

Degenerative Spine Disease



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End plate

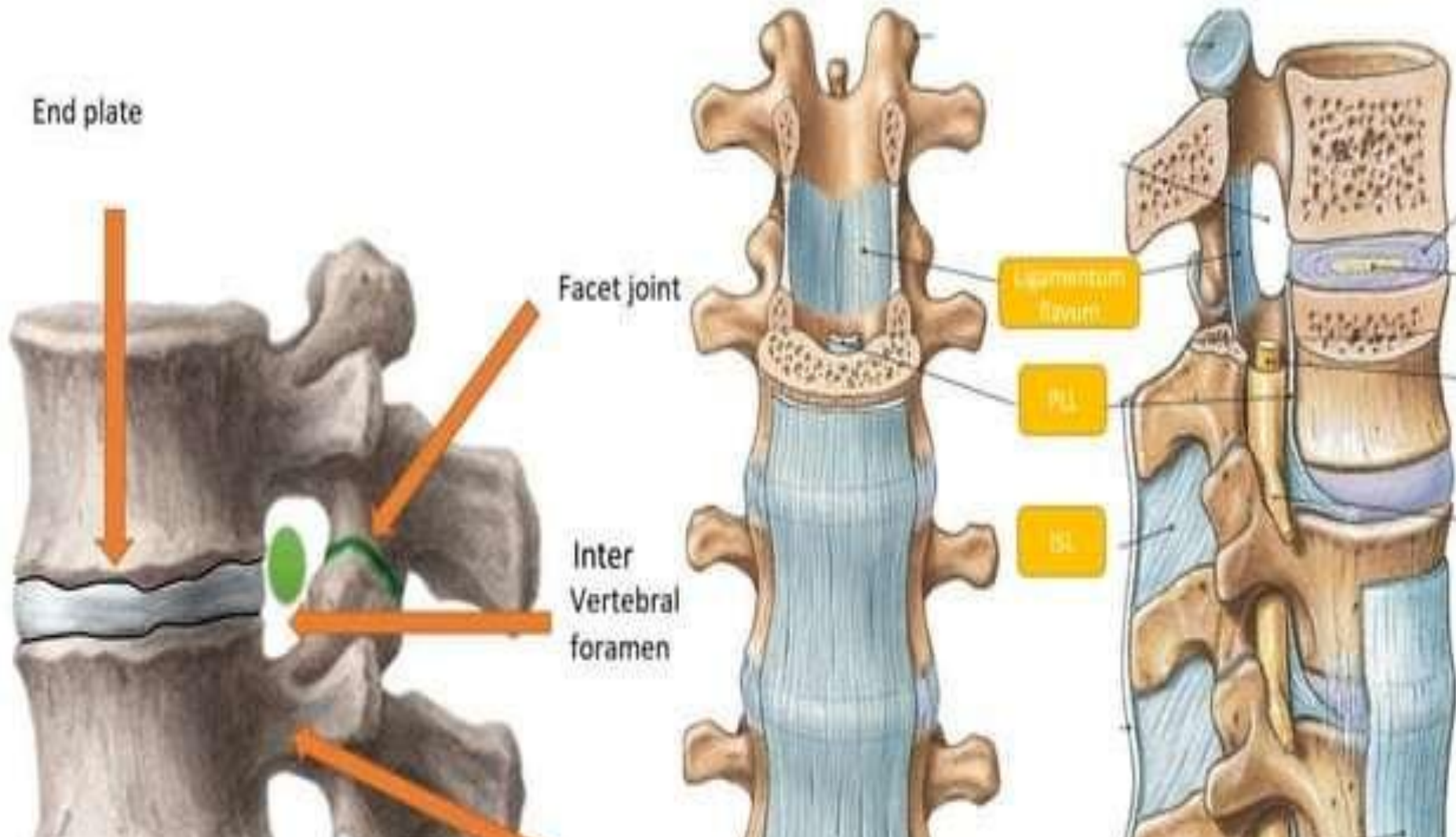
Facet joint

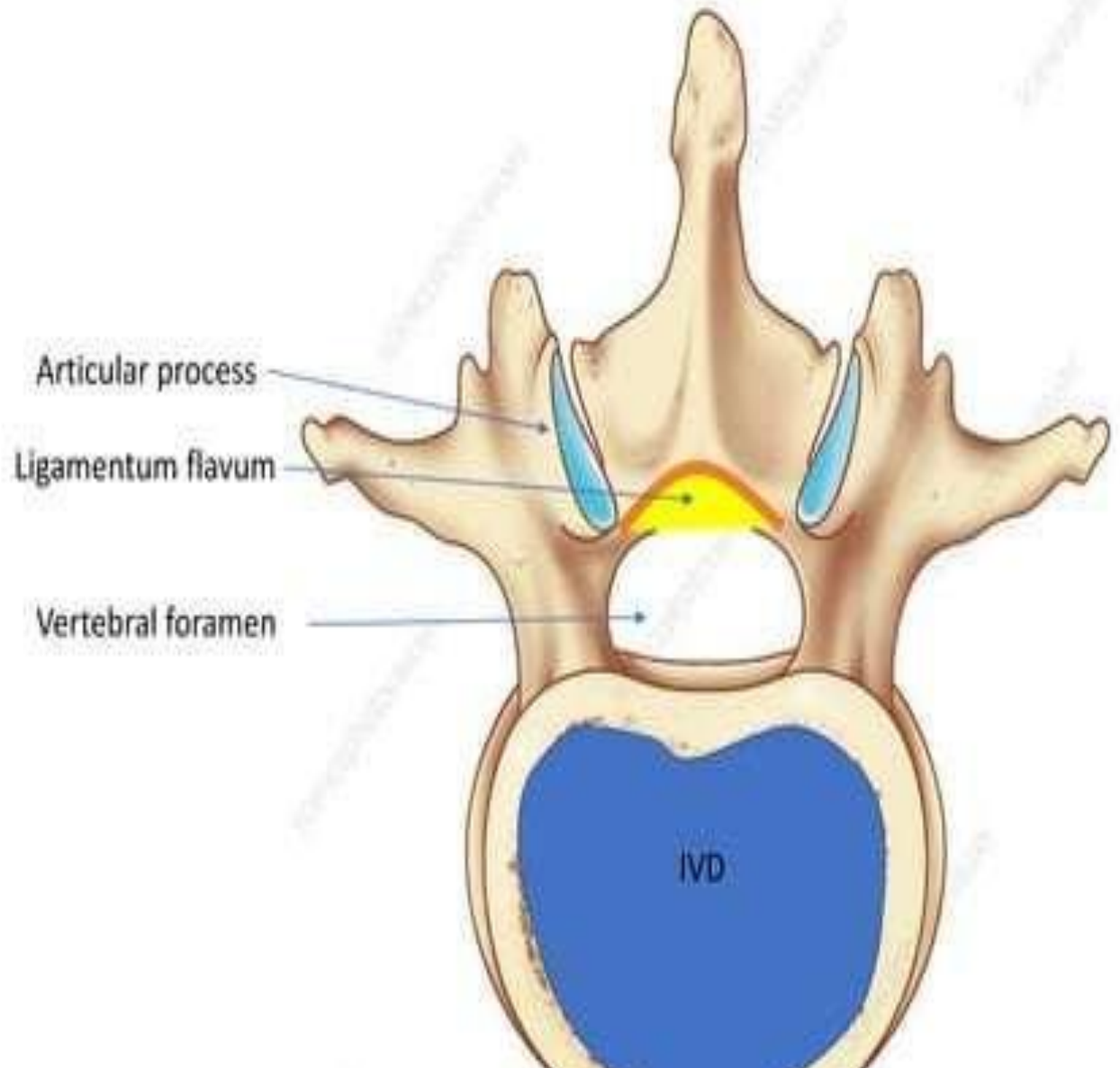
Inter Vertebral foramen

Ligamentum flavum

PLL

ISL





Articular process

Ligamentum flavum

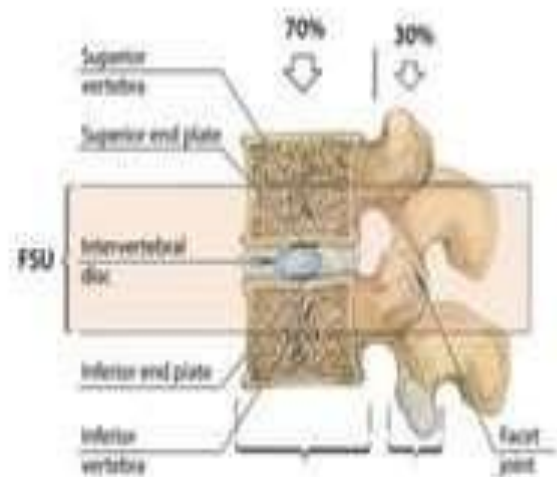
Vertebral foramen

IVD

Functional spinal unit

Spine is a multi articular structure comprising ...

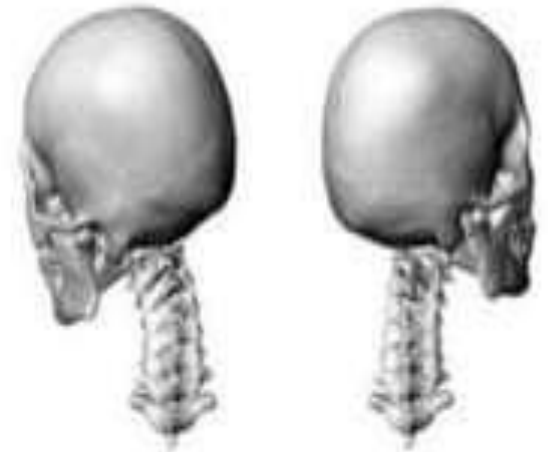
- Two adjacent vertebrae
- Intervertebral disc
- Spinal ligaments



