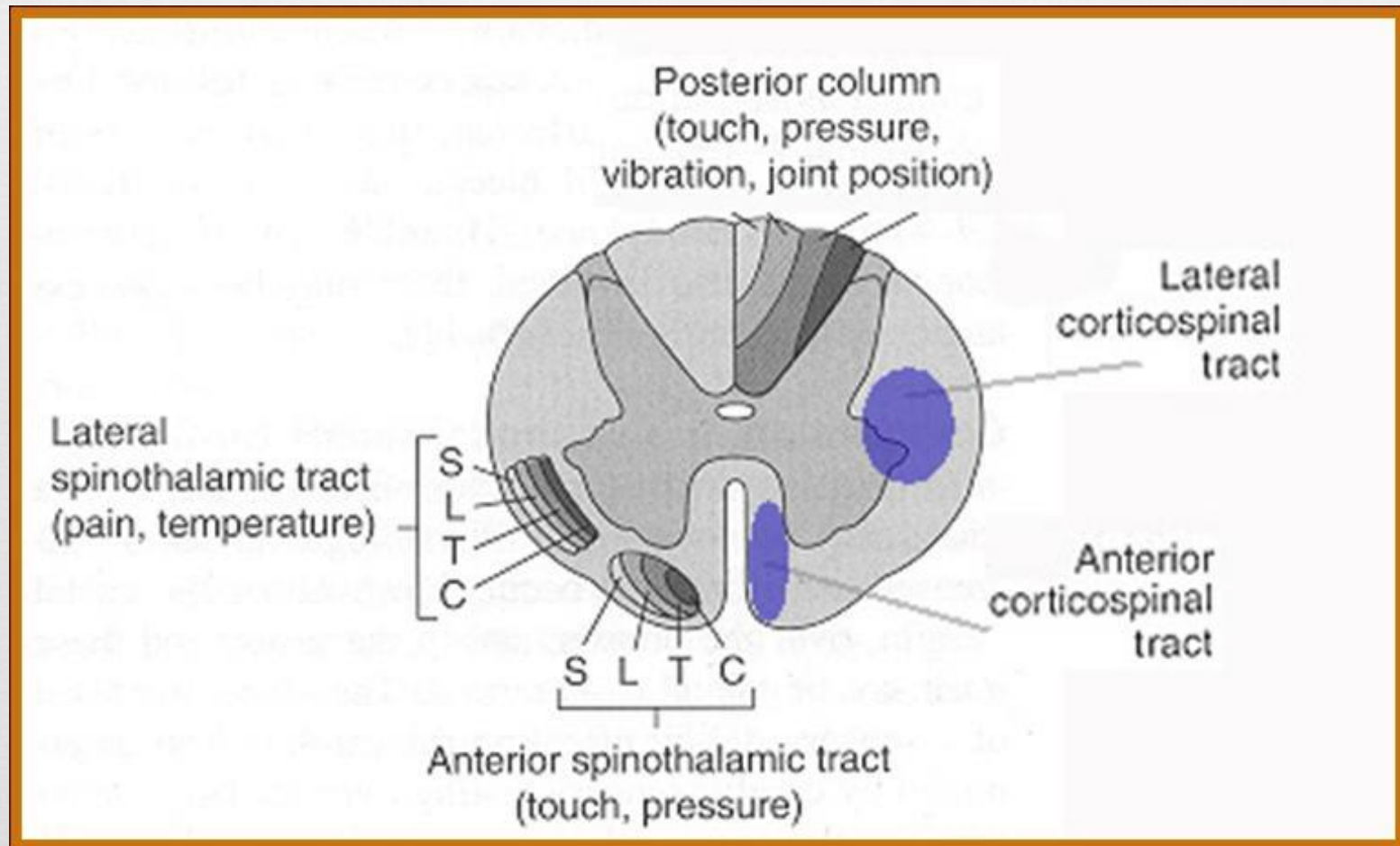
Anatomy




Anatomy



Anatomy



Epidemiology

- ❧ 56000 cases per year 
- ❧ 11000 new spinal cord injuries
- ❧ 15-20% multiple non-contiguous levels
- ❧ 10% involving the cervical spine
- ❧ 90% involving thoracolumbar spine
- ❧ 25% have neurologic deficit
- ❧ Age: mostly between 15-24 years
- ❧ Gender: mostly males (4:1)

