CERVICAL INSTABILITY

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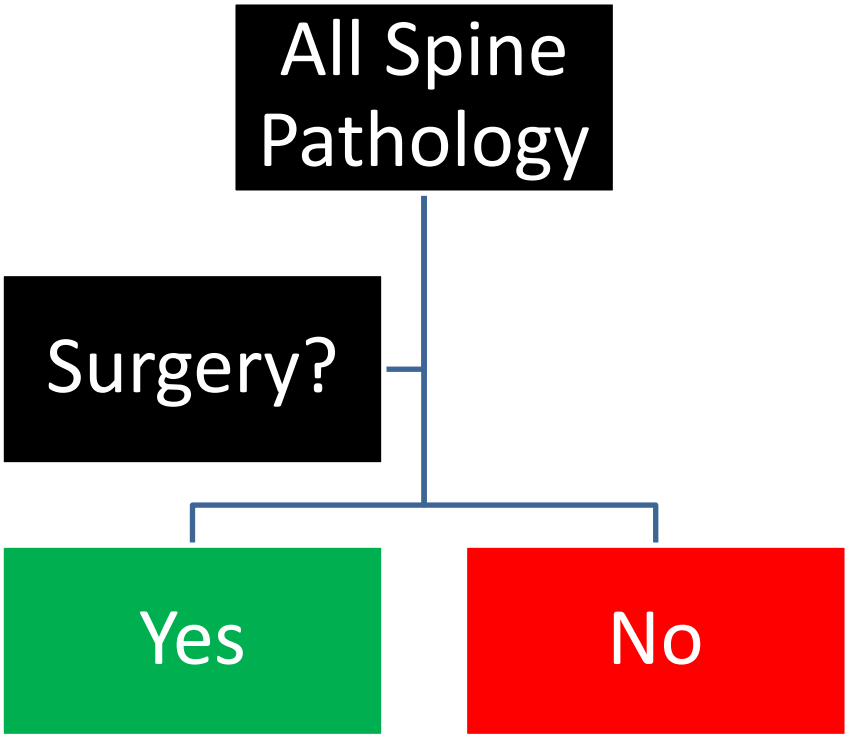
DISCLOSURES

- I have no relevant disclosures other than I'm a surgeon so I tend to use the following treatment algorithm for everything.



Introduction

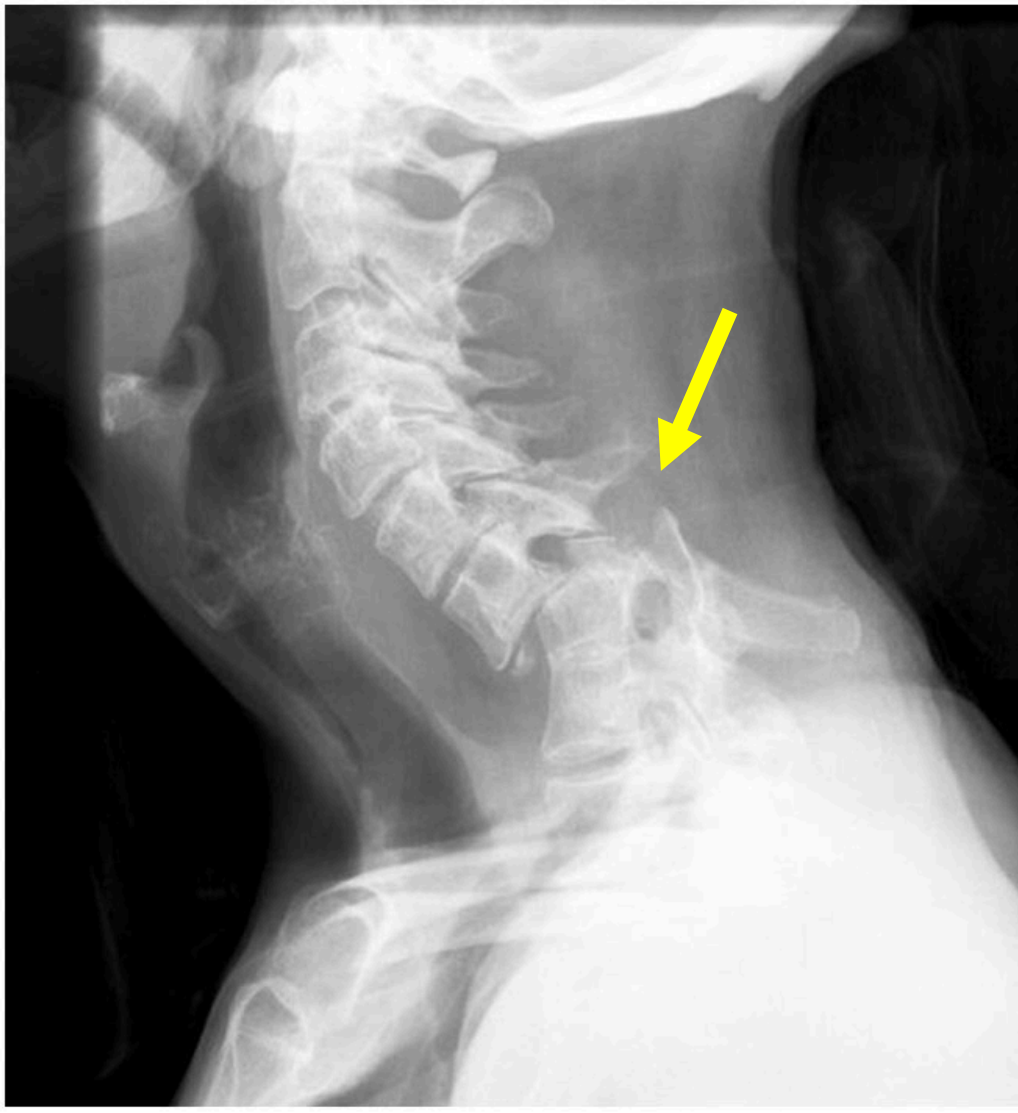
- The motion afforded to the cervical spine by its anatomy also predisposes it to risk of injury and instability.
- Cervical instability can be a cause for neck pain and/or neurological deficits.
- However, the concept is often ambiguous and poorly defined.

Introduction

- Spinal stability is defined as the ability of the spine under physiological loads to limit patterns of displacement so as not to damage or irritate the spinal cord or nerve roots.
- Although we try to divide patients into stable vs unstable, instability exists along a continuum.

Kwon BK, Vaccaro AR, Grauer JN, Fisher CG, Dvorak MF. Subaxial cervical spine trauma. J Am Acad Orthop Surg. 2006 Feb;14(2):78-89. doi: 10.5435/00124635-200602000-00003. PMID: 16467183.

Introduction

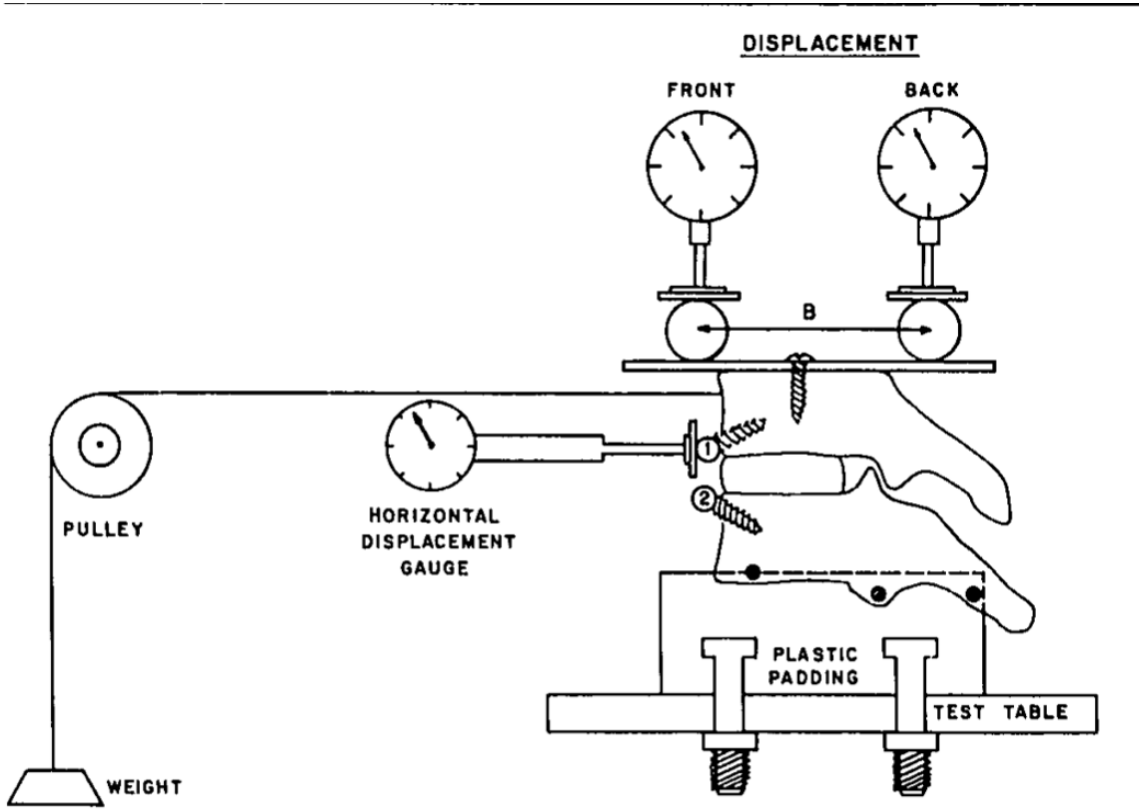


The Original Paper

- AA White 3rd, RM Johnson, MM Panjabi, W O Southwick, *Biomechanical analysis of clinical stability in the cervical spine,* Clin Orthop Relat Res 1975;(109):85-96.

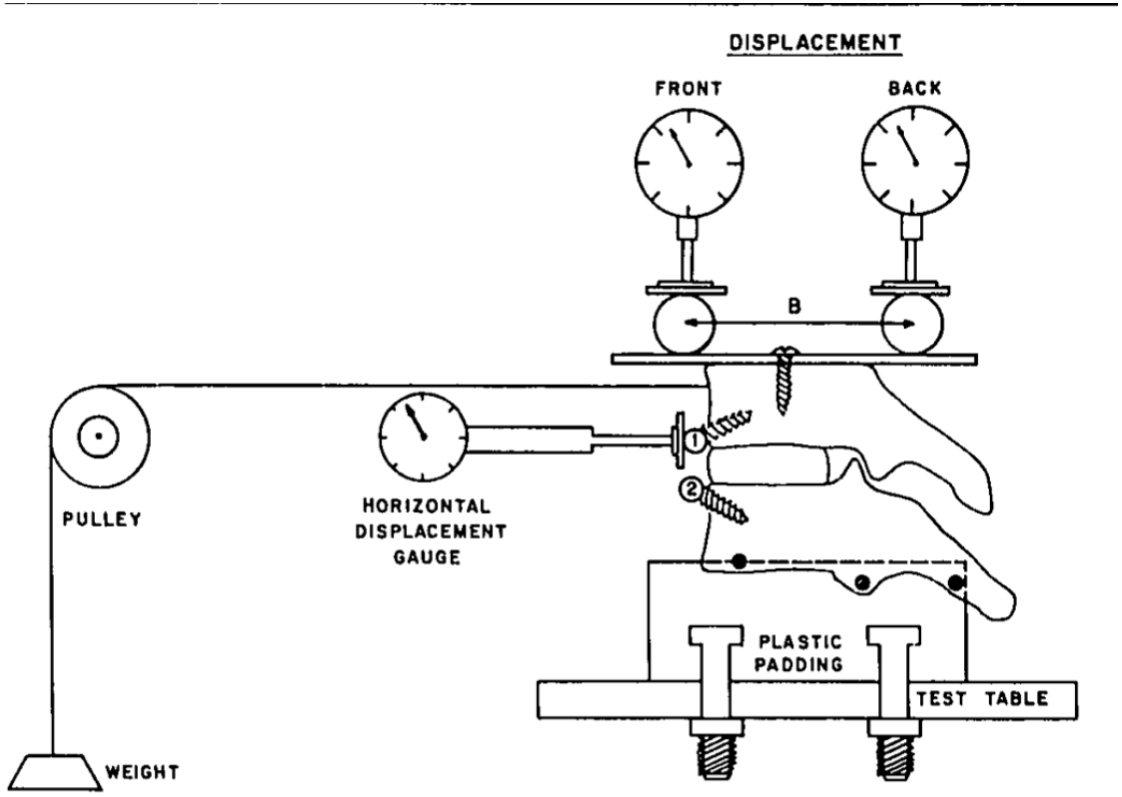
Methods

- This study was undertaken to examine clinical instability of the cervical spine below C2.
- Quantitative analysis of the behavior of the spine as a function of the systematic destruction of various anatomic elements.