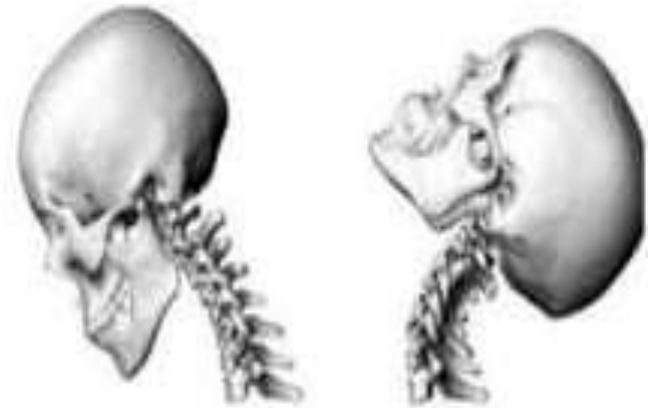
Functions of cervical vertebra

1. Weight transmission
2. Multidirectional Movement- mainly C5/C6 and C6/C7

Rotation



Flexion / Extension

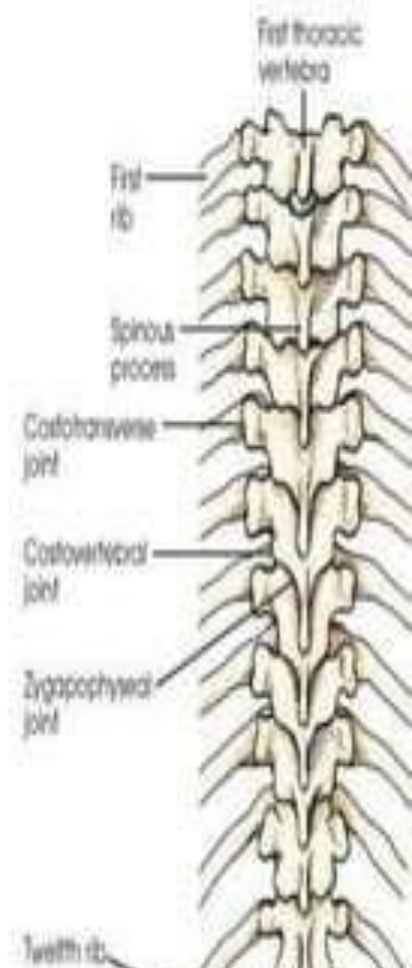
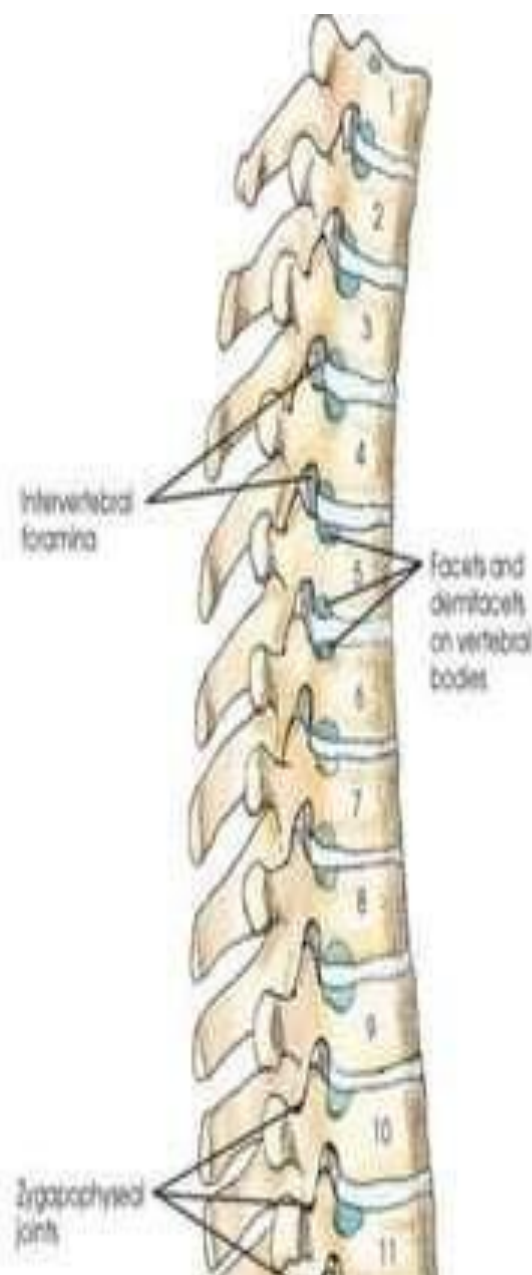


Lateral flexion

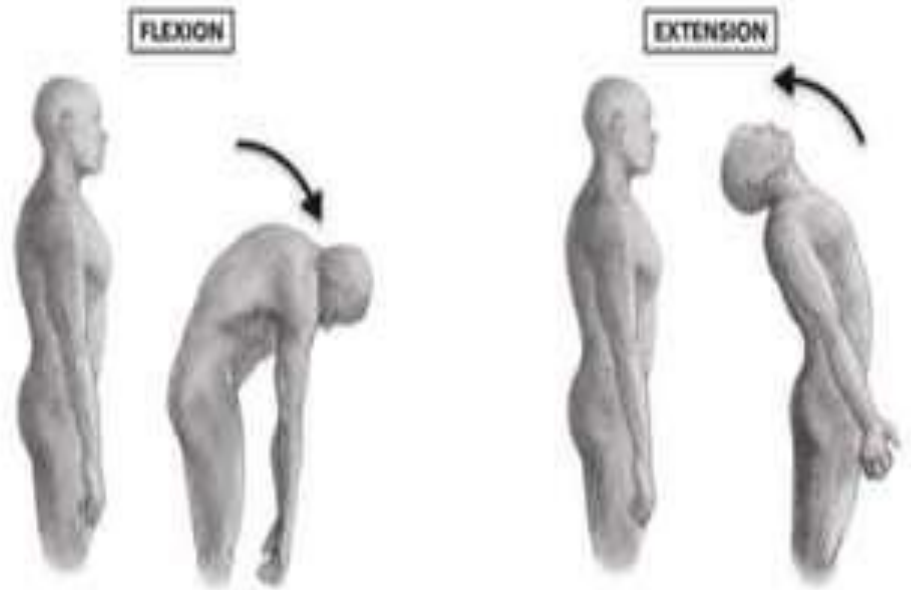


Thoracic vertebrae

- Less mobile due to rib cage
- Less frequently get degenerated



Functions lumbar vertebra



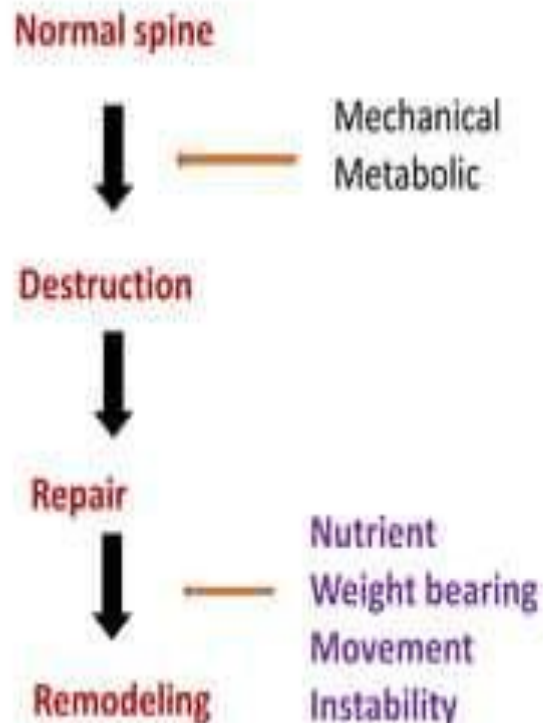
1. Weight transmission – L4/L5 and L5/S1
2. Multidirectional Movement –T12/L1



What is Degeneration ?

Definition

- Response to injury – Mechanical or Metabolic
- Is a product of lifelong degradation of FSU with synchronized remodeling
Simultaneous adaptation of the disc structures to changes in physical loading and response to the occasional injury



Risk factors

Inheritance

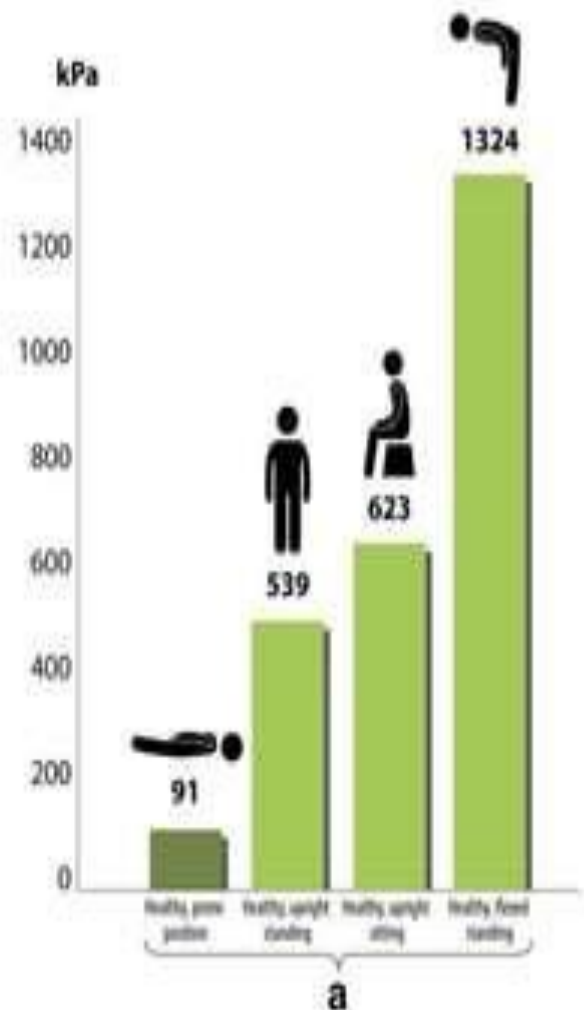
Age

Abnormal mechanical axial stress

Trauma

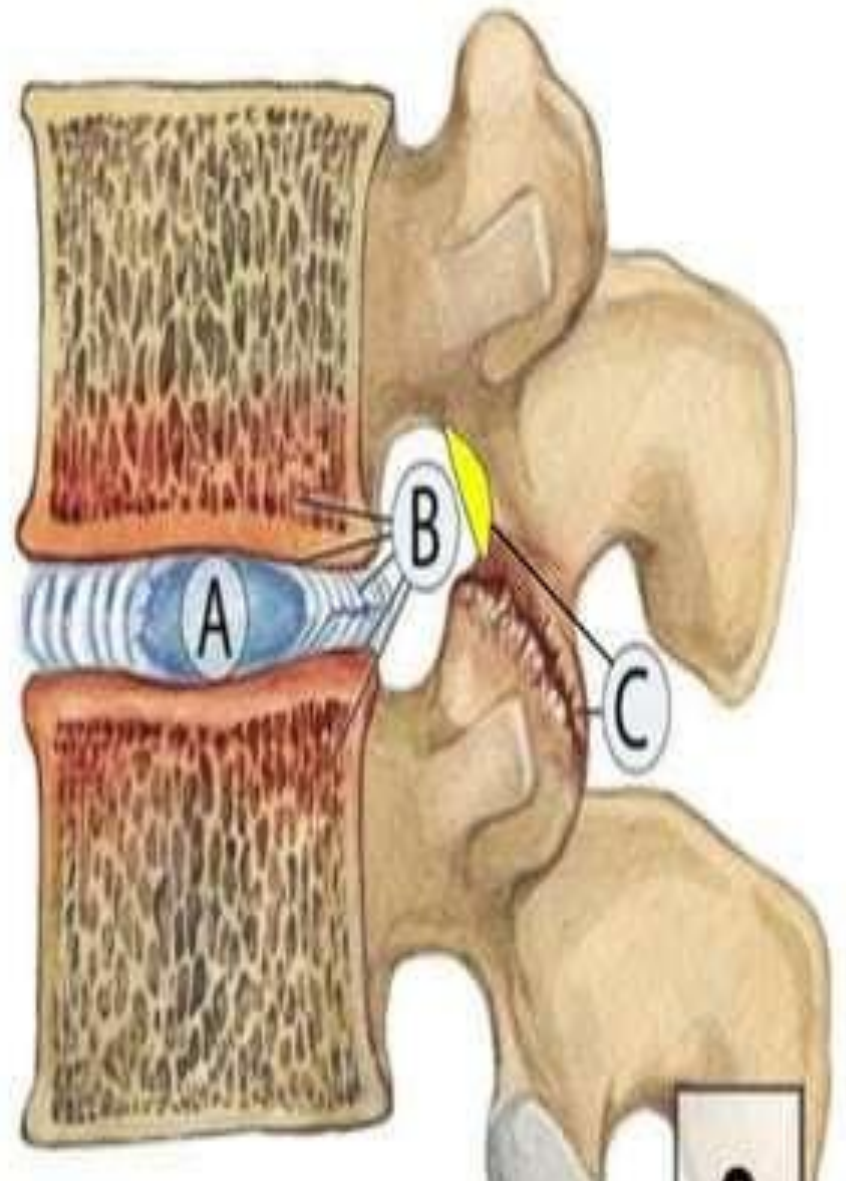
Metabolic causes

- **Mucopolysaccharidoses** – Cartilage and bone development
 - Hunter syndrome
 - Sanfilipo syndrome
- **Diabetes mellitus** – Decrease synthesis proteoglycan and hexosamine



Where does
Degeneration occur?

