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Vertebral Column

Curvatures, Stability, & Clinical

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Where opportunity creates success

Today's Session

- Part 1 – Curvatures
  - Kyphosis
  - Scoliosis
  - Movement
- Part 2 –Stability
- Part 3 – Clinical
  - Disc Herniation
  - Ankylosing Spondylitis

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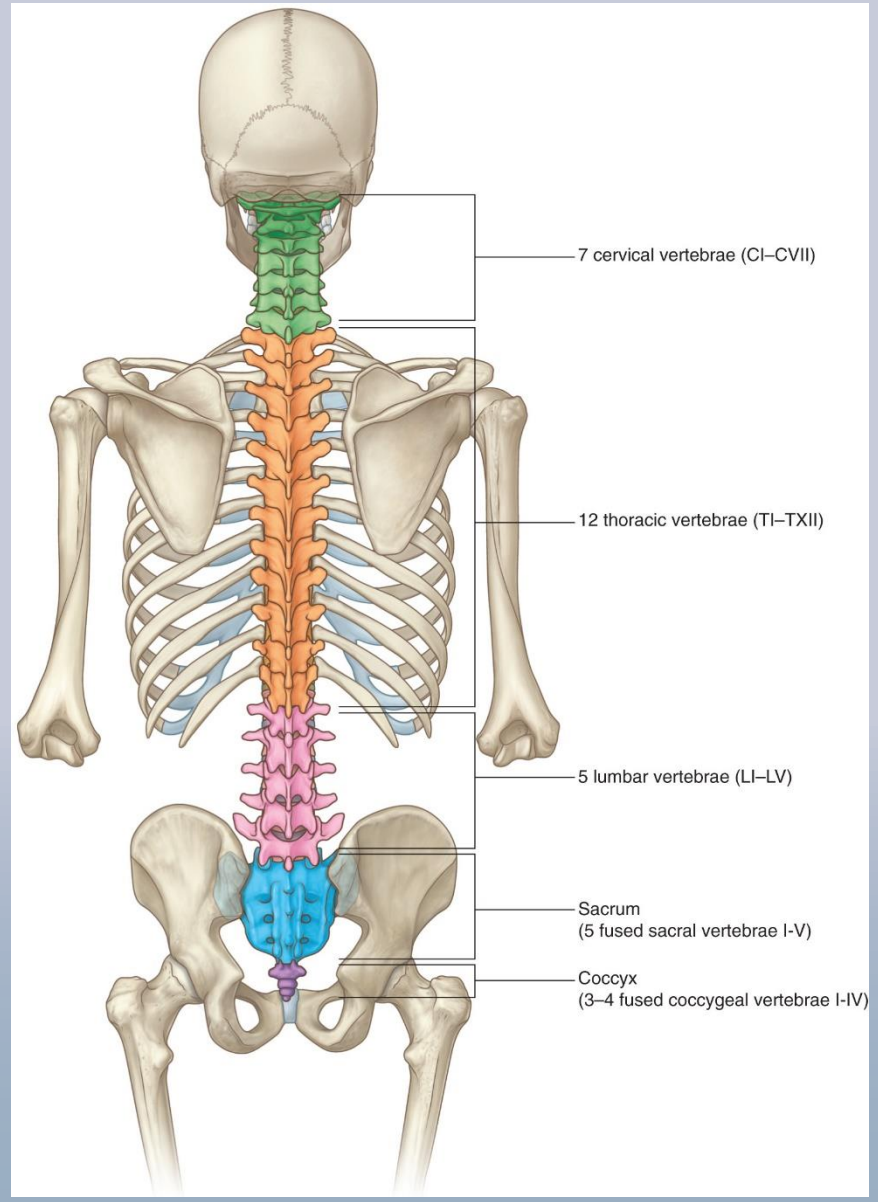
Part 1
Curvatures

Overview: Structure



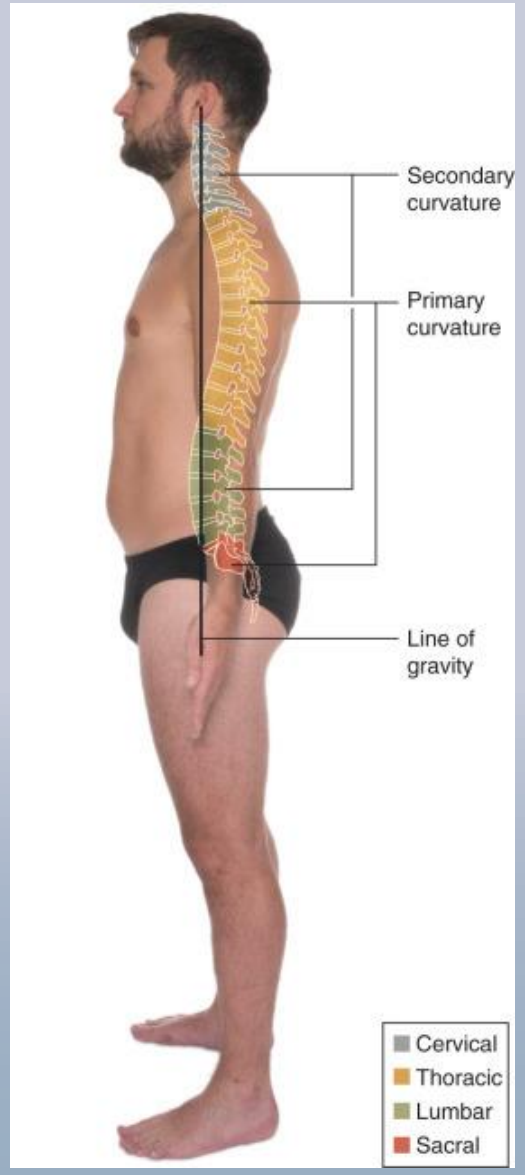
Vertebral column is usually formed of 33 bones.

- Known as vertebrae (plural) – vertebra (singular)

They are divided into different categories depending on region and function:

- 7 Cervical vertebrae (C1-C7)
- 12 Thoracic vertebrae (T1-T12)
- 5 Lumbar vertebrae (L1-L5)
- 5 (usually all fused) Sacral vertebrae (S1-S5)
- 4 (some fused) Coccygeal vertebrae (Co1-Co4)

Vertebral Column: Curvatures



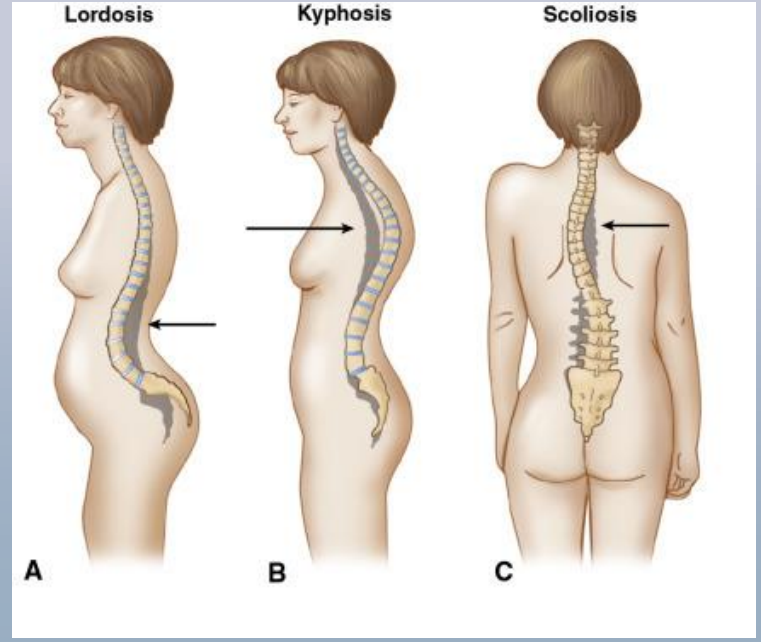
Curvatures in the spine help maintain the gravity line of the body.

Kyphosis – curve outwards (posteriorly) – Primary
Lordosis – curve inward (anteriorly) – Secondary

In a healthy individual, 4 curvatures exist:

- Cervical lordosis
  - Secondary – Supports the weight of the head
- Thoracic kyphosis
  - Primary – Exists in the foetus
- Lumbar lordosis
  - Secondary – Supports body weight
- Sacral kyphosis
  - Primary – Exists in the foetus

Alterations to these curves can occur due to many factors.

