Spinal injuries

Waleed M. Awwad, MD. FRCSC
Associate professor and Consultant
Orthopedic Surgery department

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


ROSSIGNOL


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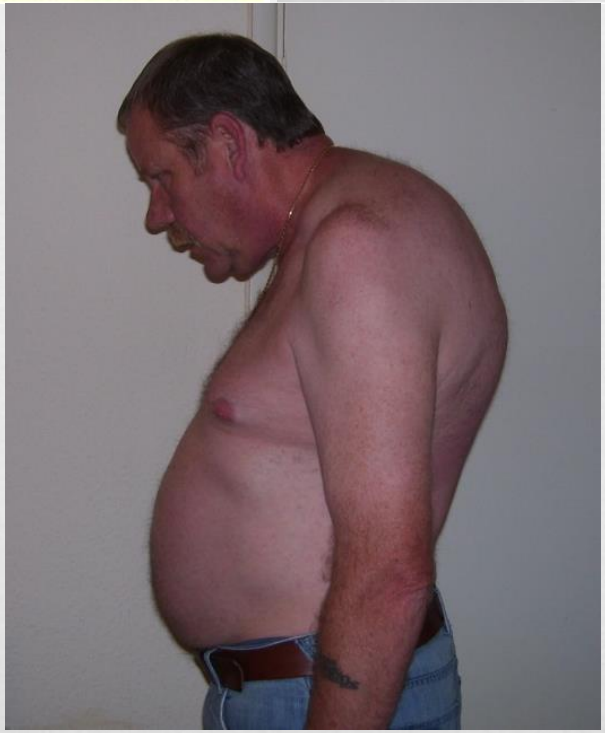


Spine Pathology Red Flag Conditions

- Beware of:

1) Cauda Equina/severe neurologic injury (perianal numbness, decreased rectal tone, loss of movement in the extremeties)

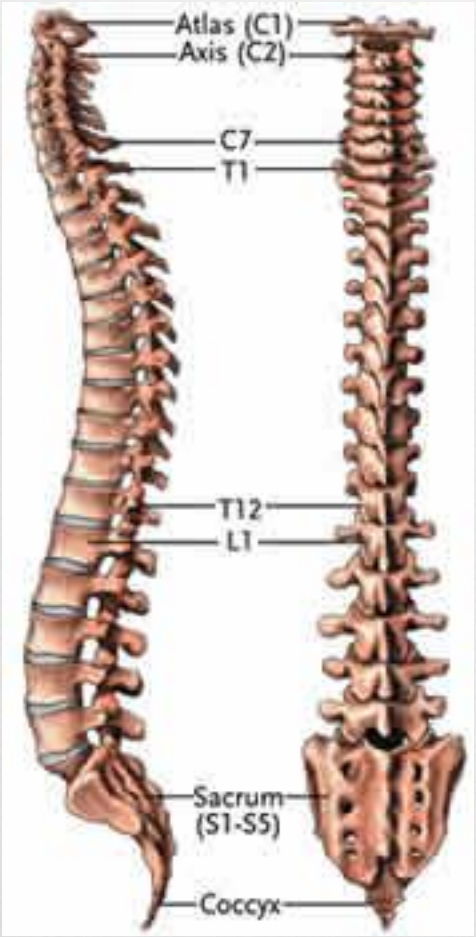
2) Tumour weakening the vertebrae (causing cord compression or vertebral fracture)

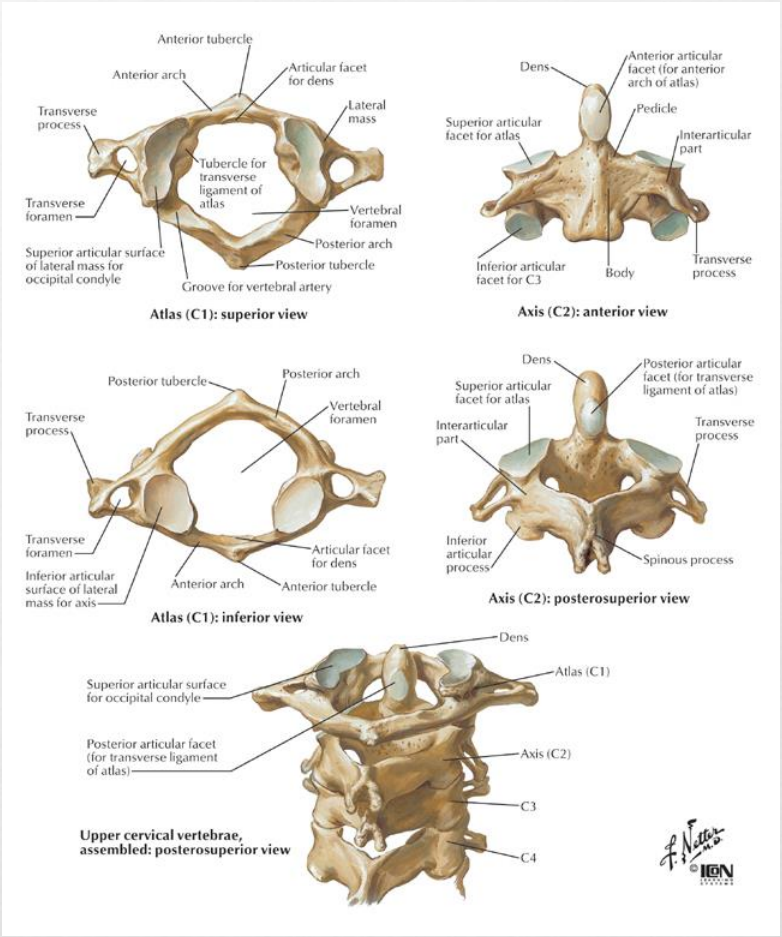
3) Infection weakening bone (causing disc/vertebral destruction or cord compression)

4) Traumatic Spine Fracture (causing vertebral angulation, pain, or neuro compromise)

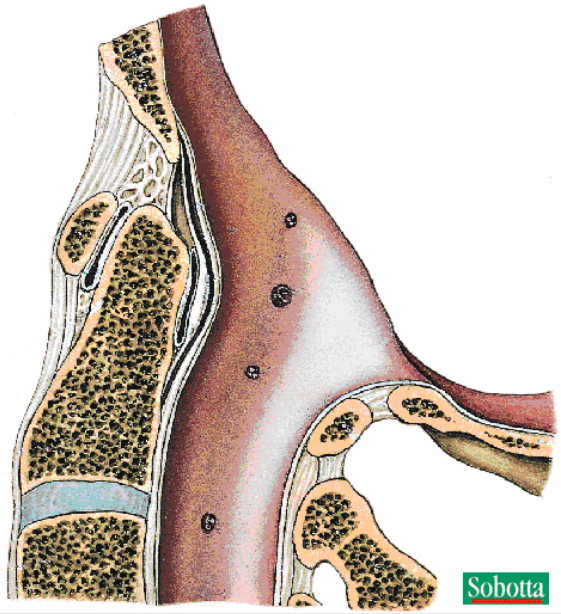
Remember that spine fracture can occur without trauma

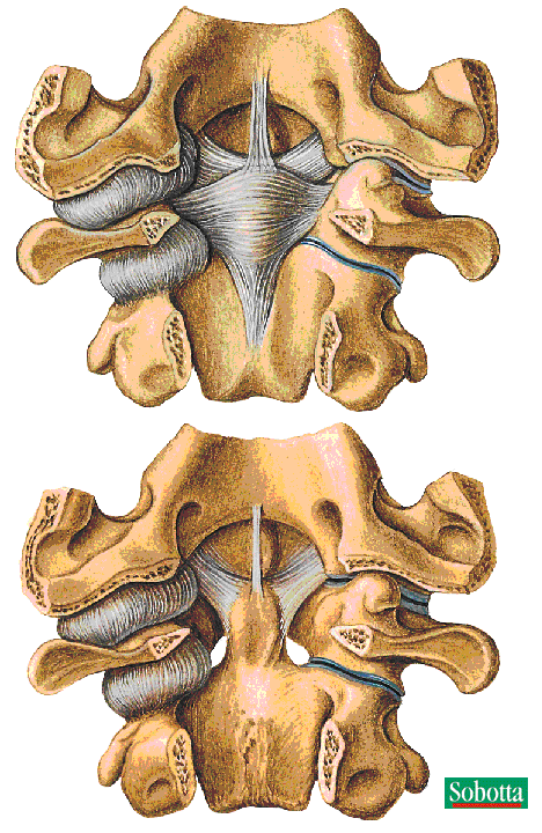
Anatomy

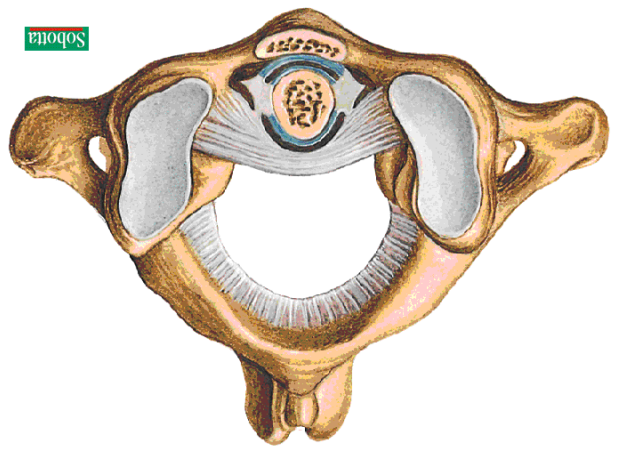

Atlas (C1)
Axis (C2)
C7
T1
T12
L1
Sacrum
(S1-S5)
Coccyx


Anterior tubercle
Anterior arch
Articular facet for dens
Transverse process
Lateral mass
Tubercle for transverse ligament of atlas
Transverse foramen
Vertebral foramen
Posterior arch
Superior articular surface of lateral mass for occipital condyle
Posterior tubercle
Groove for vertebral artery
Atlas (C1): superior view
Dens
Anterior articular facet (for anterior arch of atlas)
Pedicle
Superior articular facet for atlas
Interarticular part
Inferior articular facet for C3
Body
Transverse process
Axis (C2): anterior view
Posterior tubercle
Posterior arch
Vertebral foramen
Transverse process
Transverse foramen
Articular facet for dens
Inferior articular surface of lateral mass for axis
Anterior arch
Anterior tubercle
Atlas (C1): inferior view
Dens
Posterior articular facet (for transverse ligament of atlas)
Superior articular facet for atlas
Interarticular part
Transverse process
Inferior articular process
Spinous process
Axis (C2): posterosuperior view
Dens
Atlas (C1)
Superior articular surface for occipital condyle
Posterior articular facet (for transverse ligament of atlas)
Axis (C2)
C3
C4
Upper cervical vertebrae, assembled: posterosuperior view

