Spine Viva

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Viva 1

A 17-year-old male presents to a local Emergency Department complaining of neck pain after landing on the back of his flexed head during a failed attempt at performing a backflip.

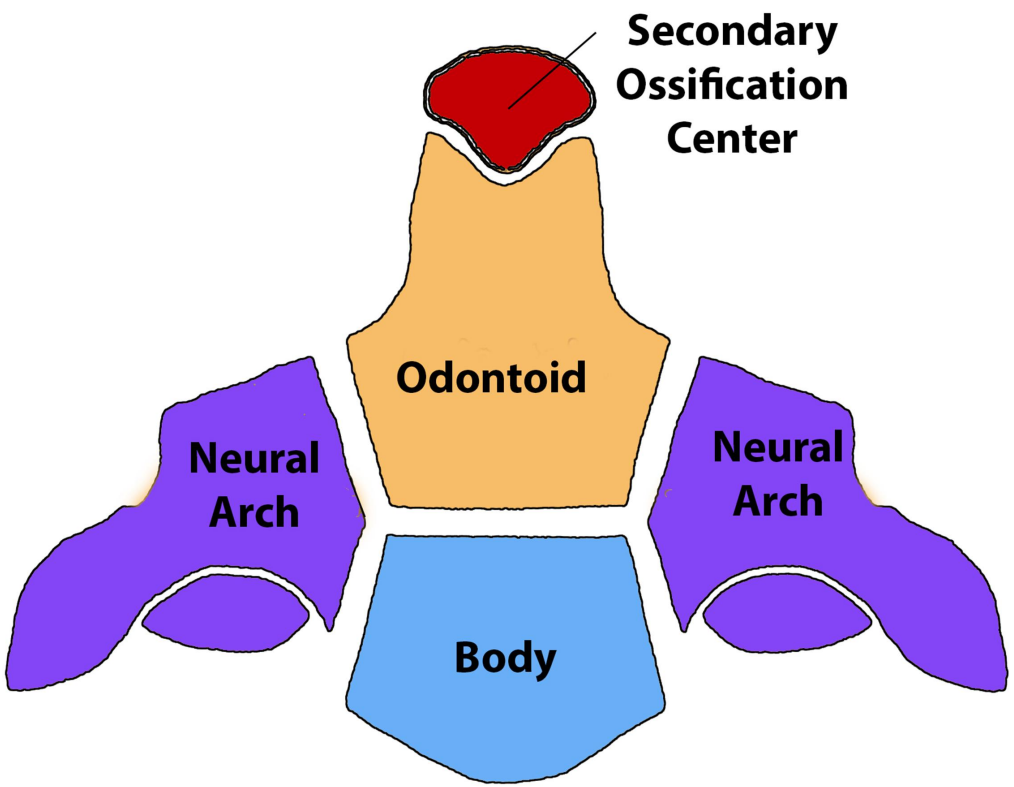
- What can you see?
- Describe the anatomy of the involved structure
- What is the mechanism of injury?
- Are you aware of any classification system?
- How would you manage this patient?
- What is os odontoideum?

What can you see?

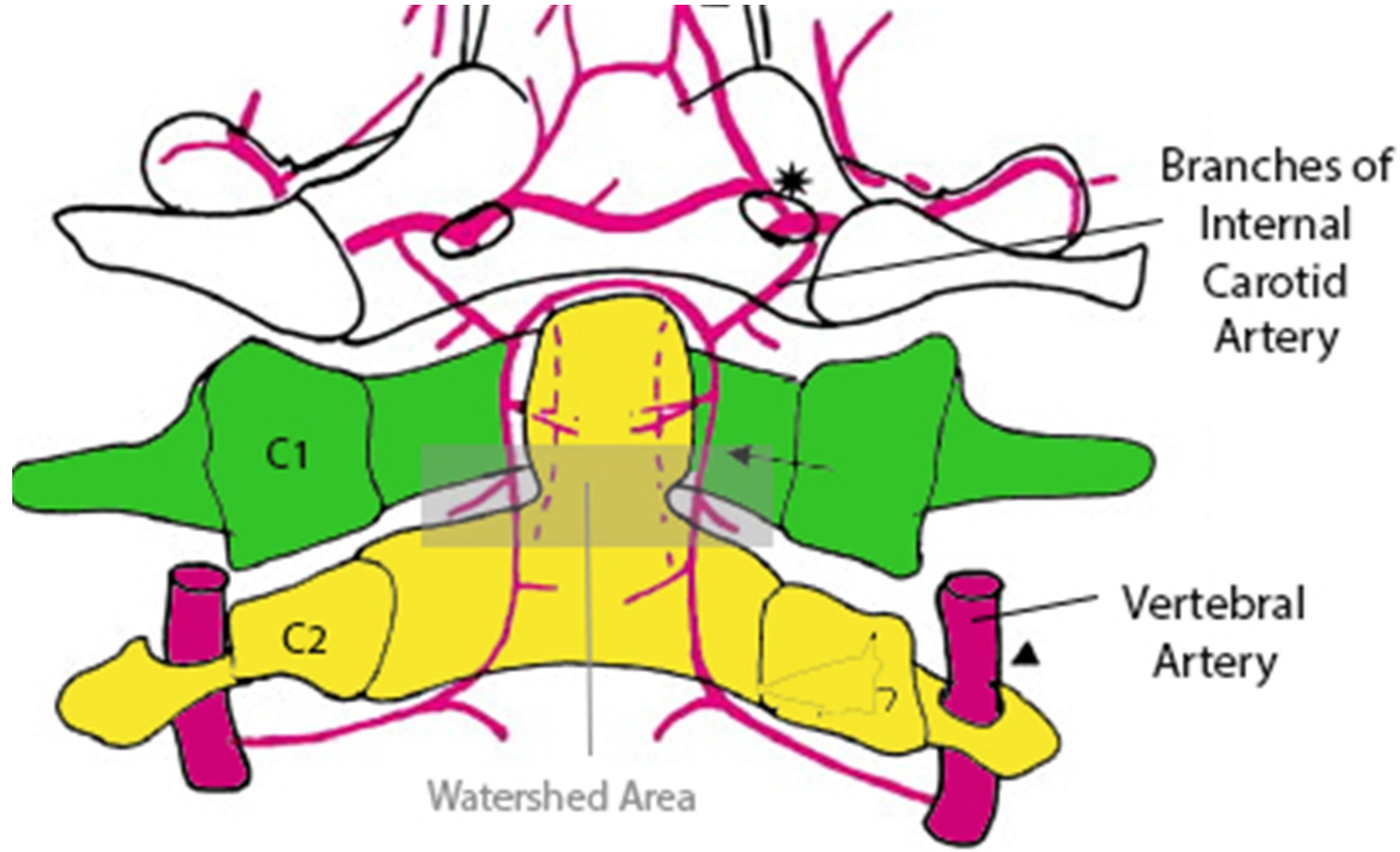
- *These are open-mouth antero-posterior and lateral radiographs of the cervical spine which showing Odontoid fracture type II with posterior and lateral displacement*

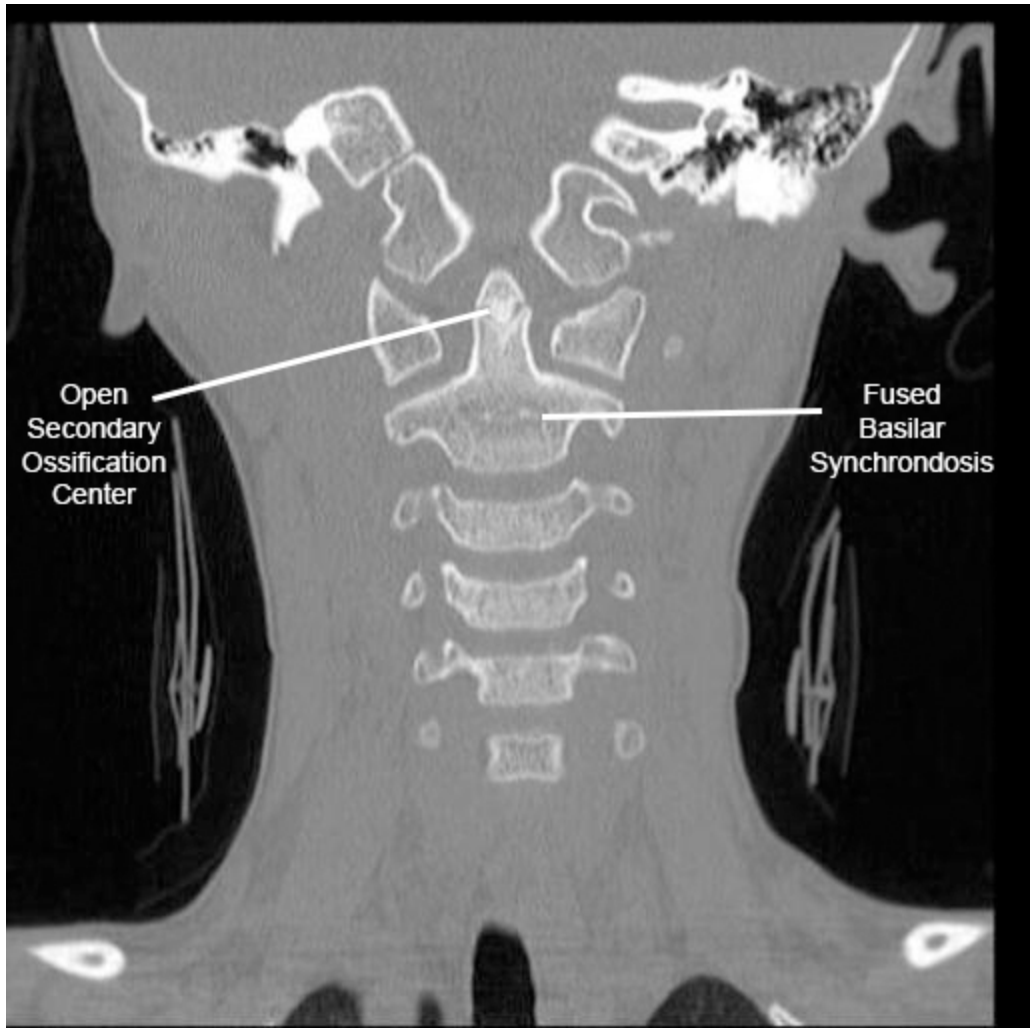
Describe the anatomy of the involved structure?

- *The axis (C2) has odontoid (dens) and body. It has 5 ossification centres (the body-the odontoid-two neural arches-secondary ossification)*
- *Secondary ossification centre appears at 3 years and fuses to dens at 12 years.*
- basilar synchondrosis is an initial cartilaginous junction between the dens and the vertebral body that does not fuse until ~6 years of age.
- *There is watershed area between apex of odontoid which is supplied by branches from internal carotid artery and the base of odontoid which is supplied by branches from the vertebral artery*



C2 Ossification Centers



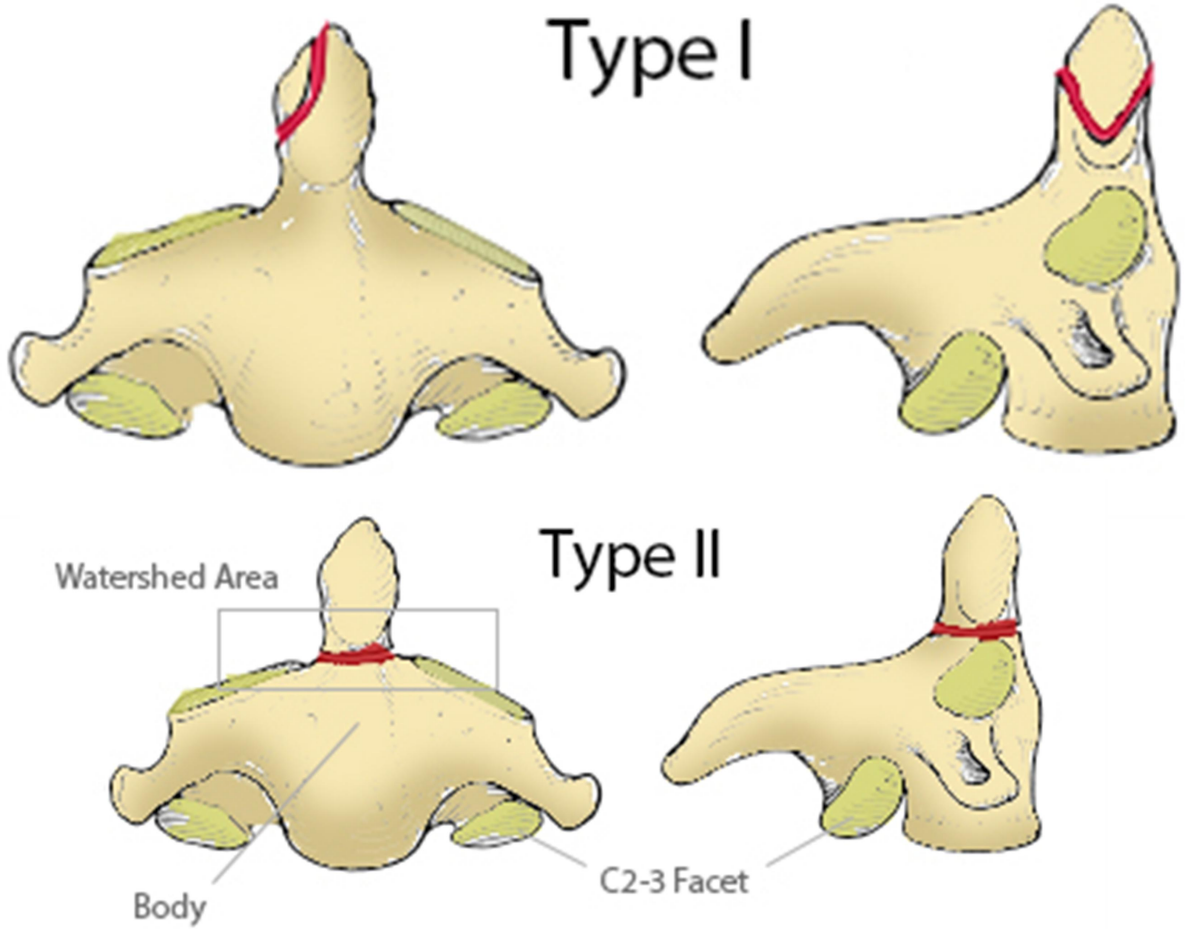

Open
Secondary
Ossification
Center
Fused
Basilar
Synchrondosis

What is the mechanism of injury?

- *The majority are caused by flexion loading which results in anterior displacement of the odontoid.*
- *A minority are caused by a posterior force on the forehead (extension loading), which results in posterior displacement of the odontoid.*

Are you aware of any classification system?

Anderson and D'Alonzo Classification	
Type I	Oblique avulsion fx of tip of odontoid. Due to avulsion of alar ligament. Although rare, atlantooccipital instability should be ruled out with flexion and extension films.
Type II	Fx through waist (high nonunion rate due to interruption of blood supply).
Type III	Fx extends into cancellous body of C2 and involves a variable portion of the C1-C2 joint.


Type I
Type II
Watershed Area
Body
C2-3 Facet
Type III
Dens
C1-2 Facet

How would you assess this patient?

- *ABCD*
- *GCS*
- *Rule out neurological shock or deficit*
- *Complete neurological examination(ASIA grading system)*
- *Initial imaging with trauma series (chest, c-spine and pelvis) X-rays.*
- *further imaging with CT scan if indicated.*

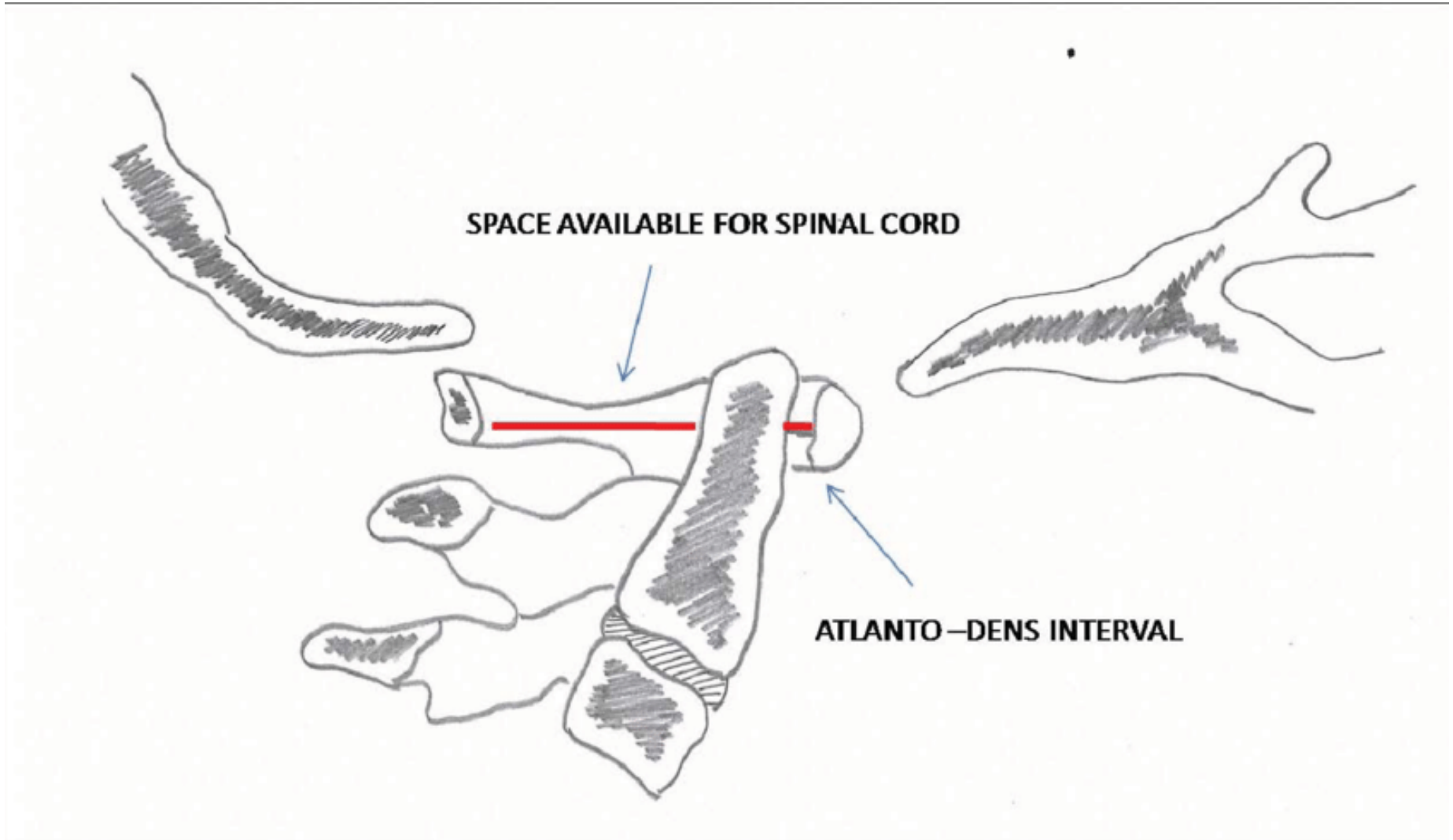
How would you manage this patient?

- *Treatment is dependent on the type of fracture:*

➢ *Type I: Hard cervical orthosis for 6-12 weeks. Check for stability by ordering flexion-extension views. Instability defined as* ***ADI >10mm or <13mm SAC****.*

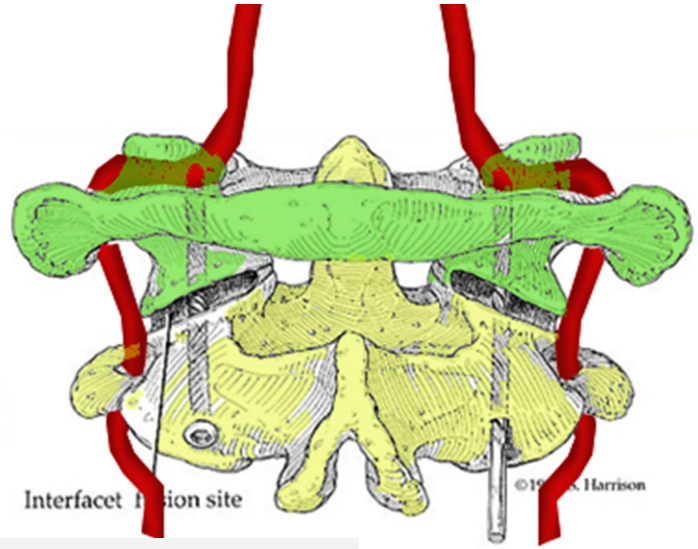
- *Type II: if no risk of non-union, in elderly → hard cervical orthosis for 6-12 weeks, due to high risk of complications with Halo. Young → halo vest immobilization for 6-12 weeks. If there is risk for non-union (post. Displacement > 5 mm-posterior re-displacement >2mm-angulation >10°-comminuted fracture-delayed start of treatment-fracture gap >1mm) → C1-C2 posterior fusion / anterior odontoid screw fixation / trans-oral odontoidectomy.*

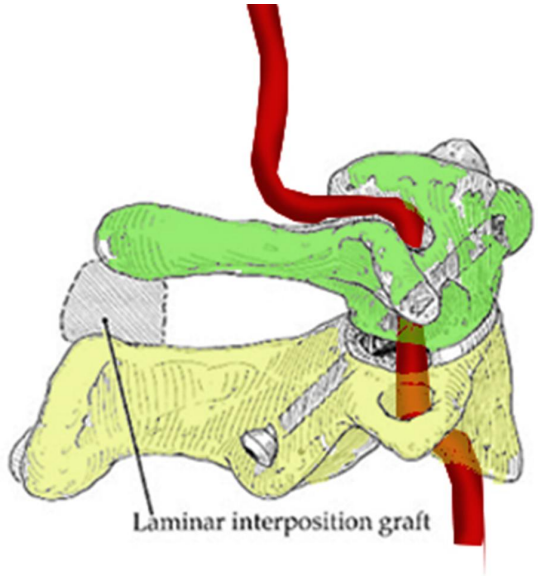
- *Type III: hard cervical orthosis 6-12 weeks*


SPACE AVAILABLE FOR SPINAL CORD
ATLANTO –DENS INTERVAL

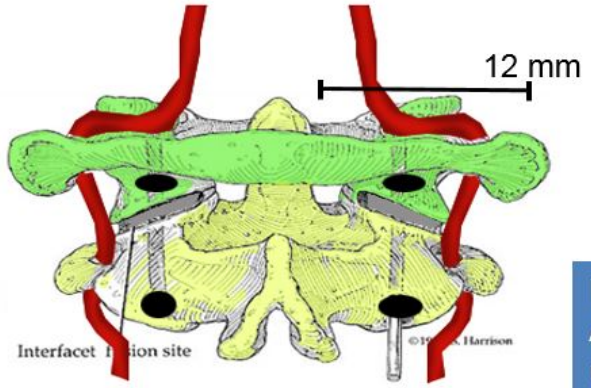
How would you manage this patient?

- *C1-C2 posterior fusion: the most commonly used, done through:*
  - *C1 lateral mass-C2 pedicle screw fixation (doesn't require post op Halo immobilization).*
  - *C1-C2 trans-articular screw fixation(contraindicated in patients with aberrant vertebral artery and internal carotid artery is at risk with bicortical screws)*
  - *Sub-laminar wiring: requires halo immobilization.*
- *Anterior odontoid screw fixation (single screw) used when there is oblique fracture perpendicular to screw trajectory.*
- *Trans-oral odontoidectomy is indicated in severe displacement of dens with spinal cord compression and neurological deficit.*





Technique: C1 Lateral Mass–C2 Pedicle Screw + BG



2012 SAE

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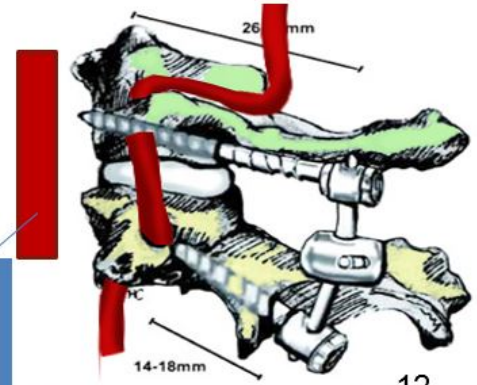
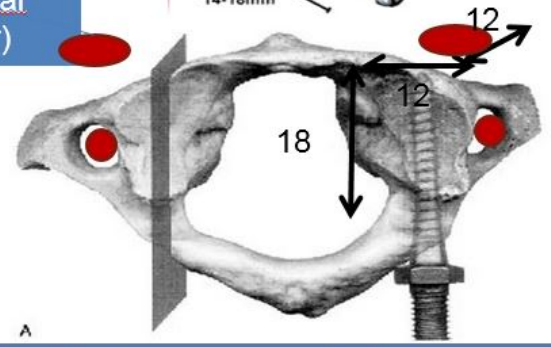
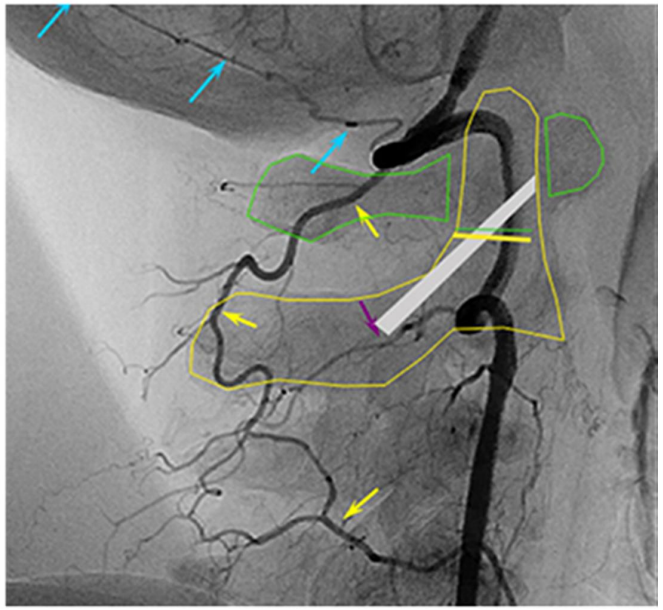
2018 SAE

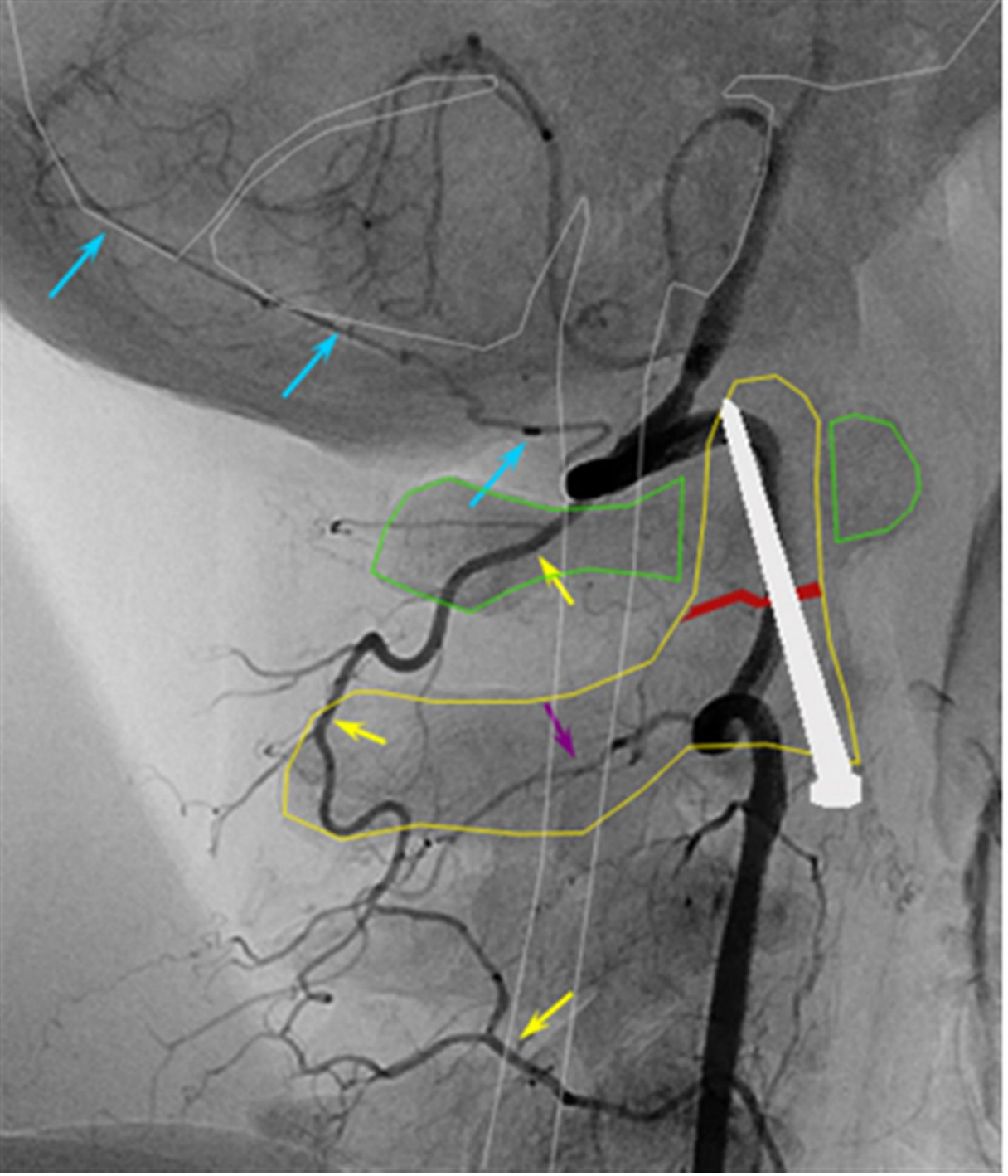
Internal Carotid Artery (at risk with bicortical C1-2 trans-articular)