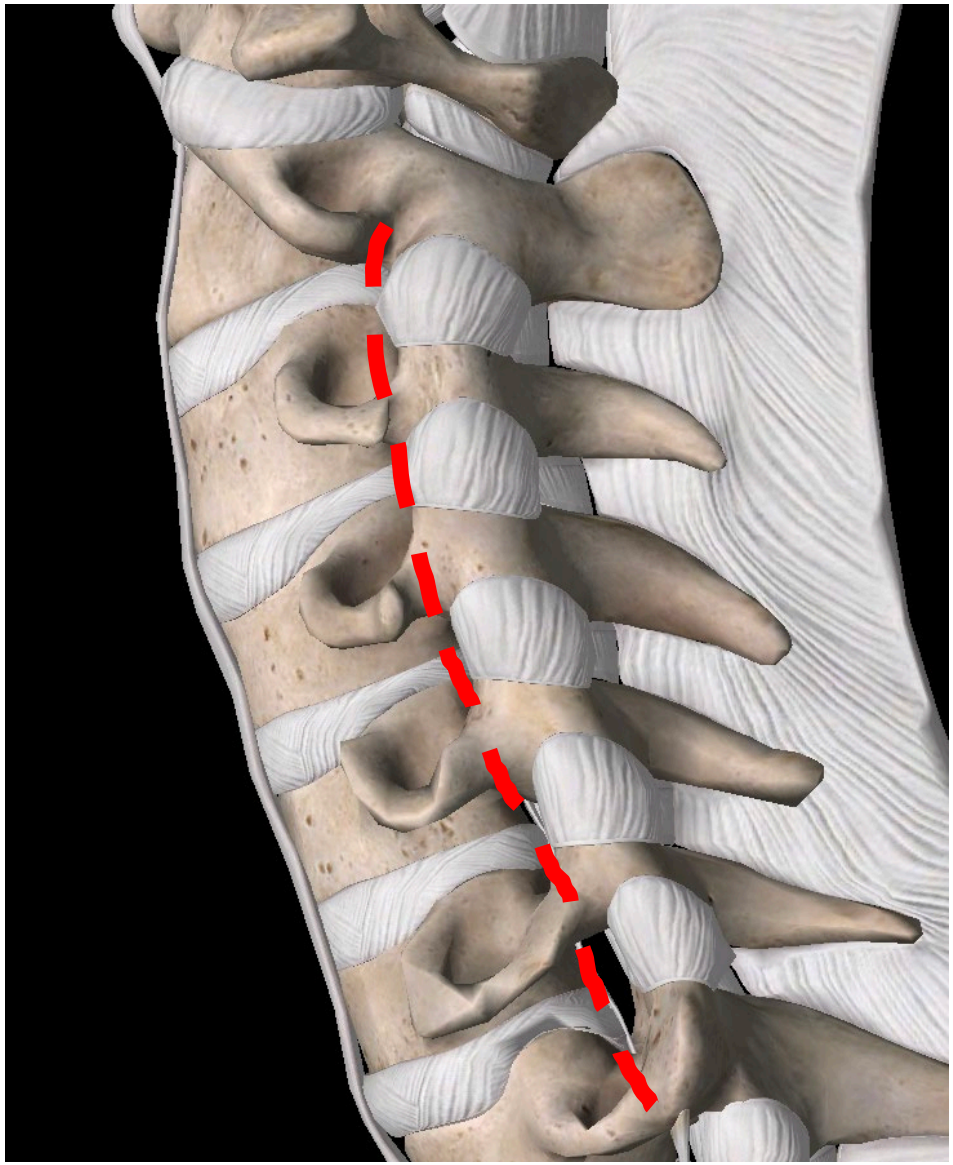
Methods

- 17 motion segments from 8 cervical spines were analyzed.
- The spines were studied with either flexion or extension simulated using physiologic loads.



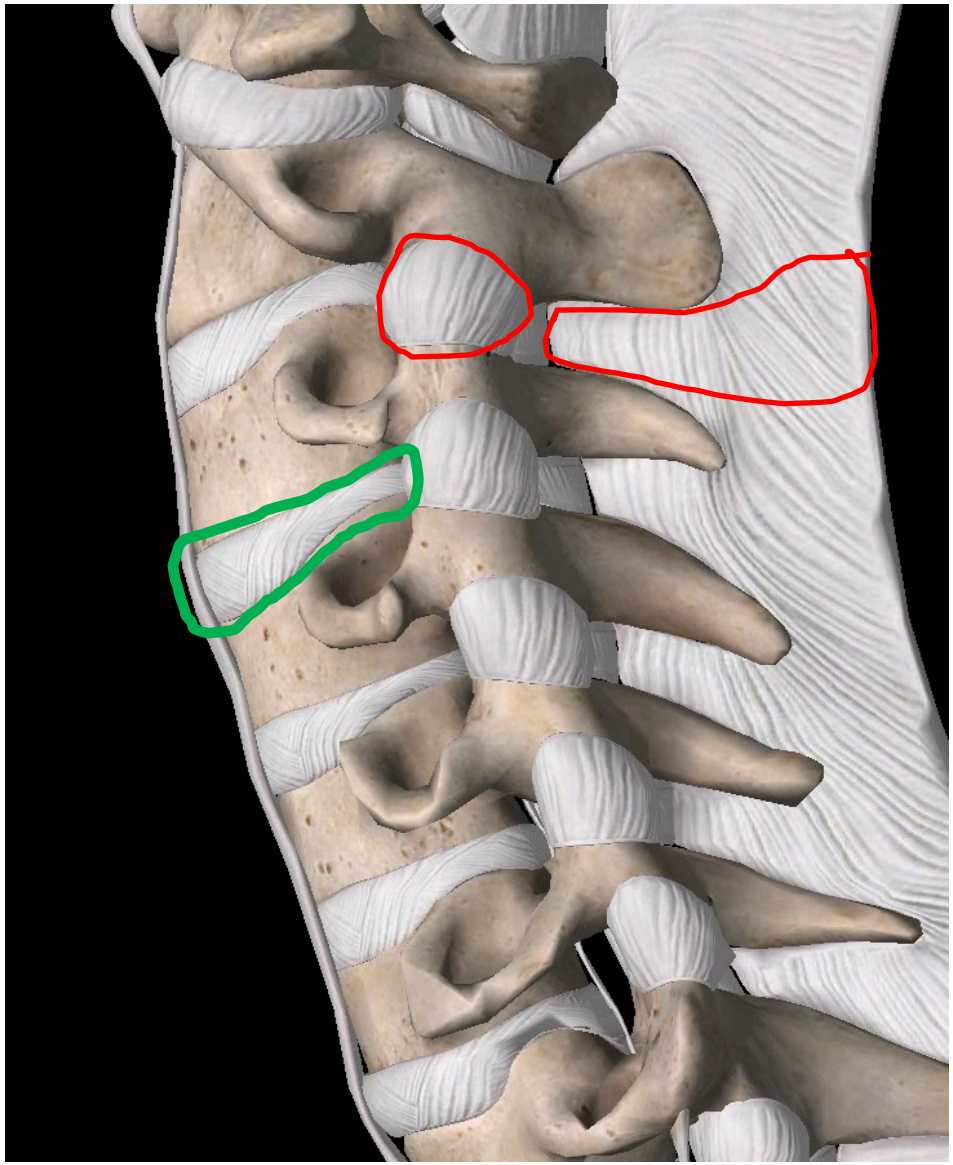
DEFINITIONS

- Anterior vs Posterior Elements – divided along the Posterior Longitudinal Ligament



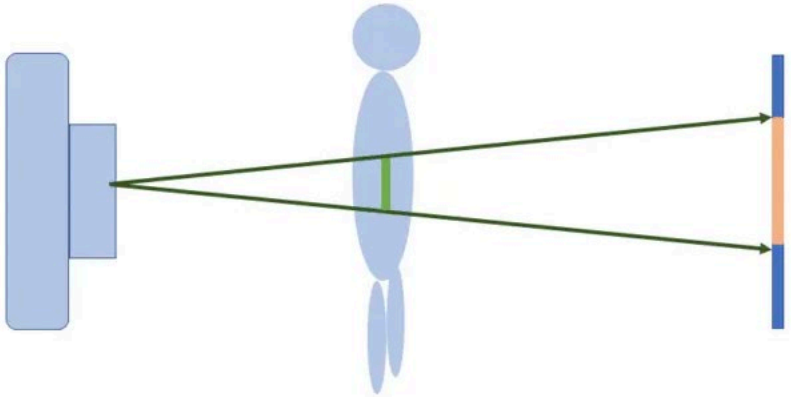
RESULTS

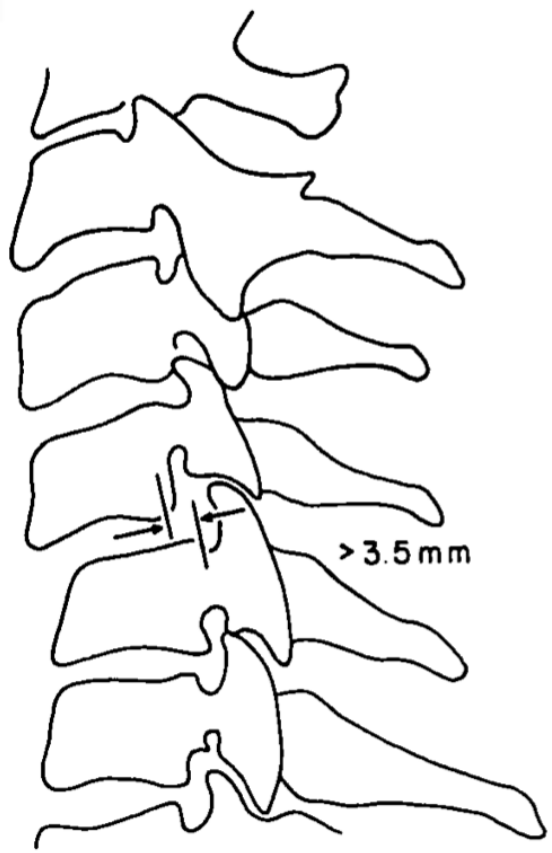
- The posterior ligaments contributed more to stability in flexion than the anterior structures.
- The anterior ligaments contribute more to stability in extension than the posterior ligaments.
- In general, a majority of ligaments had to be transected before failure occurred. Failure of the specimens usually occurred suddenly and completely without warning.



