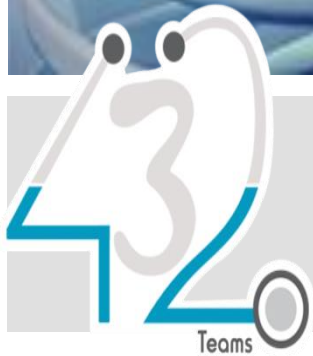


Orthopedics

7 Spinal Injuries



1st Edition:

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King Saud University



Color Code:

Slides

431 team work

Doctor's Notes

Arabic Words

Team Notes

Books' notes

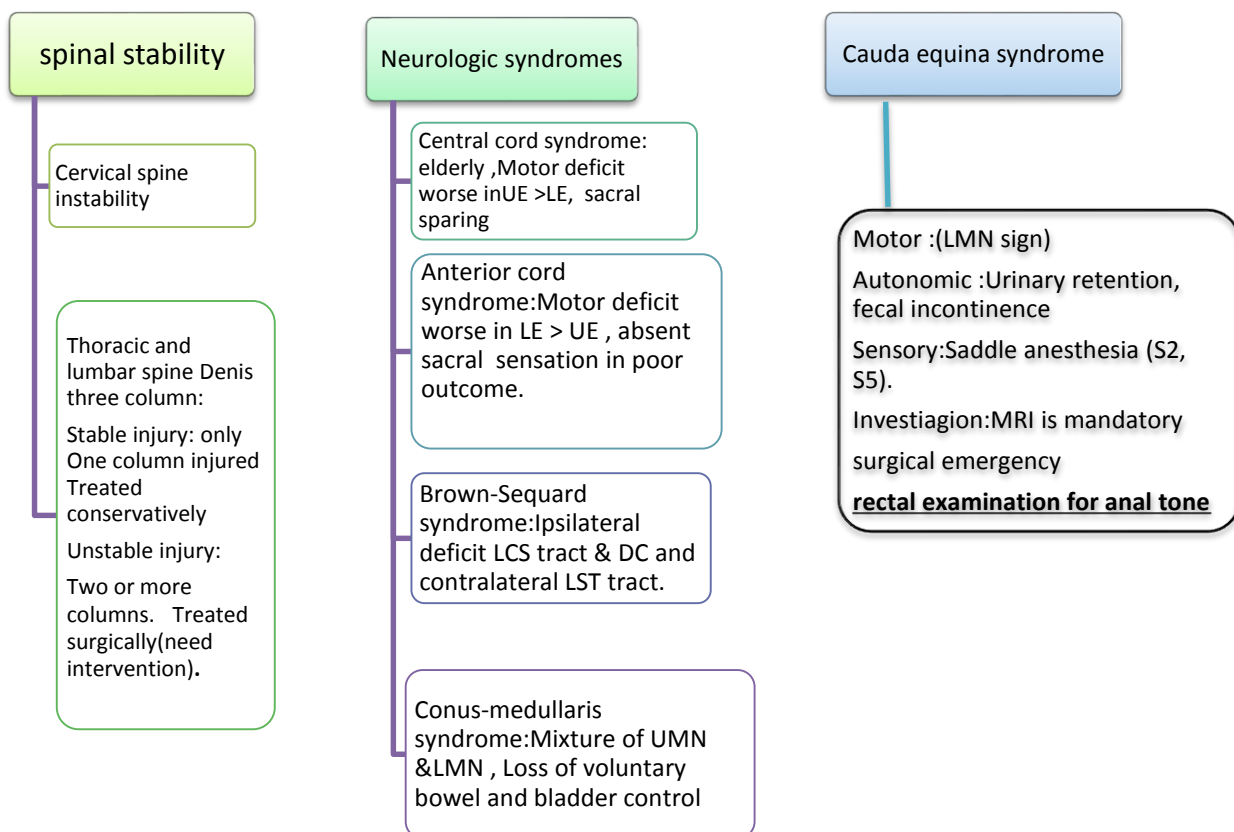
Important

Other Sources

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

MIND MAP



Spine Pathology Red Flag Conditions:

- 1) Cauda Equina/severe neurologic injury (e.g. perianal numbness, decreased rectal tone, loss of movement in the extremities).
- 2) Tumor 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).