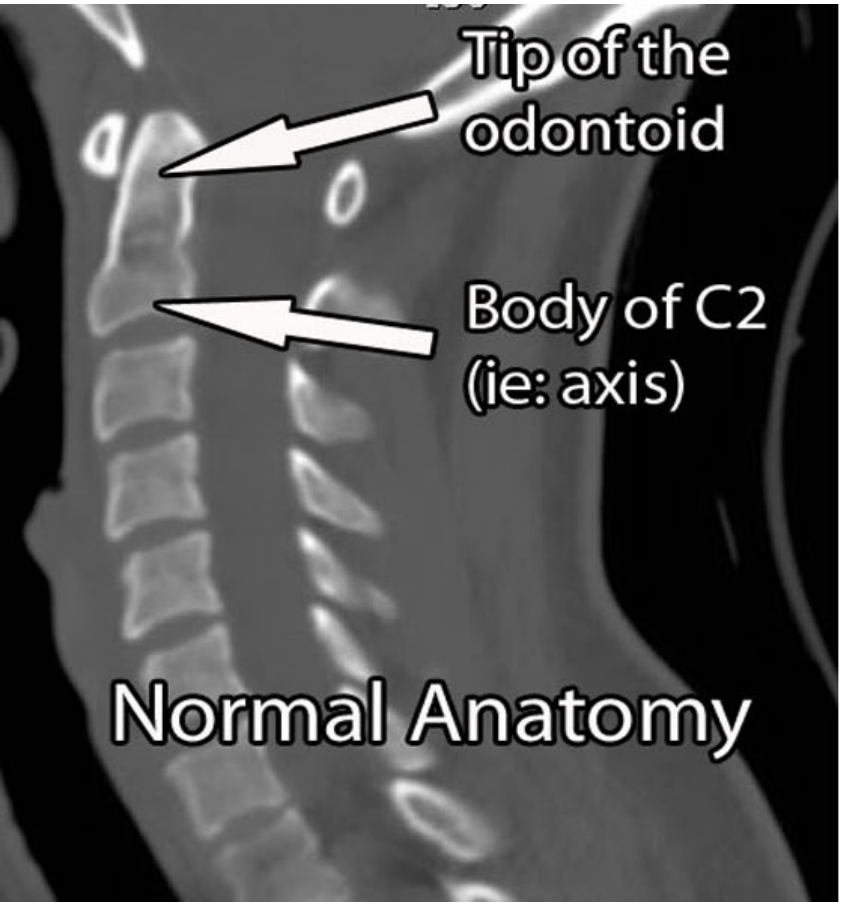


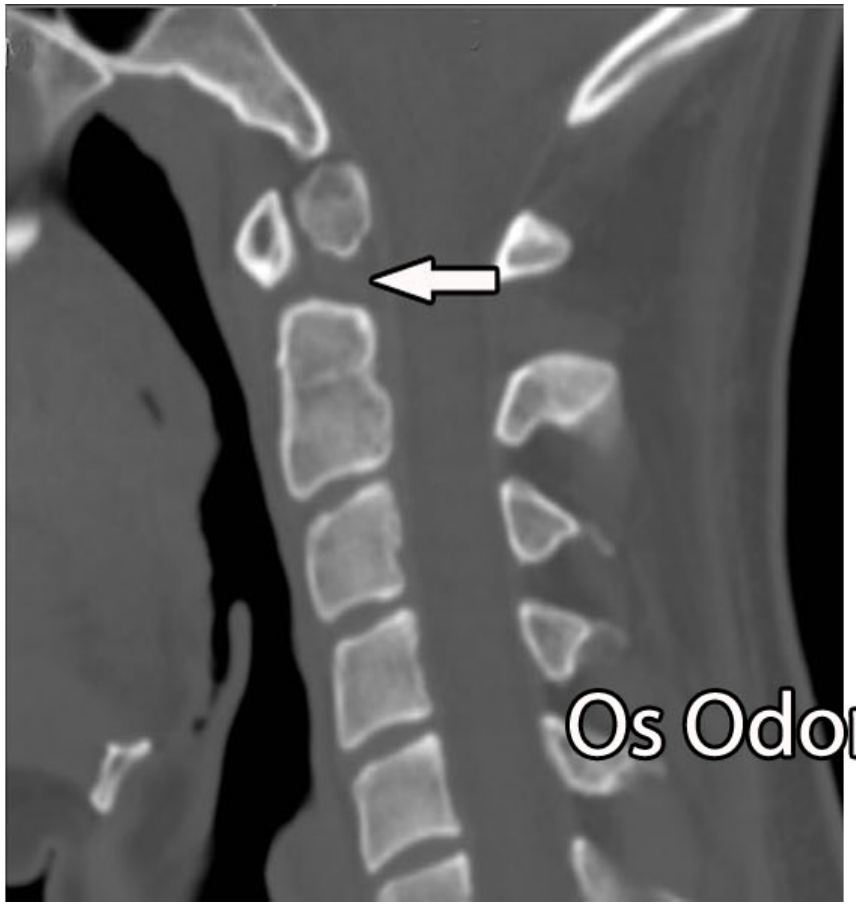
C1 lateral mass screw: 10 degrees medial, 22 degrees cephalad

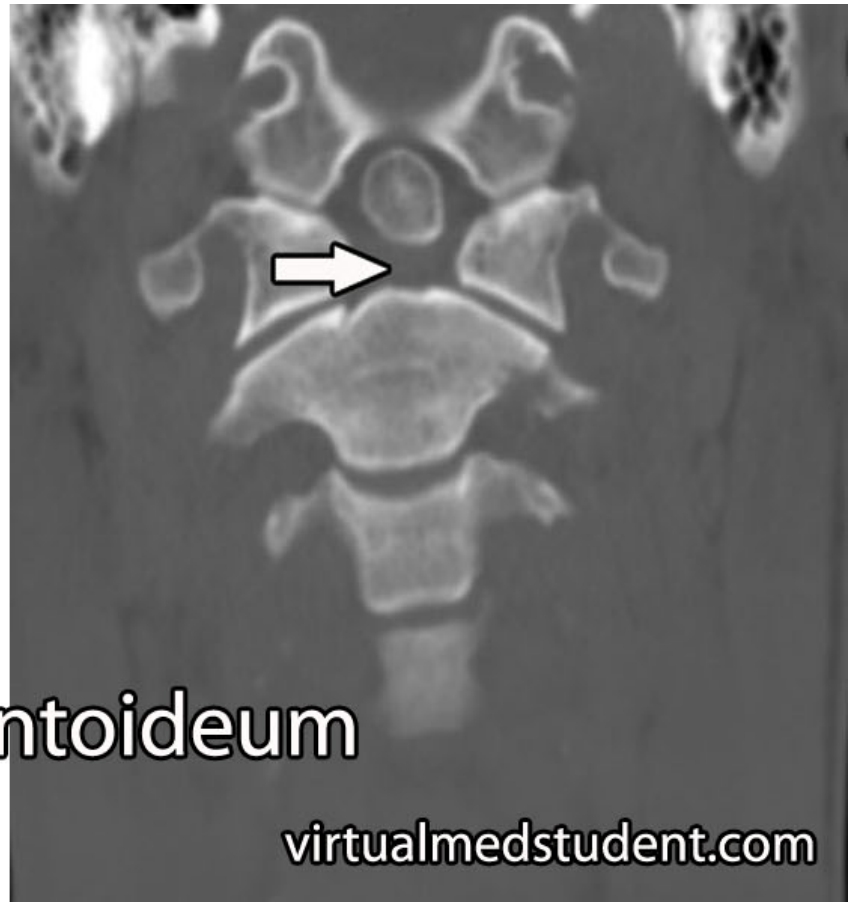


What is os odontoideum?

- *Os odontoideum is a congenital anomaly of the odontoid (dens).*
- *The dens is either completely absent, hypoplastic, or incompletely fused to the body of C2 (axis). Most commonly, patients are asymptomatic and it is discovered incidentally.*
- *Patients may present clinically with local neck symptoms and transient episodes of paraesthesia after trauma, or frank myelopathy.*
- *Non-operative treatment is sufficient for patients with a relatively stable os odontoideum and little compromise of the spinal cord.*
- *For marked instability, a cervical fusion of C1 and C2 is the procedure of choice.*


Tip of the odontoid
Body of C2 (ie: axis)
Normal Anatomy


Os Odontoideum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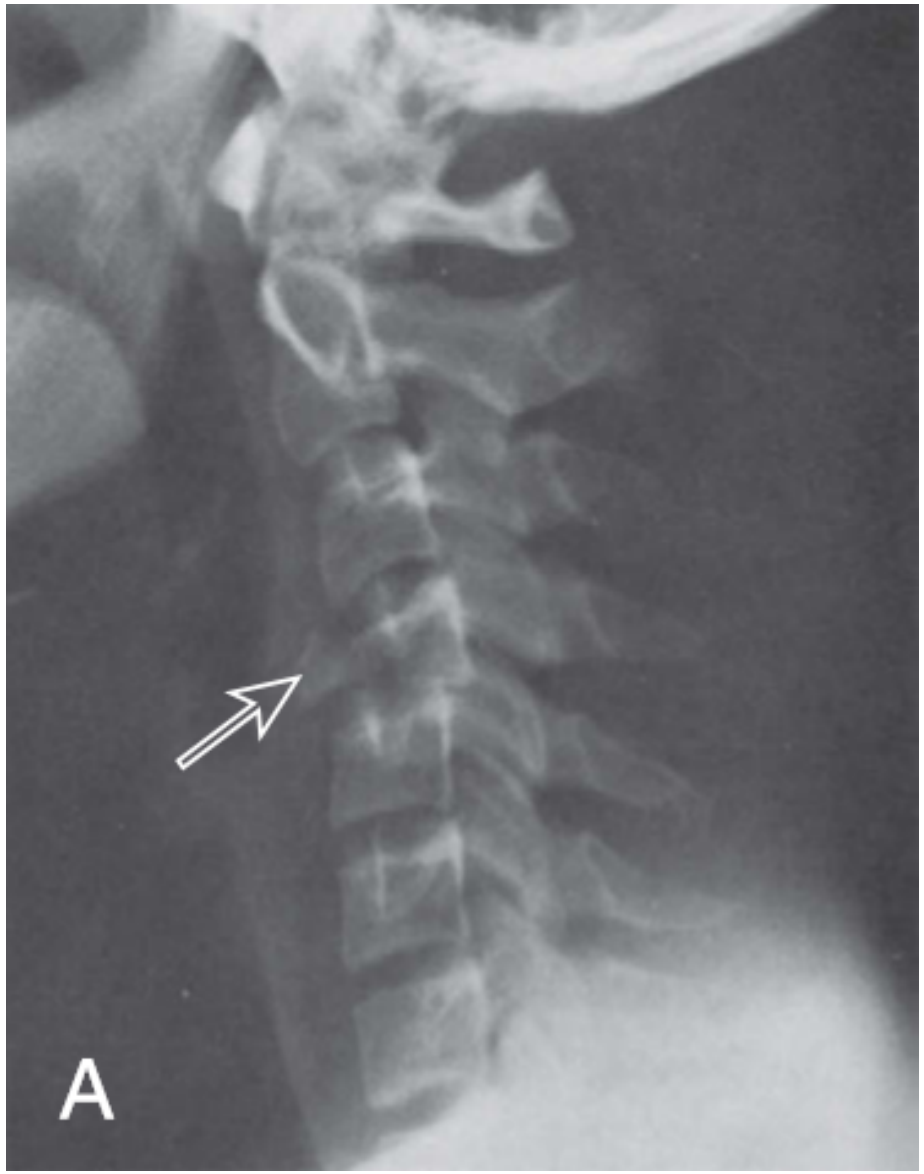
Viva 2

- Describe what you see
- How will you manage it?
- What are the component of the posterior ligament complex?



Describe what you see

- *This is lateral radiograph of cervical spine showing fracture of anterior inferior corner of C4, also known as tear drop fracture*
- *There are two types of tear drop fracture*

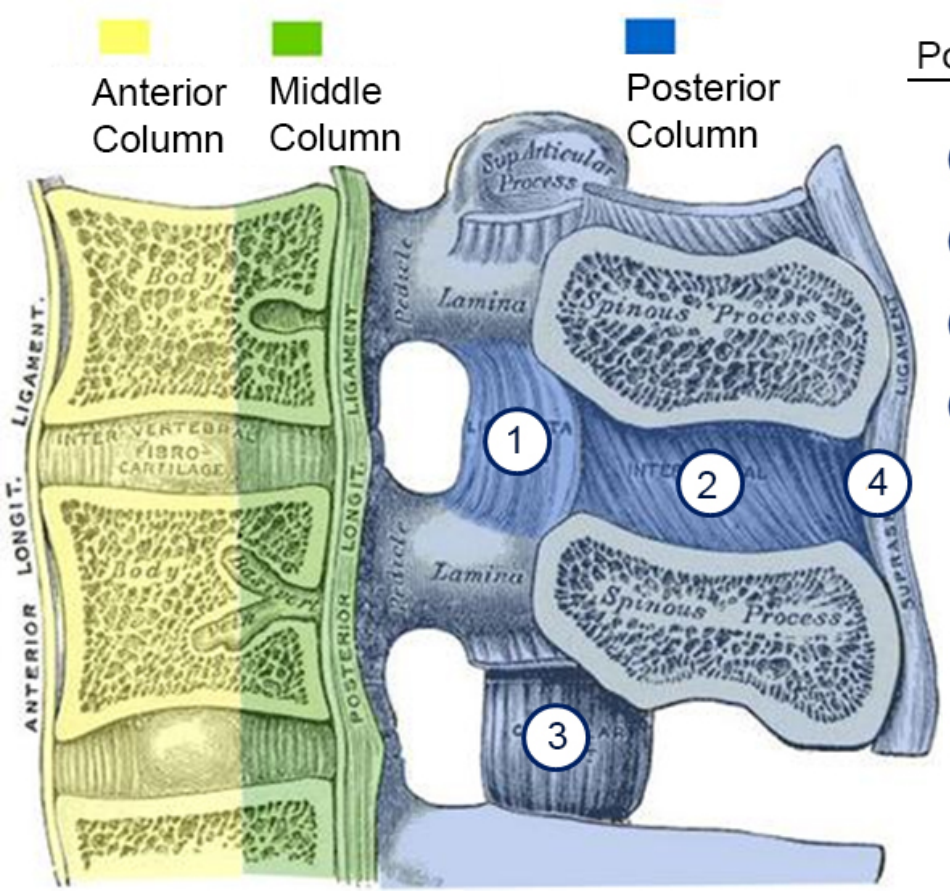
➢ *Flexion type: common in C5-C6, unstable, associated with disruption of PLL, associated with SCI due to displacement of posterior fragment.*

➢ *Extension type: common in C2, associated with disruption of ALL, conservative management.*

How will you manage it?

- *Immobilization should be maintained as soon as the injury is recognized(identified). Because this is an unstable, three column injury, surgical decompression and fusion is typically the management of choice.*

What are the component of the posterior ligament complex?



Posterior Ligamentous Complex

1. Ligamentum flavum
2. Interspinous ligament
3. Facet capsule
4. Supraspinous ligament

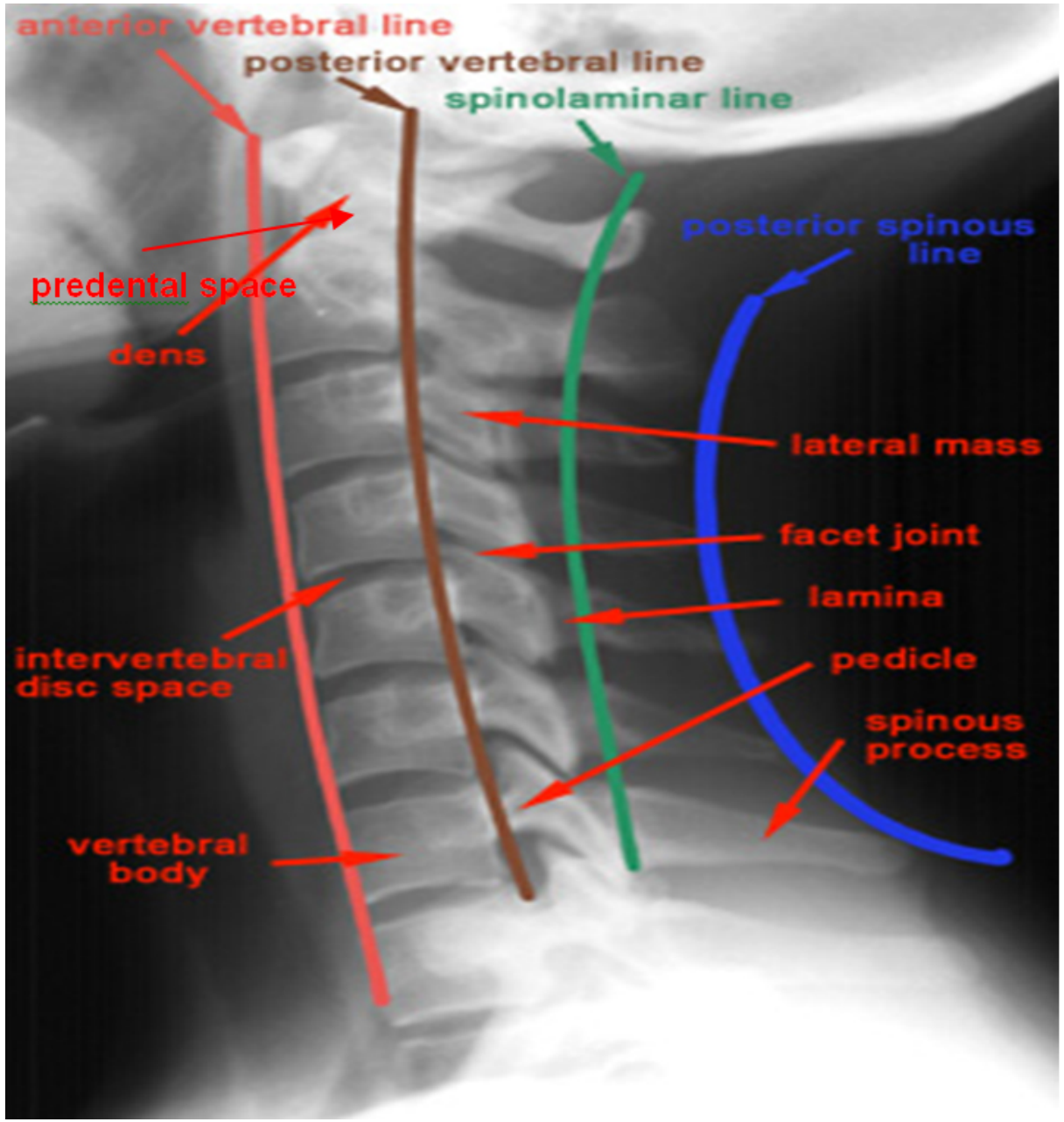
Viva 3

A 28-year-old male patient dives head first into a shallow pool

- Describe the radiograph
- What radiographic parameter may be useful in determining the presence of an occult fracture?
- Do you need any more images?
- Describe the anatomy of involved structure?
- What is the mechanism of injury?
- Are you aware of any classification system for this injury?
- What are the treatment options for this injury?

Describe the radiograph

- *This is a lateral radiograph of C spine showing separation of the anterior and posterior arches of C1, there is disruption of the anterior vertebral line*

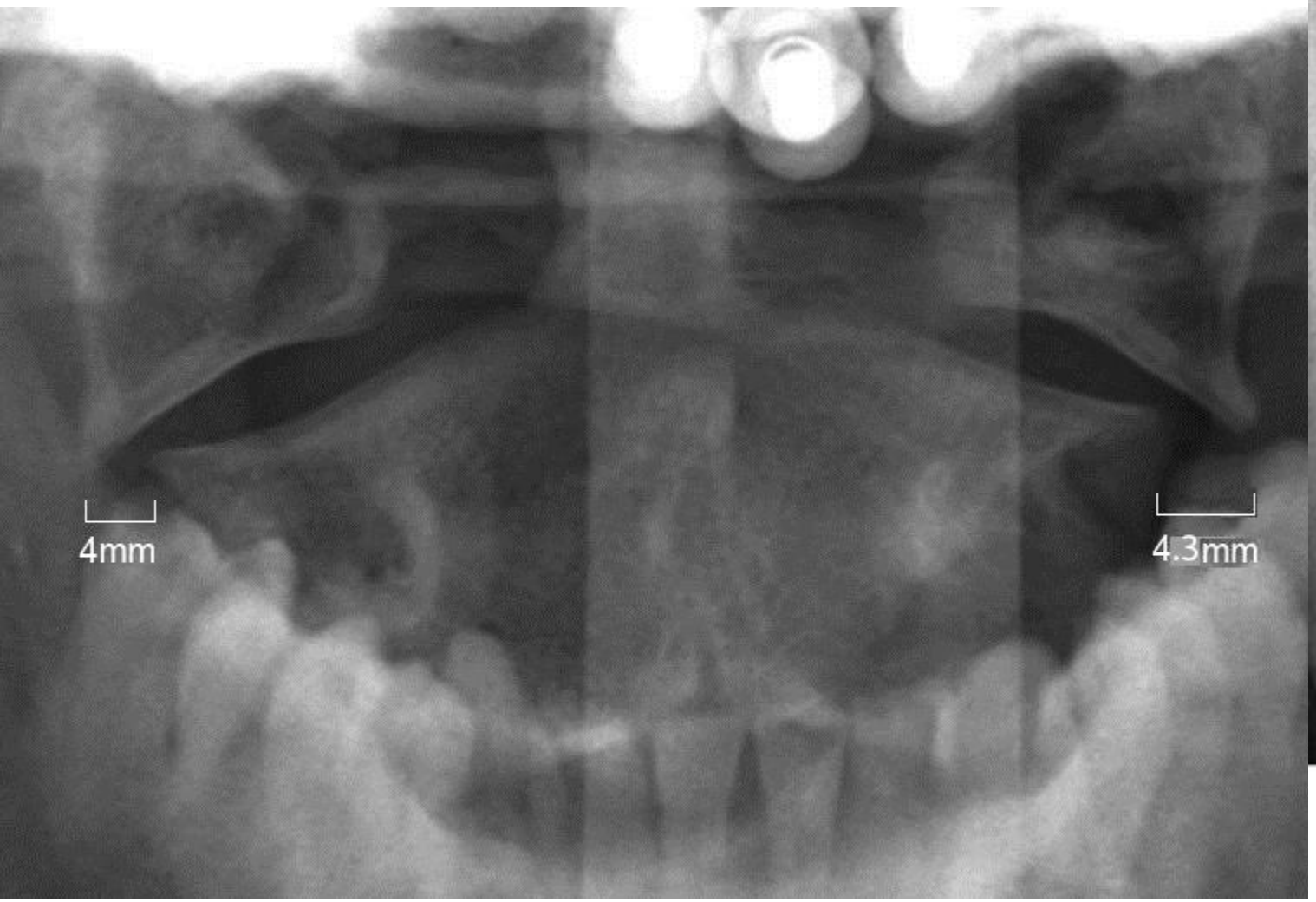

anterior vertebral line
posterior vertebral line
spinolaminar line
posterior spinous line
predental space
dens
lateral mass
facet joint
lamina
pedicle
spinous process
intervertebral disc space
vertebral body

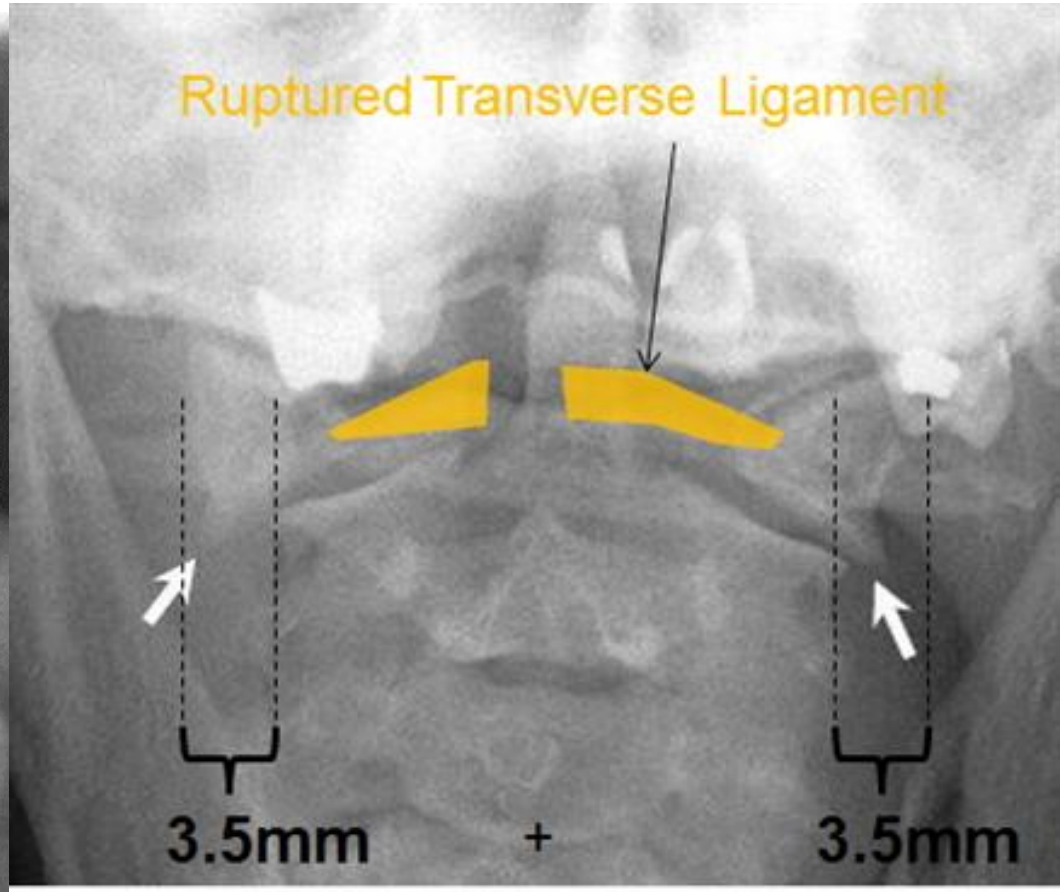
What radiographic parameter may be useful in determining the presence of an occult fracture?

- *Prevertebral soft-tissue swelling often accompanies fractures of the cervical spine.*
- *If there is no obvious evidence of fracture on plain radiographs of the cervical spine, the thickness of prevertebral soft tissues should be assessed.*
- *The prevertebral soft tissues normal limits of thickness by level: C2 =not more than 7 mm;; C6= not more than 22 mm.*
- *If abnormal widening is noted at any area along the anterior cervical spine, occult fracture should be suspected.*

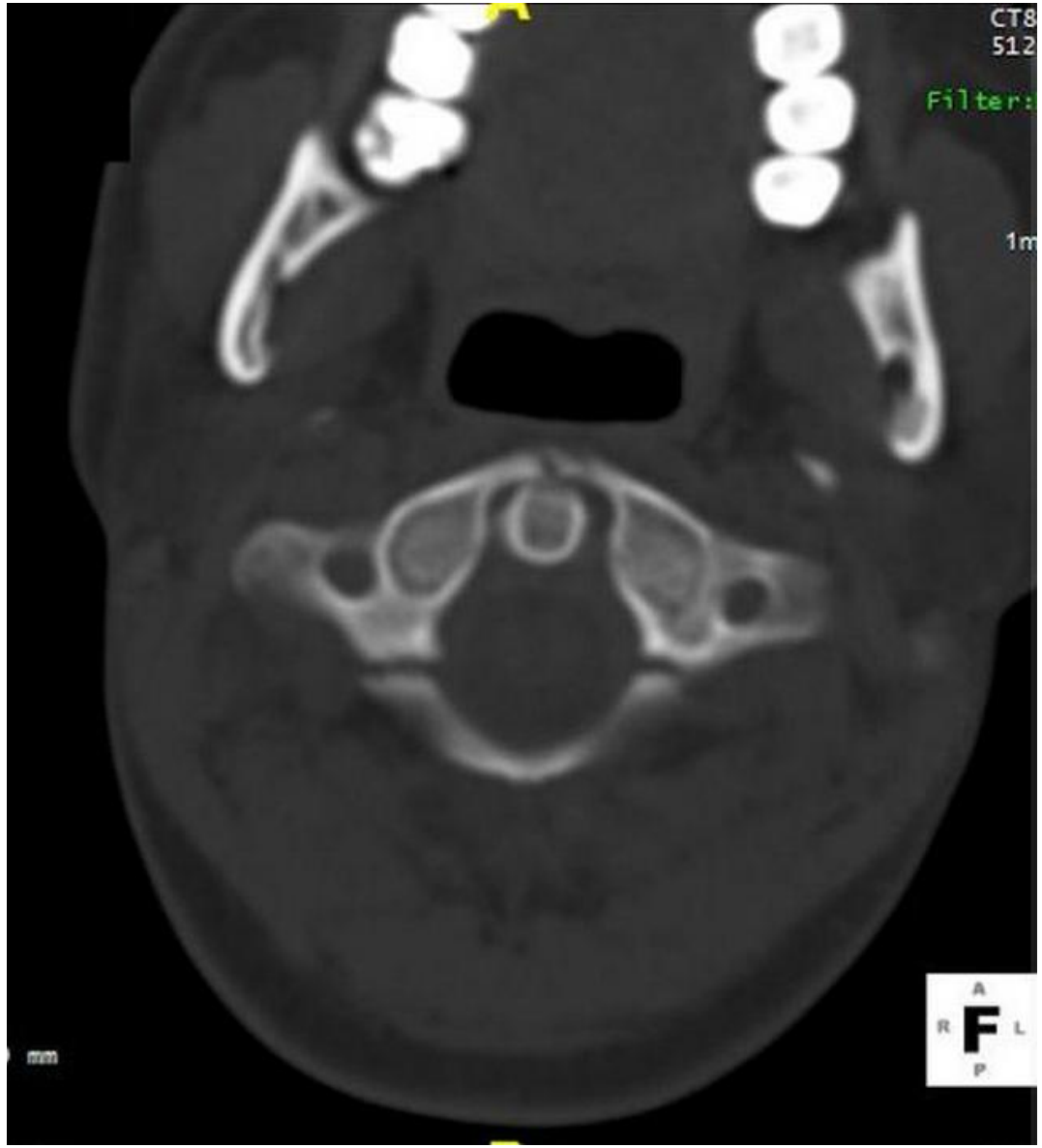
Do you need any more images?

- open-mouth radiograph to asses for lateral mass displacement.
  - Sum of lateral mass displacement >7 mm is associated with transvers ligament rupture
- axial CT scan will show 3 fracture lines in C1 (1 anterior break, and 2 posterior).