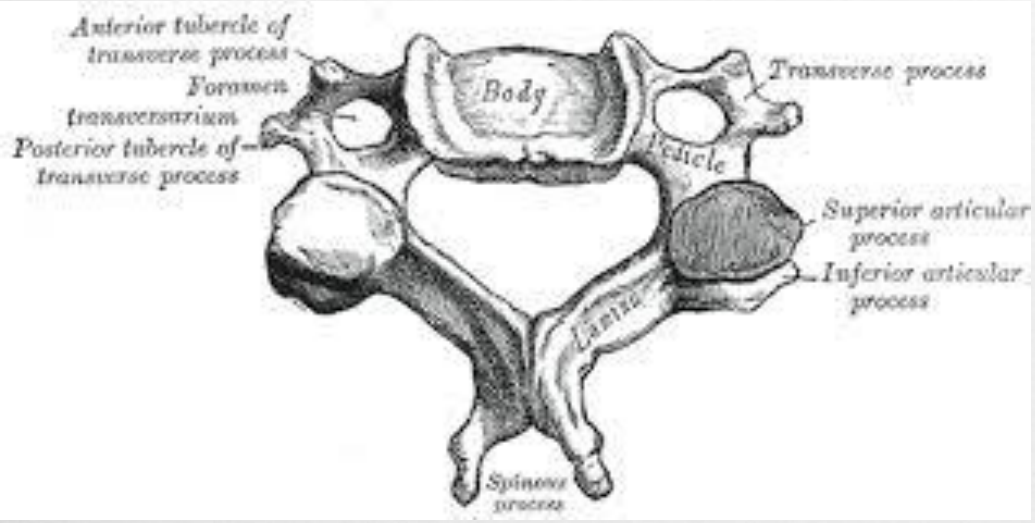
Anatomy

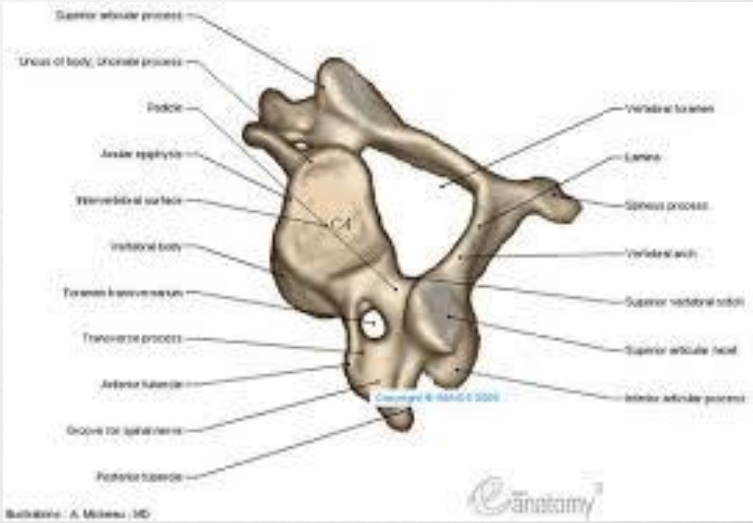




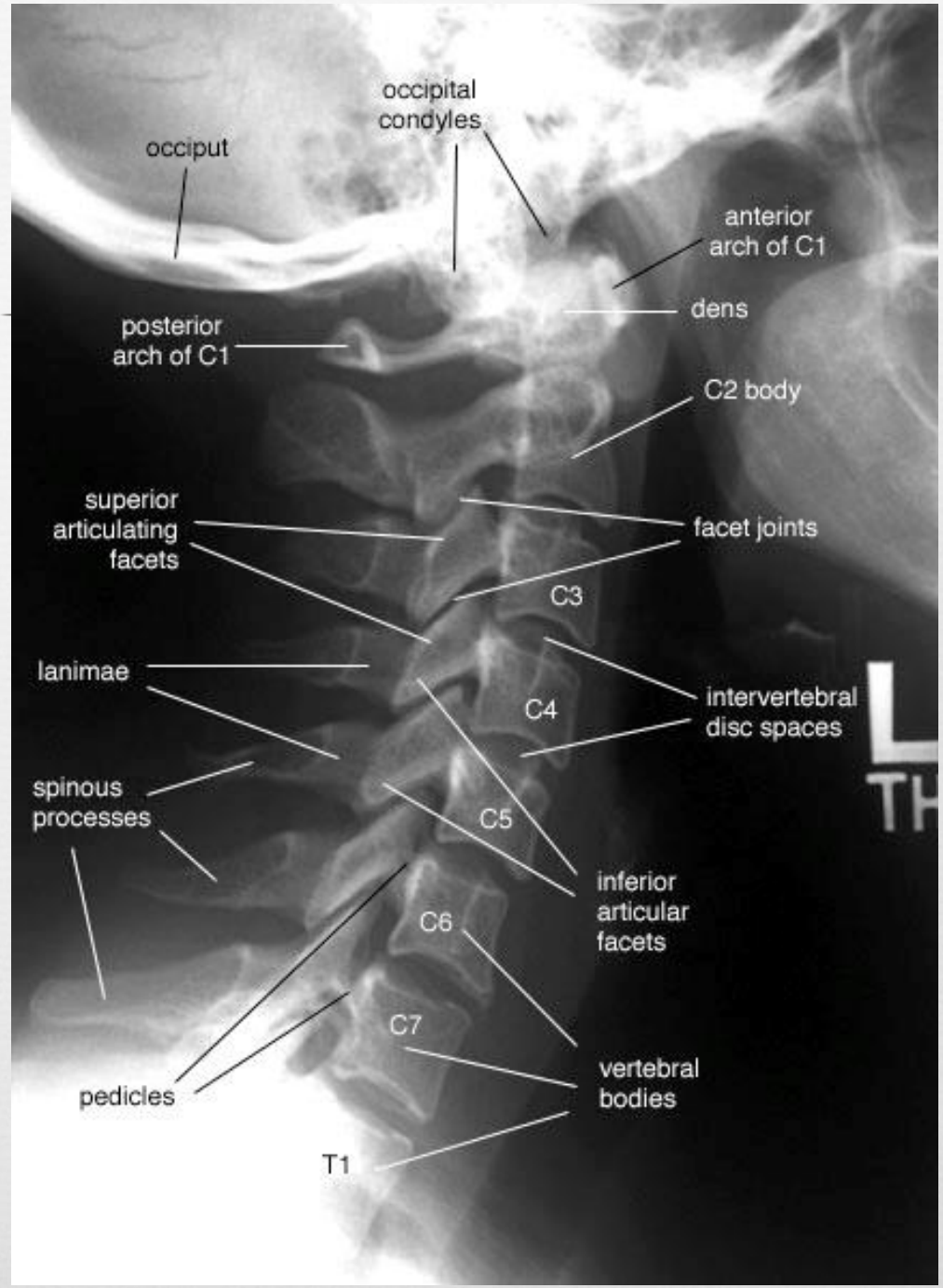


Anatomy

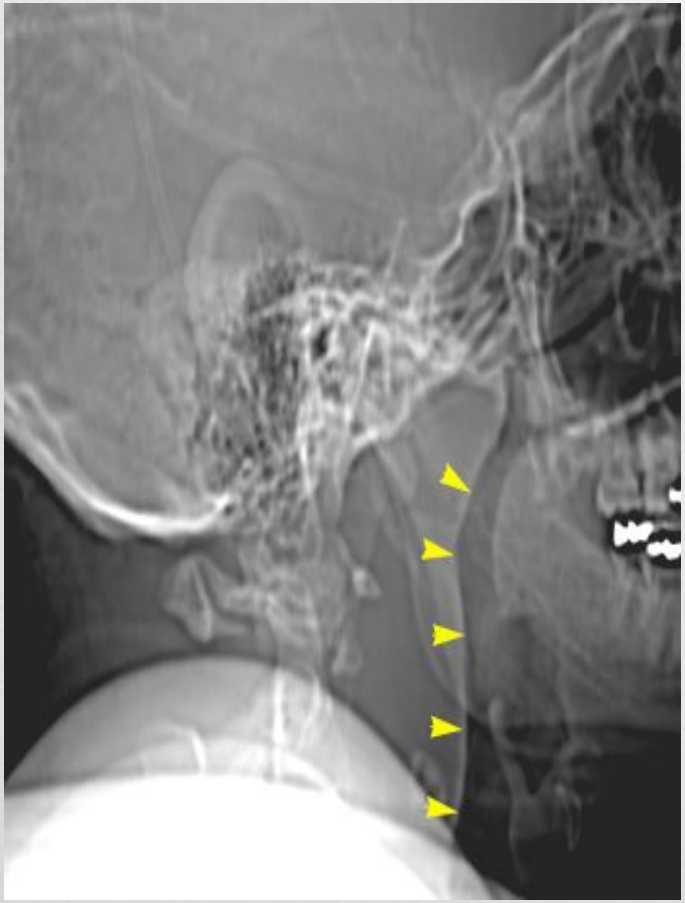

Anterior tubercle of transverse process
Foramen transversarium
Posterior tubercle of transverse process
Body
Pedicle
Transverse process
Superior articular process
Inferior articular process
Lamina
Spinous process

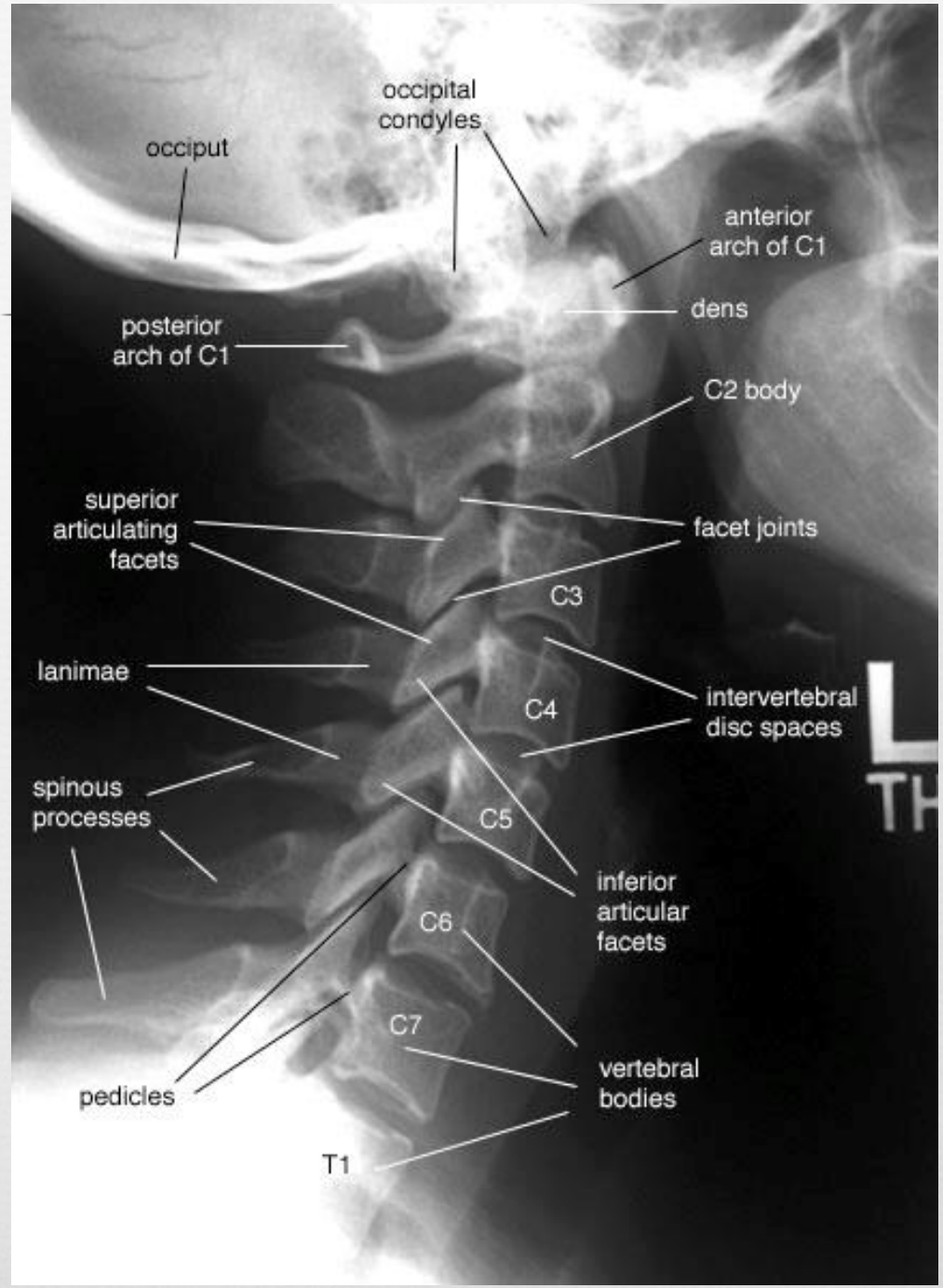

Superior articular process
Union of body, Uncinate process
Pedicle
Anular epiphysis
Intervertebral surface
Vertebral body
Foramen transversarium
Transverse process
Anterior tubercle
Groove for spinal nerve
Posterior tubercle
Vertebral foramen
Lamina
Spinous process
Vertebral arch
Superior vertebral notch
Superior articular facet
Inferior articular process
C4
Anatomy