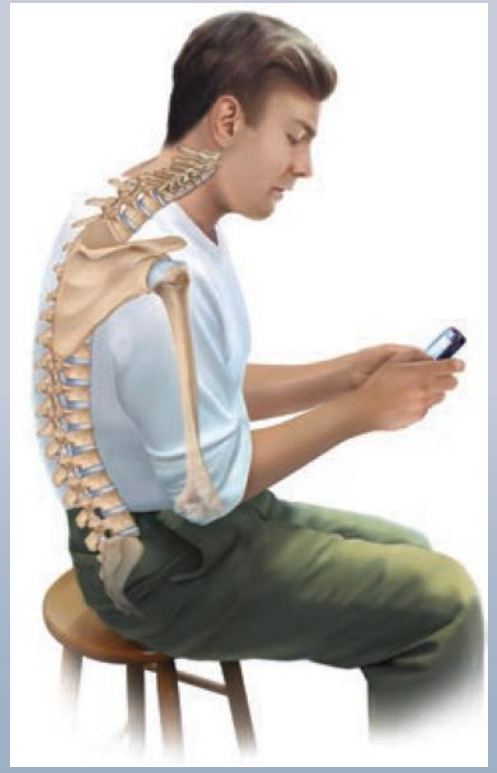


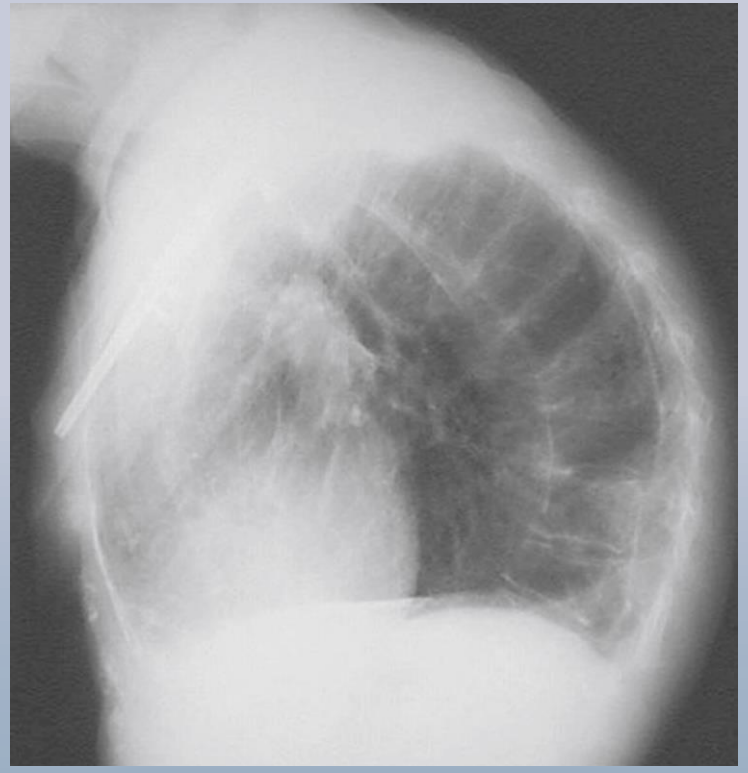
Curvature: Extreme Kyphosis

May happen with age but can be accelerated by poor posture, vertebral shape, osteoporosis etc.

What sort of symptoms would you expect someone with extreme kyphosis to have?

- Back pain, stiffness
- Tenderness
- Difficulty breathing
- Tiredness





Curvatures: Scoliosis

Lateral curvature of the spine – common in thoracic region.

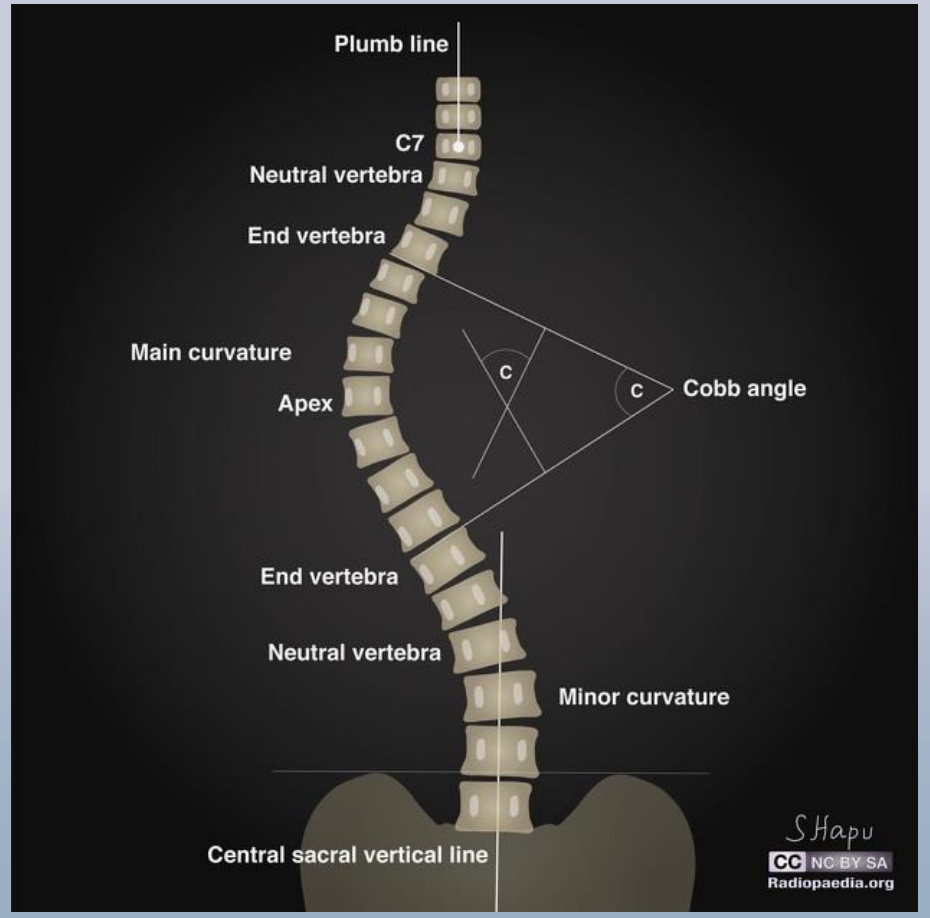
Defined as scoliosis with a Cobb angle >10°, anything below is spinal asymmetry.

Can be broadly defined as:

- Postural – can be corrected with lateral flexion
- Structural – fixed – Many different types.

Often no apparent cause for scoliosis.

Can be tested using Adams forward bend test and using a scoliometer.



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Curvatures: Scoliosis

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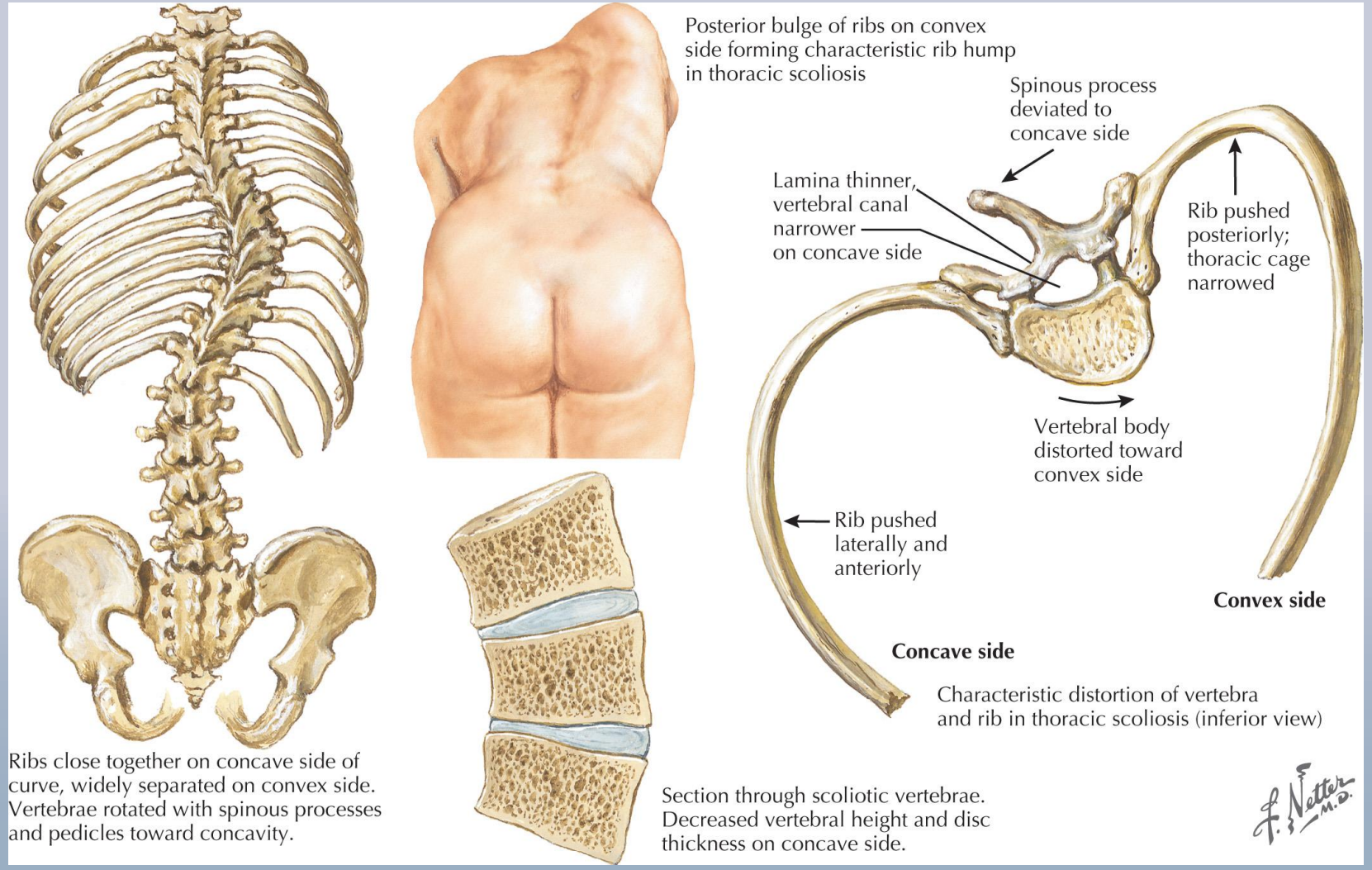
Lateral curvature usually causes rotation in the ribs, causing further issues such as compression of structures within the thorax.