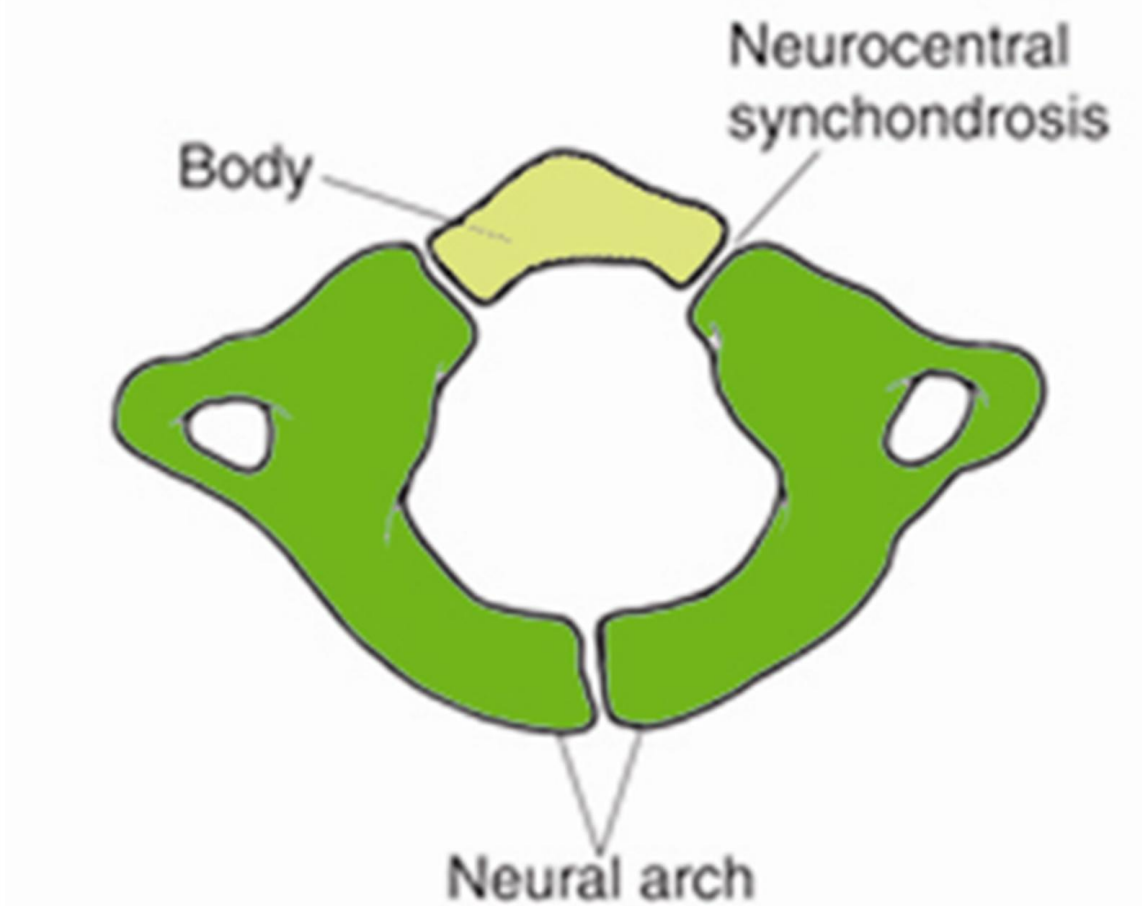


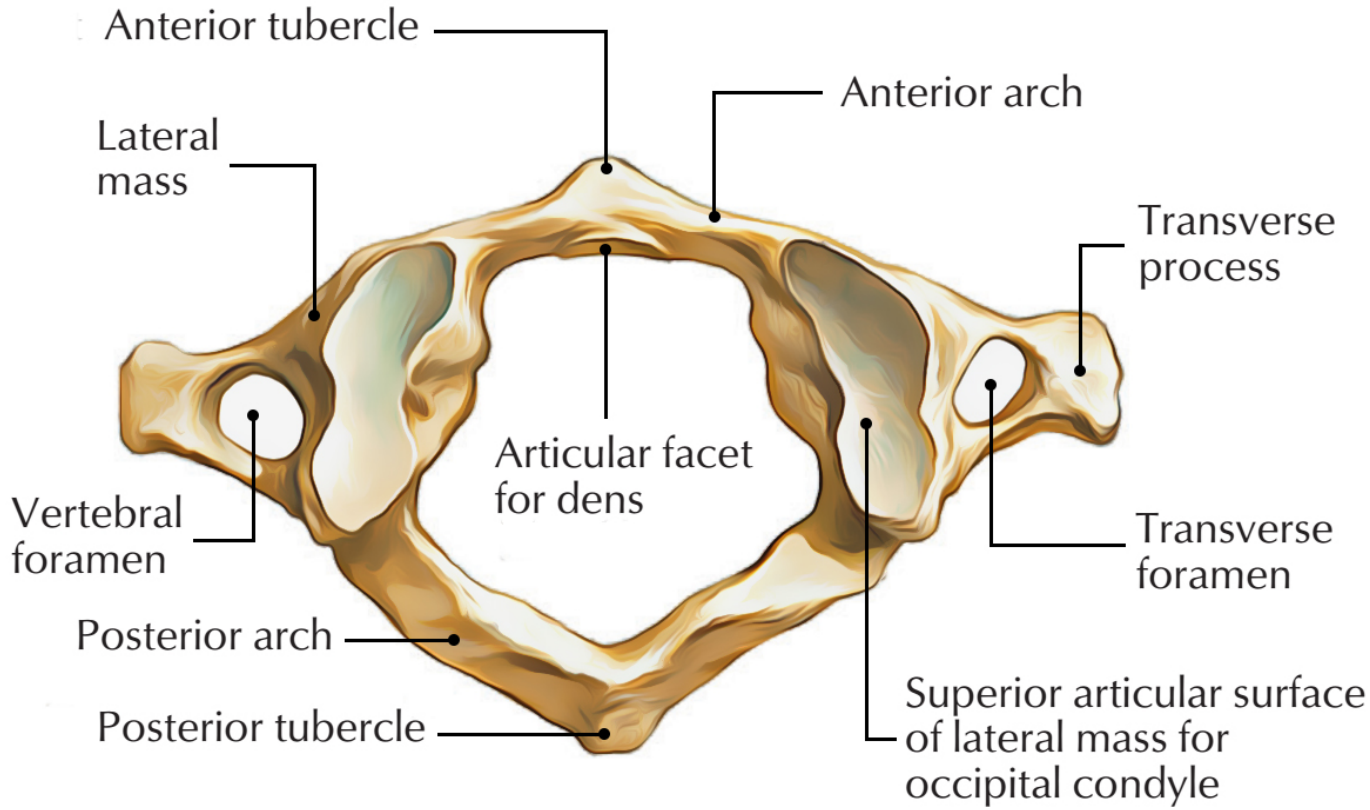
7mm

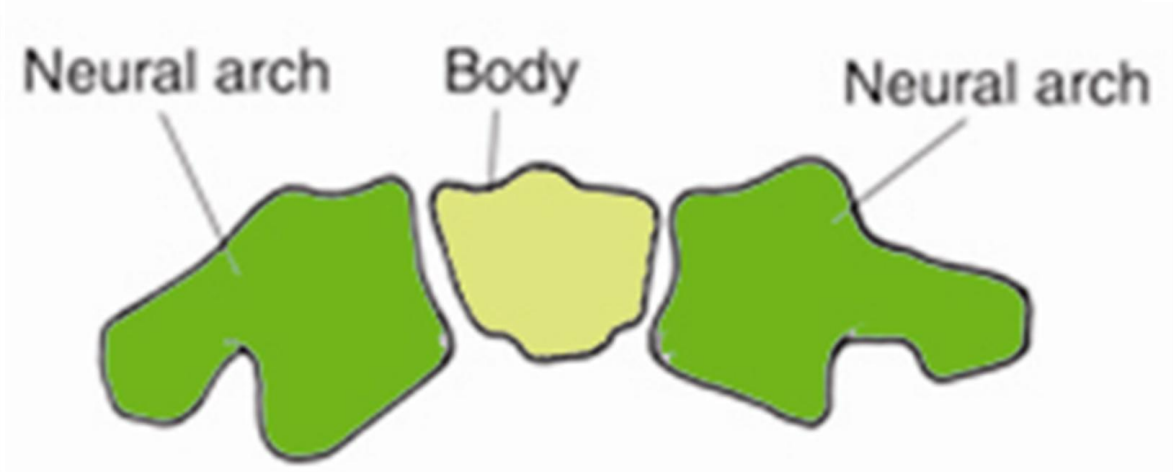

CT8
512
Filter:
1m
A
R
F
L
P

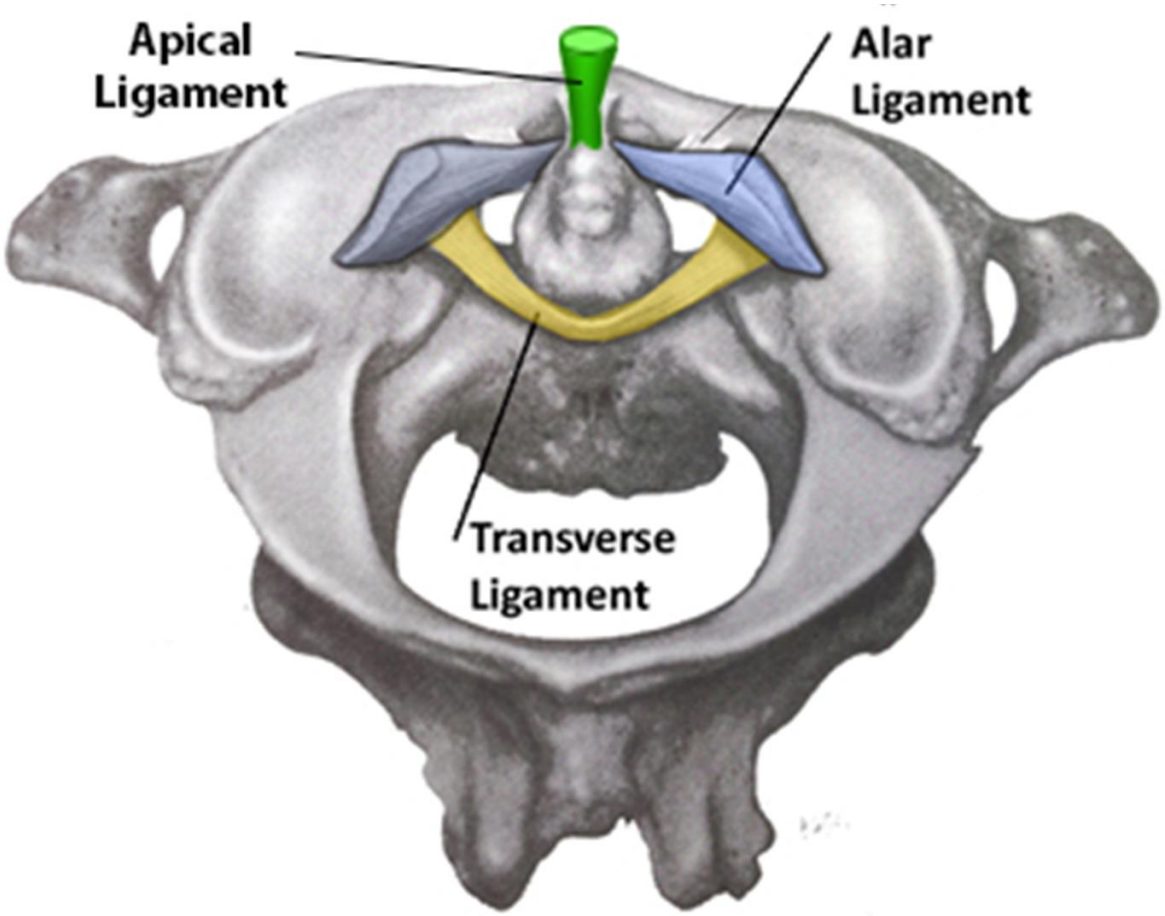
Describe the anatomy of involved structure?

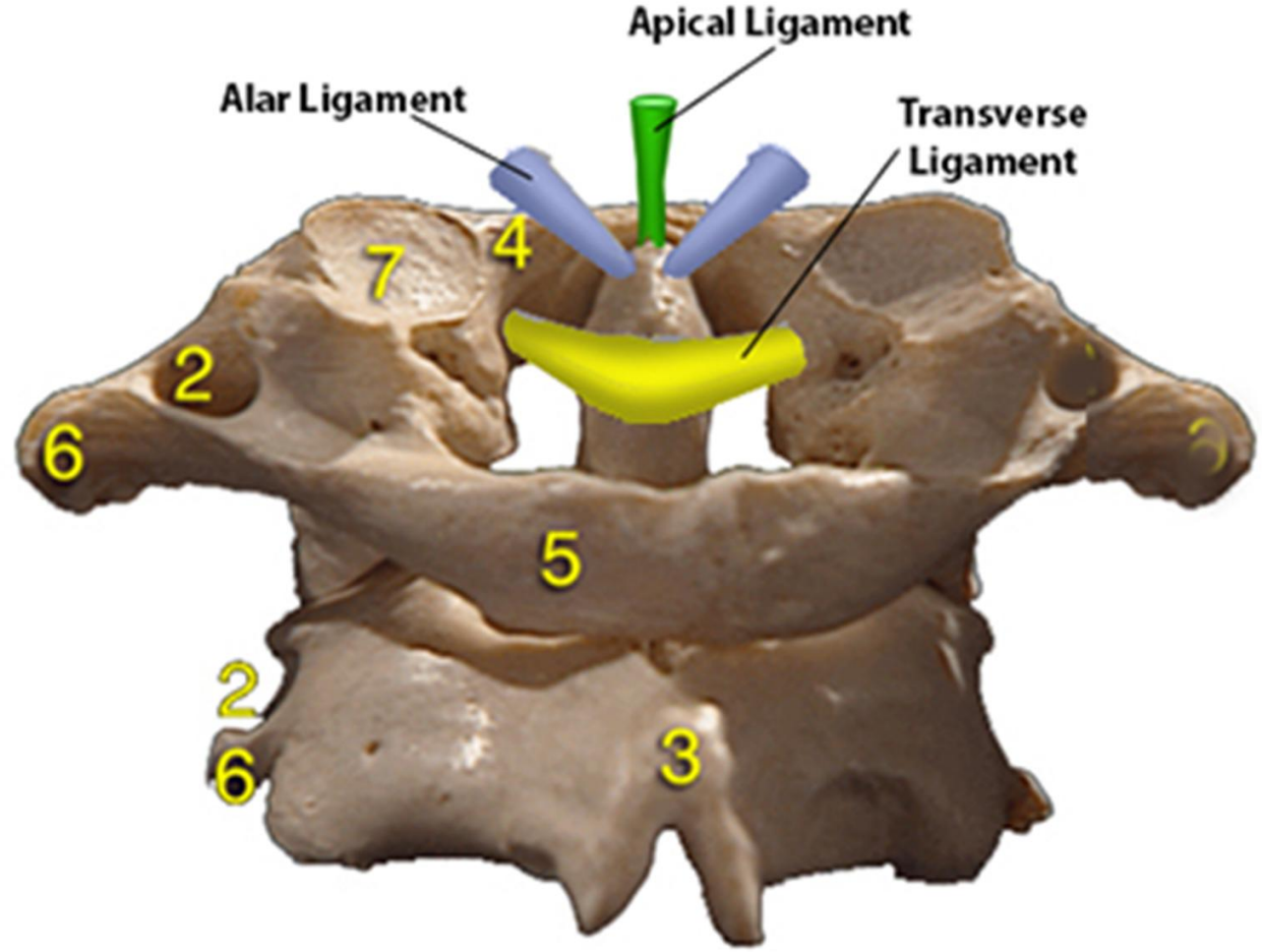
- *Atlas has no body, no spinous process.*
- *It has transverse foramen for vertebral artery.*
- *It has 3 ossification centres, 2 for lateral mass and one for anterior arch.*
- *Anterior arch doesn't appear until the age of 1 year.*
- *Incomplete formation of the posterior arch is a relatively common anatomic variant and does not represent a traumatic injury*
- *Transverse ligament: primary stabilizer, connect posterior odontoid to anterior arch*
- *Paired alar ligament: connect odontoid to occipital condyles*
- *Apical ligament: runs vertical between the odontoid and the foramen magnum*


Neurocentral synchondrosis
Body
Neural arch


Anterior tubercle
Anterior arch
Lateral mass
Transverse process
Articular facet for dens
Vertebral foramen
Transverse foramen
Posterior arch
Posterior tubercle
Superior articular surface of lateral mass for occipital condyle


Neural arch
Body
Neural arch


Apical
Ligament
Alar
Ligament
Transverse
Ligament


Apical Ligament
Alar Ligament
Transverse
Ligament
7
4
2
6
5
2
6
3

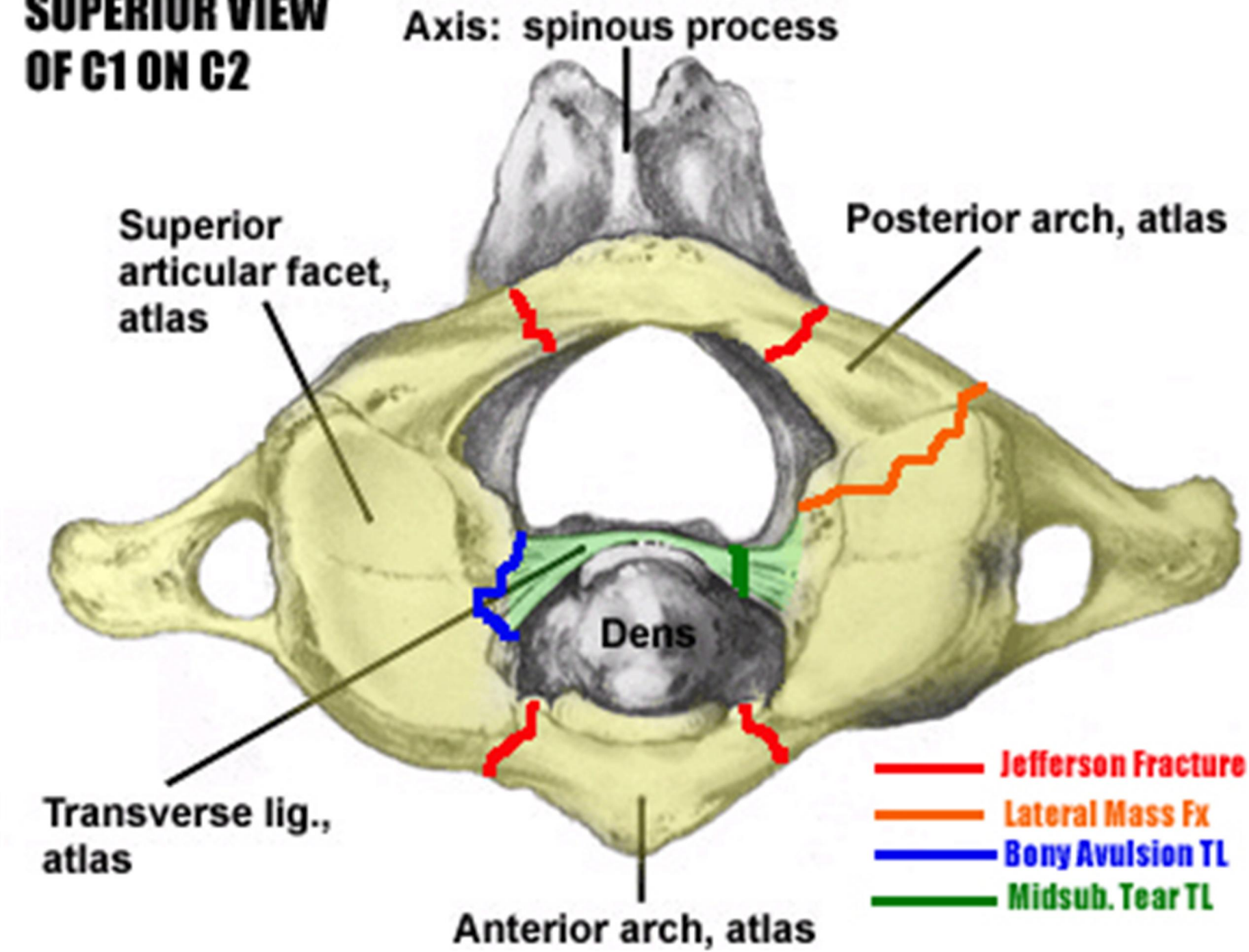
what is mechanism of injury?

- *Hyperextension??* with *lateral compression and axial compression*

Are you aware of any classification system of this injury?

Atlas Fractures Classification	
Type I	Isolated anterior or posterior arch fracture. A "plough fracture is an isolated anterior arch fracture caused by a force driving the odontoid through the anterior arch.
Type II	Jefferson burst fracture with bilateral fractures of anterior and posterior arch resulting from axial load. Stability determined by integrity of transverse ligament.
Type III	Unilateral lateral mass fx. Stability determined by integrity of transverse ligament.

SUPERIOR VIEW OF C1 ON C2



What are the treatment options for this injury?

- *The treatment of Atlas fracture depends mainly on the stability (integrity of transverse ligament).*
- *On the lateral view measure ADI: <3 mm → normal. 3 to 5mm → injury to transverse ligament with intact alar and apical ligament. >5mm → injury to all ligaments.*
- *Stable (intact transverse ligament) → hard cervical orthosis*
- *Unstable (injured transverse ligament → C1-C2 fusion if there is adequate purchase with C1 lateral mass, otherwise → occipito-cervical fusion*

Viva 4

A 70-year-old lady has been referred to your clinic

- What can you see?
- What is the compression ratio?
- What is cervical myelopathy and what are the typical features?
- Are you aware of any classification system?
- How would you treat it?

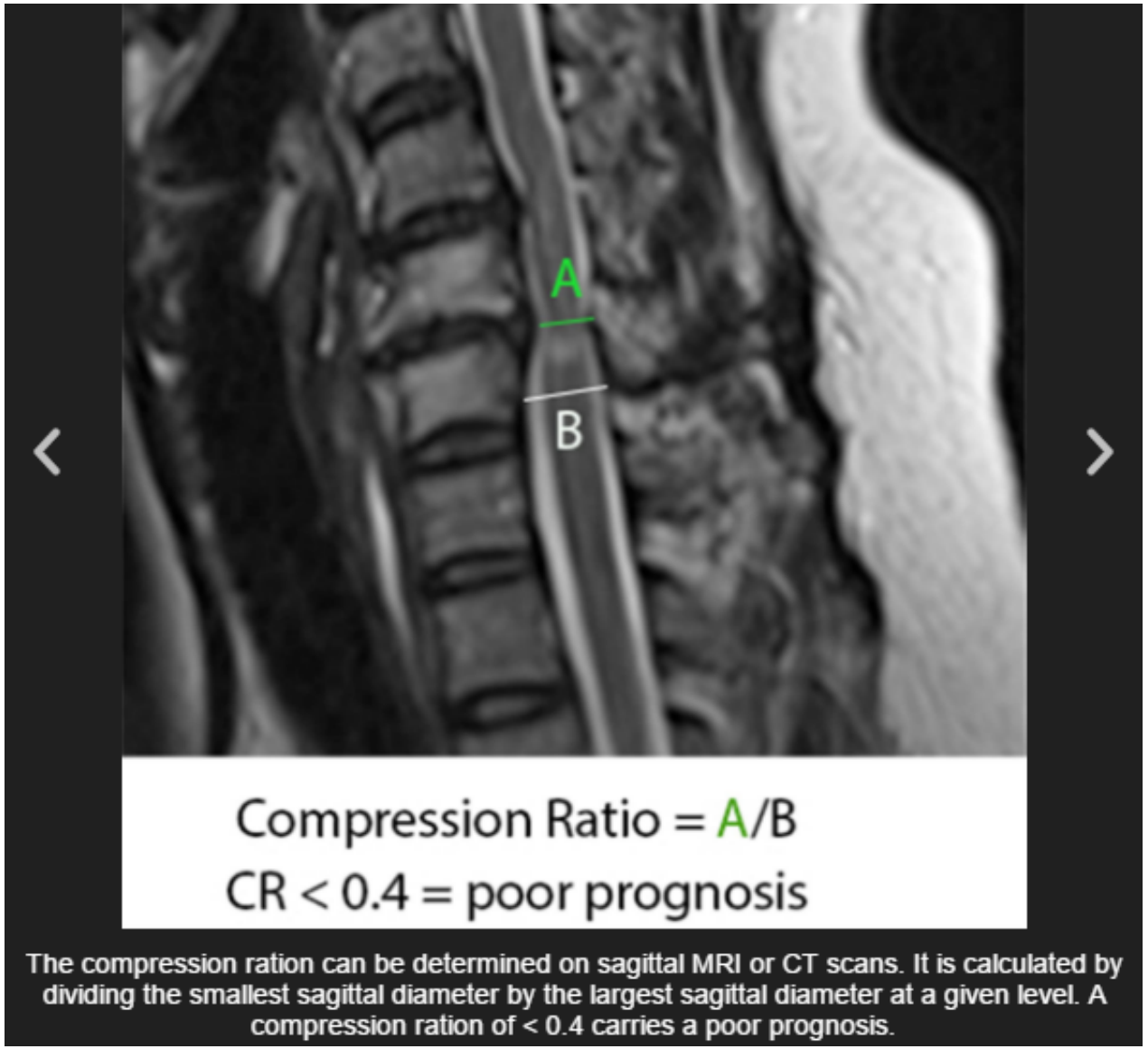
What can you see?

- *This is T2-weighted sagittal MRI image of cervical spine and upper thoracic demonstrating multi level discs degenerative changes noted by reduced height and dark signals with bulging disc mainly at the level of C5/6 with significant cervical stenosis and spinal cord changes*
- *Features are suggestive of cervical myelopathy.*

What is the compression ratio?

Compression ratio:

- The smallest sagittal diameter divided on the largest diameter at a given level
- Ratio<0.4 poor prognosis



The compression ration can be determined on sagittal MRI or CT scans. It is calculated by dividing the smallest sagittal diameter by the largest sagittal diameter at a given level. A compression ration of < 0.4 carries a poor prognosis.

What is cervical myelopathy and what are the typical features?

- *A clinical syndrome caused by compression on the spinal cord that characterized by upper motor neuron signs and symptoms in both upper and lower limbs.*

❖ *History*

- *Neck pain (axial) and stiffness*
- *Weakness and clumsiness.*
- *decreased coordination & loss of fine dexterity (e.g. buttoning a shirt, handwriting, manipulating small objects, dropping objects).*
- *balance and gait problems, may lead to patients complaining of frequent trips, falls or bumping into things*
- *problems with bowel and bladder function.*
- *Typically symptoms follow a slow, progressive course deteriorating in a stepwise manner with stable periods and periods of rapid deterioration.*

What is cervical myelopathy and what are the typical features?

❖ *Physical exam*

- *Associated (upper motor neurone) signs include: a wide based unsteady gait*
- *Difficulty in toe to heel walk (tandem gait)*
- *Romberg test: patient stands with arms held forward and eyes closed, loss of balance consistent with posterior column dysfunction*
- *upper and lower limb weakness*
- *Finger escape sign, when patient holds fingers extended and adducted, the small finger spontaneously abducts due to weakness of intrinsic muscle*
- *Grip and release test: normally a patient can make a fist and release 20 times in 10 seconds. myelopathic patients may struggle to do this*

What is cervical myelopathy and what are the typical features?

❖*Physical exam*

- *inverted brachioradialis reflex: tapping distal brachioradialis tendon produces ipsilateral finger flexion*
- *Hoffman sign: snapping patients distal phalanx of middle finger leads to spontaneous flexion of other fingers*
- *Hyper tonia-hyper-reflexia, intrinsic muscle wasting in the hand*
- *positive Babinski*
- *Sustained clonus (involuntary and rhythmic muscle contractions caused by a permanent lesion in descending motor neurons)*
- *Sensory: proprioception due to dorsal column dysfunction- pinprick testing should be done to look for global decrease in sensation or dermatomal changes due to involvement of lateral spinothalamic tract*
- *Lhermitte sign: test is positive when extreme cervical flexion leads to electric shock-like sensations that radiate down the spine and into the extremities.*

Are you aware of any classification system?

Nurick Classification	
Grade 0	Root symptoms only or normal
Grade 1	Signs of cord compression; normal gait
Grade 2	Gait difficulties but fully employed
Grade 3	Gait difficulties prevent employment, walks unassisted
Grade 4	Unable to walk without assistance
Grade 5	Wheelchair or bedbound
Based on gait and ambulatory function	

How would you treat it?

- *Depends mainly on functional impairment*
- *If there is no or mild functional impairment(gait) → conservative:*
  - *medications (NSAIDs-gabapentin)*
  - *immobilization (hard collar in slight flexion)*
  - *physical therapy for neck strengthening, balance, and gait training*
  - *Activity/lifestyle modification*
- *Close follow up for progression*

How would you treat it?

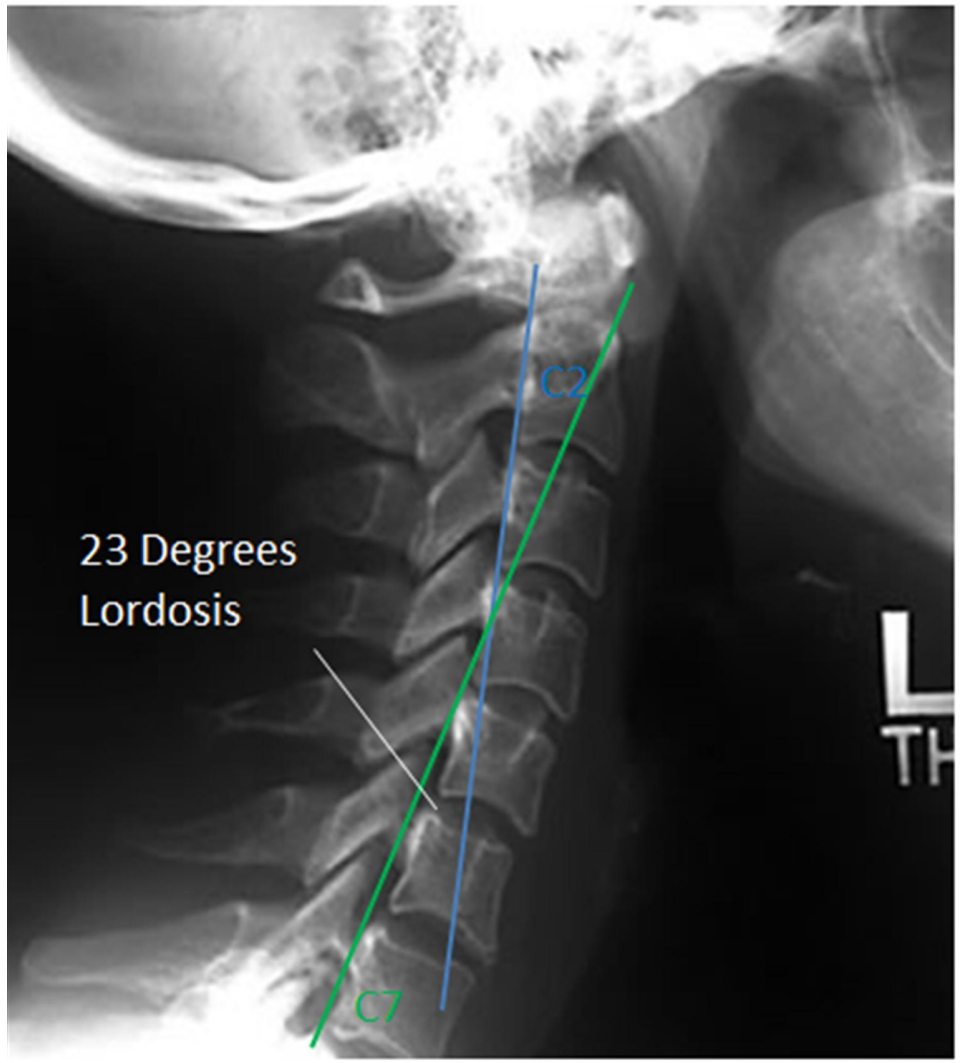
❖*Surgical treatment*

- *Goals: decompression-restoration of lordosis-stabilization and prevent progression.*
- *Things to be consider: number of stenotic levels-kyphotic angle(C2-C7 angle)*
- *Options: ACDF-laminectomy with posterior fusion-combination of anterior & posterior surgery*

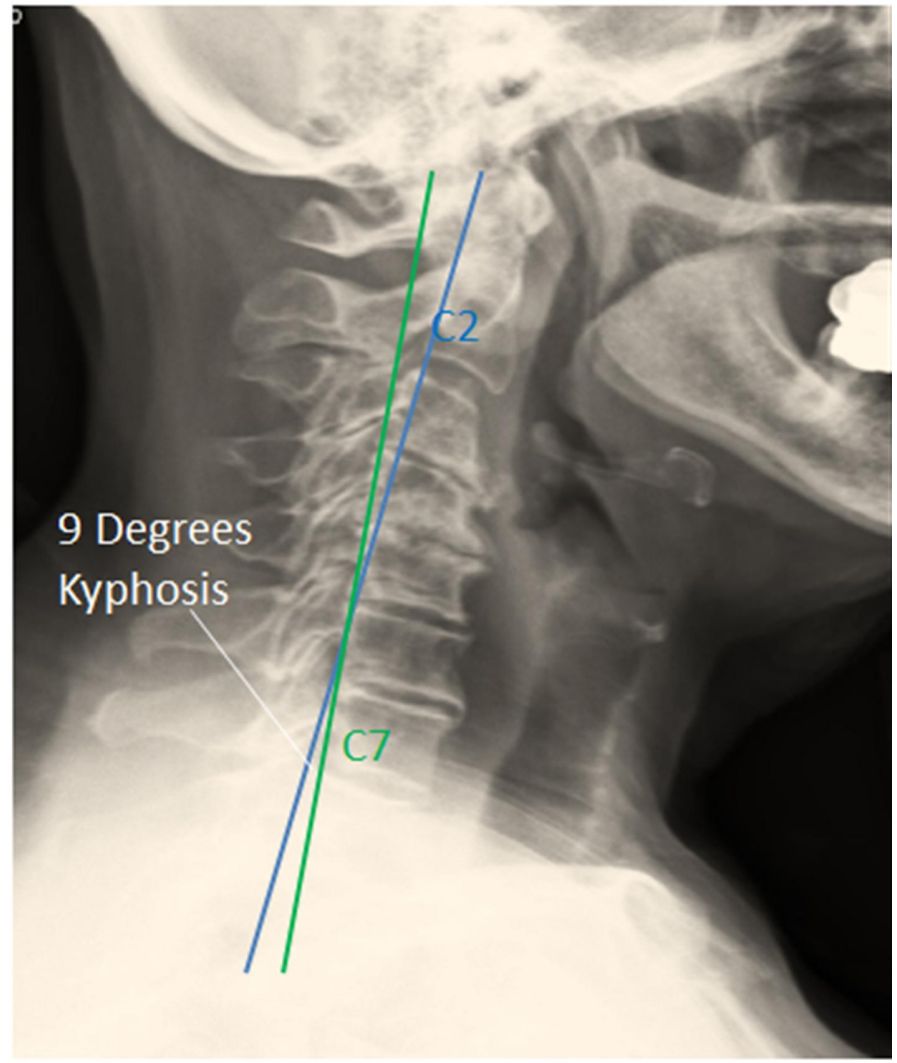
Simplified Treatment Algorithm for CSM

	1 or 2 levels of compression	3+ levels of compression
> 10 rigid Kyphosis	3 **Anterior alone (ACDF/corpectomy /hybrid)**	5 **Combined AnteroPosterior** **•Anterior to correct kyphosis/decompress** **•Posterior to Decompress**
< 10 rigid kyphosis		4 **Posterior alone** **Laminoplasty** **vs** **Laminectomy + Fusion**

Lordotic C2-C7 Angle



Kyphotic C2-C7 Angle



Cervical Spine Sagittal Alignment (C2-C7 Angle)

Viva 5

- Name this device
- What are the indications and contraindications?
- Describe the technique to apply it

Name this device

- *A halo vest is an external fixation device that encircles the head and provides traction, external support, and immobilization of the cervical spine.*
- *It is ideal to control motion in the upper cervical (occipitocervical and atlano-axial)*

What are the indications and contraindications?