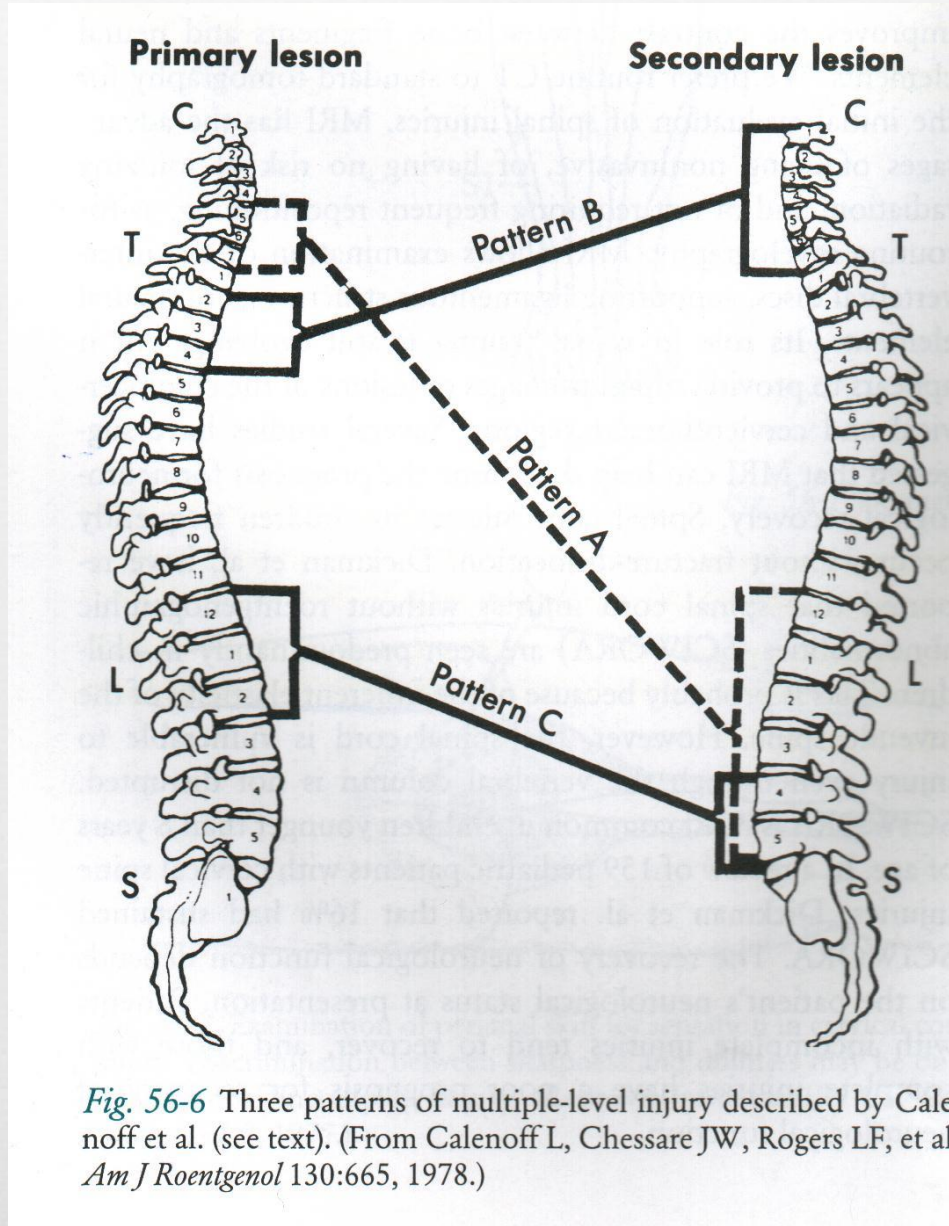
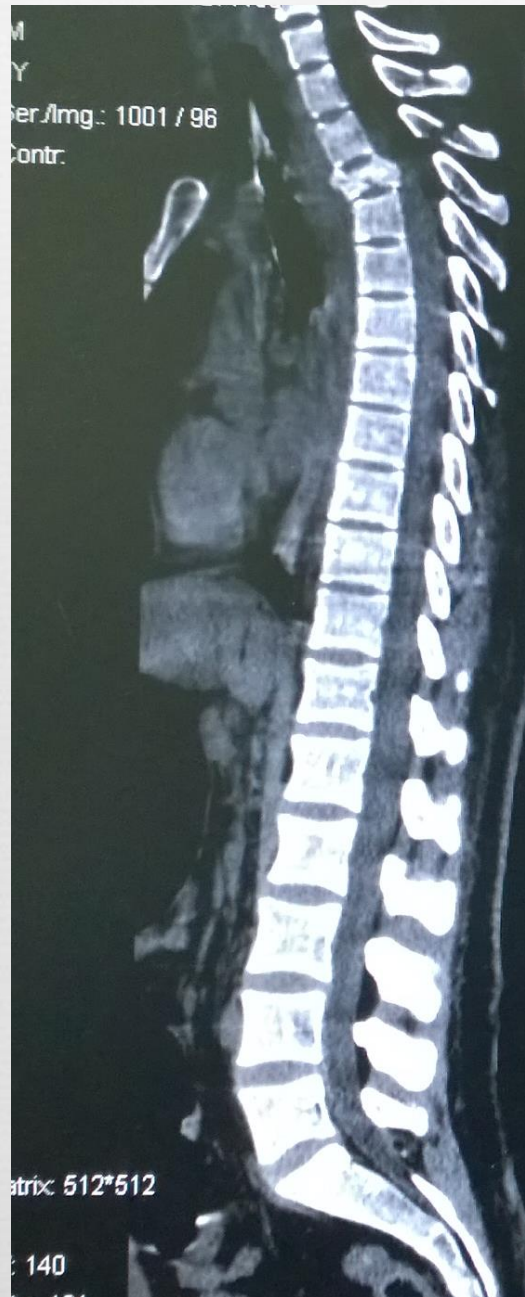


Fig. 56-6 Three patterns of multiple-level injury described by Calenoff et al. (see text). (From Calenoff L, Chessare JW, Rogers LF, et al *Am J Roentgenol* 130:665, 1978.)



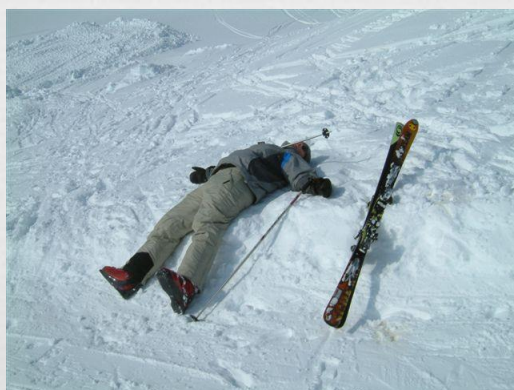
Mechanism of Injury



- ❧ High energy trauma such as an MVA or fall from a height or a horse
 - ❧ MVA: 40-55%
 - ❧ Falls: 20-30%
 - ❧ Sports: 6-12%
 - ❧ Others: 12-21%

- ❧ Low energy trauma in a high risk patient (ie a patient with known spinal canal compromise such as ankylosing spondylitis, Osteoporosis or metastatic vertebral lesions)

