12- Common Spine Disorders

Objectives:

The ability to demonstrate knowledge of the characteristics of the major conditions:

- Degenerative neck or back pain.
- Spinal cord or root entrapment (for example, herniated lumbar disc).
- Osteoporotic vertebral fracture.
- Spinal deformity (scoliosis, spondylolisthesis).
- Destructive (infectious and tumor related) back pain (for example, tuberculosis, metastasis, certain cancers).

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References: Team 435, Slides, Apley's

Degenerative Spinal Disorders

★ Overview:

#Terms:

- Spondylosis: A degenerative disease.
- Spondylolysis: A fracture or defect in the pars interarticularis.
- Spondylolisthesis: Displacement of one vertebra over the other.

Spinal motion segment is composed of:

1. Two adjacent vertebrae.
2. Three-joint complex. (intervertebral disc & 2 facet joints)
3. Ligaments.

Note that each level of your spine functions as a three-joint complex.

- There are two facet joints in the back and a large disc in front that comprise each intervertebral segment.
- This tripod creates great stability, supports all your weight above each level and provides support for you to move in all directions.
- The posterior facet joints are synovial joints whereas the intervertebral disc is a fibrocartilaginous joint.

Degeneration:

Deterioration of a tissue or an organ in which its function is diminished, or its structure is impaired.

- Other terms (that are used interchangeably with "degenerative spinal disorders"):

- Spondylosis: which could be:
  - Degenerative disc disease.
  - Facet osteoarthrosis.

Degeneration of IVD (intervertebral disc):

- Loss of cellular material and hydration "proteoglycans".
- Loss of disc height.
- Abnormal loading to the facet.
- Facet joints degeneration (Loss of height + facet OA).
- Spinal stenosis +/- instability.

With ageing there is a gradual loss of proteoglycans and the disc becomes somewhat dehydrated and degenerate, this is thought to be the underlying cause of two important disorders that occur particularly in the **lumbar** and cervical regions and to a lesser extent in the **thoracic** spine: Intervertebral disc herniation and chronic intervertebral disc degeneration.

★ Etiology:

Multi-factorial:

1. Genetic predisposition.
2. Age related. (Aging)
3. Some environmental factors:

- Smoking.
- Obesity.
- Deformity.
- Previous injury, fracture or subluxation.
- Operating heavy machinery, such as a tractor.

★ Anatomy:

○ **Anterior elements:**

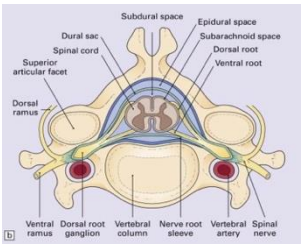
1. Vertebral body.
2. Inter-vertebral disc.

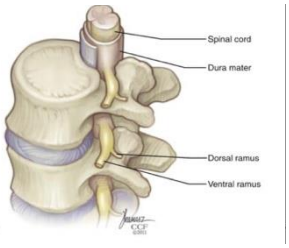
Degeneration occurs at the disc.

○ **Posterior elements:** Pedicles, laminae, spinous process, transverse process, facet joints (2 in each level)

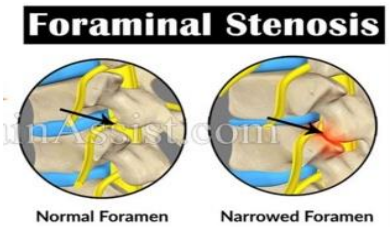
Osteoarthrosis occurs at the facet joints.