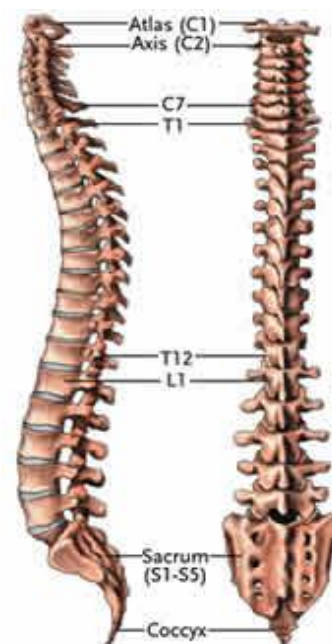
Remember that spine fracture can occur without trauma.

Anatomy:

- On a coronal plane, the anatomy of the spinal column shows:

1. Seven Cervical vertebrae.
2. Twelve Thoracic vertebrae.
3. Five Lumbar vertebrae.
4. Five Sacral vertebrae (fused.)
5. Three Coccygeal vertebrae (fused.)

All look aligned in one straight line.



- On a sagittal plane, the anatomy of the spinal column shows:

1. Secondary Cervical lordosis.
2. Primary Thoracic kyphosis.
3. Secondary Lumbar lordosis.
4. Primary Sacral and coccygeal kyphosis.

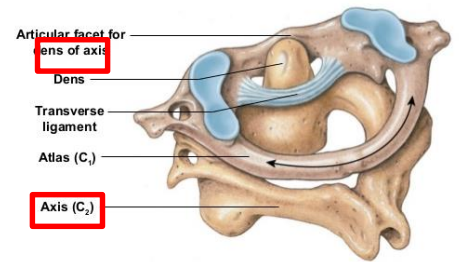
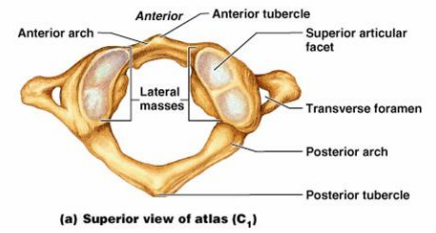
Kyphosis: refers to the convex curvature of the spine as it occurs normally in the thoracic and sacral regions. It is primary because the fetus in utero has a kyphotic spine in all regions.

Lordosis: refers to the inward curvature of the spine as it occurs normally in the lumbar and cervical regions. It is secondary because it develops later after birth. Cervical lordosis is a result of head raise in infancy and lumbar lordosis is a result of walking.

- **The spine is composed of Bones:** vertebrae that protect the spinal cord and support the body.
- Next come the anatomy of the most important regions of vertebral column.

Cervical spine anatomy:

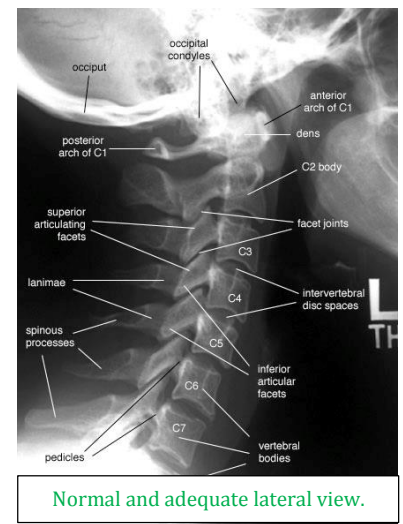
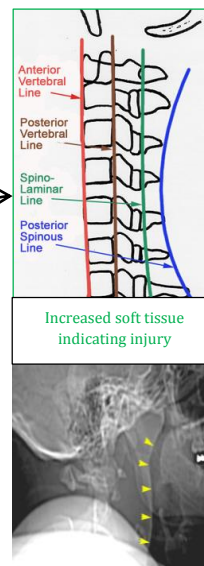
- C1 (atlas): it has anterior and posterior arches and no vertebral body (Ring-like.) Articulates with the occipital condyles of the skull superiorly through the superior articulating process, in which **50% of flexion and extension of the head** happens.
- C2 (axis): it has an anterior projection called odontoid process (or **Dens**) which is a significant stabilizer between C1 and C2. Note that C1 and C2 are held together by the transverse alar ligament. This anatomy is responsible for **50% of neck rotation**.
- Sub-axial vertebrae (C3-C7): All are similar in shape and structure and have two lateral facet joints.