Anatomy

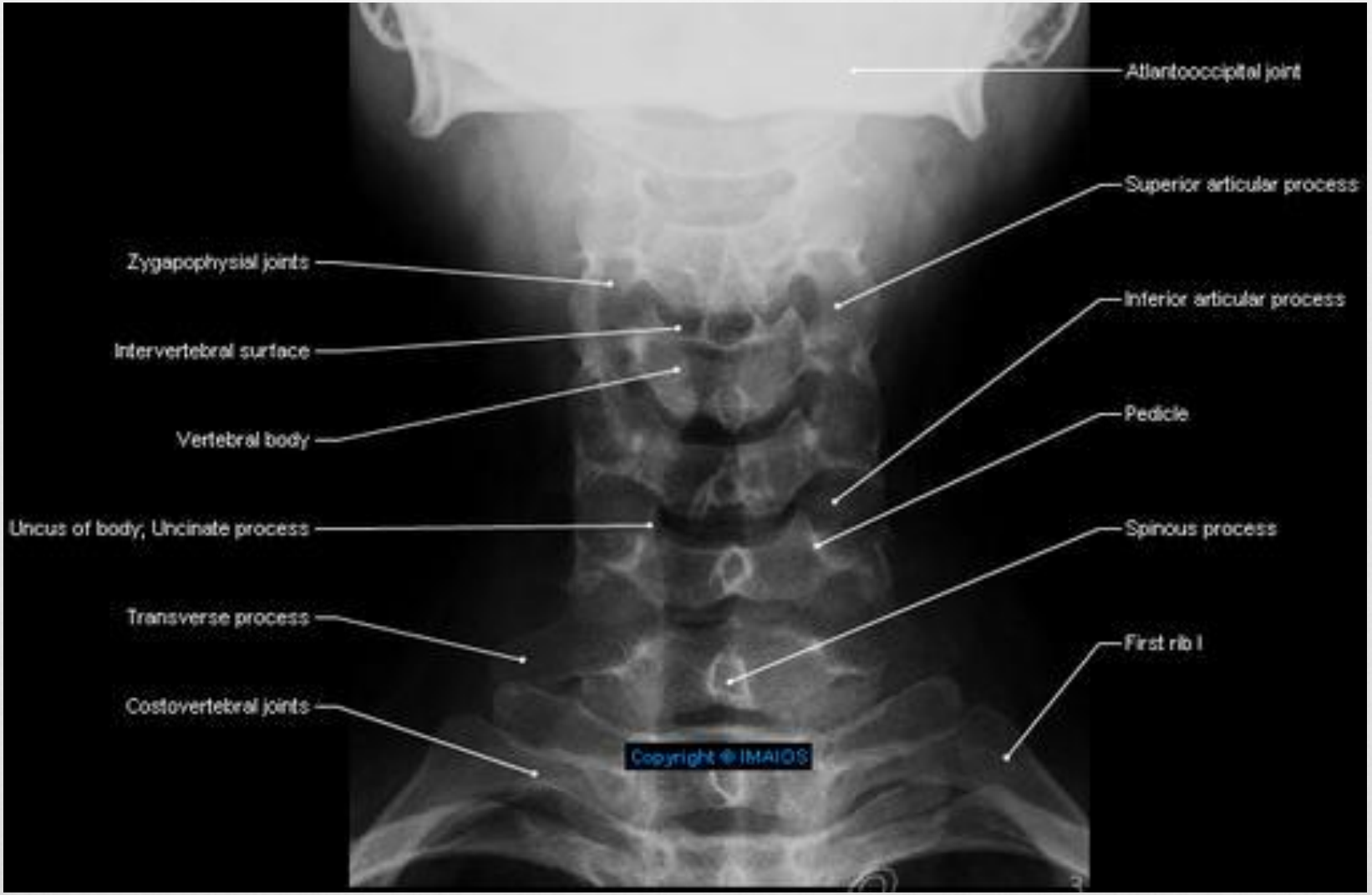

occipital condyles
occiput
anterior arch of C1
dens
posterior arch of C1
C2 body
superior articulating facets
facet joints
C3
lanimae
C4
intervertebral disc spaces
spinous processes
C5
inferior articular facets
C6
C7
vertebral bodies
pedicles
T1

Anatomy




occipital condyles
occiput
anterior arch of C1
dens
posterior arch of C1
C2 body
superior articulating facets
facet joints
C3
lanimae
C4
intervertebral disc spaces
spinous processes
C5
inferior articular facets
C6
C7
vertebral bodies
pedicles
T1

Anatomy


Atlantooccipital joint
Superior articular process
Zygapophysial joints
Inferior articular process
Intervertebral surface
Pedicle
Vertebral body
Uncus of body; Uncinate process
Spinous process
Transverse process
First rib
Costovertebral joints
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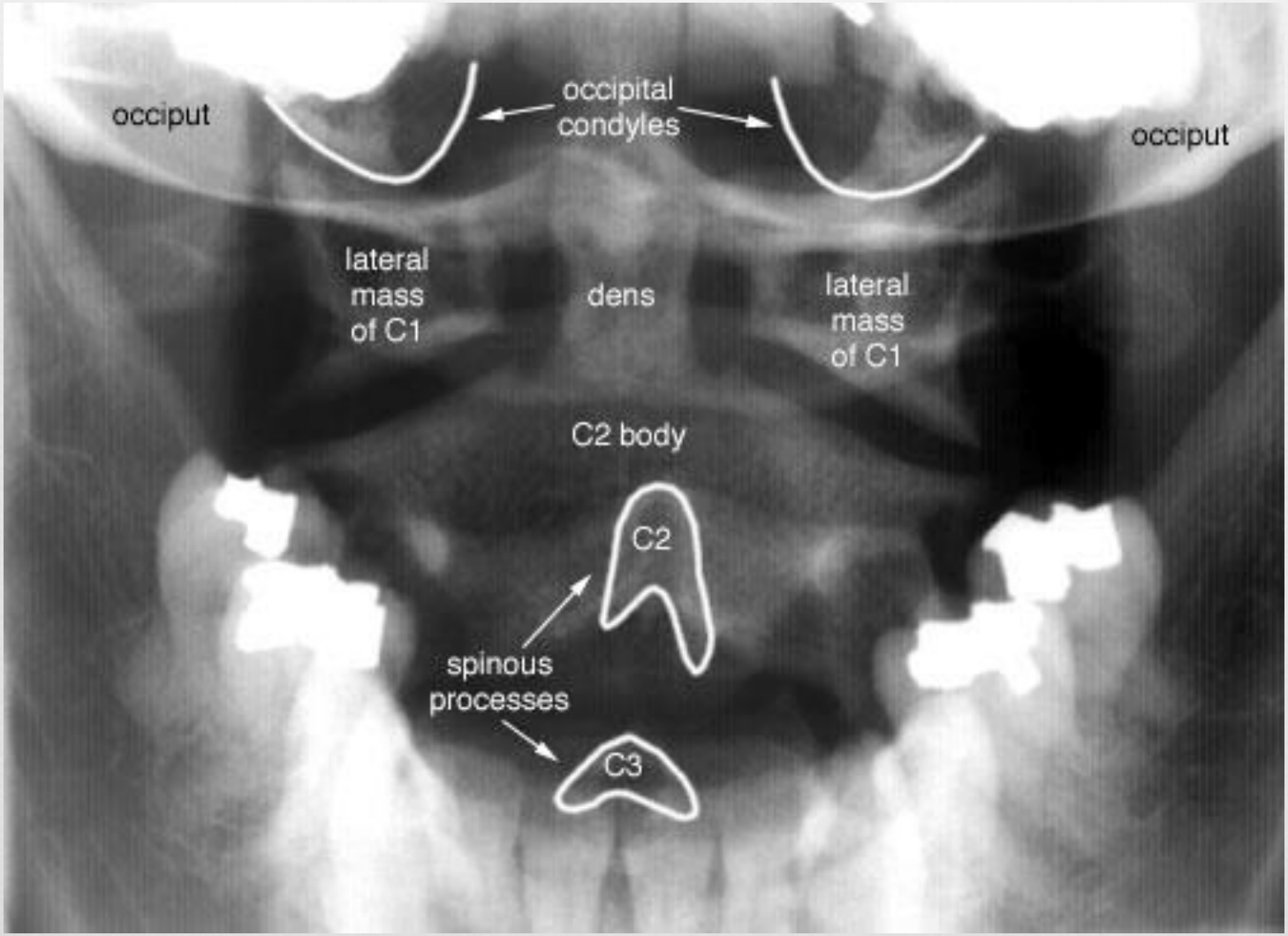
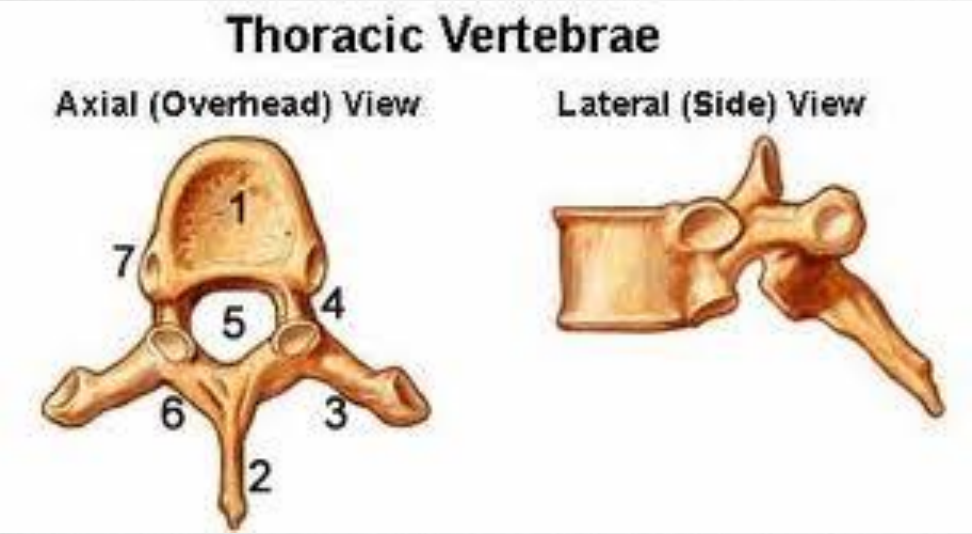
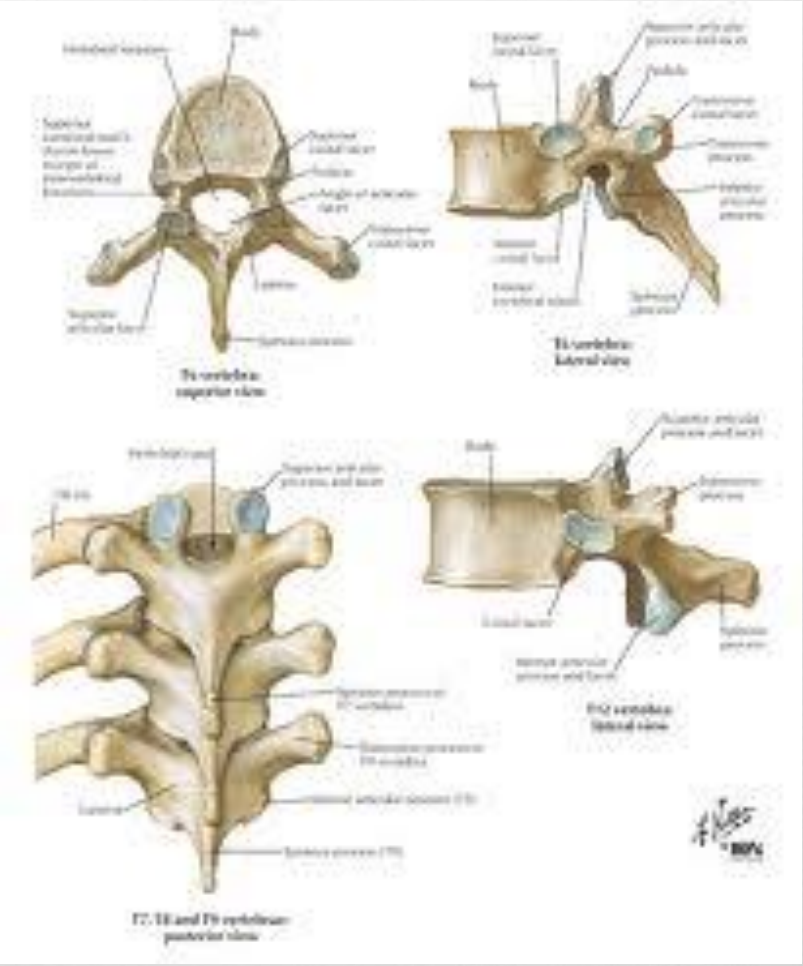
Anatomy


occiput
occipital condyles
occiput
lateral mass of C1
dens
lateral mass of C1
C2 body
C2
spinous processes
C3