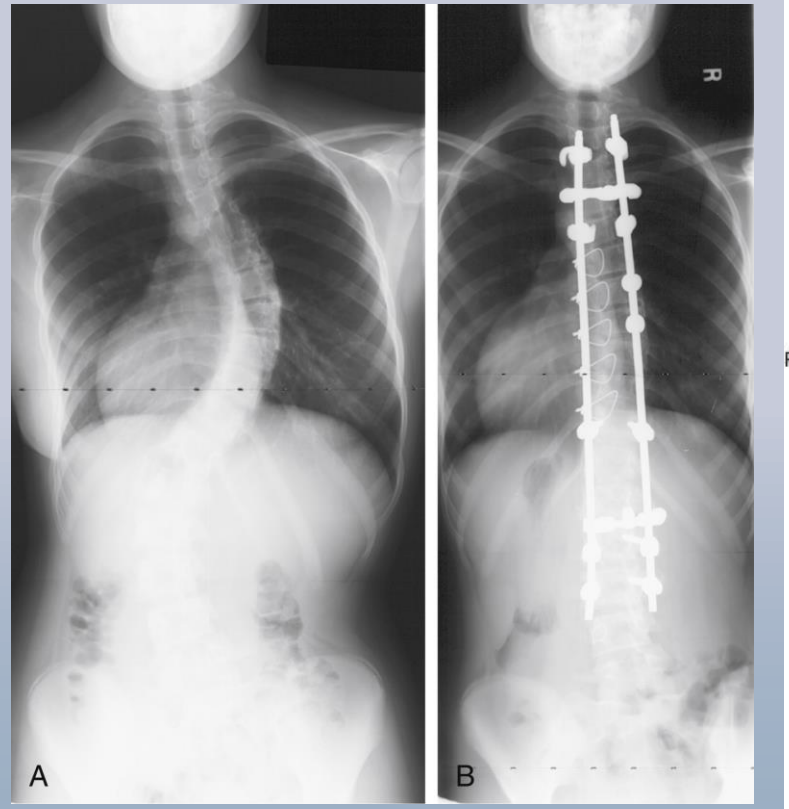


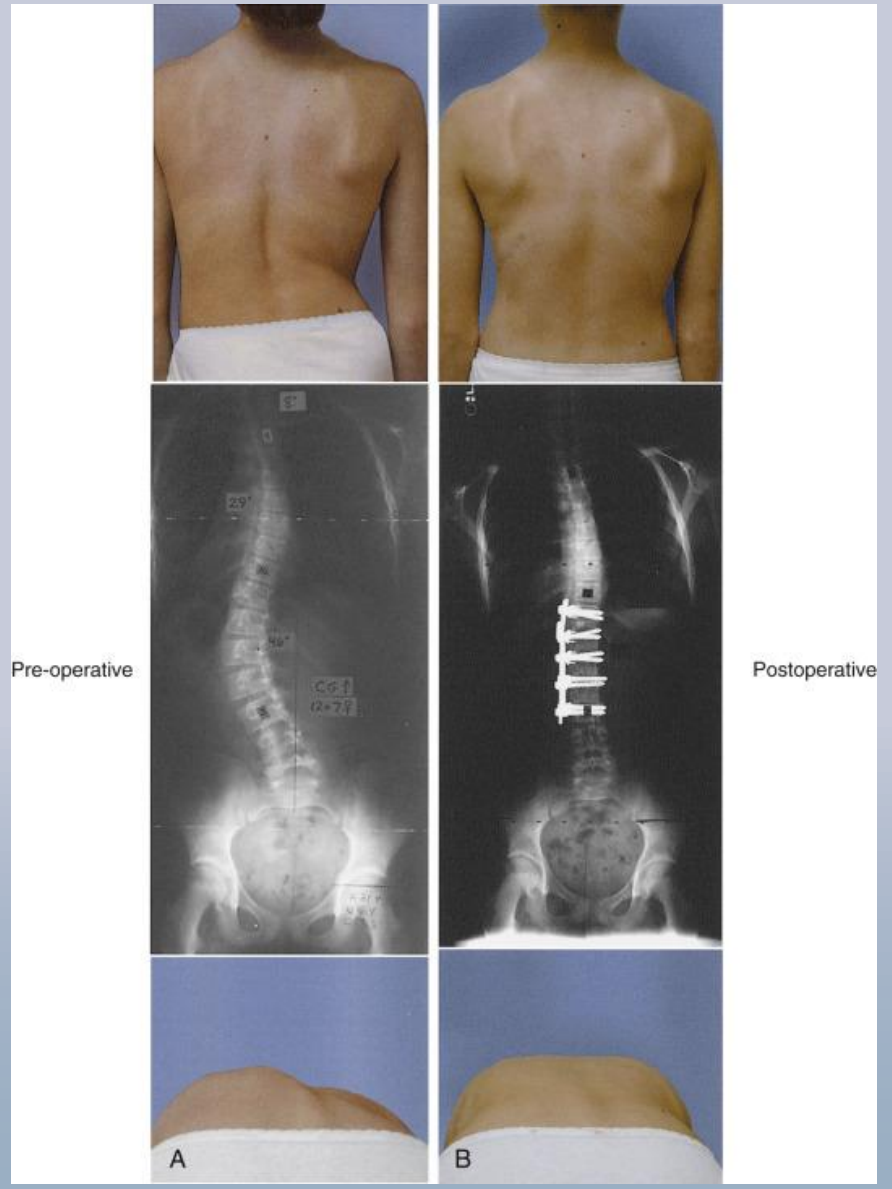
Curvatures: Scoliosis

In less severe cases or adolescent children braces can be used to correct a curve.

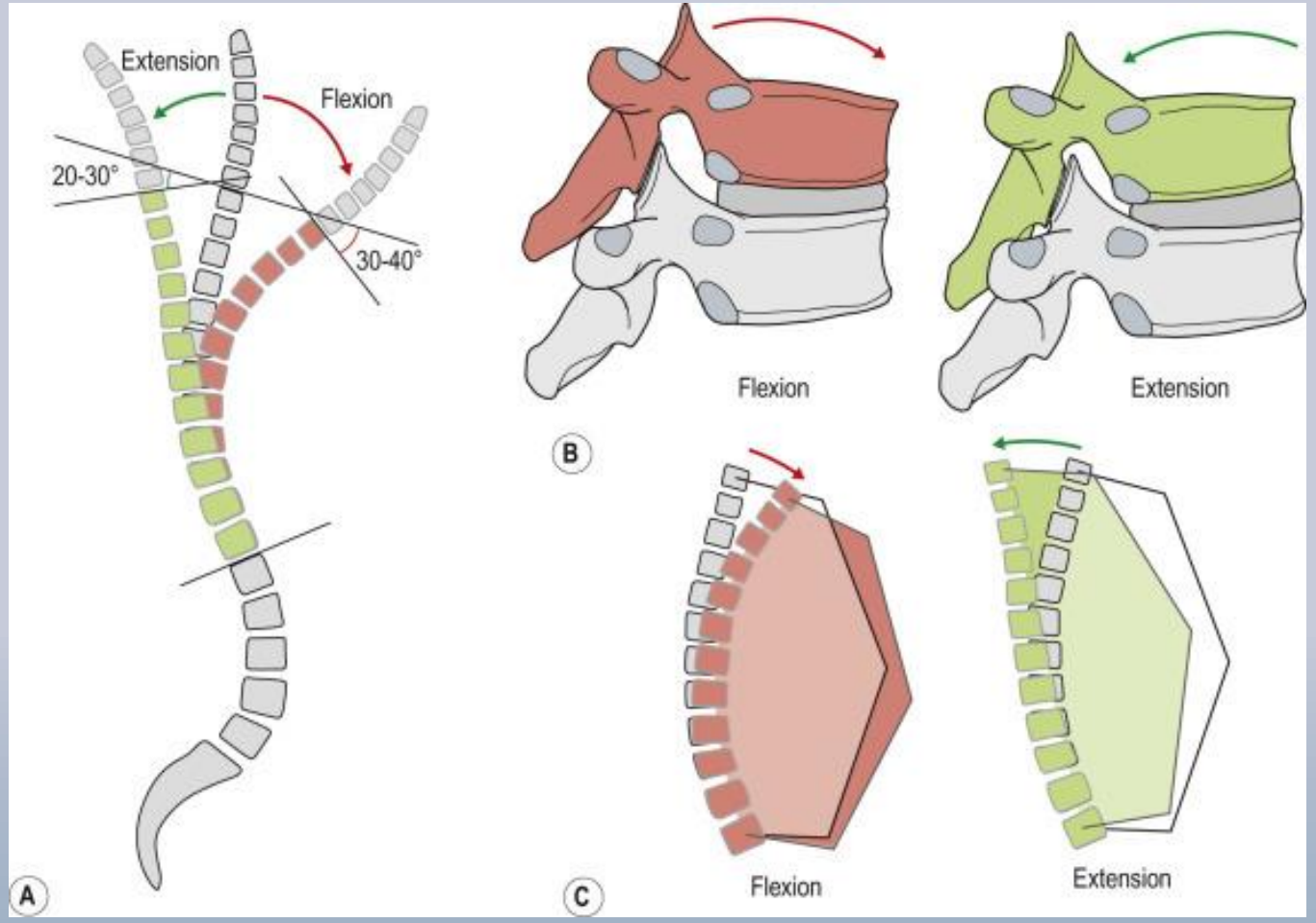
In severe and adult cases, surgery is usually the best option.

- Spinal fusion causes the vertebra to fuse together.
- Usually held together by metal rods running parallel to the vertebral column.
- Rods act as support while fusion occurs but they are usually not removed.