1. Intervertebral disk
2. End plates
3. Vertebral body
4. Posterior elements
 1. Ligamentum flavum
 2. Facet joint



Degeneration of Intervertebral disk

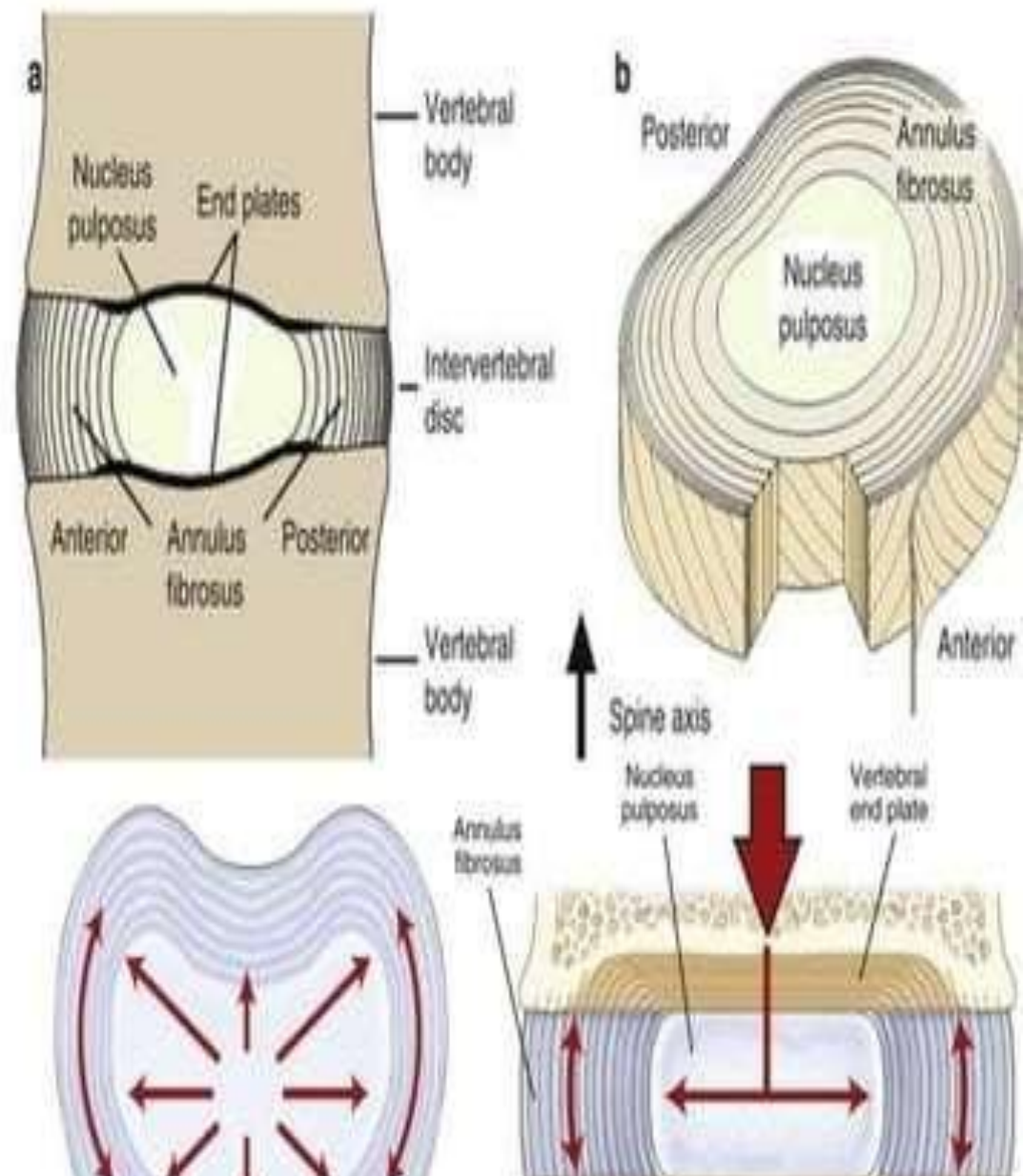
Intervertebral disc

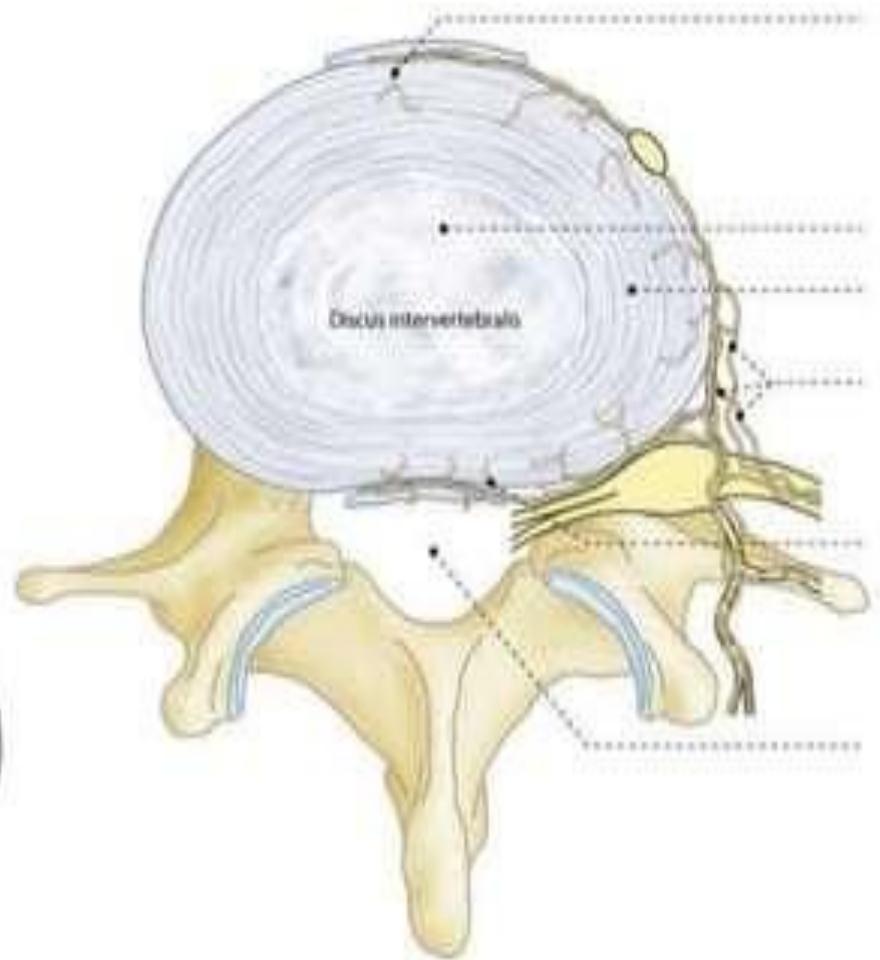
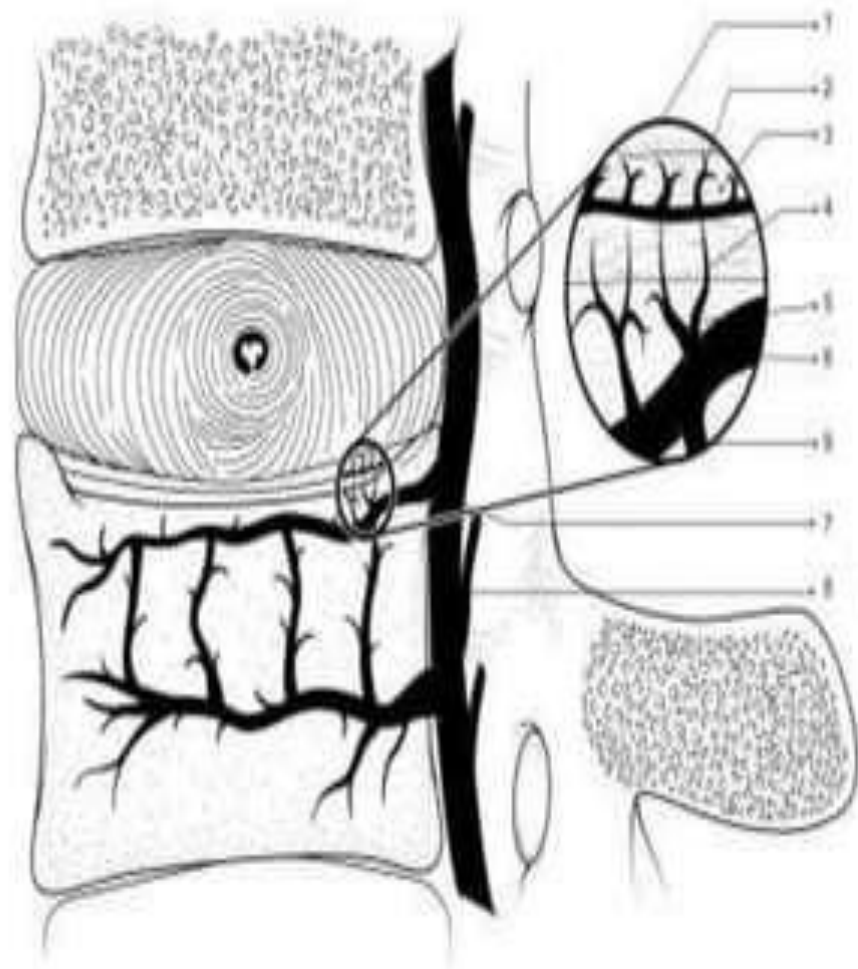
Nucleus pulposus