Radiological Anatomy of cervical spine:

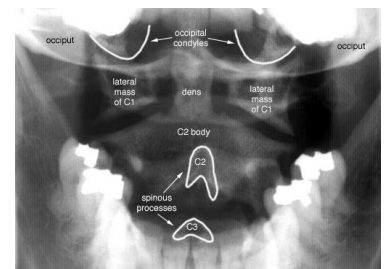
In lateral view:

- An adequate C-spine X-ray image has to have the upper border of T1.
- Observe all vertebrae for abnormality.
- Observe the alignment in three lines: anterior body line, posterior body line, and spino-laminar line.
- Observe soft tissue anterior to the vertebral bodies.



In AP view:

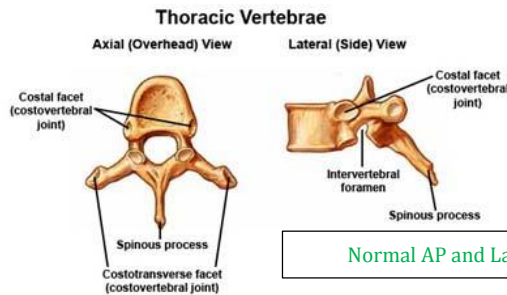
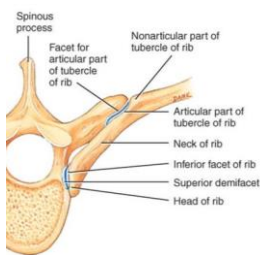
MCQ: In order to see both C1 and C2 and their articulation (including the odontoid/dens), an open-mouth X-ray is required. (Also known as odontoid view)



Thoracic spine anatomy:

The vertebrae articulate with the ribs; the rib cage makes the thoracic spine stiffer than cervical and lumbar spines, which are very mobile. If injury happens, it tends to be between the stiff and mobile area (thoracic and lumbar).

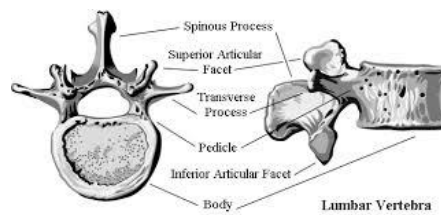
It is rarely injured; when an injury happens, suspect high energy trauma.



Normal AP and Lateral Views

Lumbar spine anatomy:

An important region. The facets are in sagittal plane, so it's where flexion and extension happen. Also, the most common region for fractures and disc herniation.



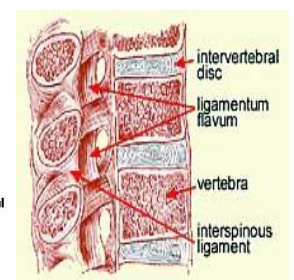
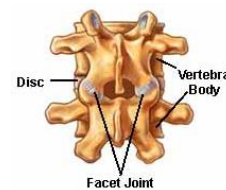
Normal AP and Lateral Views

1. **Joints:** Three joints in the spine:

- One anteriorly → **Inter-vertebral disc:** helps absorb pressure and keeps the bones from rubbing.
- Two posteriorly: 2 **facet joints**, one on each side.

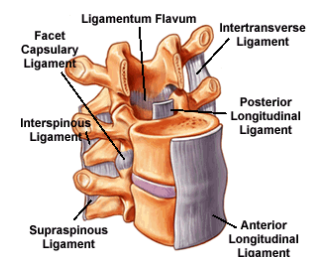
Joints = movement of the spine:

- Flexion.
- Extension.
- Lateral bending.
- Rotation.



2. **Ligaments:**

- Supraspinous ligament.
- Intraspinous ligament.
- Ligamentum Flavum (the least important in terms of stabilization)
- Anterior longitudinal ligament.
- Posterior longitudinal ligament.



