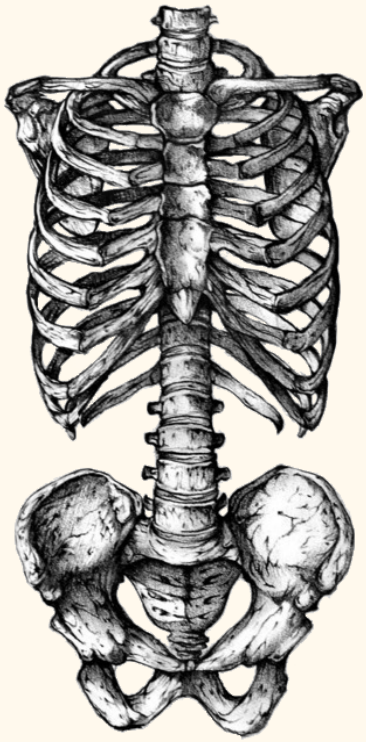
434 Orthopedics Team

6 &7-RED FLAGS: Common Spinal Disorders and Injuries

Cauda Equina Syndrome, Acute Spinal Injuries, Common spine disorders



Objectives

1. Basic anatomy of the spine.
2. Initial assessment and treatment of spinal injuries at the field.
3. Management of Cauda equina syndrome.
4. Principle of spinal stability.
5. Basic understanding of neurologic syndromes caused by spinal trauma.
6. Comprehension of the common spine disorder.
7. Disc degeneration/hernia, Spinal stenosis.
8. Common spinal deformity (Spondylolisthesis, Scoliosis).
9. Osteoporotic fracture, Destructive spinal lesions.

Anatomy of the spine: Bone, Joints, Ligaments, Muscles.

1-Cervical Anatomy:

- 7 cervical vertebrae; 8 cervical nerve roots.
- Nerve root exits above vertebra (i.e. C4 nerve root exits above C4 vertebrae), C8 nerve root exits below C7 vertebra.
- Radiculopathy = impingement of nerve root.
- Myelopathy = impingement of spinal cord.
- 80% of the weight goes to the front of the spine (the body) and 20% to the back of the spine.

C1&C2:

- C1 (atlas)→ 50% of flexion and extension (between occiput and C1). No vertebral body (ring like), no spinous process.
- C2 (axis)→ 50% of rotation of Cervical spine between C1 and C2. Has Odontoid process (or Dens.)

C3-C7:

- Have Transverse foramen which is important for Vertebral Artery → one of the structures that forms the circle of willis in the brain.
- 5% range of motion at each level.
- Transverse foramen → vertebral artery → Circle of Willis. So any fracture or disc herniation affect this area may affect the brain (not common).

2-Thoracolumbar Anatomy:

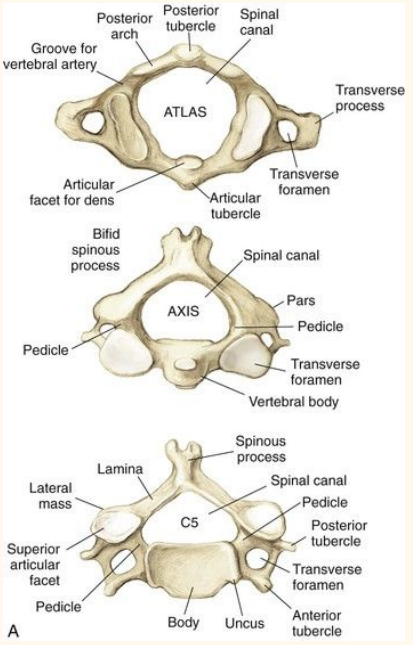
- Spinal cord terminates at conus medullaris L1/2 (L2/3 in a child).
- Individual nerve roots exit below pedicle of vertebrae (i.e. L4 nerve root exits below L4 pedicle)

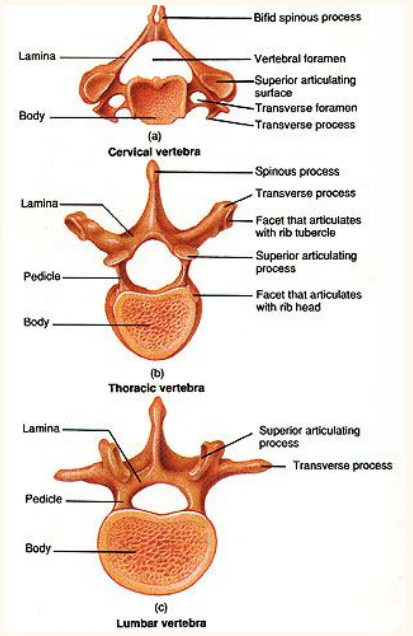
Thoracic:

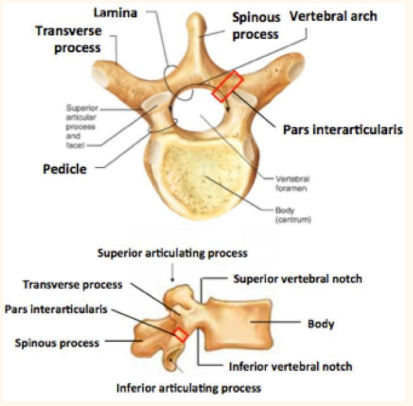
- Most rigid part of the mobile spine (C1-L5) → rarely injured (usually in high energy trauma.) → usually osteoporotic fractures.
- It articulates with the ribs, acts as a splint to stabilize the thoracic spine.
- ROM: Mainly rotation, very limited extension and flexion.