RESULTS

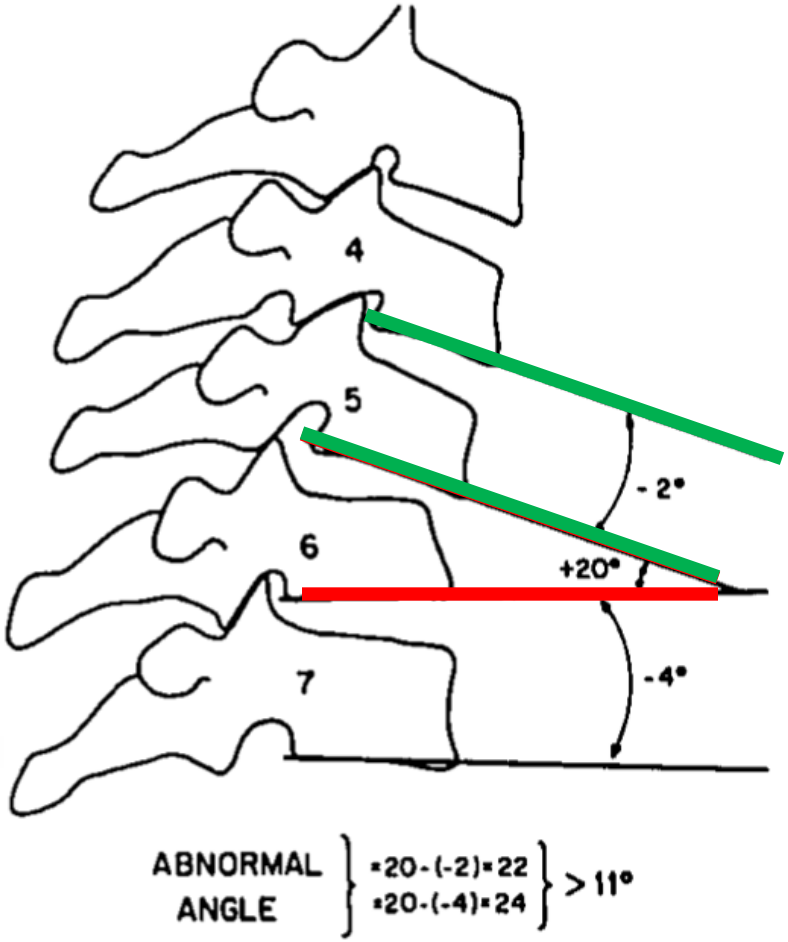
- No motion segment with less than 2.7mm of displacement was unstable.
- This number was then adjusted to 3.5mm for x-ray measurements due to x-ray magnification.





RESULTS

- No motion segment with less than 10.7° of angular displacement went on to failure. This angle was compared to the vertebrae in neutral position.
- In real life, we usually don't know what that vertebrae looked like before and so if there is angulation >11° compared to either normal adjacent vertebra then the vertebrae is considered unstable.



CONCLUSIONS

- The adult cervical spine is unstable, or on the brink of instability, when any of the following conditions are present:

  a) All the anterior or all the posterior elements are destroyed or unable to function.

  b) More than 3.5 mm horizontal displacement of one vertebra in relation to an adjacent vertebra measured on lateral roentgenograms (resting or flexion-extension).

  c) More than 11 degrees of rotation difference to that of either adjacent vertebra measured on a resting lateral or flexion-extension roentgenogram.

- LIMITATIONS: This is a study based on traumatic sectioning of ligaments. May not be as relevant to chronic degenerative setting.

HOW HAVE WE EVOLVED SINCE THEN?

- In current clinical setting, if you suspect instability you have access to MRI's and CT scan's so you can see what structures have been compromised.

- This information can then be used to suspect instability and in which direction based on structures that are compromised.

ANY NEW CRITERIA?

- In a 2011 systemic review of degenerative cervical spondylolisthesis, Jiang *et al.* found differing criteria for defining cervical instability, ranging from 1 to 3.5 mm of displacement in flexion/ extension lateral cervical radiographs.

International Orthopaedics (SICOT) (2011) 35:869–875
DOI 10.1007/s00264-010-1203-5

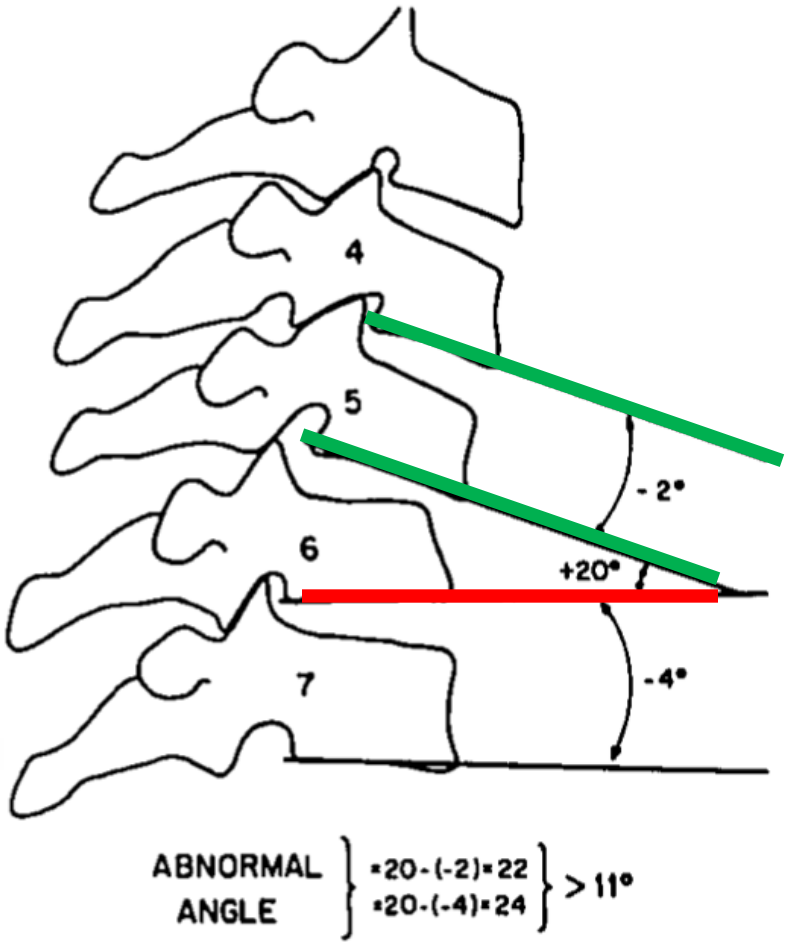
ANY NEW CRITERIA?

- In an analysis of 58 patients treated with anterior cervical discectomy and fusion, Dean et al. defined instability as >1-mm translational motion on flexion/extension view but deemed 3 mm or more on standard or flexion/extension view to be of significance.

Dean CL, Gabriel JP, Cassinelli EH, Bolesta MJ, Bohlman HH. Degenerative spondylolisthesis of the cervical spine: analysis of 58 patients treated with anterior cervical decompression and fusion. Spine J. 2009 Jun;9(6):439-46.

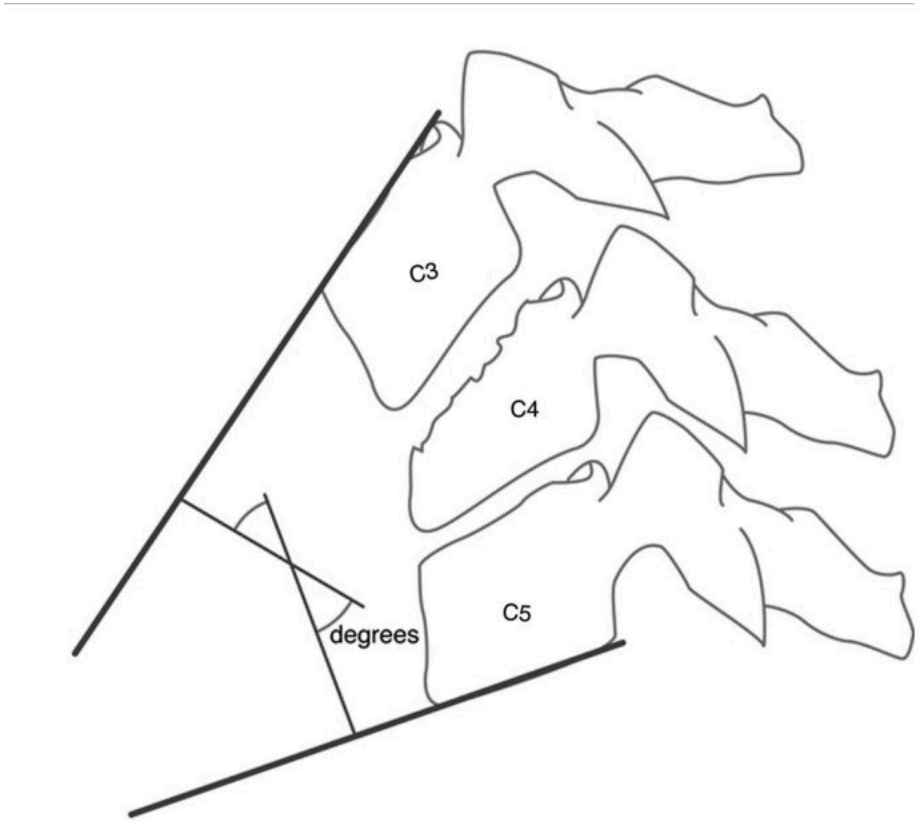
MEASUREMENT TECHNIQUES

- The Cobb Angle Method from Panjabi and White Paper using inferior endplates.



MEASUREMENT TECHNIQUES

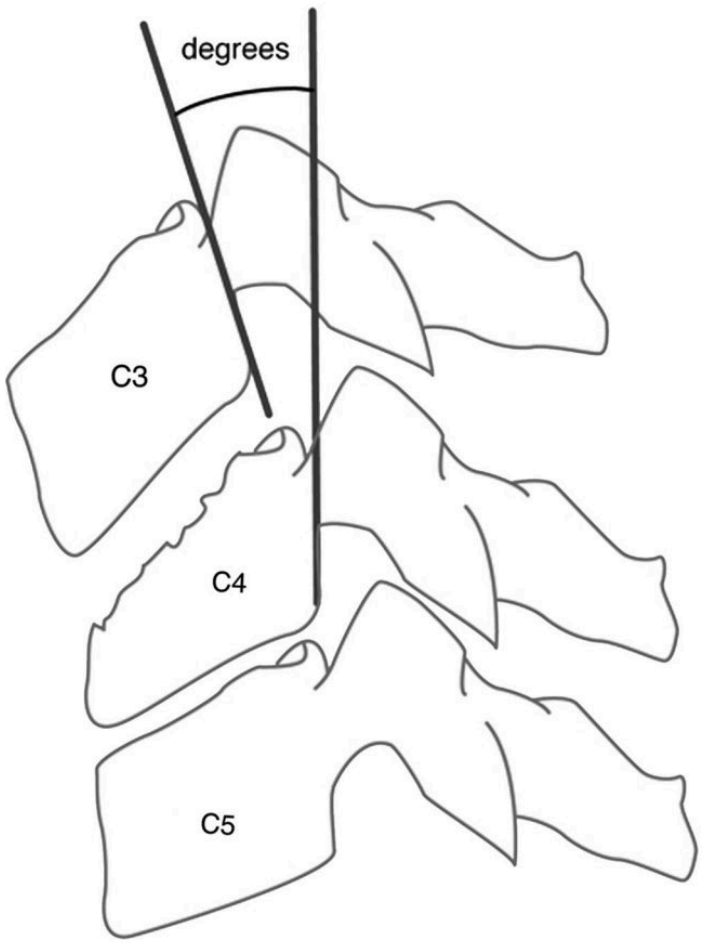
- The Cobb Angle Method from Spine Trauma Study Group
  - The Cobb method begins with marking the superior endplate of the cranial vertebral body and the inferior endplate of the caudad unaffected vertebrae.