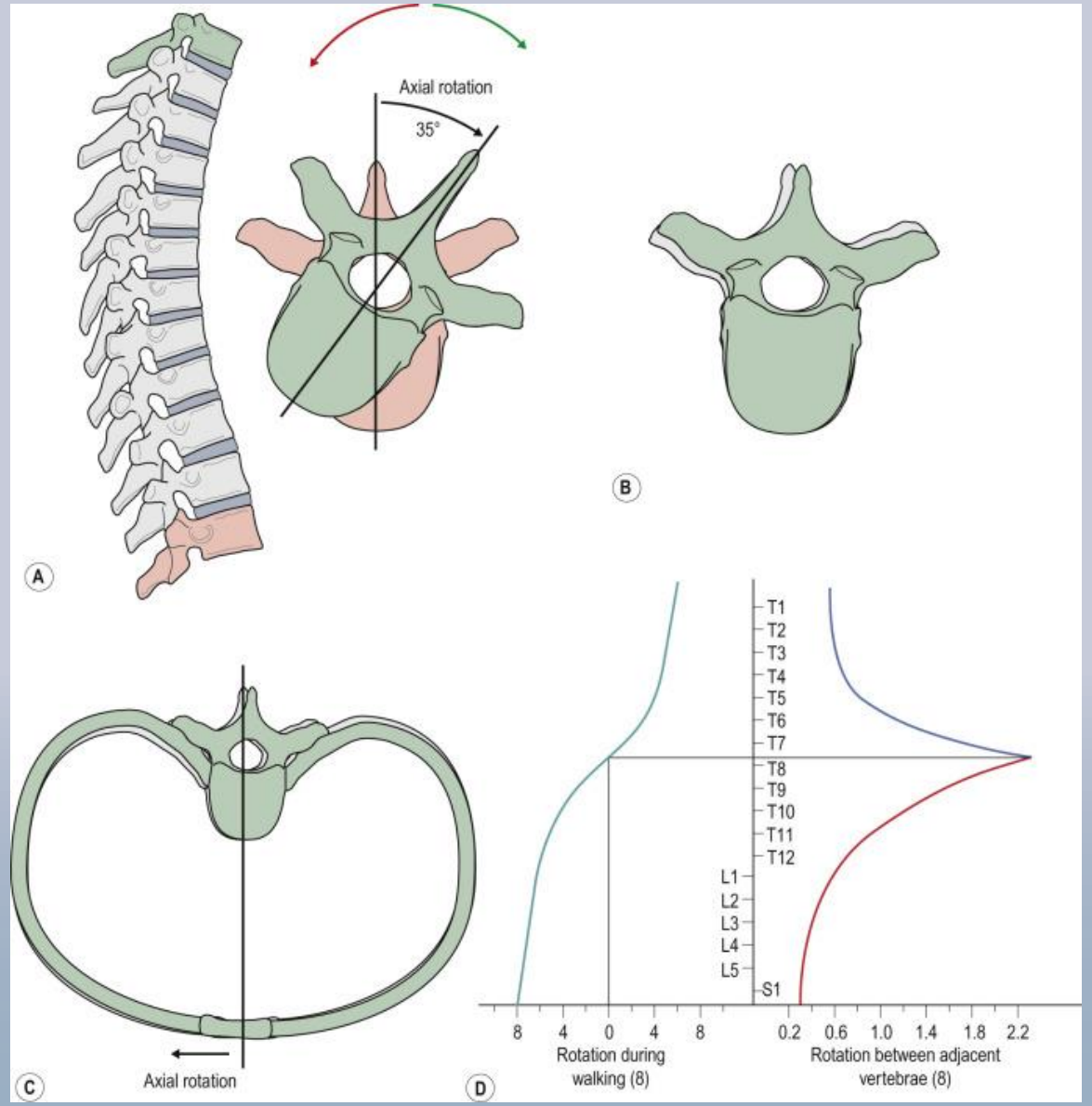


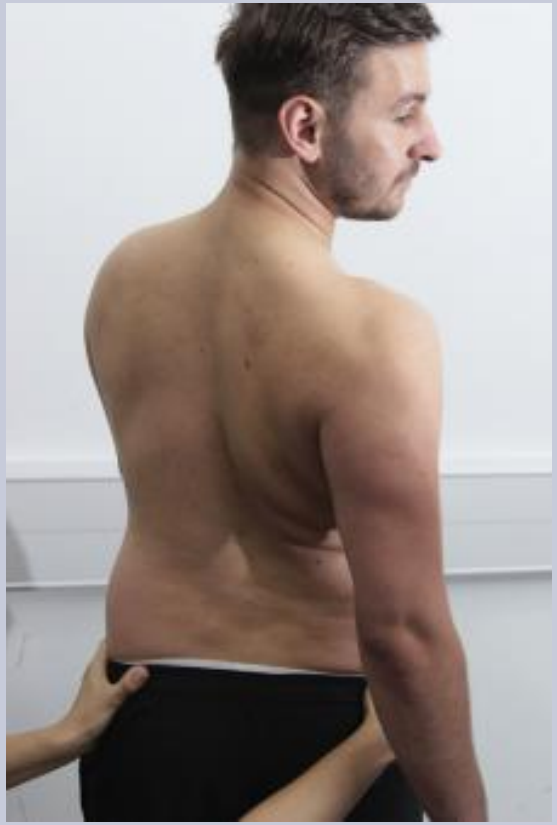


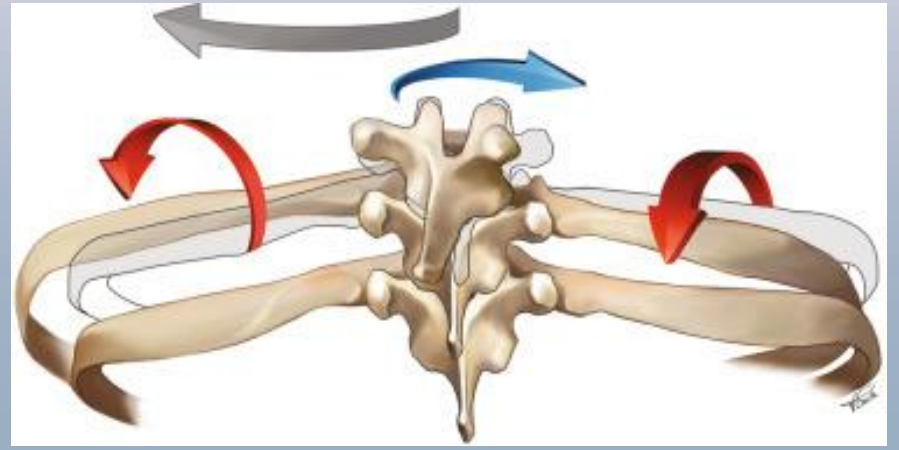
Thoracic Movement: Flexion & Extension



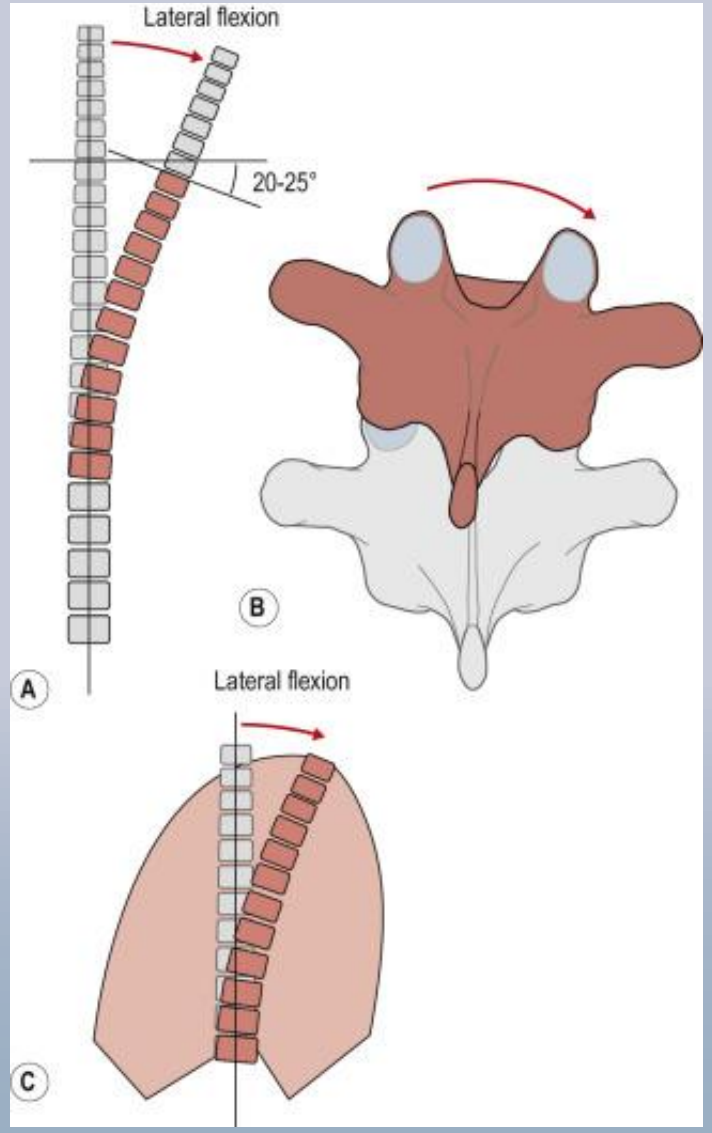
Thoracic Movement: Rotation

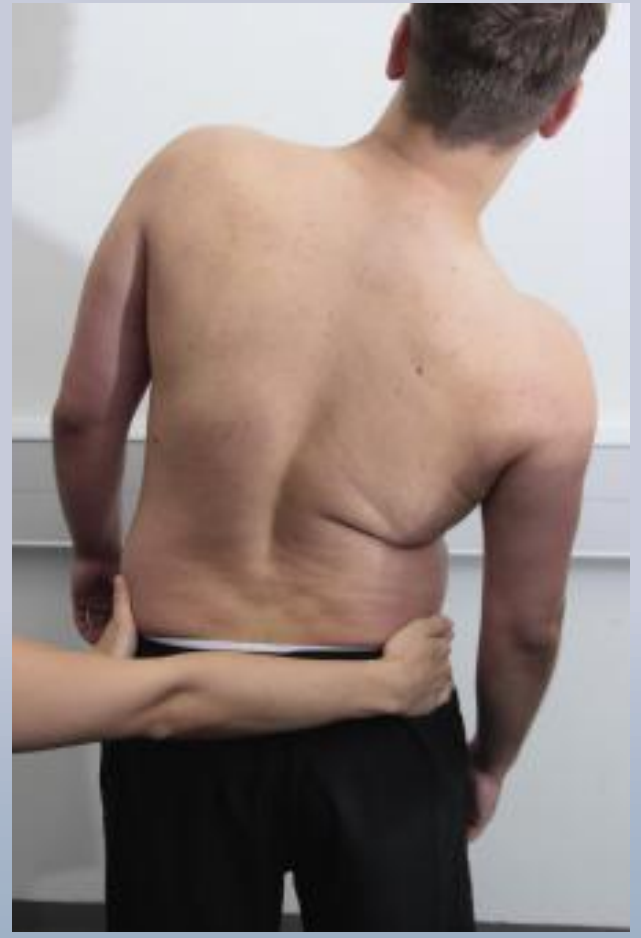






Thoracic Movement: Lateral Flexion





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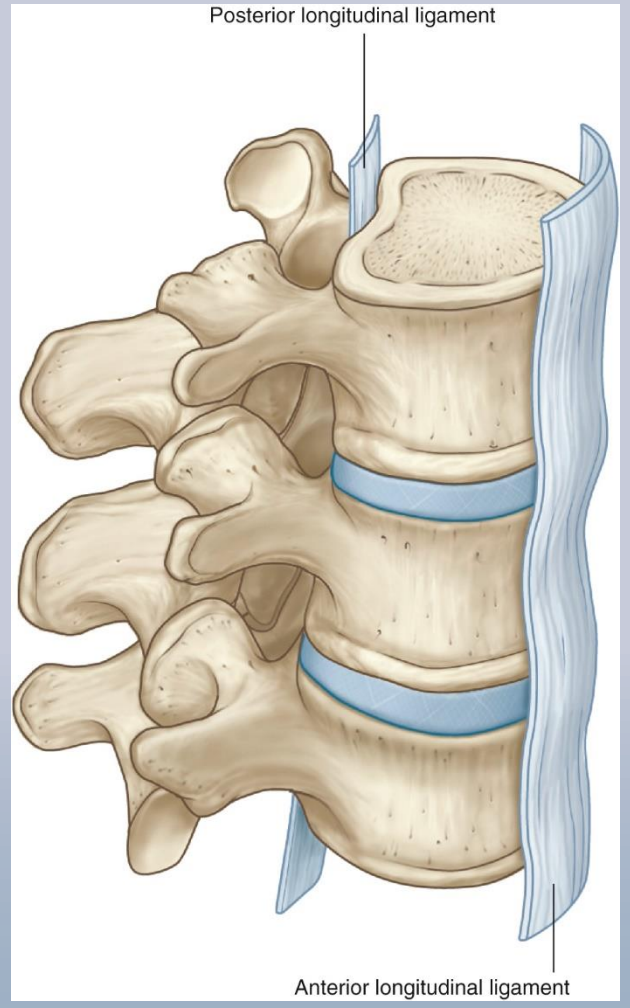
Part 2
Stability

Stability: Ligaments



Several ligaments exist to support the vertebral column.

Anterior longitudinal ligament

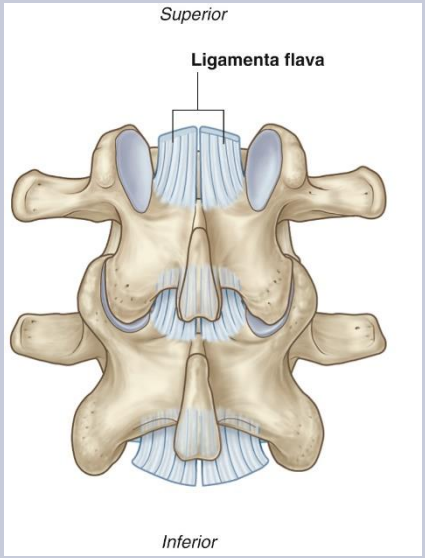
- Extends along the vertebral column anteriorly from the base of the skull to the surface of the sacrum.
- Helps prevent anterior displacement.