Lumbar:

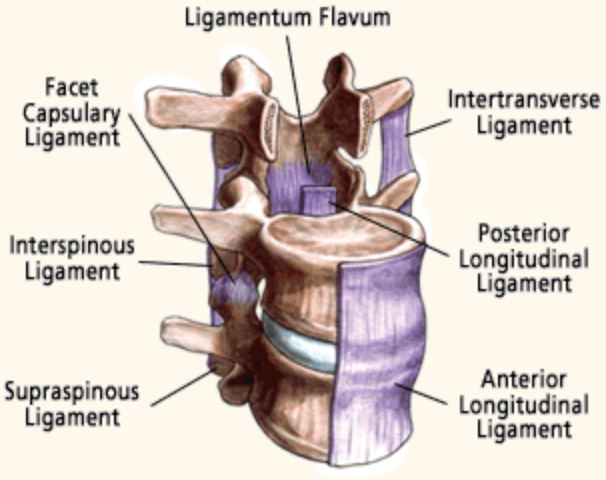
- The most common region for fractures and disc herniation.
- ROM: Flexion and Extension.
- Defect in Pars interarticularis → **Spondylolisthesis.**



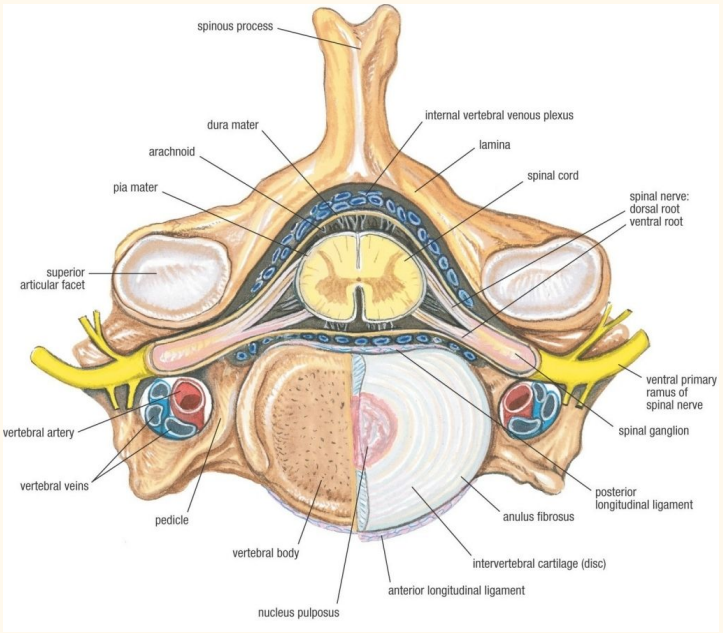




3- Ligaments Anatomy:

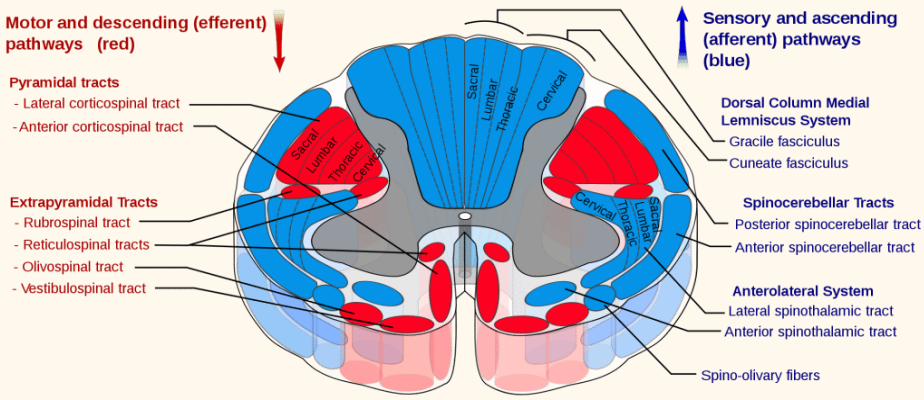


- Ligaments work as stabilizers for the spine→ so pt may have back pain and x-ray looks normal → ligaments injury.
- Ligaments that are anterior are fairly thin and ligaments that are posterior are fairly thick.
- Ligamentum flavum is very weak stabilizer
- And the disc itself act as a stabilizer especially the annulus fibrosus, because it is attached to the anterior longitudinal ligament and posterior longitudinal ligament.
- Anterior longitudinal ligament and Posterior longitudinal ligament work as a belt anteriorly and posteriorly. And the sides are free → so most of the lumbar disc herniation happen **posterolateral**.
- Nucleus pulposus of the disc is 90% water, so in T2 we see it white and bright, once it loses its content we see it dark.