Bono et al. Measurement Techniques for Lower Cervical Spine Injuries. Spine Volume 31, Number 5, pg 603-609

MEASUREMENT TECHNIQUES

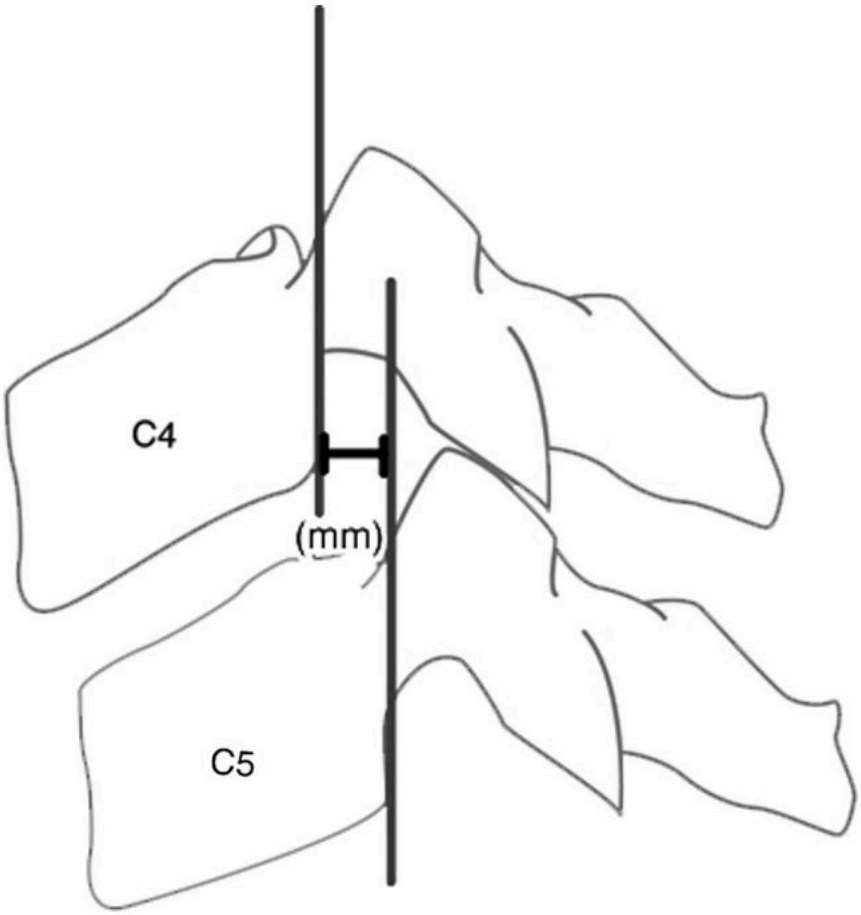
- The Posterior Vertebral Body Tangent Method
  - No Posterior Wall Involvement - lines are drawn at the fractured and next most cranial level.
  - In cases with posterior vertebral body involvement, the lines are drawn along next most cranial and caudal unaffected vertebrae.



Bono et al. Measurement Techniques for Lower Cervical Spine Injuries. Spine Volume 31, Number 5, pg 603-609

MEASUREMENT TECHNIQUES

- Sagittal Translation
  - Measured on lateral cervical plain films
  - Can also be measured on CT but the degree of translation may vary from side to side in which case the maximal translation is counted.



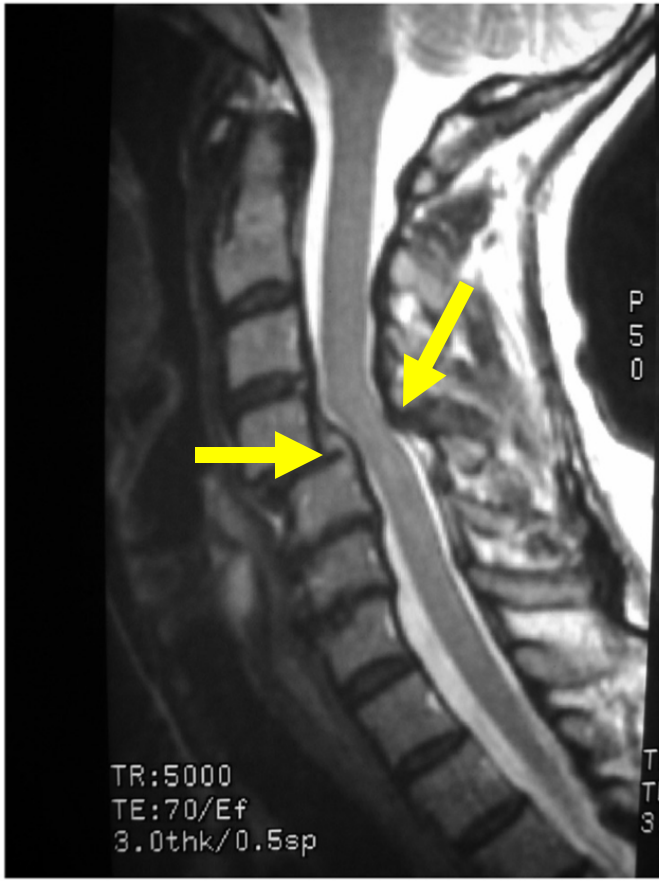
Bono et al. Measurement Techniques for Lower Cervical Spine Injuries. Spine Volume 31, Number 5, pg 603-609

CLINICAL MANIFESTATIONS

- Clinical manifestations of degenerative cervical spondylolisthesis can vary from patient to patient.
- As facet arthropathy and disc degeneration progress, patients may experience axial neck pain as their initial symptom.

CLINICAL MANIFESTATIONS

- Cord compression commonly occurs at the slip level by impingement between the posterior–superior aspect of the caudal vertebral body and ligamentum flavum.



CLINICAL MANIFESTATIONS

- Jiang et al.
  - 51% of patients had neck and/or occipital pain,
  - 52.9% had symptoms consistent with myelopathy
  - 22.5% presented with symptoms of radiculopathy
  - 11% had a mixed clinical picture of myeloradiculopathy.

CLINICAL MANIFESTATIONS

- Dean et al.
  - 65.5 % with axial neck or occipital pain
  - 48.3% with myelopathy
  - 31% with radiculopathy
  - 19% with mixed myeloradiculoapthy
  - Slip magnitude did not correlate to severity of clinical symptoms.

TYPES OF SPONDYLOLISTHESIS

- Dean classified 2 types of cervical degenerative spondylolisthesis.
  - Type I:
    - The most common type which occurs next to a stiff spondylotic cervical level. This type will have a relative preservation of disc height at the level of the spondylolisthesis. The most common slip level tends to occur at C4–5 followed by C3–4.
    - This type was more likely to have instability on dynamic radiographs due to the aforementioned transition.

Dean CL, Gabriel JP, Cassinelli EH, Bolesta MJ, Bohlman HH. Degenerative spondylolisthesis of the cervical spine: analysis of 58 patients treated with anterior cervical decompression and fusion. Spine J. 2009 Jun;9(6):439-46.

TYPES OF SPONDYLOLISTHESIS

- Type II
  - Less common
  - Occurs within spondylotic cervical segments and demonstrates more advanced disc degeneration and height collapse at the involved level.
  - Far less likely to have an instability pattern on dynamic radiographs when compared with type I.

HISTORY & EXAMINATION

- Paresthesias are common, usually in a global non-dermatomal pattern in both upper extremities.
- Subtle changes in gait and balance often precede clinically obvious weakness.
- As the things progresses, there will be impairments in fine motor control (ask about dropping objects out of their hands, handwriting, dexterity tasks such as buttons/zippers).
- Myelopathy patients usually have more compromise of proximal motor groups in lower extremities whereas those with lumbar stenosis have more distal weakness.

HISTORY & EXAMINATION

- Bowel and bladder dysfunction are a late sign and uncommon.

- Look for grip and intrinsic hand weakness/atrophy

HISTORY & EXAMINATION

- Perform a thorough Neurological Exam with Strength, Sensory and Reflex Testing in Upper and Lower Extremities.
  - C5: Deltoid
  - C6: Biceps
  - C7: Triceps
  - C8: Finger Flexors
  - T1: Hand Intrinsics
  - L1/2: Hip Flexion
  - L2/3: Knee Extension
  - L4: Tibialis Anterior
  - L5: EHL and Tibialis Anterior
  - S1: Gastrocenemius or Peroneal

HISTORY & EXAMINATION

- Sensory → Pick one spot for each dermatome and document if it is intact, diminished or absent.

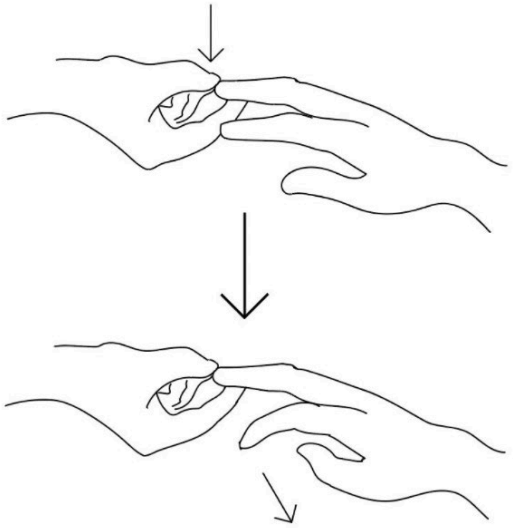
- Reflexes:
  - C5: Biceps
  - C6: Brachioradialis/Biceps
  - C7: Triceps
  - L3: Quadriceps
  - S1: Achilles

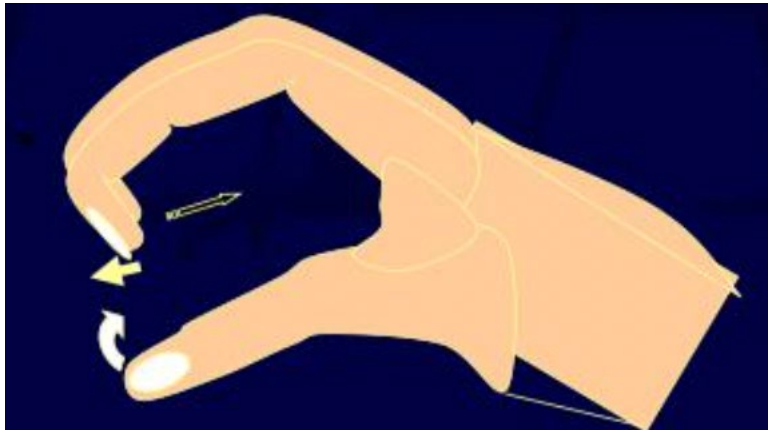
NEUROLOGICAL EXAMINATION

- In order to evaluate for myelopathy
  - Gait Imbalance (usually one of the first signs)
  - Ask or test dexterity issues with hands (buttons, zippers, handwriting etc..) – can do grip and release test (grip and release hands 25-30 times in 15 seconds – myelopathy patients tends to struggle