❖ ***Indications***

- *Occipital condyle fractures*
- *Occipito-cervical dislocation*
- *Stable atlas fracture*
- *Stable odontoid fracture*
- *Type II & IIA Hangman's fracture.*

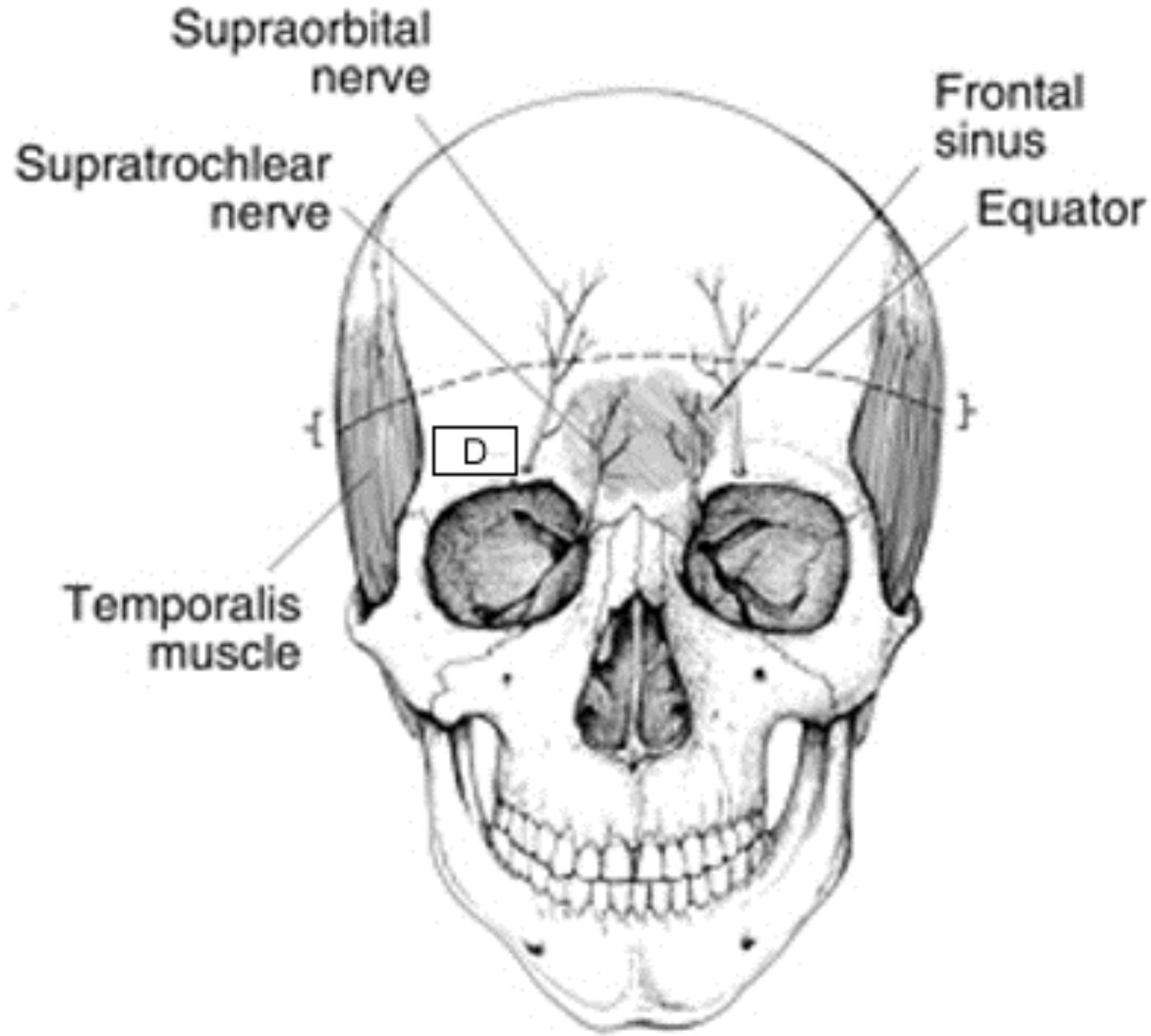
❖ ***Contraindications***

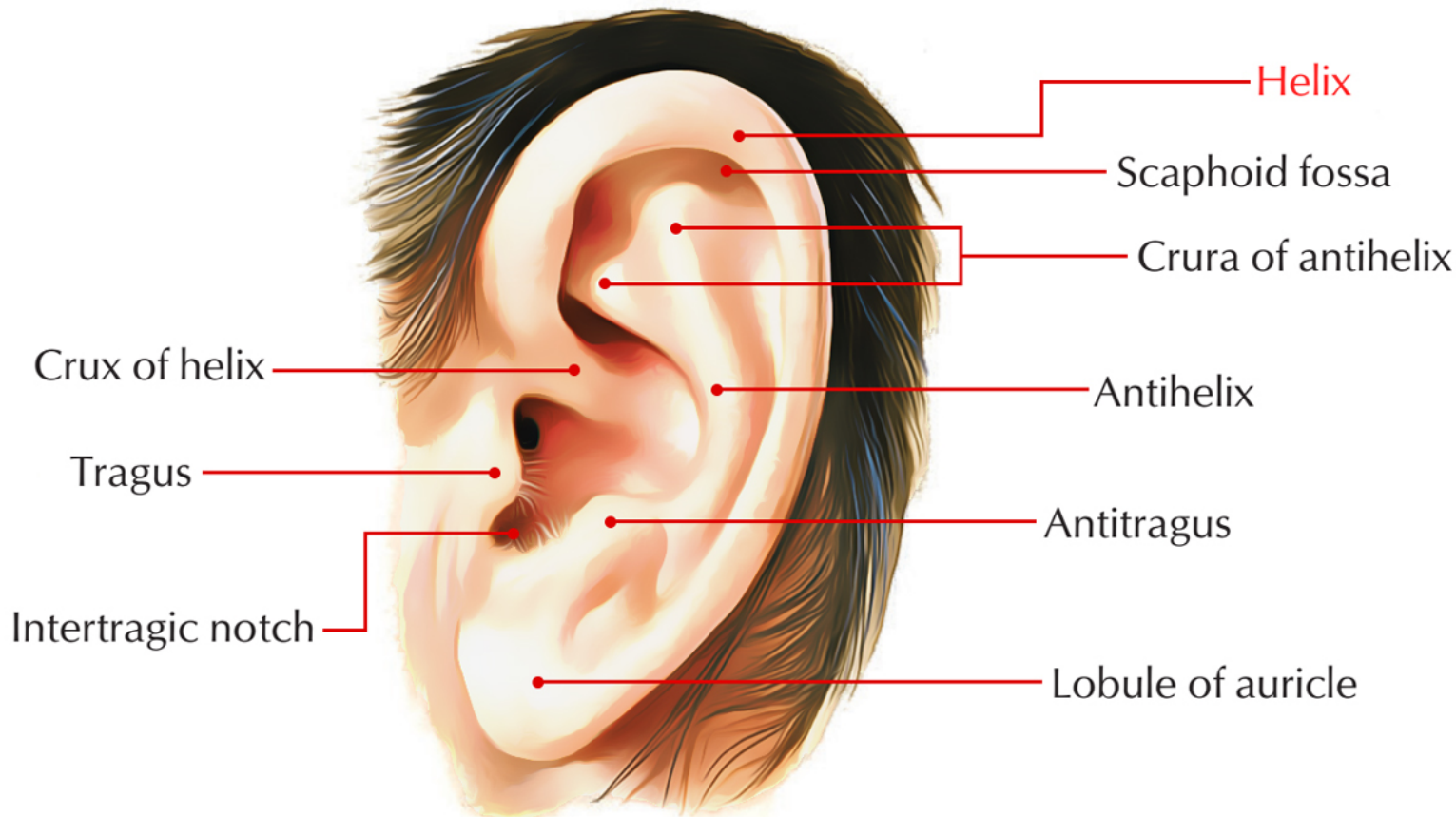
- *Cranial fractures*
- *Advanced age (high morbidity rate)*

Describe the technique to apply it

- *Two anterior pins*
  - *to be placed 1cm above the lateral 1/3 of eyebrow and below the equator of the skull.*
  - *Medial placement is associated with risk of injury to supraorbital and supratrochlear nerves.*
  - *Lateral placement is associated with risk of penetration of the temporal bone and can interfere with the muscles of mastication.*
- *Posterior pins*
  - *should be placed 1cm superior and posterior to the ear helix on the opposite site of the ring from anterior pins.*

- *Tighten to 8 inch-pound of torque in adult total 4 pins*
- *Tighten to 2-4 inch-pound of torque(finger tight) in paediatrics 6-8 pins*


Supraorbital nerve
Supratrochlear nerve
Frontal sinus
Equator
D
Temporalis muscle


Helix
Scaphoid fossa
Crura of antihelix
Crux of helix
Antihelix
Tragus
Antitragus
Intertragic notch
Lobule of auricle

Viva 7

- What do you see?
- What is the pathophysiology of spinal cord injury?
- How can you differentiate between complete and incomplete spinal cord injury?
- What is sacral sparing?
- What are the different types of incomplete spinal cord injury?
- How is neurogenic shock differentiated from spinal and hypovolemic shock?
- How is dislocated facets differentiated from normal facets in CT (Axial view)?
- What is ASIA classification?
- How do you treat it?

What do you see?

- *This is a T2-weighted sagittal MRI scan demonstrating Grade 2 spondylolisthesis of C6 upon C7 with large disc protrusion. There is spinal cord compression with signal changes and oedema, from C6 to T1*

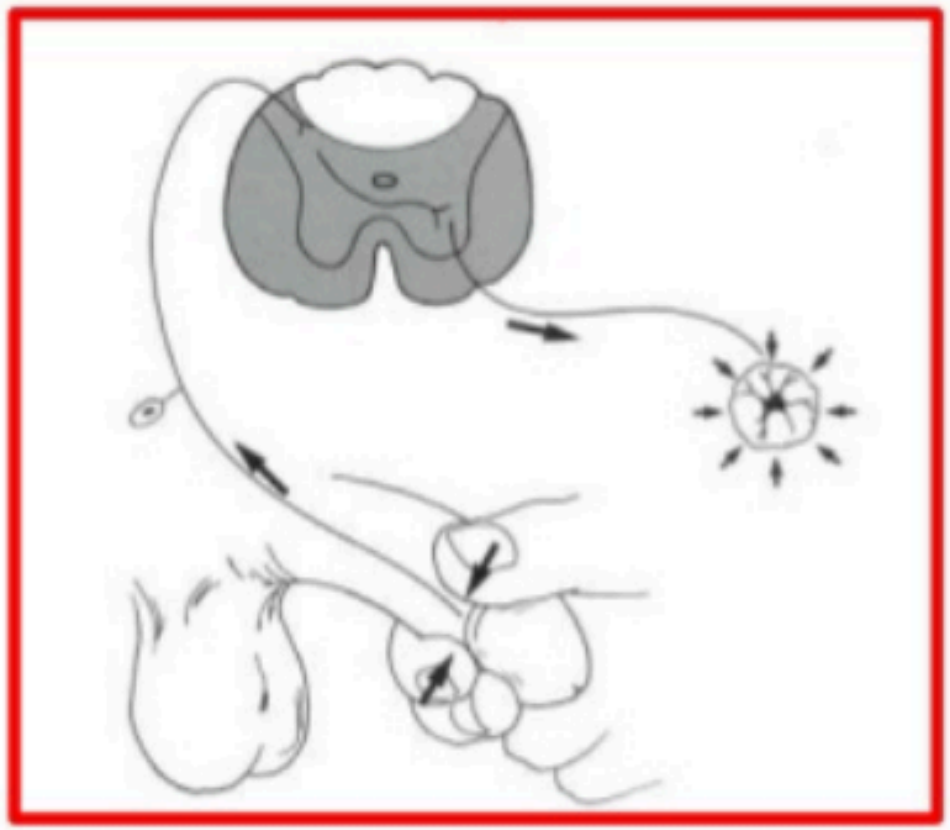
What is the pathophysiology of spinal cord injury?

- *Primary injury: damage to neural tissue due to direct trauma- it is irreversible.*
- *Secondary injury: damage to adjacent tissue due to ↓ perfusion- lipid peroxidation-free radicals (methylprednisolone prevents secondary injury)*

How can you differentiate between complete and incomplete spinal cord injury?

- *A complete spinal cord injury*
  - *Complete motor and sensory loss distal to the level of the injury.*
  - *diagnosis cannot be made until spinal shock is over. This is seen with the return of the bulbocavernosus reflex. If the bulbocavernosus reflex is positive but no sacral sensation or motor function has returned, the paralysis is complete.*
- *In an incomplete spinal cord injury some motor or sensory function is spared distal to the level of the injury.*
- *(absence of bulbocavernosus reflex is indicative that the patient is in spinal shock)*

Bulbocavernosus reflex



- Pull glans or press clitoris → anal contraction (int. sphincter) around gloved finger
- Absence is indicator of spinal shock

What is sacral sparing?

- *Sacral sparing is evident by presence of perianal sensation, rectal motor function, and great toe flexor activity.*
- *Sacral sparing means an incomplete spinal cord injury is present.*

What are the different types of incomplete spinal cord injury?

- *Several types of incomplete spinal cord syndromes have been identified:*

➢ *Central cord syndrome.*

- ➢ *The most common type,*
- ➢ *involves destruction of the central area of spinal cord due to hyperextension injury in older patients.*
- ➢ *weakness of the upper extremities more than the lower extremities. Because arm tracts are located in the centre portion of the spinal cord*
- ➢ *Sensation :burning, neuropathic pain in the distal upper extremities.*
- ➢ *good prognosis although full functional recovery rare.*
- ➢ *lower extremity recovers first → bowel and bladder function next → proximal upper extremity next → hand function last to recover*

What are the different types of incomplete spinal cord injury?

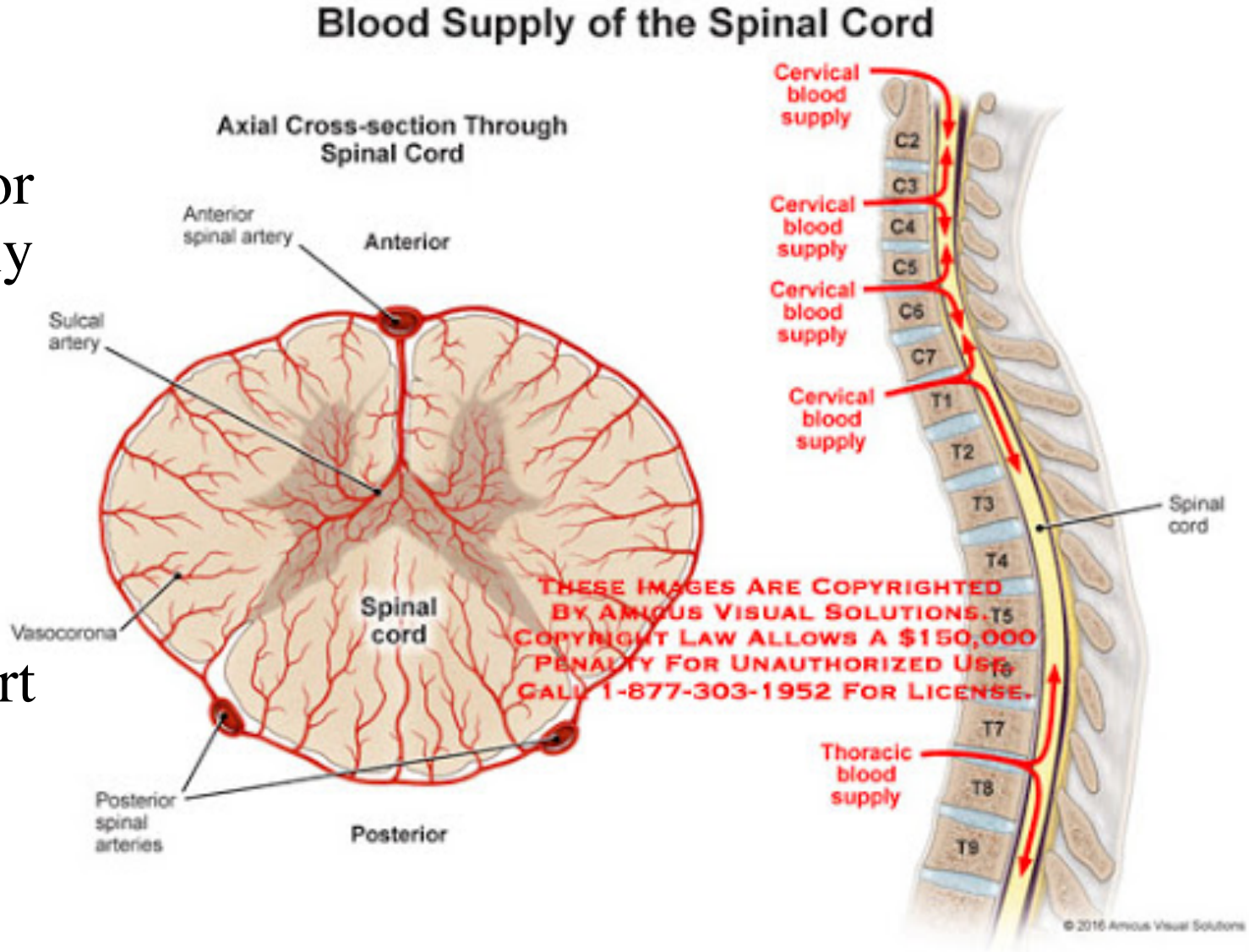
- *Several types of incomplete spinal cord syndromes have been identified:*
- *Brown-Séquard syndrome*
  - *spinal cord hemisection.*
  - *due to penetrating injury, but also can result from a lamina or pedicle fracture.*
  - *ipsilateral loss of motor and sensation with contralateral loss of pain and temperature sensation.*
  - *has best prognosis; neurologic improvement often is significant. (spinothalamic tracts cross at spinal cord level (classically 2-levels below).*

What are the different types of incomplete spinal cord injury?

- *Several types of incomplete spinal cord syndromes have been identified:*
- *Anterior cord syndrome*
  - *complete motor loss and loss of pain and temperature discrimination distal to the level of injury. Posterior columns, including deep-touch and vibratory sensation, are spared.*
  - *caused by a hyperflexion injury in which bone compresses the anterior spinal artery and cord.*
  - *worst prognosis*

What is the blood supply to the spinal cord?

- The main blood supply to the spinal cord is via a single anterior spinal artery (ASA) which supply 2/3 of the spinal cord and two posterior spinal arteries (PSA) supply 1/3 of the spinal cord.
- The anterior spinal artery is formed by the vertebral arteries which originate from the first part of the subclavian artery.

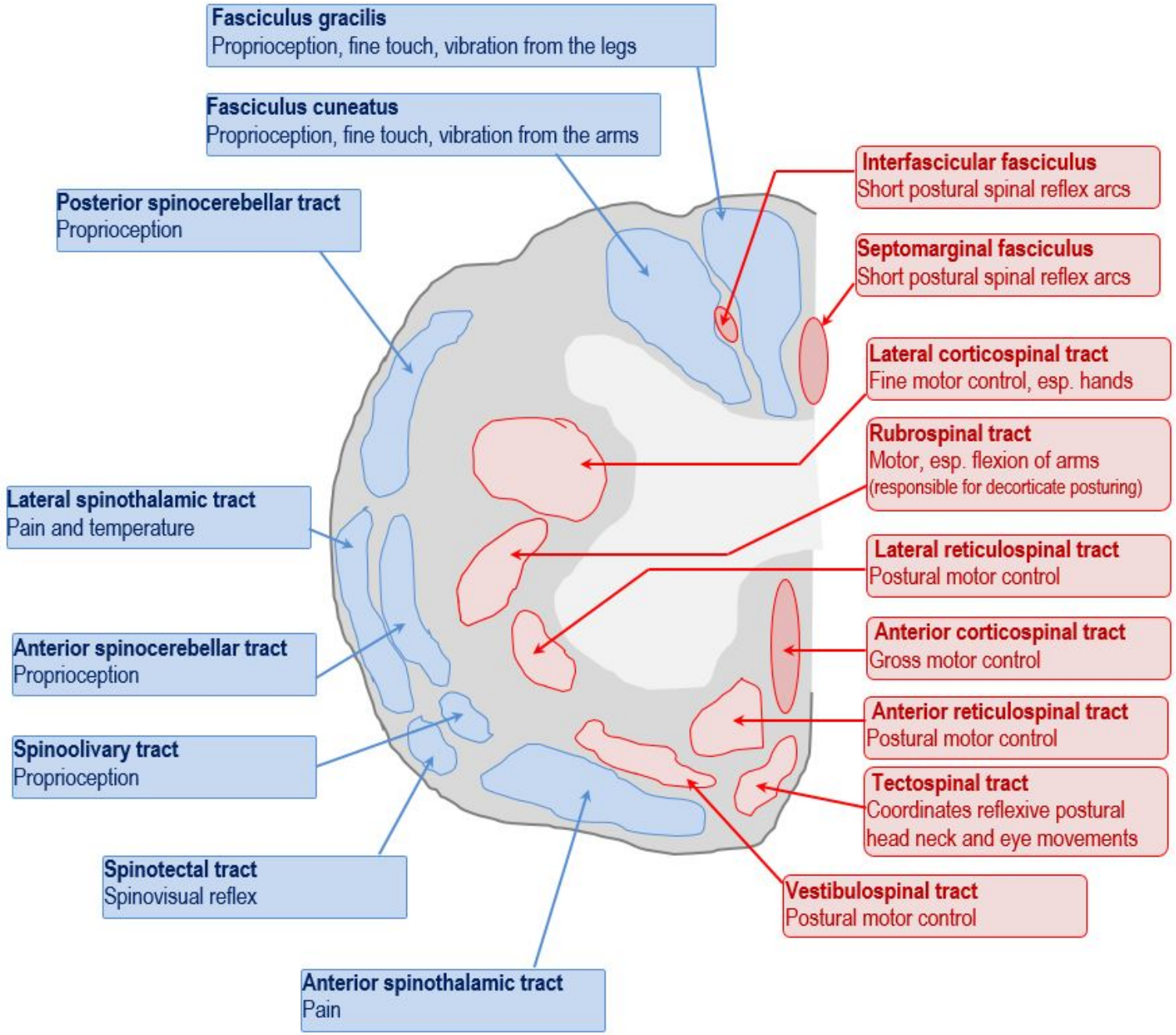


What are the different types of incomplete spinal cord injury?

- *Several types of incomplete spinal cord syndromes have been identified:*
- *Posterior cord syndrome*
  - *loss of proprioceptive vibratory sense with sparing of sensory and motor function. This syndrome is rare*

The Tracts of the Spinal Cord

Ascending tracts in blue, decending tracts in red.



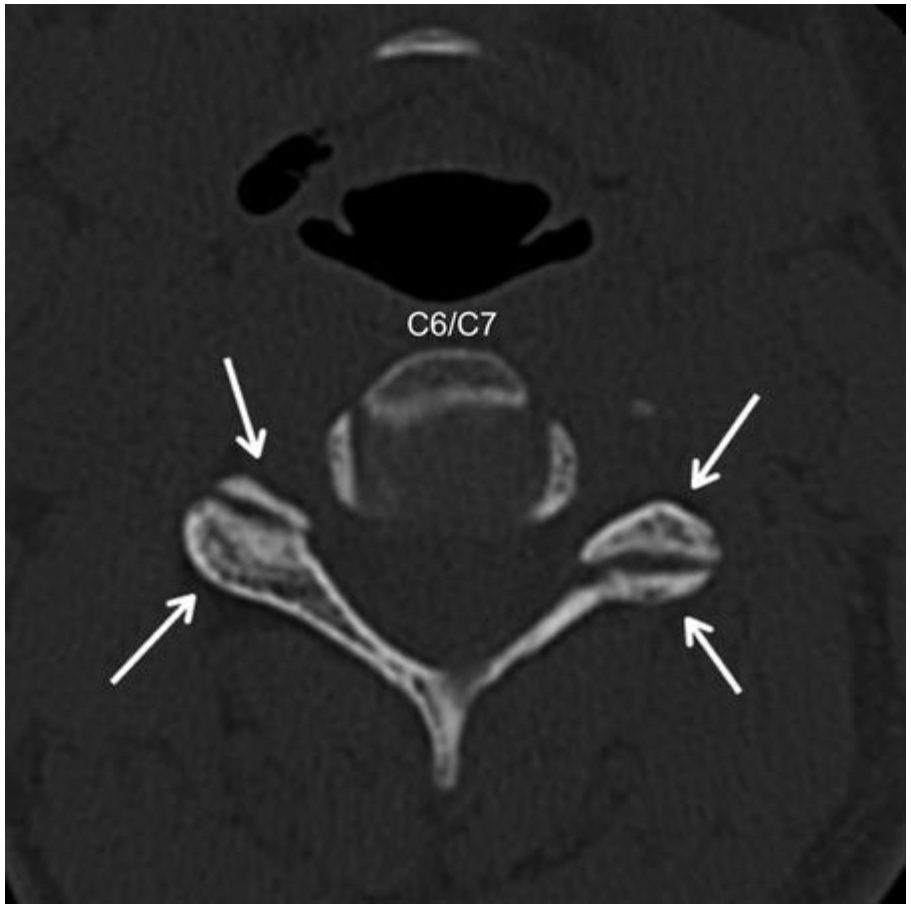
How is neurogenic shock differentiated from spinal and hypovolemic shock?

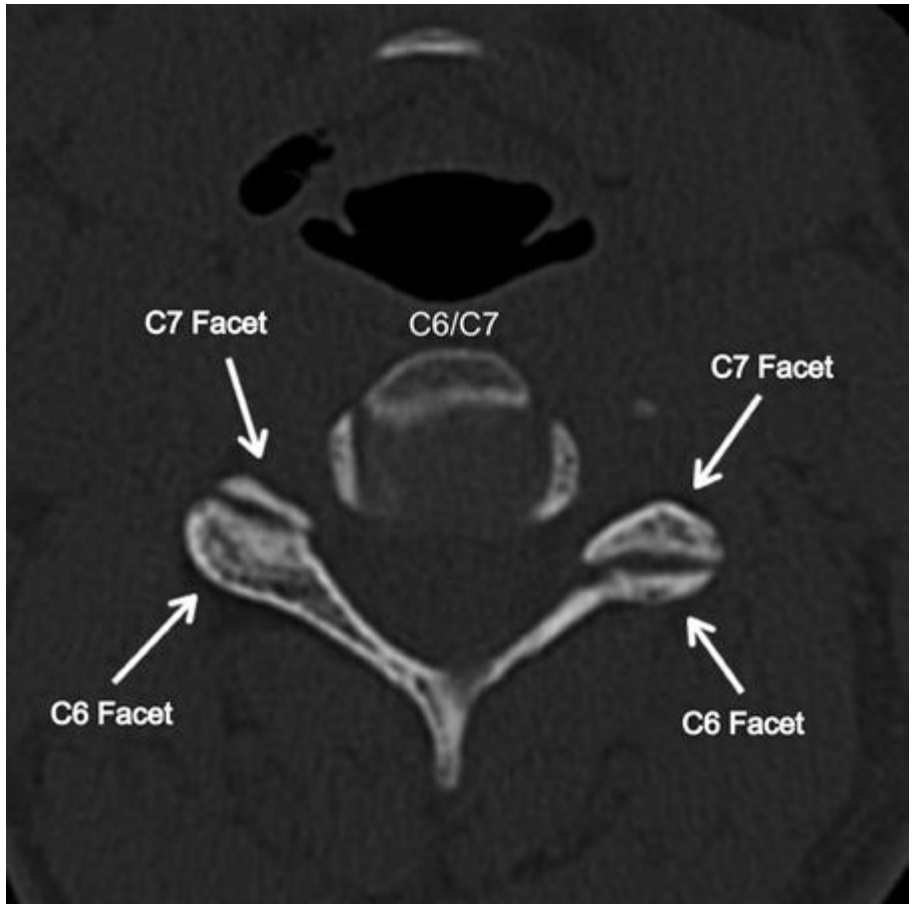
- ***Neurogenic shock**: hypotension + bradycardia due to disruption of autonomic pathway within the spinal cord. The diagnosis of neurogenic shock cannot be made until spinal shock has been ruled out.*
- ***Spinal shock**: temporary loss of spinal cord function and reflex activity. Characterized by: 1) absent bulbocavernous reflex (anal sphincter contraction in response to squeezing of glans penis or togging in foley's catheter). 2)Flaccid areflexic paralysis. 3)hypotension & bradycardia due to loss of sympathetic tone. Usually resolves within 24 hours.*
- ***Hypovolemic shock**: hypotension with tachycardia (sympathetic response).*

How is dislocated facets differentiated from normal facets in CT (Axial view)?