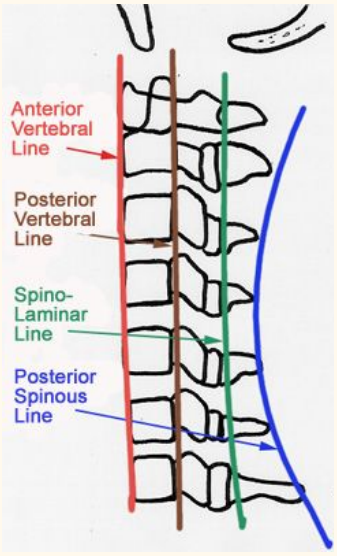


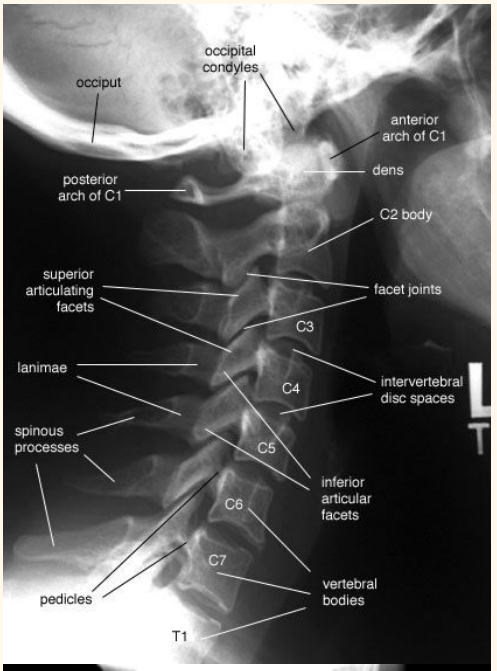
4-Ascending & Descending tracts of spinal cord: (Very important)

- Ascending→ sensory. Descending→ motor.
- **C**ervical representation is more **C**entral→ affect upper limb more than lower limb. → **Central Cord Syndrome**.
- Sacral is the last one to be affected.
- The only tract that cruciate at the **S**pinal level is the **S**pinothalamic tract.
- **P**osterior Column carries **P**s: **P**ressure, Vi**b**ration, **P**osition sense, **P**roprioception.
- Spinothalamic: pain, temperature and fine touch.

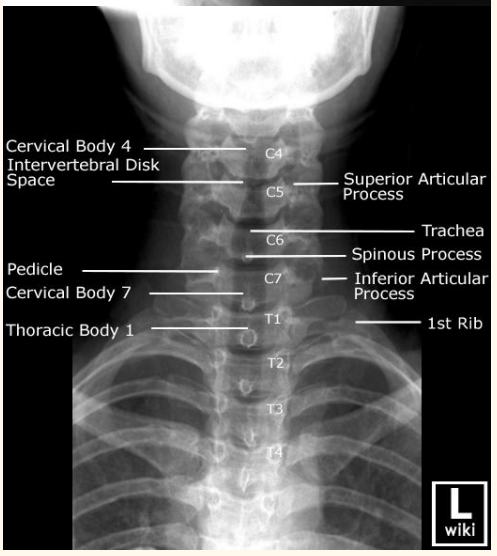


Radiologic Anatomy of the spine:



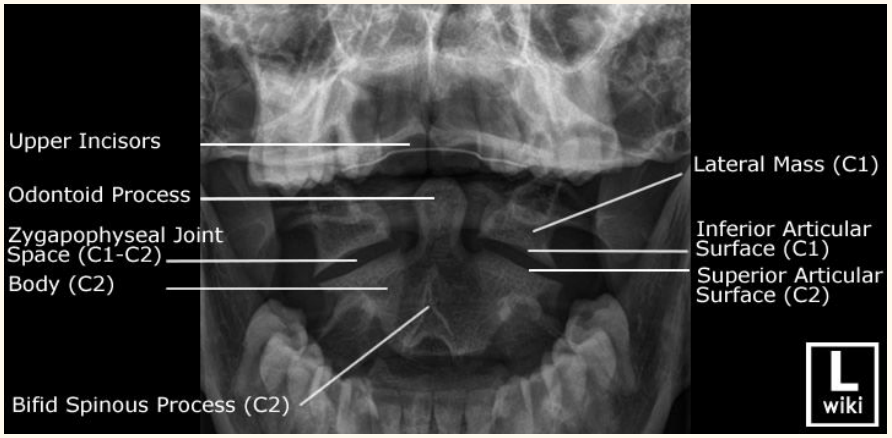


- We can see 2 occipital condyles because there is a rotation. No body in C1.
- All facet joints are congruents (متوازي).
- **The 3 Columns** : All lines should be congruents.
    - Anterior Column.
    - Middle Column.
    - Posterior Column.
- Soft tissue shadow:
    - In front of C1 around 7 mm.
    - In front of C2 2 mm.
    - In front of C7 22 mm (or you can say around ⅛ of the vertebral body width)



AP:

- There's not much to look at other than the alignment and spinal processes, if the distance is big between spinous processes = fracture and compression → gap.
- Box shaped and look at <u>pedicles</u>, very important if they disappear or there's large distance → always pathologic either infection or tumor.
- You can't see C1 and C2 because of the jaw, so if you want to see it you have to ask for **<u>open mouth</u>** X-Ray.
- Displacement of lateral mass of C1 beyond the margins of the body of C2 = **Jefferson fracture** = C1 ring is not intact anymore.