- ❧ Penetrating trauma from gunshot or knives



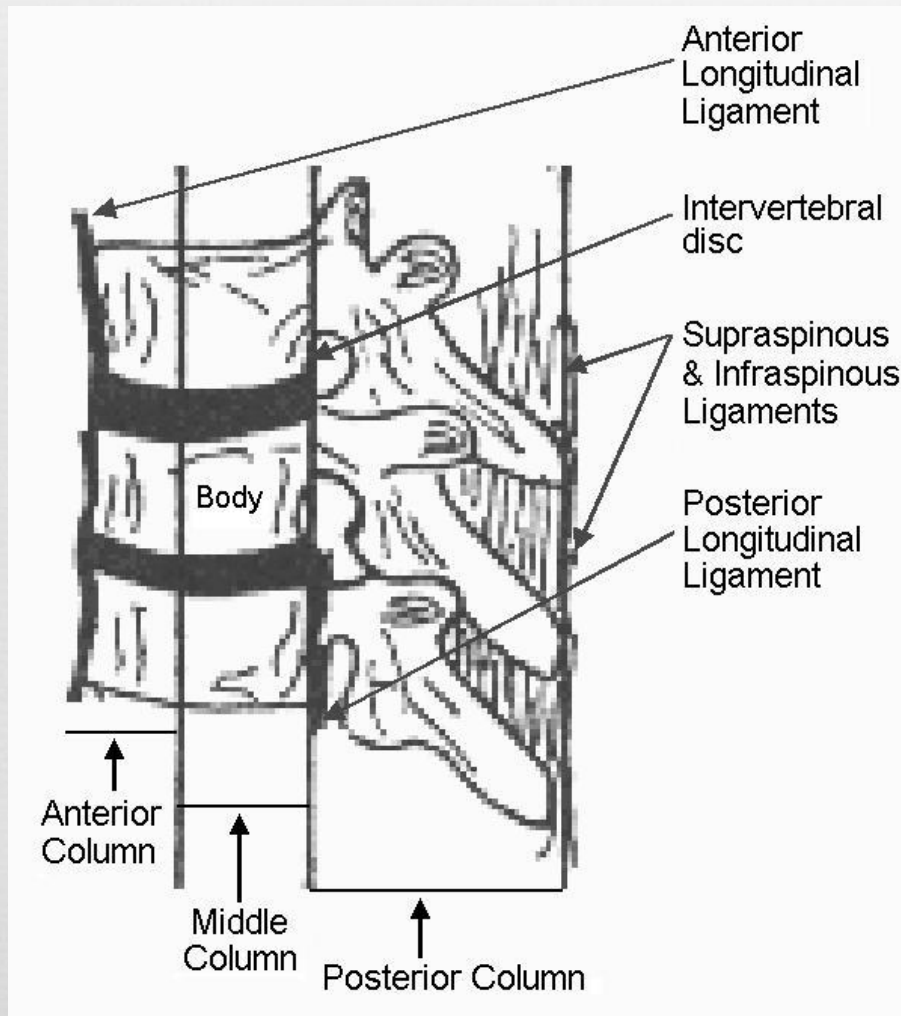
Spine stability



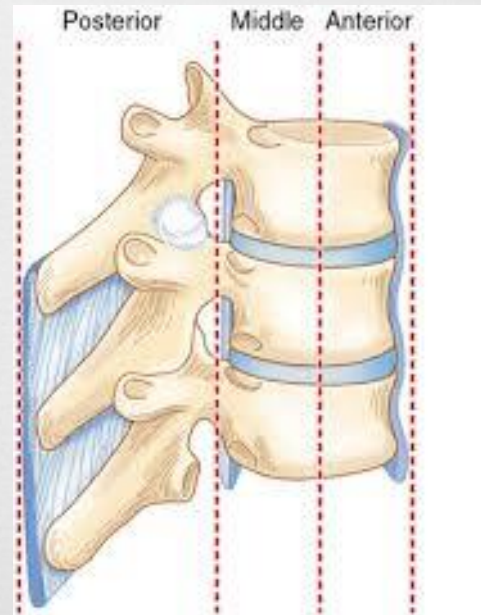
- ❧ Cervical spine instability:
 - ❧ Compression fracture with 25% loss of height
 - ❧ Angular displacement > 11 degrees
 - ❧ Translation > 3.5mm
 - ❧ Disc space separation >1.7mm

- ❧ Thoracic and lumbar spine: Denis three column

The Three columns



Instability exists with disruption of any two of three columns.



Assessment



- ❧ In cases of trauma, ABCDE's must be assessed first and treated appropriately
- ❧ Patients should be examined with spinal collar until spinal pathology is excluded
- ❧ Careful log rolling keeping the head, neck and pelvis in line should be done to examine the spine properly

Assessment



❧ Immobilization

❧ History:

❧ Mechanism of injury:

❧ compression, flexion, extension, distraction

❧ Other injuries

❧ Seat belt

❧ Other causalities

❧ Physical examination:

❧ Inspection, palpation

❧ Neurologic examination

Assessment



∞ Immobilization



Immobilization



Immobilization



Immobilization



Neurologic



❧ Muscle Test

❧ Sensory exam

**light touch, Sharp dull discrimination, Vibration sense, Proprioception
and two-point discrimination**

❧ Reflexes

Signs of Spinal Trauma



- ❧ Apnea, lower cranial nerve injury VIII-XII (high C-spine).
- ❧ Deformity of the spine or neck
- ❧ Tenderness on palpation along spinal processes
- ❧ Paralysis or muscle weakness (which spinal level)
- ❧ Loss of sensation (which dermatomes)
- ❧ Loss of rectal tone
- ❧ Positive Babinski sign

Asia Score: Brief Trauma Neurologic Survey

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	<input type="checkbox"/>	+ <input type="checkbox"/>	= <input type="checkbox"/>
(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)

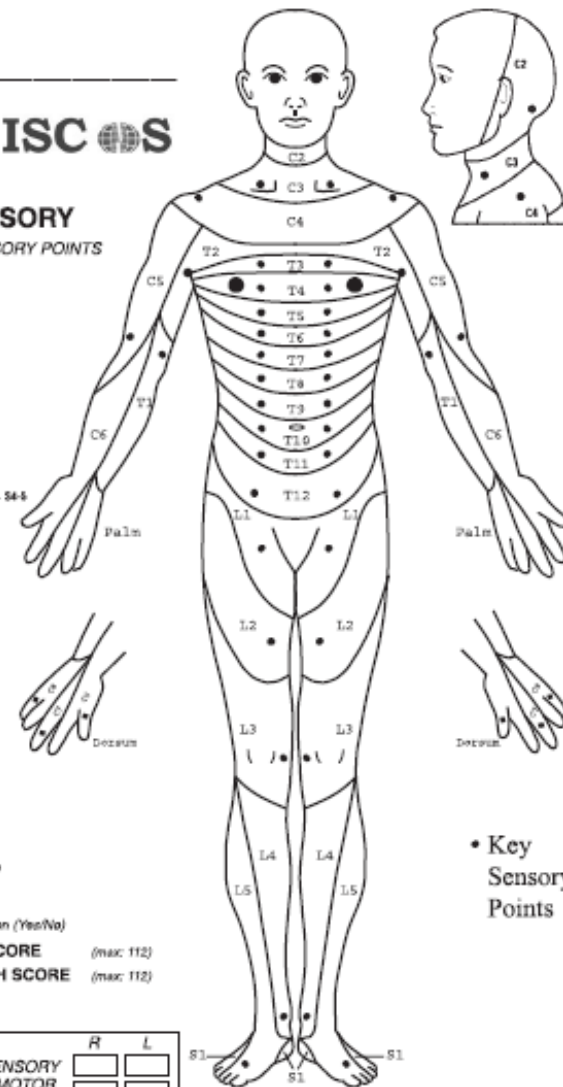
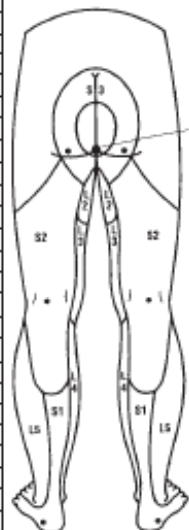
LOWER LIMB TOTAL	<input type="checkbox"/>	+ <input type="checkbox"/>	= <input type="checkbox"/>
(MAXIMUM)	(25)	(25)	(50)

	LIGHT TOUCH		PIN PRICK	
	R	L	R	L
C2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
C3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
C4	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
C5	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
C6	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
C7	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
C8	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
T1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
T2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
T3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
T4	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
T5	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
T6	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
T7	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
T8	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
T9	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
T10	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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L2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
L3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
L4	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
L5	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
S1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
S2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
S3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
S4-5	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
TOTALS	<input type="checkbox"/>	+ <input type="checkbox"/>	= <input type="checkbox"/>	<input type="checkbox"/>
(MAXIMUM)	(56)	(56)	(56)	(56)

SENSORY

KEY SENSORY POINTS

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



• Key Sensory Points

<input type="checkbox"/>	Any anal sensation (Yes/No)
<input type="checkbox"/>	PIN PRICK SCORE (max: 112)
<input type="checkbox"/>	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 innervated segments