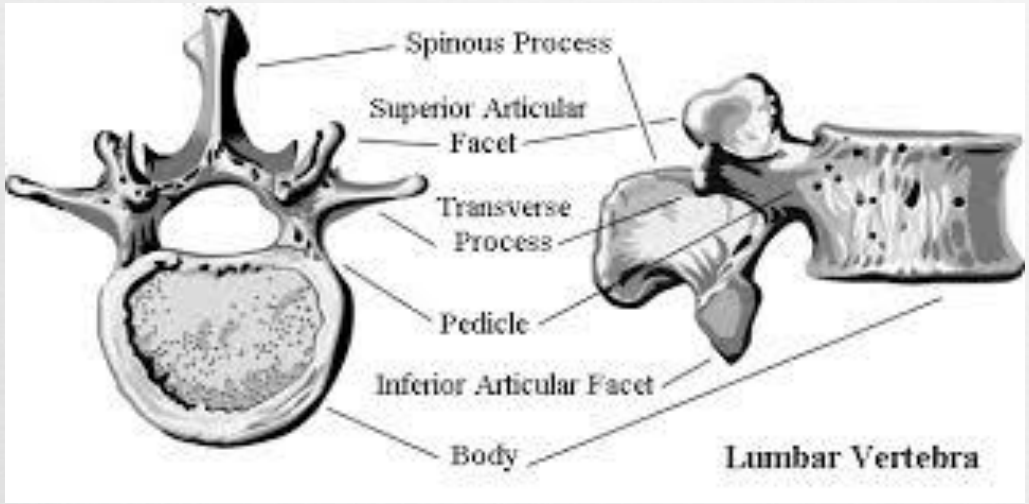
Anatomy

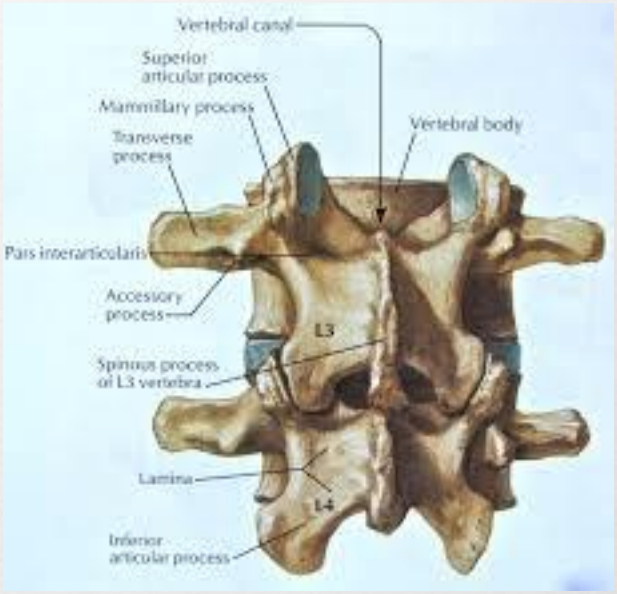

Thoracic Vertebrae
Axial (Overhead) View
Lateral (Side) View
1
7
4
5
6
3
2



Anatomy

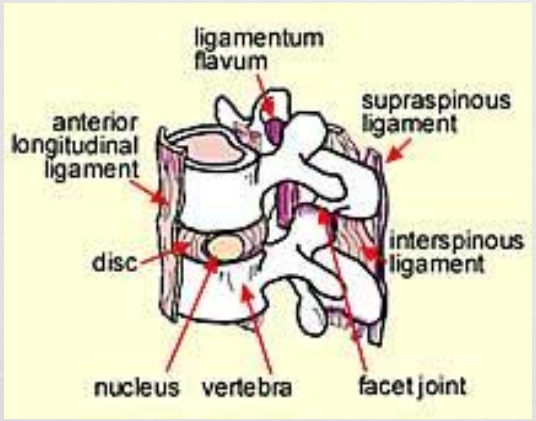
Anatomy

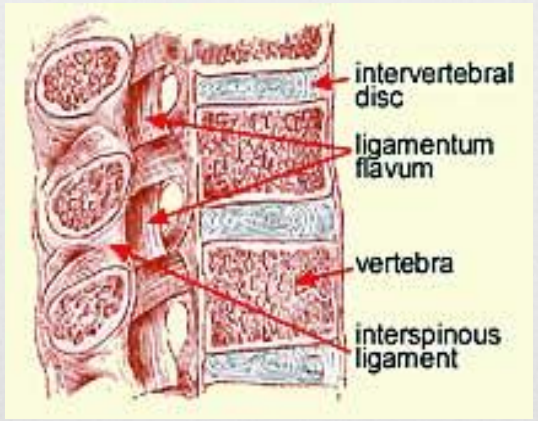

Spinous Process
Superior Articular Facet
Transverse Process
Pedicle
Inferior Articular Facet
Body
Lumbar Vertebra

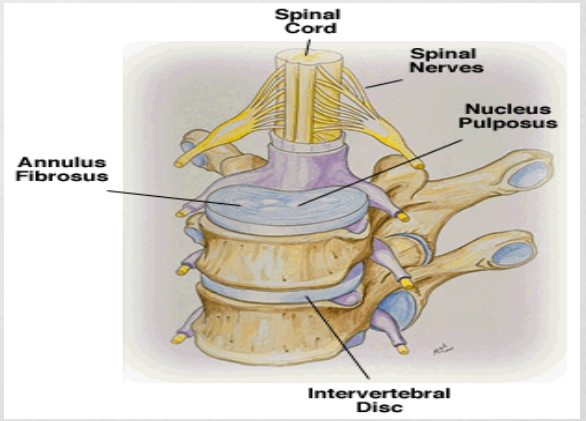

Vertebral canal
Superior articular process
Mammillary process
Transverse process
Vertebral body
Pars interarticularis
Accessory process
L3
Spinous process of L3 vertebra
Lamina
L4
Inferior articular process

Anatomy

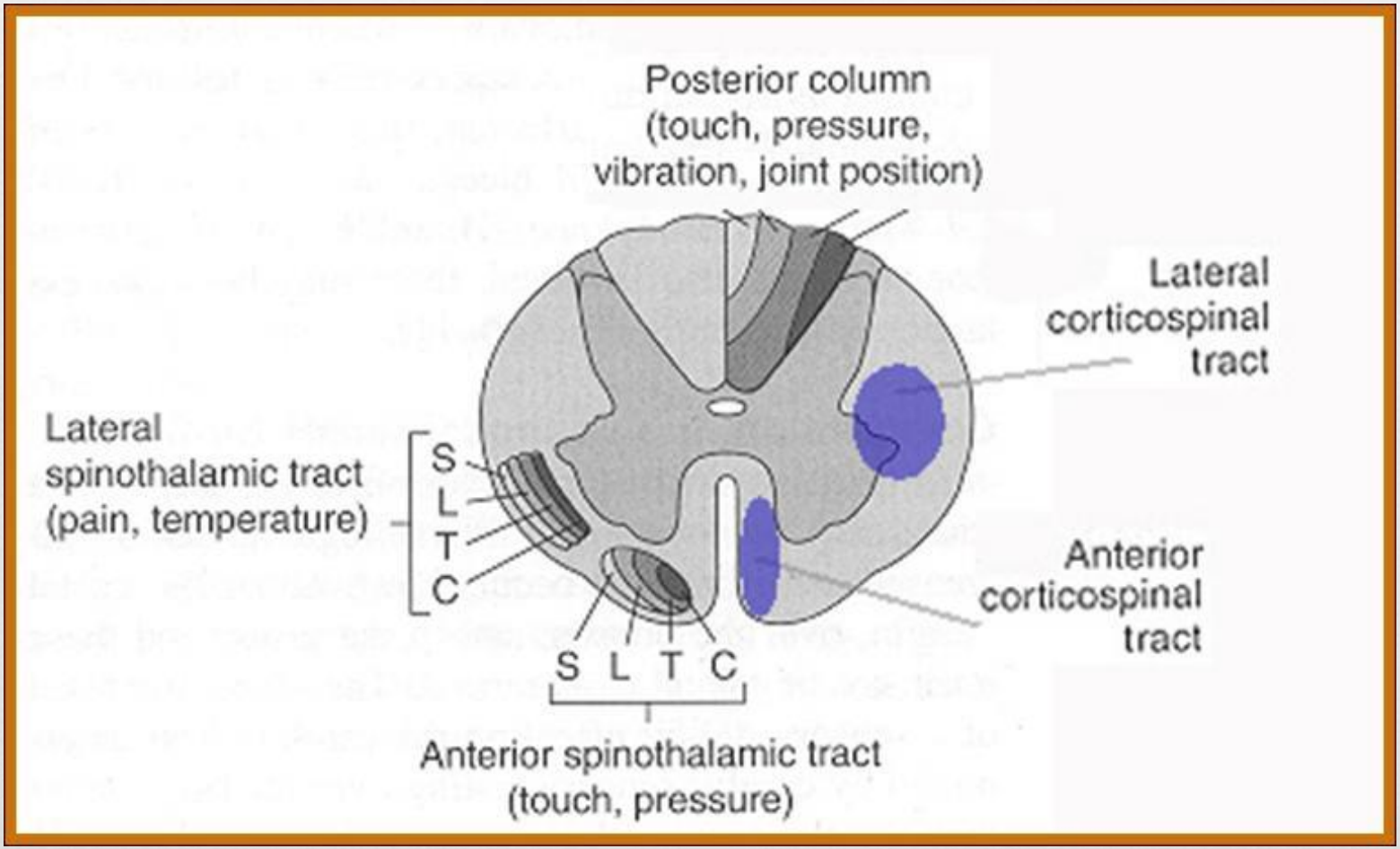
Anatomy


ligamentum flavum
supraspinous ligament
anterior longitudinal ligament
interspinous ligament
disc
nucleus
vertebra
facet joint


intervertebral disc
ligamentum flavum
vertebra
interspinous ligament


Spinal Cord
Spinal Nerves
Nucleus Pulposus
Annulus Fibrosus
Intervertebral Disc

Anatomy


Posterior column
(touch, pressure,
vibration, joint position)
Lateral
corticospinal
tract
Lateral
spinothalamic tract
(pain, temperature)
S
L
T
C
Anterior
corticospinal
tract
S L T C
Anterior spinothalamic tract
(touch, pressure)

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)