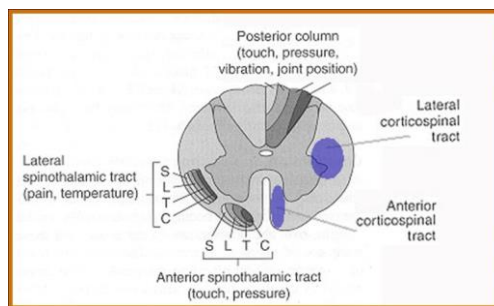
Ligament injury doesn't appear on X-ray (will look normal).

3. Spinal Cord:

In the spinal cord, all nerves related to the upper body occupy the tracts that are in the center of the cord, whereas the lower body occupies the peripheral region of the tracts.

The most important tracts are:

- **Spinothalamic tract:** pain and temperature. (Ascending; fibers decussate at the level of their entry to the spinal cord)
- **Posterior column:** touch, pressure, vibration and proprioception. (Ascending; fibers decussate within the medulla oblongata)
- **Corticospinal tract:** motor fibers. (Descending; within the medulla, fibers of the lateral corticospinal tract decussate, and anterior tract remains ipsilateral)



Spinal Injury

Epidemiology:

- 56000 cases per year.
- 11000 new spinal cord injuries.
- 15-20% **multiple** non-contiguous levels (in a comatose patient, radiological assessment of the whole spine is important when you can't examine the spine clinically)
- 10% involving the cervical spine.
- 90% involving thoracolumbar spine.
- 25% have neurologic deficit.
- Age: mostly between 15-24 years.
- Gender: mostly males (4:1).

Mechanism of Injury:

- 1- **High energy trauma.** E.g. MVA (Motor vehicle accident) or fall from a height or a horse.
 - o MVA: 40-55%
 - o Falls: 20-30%
 - o Sports: 6-12% (Thoracolumbar injury)
 - o Others: 12-21%
- 2- **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; **pathological**)
- 3- **Penetrating** trauma from gunshot or knives



Spine stability:

1- Cervical spine instability: (You shouldn't memorize the numbers)

- Compression fracture with 25% loss of height.
- Angular displacement > 11 degrees.
- Translation > 3.5mm.
- Disc space separation > 1.7mm.

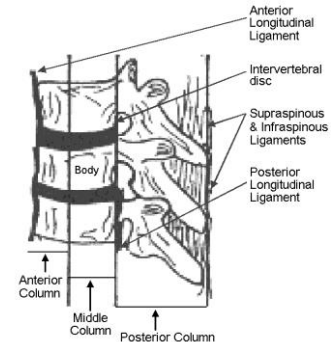
If anyone of the above is present, you describe the spine to be unstable; this affects the management later on.

2- Thoracic and lumbar spine: **Denis three columns**

The three columns:

- Anterior column (Ant. part of vertebral body)
- Middle column (Post. part of vertebral body)
- Posterior column (Pedicle + Lamina + spinal process)

Instability exists with disruption of any two of three columns.



1) Stable injury:

One column only (Wedge fracture in anterior column). **Treated conservatively.**

2) Unstable injury:

Two or more columns. **Treated surgically (need intervention).**

Assessment of spinal injury:

- 1- In cases of trauma, **ABCDE's** must be assessed first and treated appropriately.
- 2- Patients should be examined with **cervical collar until spinal pathology is excluded.**
- 3- Careful **log rolling** keeping the head, neck and pelvis in line should be done to examine the spine properly.
- 4- Immobilization (**by cervical collar, during transportation only; Temporary method**)



5- History:

- Mechanism of injury: Compression, flexion, extension, distraction, **high or low energy injury...etc**
- Other injuries
- Seat belt
- Other causalities (**presence of other passengers and their clinical situation. E.g. death at the scene indicates a possible high energy trauma**)

6- Physical examination:

Inspection, palpation, Neurologic examination

Neurological exam:

- Muscle Test
- Sensory exam: light touch, Sharp dull discrimination, Vibration sense, Proprioception and two-point discrimination
- Reflexes

Signs of Spinal Trauma:

1. **Apnea**, lower cranial nerve injury VIII-XII (high C-spine) → respiratory center
2. Deformity of the spine or neck.
3. **Tenderness** on palpation along spinal processes.
4. Paralysis or muscle weakness (which spinal level).
5. Loss of sensation (which dermatomes)
6. **Loss of rectal tone.**
7. Positive Babinski sign.