Spine Pathology Red Flag Conditions

1. **Cauda Equina/severe neurologic injury**
   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.

Why do we need to learn about spinal injury?

Because they do occur and are fairly frequent. Incidence and Significance:

• 50000 cases per year.
• 40-50% involving the cervical spine.
• 25% have neurologic deficit, not necessarily permanent.
• It's a disease of young active males:

- Age: mostly between 15-24 years.
- Gender: mostly males (3:1).

Mechanism of injury:

- Mostly by car accidents → MVA (40-55%)
- Falls (20-30%) and Sports (6-12%).

What do we do at the field of injury?

1. **Immobilization** → cervical collar is applied, 2 sandbags are placed on both sides, and the patient is placed on a spine board; the purpose of that is during transportation of the patient, he will be immobilized completely.
   a. In line immobilization: hold patients head and neck in line with his body till you can get the collar on.
   b. Log roll: logrolling is a maneuver used to move a patient without flexing the spinal column. Patient's legs are stretched, the head is held, to immobilize the neck. You palpate the back at scene if possible and spinal cord.
2. **History:** Mechanism of injury; Compression, flexion, extension, distraction. Head injuries. seat belt injury.
3. **Physical examination:** inspection, palpation, neurologic examination.

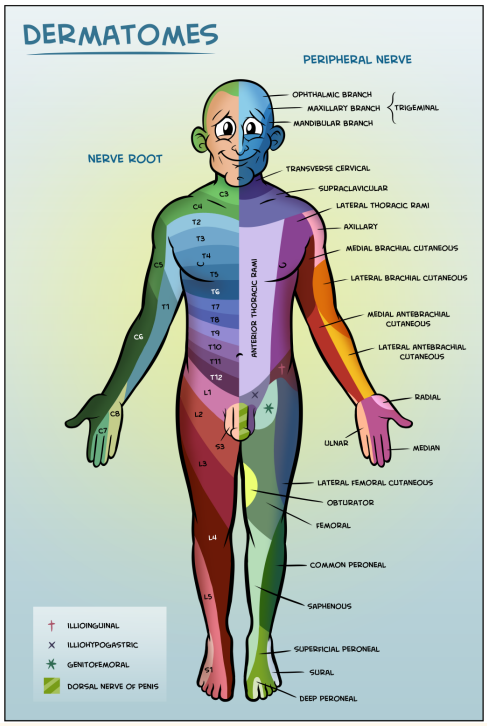
4. **At hospital:** Physician will undo everything, take the history from the paramedic and examine the neck, the back, and do neurologic examination and assessment. Sometimes Cervical traction is applied.

Neurologic examination:

- **ASIA Impairment Scale**. The extent of spinal cord injury (SCI) is defined by the American Spinal Injury Association (ASIA) Impairment Scale.
- **Dermatomes**: YOU HAVE TO KNOW THEM!!

American Spinal Injury Association Impairment Scale

Grade	Description
A	complete, no motor/sensory below neurological level including S4/5
B	incomplete, sensory but not motor function preserved below neurological level including S4/5
C	incomplete, motor function preserved below neurological level, and more than half of the key muscles below neurological level have a muscle grade <3
D	incomplete, motor function preserved below neurological level, and more than half of the key muscles below neurological level have a muscle grade ≥3
E	normal motor and sensory function



MAP KEY

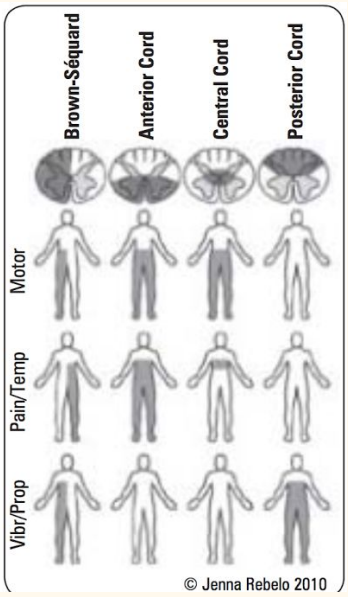
L1,2,3,4	Anterior and inner surface of lower limbs
L4,5, S1	Foot
L4	Medial side of great toe
S1,2,L5	Posterior and outer surface of lower limbs
S1	Lateral margin of foot and little toe
S2,3,4	Perineum
T10	Level of umbilicus
T12	Inguinal or groin regions
C5	Clavicles
C5, 6, 7	Lateral parts of upper limbs
C8, T1	Medial sides of the upper limbs
C6	Thumb
C6, 7, 8	Hand
C8	Ring and little fingers
T4	Level of nipples

Spinal cord syndromes:

Complete SCI	Incomplete SCI
• Flaccid paralysis below level of injury • bilateral loss of motor/sensory and autonomic function at ⩾ 4 segments below lesion/injury, with UMN signs. • About 3% of patients with complete injuries will develop some recovery within 24h, beyond 24h, no distal function will recover.	• Good prognosis for recovery. • Any residual function at ⩾ 4 segments below lesion. • Signs include sensory/motor function in lower limbs and "sacral sparing" (perianal sensation, voluntary rectal sphincter contraction).
• May involve diaphragm if injury **above C5→** C3,4,5 Phrenic nerve. • Sympathetic tone lost if fracture **above T6→** Hypotension.	• **Central cord syndrome:** Upper limb > Lower limb • **Brown Sequard syndrome:** Also called cord hemisection.