○ **Neurologic elements:** Spinal cord, Nerve roots**,** Cauda equina

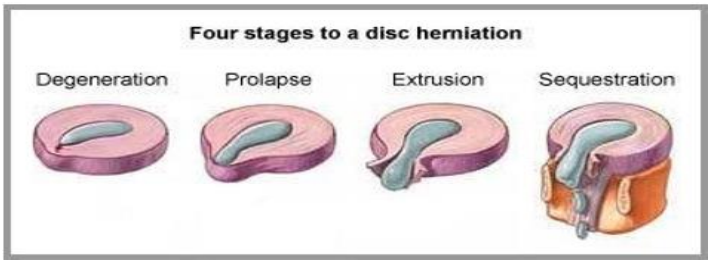




★ Pathology: Both the mechanical and neurological segments are involved

Mechanical segment	
The iner-vertebral disc "Anteriorly"	**The facet joints** "Posteriorly"
The first component of the 3 joints complex (motion segment) - It is primarily loaded in **Flexion**. - Composed of "annulus fibrosus" and "nucleus pulposus". Degeneration of the nucleus: - Loss of both: cellular material and hydration → pain! Can be asymptomatic, Water content drops disc became hard and black on the X-ray. Disc degeneration will also cause: **IMP** 1. Bulging of the disc →"Spinal" stenosis. 2. Loss of disc height →"Foraminal" stenosis. 3. Herniation of the nucleus →"Radiculopathy" (e.g. sciatica in the lumbar spine) Extra:  - Annular tear (which leads to herniation of the nucleus) is extremely painful and leads to sciatica. Will improve anyway, but it gives chronic kind of pain. - Sequestered disc (when parts of the herniated nucleus separate from it) → it's water, the body will eventually absorb it.	Scientific name is "zygapophysial joints". 1) They are synovial joints. 2) 2 in each motion segment. Are primarily loaded in **EXTENSION** (along with pars interarticularis posterior muscles and ligaments) #Pattern of degeneration similar to other synovial joints: - Loss of hyaline cartilage. - Formation of osteophytes. - Laxity in the joint capsule. it's like any synovial joints in the body the degeneration process leads to lose of joint height, osteophytes formation, redundancy in capsule, inflammatory changes, excessive fluid and eventually instability which cause spondylolisthesis usually anterior posterior slippage "the vertebral above slips anteriorly" Facet joints degeneration will cause • Hypertrophy, osteophyte formation: Contributing to spinal stenosis or foraminal stenosis. - Laxity in the joint capsule: Leading to instability (Degenerative spondylolisthesis)

Almost all will **improve within three months.**
So basically, most patients with disc pathology & herniated disc who are in severe pain & cannot leave bed WILL also IMPROVE, almost 90% will improve within 3 months



Clinical presentation: falls into 2 categories IMP

Mechanical pain

Due to joint degeneration or instability.

- "Axial pain" in the neck or back.
- Activity related-not present as rest.

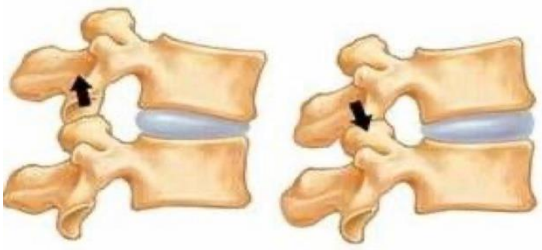
Mechanical pain: dull pain increase by movement and decrease by rest.

Associated with movement:

- Sitting, bending forward **(flexion)**:

Originating from the disc → **"Discogenic pain"** pain originated from disc, Pain when praying.

- Standing, bending backward **(extension)**: Originating from the facet joints → **"Facet syndrome"** patient present with inability for standing or walking for long time especially downstairs B/c back extension.



Neurologic symptoms

Due to neurologic impingement[1]

A) Spinal cord:

Presents as myelopathy, and spinal cord injury.

1. ***Myelopathy:*** (Compression on the cord)
   1. Loss of motor power and balance → gait disturbance.
   2. Loss of dexterity → Objects slipping from hands. Loss of balance, fine hand movements such as writing, inability to buttoning his shirt, coffee or tea cups slips from him.
   3. UMN deficit → Rigidity, hyper-reflexia, positive Babinski.
   4. Slowly progressive "stepwise" deterioration.

It happens over months. Stepping pain and usually associated with neurological symptpmes such as: numbness and parenthesis.

2. ***Spinal cord injury:***

Spinal stenosis associated with a higher risk of spinal cord injury. Since the cord is already compressed, any sudden movement may injure the cord

B) Cauda-equina and Nerve roots:

Presents as radiculopathy (e.g. sciatica) or neurogenic claudication.

1. ***Radiculopathy:***
   1. LMN deficit.
   2. Commonest is sciatica[2], but cervical root impingement causes similar complaints in the upper limb.

[1] اختناق أو تضييق

[2] Sciatica refers to the symptoms of pain, numbness, tingling, burning sensation or weakness that originate in the lower back, radiate through the buttock, and continue down the back of the thigh, leg and foot. Sciatica occurs when there is compression, inflammation or injury to the sciatic nerve or to its (spinal nerve) roots L4-S2

	Cervical level → radiculopathy → upper limb. Lumbar level → radiculopathy → sciatica. ***2. Neurogenic claudication:*** 1. Pain in both legs caused by walking. 2. Must be differentiated from vascular claudication.