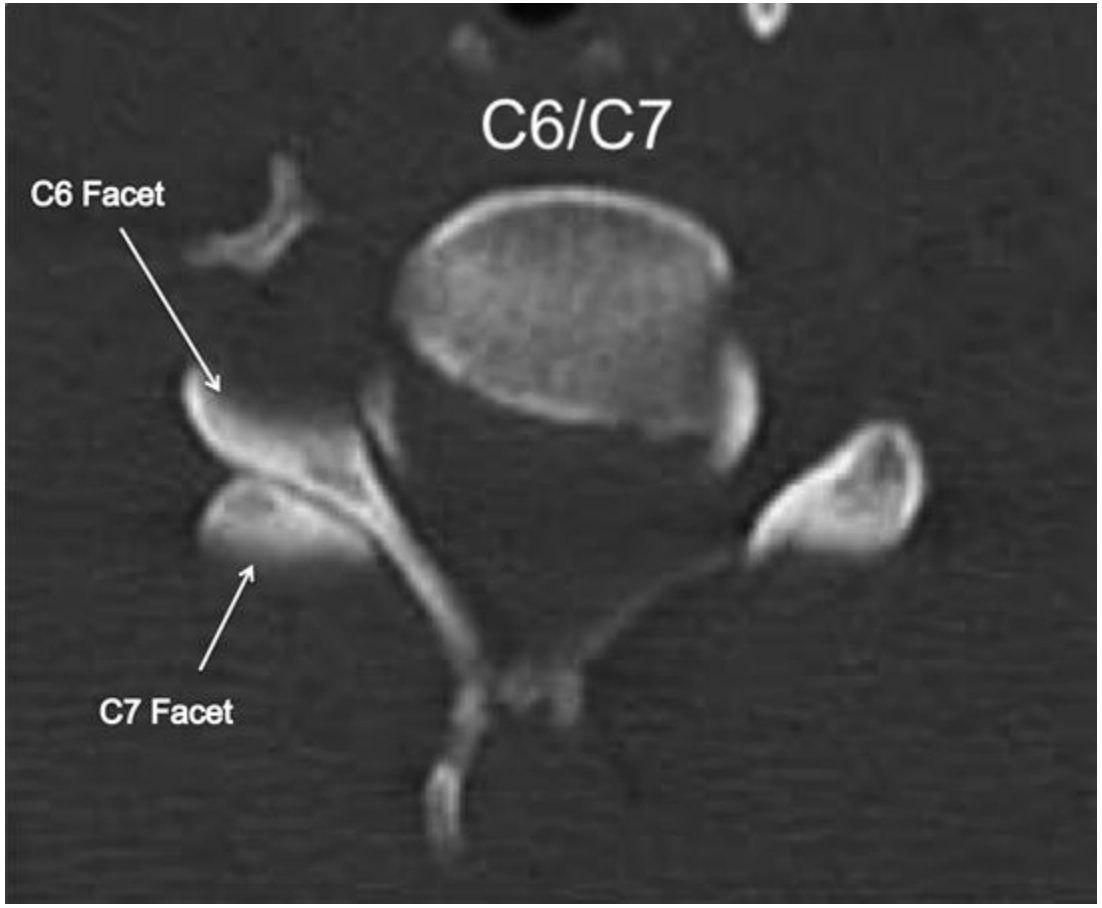
- ***Normal facets****: will appear as Hamburger sign*
- ***Bilateral facets dislocation****: reverse Hamburger sign*
- ***Unilateral facet dislocation****: bow-tie sign.*

Normal facets

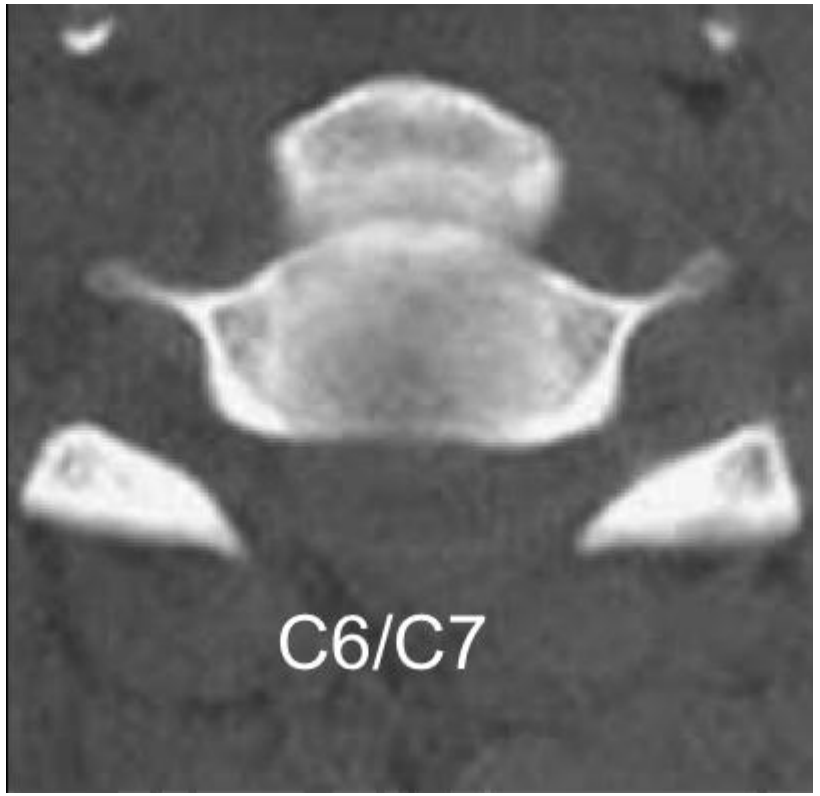




Unilateral facet dislocation



Bilateral facets dislocation



What is ASIA classification?

- *1- Check if the patient in spinal shock by checking bulbocavernous reflex*
- *2- Determine the level of neurological injury. It is the lowest segment with intact sensation and power ≥3.*
- *3-Determine whether the injury is complete or incomplete*

ASIA Impairment Scale		
A	Complete	No motor or sensory function is preserved in the sacral segments S4-S5.
B	Incomplete	Sensory function preserved but not motor function is preserved below the neurological level and includes the sacral segments S4-S5.
C	Incomplete	Motor function is preserved below the neurological level, and more than half of key muscles below the neurological level have a muscle grade less than 3.
D	Incomplete	Motor function is preserved below the neurological level, and at least half of key muscles below the neurological level have a muscle grade of 3 or more.
E	Normal	Motor and sensory function are normal.

How do you treat it?

❖***Spinal cord injury***

- ***High dose of methylpredinslone*** *:*

➢*Controversy*

➢*Indications: non-penetrating spinal cord injury within 8 hours.*

➢*Contraindications: GSW-pregnancy-children->8 hours injury*

➢*Technique: 30mg/kg over the 1st hour then followed by 5.7mg/kg for 23 hours if started < 3hours after injury- for 47 hours if started after 3 to 8 hours from injury.*

➢*Outcomes: leads to improve root function at the level of injury- may or may not improve the spinal cord function*

How do you treat it?

❖ ***Facet dislocation***

- ***Immediate closed reduction followed by MRI then surgical stabilization****:*

➢ *Indicated in facets dislocation with or without neurological deficit in AWAKE patient.*

➢ *Surgical stabilization: PSF in the absence of disc herniation- ACDF in disc herniation*

How do you treat it?

❖ ***Facet dislocation***

- ***Immediate MRI then open reduction and surgical stabilization****:*

➢ *Indicated in facets dislocation with or without neurological deficit in patients with altered mental status or failed closed reduction or neurological deterioration during closed reduction*

Viva 8

- How many vertebrae make up the cervical spine?
- Describe the orientation of articular facets in cervical spine?
- What is the normal canal diameter in C.spine?
- Which vertebrae are responsible for flexion-extension? rotation? lateral bending?

How many vertebrae make up the cervical spine?

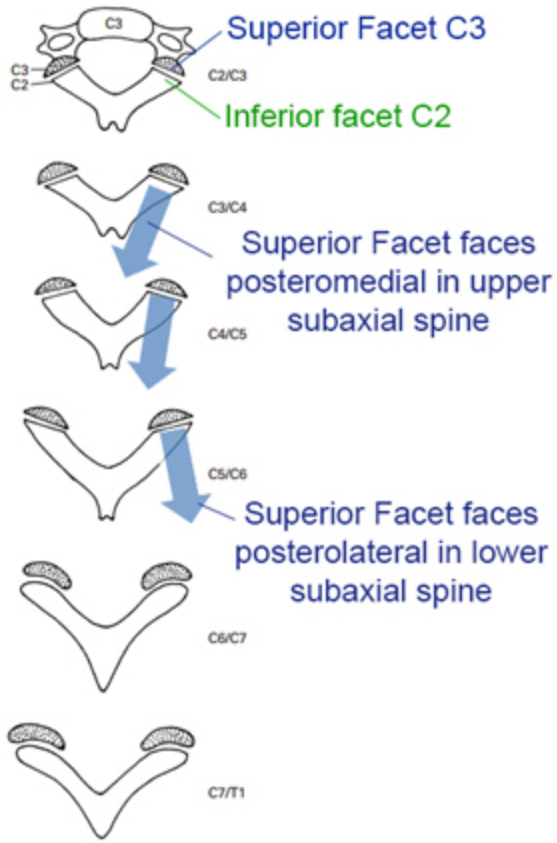
- *The cervical spine consists of the first seven vertebrae of the spinal column. C1(Atlas)-C2(Axis)-C3-C7(Subaxial)*
- *All have a transverse foramen, vertebral artery travels through transverse foramen of C1 to C6, it doesn't travel through C7 transverse foramen. It contains the vein & sympathetic nerve.*
- *C1 has no spinous process and no body*
- *C2-C6 have bifid spinous process*
- *C7 has nonbifid spinous process.*
- *there is no C8 vertebral body although there is a C8 nerve root*

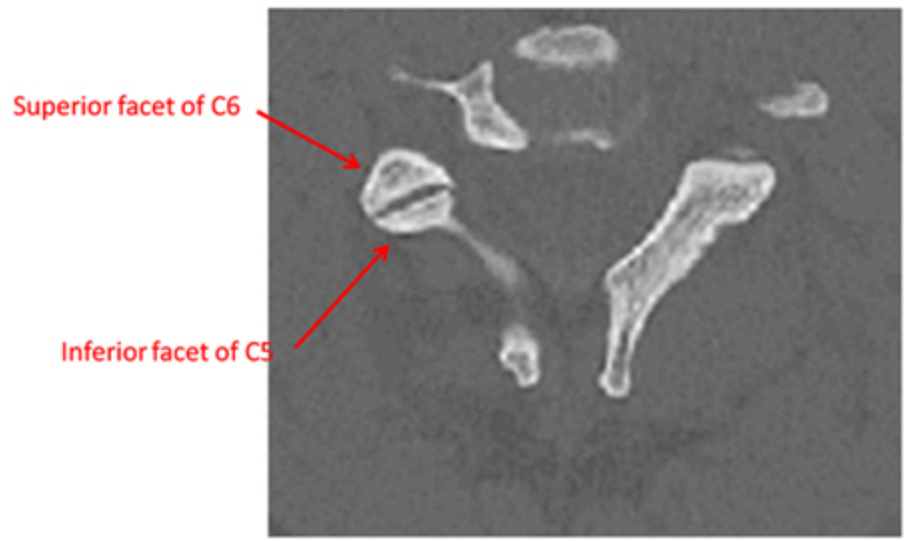
Describe the orientation of articular facets in cervical spine?

- *The superior articular facets of the subaxial cervical spine (C3-C7) are oriented in a posteromedial direction at C3 and posterolateral direction at C7, with a variable transition between these levels (as it goes caudally, it is shifted to posterolateral orientation)*
- *When viewed on axial imaging, the superior articular facet of the below vertebra is anterior to the inferior articular facet of the upper vertebra.*

Cervical Osteology & Kinematics

Orientation of Subaxial Cervical Spine Facet Joints in Axial Plane



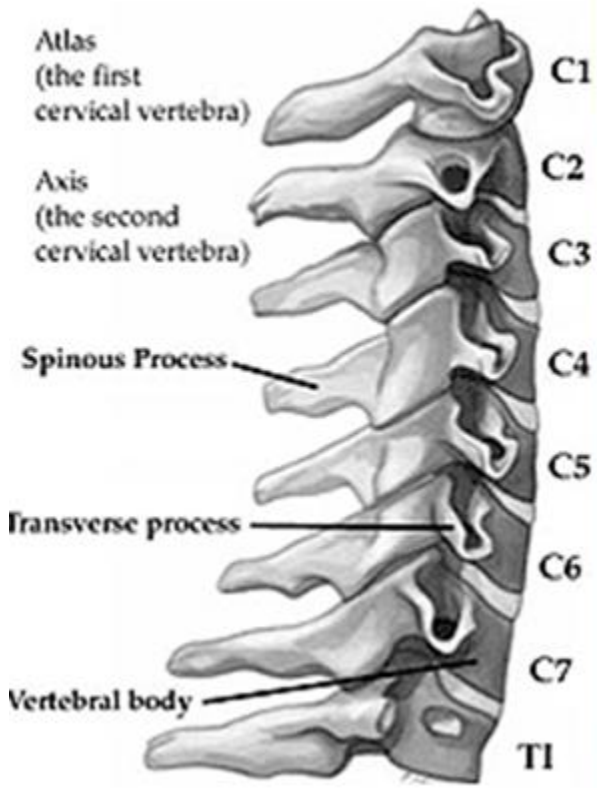


What is the normal canal diameter in C.spine?

- *normal diameter is 17mm, <13mm indicates possible cord compression*

Which vertebrae are responsible for flexion-extension? rotation? lateral bending?

- *Occipito-cervical articulation provides >50% of flexion-extension*
- *C1-C2 and subaxial provide rotation*
- *Lateral bending provided mainly by subaxial.*



	Bifid Spinous Process	Transverse Foramen / Vert?	Flexion/ Extension	Rotation	Lateral Bend
Occiput-C1			50	4	8
C1 (Atlas)	None	Yes / Yes	10	50	0
C2 (Axis)	Yes	Yes / Yes			
C3	Yes	Yes / Yes	50 (10/level)	50 (10/level)	60 (12/level)
C4	Yes	Yes / Yes			
C5	Yes	Yes / Yes			
C6	Yes	Yes / Yes			
C7 (VP)	No (95%)	Yes / No			
Total Motion			**110**	**100**	**68**

Viva 9

21-year-old lady involved in MVC

- What do you see?
- What are the criteria for adequate cervical radiographs?
- What is the mechanism of injury?
- How can you classify these injuries?

What do you see?

- *This is a lateral radiograph of C-spine, not adequate, showing spondylolisthesis of C2 on C3. also called Hangman's fracture due to bilateral fracture of C2 pars or pedicles*

What are the criteria for adequate cervical radiographs?

- Adequate cervical spine radiographs
  - Must include T1 vertebra body
  - At least 3 views
    - AP
    - LAT
    - odontoid views
- Inadequate radiographs are the most common reason for missing an injury

What the mechanism of injury?

- *Extension injury (causes pars fracture) with secondary flexion (disrupts PLL &ALL)*

How can you classify these injuries?

❖ ***Levine & Edwards* classification *(based on the mechanism of injury)***

- *Type I: minimal displacement(<3mm) & angulation with intact disc. Treatment : hard cervical collar (Philadelphia)*
- *Type II: horizontal displacement >3mm & significant angulation (disc & PLL disruption). Treatment: if <5mm → reduction with traction and then Halo immobilization. If >5mm → surgery (C2-C3 ACDF or C1-C3 fusion)*
- *Type IIA: no displacement, but significant angulation. Treatment: reduction with hyperextension without TRACTION, then Halo immobilization for 6-12 weeks.*
- *Type III: associated with bilateral facets dislocation. Requires surgery.*

Viva 10

- What is the diagnosis?
- How do you treat it?

What is the diagnosis?

- *Ossification of the posterior longitudinal ligament, commonly seen in cervical spine (C4-C6), can cause cervical myelopathy*

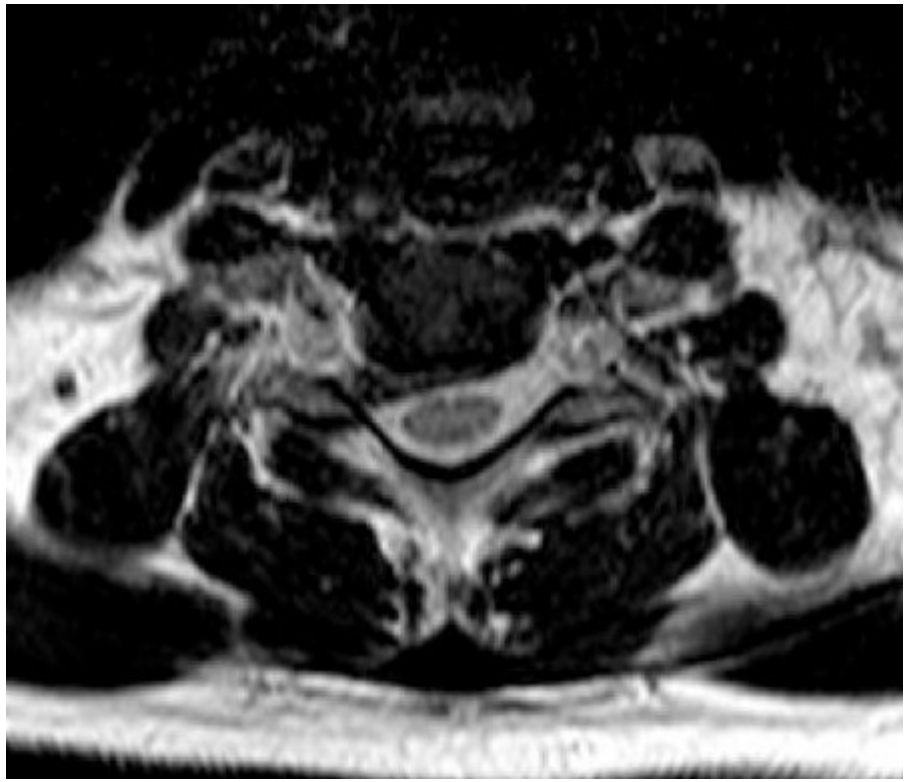
how do you treat it?

- *Observation in asymptomatic or mild symptoms.*
- *Decompression with stabilization (one method to avoid a dural tear is to perform corpectomy, and instead of removing the OPLL, allow it to "float" in to the corpectomy site)*

Viva 11

45-year-old male patient with this cut at level of C7/T1

- What can you see?
- What is cervical radiculopathy?
- What is the cause of radiculopathy?
- At what sites do disc herniations occur, and how do they differ in terms of clinical presentation?
- What would be the expected symptoms and physical exam findings in general and in this patient?
- How would you treat this patient?
- ACDF vs Total disc replacement
- Describe Smith-Robinson approach



What can you see?

- *This is axial T2 weighted MRI of cervical spine at the level of C7/T1 showing a right foraminal disc herniation*

What is cervical radiculopathy?

- *A clinical symptom caused by nerve root compression in the cervical spine, characterized by sensory or motor symptoms in the upper extremity.*

What is the cause of radiculopathy?

- *nerve root irritation caused by*

➢*direct compression*

➢*chemical pain mediators, including*

  - *IL-1*
  - *IL-6*
  - *TNF alpha*
  - *prostaglandins*

At what sites do disc herniation occur, and how do they differ in terms of clinical presentation?

- *Central disc: A direct posterior herniation causes compression in the central canal zone. This may result in central canal stenosis, and lead to cervical myelopathy or lumbar stenosis. also may result in acute cauda equina syndrome.*

➢ *paracentral herniation: causes compression in the subarticular zone, also referred to as the lateral recess. **This is the most common site of herniation** due to the thinning of the PLL and relative weakness of the annulus fibrosus.*

  ➢ *In the cervical spine, a herniation at this location typically causes compression of the **exiting nerve** root at this level (e.g., C4–C5 disc herniation resulting in C5 radiculopathy). In contrast, a lumbar paracentral disc herniation typically causes compression of the **traversing nerve** root before it exits at the level below (e.g., L4–L5 paracentral disc herniation resulting in L5 radiculopathy)*

At what sites do disc herniation occur, and how do they differ in terms of clinical presentation?

- *Foraminal disc herniation: are uncommon, but may be painful due to direct compression of the affected exiting nerve root and dorsal root ganglion.*
- *Extraforaminal or far-lateral disc herniation: are also less common, and can have varied presentations depending on exact sites of compression. Extraforaminal disc herniation may even result in compression of the superiorly exiting nerve root and ganglion (e.g., L4–L5 extraforaminal disc herniation resulting in L4 radiculopathy)*

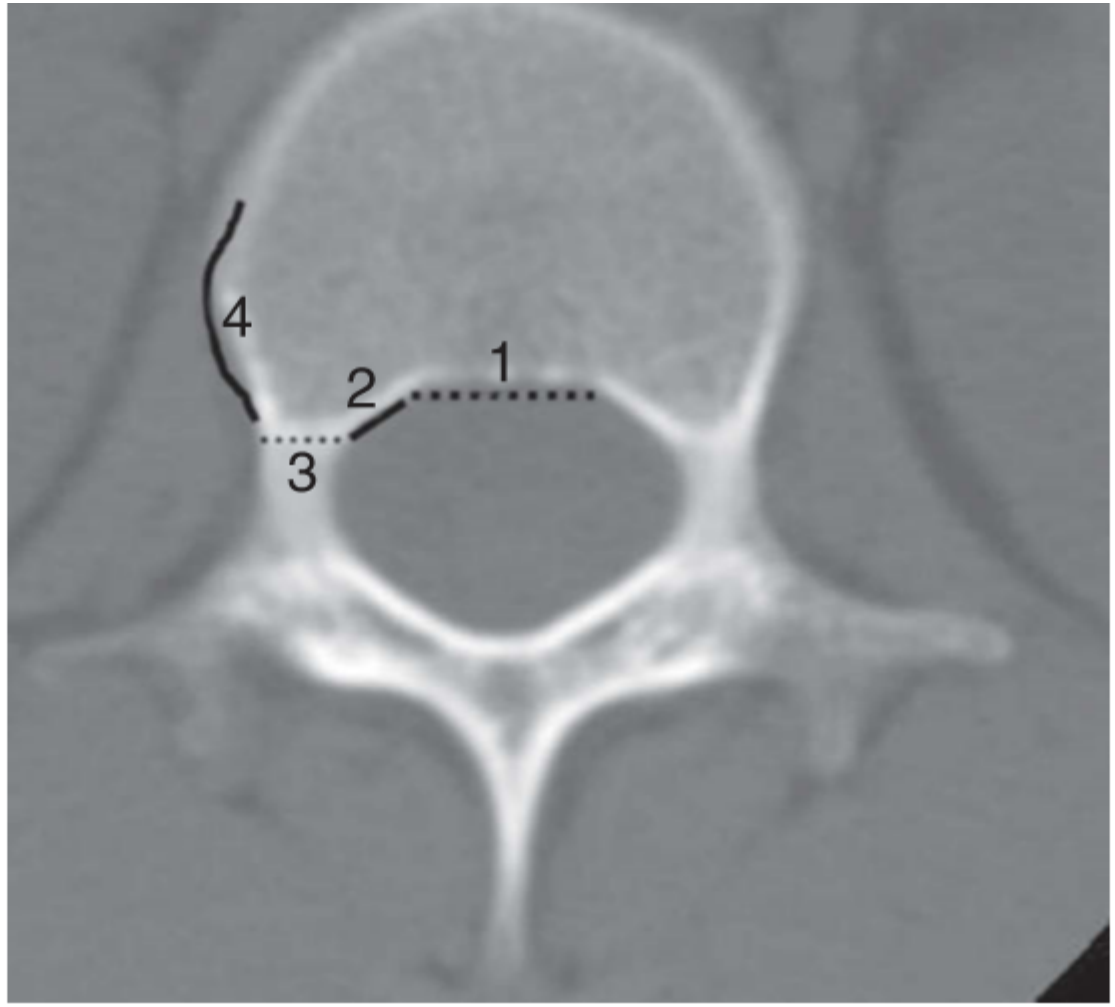
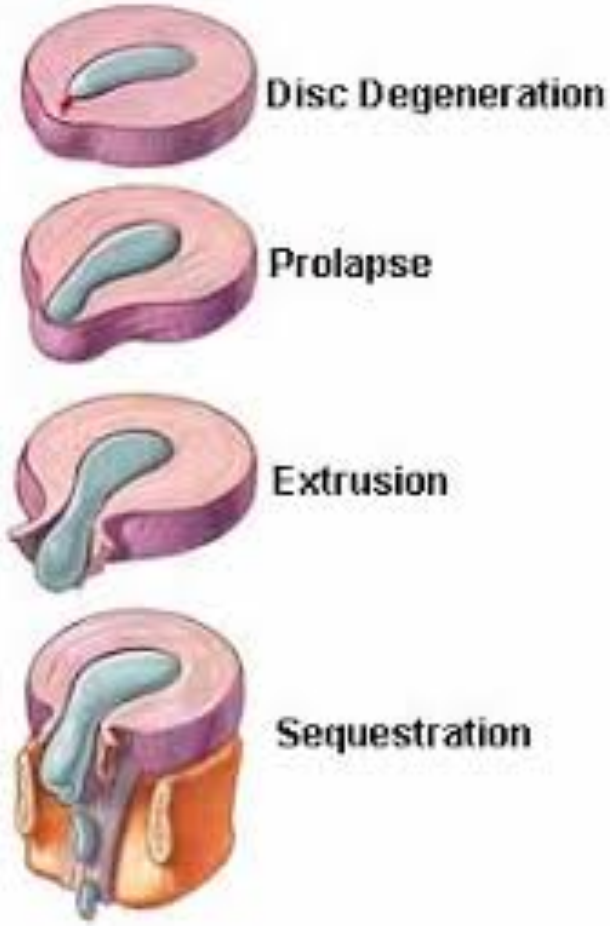


Figure 9.8. Anatomic zones of disc herniation (1: central canal zone, 2: subarticular zone or lateral recess; 3: foraminal or pedicle zone, 4: extraforaminal or far-lateral zone). *(From Wiltse LL, Berger PE, McCulloch A system for reporting the size and location of lesions in the spine. Spine 1997;22:1534–1537.)*

What are the grades of disc herniation?



➢Classifications Of Herniations

- Degeneration
  - Loss of fluid in nucleus pulposus
- Protrusion
  - Bulge in the disc but not a complete rupture
- Prolapse
  - Nucleus forced into outermost layer of annulus fibrosus- not a complete rupture
- Extrusion
  - A small hole in annulus fibrosus and fluid moves into epidural space
- Sequestration
  - Disc fragments start to form outside of the disc area.

What would be the expected symptoms and physical exam findings in general and in this patient?

❖***Symptoms:***

➢*Neck pain radiating to shoulder*

➢*numbness/tingling*

➢*Symptoms are relived by overhead activity*

What would be the expected symptoms and physical exam findings in general and in this patient?

❖ ***Physical exam:***

➢ *Radiculopathy according to the nerve root (Power-sensation-reflex)*

➢ *Provocative tests:*

- *Spurling test: simultaneous extension, rotation to affected side, lateral bend, and vertical compression reproduces symptoms in ipsilateral arm*
- *Shoulder abduction test: shoulder abduction (lifting arm above head) often relieves symptoms, valuable physical exam test to differentiate cervical pathology from other causes of shoulder/arm pain*

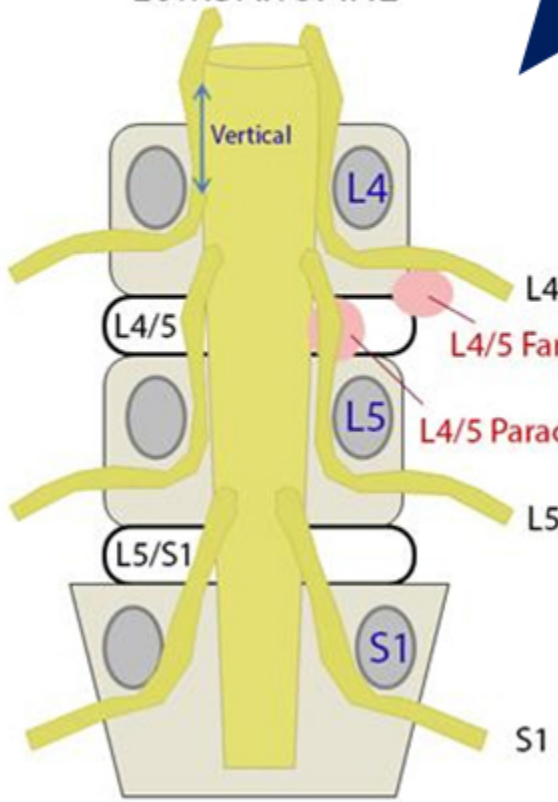
What would be the expected symptoms and physical exam findings in general and in this patient?

- *In this patient, a disc herniation at the C7/T1 level will most likely affect the C8 nerve root. A C8 radiculopathy usually presents with sensory symptoms in the medial border of the forearm and hand, and weakness in long flexor function in all digits and thumb.*
- *In the cervical spine, the nerve root runs above the corresponding pedicle in a horizontal manner. Therefore, the inferior nerve root is affected with both a central and foraminal disc herniation. This is in contrast to the lumbar spine where the nerve root runs below the corresponding pedicle. In addition, in the lumbar spine the nerve root runs in a vertical descending direction before exiting. For this reason, at each level in the lumbar spine you can find both a descending and exiting nerve root. This explains why in the lumbar spine a foraminal disc affects the exiting nerve root and a paracentral disc affects the descending nerve root*

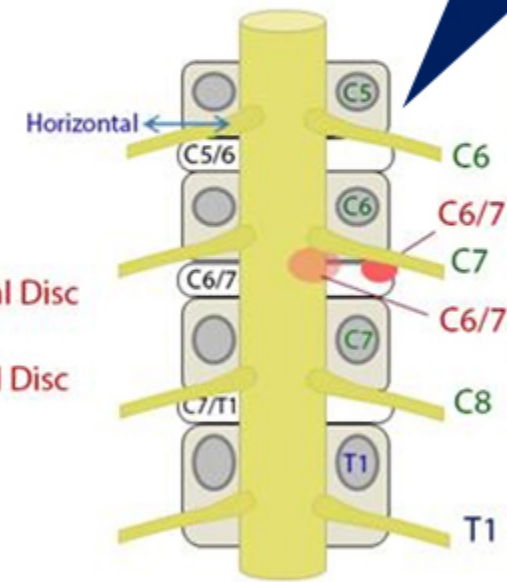
A paracentral disc at L4/5 affects L5, a far-lateral disc affects L4

A paracentral and far-lateral disc at C4/5 affects C5

LUMBAR SPINE



CERVICAL SPINE



Due to horizontal anatomy, both discs affect same nerve root in cervical spine, different than lumbar spine

C8 and above Pedicle / Nerve Root MISMATCH

"Extra C8 Nerve Root (without C8 pedicle) allows transition from MISMATCH to MATCH

T1 and below Pedicle / Nerve Root MATCH

Lumbar Spine Pedicle/nerve Root MATCH

How would you treat this patient?