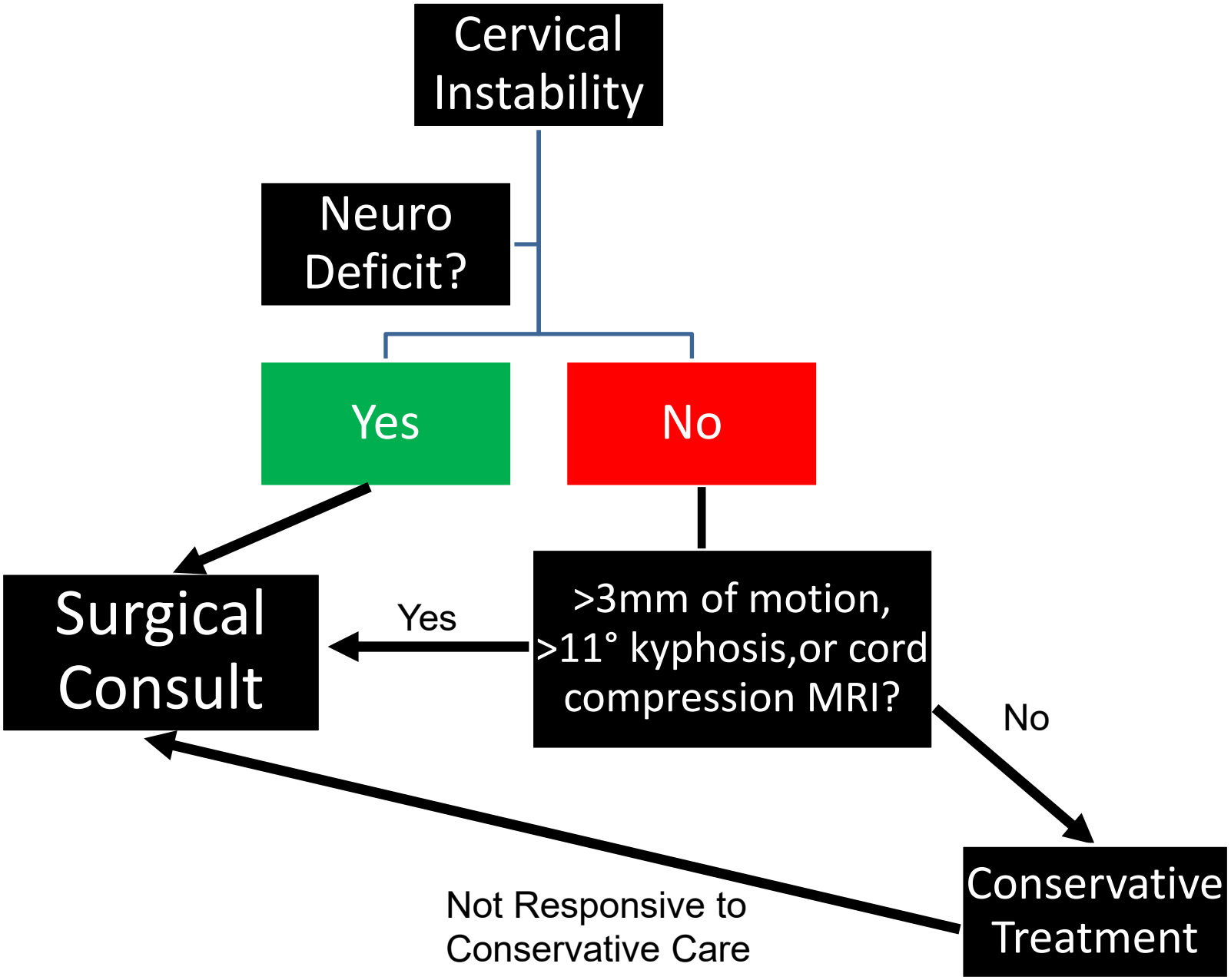
NEUROLOGICAL EXAMINATION

- Look for Pathological Reflexes
  - Presence of Hoffman reflex in hands
  - Upper and Lower Extremity Hyper-Reflexia
  - Inverted brachioradialis reflex – Finger flexion instead of wrist extension.
  - >4 beats of clonus





TREATMENT ALGORITHM



SURGICAL TREATMENT OPTIONS

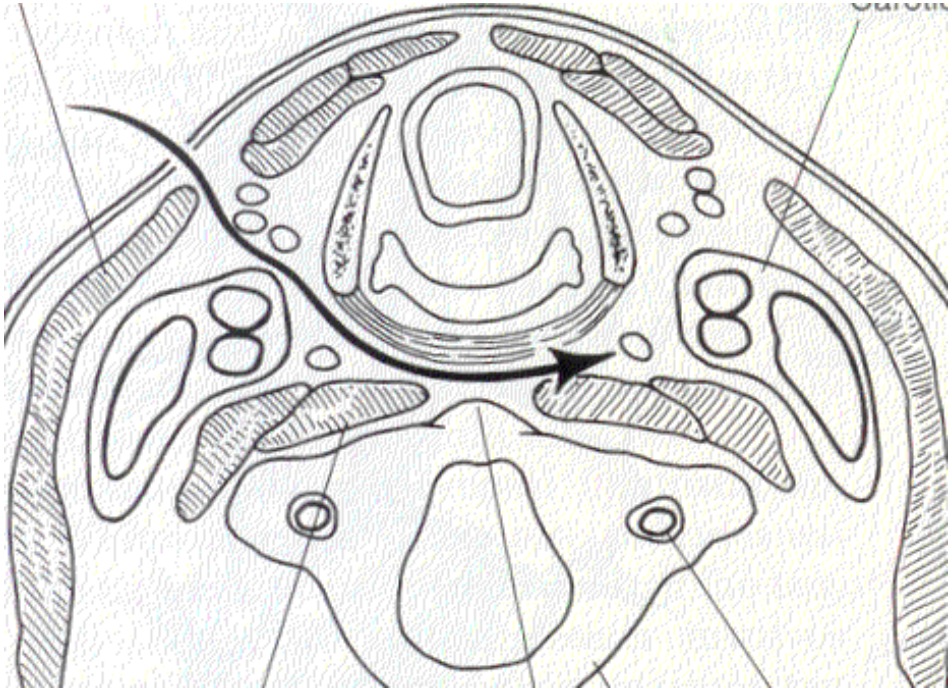
- Goal of surgery is neurological decompression and stabilization.

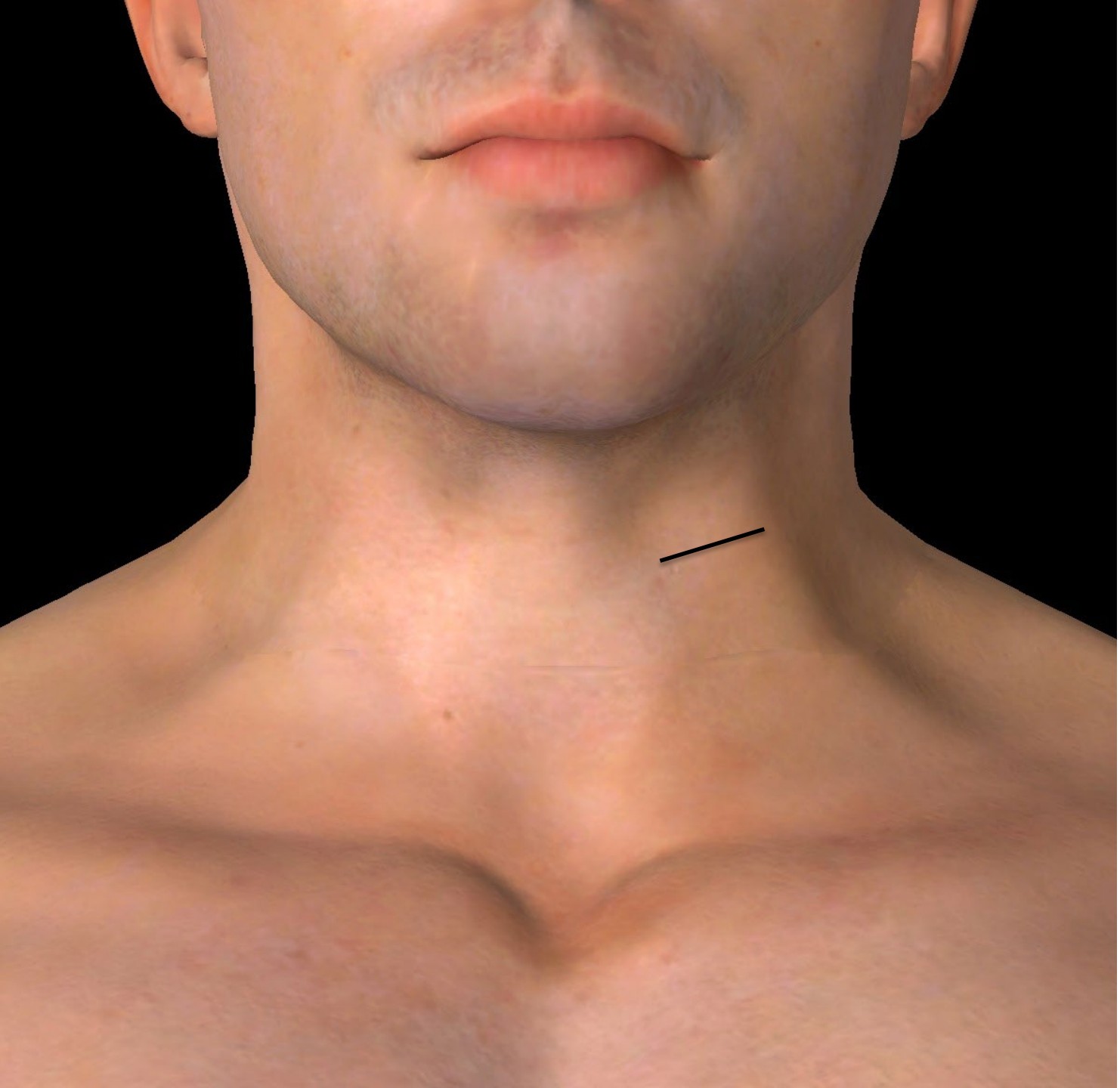
- 1 or 2 level Pathology – Typically done from an anterior approach
  - If the slip is reducible, can proceed with anterior cervical discectomy and fusion
  - If fixed in position, may need corpectomy to remove the inferior vertebral body
- > 3 levels – Typically done posteriorly

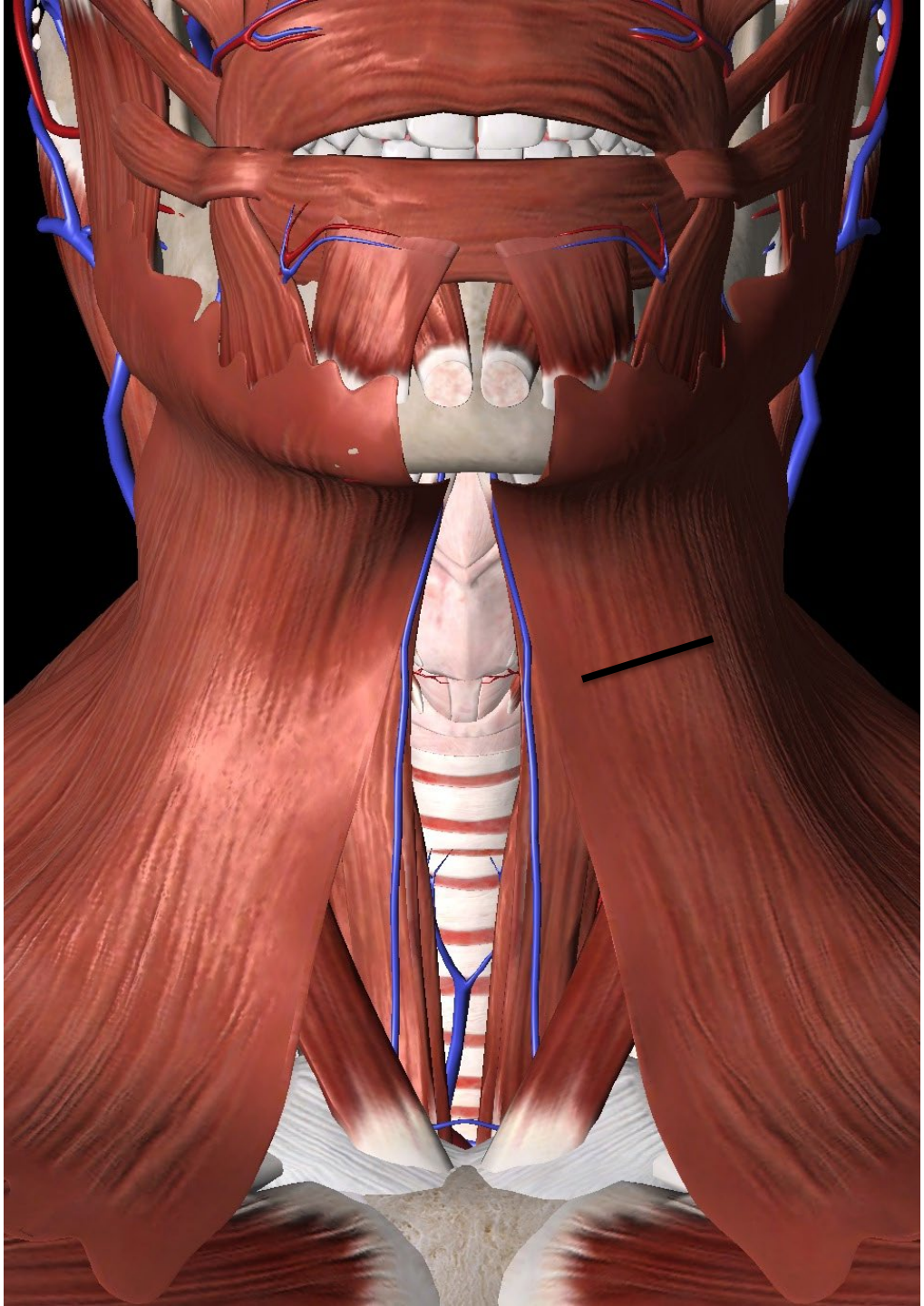
- May need combined anterior-posterior approach if cord compression is severe (>60% canal compression) or if poor bone quality, severe structural deformity etc.