The following table is very important

Table – Differentiating neurogenic and vascular claudication

Factors	Neurogenic	Vascular
Evaluation after walking	Increased weakness	Unchanged
Palliative factors	Bending over, sitting	Stopping
Provocative factors	Walking downhill Increased lordosis	Walking uphill Increased metabolic demand
Pulses	Present	Absent
"Shopping cart" sign	Present	Absent
van Gelderen bicycle test	No leg pain	Leg pain

- Flexion = widening of the spinal foramen (walking uphill requires flexion to bring the center of gravity anteriorly)
- Extension = compression of the spinal foramen (walking downhill requires extension to bring the center of gravity posterior)
- Neurogenic claudication:
  - Pain as soon as he walks from proximal to distal (he didn't use muscles → not vascular claudication).
  - Pain relieved by sitting (sitting = flexion = widening)
- Vascular claudication:
  - Pain relieved by stopping & standing (benefits from gravitational force on blood supply).
  - Why distal to proximal in vascular claudication? Because blood supply is less as you go distally
- Shopping cart sign: the patient bends while walking, because neurogenic pain is relieved in bending position. Because ligamentum flavum is hypertrophied into spinal canal and while bending يتجمع
- Bicycle sign: it is like a stress test on a bicycle, patient with vascular claudication will develop pain because the metabolic demand will increase while neurogenic patients will feel no pain.

★ Imaging:

- X-ray examination: typically shows flattening of the 'disc spaces' and spur formation at the borders of the vertebral bodies, often accompanied by characteristic features of osteoarthritis in the small facet joints.
- MRI scans: may show bulging of one or more discs in both sagittal and axial projections. Most imp scan

Patient presented after RTA with thoracic spine pain, normal neurological examination & unclear x-ray. Second step? **CT**

Now we'll discuss the disorder based on the level of spine affected, this division clinically relevant:

	Cervical Spine Toronto notes	Lumbar Spine Toronto notes
Site	Degenerative changes typically occur in **C3-C7**	Degenerative changes typically occur in **L3-S1**
Presentation	Presents with: 1. Axial neck pain. 2. Myelopathy. 3. Radiculopathy.	Presents with : 1. Axial back pain. 2. Sciatica. 3. Neurogenic claudication.
Physical examination	- Stiffness (loss of ROM) - Neurologic exam: (along upper limbs) • Weakness. • Loss of sensation. • Hyper-reflexia, hypertonia because of UMN lesion • Special tests: Spurling's sign[3] Axial compression + rotation and lateral bending to make the spinal foramen in one side more compressed to excite the nerve root that already being compressed to know if it's really radiculopathy rather than shoulder pain or peripheral neurological disease. 	- Stiffness (loss of ROM) - Neurologic exam: (along lower limbs) • Weakness. • Loss of sensation. • Hypo-reflexia, hypotonia because of LMN lesion • Special tests: Straight leg raise test (SLRT).
Managment	**#Conservative treatment:** First line of treatment for axial neck pain and mild neurologic symptoms (e.g. mild radiculopathy without any motor deficit) 1. Rest and short periods of immobilization. 2. **Physiotherapy:** Focus on ROM and muscle strengthening. 3. **(NSAID):** e.g. Diclofenac, ibuprofen, naproxen. Pay attention to patient who has peptic ulcer, nephropathy and HTN. 4. **Neuropathic medication:** for radiculopathy pain – e.g. Gabapentin or pregabalin or Amitriptyline.	**A) Axial low back pain** **#Conservative** treatment is first line and mainstay of treatment: 1. **Physiotherapy:** core muscle strengthening, posture training. 2. **NSAID.** **#Surgical** treatment Indicated for: 1. Instability or deformity e.g. high-grade spondylolisthesis. الفقرة متزحلقة على قدام 2. Failure of conservative treatment. **B) Spinal stenosis** **#Conservative** treatment is first line of treatment: 1. Activity modification.

[3] The examiner turns the patient's head to the affected side while extending and applying downward pressure to the top of the patient's head. a positive sign is when the pain arising in the neck radiates in the direction of the corresponding dermatome ipsilaterally.

#Surgical management
Indicated for:

1. Spinal stenosis causing myelopathy.
2. Disc herniation causing severe radiculopathy and weakness. **Acute** limb weakness.
3. Failure of conservative treatment of axial neck pain or mild radiculopathy.

Procedures:

- Anterior discectomy and fusion.
- Posterior laminectomy.