- Gelatinous substance
- Proteoglycan
- 80% water content

Annulus fibrosus

- Fibrocartilage
- Closely attach to the end plate
- Contain laminated Layers





Blood supply and Innervation

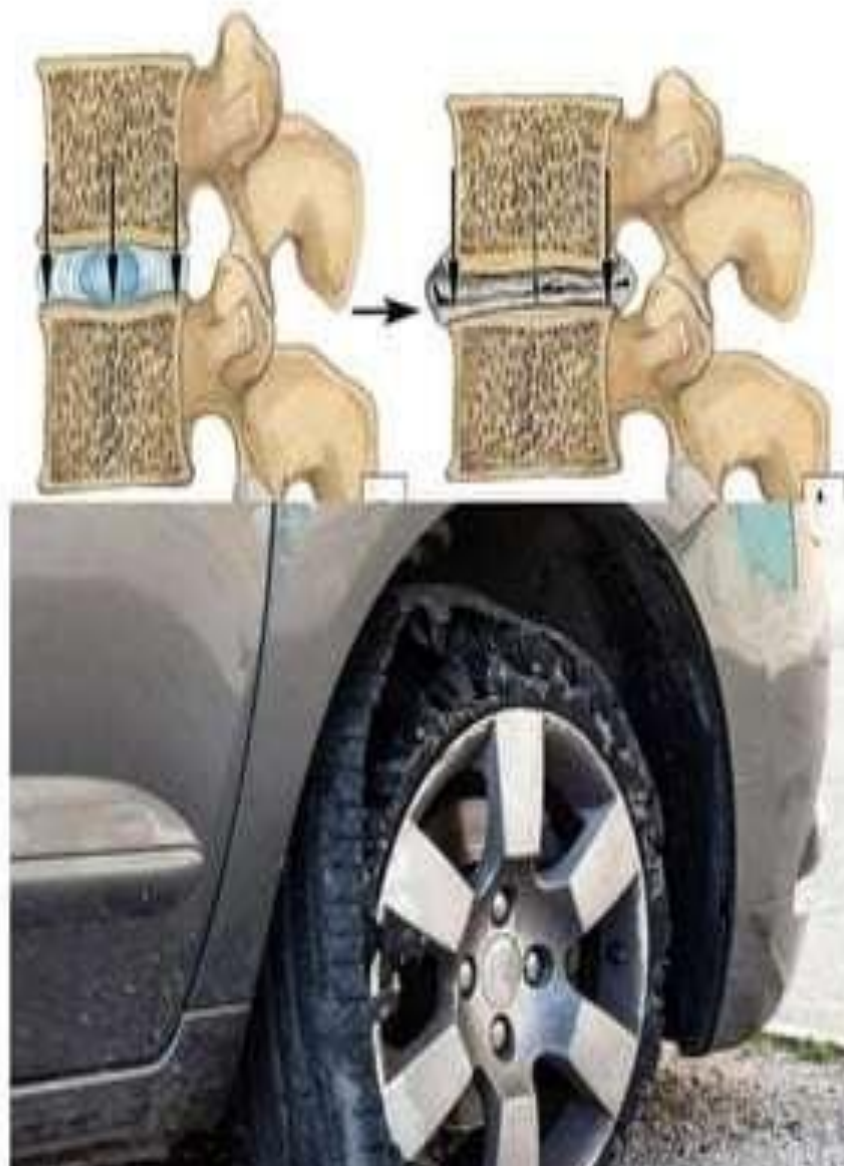
Degenerative Changes - Nucleus pulposus

Degenerative process starts from Nucleous pulposus.

The nucleous pulposus becomes dry and replaced by fibrous tissue

Reduced intradiscal pressure, thus passing the mechanical load on to the annulus fibrosus.

Annulus fibrosus has to hold greater mechanical load



Disc has a uniform high signal in the nucleus on T2.



Central horizontal line of low signal intensity.



High intensity in the central part of the nucleus with lower intensity in the peripheral regions of the nucleus.



Low signal intensity centrally and blurring of the distinction between nucleus and annulus.



Homogeneous low signal with no distinction

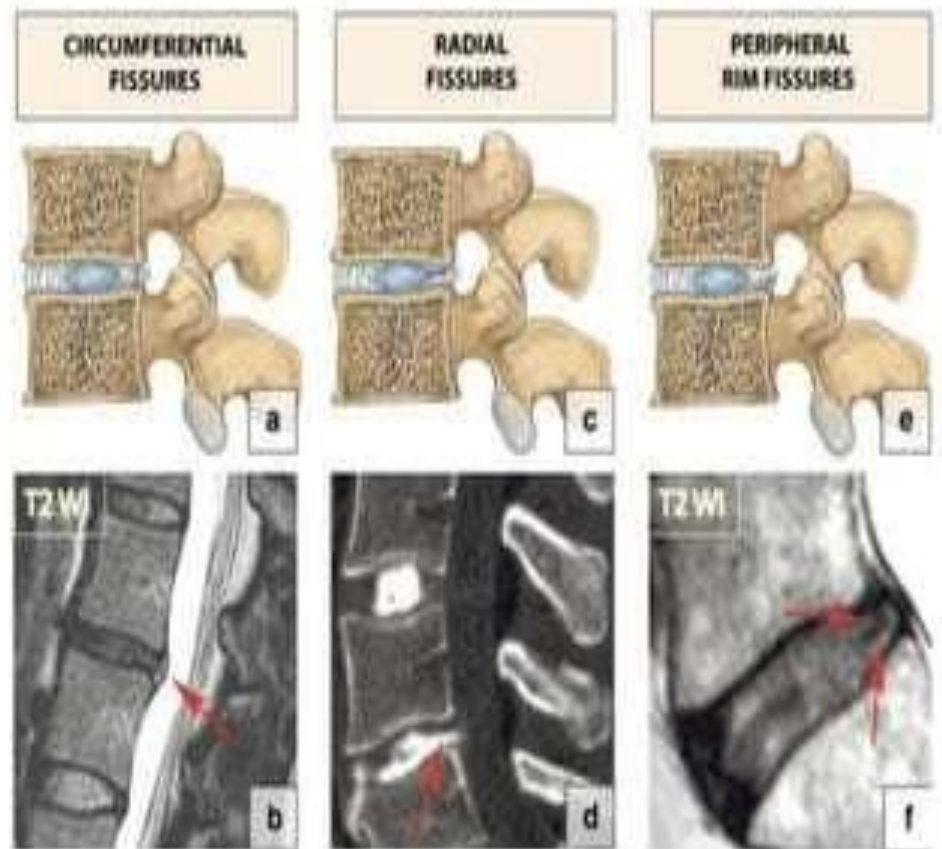


Degenerative Changes- Annulus fibrosus

Increased stress on the annulus fibrosus leads to development of cracks and cavities later progress to clefts and fissures.

Annulus fibrosus fissures can be

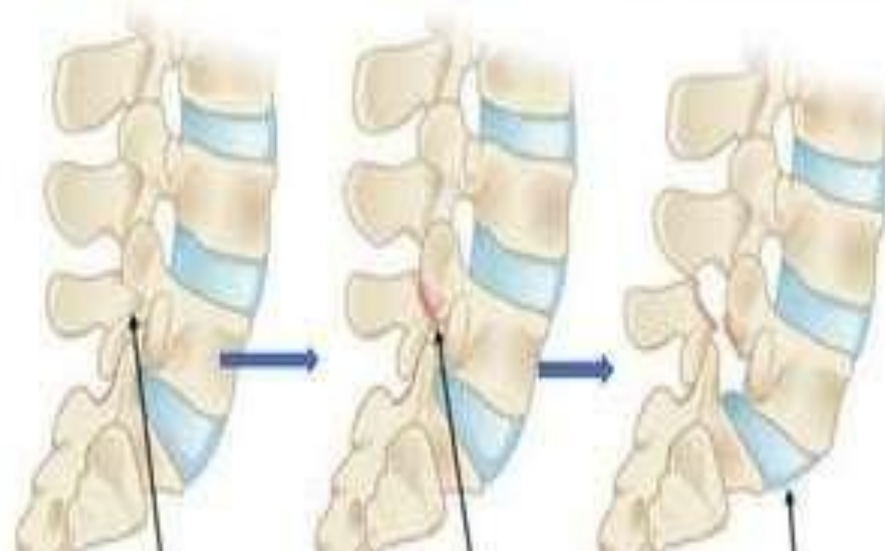
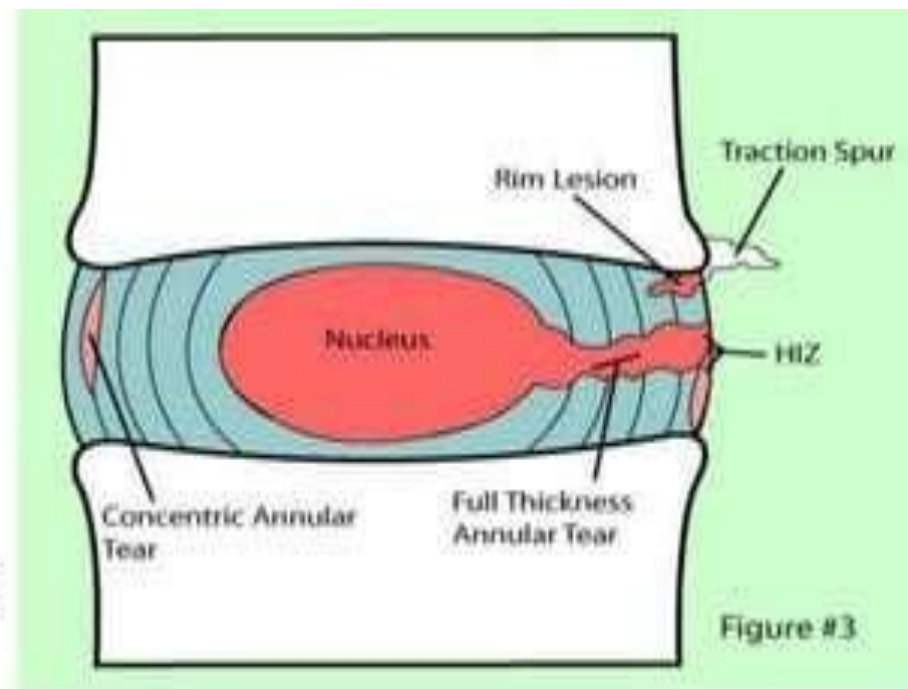
1. Circumferential
2. Radial
3. Peripheral rim



Degenerative Changes- Annulus fibrosis

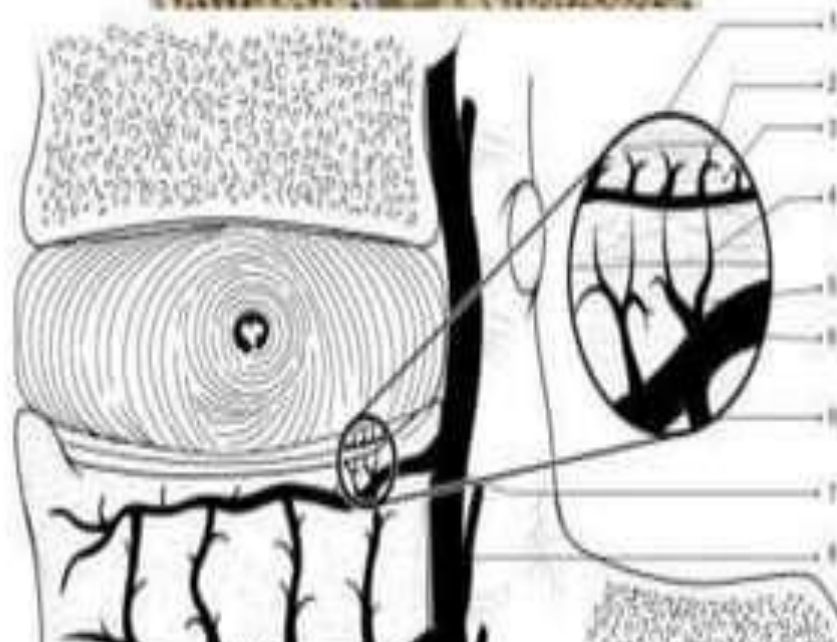
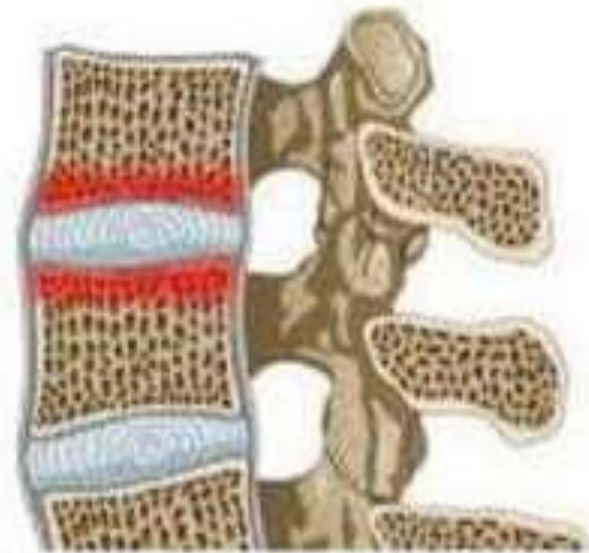
- This loss of structural integrity of annulus fibrosus results in **disc herniation**.