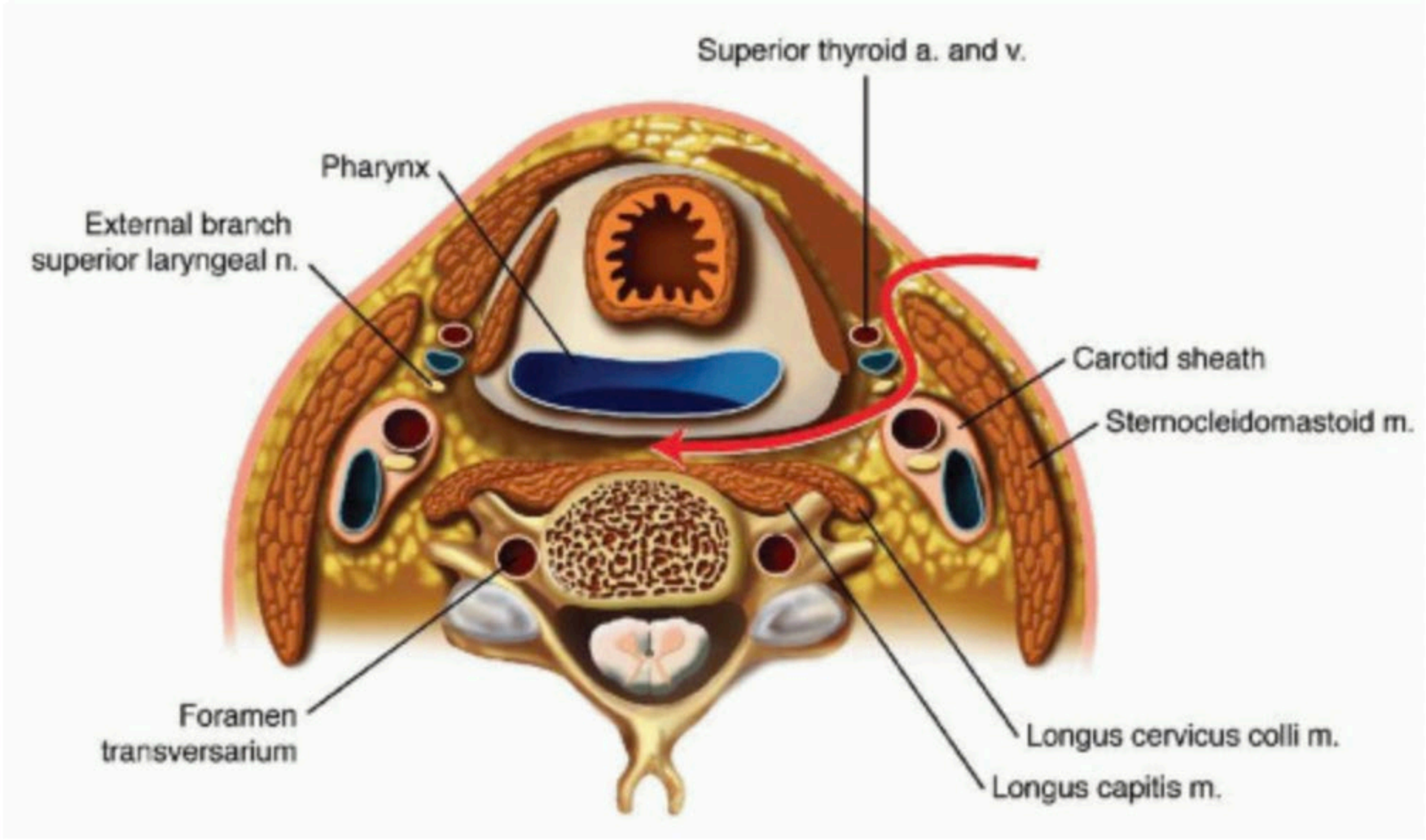
SURGICAL TREATMENT OPTIONS

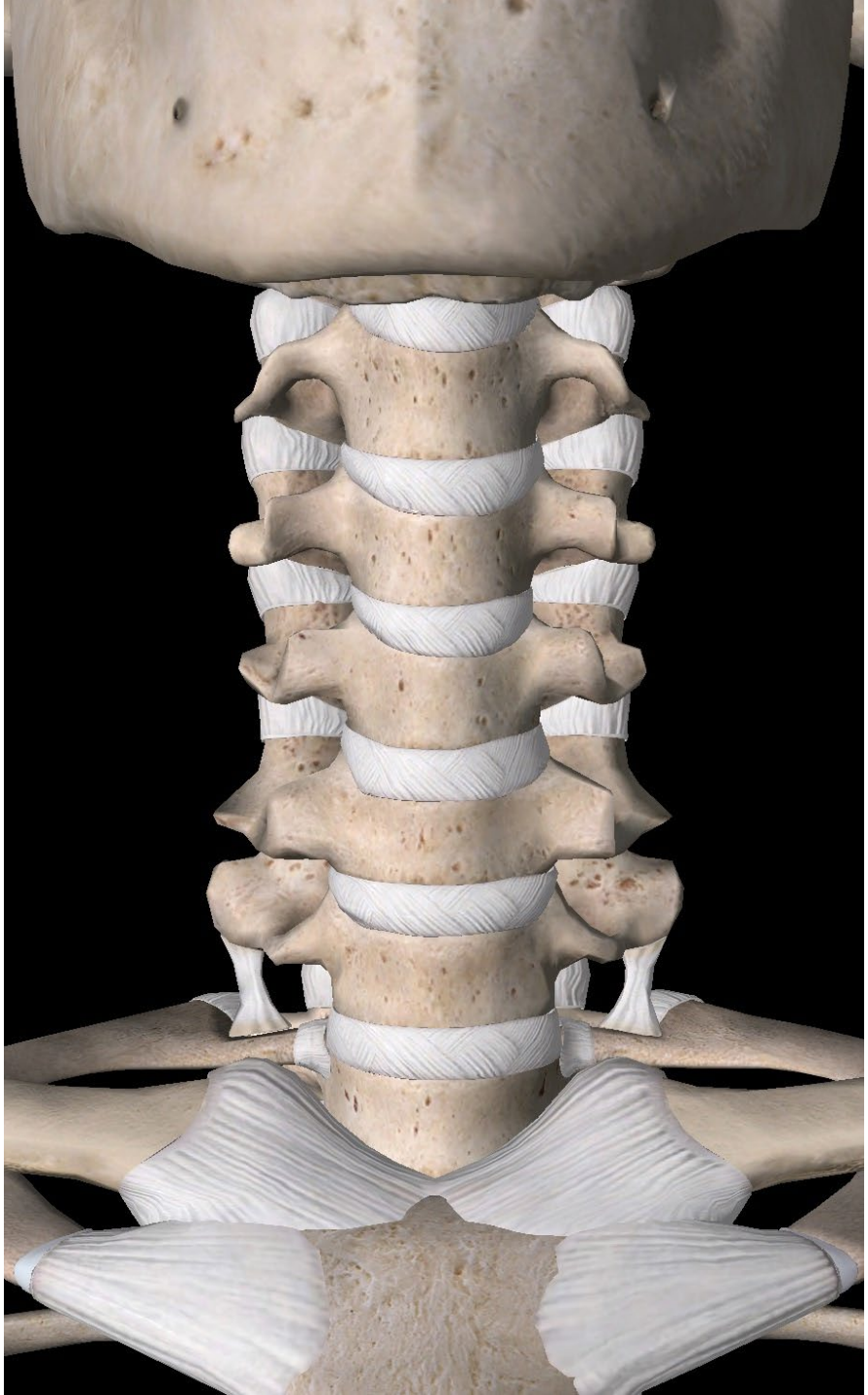
- Anterior Approach
  - Utilizes an approach between the carotid artery and the esophagus to reach the anterior portion of the cervical spine.
  - Can be done under microscope magnification