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

ASIA IMPAIRMENT SCALE

- A = Complete:** No motor or sensory 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 of 3 or more.
- E = Normal:** motor and sensory function are normal

CLINICAL SYNDROMES

- Central Cord
- Brown-Sequard
- Anterior Cord
- Conus Medullaris
- Cauda Equina

Level of Cord Injury determines level of function



Prognosis for Recovery of spinal Cord Injury:

Poor prognosis for recovery if:

- pt arrives in shock
- pt cannot breath
- pt has a complete injury

Assessment



Severity of neurologic deficit

Complete

Flaccid paralysis below level of injury

May involve diaphragm if injury above C5

Sympathetic tone loss if fracture above T6

Incomplete

? Any sensation

? Sacral sparing

Assessment

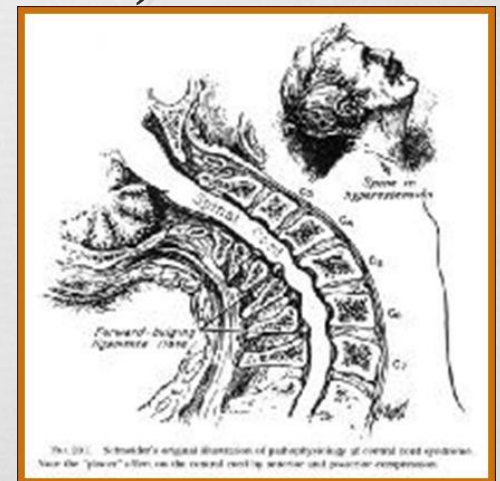


Severity of neurologic deficit

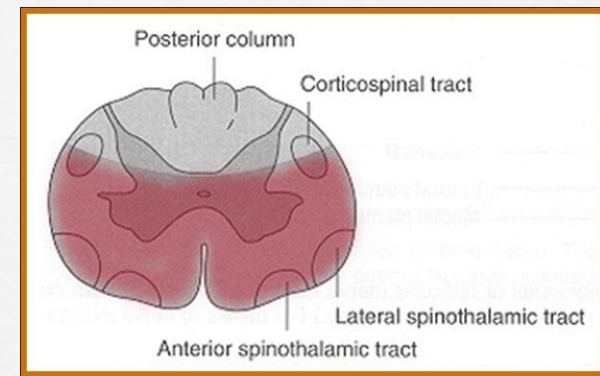
Incomplete

Central cord syndrome:

- # Characterized by disproportionally (UL>LL)
- # Mechanism: hyper-extension
- # Occur with or without fractures
- # Recovery: 50% regaining function
- # Prognosis is fair



Assessment



Severity of neurologic deficit

Incomplete

Anterior cord syndrome:

- # Characterized by loss of corticospinal and spinothalamic tract with preserved posterior column
- # Mechanism: ischemia or infarction to spinal cord
- # Common injury
- # Recovery: 10%
- # Prognosis is good if progressive recovery within 24hrs, absent SS after 24hrs pretends a poor outcome

Assessment



Severity of neurologic deficit

Incomplete

Brown-Sequard syndrome:

Characterized by hemicord injury with ipsilateral paralysis, loss of proprioception and light touch, and contralateral temperature and sharp pain loss

Prognosis is good, with over 90% regaining of bowel and bladder function and ambulatory capacity

Assessment



Severity of neurologic deficit

Incomplete

Conus Medullaris syndrome:

Seen in T12-L1 injuries

Loss of voluntary bowel and bladder control with preserved lumbar root function

Uncommon as pure lesion (mixed conus-cauda)

Assessment



Severity of neurologic deficit

Incomplete

Cauda Equina syndrome:

Saddle anesthesia, urinary retention and stool incontinence

Usually due to large central disc herniation rather than fracture

Nerve root deficit: LMN



❧ **Spinal Shock**

- ❧ Transient loss of spinal reflexes
- ❧ Lasts 24-72 hours

❧ **Neurogenic shock**

- ❧ Reduced tissue perfusion due to loss of sympathetic outflow and un-opposed vagal tone
- ❧ Peripheral vasodilatation (hypotension and bradycardia)
- ❧ Rx: fluid resuscitation and vasopressors

Imaging



- ❧ **X-rays:**
 - ❧ Cervical: 3 views
 - ❧ AP, lateral and open mouth
 - ❧ Thoraco-lumbar: 2 views
 - ❧ AP & lateral
 - ❧ Flexion-Extension views
- ❧ **CT:** best for bony anatomy
- ❧ **MRI:** best to evaluate soft tissue

Management of Spinal Injuries



↳ Depends on:

- ↳ Level of injury
- ↳ Degree and morphology of injury: **STABILITY**
- ↳ Presence of neurologic deficit
- ↳ Other factors



∞ **Some general rules:**

∞ *Stable* injuries are usually treated conservatively

∞ *Unstable* injuries usually require surgery

∞ Neurologic compression requires decompression

Specific Injuries



Cervical spine fractures



- ❧ Descriptive: depends on mechanism of injury
 - ❧ Flexion/extension
 - ❧ Compression/distraction
 - ❧ Shear

- ❧ Presence of subluxation/dislocation

- ❧ SCI:
 - ❧ high fracture results in quadriplegia
 - ❧ Low fracture results in paraplegia

Cervical spine fractures



❧ SCI:

- ❧ high fracture results in quadriplegia
- ❧ Low fracture results in paraplegia



Cervical spine fractures

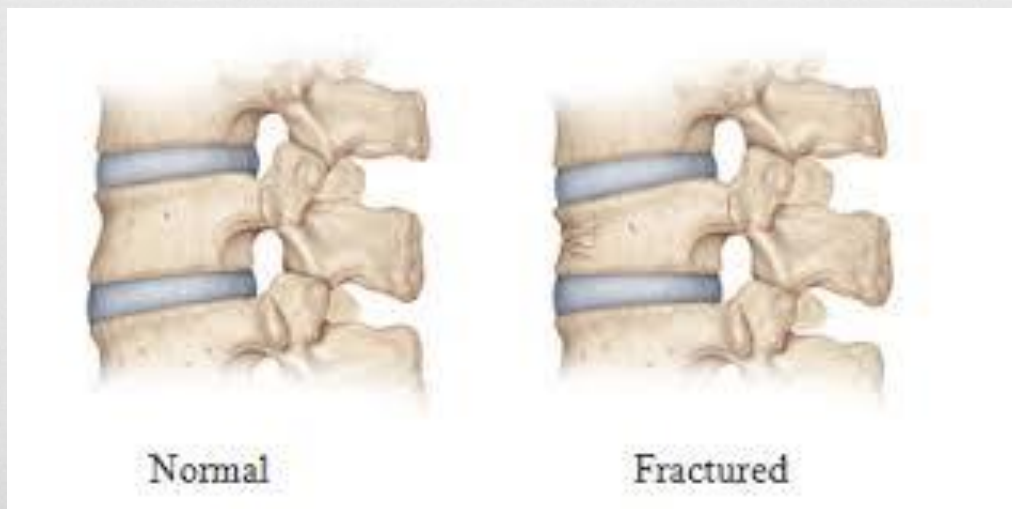
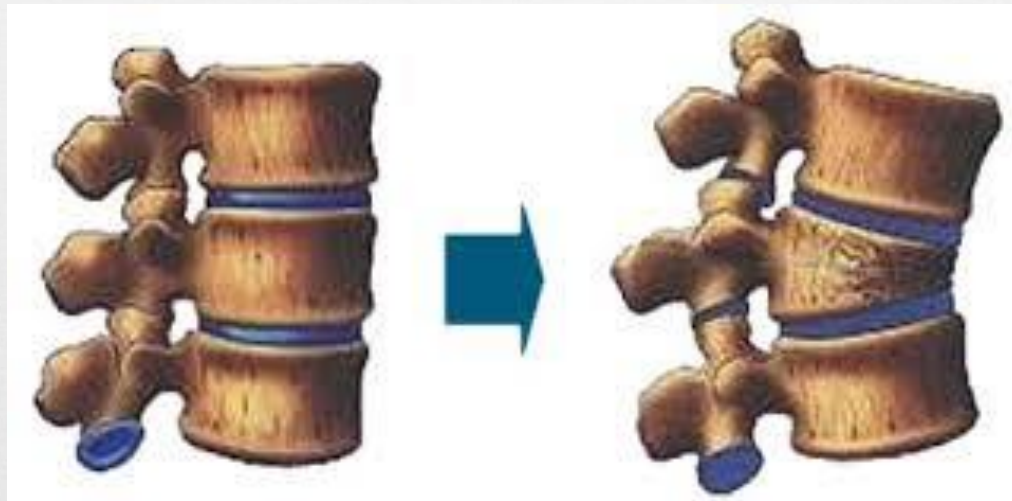


Thoraco-Lumbar fractures



- ❧ Spinal cord terminates at L1/2 disc in adult
 - ❧ L2/3 in a child
- ❧ 50% of injuries occur at Thoraco-lumbar junction
- ❧ Common fractures:
 - ❧ Wedge fracture (flexion/compression)
 - ❧ Burst (compression)
 - ❧ Chance (flexion/distraction)

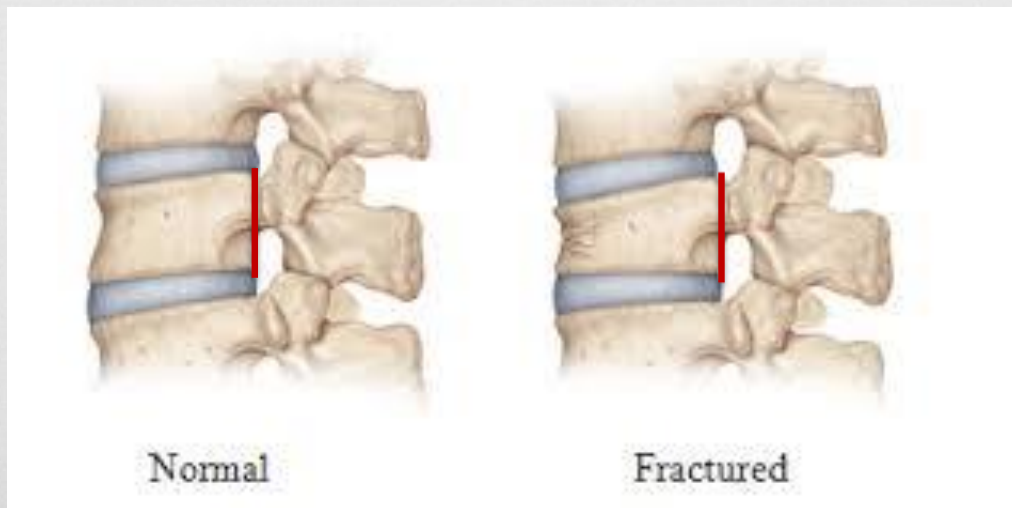
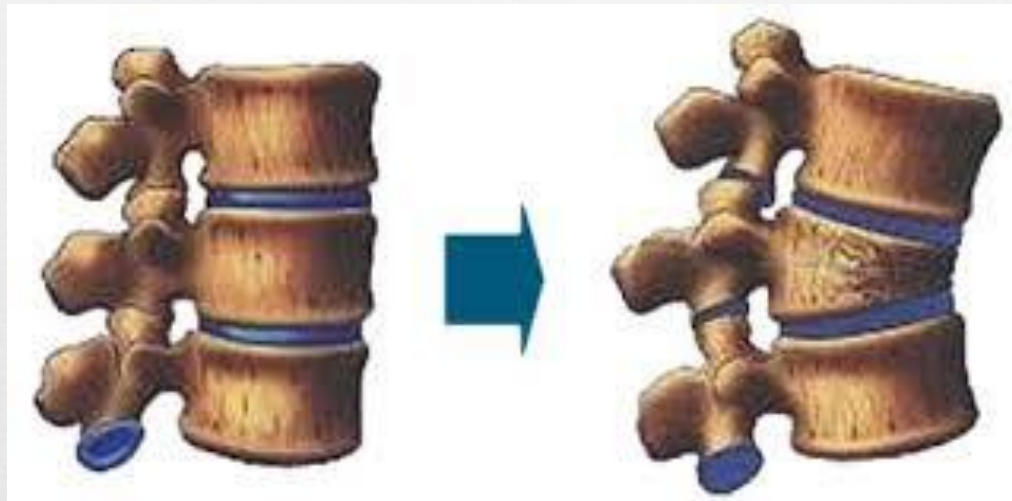
Wedge fracture