- Structural weakness may lead to the inability of the disc to maintain anatomical alignment and position progressing to **instability and/or spondylolisthesis**.



Degenerative changes in End plate

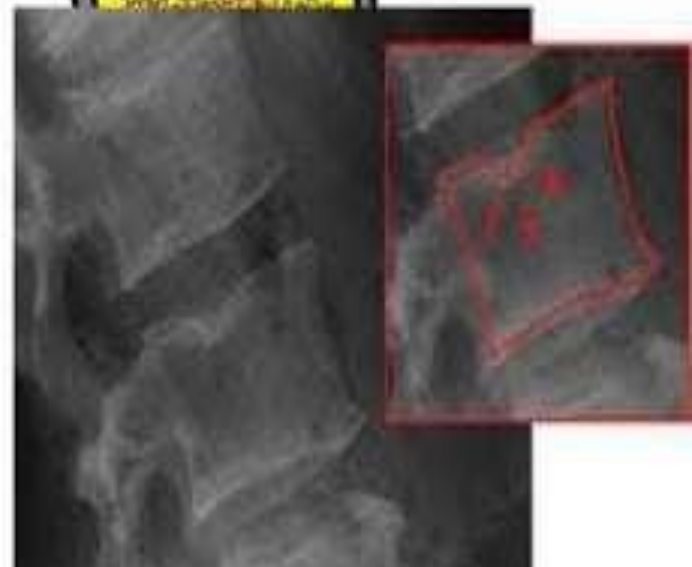
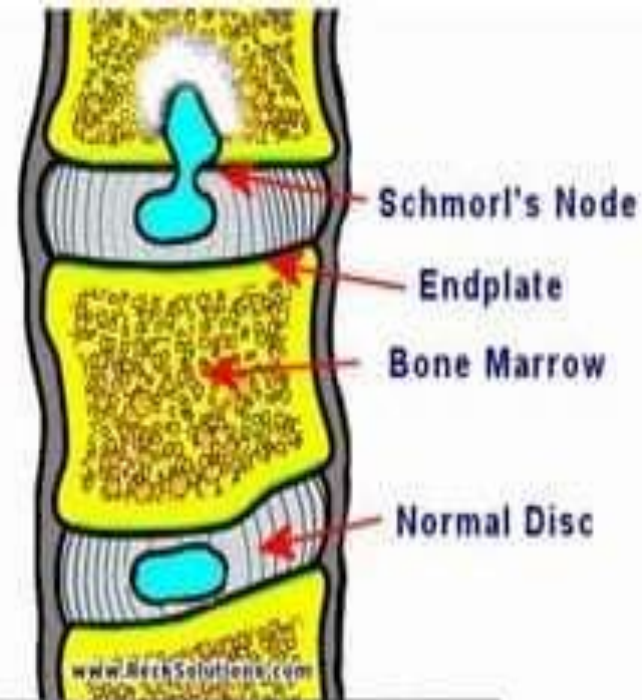
- End plate damage is the hallmark of degenerative changes
- End plates play a crucial role in the maintenance of the mechanical environment
- Participate the proper nutrition of avascular discs.



<p>Type I Normal endplate, with no interruption.</p>	<p>No Modic changes</p>	<p>HEALTHY</p>		
<p>Type II Thinning of the endplate, no obvious break.</p>		<p>AGING</p>		
<p>Type III Focal endplate defect with established disc marrow contact but with maintained endplate contour.</p>				
<p>Type IV Endplate defects <25% of the endplate area.</p>	<p>Associated with Modic changes</p>	<p>DEGENERATIVE</p>		
<p>Type V Endplate defects up to 50% of the endplate area.</p>				
<p>Type VI</p>				

Degenerative Changes in End plate

- End plate fractures lead to sudden depressurisation of the nucleous pulposus and the migration of the nucleous pulposus material into the vertebral body.
- This elicits an inflammatory response and oedema
- Very large end plate damage with a large volume of migrated nucleous pulposus material usually indicates **Schmorl's nodules**



A sagittal MRI scan of the spine, showing the vertebral bodies and intervertebral discs. The image is in grayscale. The text "Schmorl's nodules" is overlaid in white. The nodules are visible as small, dark, wedge-shaped indentations on the superior surface of the vertebral bodies, particularly in the lower thoracic and upper lumbar regions. The intervertebral discs appear as dark, horizontal bands between the vertebral bodies. The overall structure of the spine is clearly visible, with the vertebrae stacked vertically.

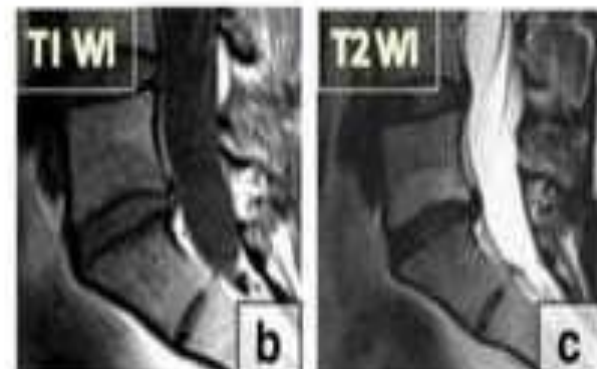
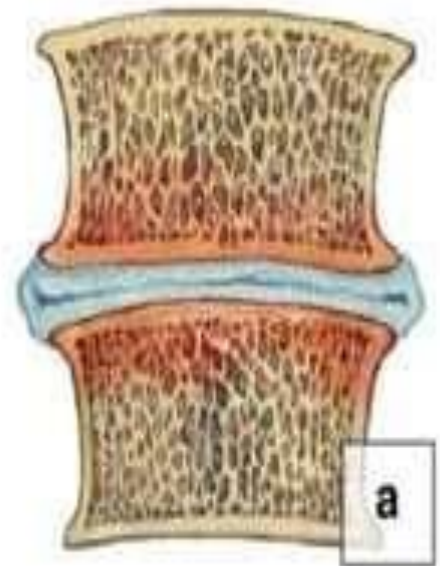
Schmorl's nodules

Degenerative changes Vertebral body - Modic Changes

- Extract pathology – Related to Mechanical stress.
- The abnormal **uneven distribution load** will affect vertebral end plates and the microenvironment of adjacent vertebral bone marrow, resulting in histological changes
- There are three main forms of degenerative change involving the bone marrow of the adjacent vertebral bodies.

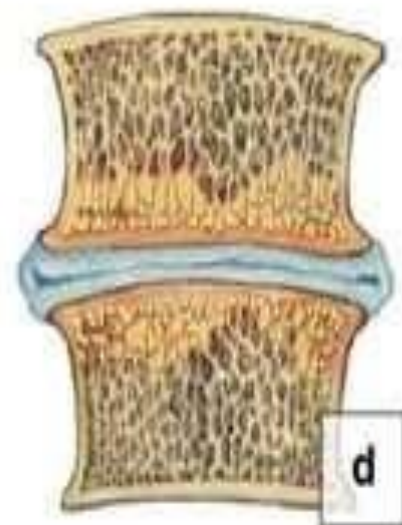
Type 1- Modic changes

- Correspond to inflammatory stage of bone marrow leads to **oedema and vascularized fibrous tissues**
- Signal changes may mimic or suggest suggest infection.
- Slow progressive degenerative disc disease produces a well-defined border response.
- Strongly associated with nonspecific backpain and instability

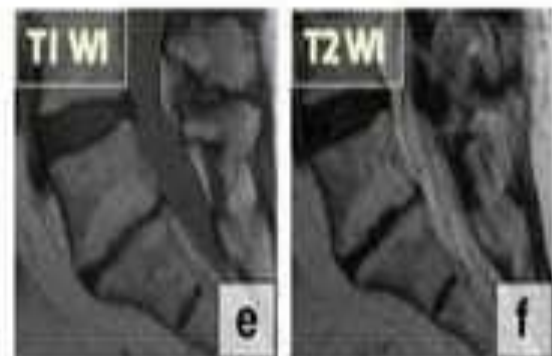


Type 2- Modic changes

- Type 2 changes reflect the presence of yellow marrow in the vertebral bodies

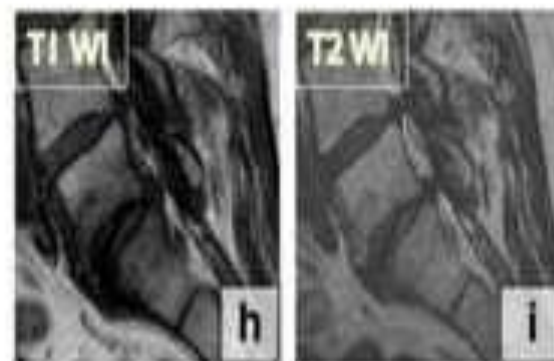
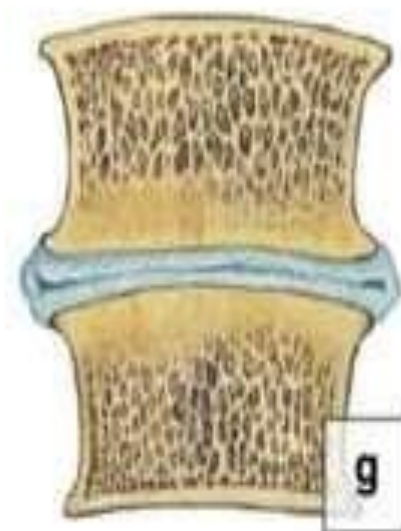


- Fatty changes – Local fatty replacement of bone marrow



Type 3- Modic changes

- Reactive osteosclerosis of adjacent to the endplates
- Type 3 changes represent dense woven bone and the absence of marrow.
- These changes are potentially stable and almost always asymptomatic