➢*Non-operative treatment:*

✓*Immobilization for short period (<2weeks)*

✓*Medications (NSAIDs-GABA inhibitor-Narcotics)*

✓*Physiotherapy (cervical isometric exercises)*

75% of patients will improve with non-operative measures

➢*Selective nerve root corticosteroid injection*

How would you treat this patient?

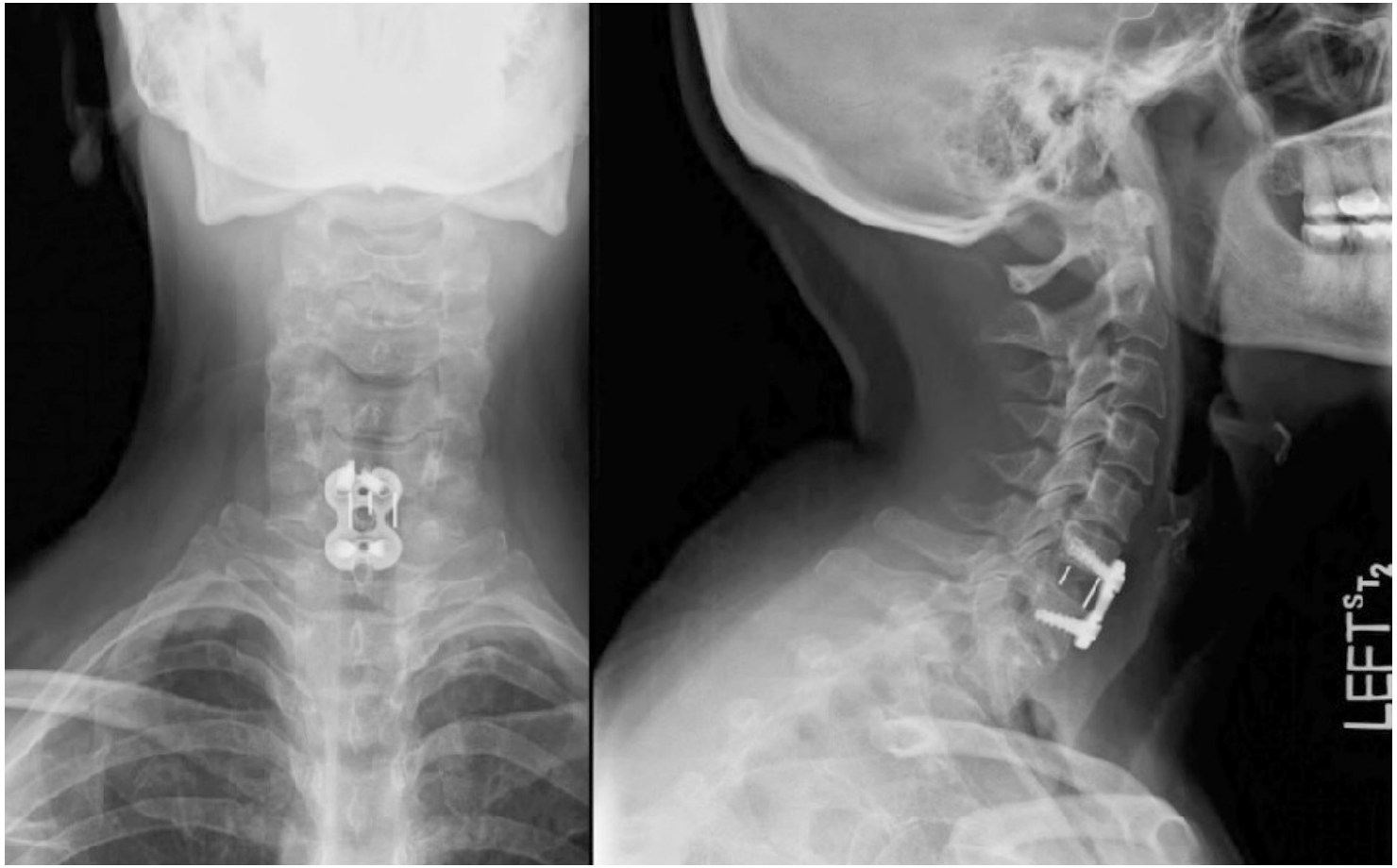
- *Operative (after exhaustion of all non-operative measures):*
  - ✓ *A posterior cervical foraminotomy would be an appropriate treatment option in this patient.*

ACDF vs Total disc replacement

- ***Anterior cervical decompression and fusion***
- *remains gold standard in surgical treatment of cervical radiculopathy*
- *placement of bone graft increases disc height and decompresses the neural foramen indirectly*
- *corpectomy and strut graft may be required for multilevel spondylosis*
- *anterior plating functions to increase fusion rates and maintain position of interbody cage or strut graft*

Corpectomy + fibular strut graft

ACDF + interbody cage



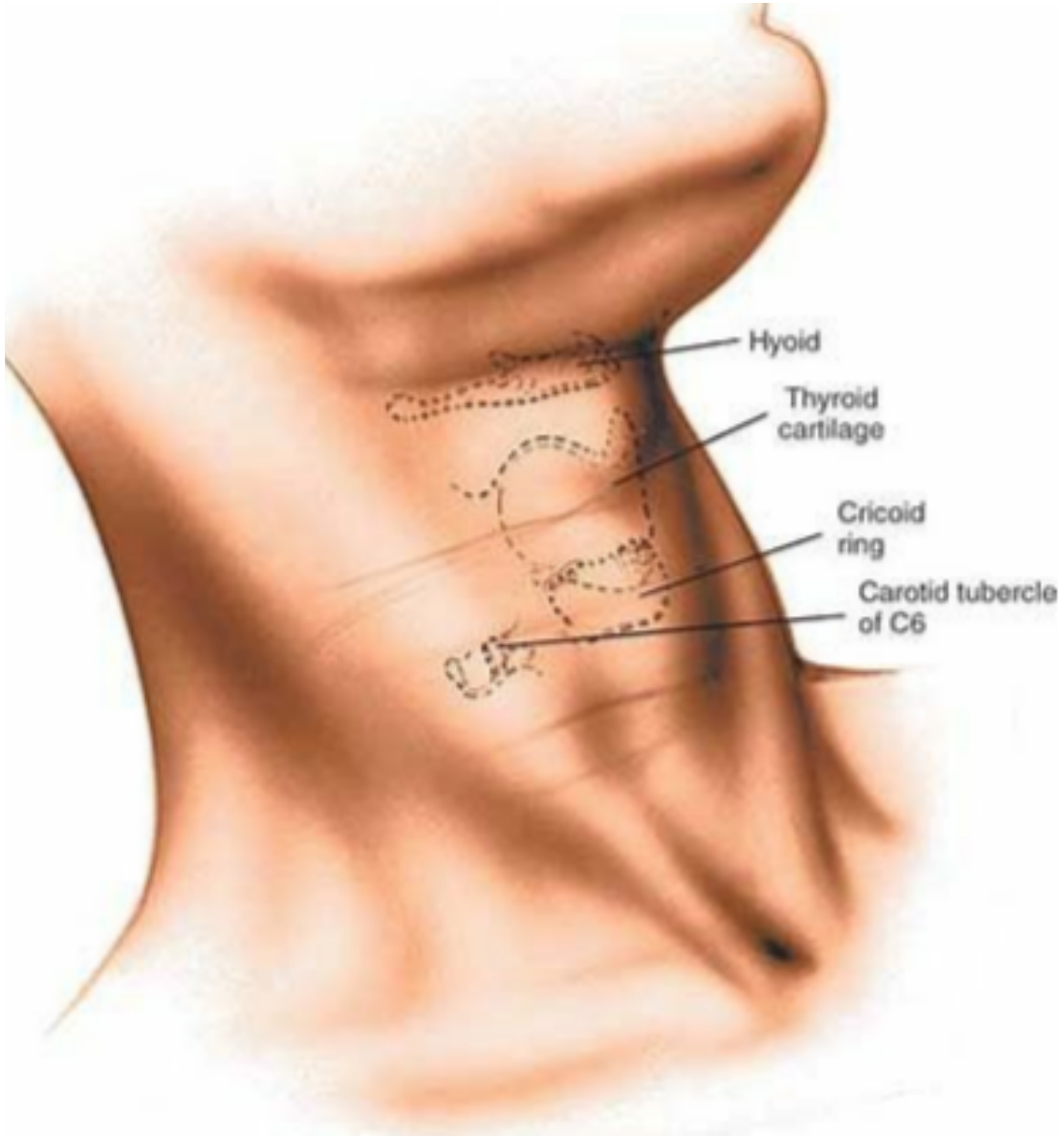
ACDF vs Total disc replacement

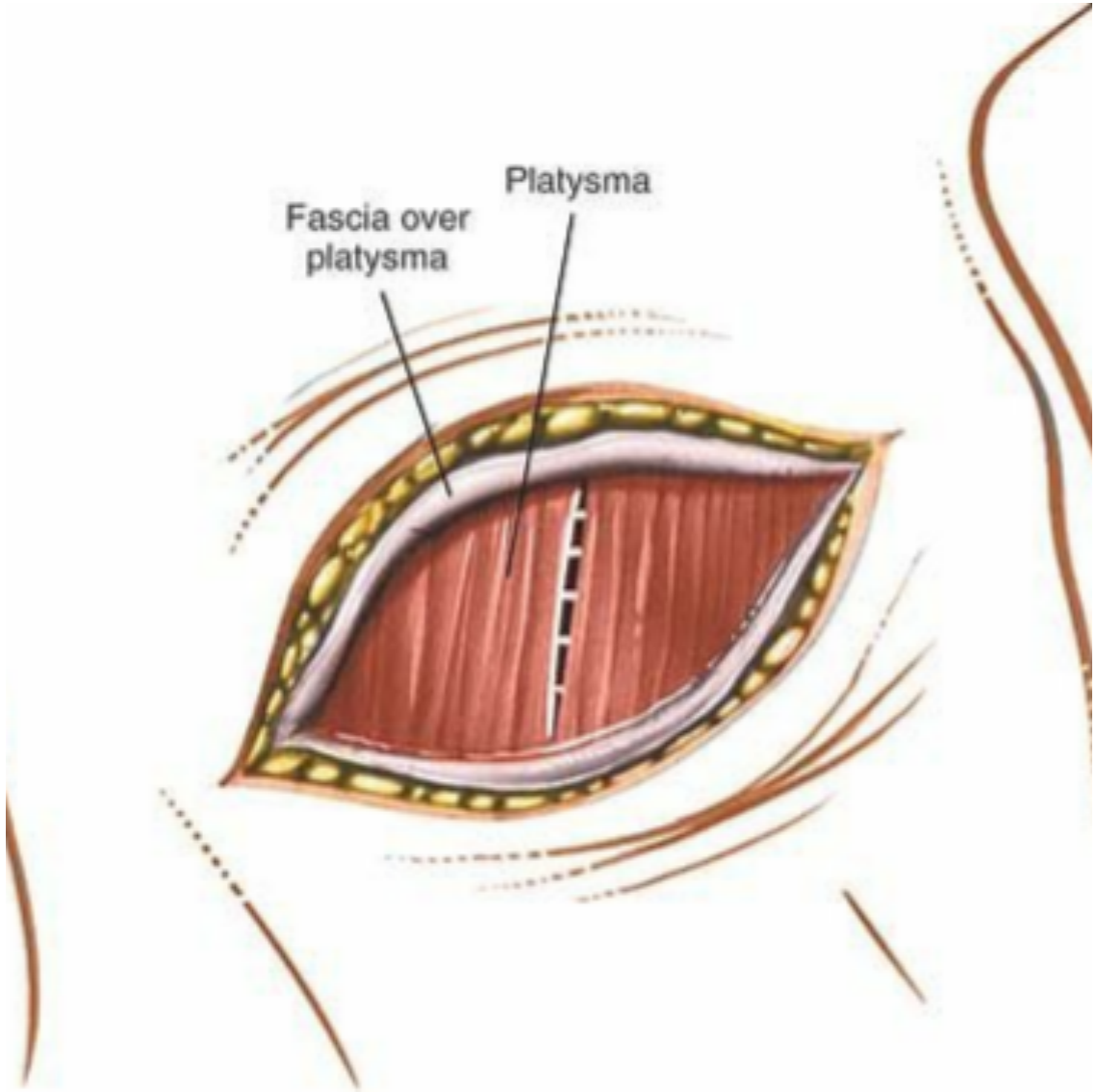
❖ ***Cervical disc replacement***

- *It is a newer technique which treats similar pathologies through the same anterior approach but attempts to preserve motion in the cervical spine by replacing the cervical disc with materials similar to those used in large joint arthroplasty.*
- *Indicated in a single level disease with a minimal facet arthrosis*
- *Studies showed equivalence to ACDF*
- *It preserves motion in cervical spine and avoids non-union that associated with ACDF*

Describe Smith-Robinson approach

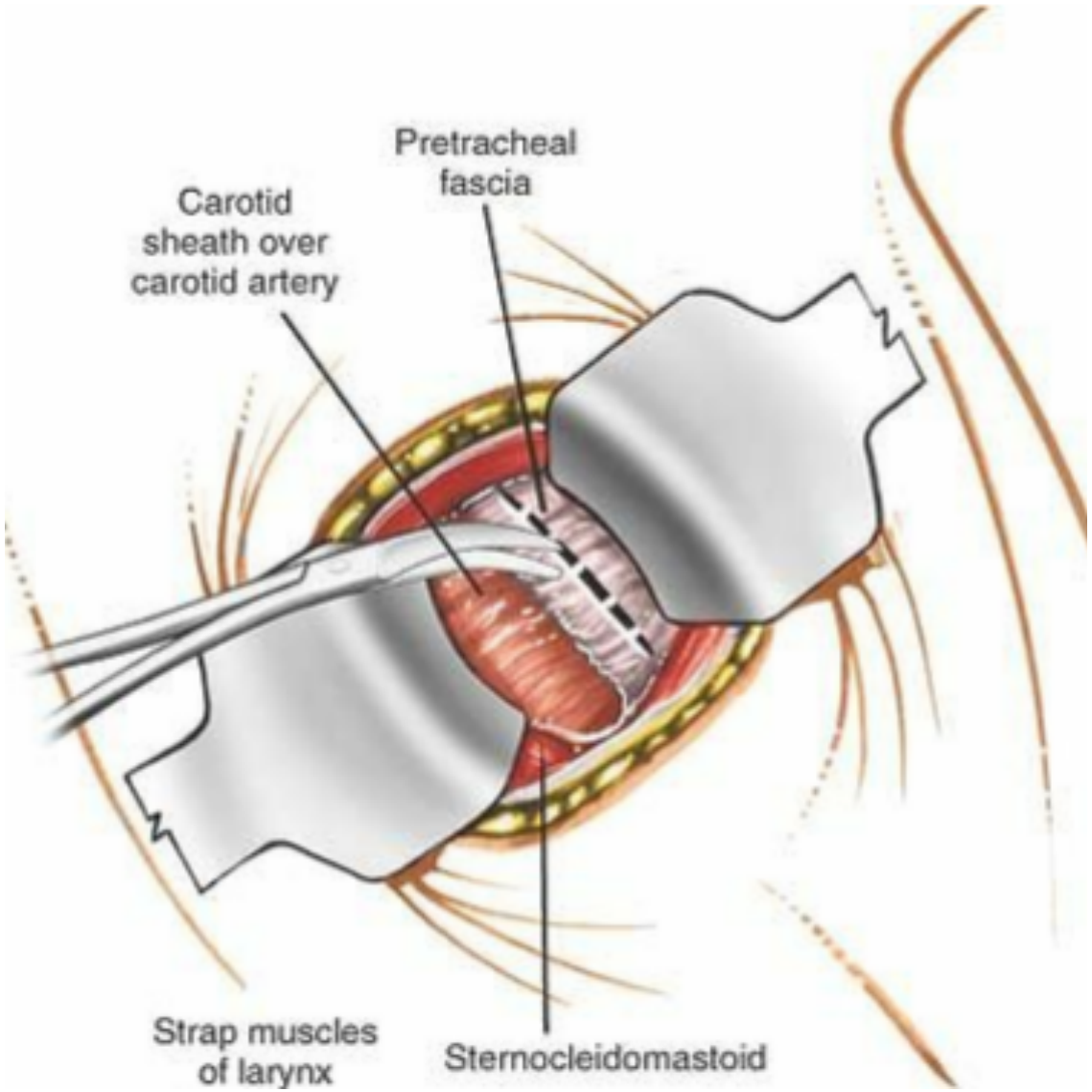
- ***Skin landmarks:*** *angle of mandible C2/C3 – Hyoid C3 – Thyroid cartilage C4/C5 – Cricoid C6.*
- ***Position:*** *supine position on operating table, with a sandbag between the shoulder blades, head turned away from planned incision, table is elevated to 30°*
- ***Incision:*** *transverse incision at the appropriate level of vertebral pathology from midline to posterior border of SCM muscle. A longitudinal incision along the anterior border of SCM muscle is used when more than three vertebrae have to be visualised.*

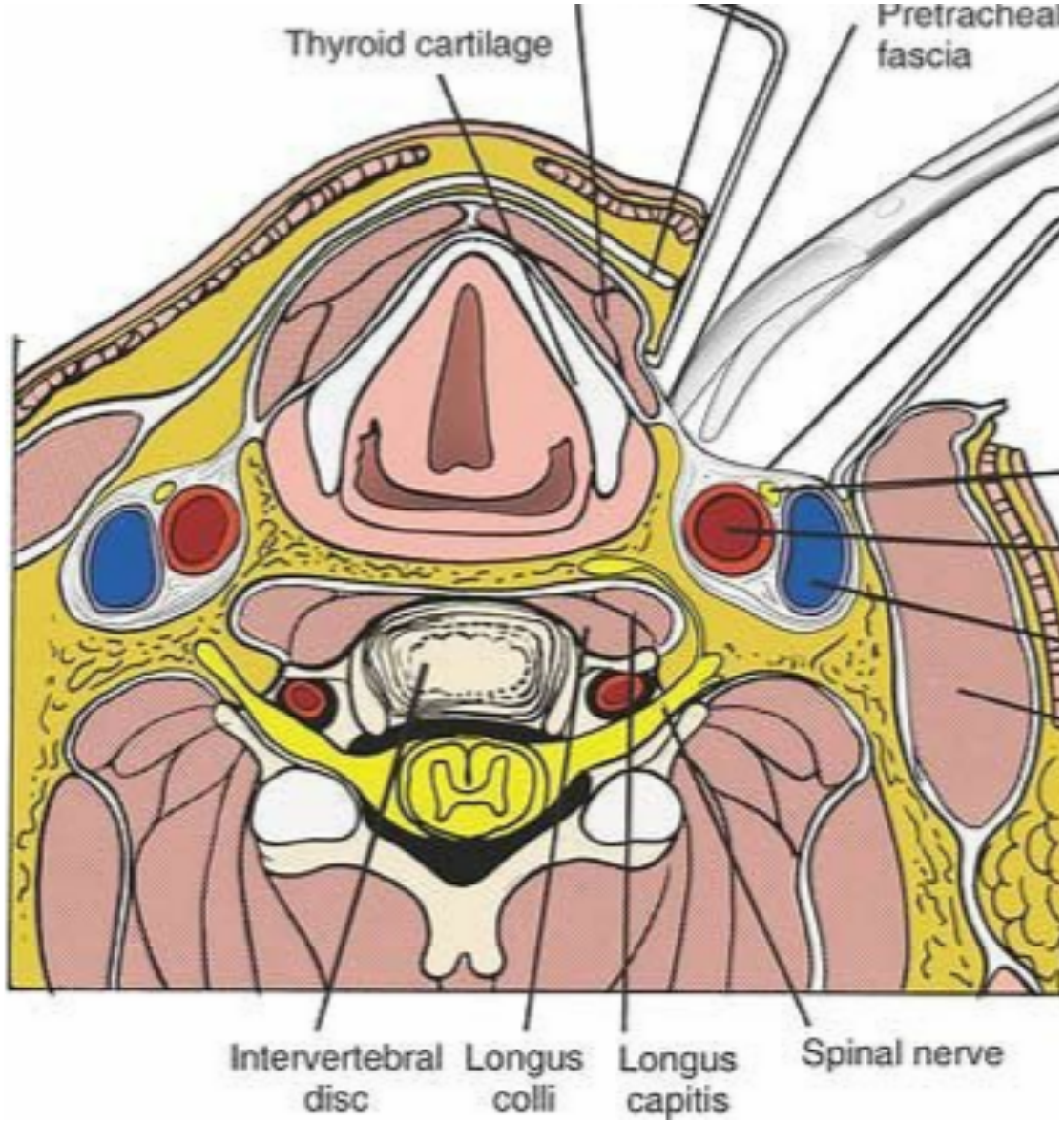

Hyoid
Thyroid cartilage
Cricoid ring
Carotid tubercle of C6


Platysma
Fascia over platysma

Describe Smith-Robinson approach

- ***Superficial fascia:*** *incise the fascia over the platysma, split the platysma longitudinally parallel to its long fibres , to identify the medial border of SCM and retract it laterally. Incise the fascia(deep cervical fascia) medial to it. Retract the strap muscles (sternohyoid & sternothyroid)with trachea & esophagus medially. Identify the carotid pulse. The plane between the larynx and oesophagus medially and the carotid sheath laterally is dissected using blunt dissection. Retract the carotid sheath laterally and incise the pretracheal fascia immediately medial to the carotid sheath carefully identify the sup & inf thyroid arteries).*
- ***Deep surgical dissection:*** *Split medial borders of longus coli muscles & ALL which lie on the anterior surface of the vertebral bodies.*


Pretracheal fascia
Carotid sheath over carotid artery
Strap muscles of larynx
Sternocleidomastoid


Thyroid cartilage
Pretracheal fascia
Intervertebral disc
Longus colli
Longus capitis
Spinal nerve

Describe Smith-Robinson approach

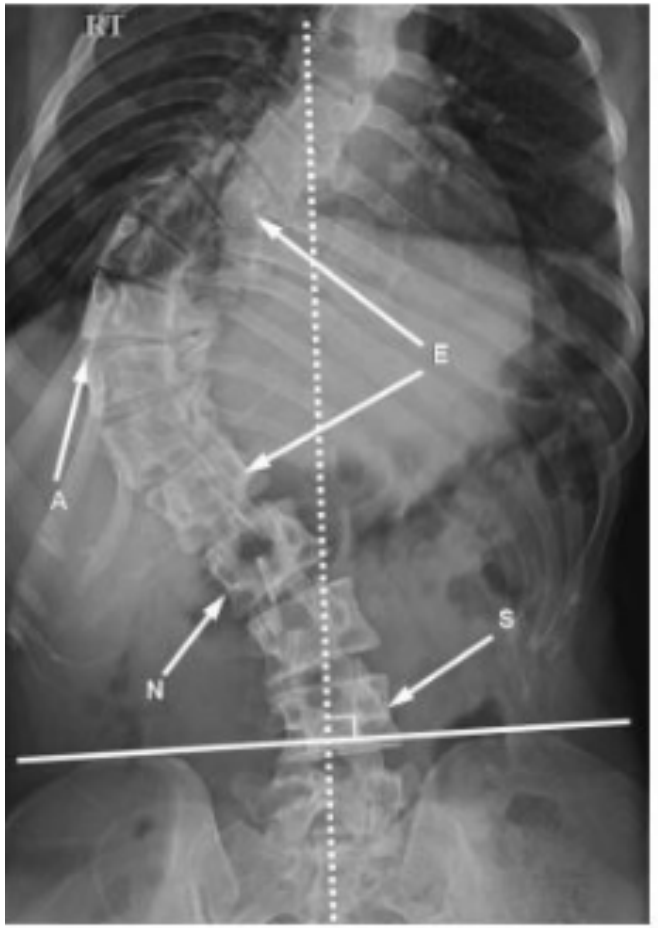
➢ ***Structures at risk:***

✓ *Recurrent laryngeal nerve*

✓ *Sympathetic N: located at the lateral border of longus coli muscles at C6*

Viva 12

- Explain the diagnosis and how can be classified?
- How would you assess this patient?
- What are the recommended radiographic views?
- Name the vertebrae shown on the radiograph
- What are the indications for MRI?
- What are the factors that determine curve progression in AIS?
- What is Early onset scoliosis?
- Are you aware of any classification system used in AIS?
- What is the natural history?
- Outline the principles of treatment of this condition?



Explain the diagnosis and how can be classified?

- *This is A/P radiograph demonstrates curvature of thoracic spine, convex to the left.*
- *Scoliosis is a combined rotational deformity and coronal plane deviation of the spine. The diagnosis is made when the cobb angle exceeds 10°.*
- *The scoliosis can be classified in several ways:*

✓ Underlying etiology

✓ Age of presentation

✓ Type and extent of deformity

Explain the diagnosis and how can be classified?

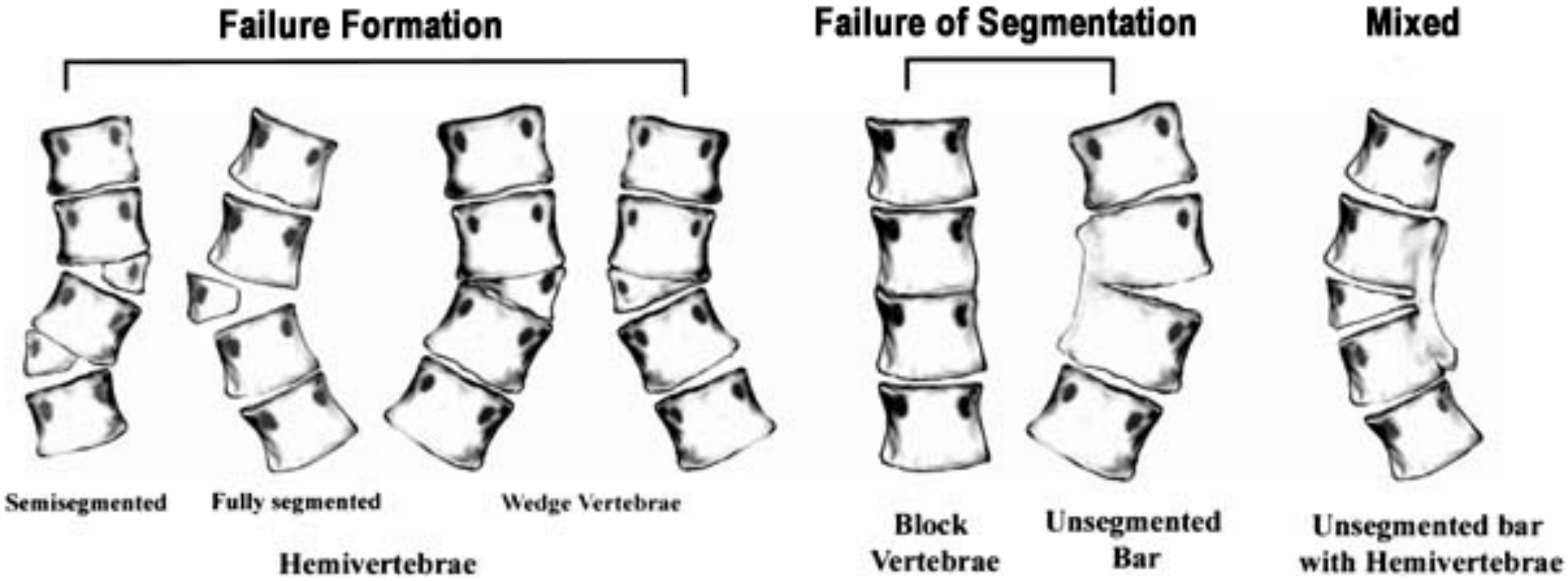
❖ ***Underlying etiology***

- *Congenital: results from*
  - *failure of formation: the commonest abnormality is a hemivertebra, which may be fully, partially or unsegmented.*
  - *Failure of segmentation: this results in block vertebrae, and unilateral bar. Or combination of these: unilateral bar & hemivertebra (the worst prognosis)*
- *Syndromic: (Neurofibromatosis-Marfan - Ehler Danlos)*
- *Neuromuscular: involves longer segment of spine, less likely to have compensatory curves, rapid progression that does not stop at skeletal maturity. (CP-DMD-SMA)*
- *Idiopathic: the commonest form of scoliosis, unknown etiology, most commonly right curve, left curves require careful evaluation and MRI to exclude underlying neuropathology, usually does not progresses after skeletal maturity*

Explain the diagnosis and how can be classified?