Asia Score: Brief Trauma Neurologic Survey

Patient Name _____
 Examiner Name _____ Date/Time of Exam _____

ASIA STANDARD NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY

MOTOR
 KEY MUSCLES (Assign to one side)
 C5 Elbow flexors
 C6 Wrist extensors
 C7 Elbow extensors
 C8 Finger flexors (first phase of middle finger)
 T1 Finger abductors (first finger)

SENSORY
 KEY SENSORY POINTS
 C2-8 Light touch, Pin Prick
 T1-12 Light touch, Pin Prick
 L1-5 Light touch, Pin Prick
 S1-2 Light touch, Pin Prick

It's not important to know all the details of ASIA. Just know that it is used to assess motor and sensory functions.

It's important to know the impairment scale but not in detail (complete and incomplete and normal).

absent

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

Excellent

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:
 - Patient arrives in shock
 - Patient cannot breath
 - Patient has a complete injury

Severity of neurologic deficit:

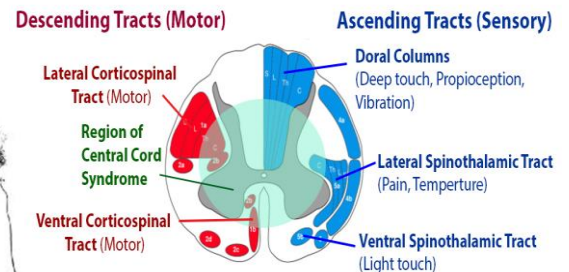
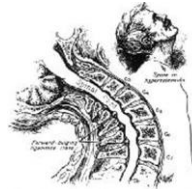
- 1- **Complete deficit:**
 - Flaccid paralysis below level of injury.
 - May involve diaphragm if injury above C5.
 - Sympathetic tone loss (neurogenic shock) if fracture above T6. (MCQ)
 (if a spinal injury is below T6, neurogenic shock is unlikely)

2- Incomplete deficit:

- If there's any sensation.
- If there's sacral sparing.
- **Syndromes: an important topic; you should know the features of each syndrome.** (Consider revising the anatomy of the spinal cord on page 4)

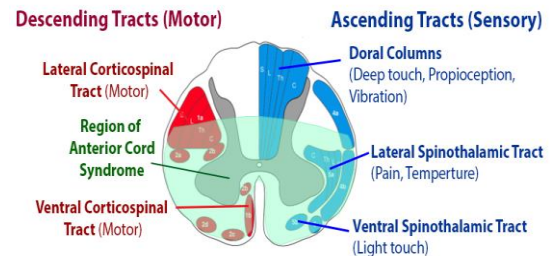
1. Central Cord Syndrome:

- Characterized by disproportion. (**Upper Limb > Lower Limb**. In other words, worse in the upper limb. There's sacral sparing)
- **Mechanism: hyper-extension.**
- Occur with or **without fractures.**
- Recovery: **50% regaining function.**
- Prognosis is fair.



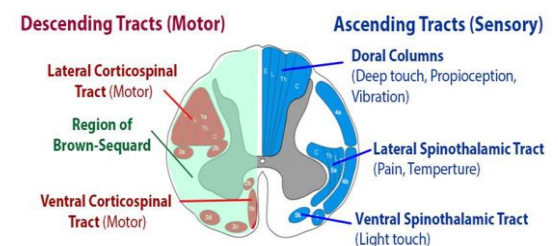
2. Anterior Cord Syndrome:

- Characterized by loss of corticospinal and spinothalamic tract with **preserved posterior column**. (Which mean loss of pain, temperature and motor lower limb > upper limb, and preservation of deep touch, proprioception and vibration.)
- **Mechanism: ischemia (reversible) or infarction (irreversible) to spinal cord.**
- Common injury.
- Recovery: 10%.
- Prognosis is good if progressive recovery within 24hrs, **absent sacral sparing** after 24hrs portends a **poor outcome**.