Normal

Fractured

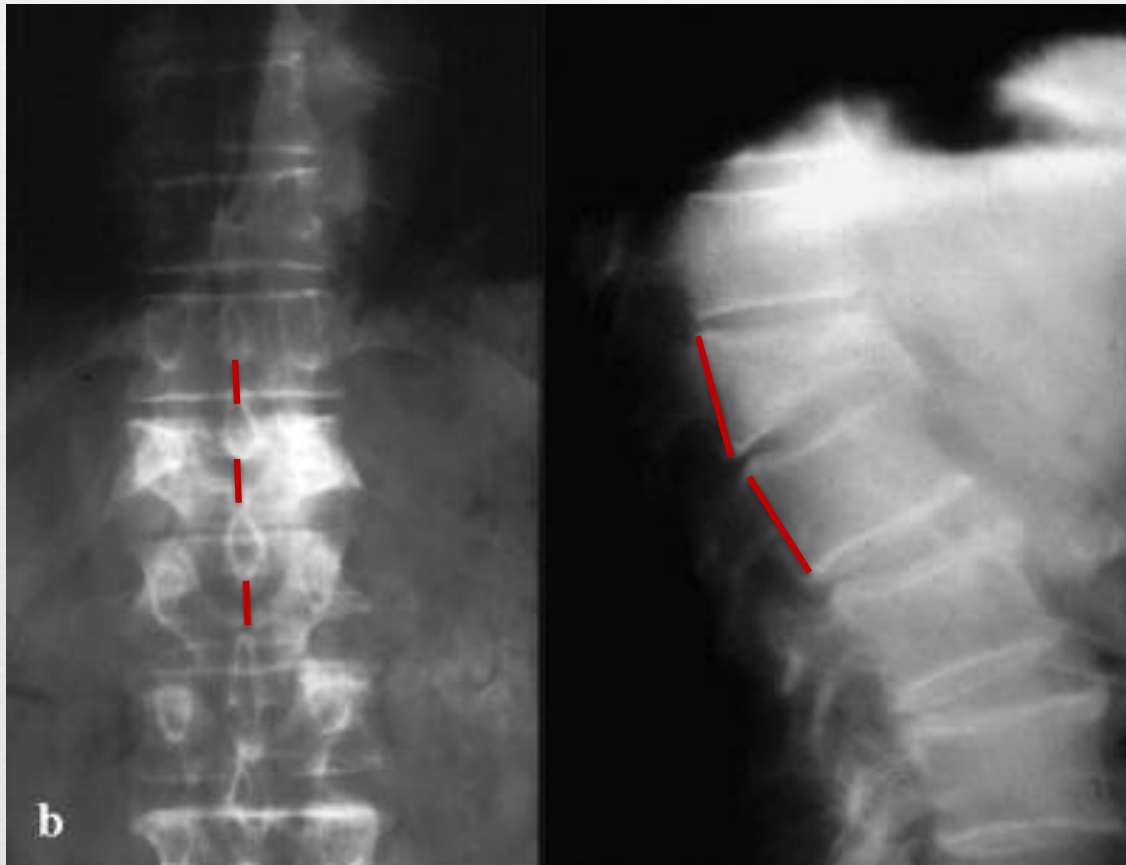
Wedge fracture



Wedge fracture



Wedge fracture



Burst fracture

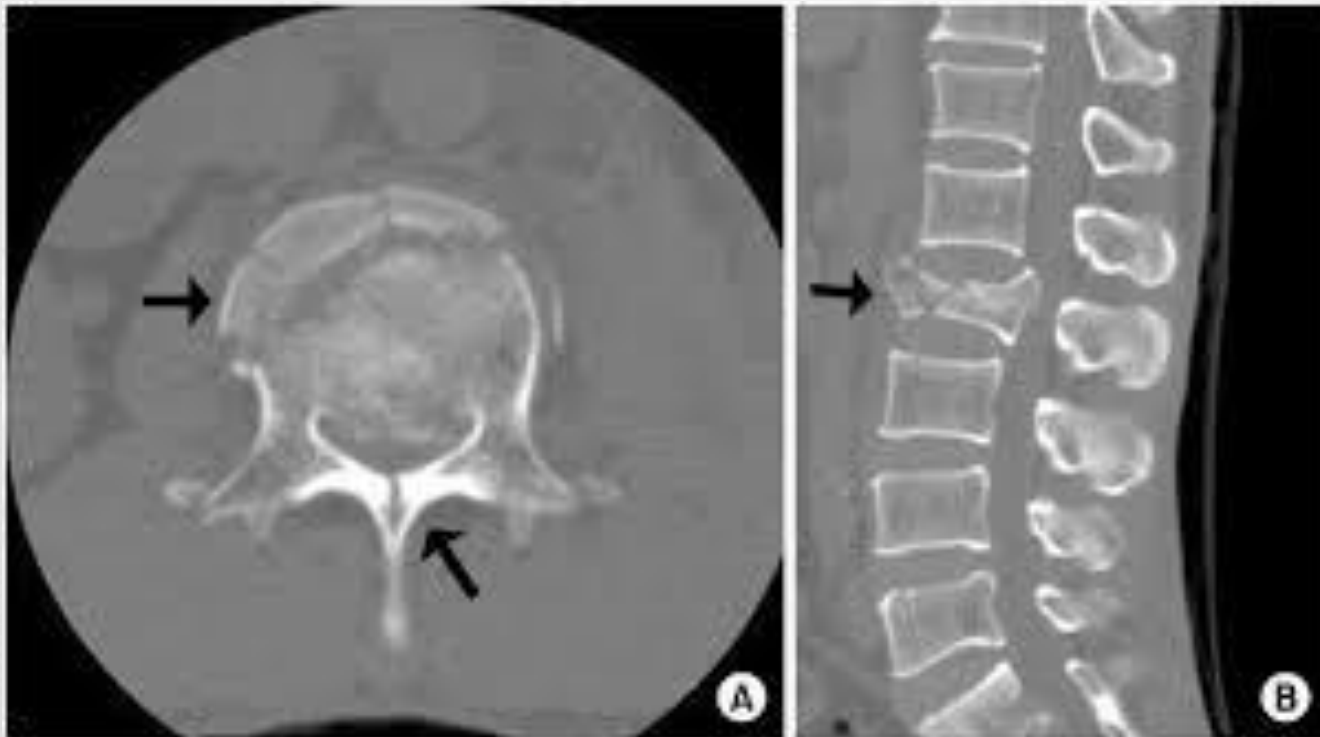


Burst Fractures - characteristics

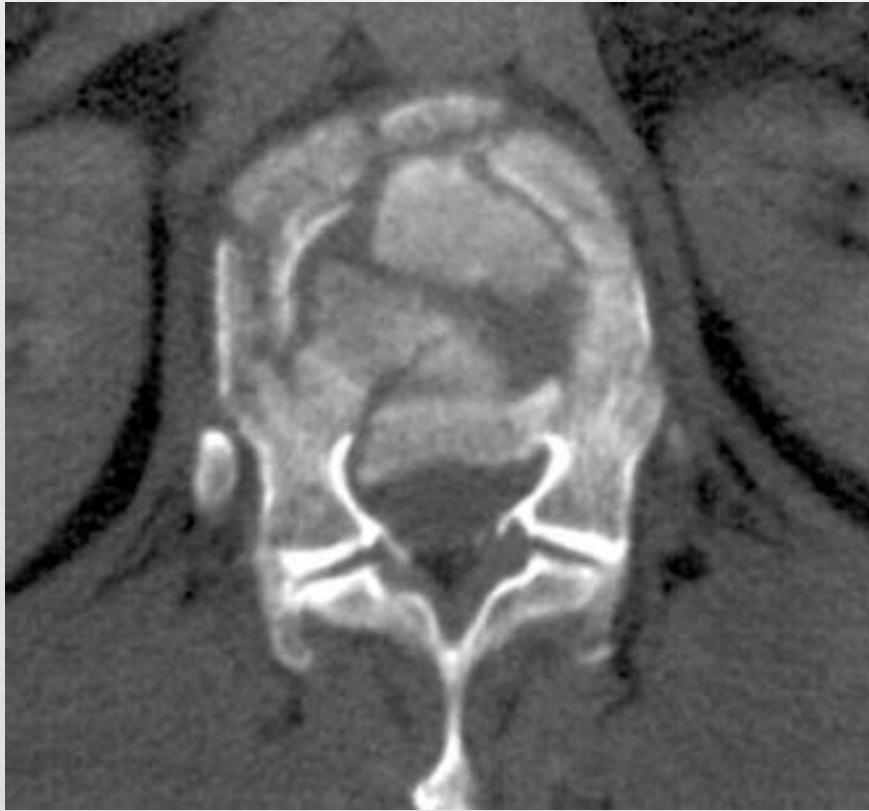
1. **Retropulsion** of posterosuperior vertebral body fragment
 - Wedge compression may **bulge** posterior cortex but not posteriorly displace
2. Sagittal fracture of vertebral body (90%)
3. Sagittal posterior element fracture (85%)
4. Widening of interpedicular distance (80%)