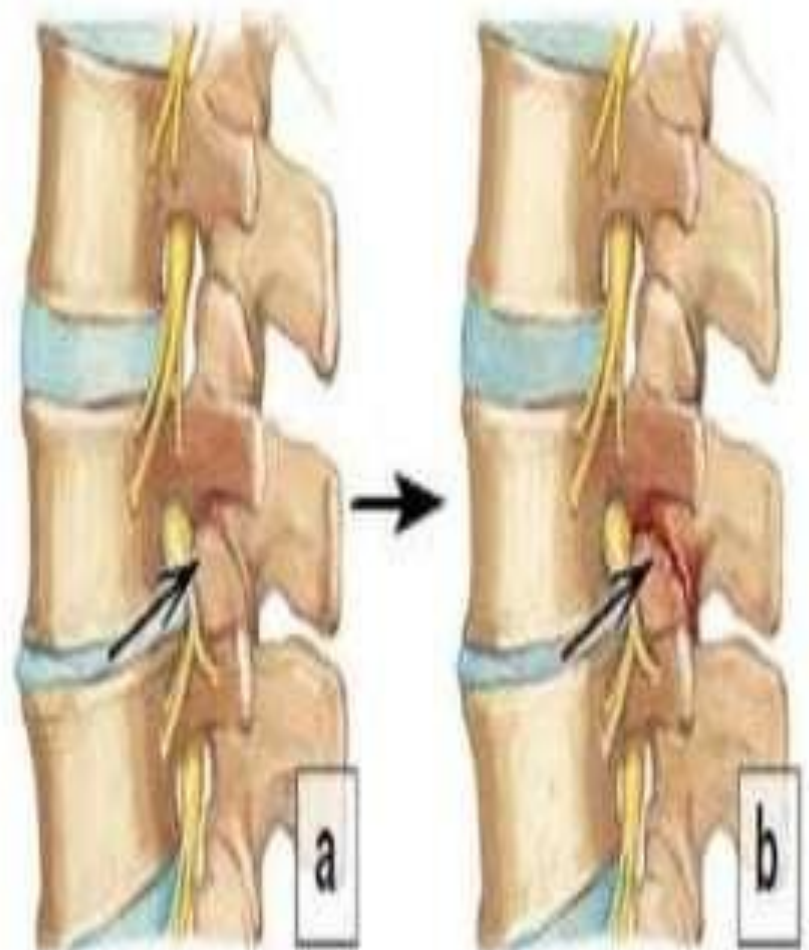


Degenerative changes - Facet joints

True synovial joints





Degenerative Changes are

1. Cartilage lining loses water content and wears away
2. Narrowing of the joint cavity
3. Osteophyte formation
4. Synovial cyst formation



Degenerative changes – Facet joints

- Hypertrophic facet joint osteoarthritis can result in narrowing of the central canal, lateral recesses and foramina.
- **Osteophytes** protruding ventrally from the anteromedial aspect of the facet joints may narrow the lateral recesses and intervertebral foramina causing central or lateral spinal canal stenosis

Grade	Facet joint osteoarthritis	
Grade 0 Normal		 a
Grade 1 Mild	Mild narrowing and joint irregularity.	 b
Grade 2 Moderate	Moderate narrowing and joint irregularity, sclerosis, and osteophyte formation.	 c
Grade 3 Severe	Severe narrowing and almost total loss of joint space.	

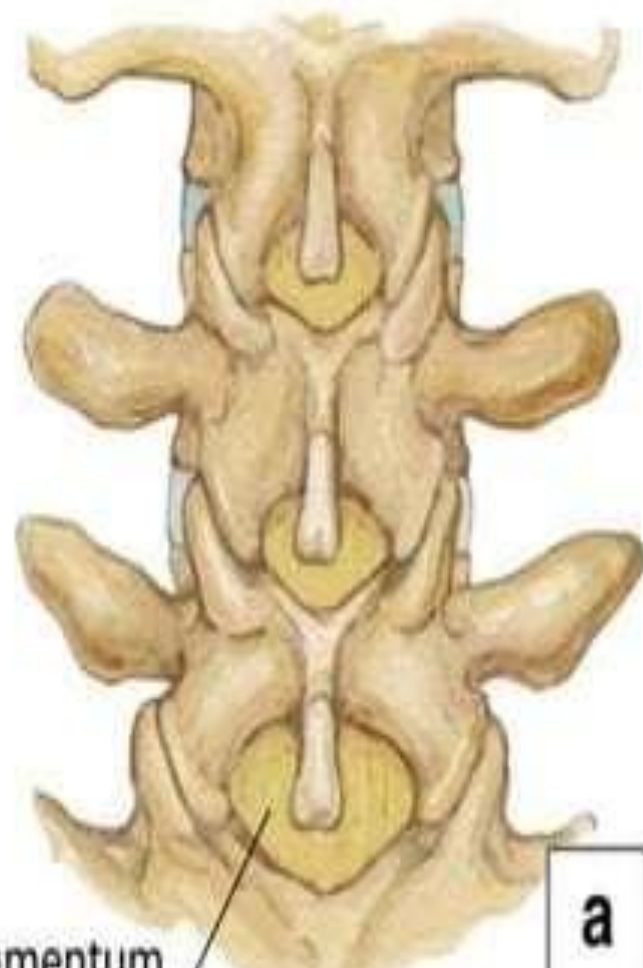
Degenerative changes – Facet joints

- Bulging of the synovium through the facet joint capsule, especially in the presence of instability, may result in synovial cysts.
- The majority (about 90%) of synovial cysts are found at the L4–L5 level and present clinically with lumbar radiculopathy.



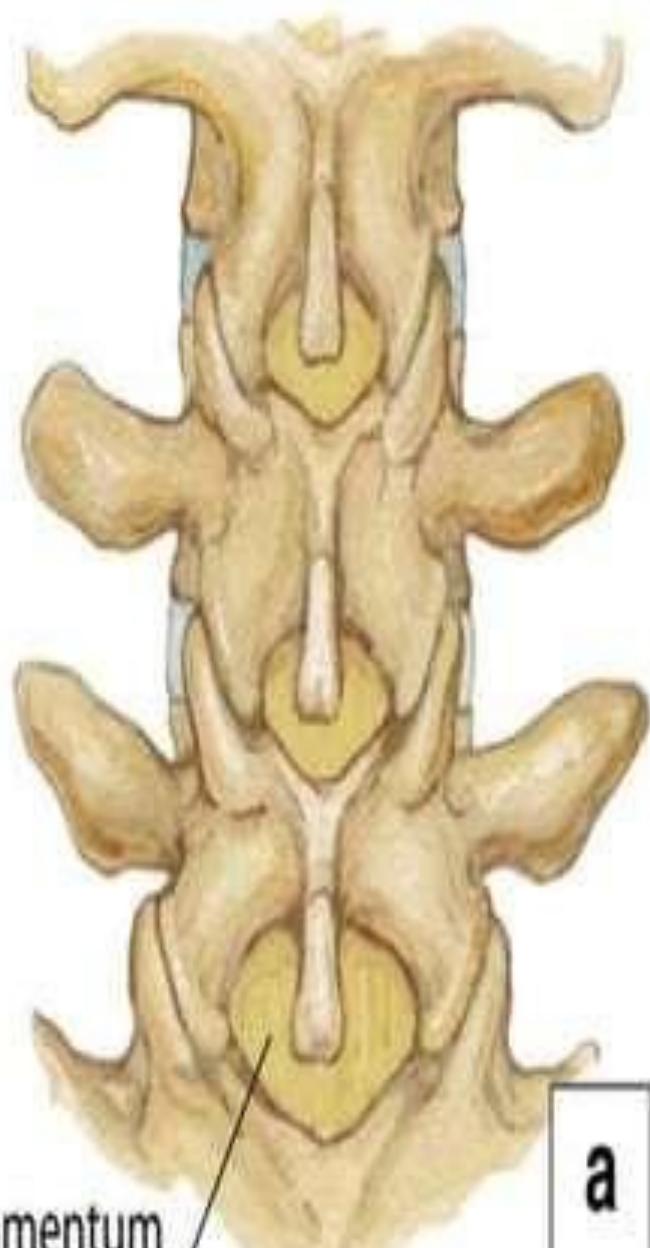
Ligamentum flavum hypertrophy

- It extends from the 2nd vertebra to the 1st sacral vertebra, connecting the two adjacent laminae
- The ligamentum flavum tends to become hypertrophic with the degeneration of the elastic fibres and the proliferation of type II collagen.
- **Abnormal motions and instability** within the involved segments are potential aetiologies of ligamentum flavum hypertrophy as the body tries to stabilise the diseased segment by making it

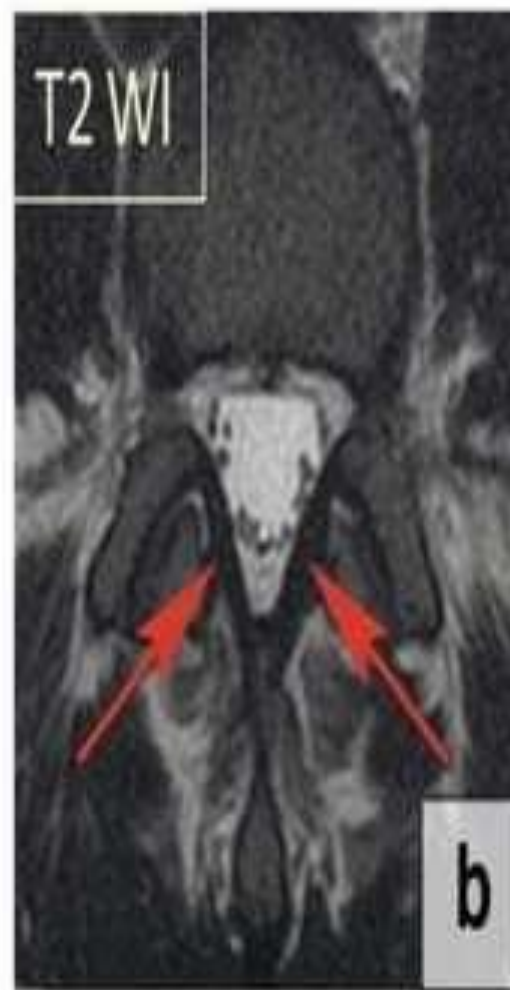


Ligamentum

a



a



b



c

Ligamentum

PLL Calcification



Spondylosis

Spondylosis is common nonspecific term used to describe hypertrophic changes of the **end plates** (osteophytes) and **facet joints**.

They result from **increased flexibility** between the vertebral bodies and the production of **inhomogeneous mechanical stress** on the annulus fibrosus and edges of the vertebral body, with subsequent sclerotic or hyperplastic changes occurring on the edges of the vertebral bodies.

There are three types of true degenerative osteophytes:

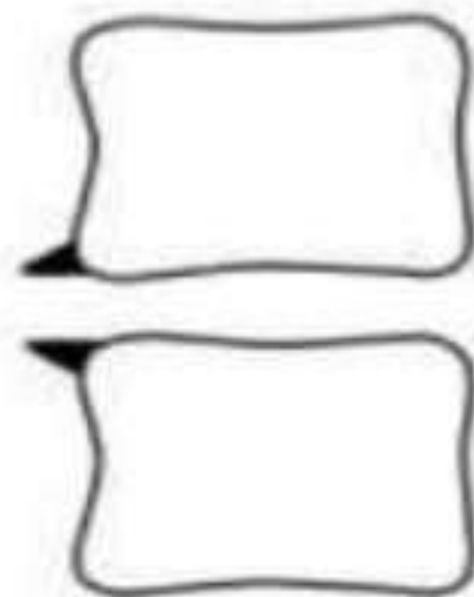
Spondylosis

Traction osteophytes

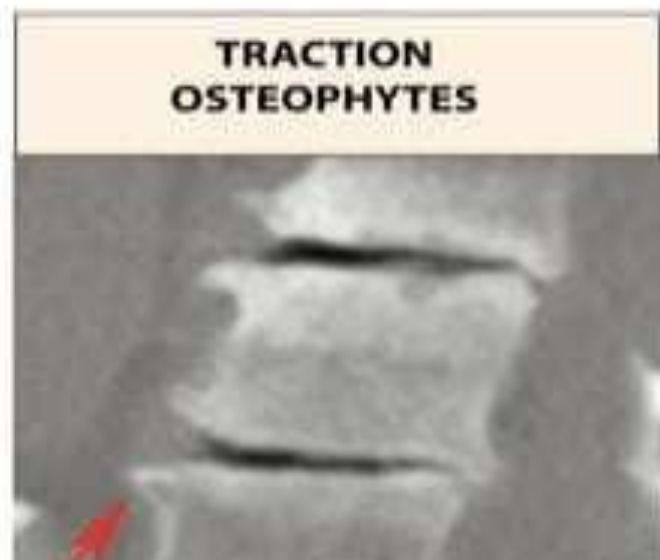
Increase **shear stress across** the disk

2–3-mm bony spikes

Osteophytes with a gap between the endplate and the base of the osteophytes and with the tip not protruding beyond the horizontal plane of the vertebral end plate



**TRACTION
OSTEOPHYTES**

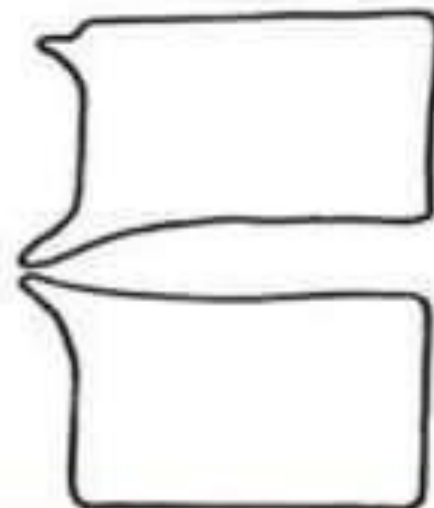


Spondylosis

Claw osteophytes

Are associated with **horizontal instability**.