Table 17. Comparison Between Incomplete Spinal Cord Lesion Syndromes

Syndrome	Etiology	Motor	Sensory
Brown-Séquard	Hemisection of cord	Ipsilateral LMN weakness at the lesion Ipsilateral UMN weakness below the lesion	Ipsilateral loss of vibration and proprioception Contralateral loss of pain and temperature Preserved light touch
Anterior Cord	Anterior spinal artery compression or occlusion	Bilateral LMN weakness at the lesion Bilateral UMN weakness below the lesion Urinary retention	Preserved vibration and proprioception Bilateral loss of pain and temperature Preserved light touch
Central Cord (most common)	Syringomyelia, tumours, spinal hyperextention injury	Bilateral motor weakness: Upper limb weakness (LMN lesion) > Lower limb weakness (UMN lesion) Urinary retention	Variable bilateral suspended sensory loss Loss of pain and temperature > loss of vibration and proprioception
Posterior Cord	Posterior spinal artery infarction, trauma	Preserved	Bilateral loss of vibration, proprioception, light touch at and below the lesion Preserved pain and temperature



Other neurologic syndromes: **1-Nerve root deficit**: LMN.

2-Conus medullaris syndrome	**3-Cauda Equina syndrome** A surgical emergency	**4-Spinal shock** *Neurologic syndrome*	**5-Neurogenic shock** *Hemodynamic syndrome*
-Mixture of UMN and LMN deficits. -At the level of L1. (Not important)	-**Urinary retention**, bowel incontinence and saddle anesthesia (peri-anal numbness, decreased rectal tone, loss of movement in the extremities). -Usually due to large central disc herniation rather than fracture. -Requires full neurologic examination including rectal examination for anal tone. -Investigations: X-rays initially, but **MRI** is mandatory as X-rays are usually unremarkable. -Causes of Cauda Equina Syndrome: 1)Central disc herniation. 2)Burst fractures of lumbar spine. 3)Tumors compressing the lower spinal nerve roots. 4)Penetrating injuries such as stab wounds or bullets. **Rx: Emergency decompression, usually discectomy,within 24 hrs.**	-Transient loss of spinal reflexes Lasts 24-72 hours. -Peripheral vasodilation. -Transient loss of all neurologic function below the level of the spinal cord injury, causing flaccid paralysis and areflexia for variable periods.	-Reduced tissue perfusion due to loss of sympathetic outflow and unopposed vagal tone. -Hypotension that follows SCI (sBP usually ⩽80 mmHg) caused by: - Interruption of sympathetics (unopposed parasympathetics) below the level of injury. -Loss of muscle tone due to skeletal muscle paralysis below level of injury → venous pooling (relative hypovolemia). -Blood loss from associated wounds (true hypovolemia). **Rx: fluid resuscitation**

Imaging:

X-rays:

a. **Cervical**, 3 views: AP, lateral and open mouth
b. **Thoraco-lumbar**, 2 views: AP & lateral; **Flexion-Extension** view (Assess ligamentous instability using flexion/extension x-ray views of ±MRI). Thoracolumbar spine unstable if 4/6 segments disrupted (3 columns divided into left and right)
    i. **Anterior column**: anterior half of vertebral body, disc, and anterior longitudinal ligament
    ii. **Middle column**: posterior half of vertebral body, disc, and posterior longitudinal ligament
    iii. **Posterior column**: posterior arch, facet joints, pedicle, lamina and supraspinous, interspinous, and ligamentum ligaments.

CT: best for **bony** anatomy

MRI: best to evaluate **soft tissue →** in **disc herniation.**

Management of spinal injuries: (Most important part of the lecture)

Depends on: Level of injury, Degree and morphology of injury: **STABILITY**, Presence of neurologic deficit, Other factors (i.e. Age).

Some general rules:

1. **Stable** injuries are usually treated conservatively.
2. **Unstable** injuries usually require surgery.
3. **Neurologic compression** requires decompression.

Specific injuries:

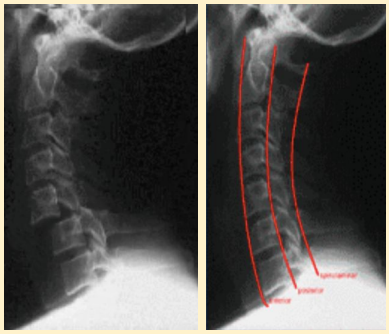
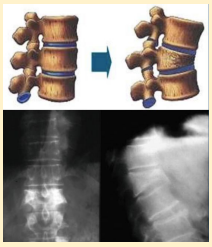
<table>
<tr><th>1-Cervical spine fractures</th><th colspan="3">2-Thoracolumbar fractures</th></tr>
<tr><td>Descriptive: depends on mechanism of injury: Flexion\ extension, Compression\ distraction, Shear.
-Presence of subluxation\ dislocation.
-SCI:
1. High fracture results in quadriplegia.
2. Low fracture results in paraplegia.</td><td colspan="3">50% of injuries occur at thoracolumbar junction.
Common fractures:
1. Wedge fracture (flexion/ compression)
2. Burst (compression)
3. Chance (flexion/ distraction)</td></tr>
<tr><td>  </td><td>Wedge fracture
  </td><td>Burst
  </td><td>Chance (gap felt on physical exam)
  </td></tr>
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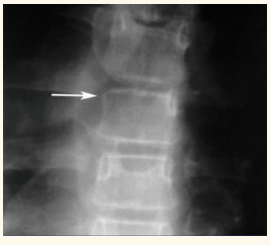
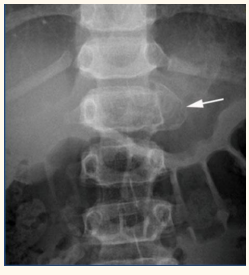
Table 20. Denis Classification of Spinal Trauma