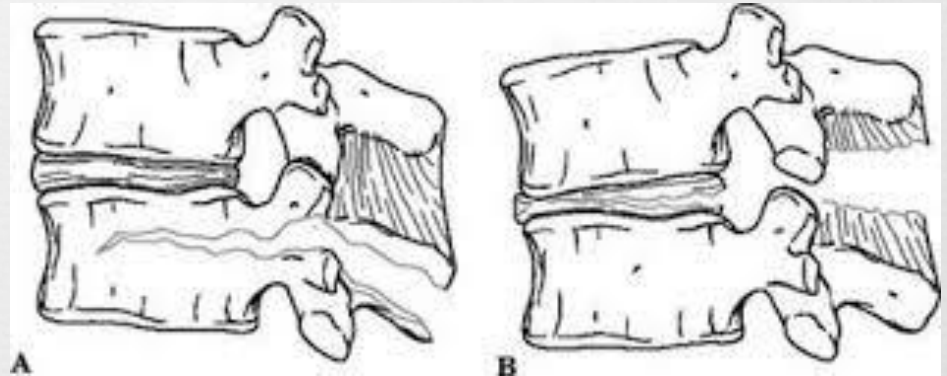
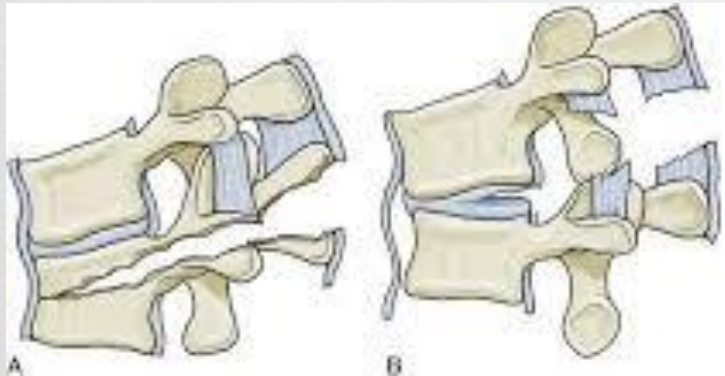
Burst fracture



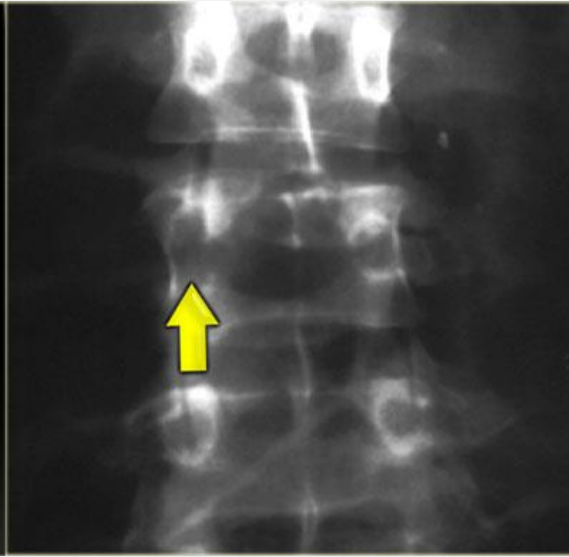
Burst fracture



Chance fracture



Chance fracture



Chance fracture

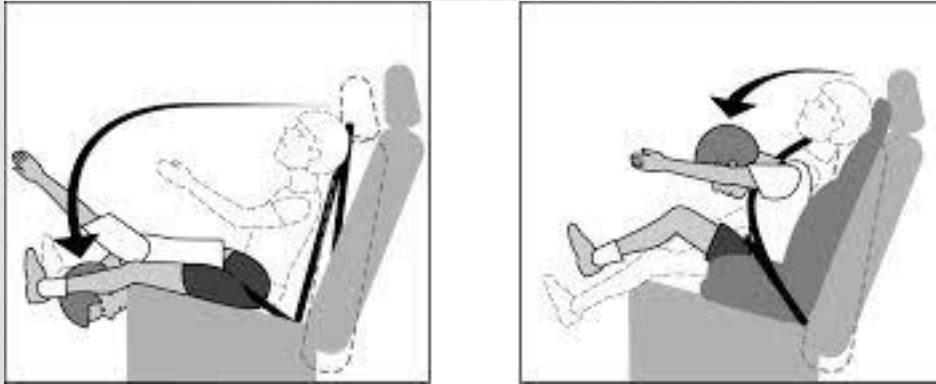
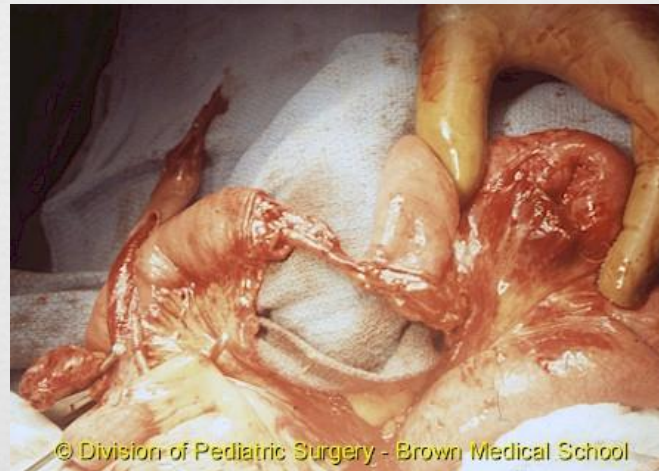