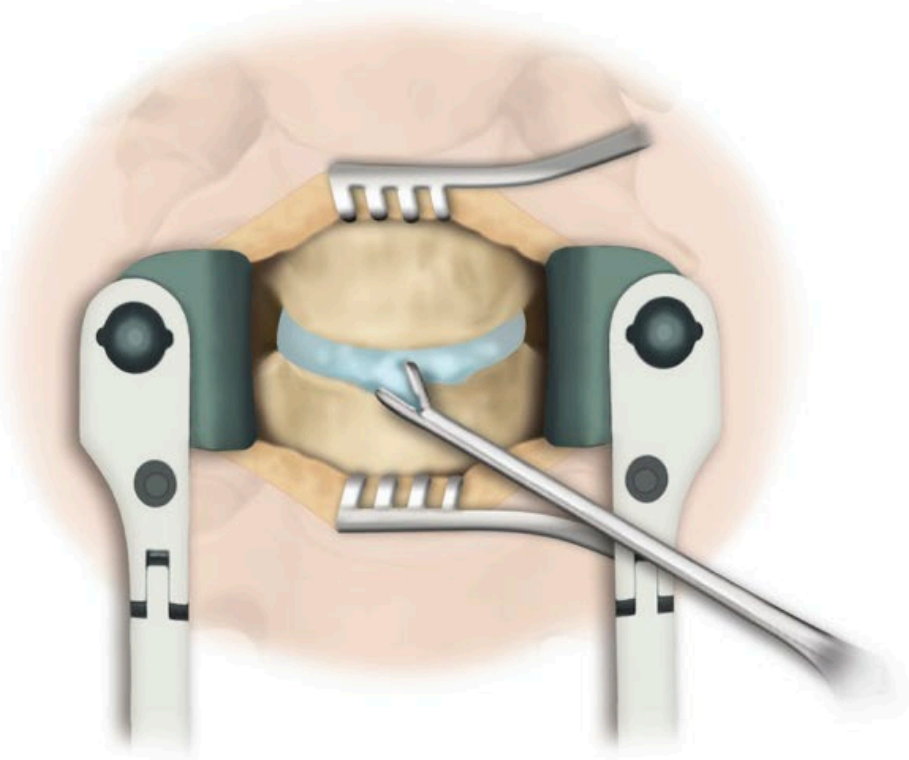


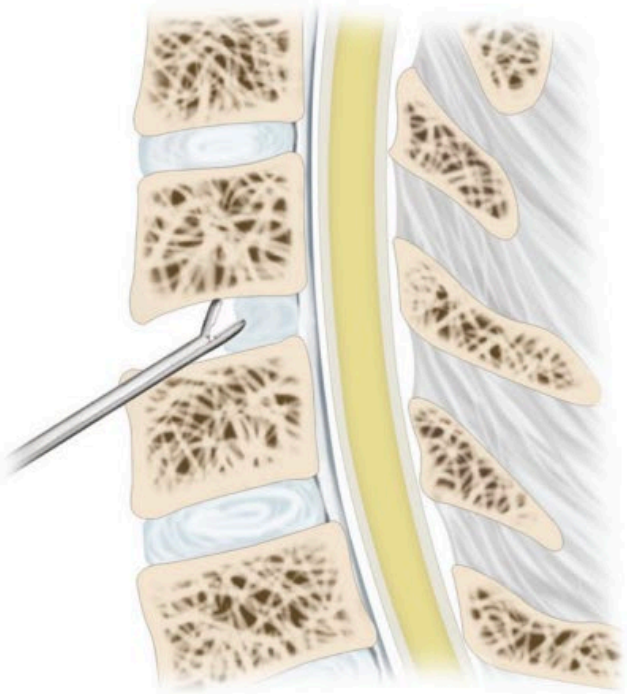


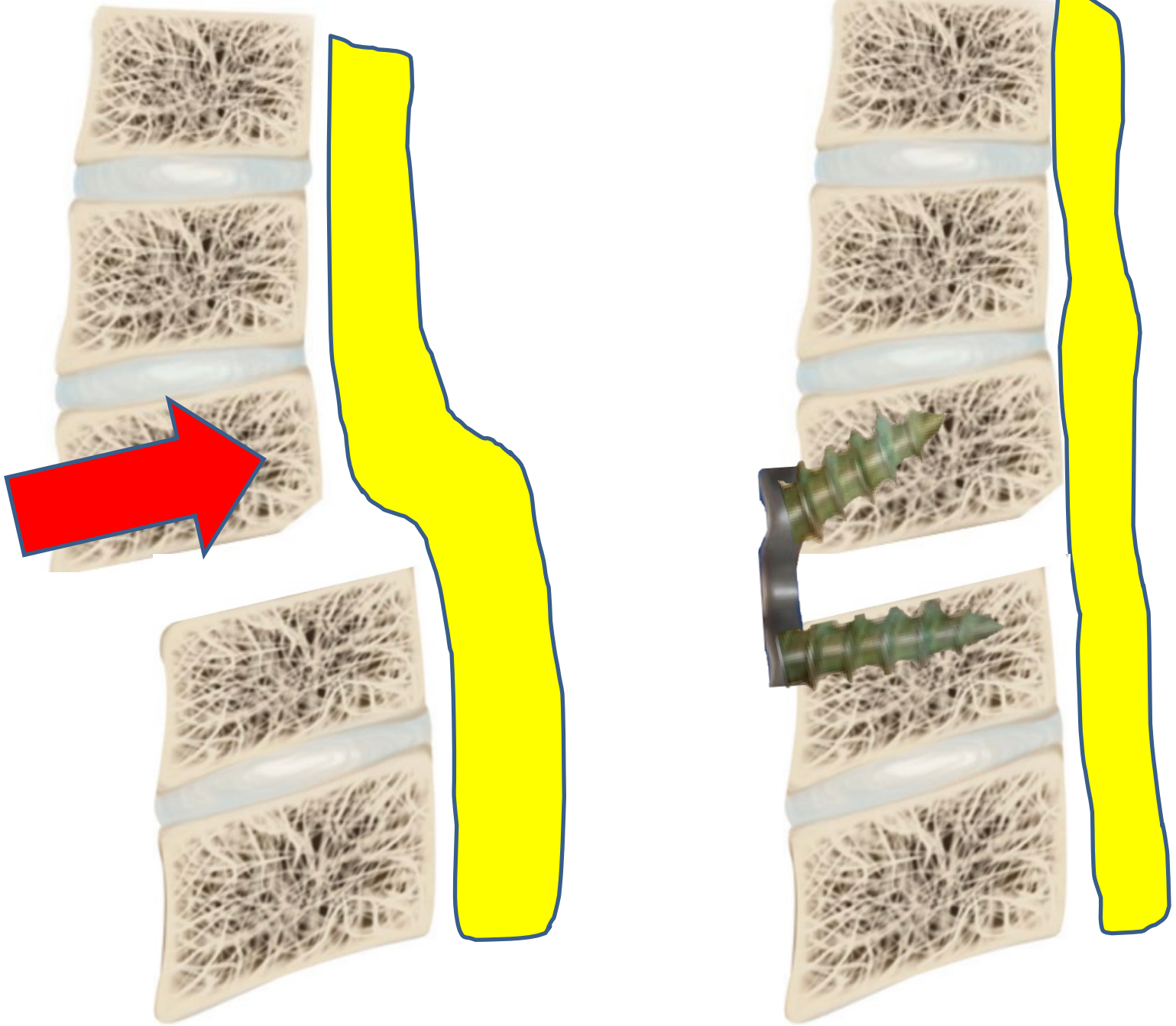

Superior thyroid a. and v.
Pharynx
External branch
superior laryngeal n.
Carotid sheath
Sternocleidomastoid m.
Foramen
transversarium
Longus cervicus colli m.
Longus capitis m.

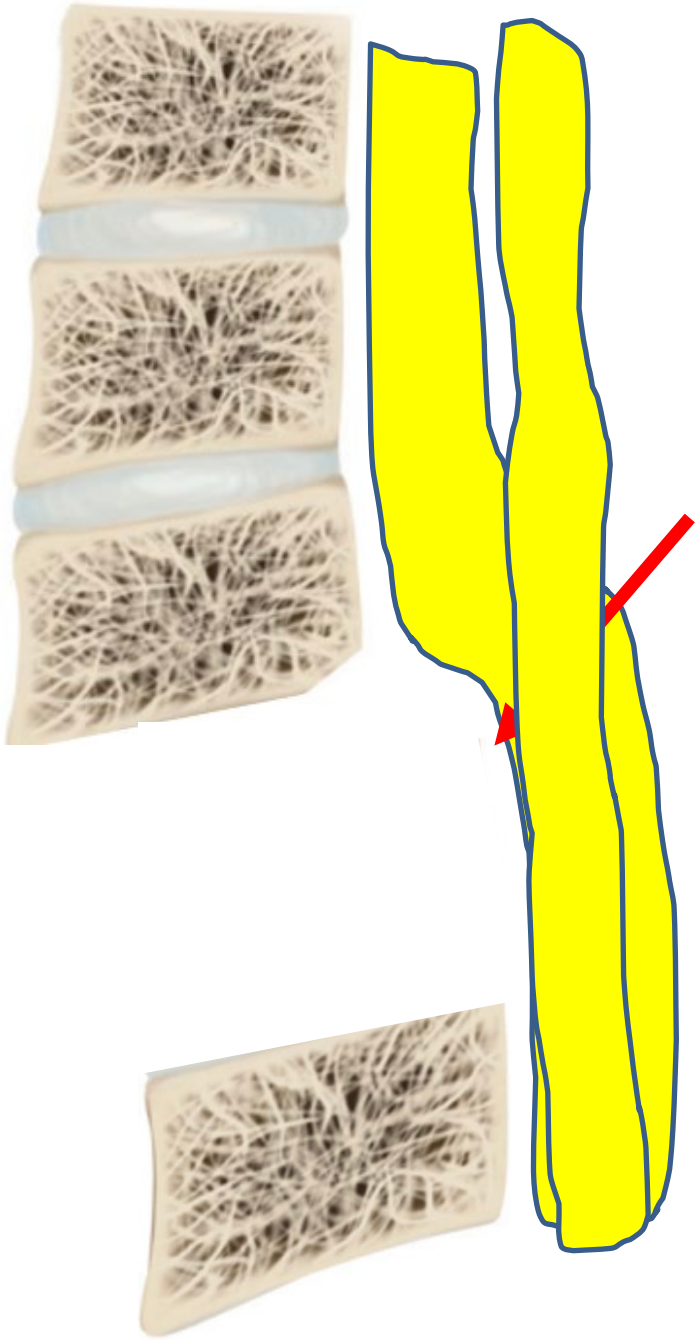


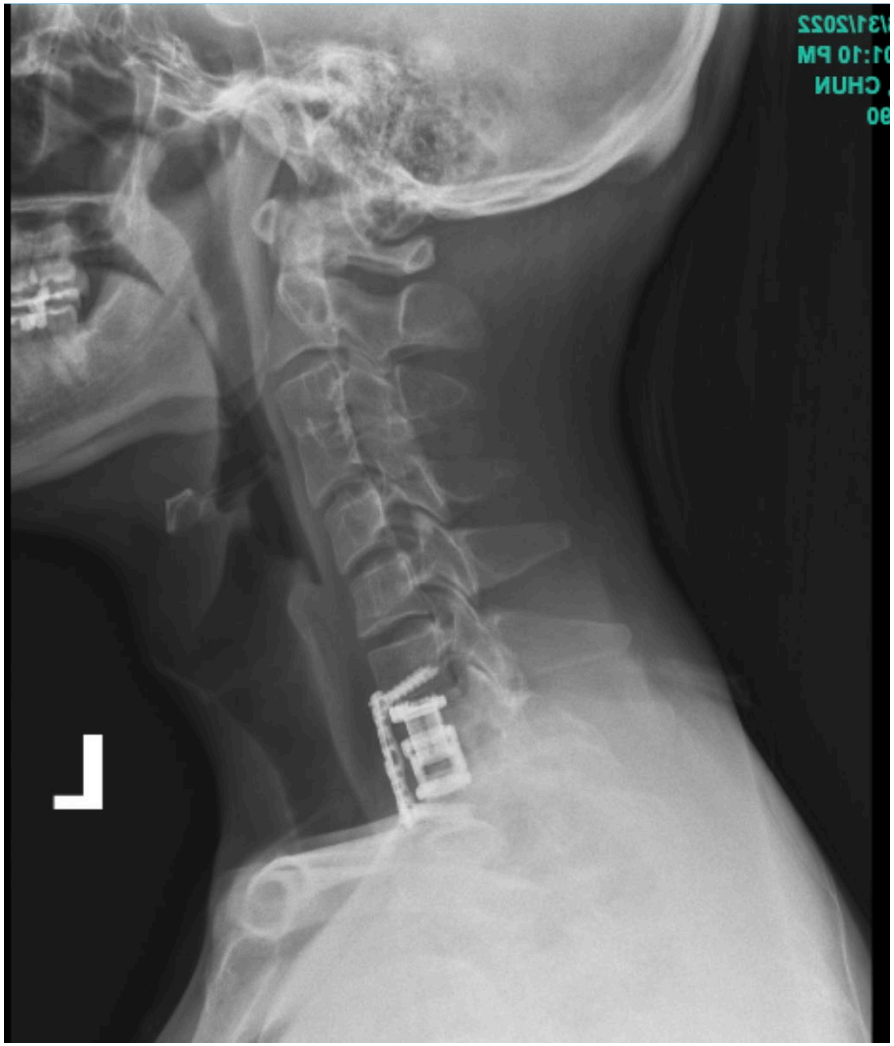
- Anterior Approach
  - Once on the disk space, the disk can be resected back to the PLL.