Fracture Type	Description
Compression Fracture (58%)	Produced by flexion Posterior ligament complex (supraspinous and interspinous ligaments, ligamentum flavum, and intervertebral joint capsules) remain intact Fractures are stable but lead to kyphotic deformity
Burst Fracture (17%)	Stable: anterior and middle columns parted with bone retropulsed nearby Hallmark is pedicle widening on AP x-ray Spinal cord (seen on x-ray and CT); posterior column is uninjured Unstable: same as the stable but with posterior column disruption (usually ligamentous)
Flexion Distraction Injury (6%)	Hyperflexion and distraction of posterior elements Middle and posterior columns fail in distraction Classic: Chance = horizontal fracture through posterior arch, pedicles, posterior vertebral body Can be purely ligamentous, i.e. through PLL and disc
Fracture-Dislocation (6%)	Anterior and cranial dislocation of superior vertebral body → 3 column failure Three types: (1) flexion-rotation, (2) flexion-distraction, (3) shear/hyperextension (rare)

3-Pathologic fractures: Usually due to infection or tumor, Low energy fractures. **Osteoporotic** is common. X-rays: "winking owl" sign.





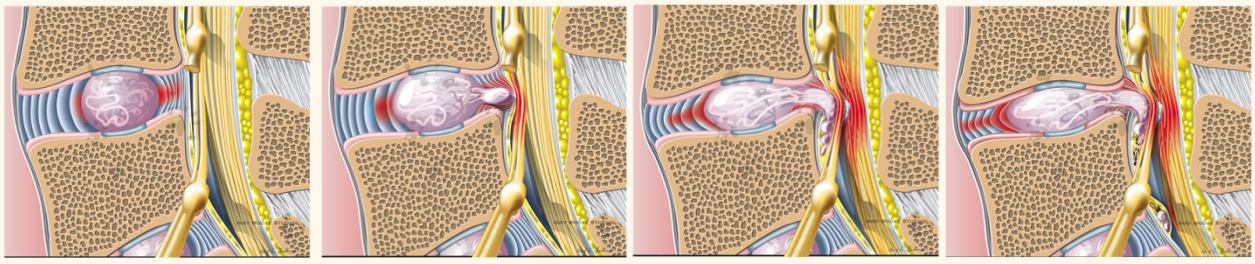
Common spinal injuries

Pathophysiology IVD:

The disc is completely avascular, the body does not know the disc itself, so once it is there it will be irritating and sometimes could create antibodies against it, but most importantly is that the water or the fluid from the disc will act as irritant to the nerves (i.e. sciatica).

Back pain:

- If painful **flexion** (like in sitting) → disc related pathology; starts with loss of cellular material and dehydrated disc (due to Disc hernia) → becomes black because of degeneration → it will become short (loss of height) → increase loading of the facet → Osteophytes formation → Facet joints degeneration→ instability → ligamentum flavum will start to become thicker → stenosis of the canal (Spinal stenosis).
- If painful **extension** → facet or pars interarticularis related pathology.



Deterioration of annulus fibrosus | Prolapse of nucleus pulposus | Extrusion of nucleus pulposus | Sequestration of nucleus pulposus

Clinical presentation:

Mechanical pain:

Back pain NOT due to prolapsed disc or any other clearly defined pathology.

Clinical Features:

- Dull back ache aggravated by activity and prolonged standing.
- Morning stiffness.
- No neurological signs.
- Degeneration +/- Instability. Axial pain.

Neurological symptom: (Very Important)

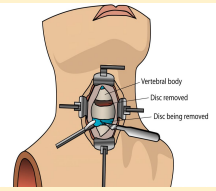
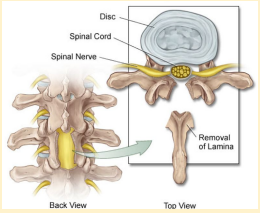
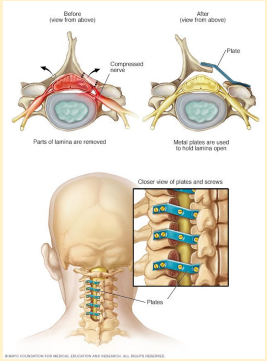
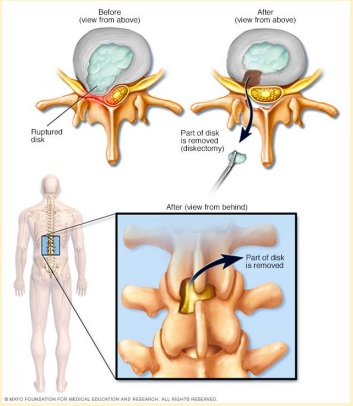
1. Spinal cord: Cervical and Thoracic → Spinal cord compression.
    a. Cervical: Myelopathy (CSM) → Variable loss of sensory and motor loss, fine movement loss, motor deficit in Upper Limb, fall of objects from hands, upper motor neuron signs in the lower limb; clonus, babinski. (refer to central cord in table 17)
    b. Spinal cord injuries: complete vs incomplete.
2. Nerve roots: Sciatica
3. Cauda equina: prevalence 0.0004/LBP but serious→ stress incontinence or urinary retention you can know by palpating the bladder.
4. Spinal stenosis: Neurogenic claudication