3. Brown-sequard Syndrome:

- Characterized by **hemi-cord injury** with ipsilateral paralysis, loss of proprioception and light touch, and contralateral temperature and sharp pain loss. (Ipsilateral deficit of lateral corticospinal tract & dorsal column and contralateral lateral spinothalamic tract.)
- Prognosis is good, with over **90% regaining** of bowel and bladder function and ambulatory capacity.



4. Conus-medullaris Syndrome:

- Seen in T12-L1 injuries. (mixture of UMNL and LMNL)
- Loss of voluntary bowel and bladder control with preserved lumbar root function.
- Uncommon as pure lesion (mixed conus-cauda).

5. Cauda Equina Syndrome

- **Saddle anesthesia, urinary retention and stool incontinence.**
- Usually due to large central **disc herniation** rather than fracture.

Apley's: Typical cauda equine syndrome presents with lower limb weakness, absent reflexes, impaired sensation and urinary incontinence (with **over-flow** probably mimicking incontinence).

Quick review for Incomplete Spinal Cord Injuries:

<http://www.orthobullets.com/spine/2008/incomplete-spinal-cord-injuries>

3- Nerve root injury (LMN lesion).

Shock

1- Spinal Shock

- Transient loss of spinal reflexes. (physiological shutdown of function)
- Lasts 24-72 hours.

You can't tell if the spinal injury is complete or incomplete in the presence of spinal shock. **There's only one way to know that the shock has subsided: the presence of bulbo-cavernosus reflex.** If the reflex is present, spinal shock is over (it's the only reflex intact in complete spinal injury). To elicit bulbo-cavernosus reflex, squeeze the glans of penis in males or the clitoris in females and look for anal sphincter contractions.

2- Neurogenic shock

- Reduced tissue perfusion due to loss of sympathetic outflow and un-opposed vagal tone.
- **Injury above T6 level.**
- Peripheral vasodilatation (**hypotension and bradycardia**).
- Rx: fluid resuscitation and vasopressors. (When fluid resuscitation fails in a patient with neurogenic shock, do not repeat the initial bolus and start **vasopressors**)

Imaging:

1. X-ray:

- Cervical → 3 views: AP, lateral and **open mouth (MCQ)**
- Thoraco-lumbar → 2 views: AP & lateral and flexion-extension views.

2. CT: best for bony anatomy.

3. 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.

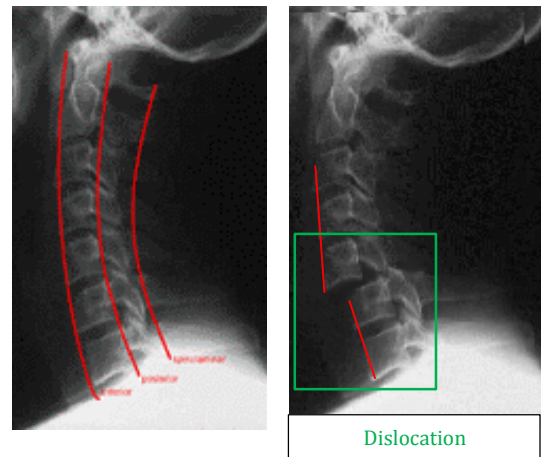
Some general rules:

- **Stable** injuries are usually treated **conservatively**.
- **Unstable** injuries usually require **surgery**.
- Neurologic compression requires decompression. Make sure you understand spine stability – page 6.

Specific Injuries:

Cervical spine fractures:



- Descriptive; depends on mechanism of injury:
 - o Flexion/extension.
 - o Compression/distraction.
 - o Shear.
- Presence of subluxation/dislocation
- SCI (spinal cord injury):
 - o **High level fracture results in quadriplegia.** Generally speaking, cervical injury = quadriplegia.
 - o Low level fracture results in paraplegia. (C6 & C7 OR C7 & T1)



Thoraco-Lumbar fractures:

- Spinal cord terminates at L1/2 disc in adult and L2/3 in a child.
- **50% of injuries occur at Thoraco-lumbar junction (most common site).**
- **Common fractures:**
 1. Wedge fracture (flexion/compression) “most common”.
 2. Burst (compression).
 3. Chance (flexion/distraction).