Arising from the vertebral margin with no gap and having an obvious **claw appearance**



**CLAW
OSTEOPHYTES**



Spondylosis.....

A wraparound bumper osteophytes

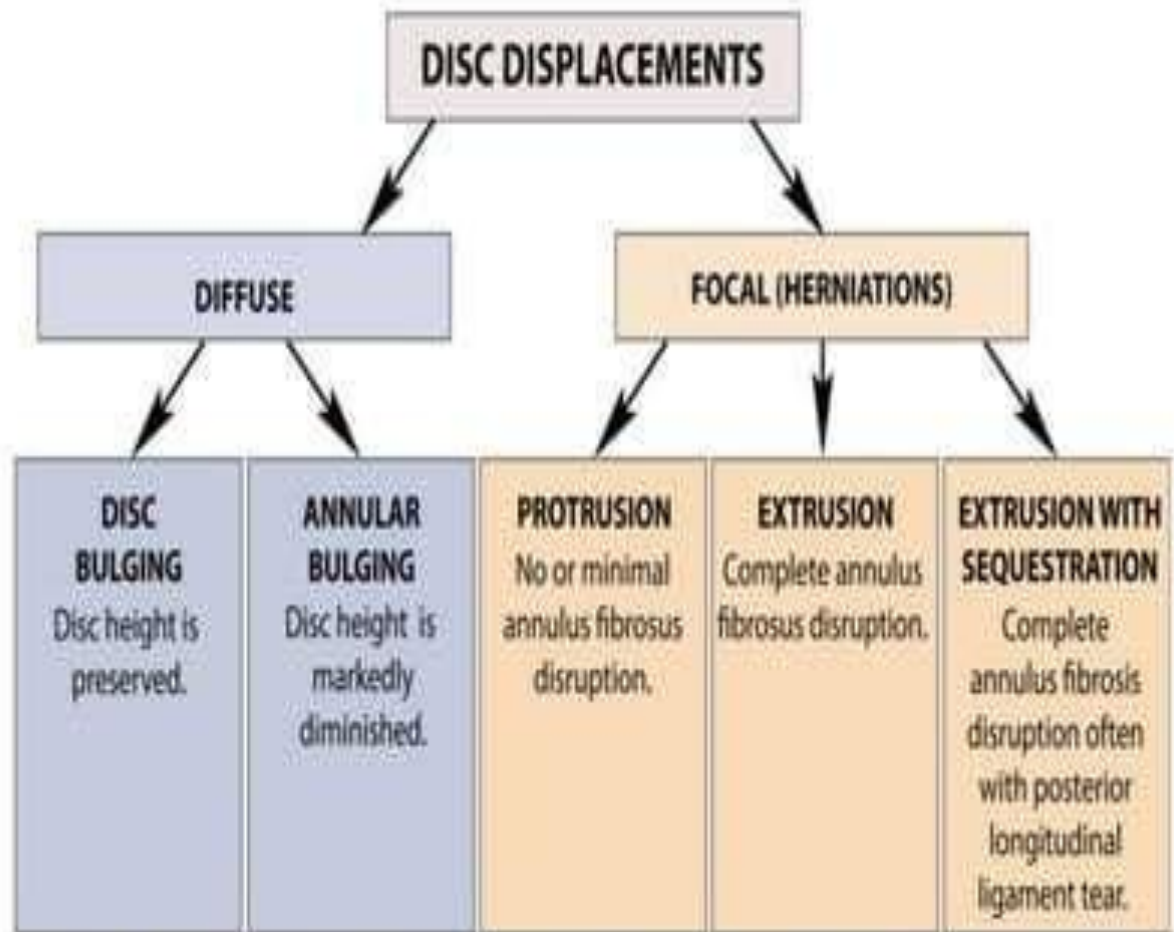
A wraparound bumper develops along the **capsular insertion of the facet joints** and is believed to be associated with instability



Disk Herniation

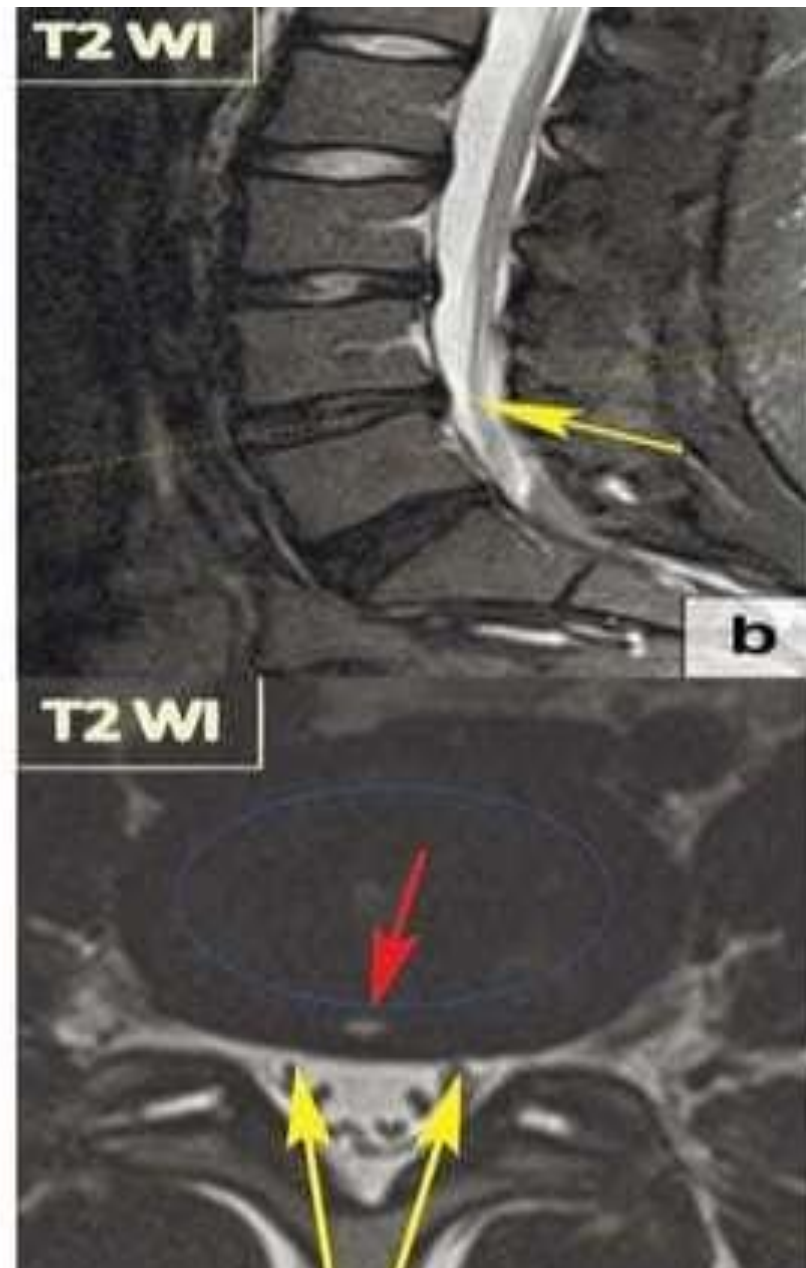
Disc Herniation

Displacement of disc material beyond the limits of the IVD space



Disc bulging

- Early sign of degeneration
- A rapid increase in intradiscal pressure in the setting of bulging leads to the development of annular fissures and herniation.
- Features
 - Height of the disc preserved
 - annulus fibrosus is intact
- Often seen in asymptomatic individuals



Focal herniation - Protrusion

Focal displacement of disc material with **no or minimal disruption** of the fibres of the overlying annulus fibrosus and intact PLL

Localised (>25% of the circumference of the disc) displacement of disc material





Extrusion

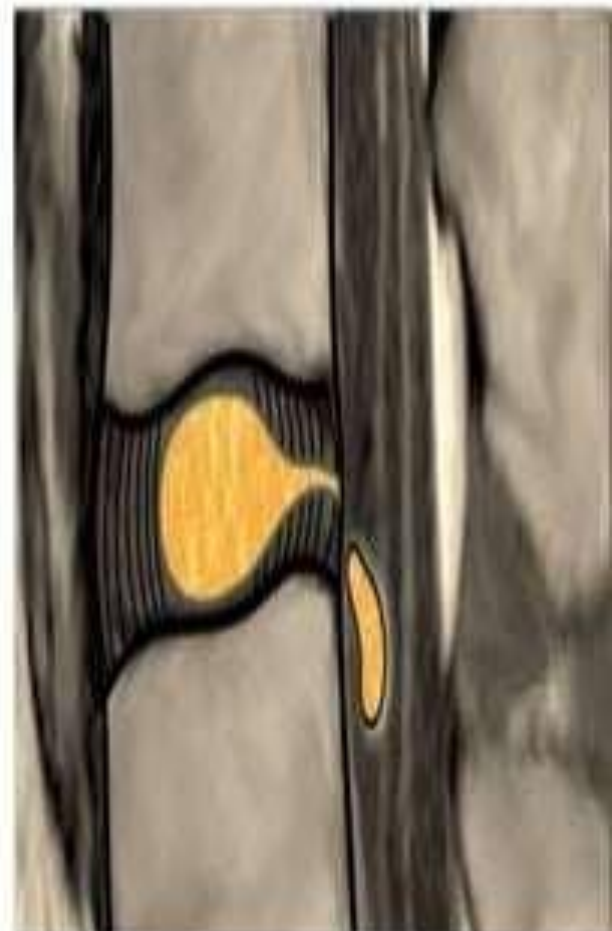
Extrusion is the displacement of disc material with a full thickness disruption of the annulus fibrosus fibres

Usually PLL remains intact



Extrusion with sequestration

- When extruded disc material that has no continuity with the disc of origin.
- Fragment of disk may stay at the level of the disc or may migrate superiorly or inferiorly.
- Pain and neurological symptoms may fluctuate with the migration of the free fragment within the spinal canal.
- The acute displacement of a free fragment from the disc into the spinal canal may cause acute cauda equina syndrome