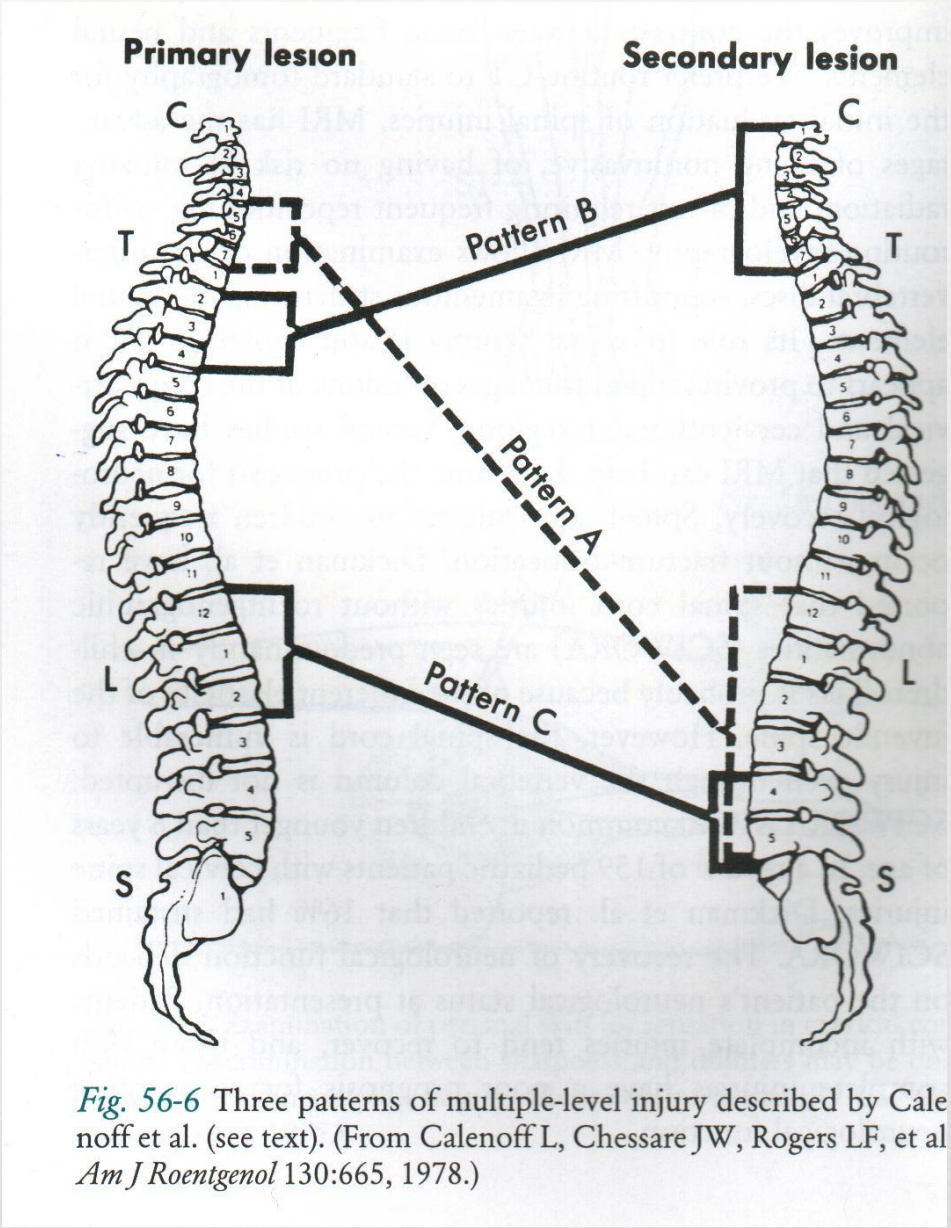


Fig. 56-6 Three patterns of multiple-level injury described by Calenoff et al. (see text). (From Calenoff L, Chessare JW, Rogers LF, et al *Am J Roentgenol* 130:665, 1978.)


Ser./Img.: 1001 / 96
Contr:
atrix: 512*512
: 140


Thickn.: 1.0mm
Pat.Pos.: HFS
3 / 40
10 cm
Thickn.: 2.0mm
Pat.Pos.: HFS
R
10 cm

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 metatstatic vertebral lesions)
- Penetrating trauma from gunshot or knives

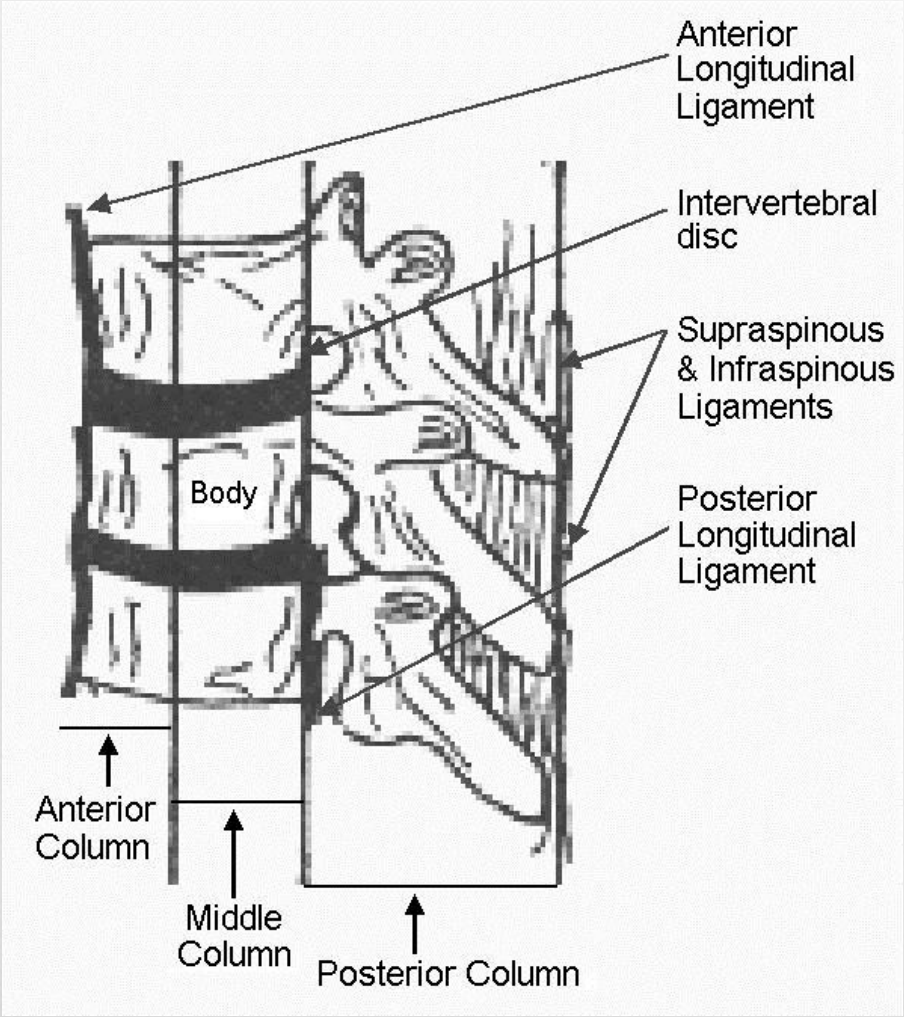

(COl)
Acq
m/s
n:DCM / Id:ID
50
DFOV


340

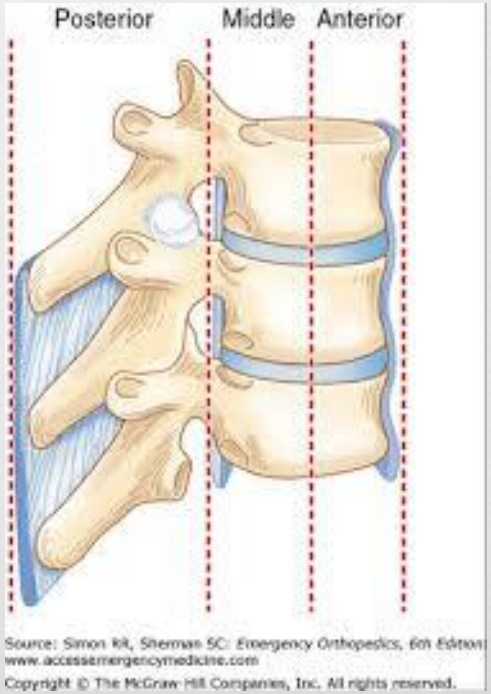
Spine stability

- 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

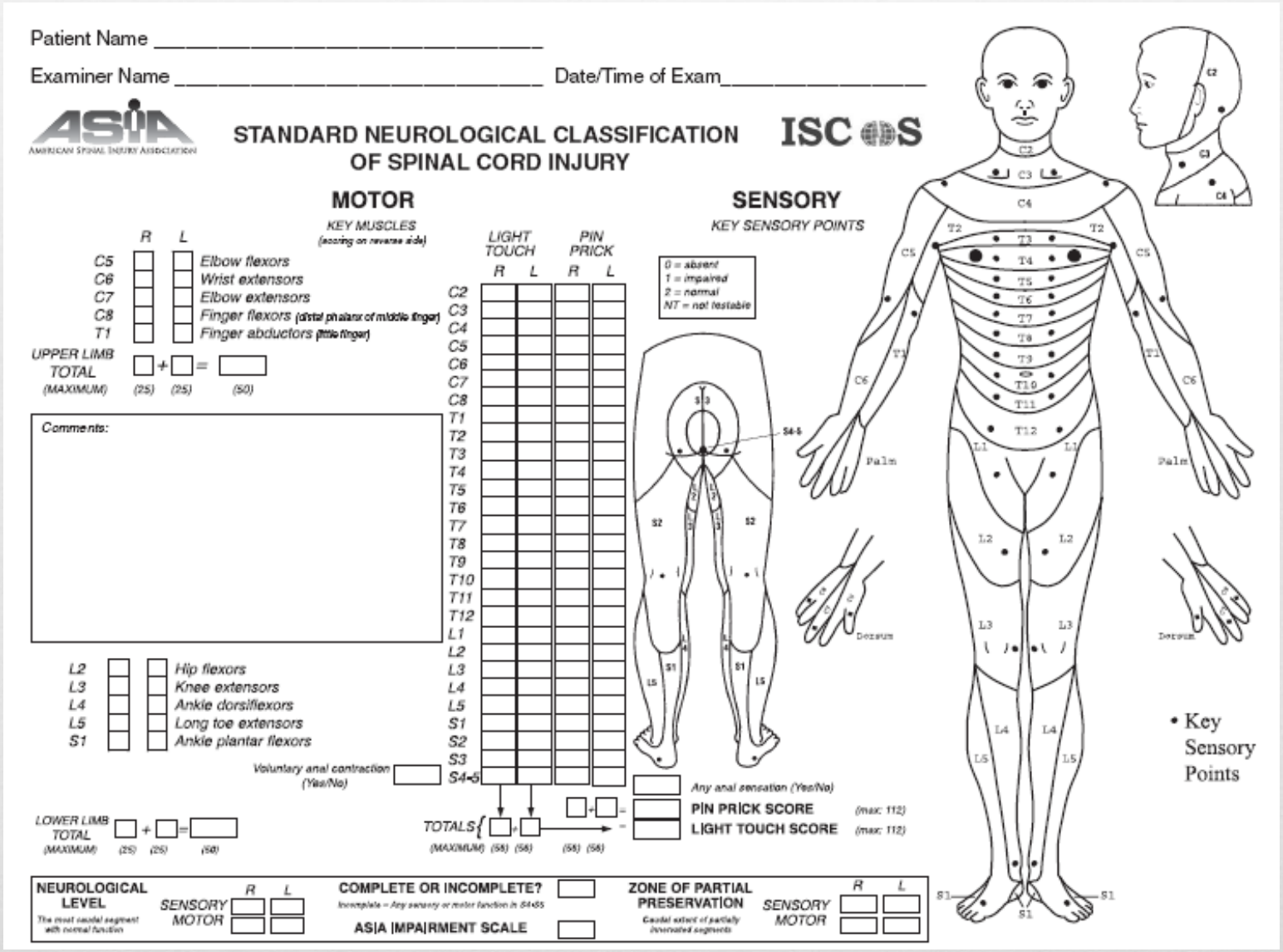
light touch, Sharp dull discrimination, Vibration sense, Proprioception and two-point discrimination

- 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 dermatones)
- Loss of rectal tone
- Positive Babinski sign

Asia Score: Brief Trauma Neurologic Survey



Patient Name _____

Examiner Name _____ Date/Time of Exam_____

ASIA
American Spinal Injury Association

STANDARD NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY

ISCOS

MOTOR

KEY MUSCLES (scoring on reverse side)

	R	L	
C5			Elbow flexors
C6			Wrist extensors
C7			Elbow extensors
C8			Finger flexors (distal phalanx of middle finger)
T1			Finger abductors (little finger)

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

Comments:

L2			Hip flexors
L3			Knee extensors
L4			Ankle dors/flexors
L5			Long toe extensors
S1			Ankle plantar flexors

Voluntary anal contraction (Yes/No) ____

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

SENSORY

KEY SENSORY POINTS

	LIGHT TOUCH R	LIGHT TOUCH L	PIN PRICK R	PIN PRICK 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

Any anal sensation (Yes/No) ____

PIN PRICK SCORE (max: 112) ____

LIGHT TOUCH SCORE (max: 112) ____

TOTALS (MAXIMUM) ____ (56) + ____ (56) = ____ (56) + ____ (56) = ____

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 ____

- Key Sensory Points

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:

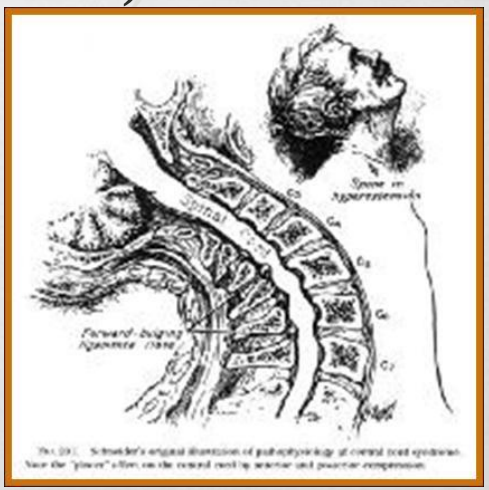
Characterized by disproportionally (UL>LL)

Mechanism: hyper-extension

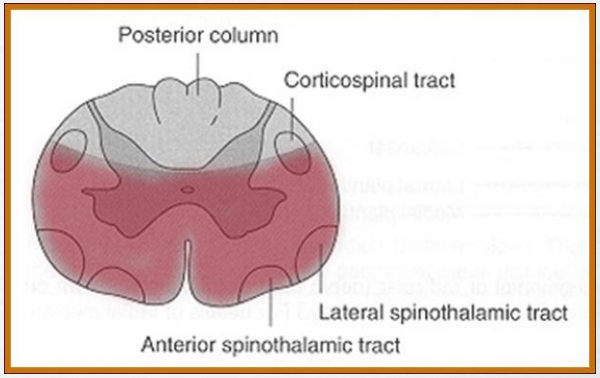
Occur with or without fractures

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-apposed 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

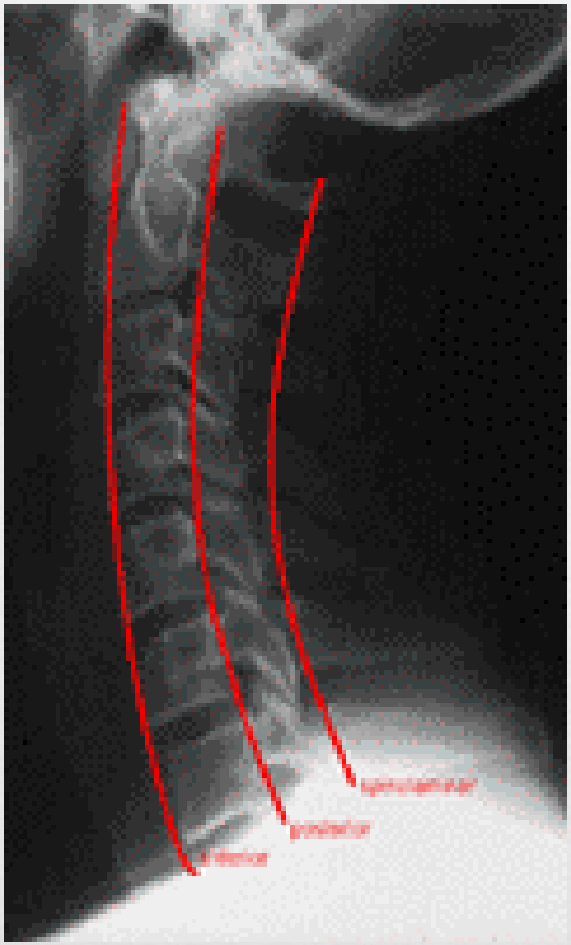
Cervical spine fractures

- 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

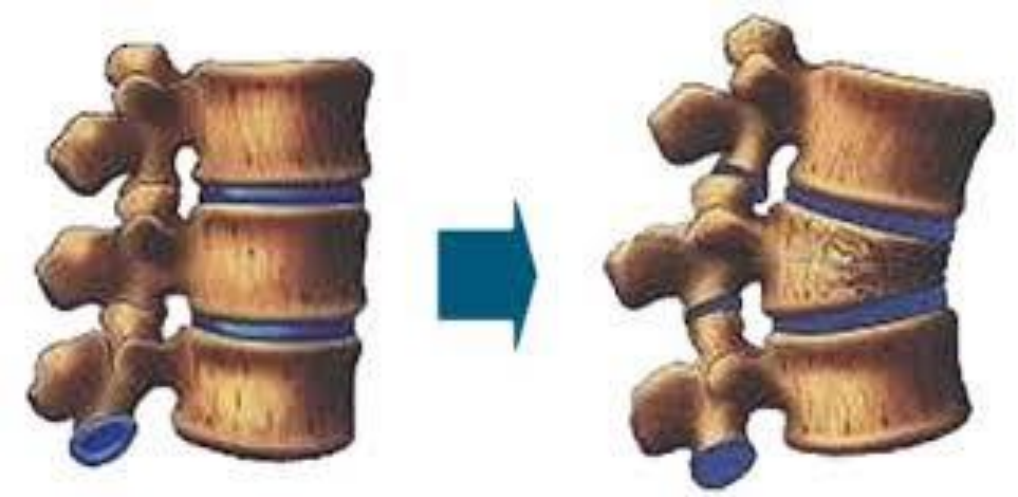
Cervical spine fractures

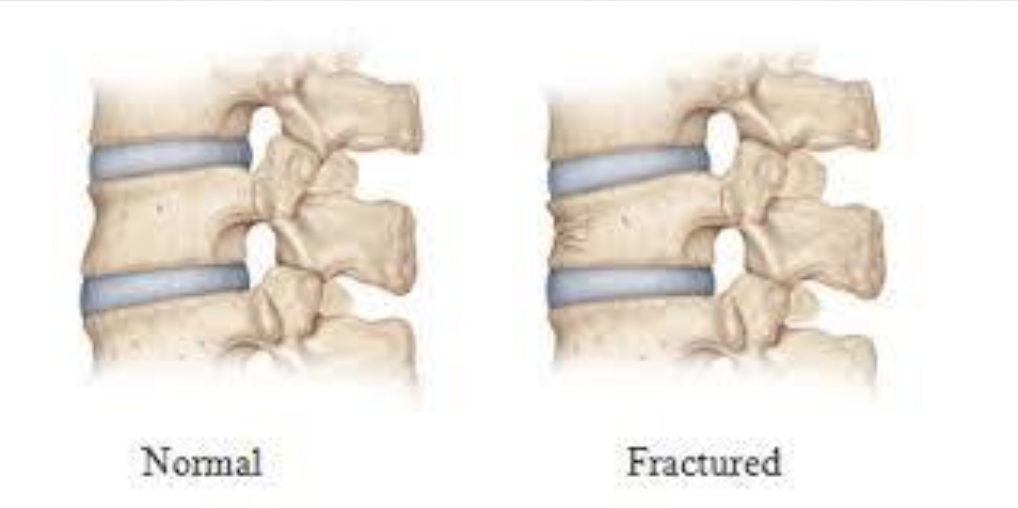


Thoraco-Lumbar fractures

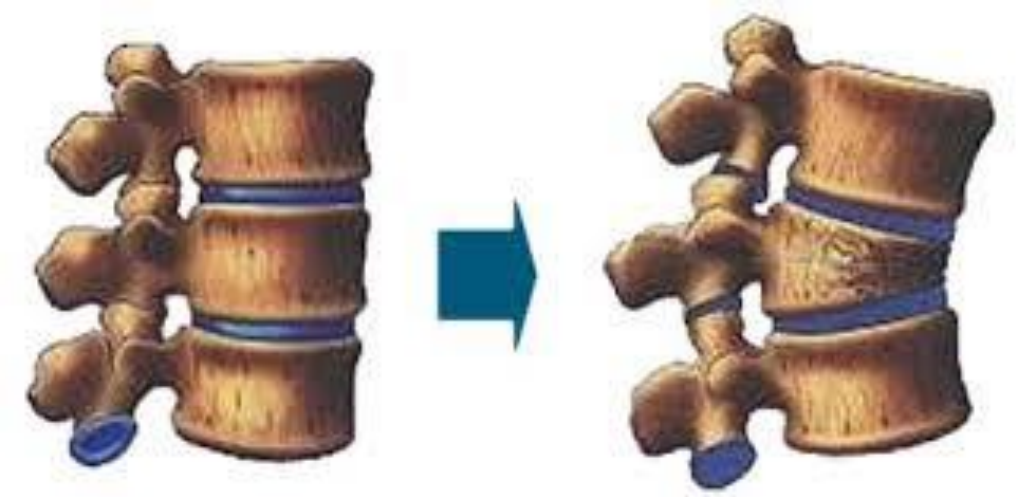
- Spinal cord terminates at L1/2 disc in adult
  - L2/3 in a child
- 50% of injuries occur at Thoraco-lumbar junction
- Common fractures:
  - Wedge fracture (flexion/compression)
  - Burst (compression)
  - Chance (flexion/distraction)