Wedge Fracture

The distance between spinal processes is equal → stable injury managed **conservatively** (pethidine and belt).

This spine looks normal from this view

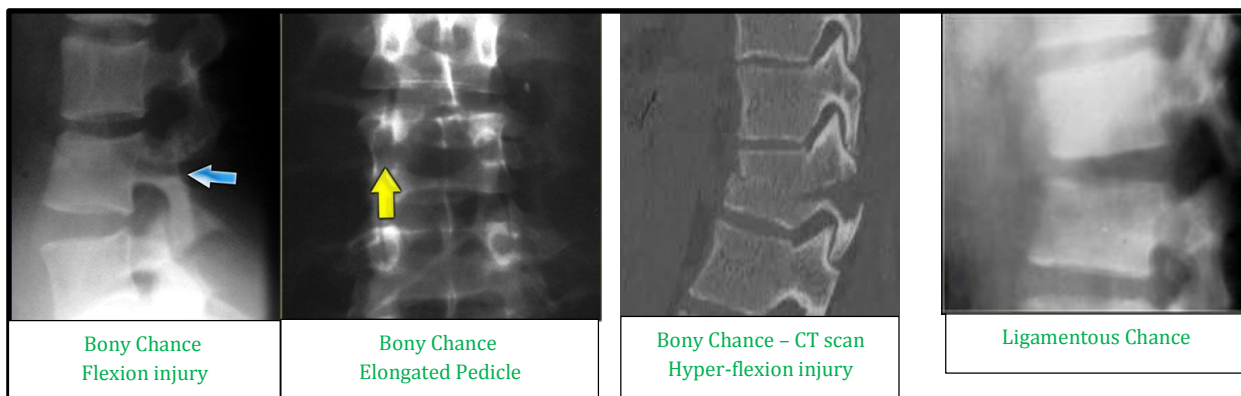
Compressed anterior column only → stable

Burst Fracture
Retro-avulsion traction, disturbed vertebral body, wide distance between pedicles. In the CT: there are fragments in the canal. Significant kyphosis. Unstable fracture managed surgically (compression or fixation) according to neurological deficit.

Wide-placed pedicles

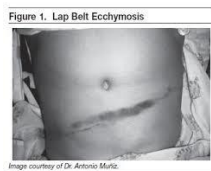
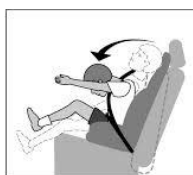
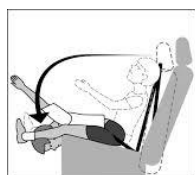
All three columns are damaged



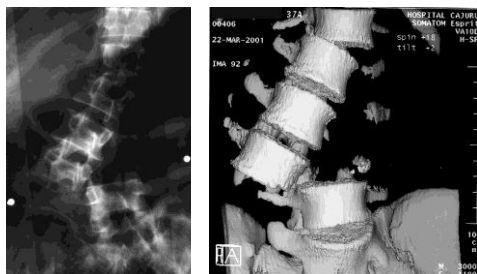
Chance Fracture

- Chance fracture could be: A-bony chance B- Ligamentous chance.
- The spinal processes are not aligned.
- There is space between pedicles.
- Unstable fracture, managed **surgically**

Chance fracture is caused by a seatbelt injury mainly in children who wear the seatbelt without the chest piece. 40% is associated with intraabdominal injury.



Fractures Dislocation:



Pathological Fractures:

- Low-energy fractures.
- Osteoporotic is common.
- Usually due to infection or tumor → X-rays: **“winking owl”** sign

(Winking owl sign is generally an indication of a pathological lesion, with or without a fracture. It is formed of a **missing pedicle**. A winking owl sign + fracture = pathological fracture).



Cauda Equina Syndrome:

- A surgical emergency (Common cause is disc herniation and spinal stenosis).
- Requires full neurologic examination **including rectal examination for anal tone “MCQ”**.