❖ ***Underlying etiology***

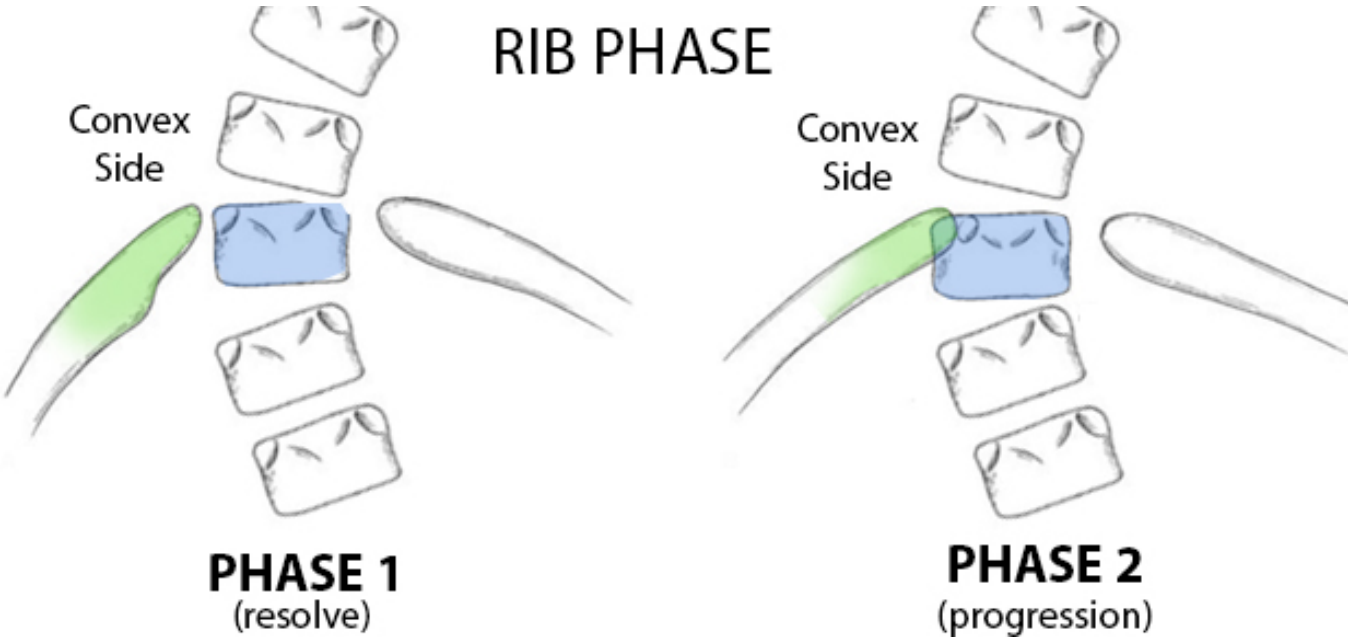
- *Degenerative: This form of curve typically develops in the fifth or later decade of life, often in a previously normal spine;*
- *Functional: there is no underlying bony change, and the deformity corrects when the underlying cause is addressed. (LLD- muscle spasm)*

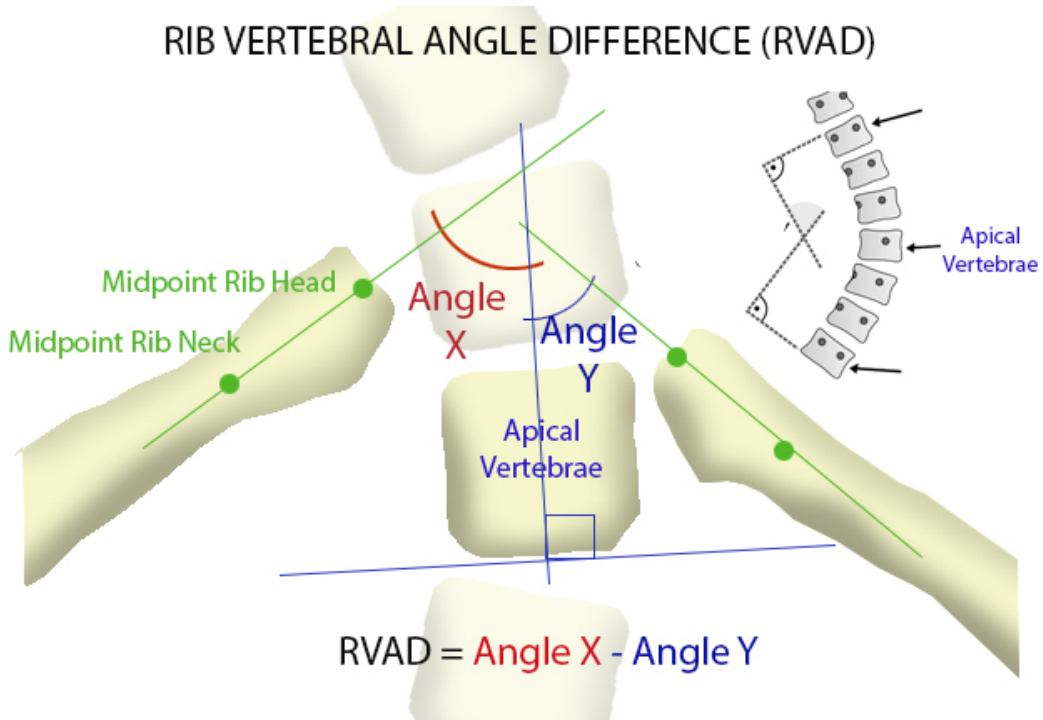

Failure Formation
Failure of Segmentation
Mixed
Semisegmented
Fully segmented
Wedge Vertebrae
Hemivertebrae
Block Vertebrae
Unsegmented Bar
Unsegmented bar with Hemivertebrae

Explain the diagnosis and how can be classified?

❖***Age of presentation***

- *Idiopathic scoliosis is subdivided into three forms based on the age of onset:*
- *1. Infantile (0–3 years): (4% of all idiopathic curves, commonly seen in boys and is usually a left thoracic curve, It is the only true scoliosis that can resolve spontaneously, this can be predicted by measuring the rib–vertebra angle difference (RVAD) of Mehta on an AP radiograph). Curves with Mehta angle >20°, and phase 2 ⟶ indicative of curve progression*
- *2. Juvenile (4–10 years): (15% of all idiopathic curves, commonly seen in girls, right thoracic curves are common, spontaneous resolution is uncommon, 95% of curves will progress, >20% incidence of neural axis abnormality,* ***MRI is necessary****)*
- *3. Adolescent (>10 years): (the most common form, commonly seen in girls, commonly right thoracic curves, left thoracic curves indicate MRI)*


RIB PHASE
Convex Side
PHASE 1
(resolve)
Convex Side
PHASE 2
(progression)


RIB VERTEBRAL ANGLE DIFFERENCE (RVAD)
Midpoint Rib Head
Midpoint Rib Neck
Angle X
Angle Y
Apical Vertebrae
Apical Vertebrae
RVAD = Angle X - Angle Y

Explain the diagnosis and how can be classified?

❖ ***Type and extent of deformity***

- *Thoracic*
- *Lumbar*
- *Thoracolumbar (single curve crossing both region)*
- *Double major (thoracic and lumbar curves)*
- *Double thoracic (2 curves both in thoracic spine)*

How would you assess this patient?

❖***History***

- *Age*
- *Time since onset of scoliosis (when was the deformity noticed? Who noticed it?)*
- *Rate of progression*
- *Pain (can be due to osteoid osteoma-NF)*
- *Any neurological symptoms (numbness-weakness-bladder & bowel dysfunction)*
- *Cardiorespiratory symptoms*
- *Congenital problems. (perinatal history-developmental milestone)*
- *Age of menarche. (important)*
- *Family history of spinal deformity*
- *Impact of the spinal deformity at school, ADLs*
- *What has been done?*
- *Patient's concerns (shape-pain)*

How would you assess this patient?

❖***Physical examination***

- ***Look (standing)-*** *The trunk should be inspected from front, side and behind*
- *Comment on cutaneous manifestation. Café-au-lait spots or axillary freckling (NF)*
- *Midline hairy patches- dimples*
- *Short neck- low hair line*
- *Comment on the curve (thoracic or lumbar or thoracolumbar- apex left or right). Drop a plumb line from C7 to the natal cleft*
- *Shoulder height asymmetry (when the shoulders are level or high on the side opposite the convexity, suspect a compensatory curve)*
- *Size and level of scapulae. Small high riding scapula in Sprengel's deformity*
- *Waist and hip asymmetry- pelvic obliquity. Are ASIS are level?. In thoracolumbar scoliosis the waist is flattened on the convex side of the curve, prominent on the concave side.*

How would you assess this patient?

❖***Physical examination***

- ***Look (standing)-*** *The trunk should be inspected from front, side and behind*
- *If there is a rib hump (rib prominence), does it become more prominent on bending forward? (Adam forward test) which can measured using a scoliometer. A rib hump indicates vertebral rotation, which means this is a structural, rather than compensatory curve. If the curve disappear with forward bending, it is a non-structural curve.*
- *Sagittal shape and balance. Assess for thoracic kyphosis and cervical and lumbar lordosis.*
- *LLD. This is can be a cause of postural scoliosis*
- *Foot deformities (cavovarus)*

How would you assess this patient?

❖***Physical examination***

- ***Look (gait)***
- *How does the patient walk? spastic or scissoring (CP)- short leg*

How would you assess this patient?

❖***Physical examination***

- ***Feel***
- *A step in the spinous process in the lower lumbar spine may suggest a spondylolisthesis associated with AIS.*
- *Any abnormal masses should be palpated*

How would you assess this patient?

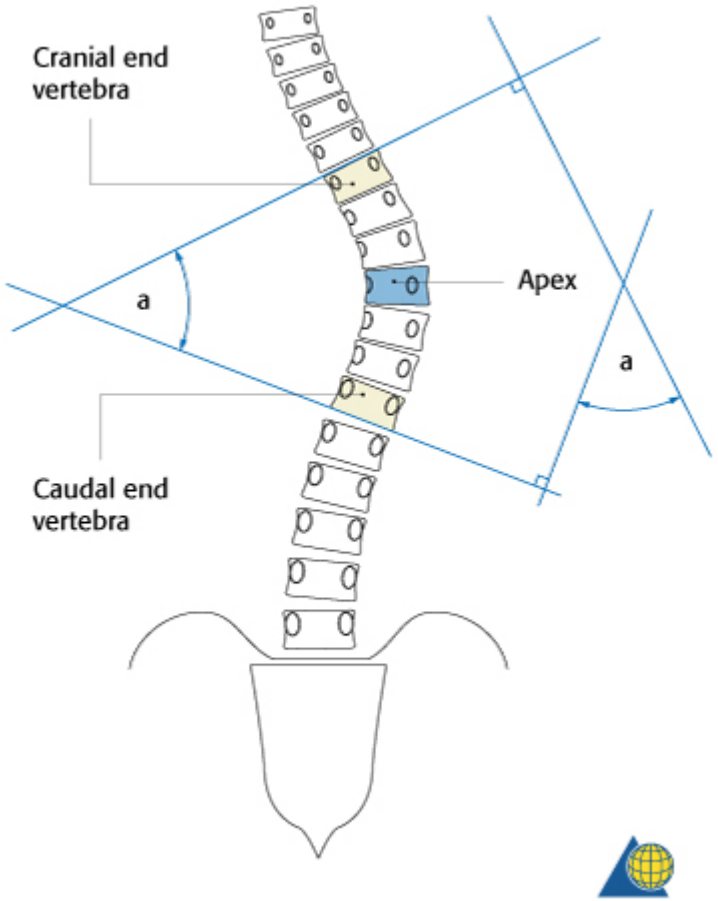
❖***Physical examination***

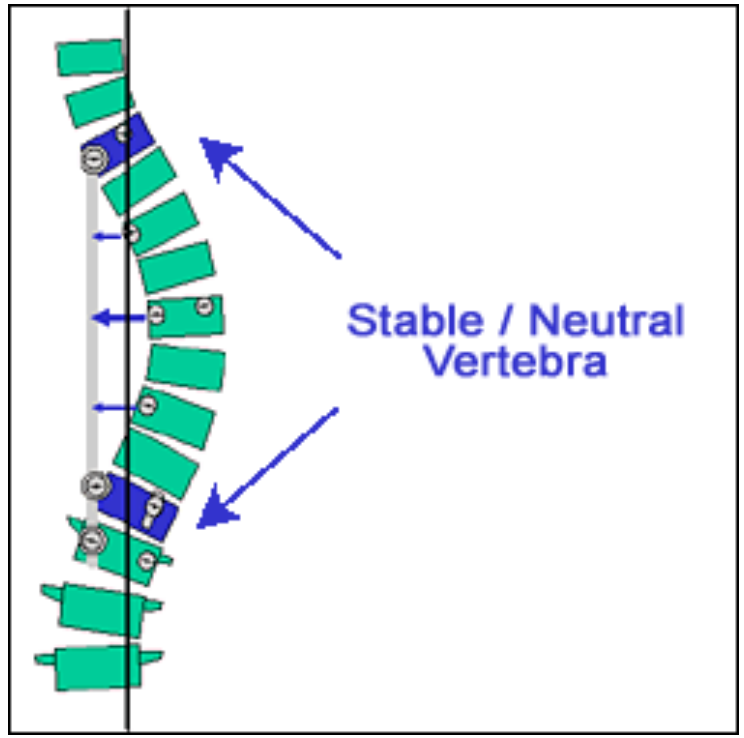
- ***Neurological examination***
- *Motor*
- *Sensory*
- *Upper and lower limb reflexes- superficial abdominal reflexes (asymmetric reflexes indicate MRI)*
- *Hoffman's sign- Ankle Clonus- Babiniski*

What are the recommended radiographic views?

recommended views are standing PA & lateral views of the spine – pelvis A/P

- ***Cobb angle***
- *The angle between the most tilted vertebrae (terminal vertebra) above and below the apex of the curve (apical vertebra)*
- *Use the upper end plate of the cranial vertebra and the lower end plate of the caudal one.*
- ***Terminal (end) vertebra (E)**: the most tilted vertebra*
- ***Apical vertebra (A)**: the most lateral displaced vertebra & most horizontally oriented.*
- ***Stable vertebra (S)**: the most caudal vertebra that bisected by central sacral vertical line*
- ***Neutral vertebra (N)**: rotationally neutral. Spinous process has equal distance to pedicles.*


Cranial end vertebra
Apex
a
a
Caudal end vertebra


Stable / Neutral Vertebra

What are the indications for MRI?

- *To evaluate for neural axis abnormality (Chiari malformation-tethered cord-syringomyelia-diastematomyelia-intradural lipoma)*
- *Neurological deficit*
- *Atypical curve pattern (left thoracic curve, short angular curve, apical kyphosis)*
- *Juvenile IS*
- *Infantile IS with curve >20°*
- *Congenital scoliosis prior to surgery*
- *Rapid progression*
- *Painful deformity*
- *Foot deformities*

What are the factors that determine curve progression?

❖ ***Remaining skeletal growth (skeletal maturity)***

- *It is assessed by Tanner stage- Risser grade- age of menarche- presence of open triradiate*
- *Tanner whitehouse method is 8 stages specifically uses the distal radial and ulnar epiphyses and the metacarpal and phalangeal epiphyses of the first, third, and fifth digits for determination of skeletal age. It is more time consuming, it provides a better assessment of maturity and prognosis determination for curve progression in idiopathic scoliosis*
- *Risser classification is used to grade skeletal maturity based on the level of ossification and fusion of the iliac crest apophyses*
- *Girls at risk for progression: pre-menarche- Risser grade 0, Tunner stage <3, open triradiate cartilage*
- *Spine growth usually stop 18-24 months after menarche.*

What are the factors that determine curve progression in AIS?

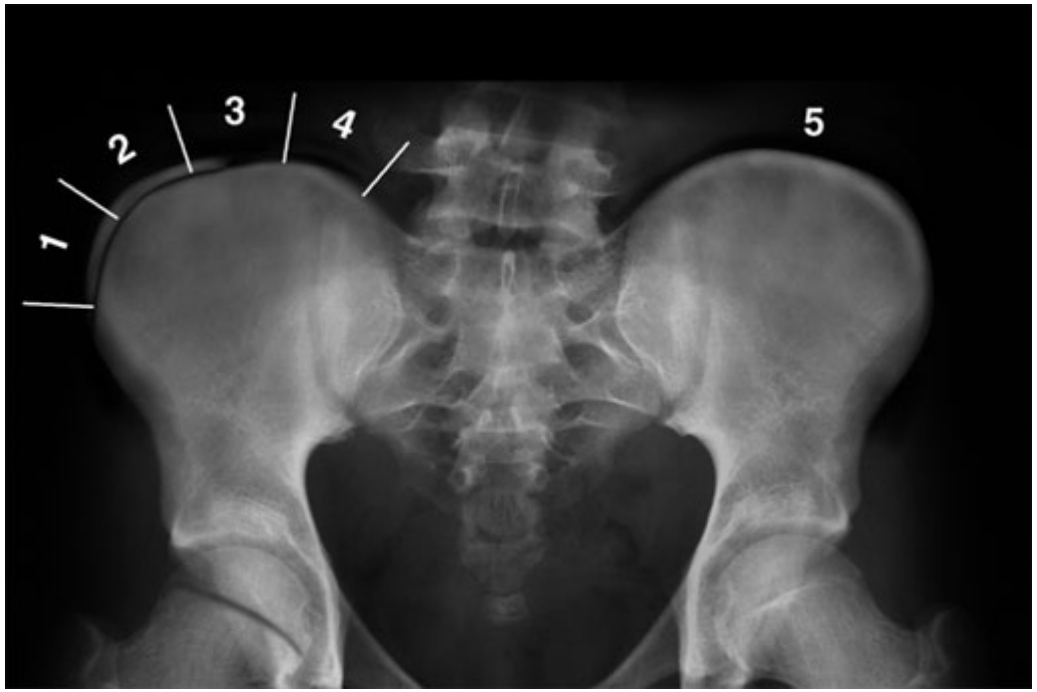
❖ ***Curve magnitude***

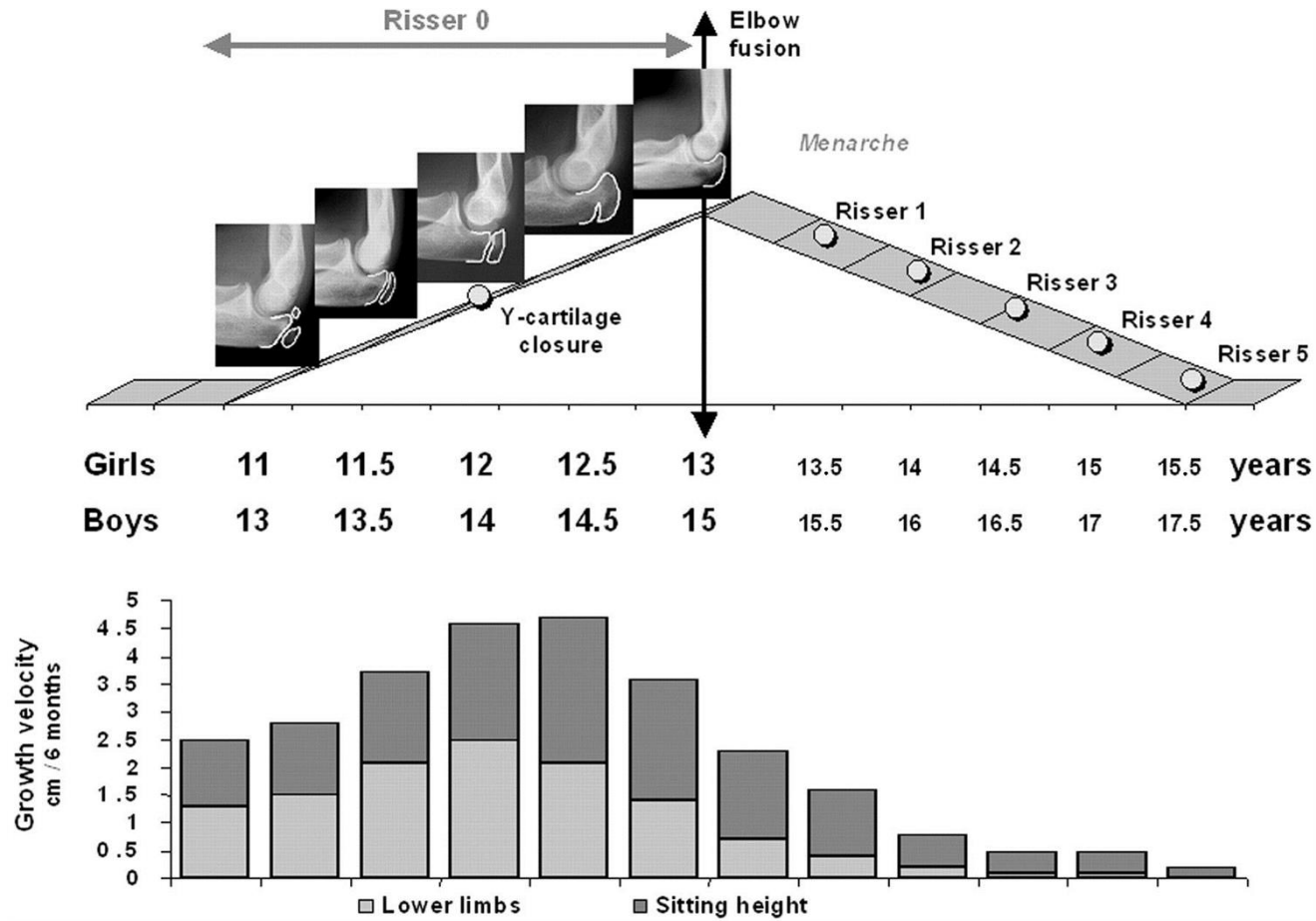
- *Thoracic curve > 50°, lumbar curve > 40° have been shown to progress up to a mean of 1°/ year after skeletal maturity*
- *Curves > 25° before skeletal maturity will continue to progress*

What are the factors that determine curve progression?

❖ ***Curve type***

- *Thoracic curve progress > lumbar curves*
- *Double curves progress > single curve*


1
2
3
4
5


Risser 0
Elbow fusion
Menarche
Risser 1
Risser 2
Risser 3
Risser 4
Risser 5
Y-cartilage closure
Girls 11 11.5 12 12.5 13 13.5 14 14.5 15 15.5 years
Boys 13 13.5 14 14.5 15 15.5 16 16.5 17 17.5 years
Growth velocity cm / 6 months
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Lower limbs
Sitting height

What is Early onset scoliosis?

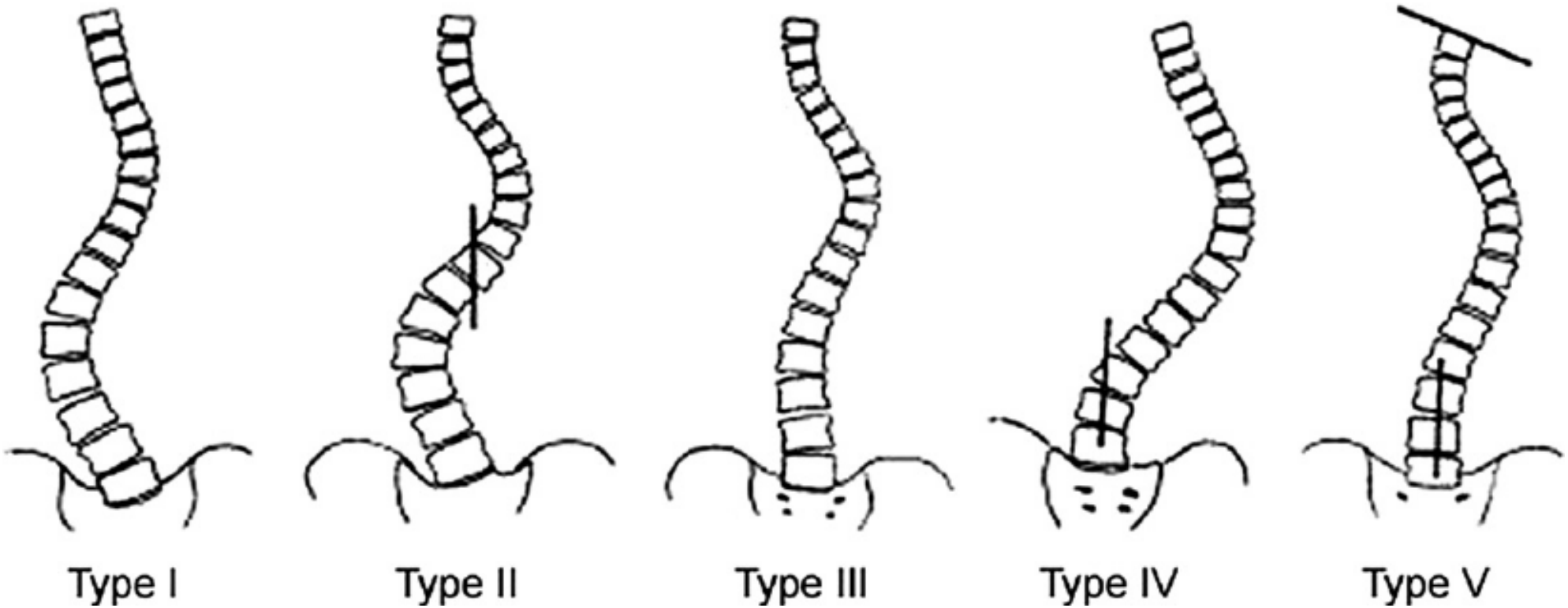
- *The term early- onset scoliosis applies to patients under the age of 7 with an idiopathic scoliosis. It is significant because at this young age the development of the lungs is not complete and cardiorespiratory compromise may result from a progressive curve and there may be a decreased life expectancy.*

Are you aware of any classification system used in AIS?

Type I	S-shaped curves in which both thoracic and lumbar curves cross mid-line. Lumbar curve is larger. The thoracic curve is more flexible than the lumbar on supine-bending films
Type II	S-shaped curves in which both thoracic and lumbar curves cross mid-line. Thoracic curve is equal to or larger than the lumbar curve. The thoracic curve is more flexible than lumbar curve on supine-bending films
Type III	Single Thoracic curve in which the lower level does not cross the mid line
Type IV	Single long thoracic curve in which L5 is centered over the sacrum but L4 tilts into the long thoracic curve
Type V	A double thoracic curve in which T1 is tilted into the convexity of the upper curve (the upper curve is structural on supine-bending film)

AIS = Adolescent idiopathic scoliosis

Are you aware of any classification system used in AIS?



What is the natural history?

- *increased incidence of acute and chronic pain in adults if left untreated.*
- *curves > 90° are associated with cardiopulmonary dysfunction, early death.*

Outline the principles of treatment of this condition?

❖***Observation***

- *If curve < 25°. 6 monthly radiographs should be obtained until skeletal maturity*
- *Skeletal maturity is defined as:*

✓*Risser 4*

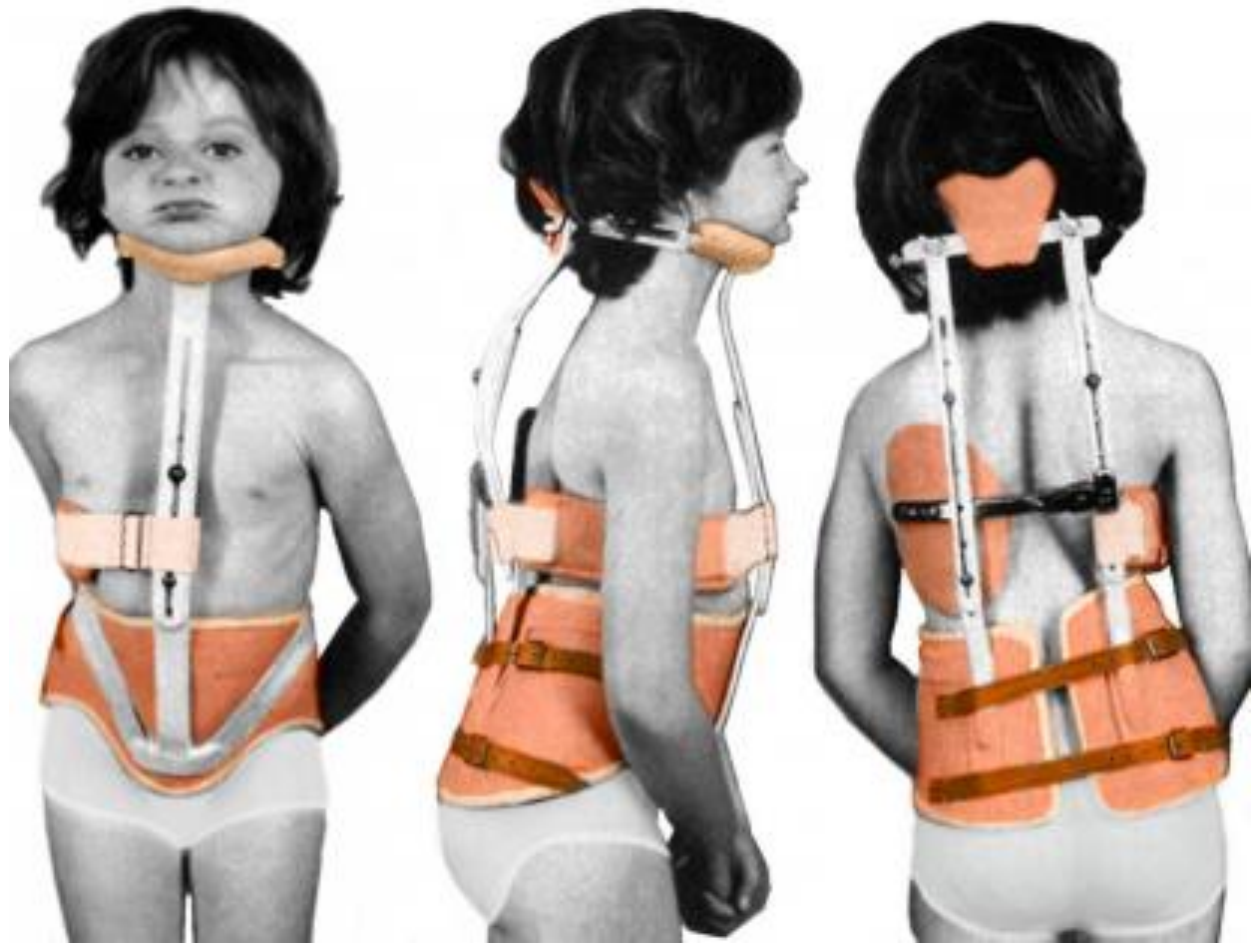
✓*< 1cm in height over 2 visits 6 months apart*

✓*2 years post menarche*

Outline the principles of treatment of this condition?

❖ ***Bracing***

- *If curve 25° - 45°.*
- *only effective for flexible deformity in skeletally immature patient (Risser 0, 1, 2)*
- *The aim is to prevent curve progression during growth.*
- *TLSO is effective when the apex is at T7 or below*
- *curves with apex above T7 Milwaukee brace (cervicothoracolumbosacral orthosis)*
- *recommended for 16-23 hours/day until skeletal maturity*
- *bracing success is defined as <5° curve progression*
- *bracing failure is defined*
  - *6° or more curve progression at orthotic discontinuation (skeletal maturity)*
  - *absolute progression to >45° either before or at skeletal maturity, in favour of surgery*



Outline the principles of treatment of this condition?

❖***Surgery***

- *Principles of fusion:*

✓*Provide satisfactory coronal and sagittal balance*

✓*Must include the stable vertebra*

✓*Avoid fusion below L3 if possible, associated with high incidence of long term back pain*

✓*Avoid excessive distraction*

✓*Appropriate use of bone graft*

✓*Rigid fixation*

Outline the principles of treatment of this condition?

❖***Surgery***

- ***Posterior spinal fusion****: cobb angle > 45 degree- can be used for all types of idiopathic scoliosis- remains gold standard for thoracic and double major curves (most cases)*
- ***Anterior spinal fusion****: best for thoracolumbar and lumbar cases with a normal sagittal profile*
- ***Anterior/Posterior fusion****: considered for larges curves (> 75°) or stiff curves- young age (Risser grade 0, girls <10 yrs, boys < 13 yrs) in order to prevent crankshaft phenomenon*

Viva 13

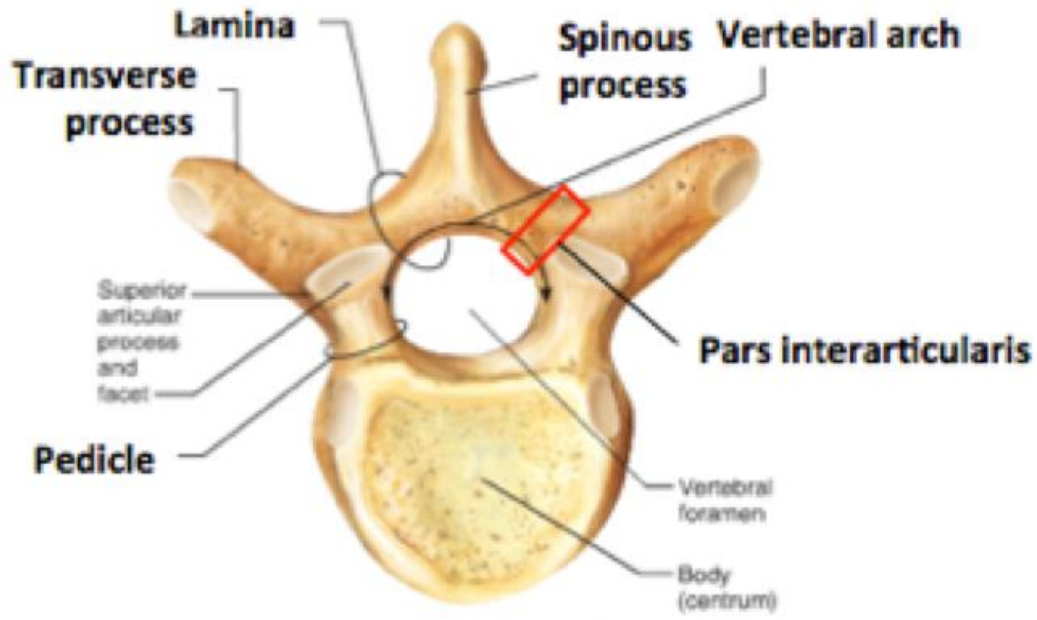
- What can you see?
- Are you aware of any classification system of this condition?
- What are the clinical features?
- What are the different imaging modalities used for diagnosis and assessment of this condition?
- How do treat it?