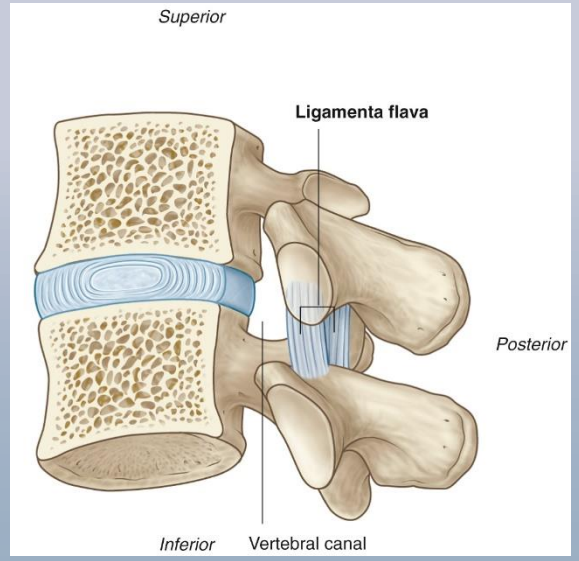
Posterior longitudinal ligament

- Extends along the vertebral column posteriorly.
- Attached from posterior surface of the sacrum to C2
- At C2 it broadens and attaches on to the base of the skull as the tectorial membrane.
- Helps prevent posterior displacement – especially in disc herniation, causes displacement to occur posterolaterally.

Both attach to the vertebral bodies and the intervertebral discs.

Stability: Ligaments



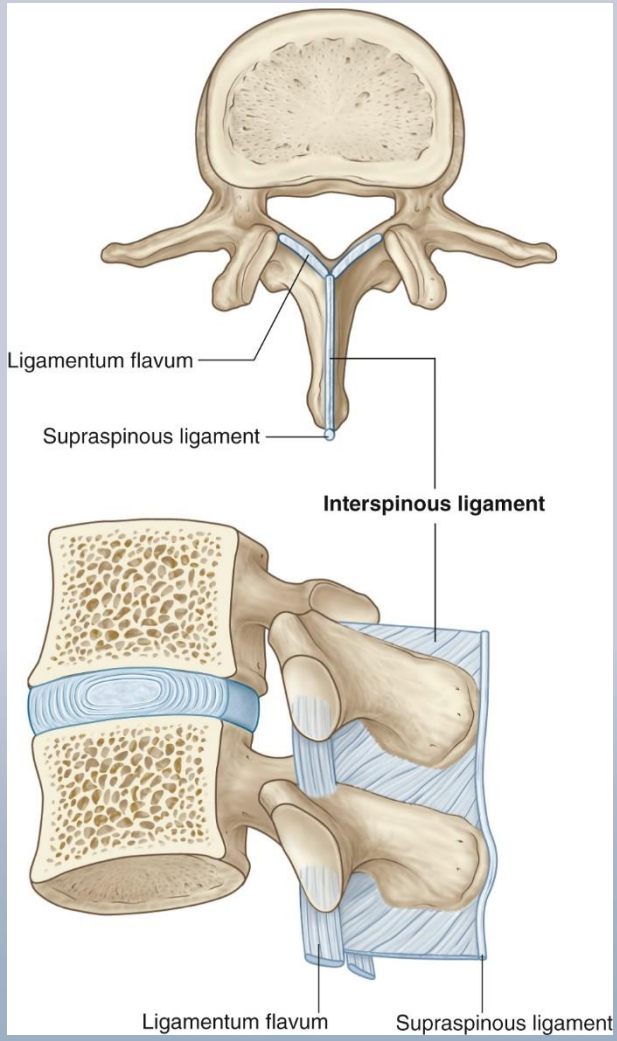


Ligamentum flava

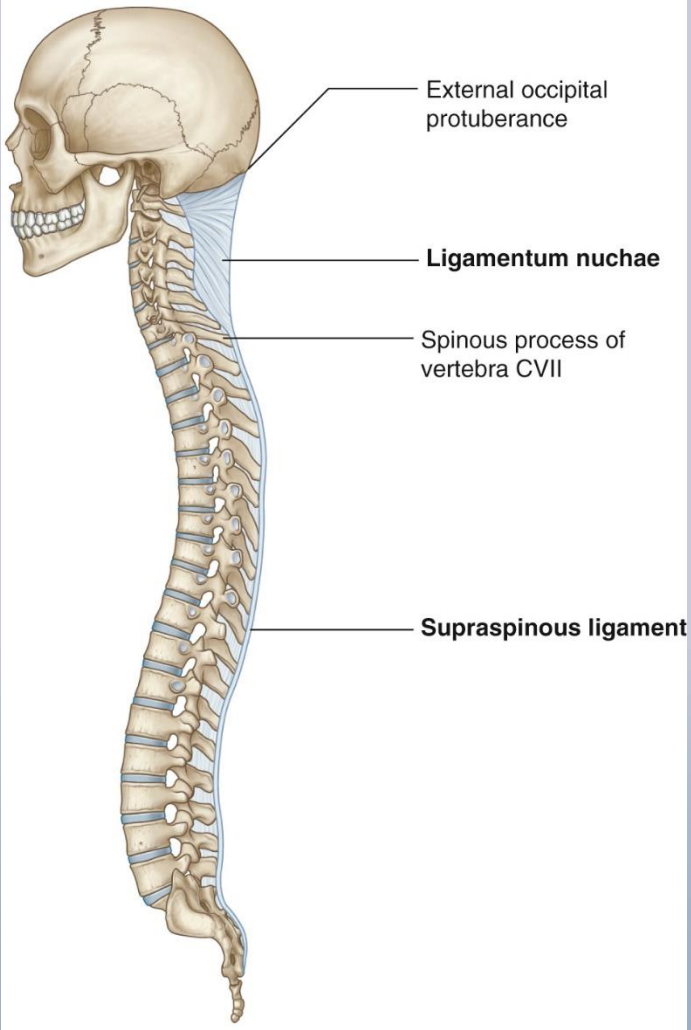
- Interconnect vertebrae by their lamina
- Mostly elastic tissue
- Allow movement in flexion and help pull the vertebral column back to anatomical position during extension.