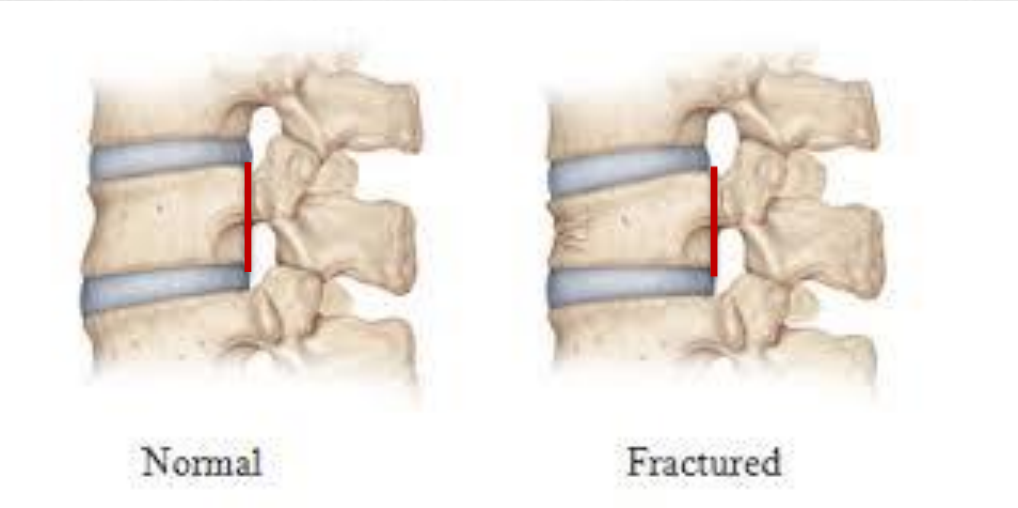
Wedge fracture



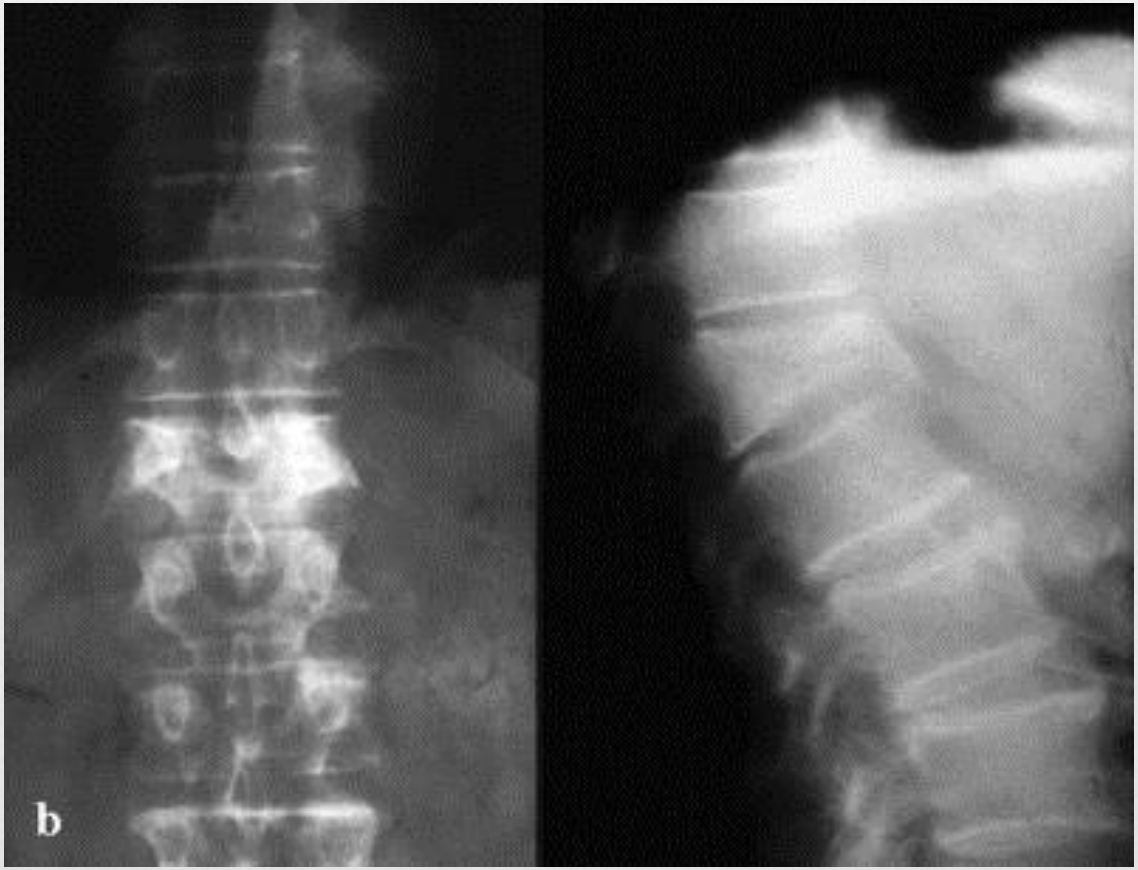


Wedge fracture

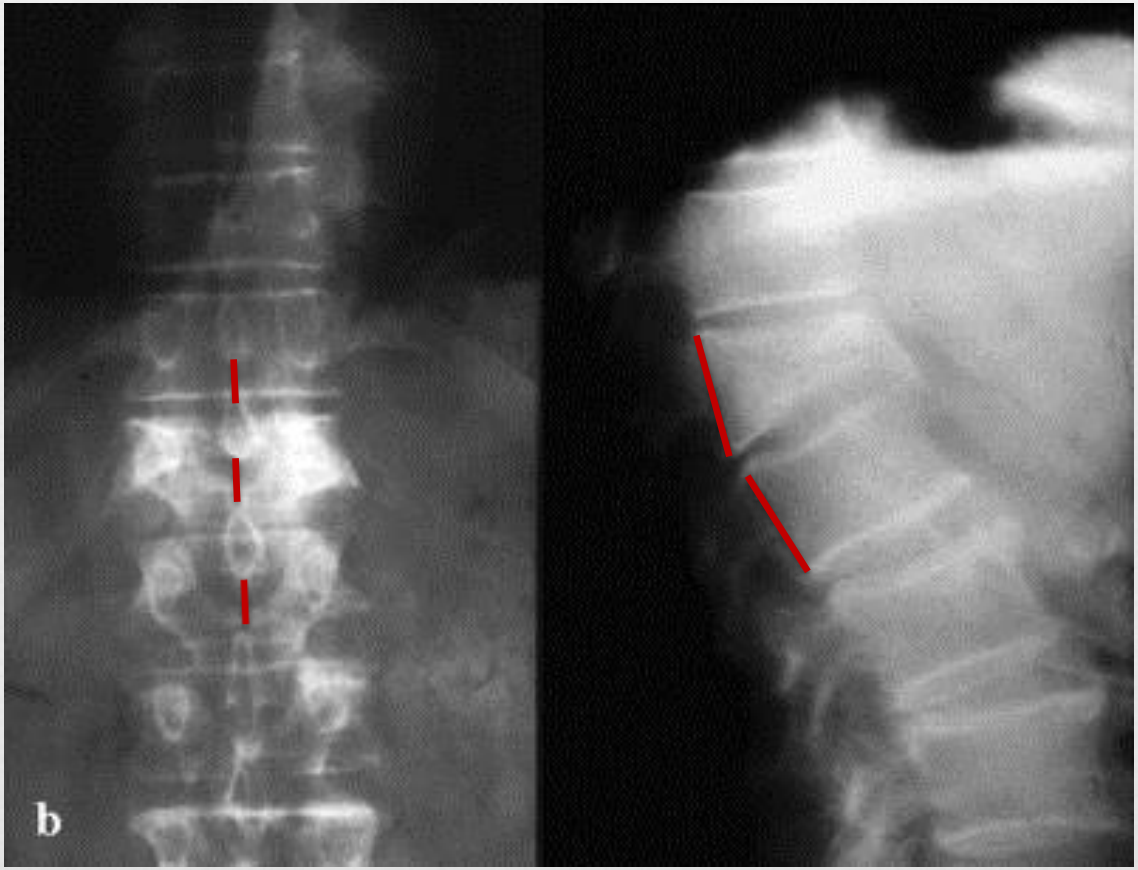




Wedge fracture



Wedge fracture



Burst fracture

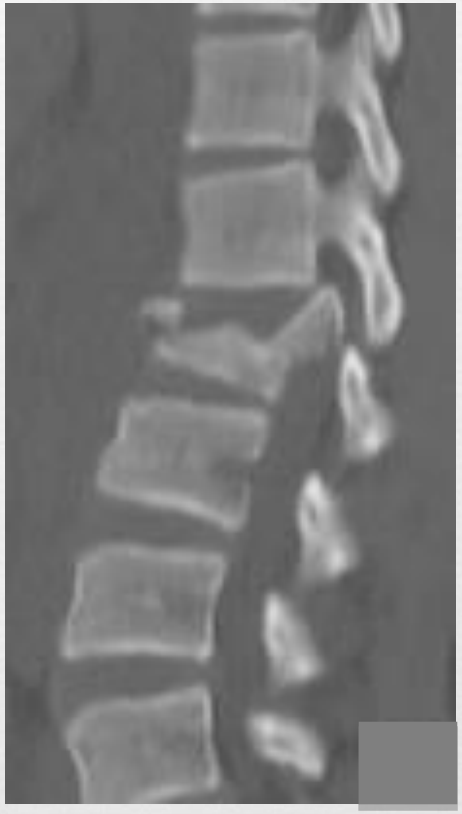
Burst Fractures - *characteristics*

1. ***Retropulsion*** of posterosuperior vertebral body fragment
   - Wedge compression may ***bulge*** posterior cortex but not posteriorly displace

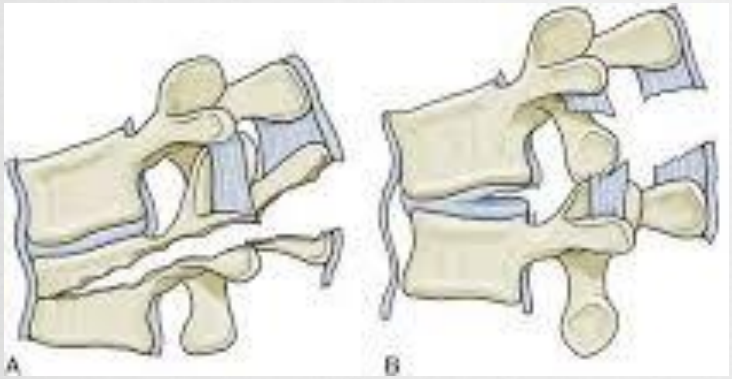
2. Sagittal fracture of vertebral body (90%)
3. Sagittal posterior element fracture (85%)
4. Widening of interpedicular distance (80%)