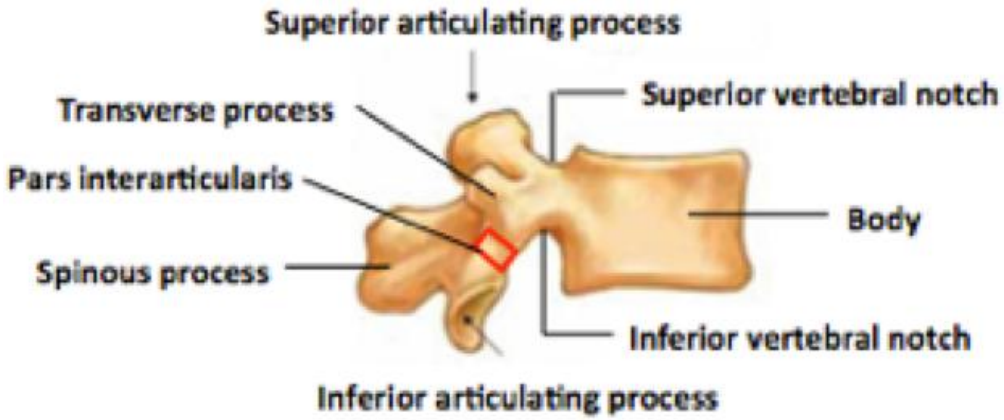
What can you see?

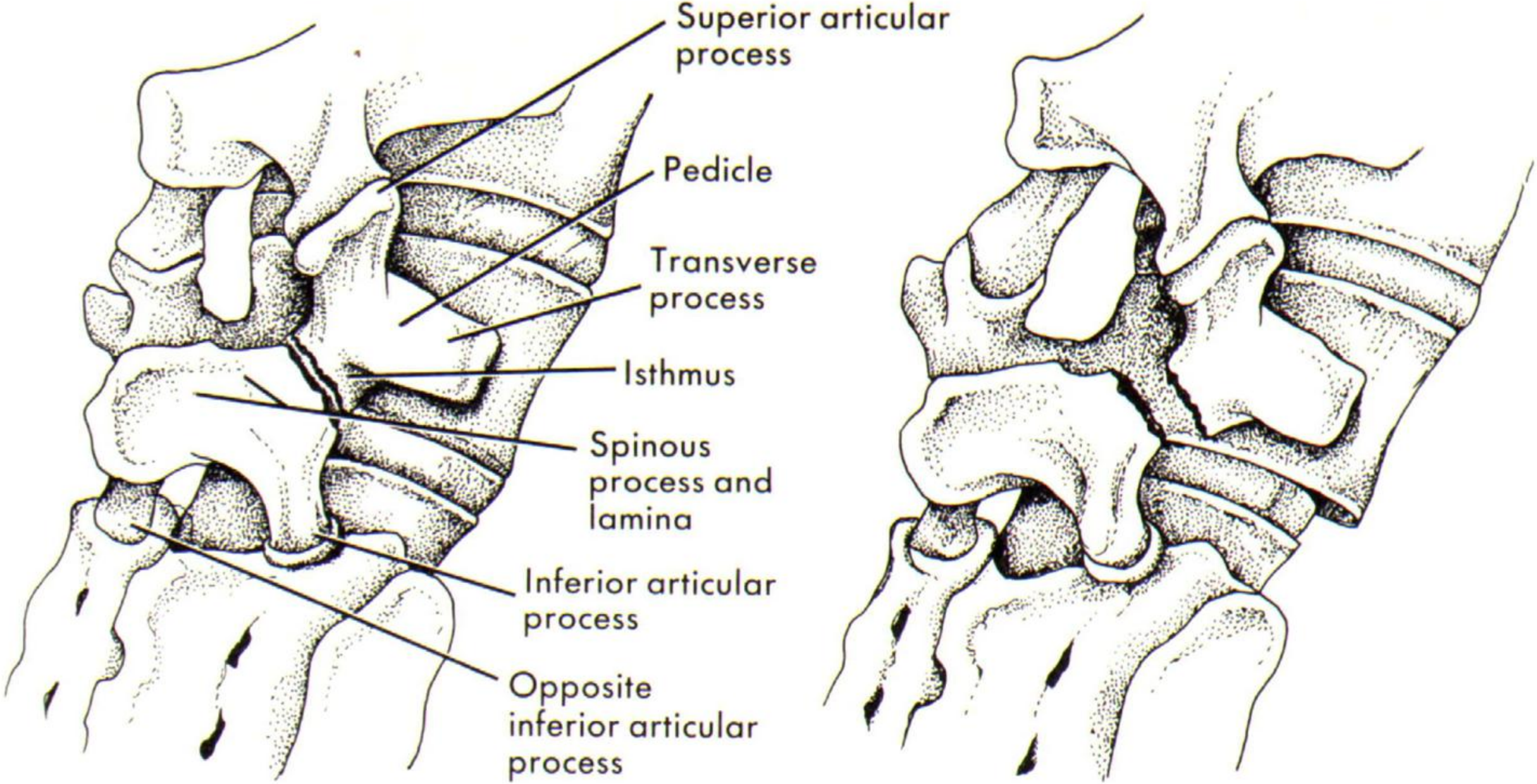
- *This is an oblique radiograph (Scotty dog) of the lumbar spine that showed L5 pars defect (spondylosis) without listhesis.*
- *It is a common cause of low back pain in children and adolescents.*
- *Approximately 15% of individuals with a pars interarticularis lesion will have progression to spondylolisthesis*
- *most common at L5-S1 (90%) in adolescents and adults. Degenerative spondylolisthesis common at L4-L5.*
- *The parts of the dog are as follows: the transverse process-the nose; the pedicle-the eye; the pars interarticularis-the neck; the superior articular facet-the ear; the inferior articular facet-the front leg*

What is the pars interarticualris?

- Pars interarticularis refers to a small segment of bone that connects the superior and inferior articular facet of a single vertebra.






Superior articular process
Pedicle
Transverse process
Isthmus
Spinous process and lamina
Inferior articular process
Opposite inferior articular process

Are you aware of any classification system of this condition?

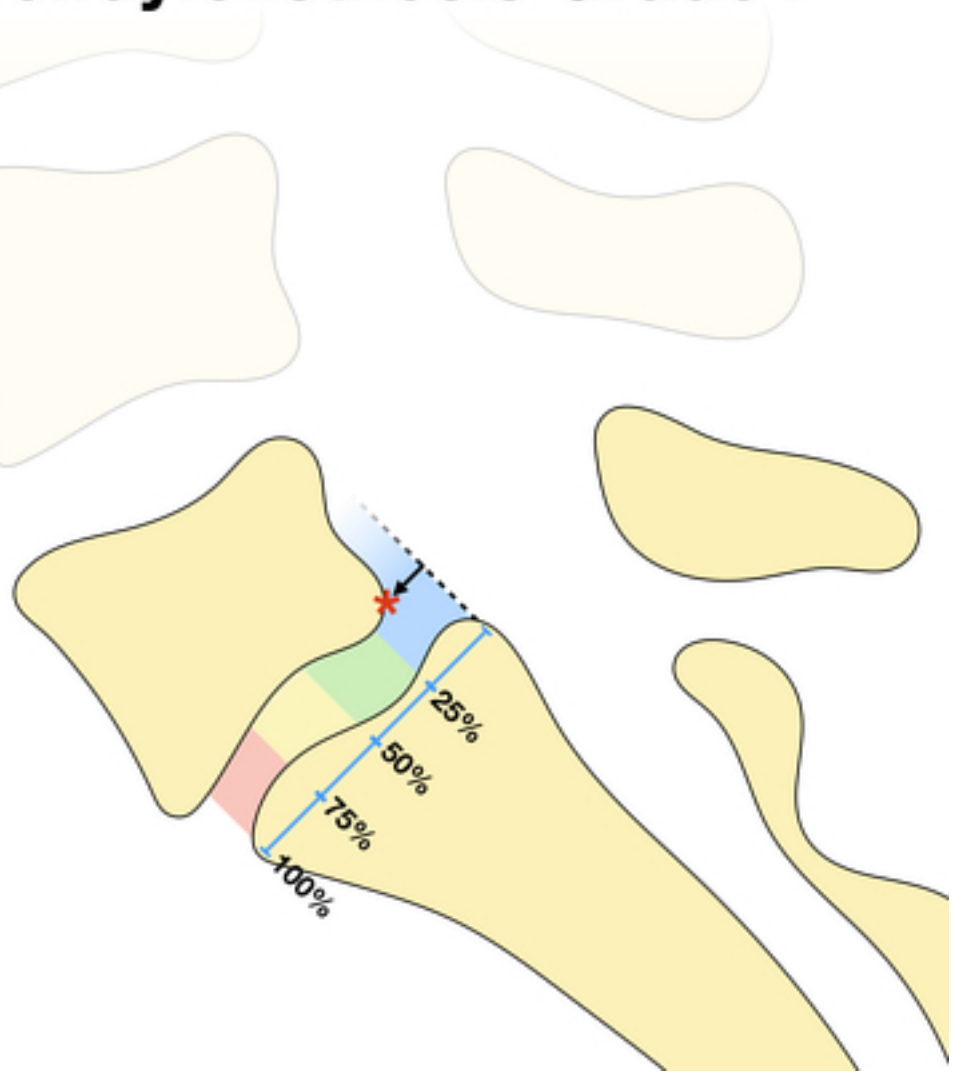
Wiltse-Newman Classification	
Type I	• Dysplastic • Secondary to congenital abnormalities of lumbosacral articulation including maloriented or hypoplastic facets, sacral deficiency, poorly developed pars • Posterior elements are intact (no spondylolysis) • More significant neurologic symptoms
Type II-A	• Isthmic - Pars Fatigue Fx
Type II-B	• Isthmic - Pars Elongation due to healed stress fx
Type II-C	• Isthmic - Pars Acute Fx
Type III	• Degenerative
Type IV	• Traumatic
Type V	• Neoplastic

Are you aware of any classification system of this condition?

Myerding Classification	
Grade I	• < 25%
Grade II	• 25-50%
Grade III	• 50-75%
Grade IV	• 75-100%
Grade V	• Spondyloptosis

Instability is defined when there is more than 4 mm translation of the vertebra on dynamic views

Spondylolisthesis Grade I



What are the clinical features?

➢Symptoms:

- *most cases of spondylolysis are asymptomatic*
- *symptoms include insidious onset of activity related low back pain and/or buttock pain*
- *neurologic symptoms include*
  - *hamstring tightness (most common) and knee contracture*
  - *radicular pain (L5 nerve root)*
  - *bowel and bladder symptoms*
  - *cauda equina syndrome (rare)*
- *listhetic crisis*
  - *severe back pain aggravated by extension and relieved by rest*
  - *neurologic deficit*
  - *hamstring spasm - walk with a crouched gait*

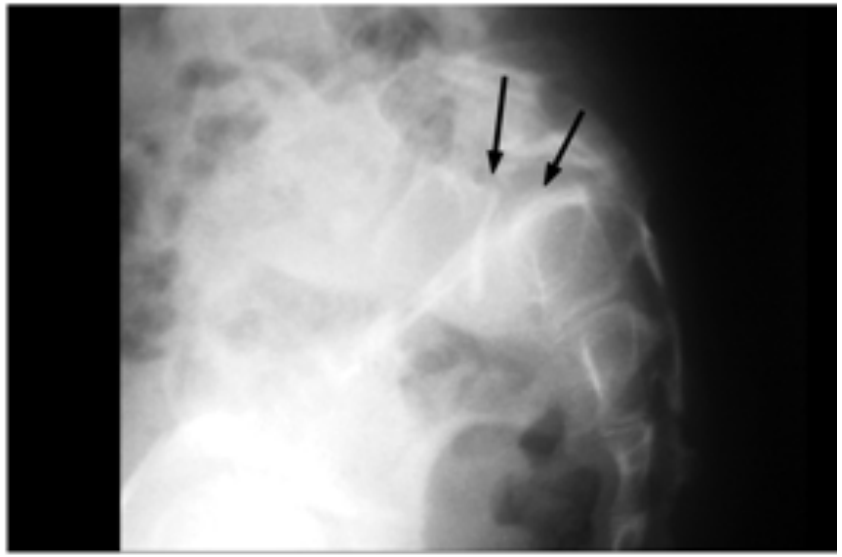
What are the clinical features?

➢Physical exam

- *flattened lumbar lordosis with marked transverse creases in the skin across both loins.*
- *palpable step off of spinous process*
- *limitation of lumbar flexion and extension*
- *pain with single-limb standing lumbar extension (characteristic)*
- *measure popliteal angle to evaluate for hamstring tightness*
- *neurologic exam*
- *straight leg raise may be positive*
- *rectal exam if bowel and bladder symptoms present*

A

B



C

What are the different imaging modalities used for diagnosis and assessment of this condition?

➢Radiograph

- *A/P – lateral (neutral – flexion – extension) – oblique views.*

➢*CT*

- *best study to diagnose and delineate anatomy of lesion*

➢*Single photon emission computer tomography (SPECT)*

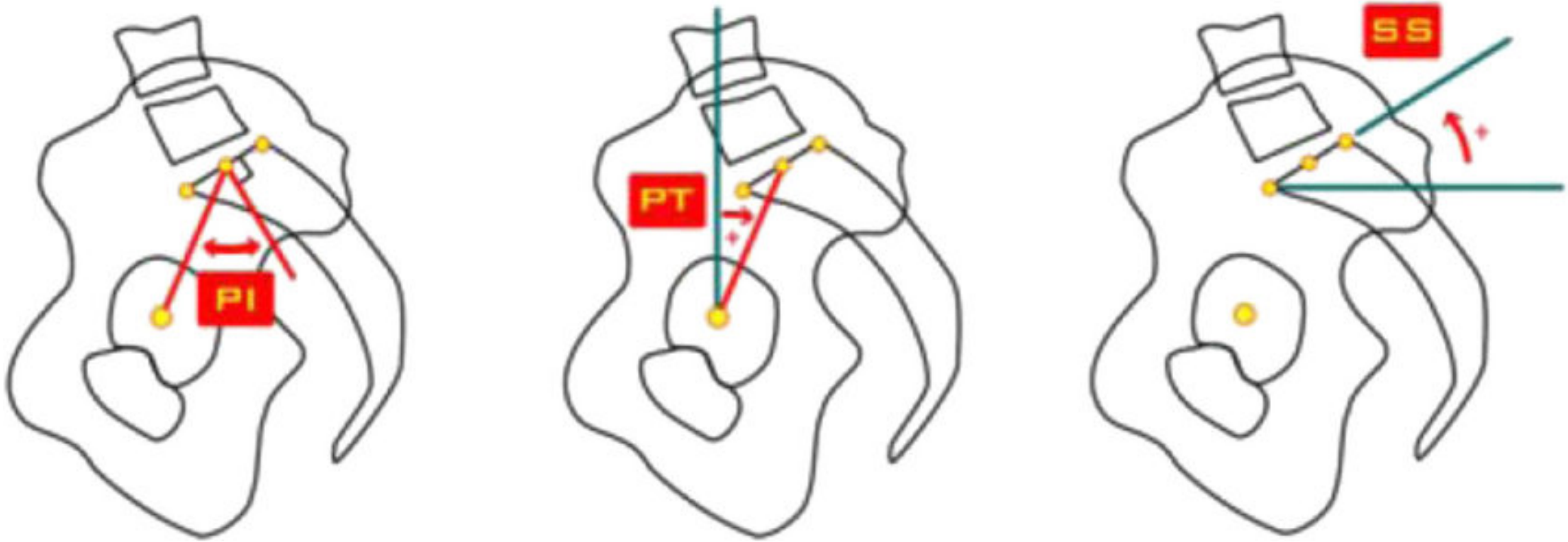
- *best diagnostic adjunct when plain radiographs are negative*

What are the different imaging modalities used for diagnosis and assessment of this condition?

➢Measurement

- *Slip grade*
- *Pelvic incidence: correlates with the severity*
- *Pelvic tilt*
- *Sacral slop*

PI = PT + SS



Mean PI 51
Mean PT 12
Mean SS 38

How can you calculate the lumbar lordosis

how do you treat it ?

- Nonoperative
  analgesia and NSAIDs, activity modifications, physiotherapy

how do you treat it ?

- Operative: the goal to reduce the slip if possible and improve the sagittal balance
  - L5-S1 decompression and instrumented fusion +/- reduction:
    - Indications:
    1. L5-S1 low-grade spondylolisthesis with persistent pain that failed 6 months of nonoperative management (most common)
    2. progressive neurologic deficit
    3. slip progression
    4. cauda equina syndrome

  complication: risk of stretch injury to L5 nerve root with reduction
  - L4-S1 decompression and instrumented fusion +/- reduction
    - L5-S1 high-grade spondylolithesis with persistent pain that has failed 6 months of nonoperative management

Saggital balance

Viva 14

What is ankylosing spondylitis?

- *Systemic chronic autoimmune seronegative spondyloarthropathy of unknown etiology that primarily affects axial spine, characterized by positive HLA B27 in 90% of cases.*
- *More common in males than females 2:1 to 10:1.*
- *Presents in the 3rd to 4th decades of life.*
- *The hip joint is involved in 30 to 50% of cases and usually bilateral*

What is the Pathoanatomy?

- *The exact mechanism is unknown, but most likely due to an autoimmune reaction to an environmental pathogen in a genetically susceptible individual.*

What are the clinical features?

- *Symptoms*

➢ *Insidious onset of low back pain.*

➢ *Neck and upper thoracic pain (occurs later in life)*

➢ *Morning stiffness*

➢ *shortness of breath caused by costovertebral joint involvement, leading to reduced chest expansion*

➢ *Ocular pain (anterior uveitis)*

What are the clinical features?

- *Physical examination*

➢ *Early: Hang-dog posture (rounding of the shoulders and slight dorsal kyphosis). Later: stoop develops with limitation of forward vision with thoracolumbar kyphosis and flexion deformities of the hip (question mark posture)*

➢ *Loss of lumbar lordosis.*

➢ *Chin – brow to vertical angle: used to measure chin-on-chest deformity, useful for preoperative planning for osteotomy.*

➢ *Occiput to wall distance. Unable to stand with his back flush against wall.*

➢ *Fixed flexion deformity of hip joints*

➢ *Reduced chest expansion. Measures at the level of the nipples from full expiration to full inspiration, it is reduced to 3cm compared to a normal expansion of 7cm.*

What are the clinical features?

- *Physical examination*

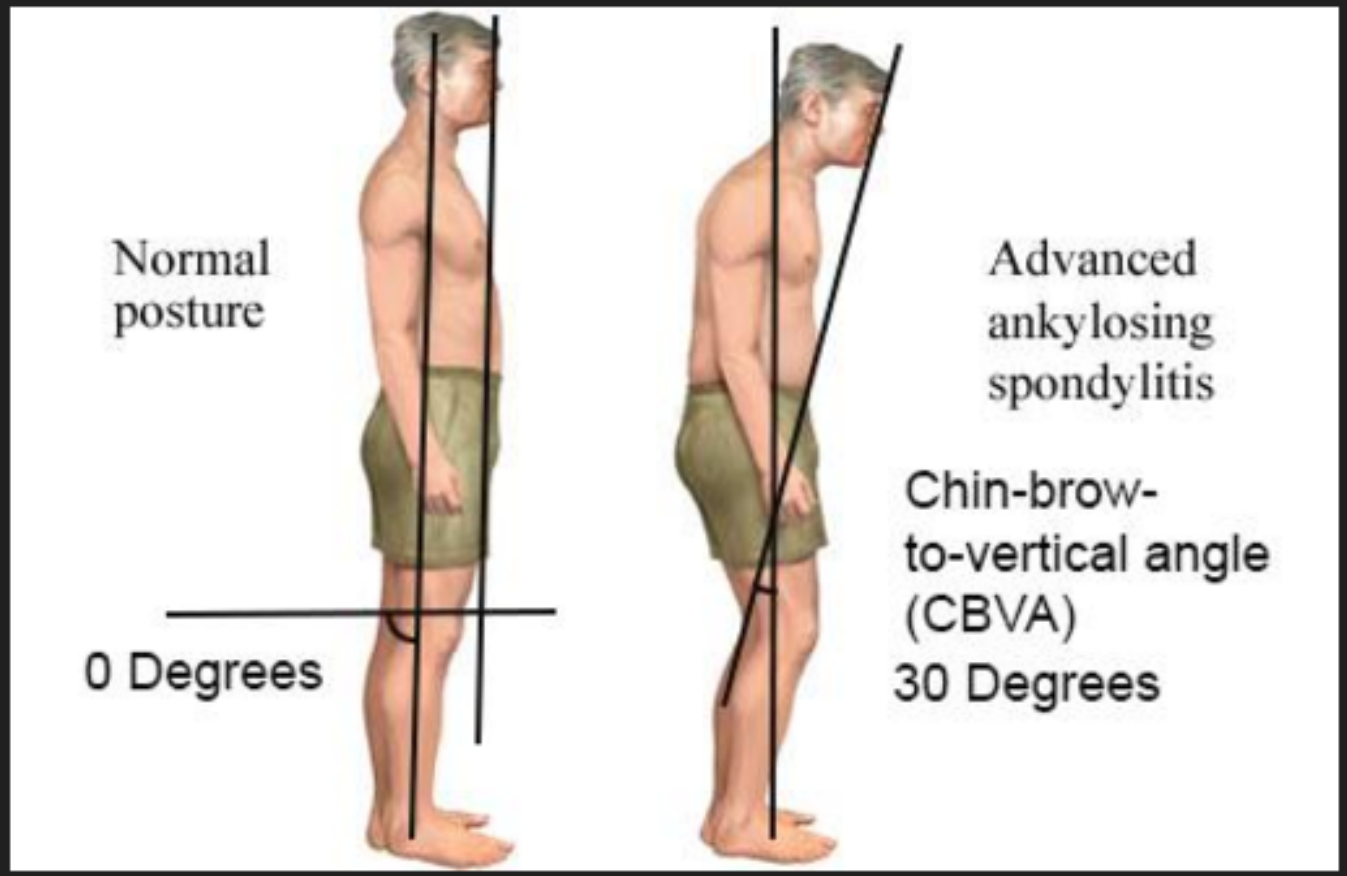
➢ *Limited spinal movements.*

➢ *Schober's test*

➢ *Limited hip motions.*

➢ *Positive Faber test (Sacroiliitis)*

➢ *Tenderness (Romanus lesion)*



Shows Chin-Brow to Vertical angle in a normal patient and a patient with AS. The CVBA is used to measure the kyphotic deformity in AS. It is the angle measured between a vertical line and a line connecting the brow to the chin. It can be measured in a standing individual or a lateral standing radiograph. Normal is 0 degrees. Correction of this angle with surgical treatment has been shown to correlate with surgical outcomes.

What are the extraskeletal manifestations?

- *Heart disease (carditis – aortic valve disease)*
- *Lung: pulmonary fibrosis*
- *Renal amyloidosis*
- *Uveitis*
- *Klebsilella pneumoniae synovitis. HLA-B27 individuals are more susceptible to Klebsilella pneumoniae synovitis*

What is the diagnostic criteria of AS?

- *Bilateral sacroiliitis.*
- *HLA-B27 positive*
- *+/- uveitis*

What are radiographic features of AS?

- ***Spine (standing full length A/P & letaral)***

➢ *Early: squaring of the vertebral body due flattening of the normal anterior concavity and ossification of ALL.*

➢ *Erosion and fuzziness of the SI joints and then sclerosis, especially on the iliac side of the joint, joint narrowing, finally bony ankylosis and obliteration of the SI joints.*

➢ *Later: Ankylosis of the facet joints, ossification of the annulus fibrosus and marginal syndesmophyte formation. (bamboo spine)*

❖ *Radiographic differential diagnosis of SI joints lesions*

✓ *Reiter's disease*

✓ *Psoriatic arthritis*


R

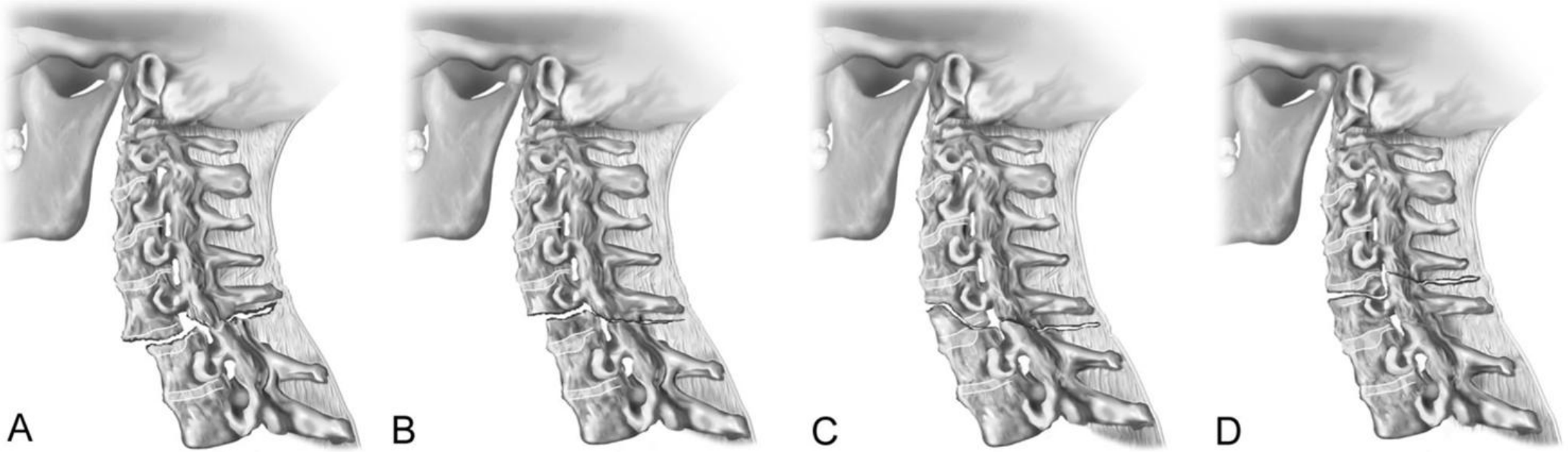
What are radiographic features of AS?

- ***Pelvis***

➢ *Furgeson pelvic tilt view: allows better visualization of SI joints. X-ray beam is directed 10 to 15 degrees cephalad*

➢ *Acetabuli protrusion*

Caron classification
of spine fractures in ankylosing spondylitis (Type A, disc injury; Type B, body injury; Type C, anterior body, posterior disc injury; Type D, anterior disc, posterior body injury).



Treatment

- ***General***

➢ *NSAIDs: 1st line of treatment*

➢ *TNF – alpha – blocking agents: 2nd line of medical treatment*

➢ *Steroids: not recommended*

Treatment

- ***Hip***

➢ *Hip injection: if there is any uncertainty whether pain is arising from the hip joint or spine.*

➢ *THA is considered before spinal osteotomy because improvement in the hip's ROM and pain relief may obviate the need for spinal osteotomy*

➢ *Technical difficulties:*

✓ *Delicate skin and soft tissues (adequate release of soft tissue)*

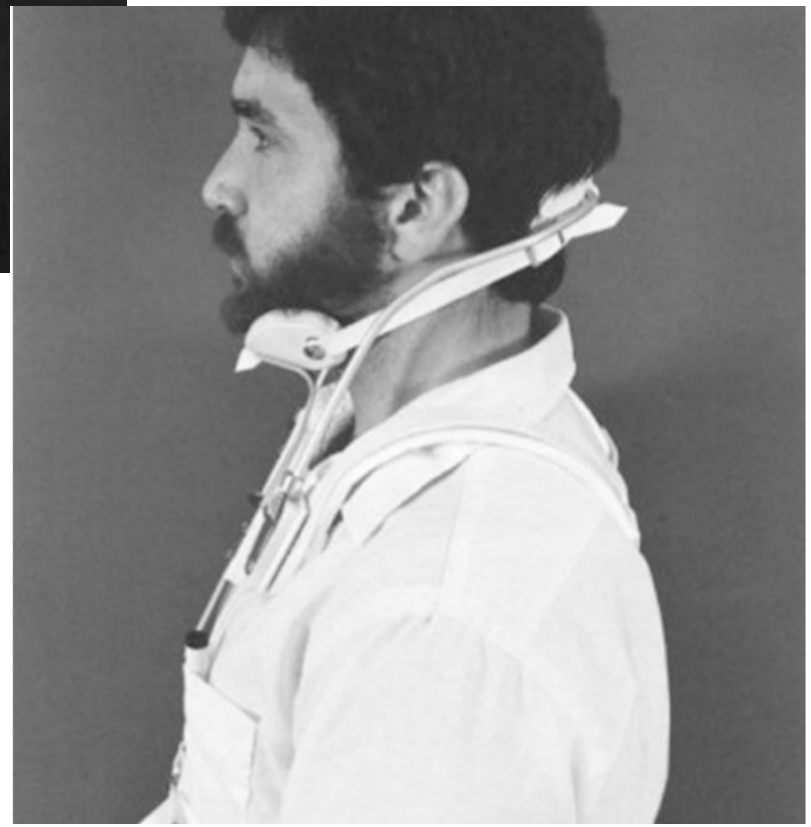
✓ *Correction of long standing contractures.*

✓ *Because of the relative hyperextension of the hips after THA, patients with AS are more prone to anterior dislocation when acetabular components are placed in their normal position relative to the pelvis*

✓ *Higher incidence of HO*

Viva 6

Name these devices



Name these devices

- *Philadelphia collar: It is a rigid neck collar that restricts flexion and extension of the cervical spine, but allows minor rotation and lateral bending. It is made of two pieces, a front and a back, that are held together with Velcro straps. This is typically worn following cervical fusion, cervical strain, or certain fractures that are not considered highly unstable.*
- *Cervico-thoracic brace: A neck brace attached to a two-piece thoracic padded jacket. It is used to restrict neck and upper back movement after cervical spine surgery, or certain injuries including less unstable fractures*