Interspinous ligament

- Interconnect vertebrae by their spinous processes
- Blends with the supraspinous ligament posteriorly
- Blends with the ligamentum flava anteriorly



Stability: Ligaments



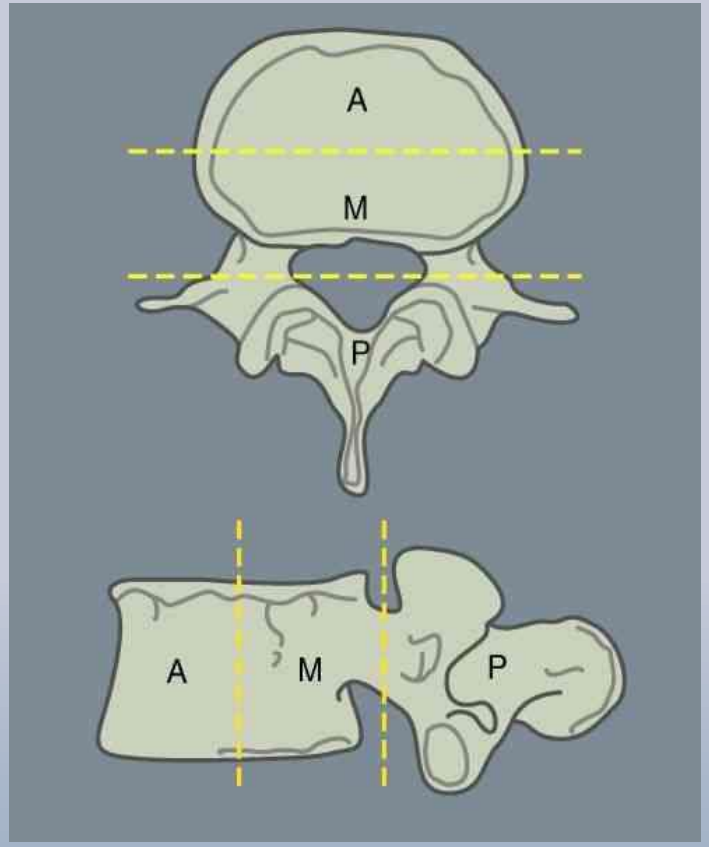
Supraspinous ligament

- Connects along the apex of the spinous processes
- Helps keep the shape of vertebral column

Ligamentum nuchae

- Blends with supraspinous ligament but structurally distinct
- Triangular structure connecting the spinous process of C7 to:
  - The base of the skull (external occipital protuberance to foramen magnum).
  - Posterior tubercle of C1 and remaining spinous processes.
- Supports the head, aids in returning it to anatomical position and resists flexion.

Stability: Three-column Concept



Three-column method is commonly used to determine stability of thoraco-lumbar spinal fractures.

Anterior column:
- Prevertebral muscles
- Anterior longitudinal ligament
- Anterior vertebral body and disc

Middle column:
- Paravertebral muscles
- Posterior vertebral body and disc
- Posterior longitudinal ligament

Posterior column:
- Paravertebral muscles
- Erector spinae muscles
- Ligamentum flava and spinous ligaments
- Bony features of posterior vertebra (transverse & spinous processes, lamina, pedicles, etc.)

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Part 3
Clinical

Clinical: Disc Herniation – Cervical

What condition is illustrated in the image below and how may it have occurred?

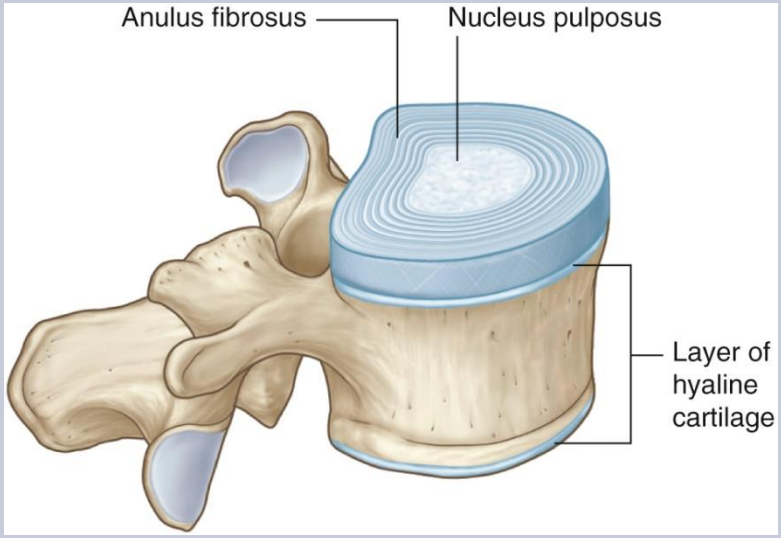
What can you see?

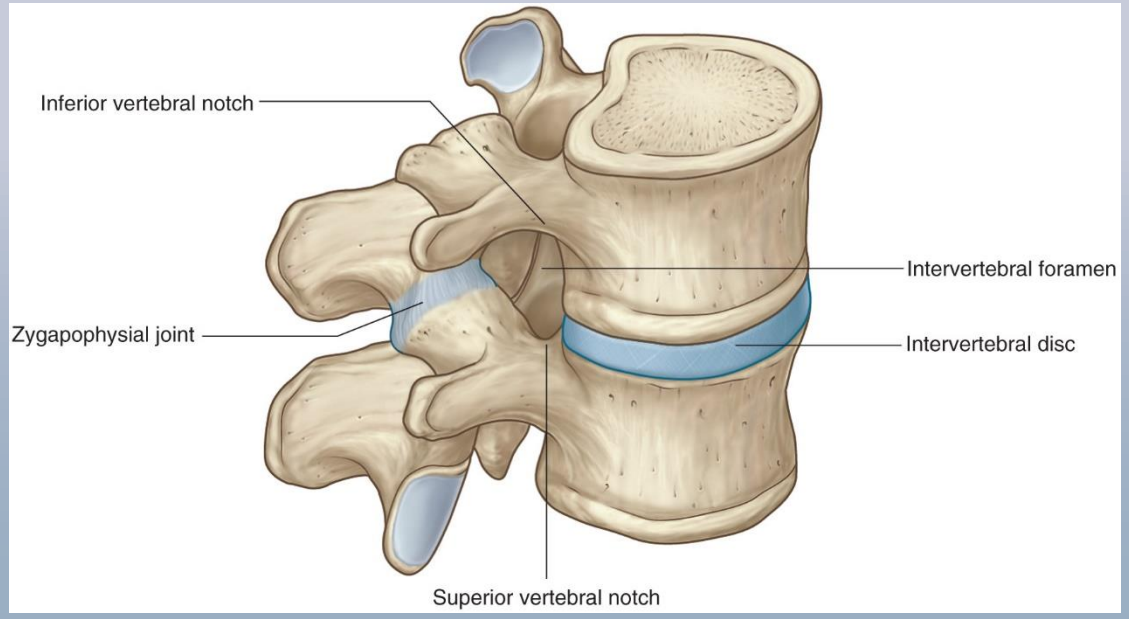
- Posterior disc herniation in the cervical region.
- Intervertebral disc between C5-C6.

Intervertebral disc herniation

- The most common sites for disc herniation are the cervical region (C5-C7) and the lumbar region (L4-S1).
- This occurs when a portion of the nucleus pulposus herniates through a tear in the anulus fibrosus in the vertebral column.
- This often leads pressure on part of the spinal cord or nerve roots.
- This commonly occurs in a posterolateral direction, as the posterior longitudinal ligament prevents direct posterior herniation on to the spinal cord.

Clinical: Intervertebral Joint





Hyaline cartilage lines the inferior and superior aspects of the vertebral body, with a intervertebral disc between each vertebra.

Intervertebral disc is composed of two parts:

- Anulus fibrosus
  - Strong outer ring of collagen surrounding fibrocartilage, arranged in a lamellar structure.
  - This strong connection limits rotation of vertebrae.
- Nucleus pulposus
  - Gelatinous filling that absorbs compression forces between vertebrae.

Clinical: Disc Herniation – Cervical

What condition is illustrated in the image below and how may it have occurred?

How may this have occurred?

- Cervical hyperextension – Sometimes from whiplash
- During an impact injury (usually a car crash, often rear-ended) the neck is thrown backwards causing hyper extension, with the head recoiling forward and leading to extreme flexion.
- The hyperextension of the cervical spine often results in torn muscles or ligaments, vertebral fractures, or disc herniation, among other injuries.

Clinical: Disc Herniation – Lumbar

What condition is present?

- Intervertebral disc herniation.
- L4-L5 level.

Symptoms?

Lumbar Disc Herniations

- As you move down the spinal cord the size of the intervertebral foramen (where the spinal nerve leaves) increases in size.
- The lumbar nerve roots exit beneath the corresponding vertebral pedicle through their respective foramen, but above their intervertebral disc.
- Since most disc herniations occur posterolaterally, the root that gets compressed is actually the root that exits the foramen below the herniated disc – essentially falls behind the lower vertebra.