Table 15. Differentiating Claudication

	Neurogenic	Vascular
Aggravation	With standing or exercise Walking distance variable	Walking set distance
Alleviation	Change in position (usually flexion, sitting, lying down)	Stop walking
Time	Relief in ~10 min	Relief in ~2 min
Character	Neurogenic ± neurological deficit	Muscular cramping

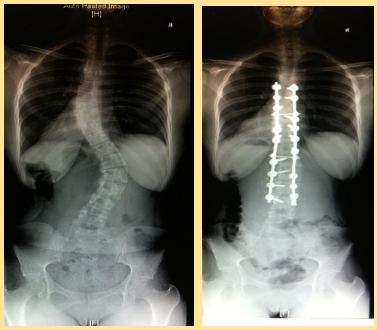
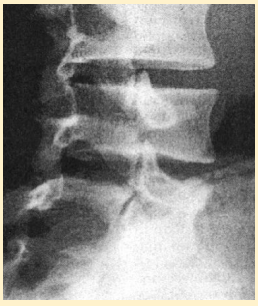
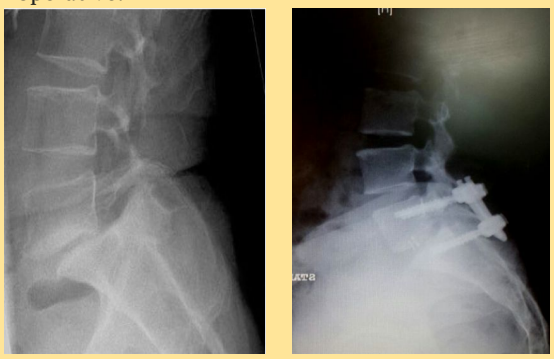
		DEGENERATIVE DISC DISEASE	LUMBAR DISC HERNIATION	SPINAL STENOSIS
General principals		Loss of vertebral disc height with age result in: ■ bulging and tears of annulus fibrosus. ■ change in alignment of facet joints. ■ osteophyte formation. **Mechanism:** Compression over time with age.	■ Tear in annulus fibrosus allows protrusion of nucleus pulposus causing either a central, posterolateral, or lateral disc herniation, most commonly at L5-S1 > L4-5 > L3-4. ■ 3:1 male to female. ■ Only 5% become symptomatic. ■ Usually a history of flexion-type injury. **Prognosis:** 90% of patients improve in 3 mo with non-operative treatment.	■ narrowing of spinal canal <10mm. ■ congenital (idiopathic, osteopetrosis, achondroplasia) or acquired (degenerative, iatrogenic–post spinal surgery, ankylosing spondylosis, Paget's disease, trauma).
Clinical Features		• Axial back pain without radicular symptoms. • Pain worse with axial loading and flexion. • Negative straight leg raise.	• Back dominant pain (central herniation) or leg dominant pain (lateral herniation). • Tenderness between spinous processes at affected level. • Muscle spasm ± loss of normal lumbar lordosis • Neurological disturbance is segmental and varies with level of central herniation: ■ motor weakness (L4, L5, S1). ■ diminished re exes (L4, S1). ■ diminished sensation (L4, L5, S1). • positive straight leg raise. • positive contralateral SLR. • positive Lasegue and Bowstring sign. • cauda equina syndrome (present in 1-10%): surgical emergency.	• ±bilateral back and leg pain. • neurogenic claudication. • ±motor weakness. • normal back flexion;difficulty with back extension (Kemp sign). • positive Straight leg raise, pain not worse with Valsalva.
Investigations		X-ray, MRI, provocative discography	X-ray, MRI, consider a post-void residual volume to check for urinary retention; post-void should heighten suspicion for cauda equina syndrome.	CT/MRI reveals narrowing of spinal canal, but gold standard = CT myelogram.
Rx	**non-operative**	■ Staying active with modified activity. ■ Back strengthening. ■ NSAIDs. ■ Do not treat with opioids; no proven efficacy of spinal traction or manipulation.	Symptomatic: ■Extension protocol. ■NSAIDS. Most of them will improve (85%), with or without treatment	Vigorous physiotherapy (flexion exercises, stretch/strength exercises), NSAIDs, lumbar epidural steroids.
	operative	■ Decompression±fusion. ■ No difference in outcome between non-operative and surgical management at 2 yr.	■ Indication: progressive neurological deficit, failure of symptoms to resolve within 3 mo or cauda equina syndrome due to central disc herniation. ■ Surgical discectomy.	■ Indication: non-operative failure >6 mo. ■ Decompressive surgery.