Image of anterior discectomy and fusion

2. Analgesic.
3. Epidural corticosteroid injections.

#Surgical treatment Indicated for:

1. **Acute** Motor weakness e.g. drop foot if there is foot drop it is an emergency you have to operate within a day or less.
2. Failure of minimum 6 months of conservative treatment.

Procedure:
Spinal decompression (laminectomy) is the commonest procedure.

C) Disc herniation: IMP
#Conservative treatment is first line of treatment for mild sciatica without motor deficit:

1. Short (2-3 day) period of rest.
2. NSAID.
3. Physiotherapy
4. Epidural cortico-steroid injection.

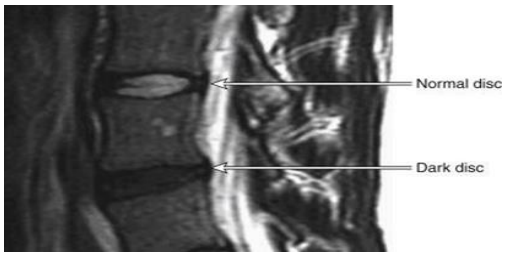
95% of sciatica resolves within the first 3 months without surgery.

#Surgical treatment Indicated for : IMP

1. Cauda-equina syndrome.
2. Acute Motor deficit. Muscle power 3 or less
3. Failure of 2-3 months of conservative treatment.

Procedure:
Discectomy (only the herniated part)

In an MRI, notice how upper discs are white (good disc, good water content) whereas lower discs are black.



Lumbar Spondylosis

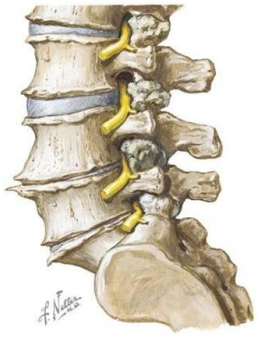
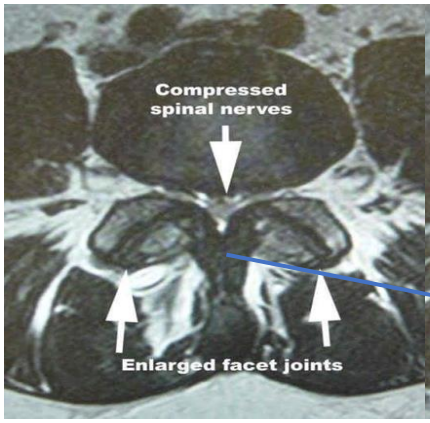
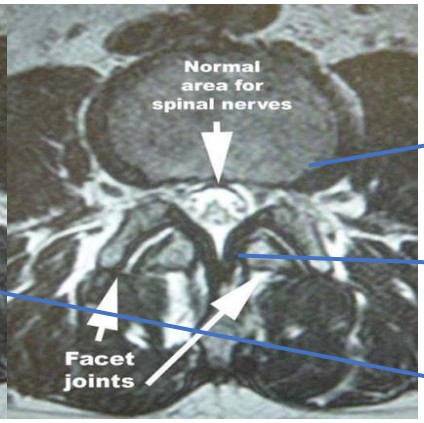
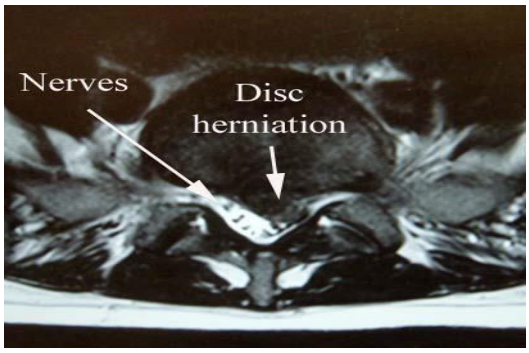
They can place the same image but the scenario will indicate the management:

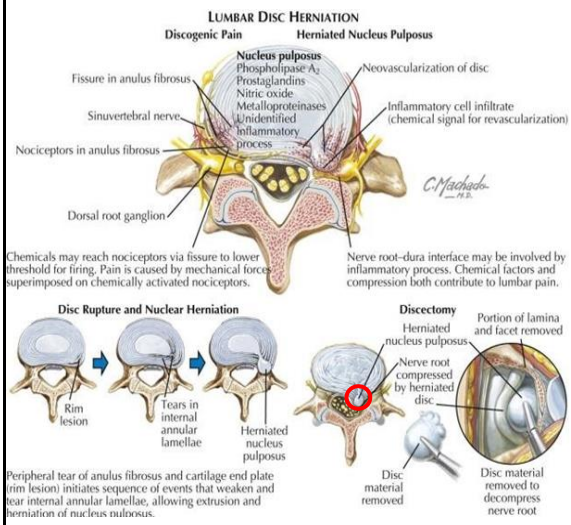
1. Patient has 10 days acute severe pain, can't get out of the bed Management → CONSERVATIVE, because still 10 days & no red flags.
2. Patient with 4 Months history of pain & failed physiotherapy Management → SURGERY
3. Patient with 2 days history of pain with (...) "features of cauda equina" Management → SURGERY.

Why most herniated discs are posterolateral not central? Central part is stronger due to the support of the posterior longitudinal ligament.

[Myelomalacia is a pathological term referring to the softening of the spinal cord. Can be caused by a hemorrhagic infarction (bleeding) of the spinal cord as a sequela to acute injury, such as that caused by intervertebral disc extrusion (being forced or pressed out).]

★ Imaging:

Lumbar Spondylosis	  
Spinal stenosis	  It is kidney shape دائرية صارت مثلث
Disc herniation	 

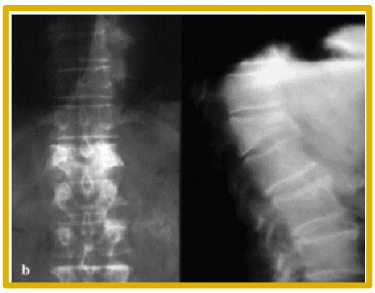
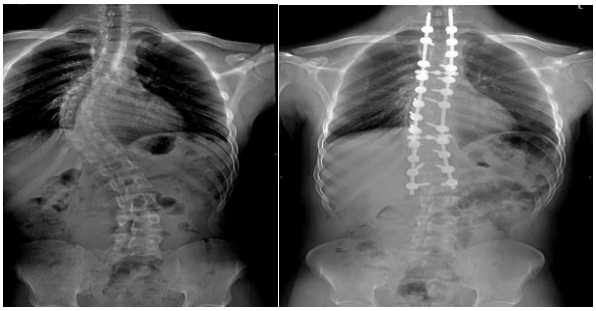


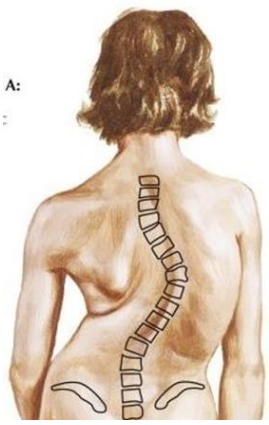
Discectomy

It just remove of the segment in red circle

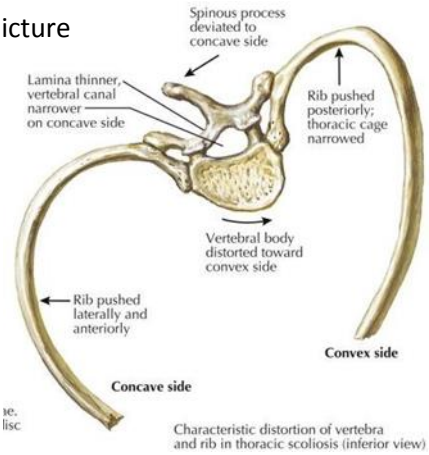
Spinal fusion

Other spinal disorders:

Spinal deformities	
1- Kyphosis	Deformity of the spine in the Sagittal plane. Give the patient **anti-osteoporotic** medications 
2- Scoliosis	Deformity of the spine in the Coronal plane (more common than kyphosis) **Types:** - **Congenital**: Associated with anomalies of the bony vertebral column, e.g hemivertebra. - **Acquired:** Secondary to other pathology, e.g tumor, infection. - **Idiopathic:** Most common is adolescent type. - **Syndromic:** Secondary to other syndromes e.g. Ehler danlos', marfan's syndrome. - **Neuromuscular:** Secondary to poor muscle control or nerve problems e.g. muscular dystrophy, cerebral palsy. **Adolescent idiopathic scoliosis:** Between 10 and 14 years old • Three dimensional deformity of the spine – Vertebral **Rotation** is the hallmark. (meaning it's not just curving in different directions NO it's a 3D deformity) • Painless deformity: Usually noticed by parents or others. • Examination: neurologically normal, positive Adams test. When the patient bend forward the back is not symmetrical there's hump in one side • Management: depends on age & degree of deformity (45 degrees or more) you do not need to know the details of but if the patient have sever scoliosis we will operate - instrumented PSF (posterior spinal fusion) What are the positive clinical signs in this patient shown in the x-ray? 1. Shoulder asymmetry (which side is elevated? Left, evident by the clavicle another hint shoulder is usually elevated at the convex side of spine). 2. Waist is asymmetric right side is bulging, left side is pushed. 3. Positive Adam forward test + rib hump. 4. Lateral image will show either exaggerated kyphosis or hypokyphosis of thoracic spine.  RX: surgically, attempt to correct as much as possible and prevent further progression