Clinical features:

- Motor (LMN signs): Weakness and reduced deep tendon reflex (knee or ankle).
- Autonomic: Urinary retention and fecal incontinence due to loss of anal sphincter tone.
- Sensory:
 - Sciatica (low back pain radiating to thighs and legs).
 - Bilateral** sensory loss or pain depending on the level affected.
 - Saddle anesthesia (S2, S5).
 - Sexual dysfunction (late presentation).

Investigations:

X-rays initially, but **MRI is mandatory** as X-rays are usually unremarkable.

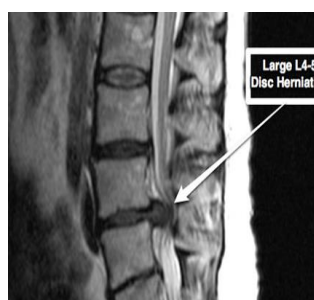
Treatment:

Emergency decompression, usually discectomy and wide laminectomy within 24 hours.

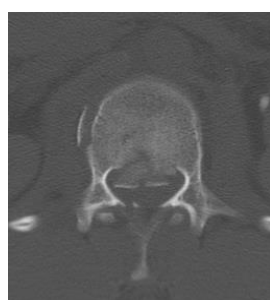
Prognosis is markedly improved with surgical decompression.

Cauda Equina Causes:

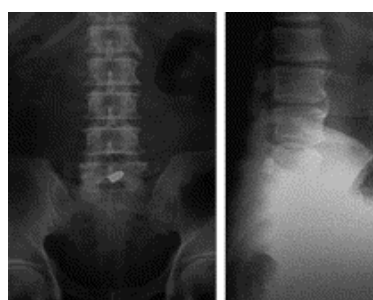
- Central disc prolapse.
- Burst fractures of lumbar spine.
- Penetrating injuries such as stab wounds or bullets.
- Epidural hematoma from spinal anesthesia, or post-surgery(rare).
- Tumors compressing the lower spinal nerve roots.
- Spinal Stenosis.



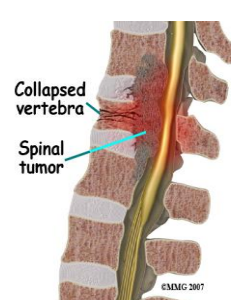
Disc hernia



Burst fracture



Bullet to cauda



Tumor

Questions

A- An 18-year-old male is evaluated for a suspected spinal cord injury. His neurological exam shows diminished sensation below the T7 level. His bulbocavernosus reflex is intact. Which physical finding of motor function, below the affected neurological level, would classify this injury as an ASIA B according to the American Spinal Injury Association impairment scale?

1. More than half of the major muscles demonstrate palpable or visible muscle contraction
2. At least half of key muscles have a muscle grade of 5.
3. More than half of key muscles have a muscle grade less than 3.
4. At least half of key muscles have a muscle grade of 3 or more.
5. No motor function preserved below affected neurological level

B- A 51-year-old male with a pacemaker reports difficulty with urination and

numbness in his bilateral buttock. His symptoms began 12 hours ago. What is the next most appropriate step in management?

1. MRI of the lumbar spine
2. CT myelogram of the lumbar spine
3. Epidural steroid injection
4. Emergent lumbar decompression
5. High dose methylprednisone

C- A 30-year-old male is involved in a motor vehicle accident and sustains a fracture-dislocation of the cervical spine. On physical exam he has absent distal motor function, absent sensation, absent rectal tone, and an intact bulbocavernosus reflex. Which term best describes this spinal cord injury pattern?

1. Central cord syndrome
2. Incomplete spinal cord injury
3. Complete spinal cord injury
4. Neurogenic shock
5. Spinal shock

Key answers: A-5 , B-2 ,C-3 (explanation for Question "C" : The key to answering this question is understanding the meaning of an intact bulbocavernosus reflex. If the bulbocavernosus reflex is intact then the patient is no longer in spinal shock and we can determine a final classification of their spinal cord injury pattern. If the bulbocavernosus reflex is absent, then it is possible the patient is in a state of spinal shock, and therefore we can not classify his final spinal cord injury pattern).