Figure 1. Lap Belt Ecchymosis

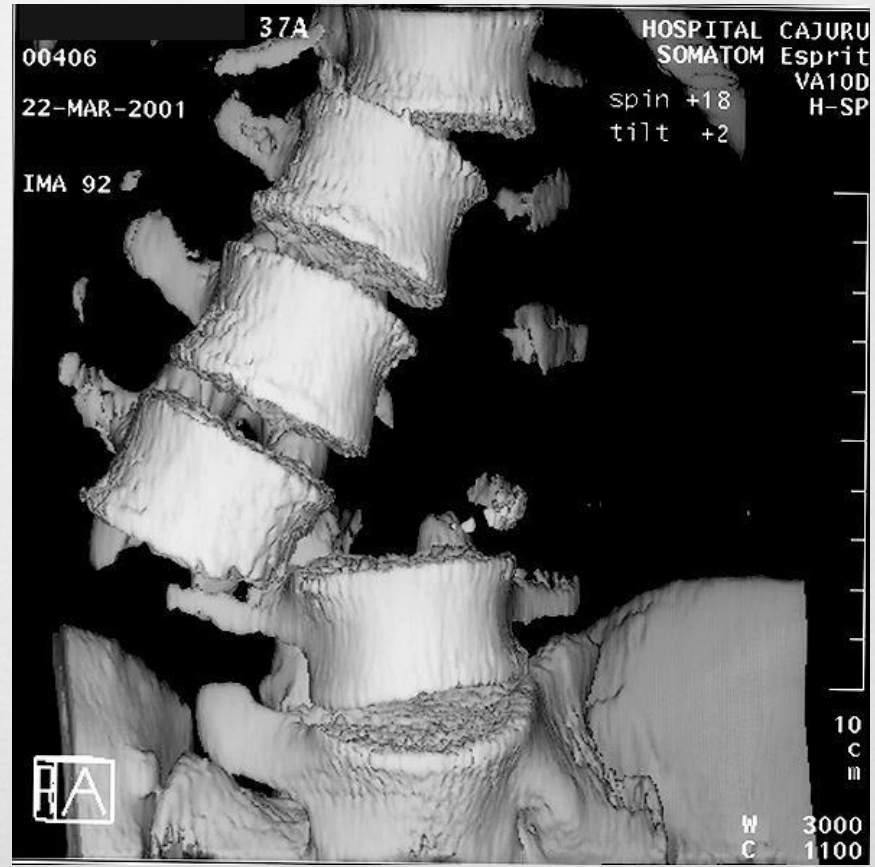


Image courtesy of Dr. Antonio Muñoz.



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Fracture dislocation



Pathologic fractures



- ❧ Low-energy fractures
- ❧ Usually due to infection or tumour
- ❧ Osteoporotic is common
- ❧ X-rays: “winking owl” sign for infection or tumour

Pathologic fractures



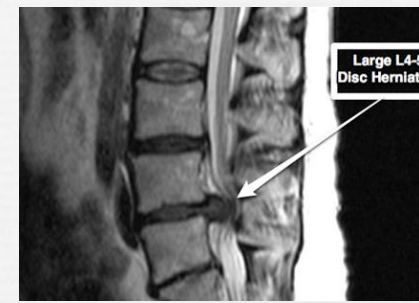
Cauda Equina Syndrome



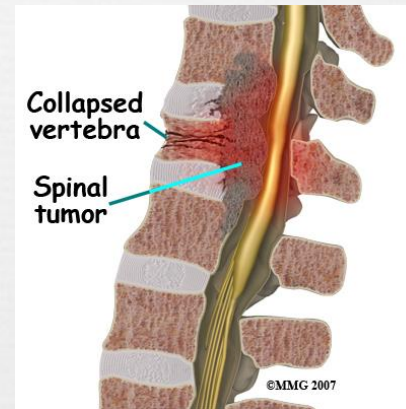
- ❧ A surgical emergency
- ❧ Requires full neurologic examination *including rectal examination for anal tone*
- ❧ Investigations: X-rays initially, but *MRI is mandatory as X-rays are usually unremarkable*
- ❧ Treatment: Emergency decompression-usually discectomy and wide laminectomy within 24 hours

Cauda Equina Causes

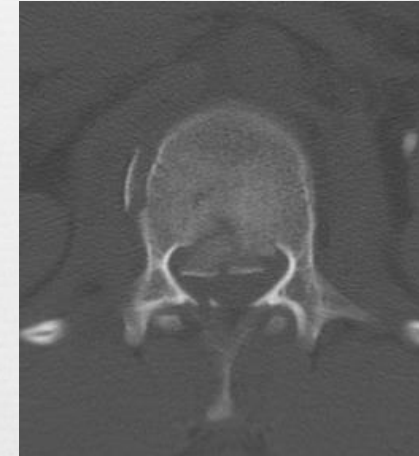
- ❧ Central disc prolapse
- ❧ Burst fractures of lumbar spine
- ❧ Penetrating injuries such as stab wounds or bullets
- ❧ Epidural hematoma from spinal anesthesia, or post surgery(rare)
- ❧ Tumors compressing the lower spinal nerve roots
- ❧ Severe spinal Stenosis



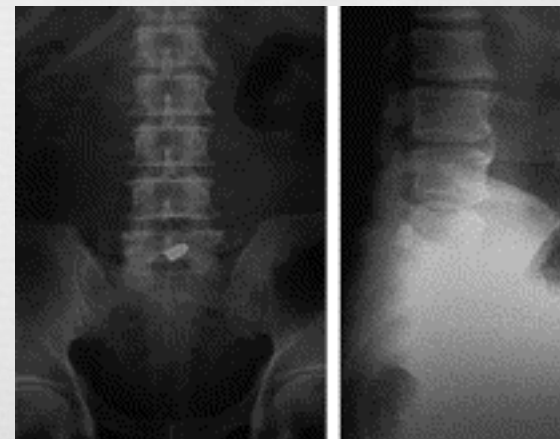
Disc hernia



Tumor

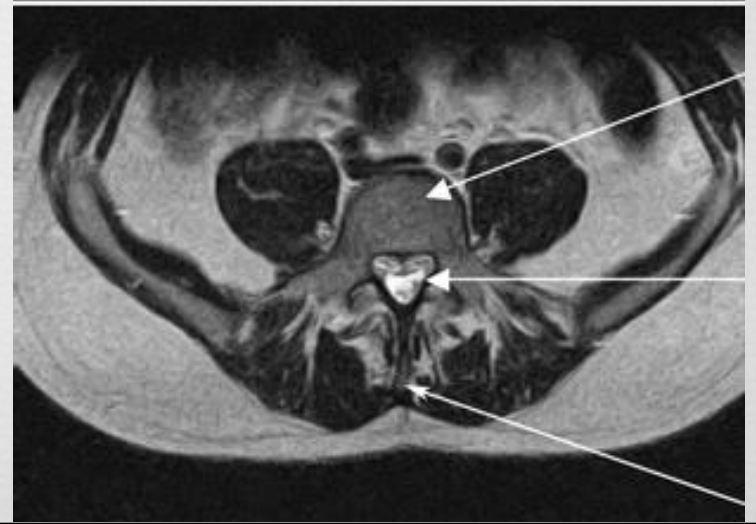


Burst fracture



Bullet to cauda

Cauda Equina Syndrome



Questions