Adam test : positive in this picture



3- Spondylolisthesis

Translation (Displacement) of one vertebra over another.

- It's a defect in the pars interarticularis.
- Most people are asymptomatic.

#Types:

1. "Degenerative" Spondylolisthesis
2. "Isthmic" spondylolisthesis → Caused by interarticularis defect (spondylolysis) pars = body, interarticularis = in between two joints (facet joints) acquired from pedicle trauma or congenitally

- Severity is according to the degree of displacement.

#Management:

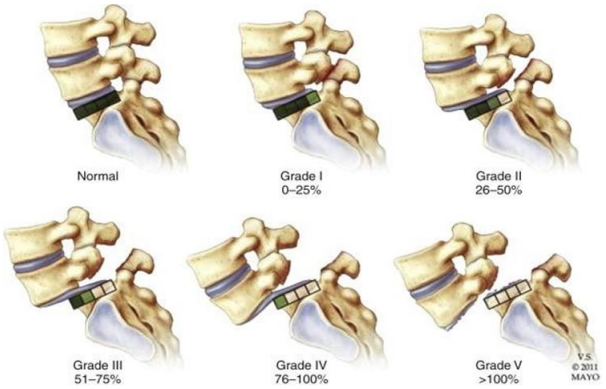
Conservative treatment first.

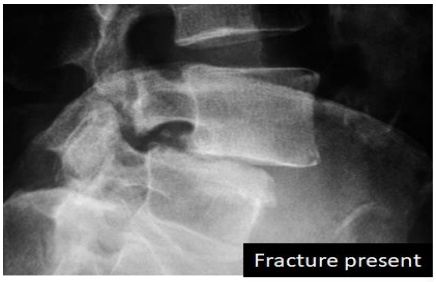
Surgery if Grade 3 or more or failed conservative management

- Surgical procedure: Instrumented PSF (posterior spinal fusion) with decompression +/- interbody fusion is the commonest.

Grades: (IMP)

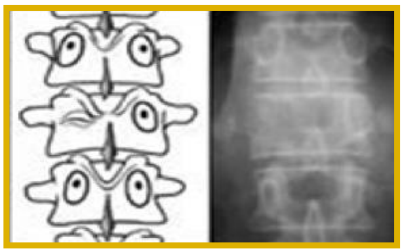
- Grade I 25% displacement
- Grade II 50% displacement
- Grade III 75% displacement
- Grade IV full displacement
- Grade V = spondyloptosis (no contact)





Osteoporotic vertebral fractures:

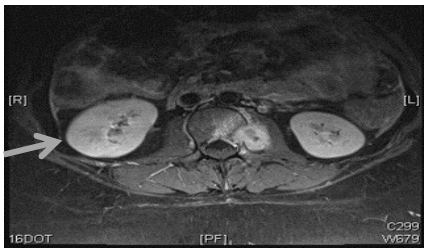
- Pathologic, low energy fractures.
- Anterior column (±middle column) only compromised (Wedge/Burst Fracture).
- Often missed (Common injury in postmenopausal women).
- Repetitive fractures result in kyphotic deformity (hunchback).
- Treat the underlying cause (e.g. osteoporosis). It increases the mortality rate by Increasing The DVT and pneumonia
  - Possible surgical management is kyphoplasty/ vertebroplasty if severe pain is present.
  - Other pathological vertebral fractures are also low energy fractures and are caused most commonly by either infection or tumors (red flags).
  - With these pathological fractures, spinal X-ray shows "winking owl sign" also known as "absent pedicle sign" which indicates erosion of spinal pedicle (most commonly suggests osteolytic spinal metastasis).