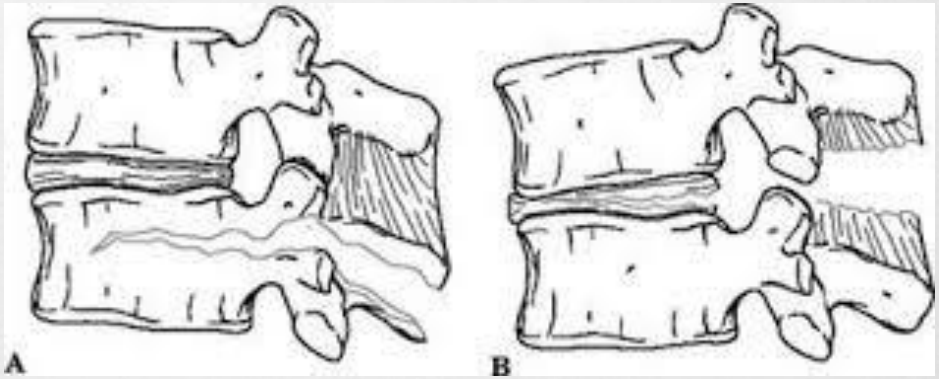
Burst fracture

Burst fracture

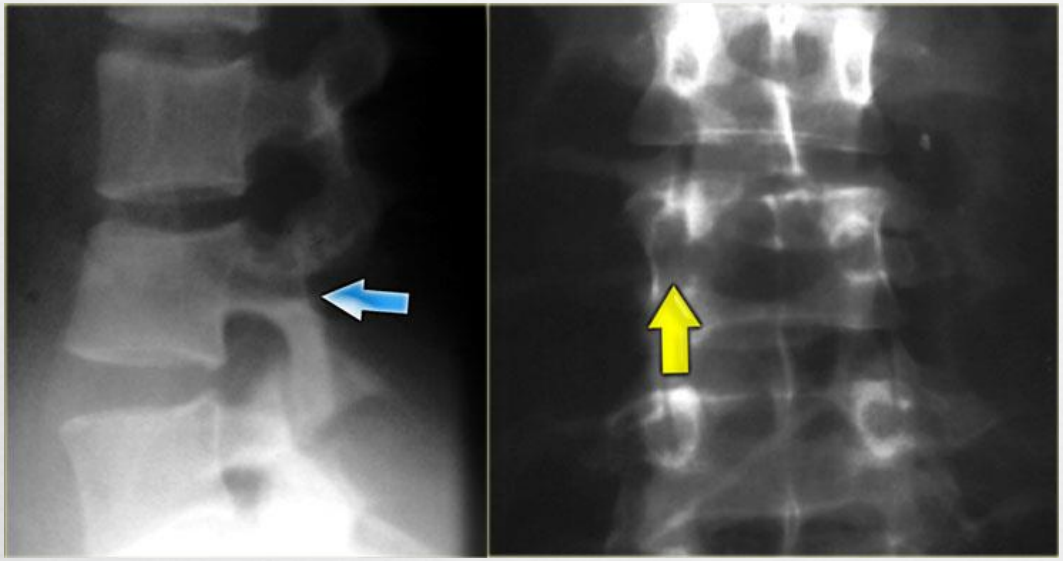


Chance fracture

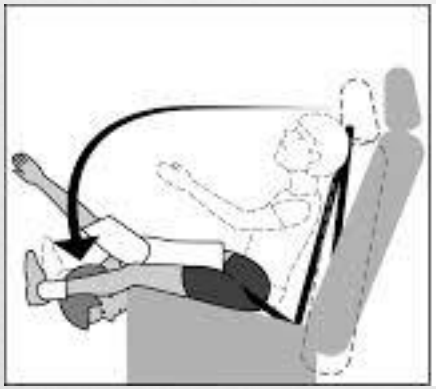




Chance fracture



Chance fracture



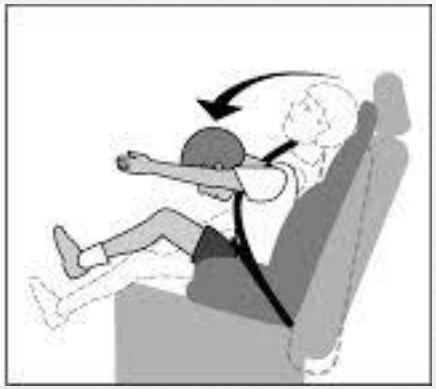
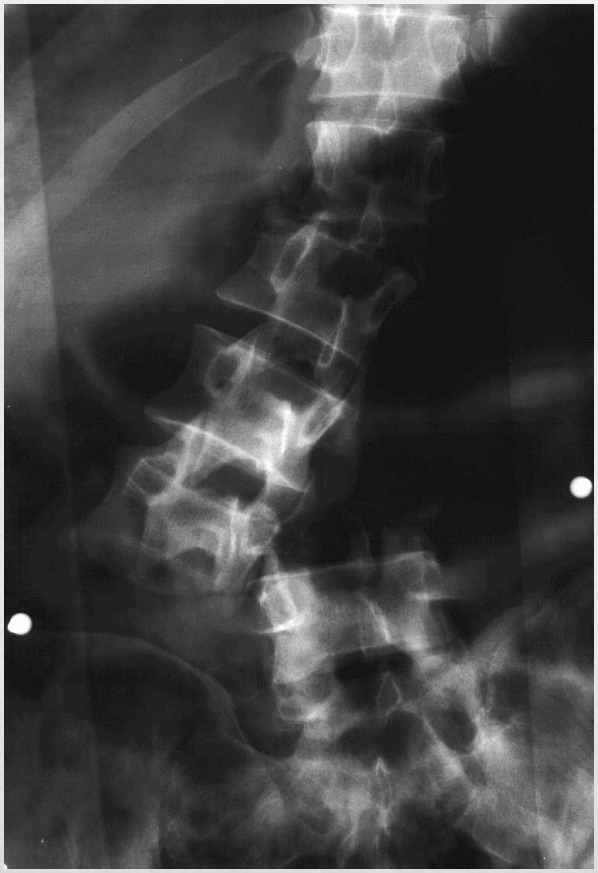
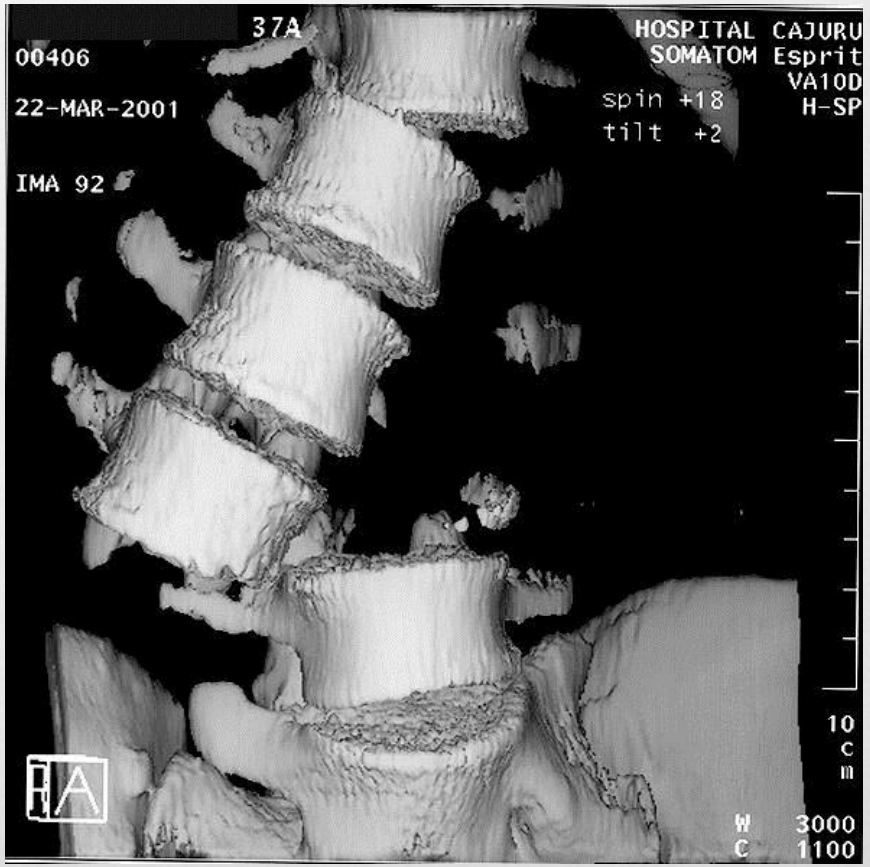


Figure 1. Lap Belt Ecchymosis

Image courtesy of Dr. Antonio Muñiz.

Fracture dislocation

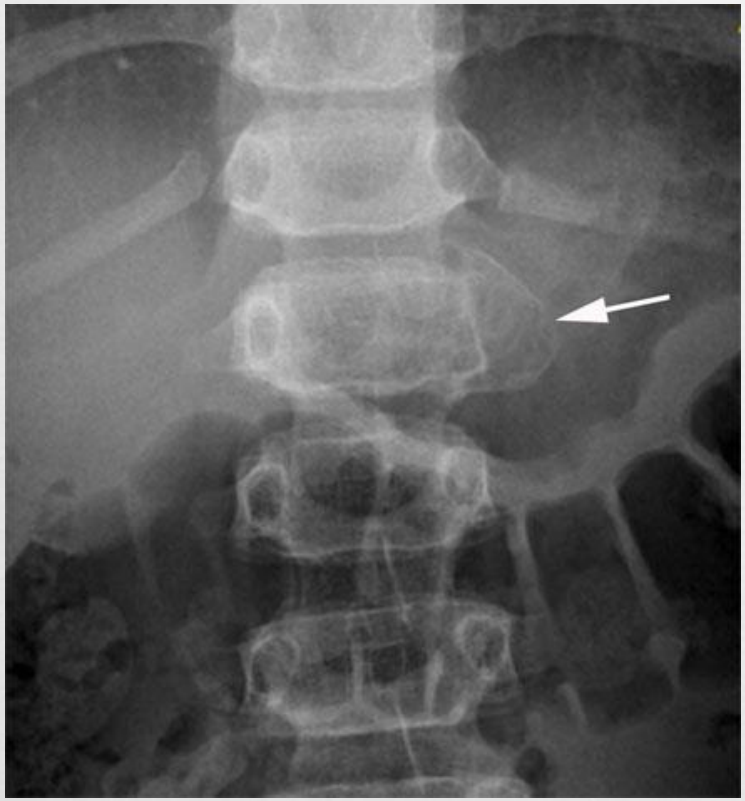




Pathologic fractures

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

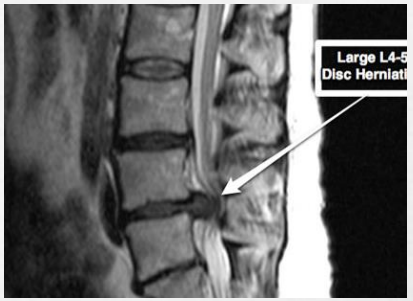
Pathologic fractures



Cauda Equina Syndrome

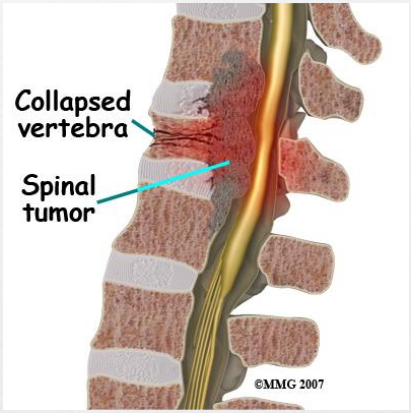
- A surgical emergency
- Requires full neurologic examination *including rectal examination for anal tone*
- Investigations: X-rays initially, but *MRI is mandatory as X-rays are usually unremarkable*
- Treatment: Emergency decompression-usually discectomy and wide laminectomy within 24 hours

Cauda Equina Causes

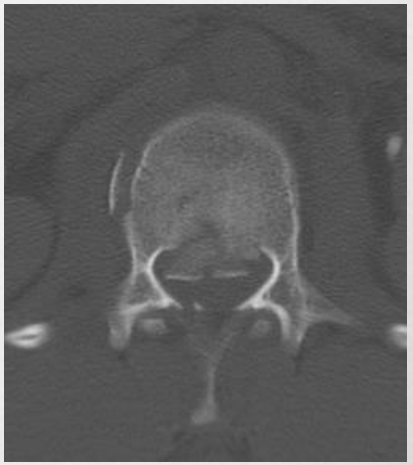


Disc hernia

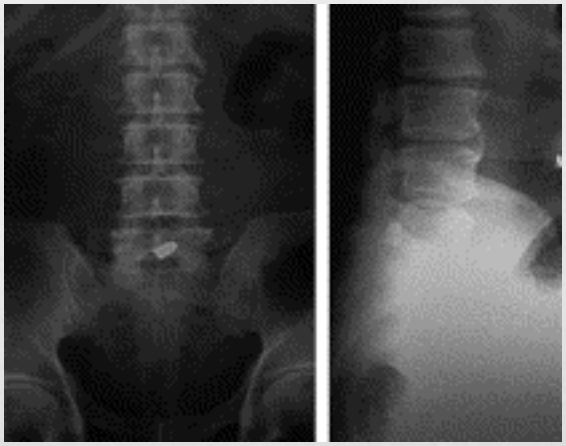
- Central disc prolapse
- Burst fractures of lumbar spine
- Penetrating injuries such as stab wounds or bullets
- Epidural hematoma from spinal anesthesia, or post surgery(rare)
- Tumors compressing the lower spinal nerve roots
- Severe spinal Stenosis



Tumor

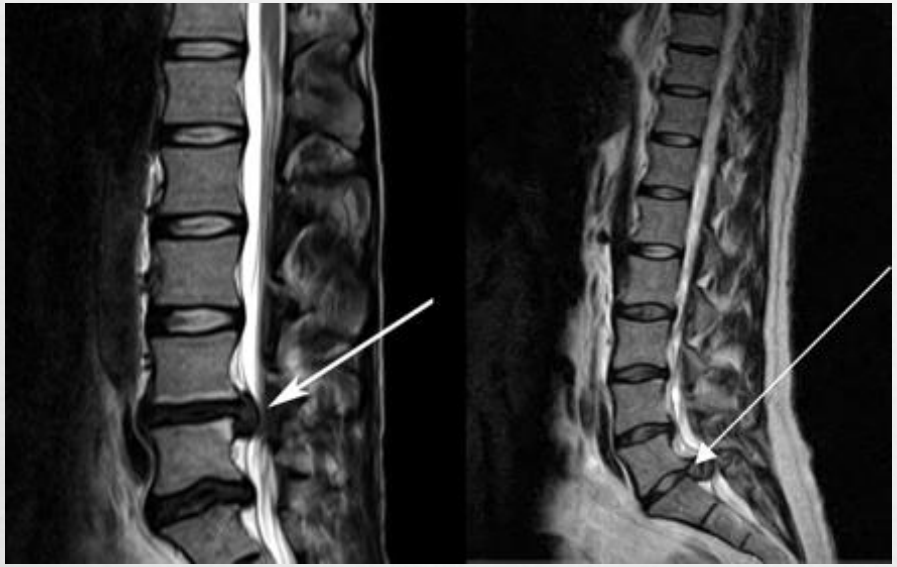


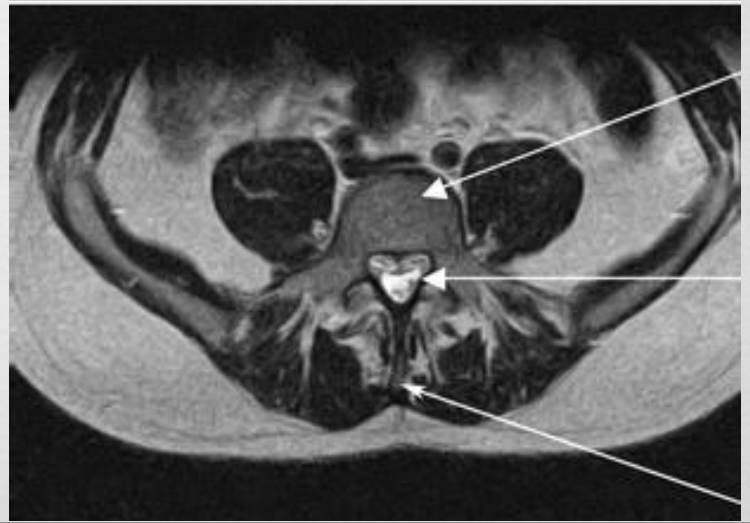
Burst fracture



Bullet to cauda

Cauda Equina Syndrome





Questions