Clinical: Disc Herniation

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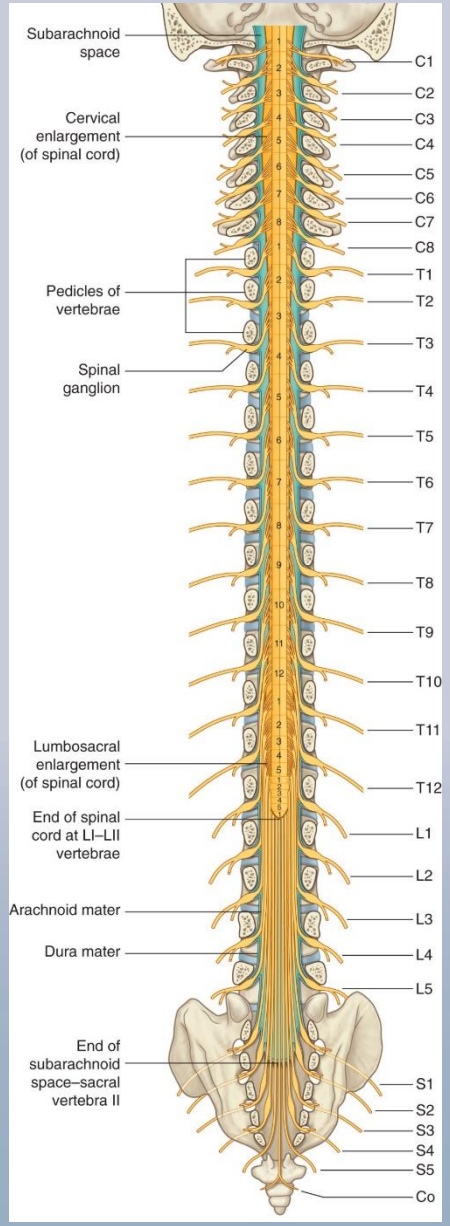

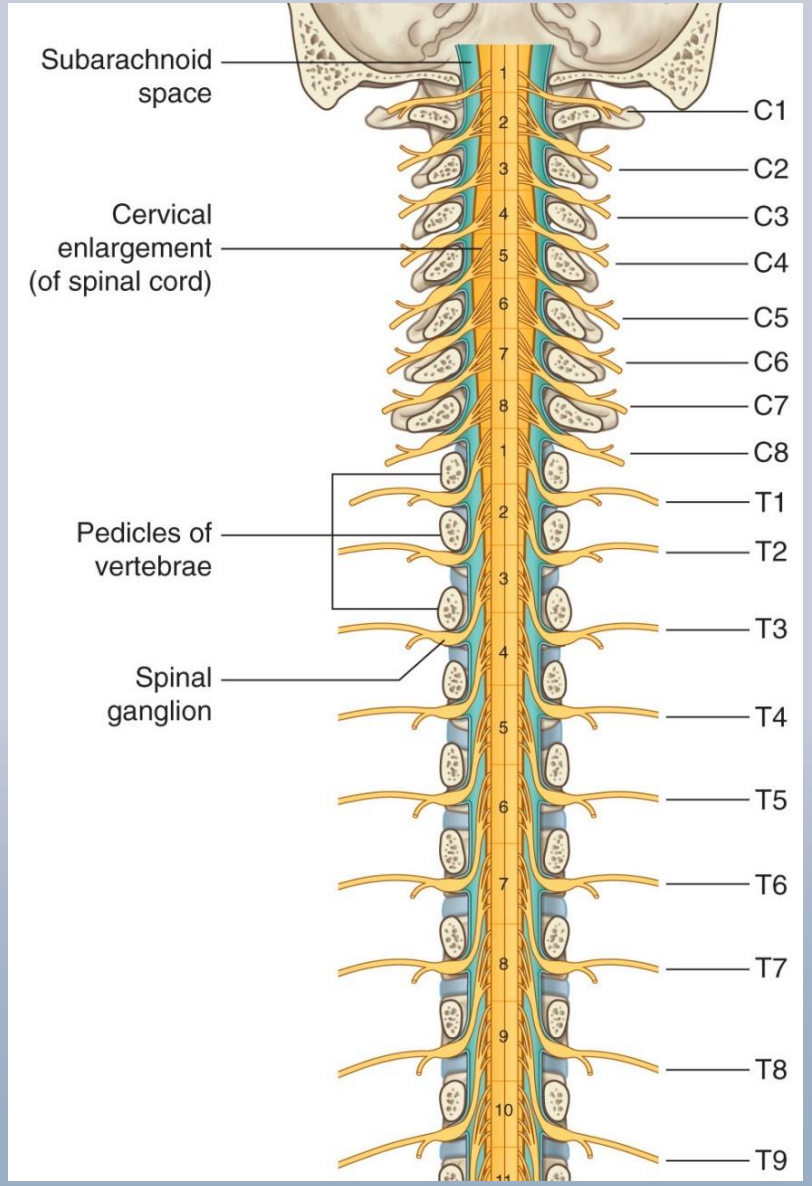

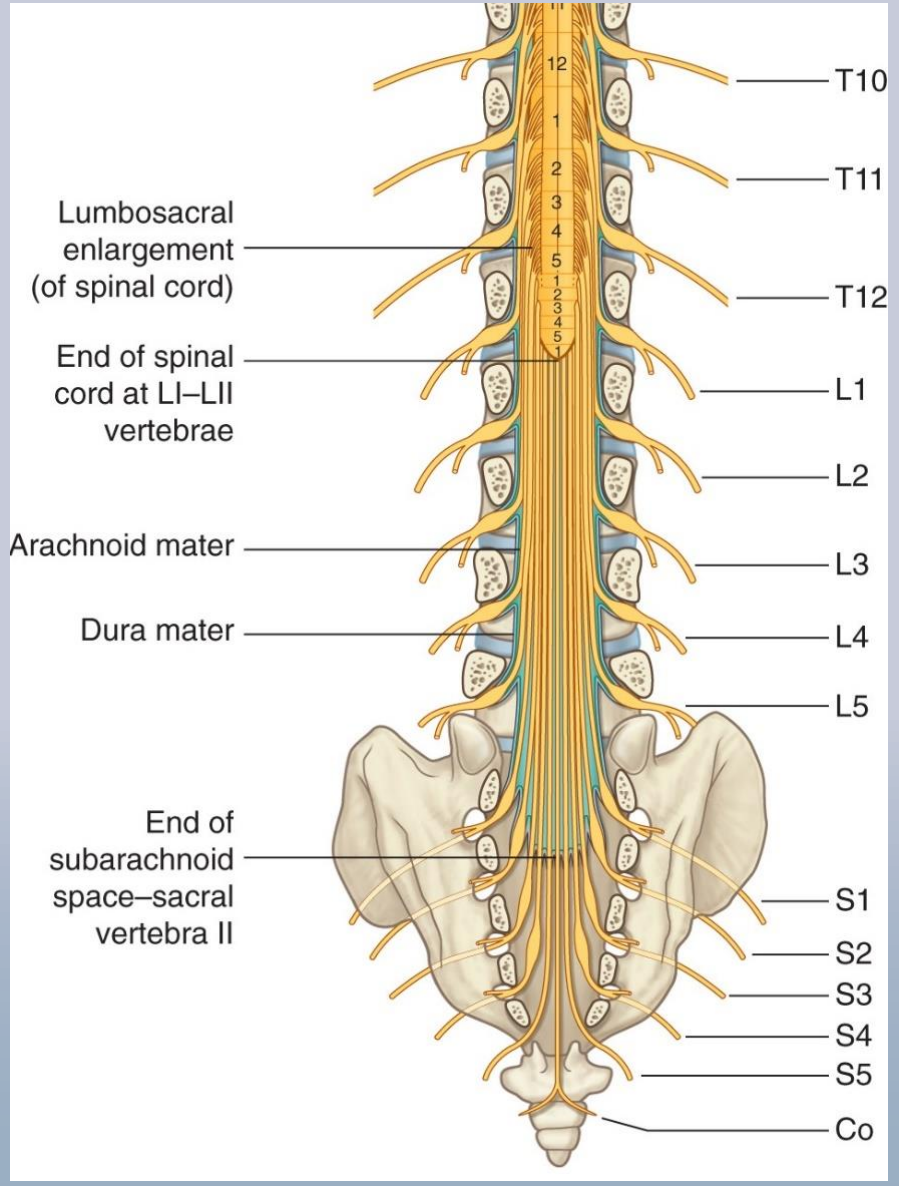

Clinical: Spinal Nerve Roots

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Table shows which spinal nerve exits through each intervertebral foramen.
Also note disc herniations: in cervical region impacts the nerve leaving foramen; in lumbar region impacts the nerve leaving the foramen below.