Destructive Spinal Lesions:

- Present with **pain at rest** or **pain at night** → this spinal lesion weakens bone → more pain (axial pain with movements) → further fracture with minor trauma → severe pain with loss of function.
- Associated with constitutional symptoms.
- Most common causes are infection & tumors (infection is always a differential for tumor and vice versa)
- Vertebral body and pedicles are the commonest sites of pathology. Why? B/C it's highly vascular.

1) Tumor	#Primary Spinal tumors: - Rare. - Either benign (e.g. osteoid osteoma) or malignant (e.g. chordoma). - Management depends on pathology. #Spinal metastasis: - Very common. - **Biopsy** required if primary unknown. If you suspect lesion = biopsy! Spinal cord presentation is according to the site of compression (thoracic vs cervical, anterior vs posterior, hemi brown Sequard syndrome or combined feature...etc.)
2) Infection	○ Most common is TB and Brucellosis. ○ History of contact with TB patient or raw milk ingestion. ○ Potentially treatable diseases once diagnosis is established and antimicrobials

	administered. (management is usually medical). Most indicative feature is **fever**. Spinal Tuberculosis with psoas abscess: (Abscess can act just like tumor and compresses structures in the spine)  Treat the cause and all symptoms will go away

★ Spinal pathology red flags: Very important!

1. Age more then 50
2. History of malignancy. Tumour weakening the vertebrae (causing cord compression or vertebral fracture
3. History of trauma. Traumatic Spine Fracture (causing vertebral angulation, pain, or neuro-compromise)
4. History of infection. weakening bone (causing disc/vertebral destruction or cord compression)
5. Urinary retention/fecal incontinence. "Cauda equina" (perianal numbness, decreased rectal tone, loss of movement in the extremities)
6. Acute motor deficit. Any acute loss of motor power = Emergency Surgery rush to the OR as soon as possible 6-12 hours to save it.
7. Constitutional symptoms. (Loss of appetite, loss of weight, fever, night sweat , pain at night)
   Remember that spine fracture can occur without trauma patient can have severe osteoporosis coughs or sneezes (or any **minor** load) → fracture!

#Important points the doctor mentioned at the end of the lecture you should focus on:

1) The Red Flags.
2) If myopathy Tx is Decompression.
3) Radiculopathy = drop foot Tx is surgery.
4) Sciatica Tx is conservative.
5) Pain when standing relieves when he bends forward, pain in down hill vs up hill.
6) Scoliosis = Adam's test, Coronal plane, Rotation.
7) Spondylolisthesis if it's a high-grade surgery!

★ Anatomy:

Structure of the vertebra:

1. Body or Centrum: Weight-bearing part of the vertebra that lies anteriorly.
2. Vertebral arch:
    - Formed from fusion of: 2 Pedicles and 2 Laminae.
    - The vertebral arch carries 7 process:
    - 2 Transverse processes.
    - One spinous process.
    - 2 Superior and 2 inferior articular processes: (four facet joints associated with each vertebra)
3. Vertebral foramen: Lies between the body and the arch, through which the spinal cord passes.
4. Intervertebral disc: Pads of flexible fibrocartilage that separate the vertebrae.
    - The intervertebral discs cushion the vertebrae and absorb shocks.
    - They also make the body trunk flexible. They are thickest in the cervical and lumbar regions, where the movements of the vertebral column are greatest

    Each disc consists of:
    - Peripheral part: the annulus fibrosus composed of fibrocartilage.
    - Central part: the nucleus pulposus, a mass of gelatinous material containing a large amount of water 90% water, a small number of collagen fibers, and a few cartilage cells.
    - No discs between the first & second cervical vertebrae or in the sacrum or coccyx.
    - Normally disc appears WHITE in T2 weighted image (because it contains mostly water)

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.

C1&C2:

- C1 (atlas):
    - No vertebral body (ring like), no spinous process and attached to the occipital condyles (hemisphere) above (50% of cervical flexion and extension happens between occiput and C1).
    - This joint allows you to nod “YES”.
- C2 (axis):
    - Has Odontoid process (or Dens.) (50% of rotation in cervical spine occurs between C1 and C2).
    - This joint allows you to nod “NO”.

C3-C7:

Have Transverse foramen (specific to cervical vertebrae) which is important for Vertebral Artery which forms the circle of willis in the brain (only the vertebral vein passes through C7).
So any fracture or disc herniation affect this area may affect the brain (not common).