Management:

	Cervical spine				Lumbar spine
Notes	Axial neck pain and radiculopathy, without neurological deficits.				-Disc hernia -Axial LBP (Conservative) -Spinal stenosis (Laminectomy is common) Lumbar spine (acute disc hernia): 90% resolved within 12 weeks
Conservative	-rest and short period of immobilization -Physiotherapy: ROM and strengthening -Pain management -Neuropathic medication for radiculopathy				short period of rest, PT, Pain management (non-invasive and invasive;epidural and facet injections)
Surgical indication	-Cervical stenosis causing cervical myelopathy -Disc hernia causing radiculopathy associated with weakness Failure of conservative managements				Cauda equina, motor deficit, deformity , instability, severe neurogenic claudication, and failure of 6 months conservative treatment.
Surgical procedures	Anterior cervical discectomy and fusion	Posterior laminectomy +/- fusion	Laminoplasty	Cervical disc arthroplasty	1)Laminectomy 2)Discectomy
Pictures					

Spinal deformities:

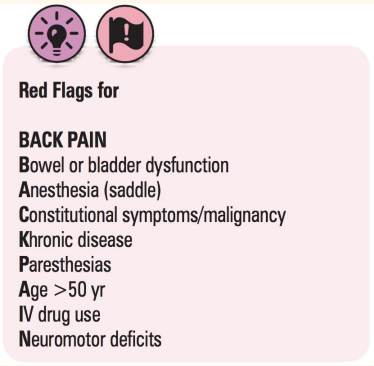
<table>
<tr><th></th><th>Scoliosis</th><th>Spondylolysis</th><th>Spondylolisthesis</th></tr>
<tr><td>Notes & Causes</td><td>1. Congenital
2. Syndromic
3. Neuromuscular
4. Idiopathic: most common type.</td><td>-Is a defect in the pars interarticularis.
-Plan lateral radiograph 80%, oblique another 15%.
-Single photon emission computed tomography.
Mechanism:
trauma: gymnasts, weightlifters, backpackers, loggers, labourers
Clinical Features:
Activity-related back pain, pain with unilateral extension (Michelis' test).
Investigations:
• oblique x-ray: "collar" break in the "Scottie dog's" neck.
• bone scan.
• CT scan.
Treatment:
• non-operative: activity restriction, brace, stretching exercise.</td><td>•Displacement of a vertebra in relation to a vertebra below.
•Most people are asymptomatic
•Commonest causes are:
● Degenerative
● Isthmic
•Severity according to the degree of displacement.
•<u>Surgical indication:</u> grade 3 or more, failed conservative
•<u>Surgical procedure:</u> according to severity. Instrumented PSF +/- interbody fusion is the commonest</td></tr>
<tr><td>Types</td><td>ADOLESCENT IDIOPATHIC SCOLIOSIS

•Between 10 and 14 years
•Vertebral rotation
•Deformity without significant pain
•Normal neurological examination
•<u>Surgical indication</u>: 45 degrees or more
•<u>Surgical procedure:</u> instrumented PSF
  </td><td>  </td><td>ADULT ISTHMIC SPONDYLOLISTHESIS
Definition:
• defect in pars interarticularis causing a forward translation or slippage of one vertebra on another usually at L5-S1, less commonly at L4-5.
Mechanism:
• congenital (children), degenerative(adults), traumatic, pathological, teratogenic.
Clinical Features:
• lower back pain radiating to buttocks relieved with sitting.
• neurogenic claudication.
• L5 radiculopathy.
• Meyerding Classification (percentage of slip).
Investigations:
• x-ray (AP, lateral, obliques flexion-extension views), MRI.
Treatment:
• non-operative
■ activity restriction, bracing, NSAIDS
• operative.
  </td></tr>
</table>

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.



Pathologic fractures:

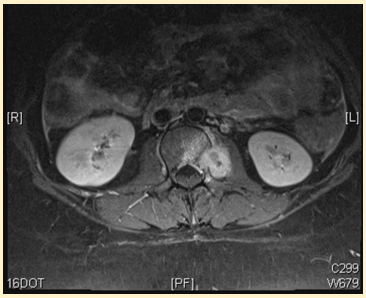
- Low-energy fractures
- Osteoporotic is common
- Usually due to infection or tumor.
- X-rays : "winking owl" sing.

Osteoporotic fracture:

- Common injury post menopausal, if repetitive will result in loss of height and kyphotic deformity.
- Often missed.
- Treatment: Underlying disease.

Red flag: Destructive Spinal Lesions

- Present with pain at rest or at night
- Associated with constitutional symptoms
- Vertebral body and pedicle are the commonest sites of pathology
- Most common causes:

Infection	Tumors	
-Most common is TB and Brucellosis. -History of contact with TB patient, raw milk ingestion. -Potentially treatable diseases once diagnosis is established and antimicrobials administered.  Spinal Tuberculosis (with psoas abscess)	**Primary Spinal tumors** -Rare. -Benign (e.g. osteoid osteoma) or malignant (e.g. chordoma). -Management depends on pathology.	**Spinal metastasis** -Very common. -Biopsy required if primary unknown.

References:

- Doctors Slides and Notes.
- Toronto Notes 2017.

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