T2 WI



T2 WI



Location Of Disk Herniation

AXIAL PLANE

ANTERIOR

POSTERIOR

CENTRAL

PARACENTRAL

FORAMINAL

EXTRA-FORAMINAL

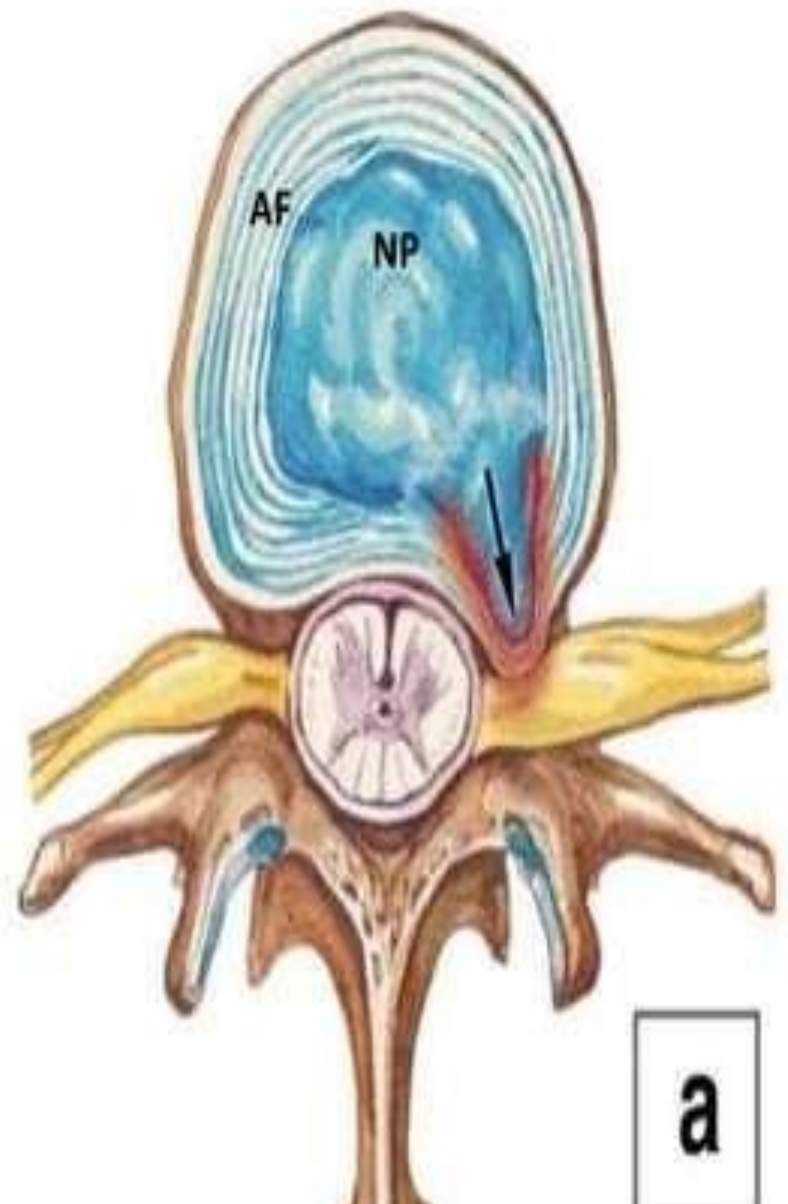
90-95%

5-10%



Acute disc Herniation - <4weeks

- It occurs at the early stages of degeneration
- Trauma /lifting heavy weight
- when the intradiscal pressure is high displacement of NP through compromised AF fibers
- Fibers of Annulus fibrosus get rupture and elicit acute local inflammation.



Subacute

Disc herniation < 4-12 weeks

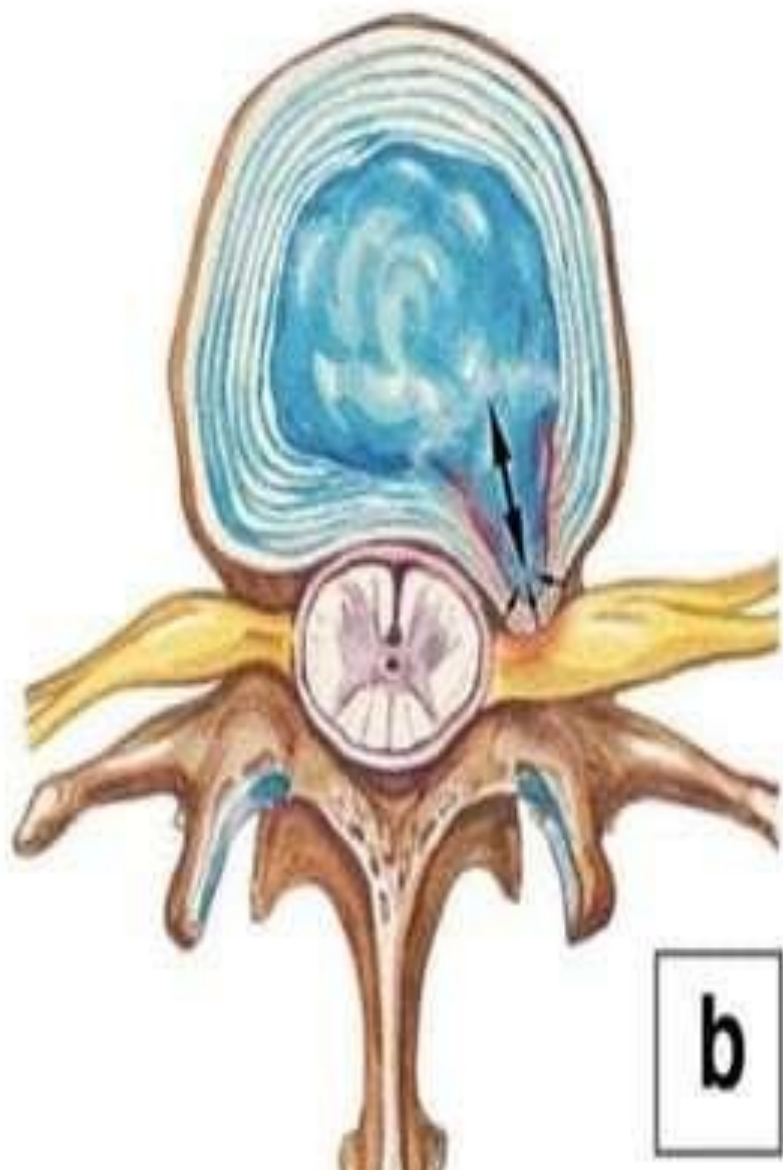
Classic Mechanical backache

Pain usually arises only when the disc material migrates peripherally with increasing intradiscal pressure

Pain improves when the intradiscal pressure drops.

The remaining intact fibres of the annulus fibrosus recoil to bring the extruded material back into the disc space.

MRI- Prone position – disk comes back to normal



Chronic disc herniation < 12weeks

Stable displacement of the disc material - because of high intradiscal pressure pushing the nucleous pulposus material out of the disc

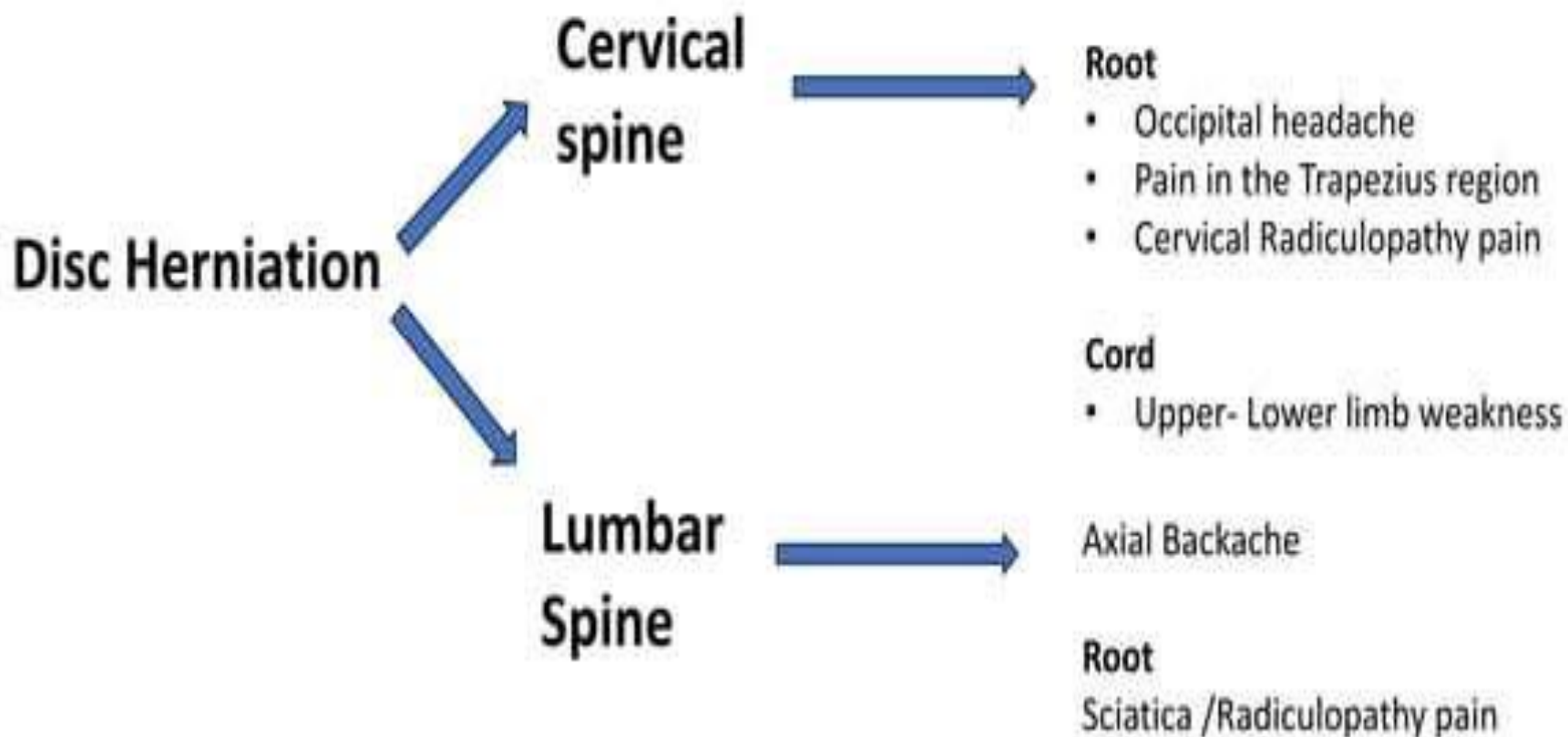
AF – get calcified loss of recoiling effect

Excess axial stress –

1. Tearing of annular fibers – Acute stage pain



Complications of disc displacement



Degenerative spondylolisthesis

Common - lumbar spine






Less common – C.spine

Never occurs in the thoracic spine.



Grading -

- Based on the ratio of the overhanging part of the superior vertebral body to the anteroposterior length of the adjacent inferior vertebral body

GRADE I <25%	GRADE II 25-50%	GRADE III 50-75%	GRADE IV 75-100%	SPONDYLOPTOSIS >100%
				

Spinal canal stenosis