Intervertebral Foramen	Spinal Nerve	Intervertebral Foramen	Spinal Nerve	Intervertebral Foramen	Spinal Nerve
C0(Skull)-C1	C1	T1-T2	T1	L1-L2	L1
C1-C2	C2	T2-T3	T2	L2-L3	L2
C2-C3	C3	T3-T4	T3	L3-L4	L3
C3-C4	C4	T4-T5	T4	L4-L5	L4
C4-C5	C5	T5-T6	T5	L5-S1	L5
C5-C6	C6	T6-T7	T6	S1-S2	S1
C6-C7	C7	T7-T8	T7	S2-S3	S2
C7-T1	C8	T8-T9	T8	S3-S4	S3
		T9-T10	T9	S4-S5	S4
		T10-T11	T10	S5-Co	S5
		T11-T12	T11	Coccyx (Caudal end)	Co
		T12-L1	T12		

= Most common disc herniation locations

Number = Most likely nerve compressed from herniation

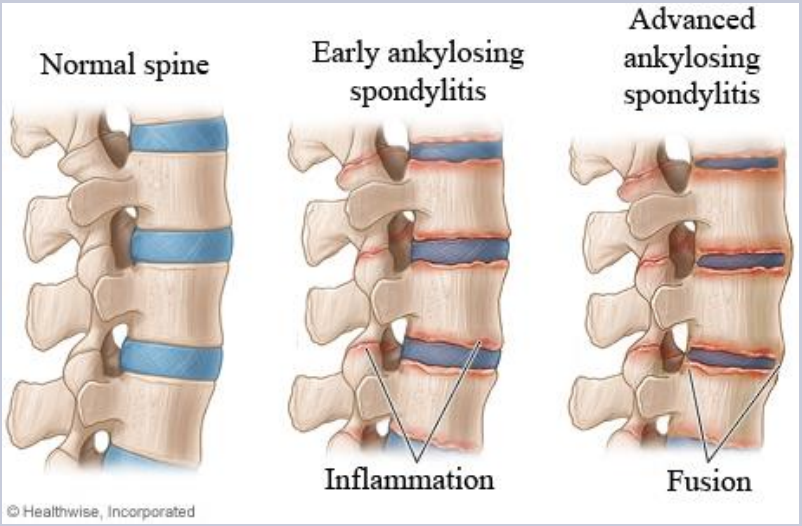
Clinical: Ankylosing Spondylitis

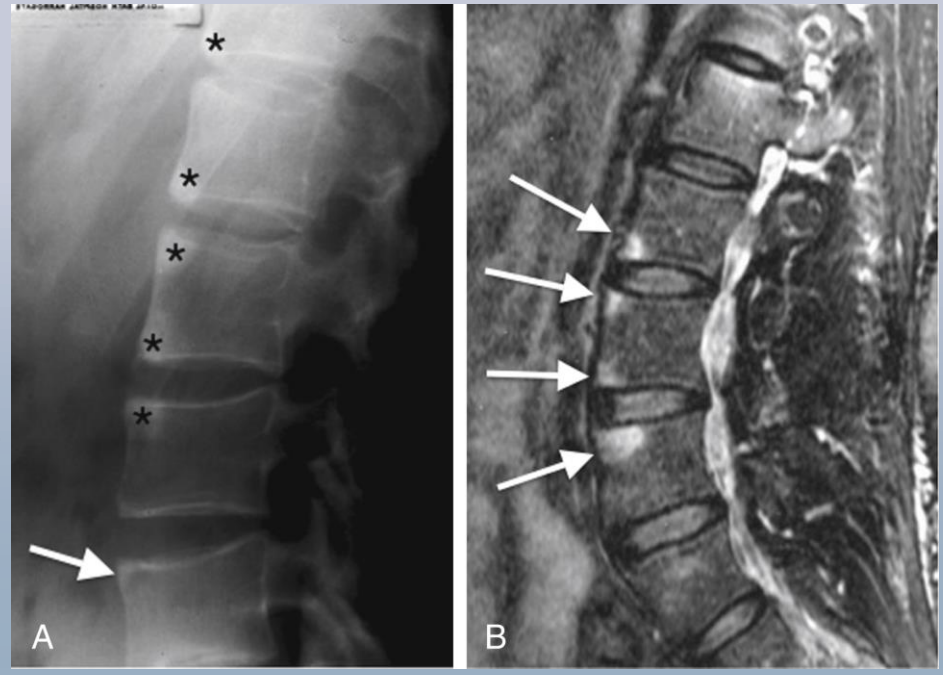
Ankylosing spondylitis (AS)

- Often starts in sacroiliac joint (sacroiliitis) and lumbar region.
- Over time can progress to thoracic and cervical.
    - Can also occur solely in those regions, though less common.

Inflammation starts at the site of ligament attachment to the bone and over time damages the bone and ligaments.

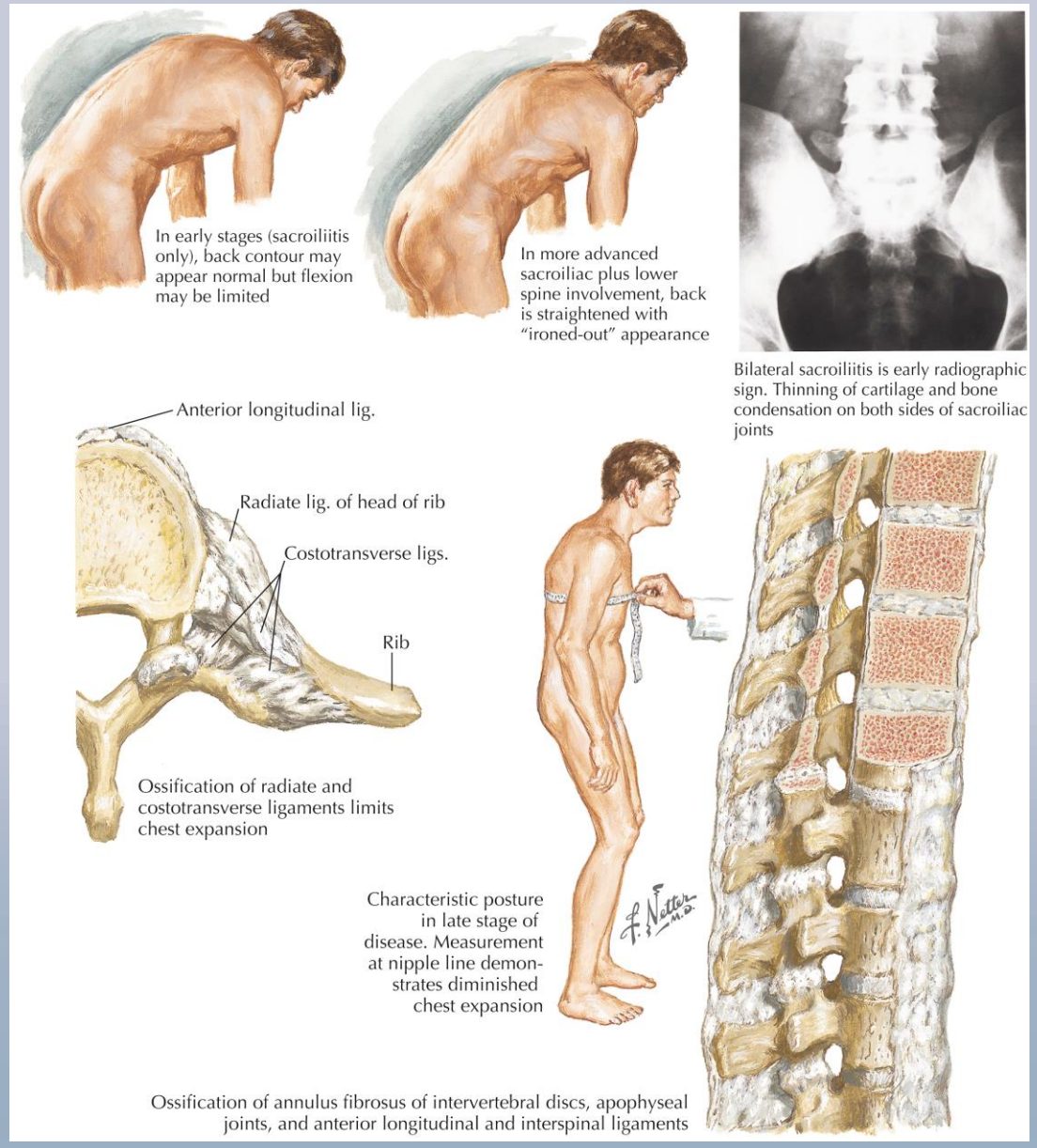
- Usually destroys the anterior and/or posterior corners of the vertebra.
    - Radiologically, are called ‘Romanus lesions’
    - If the lesion is central, it is called an ‘Anderson lesion’
- In the healing process, new bone is formed.
- This results in the vertebra losing its obvious anterior concavity, becoming squarer when viewed laterally.
- ‘Bridges’ of bone (known as syndesmophytes) extend from the vertebral bodies of adjacent vertebra.
- Over time these link and fuse the spine.
    - Periphery of anulus fibrosis ossifies to form the middle link.
    - This can look like bamboo stems x-rays, giving the term ‘bamboo spine’
- Once fused, the pain often stops but mobility is severely limited in that region.
    - Spine is also more brittle and can fracture or compress.





Ankylosing Spondylitis: Progression

- Fusion of sacroiliac joint
- Fusion of spine – bamboo spine.
- Ossification of ligaments
- Spreading along spine
  - Causes kyphosis of thoracic
- Question mark appearance
  - Compensatory hyperextension of neck and flexion of knees.
  - Fixed flexion of hips



Ankylosing Spondylitis: Cause & Symptoms

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What causes it?

- Unknown exactly – most are idiopathic, some autoimmune
- Usually starts young (15-30) and more common in men (~2:1)
- Has different levels of severity, some are affected more than others.
- Potentially some genetics factors
    - Presence of HLA-B27 gene may indicate vulnerability to developing AS.

Other potential symptoms:

- Improves with exercise, worse with rest
- Tenderness at other tendon insertions sites (often Achilles tendons)
- Loss of chest expansion – Indicates thoracic and rib cage involvement
- Peripheral joint arthritis or other forms of spondyloarthritis (psoriatic, reactive, enteropathic)
- Nail separation from nail bed (onycholysis)
- Malaise
- Apical lung fibrosis (rare)
- Anterior uveitis or iritis – Increased incidence (30-40% lifetime prevalence)
- Aortic regurgitation (aortitis)
- Anaemia
- Amyloidosis

Today's Session

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