Thoracic anatomy:

- Most thoracic vertebrae are typical, have bodies, vertebral arches and seven processes for muscular and articular connection.
- It articulates with the ribs which acts as a splint to stabilize the thoracic spine.
- Most rigid part of the mobile spine (due to rib attachment).
- Rarely injured (usually in high energy trauma.), usually osteoporotic fractures.
- ROM: Mainly rotation, very limited extension and flexion. Why? due to the way the thoracic articular facets are oriented (superior facet is posterolateral, inferior facet is anteromedial)

Characteristics of thoracic vertebra:

- Costal facets are present on the transverse processes for articulation with the tubercles of the ribs (T11 and 12 have no facets on the transverse process).
- The spines are long and inclined downwards.
- The vertebral foramen is small and circular.
- The body is medium sized and heart shaped.

Lumbar anatomy:

- The most common region for fractures and disc herniation. Most of the lumbar disc herniation happen posterolateral.
- ROM: Flexion and Extension. (again, due to facet orientation that goes in the sagittal plane)
- **Defect in the pars interarticularis (connection between pedicle & lamina) → Spondylolisthesis.**

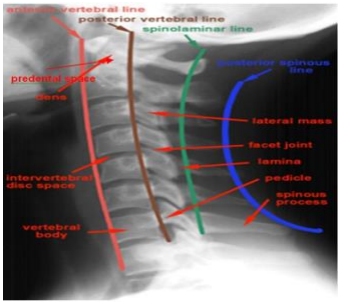
Characteristics of Lumbar vertebra:

- The Spinous process are short, flat, and quadrangular and project backwards.
- The vertebral foramina are triangular, and the body is large, and kidney shaped.
- The laminae are thick, and the transverse process are long and slender
- The Pedicles are strong and directed backwards.

Radiological anatomy:

When looking to a spine x-ray always notice the alignment of each of:

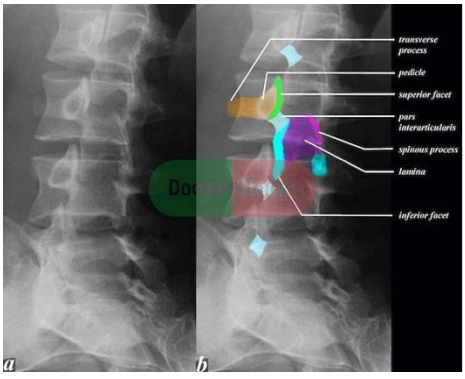
- the anterior vertebral line, the posterior vertebral line and the spinolaminar line.
- These lines need to be congruent otherwise this might indicate, fractures, displacement or any other spinal column pathology.



The soft tissue shadow should measure:

- in front of C1 = 7 mm
- in front of C2 = 2-3 mm
- in front of C6-C7 = 22 mm

Generally speaking, if it was significantly displaced → indicates trauma



We must see pedicles at each level (very important), also pay attention to the alignment of the spines and the space between each vertebral body = intervertebral disc.

A. Spinal cord

- It is suspended in the vertebral canal & surrounded by the meninges and cerebrospinal fluid (CSF).
- In adults, its Length is approximately 45 cm.
- Extends from foramen magnum to L1- L2 (In children it extends to L3).
- The spinal cord gives rise to 31 pairs of spinal nerves.

Conus medullaris: Is termination of spinal cord.

Filum terminale: Is residual fragment of spinal cord that extends from conus medullaris to sacrum.

Cauda equina: Nerve roots and filum terminale surrounded by dura that extend from the spinal cord.

#Spinal tracts:

a. Ascending Tracts (Sensory):
   1. Posterior columns:
      - Deep touch (pressure), proprioception (joint position), 2 point discrimination, vibrations.
      - when the posterior column is affected the patient can present with:
        - Gait disturbance: elicited by Tomberg's test.
        - Loss of dexterity.
   2. Lateral spinothalamic tract: pain and temperature.
   3. Anterior spinothalamic tract: light touch.

The only tract that doesn't decussate at the brain stem and instead decussate at the spinal level is the spinothalamic tract.

b. Descending tracts (motor):

   Corticospinal tract (anterior and lateral): main voluntary motor.

Upper extremity motor pathways are more medial (central) which explains why a central cord injury affects the upper extremities more than the lower extremities.

the representation of the fibers in the spinal cord differs; the fibers with the most **c**entral representation are **c**ervical fibers after that comes thoracic, lumbar then sacral (i.e. sacral fibers are the last fibers to be affected when the source of pathology is central, a phenomenon known as sacral sparing).