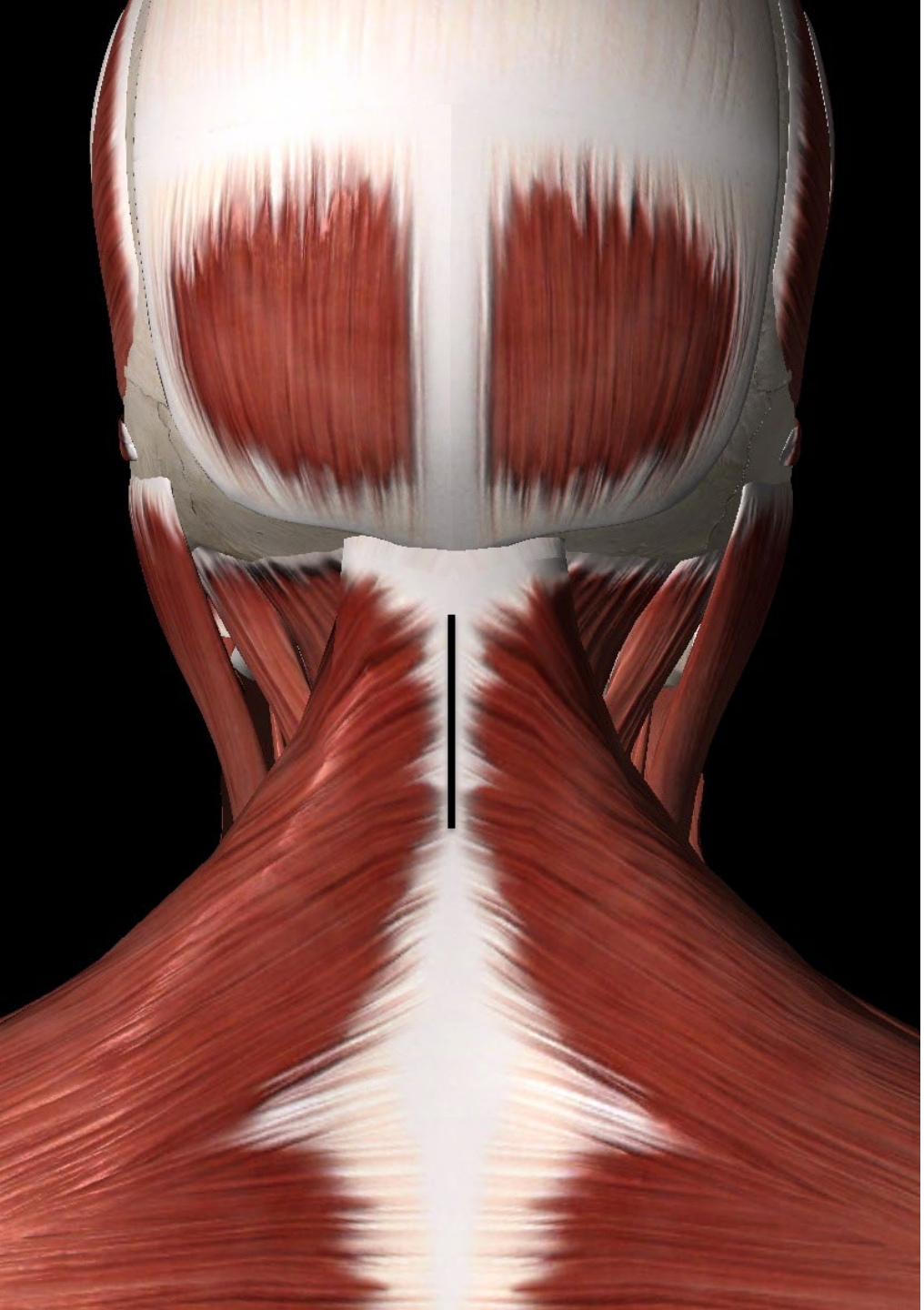


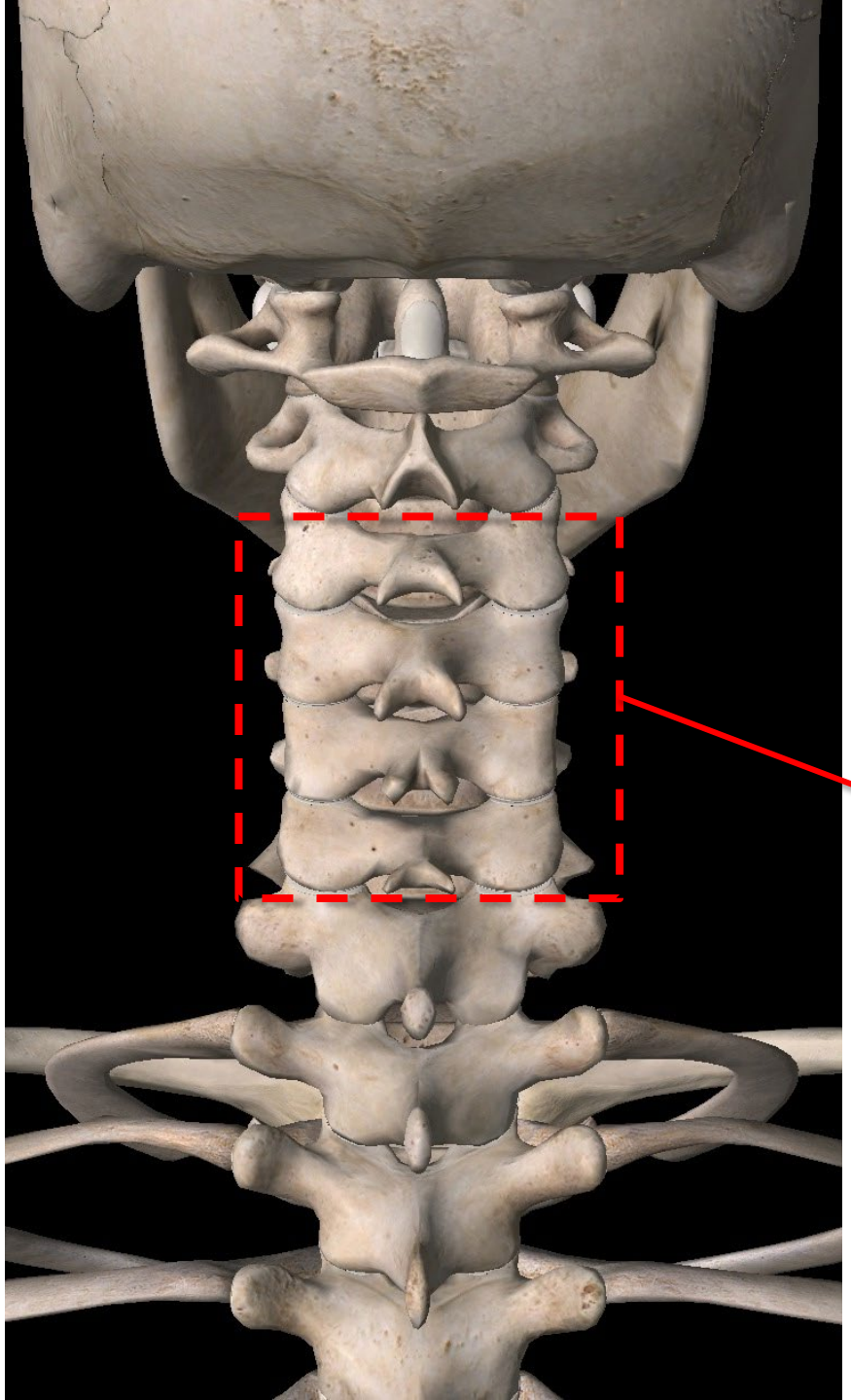


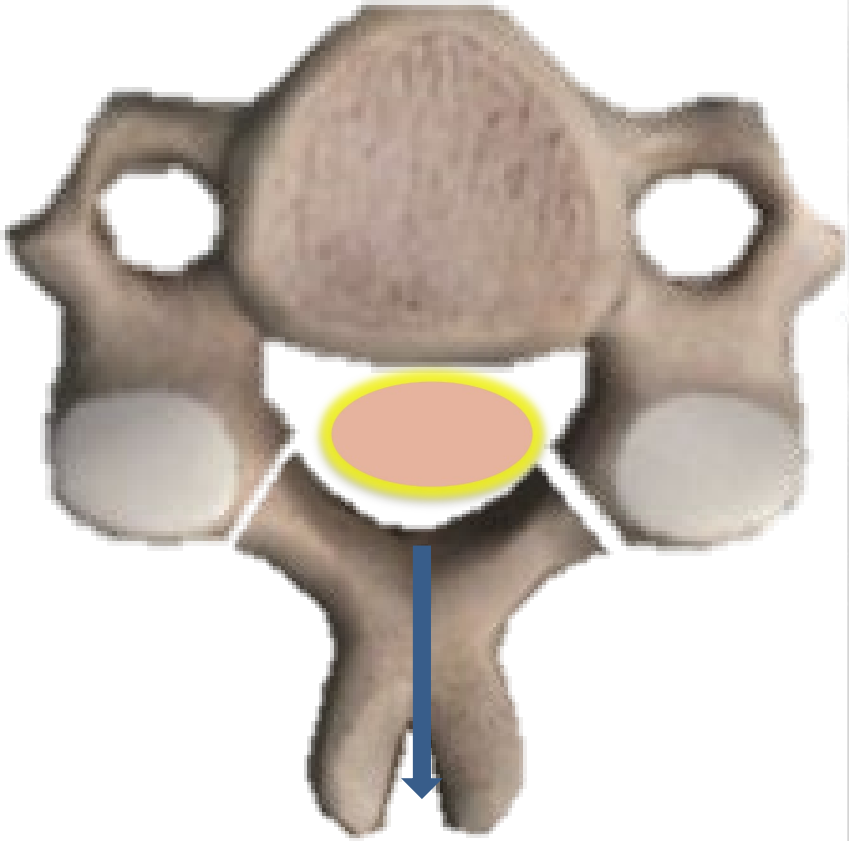


SURGICAL TREATMENT OPTIONS

- Posterior Approach
  - Good for multilevel involvement.
    Unstable level will undergo fusion.
    Other levels are candidates for
    either laminoplasty or fusion.




Area of
Interest

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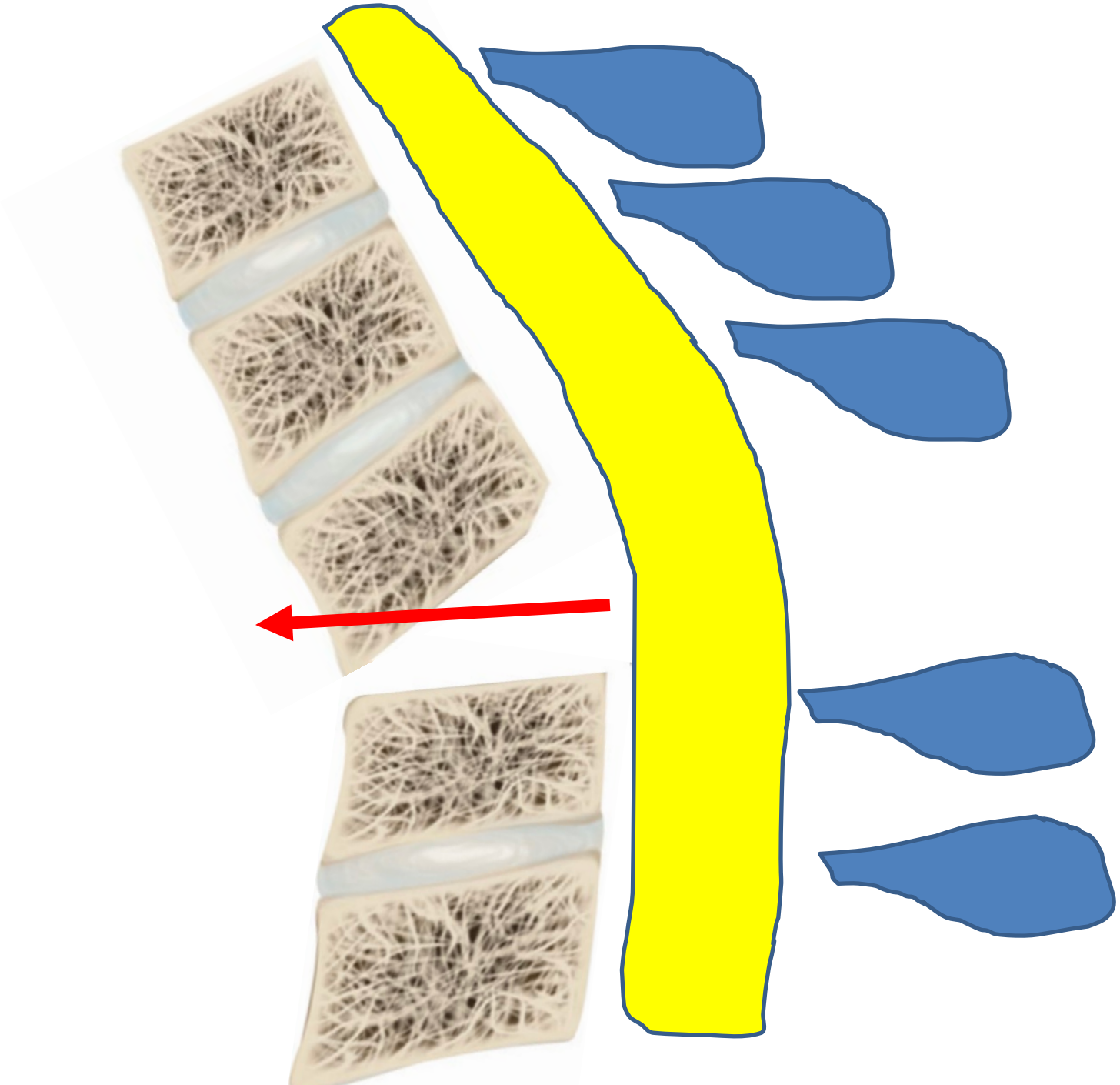
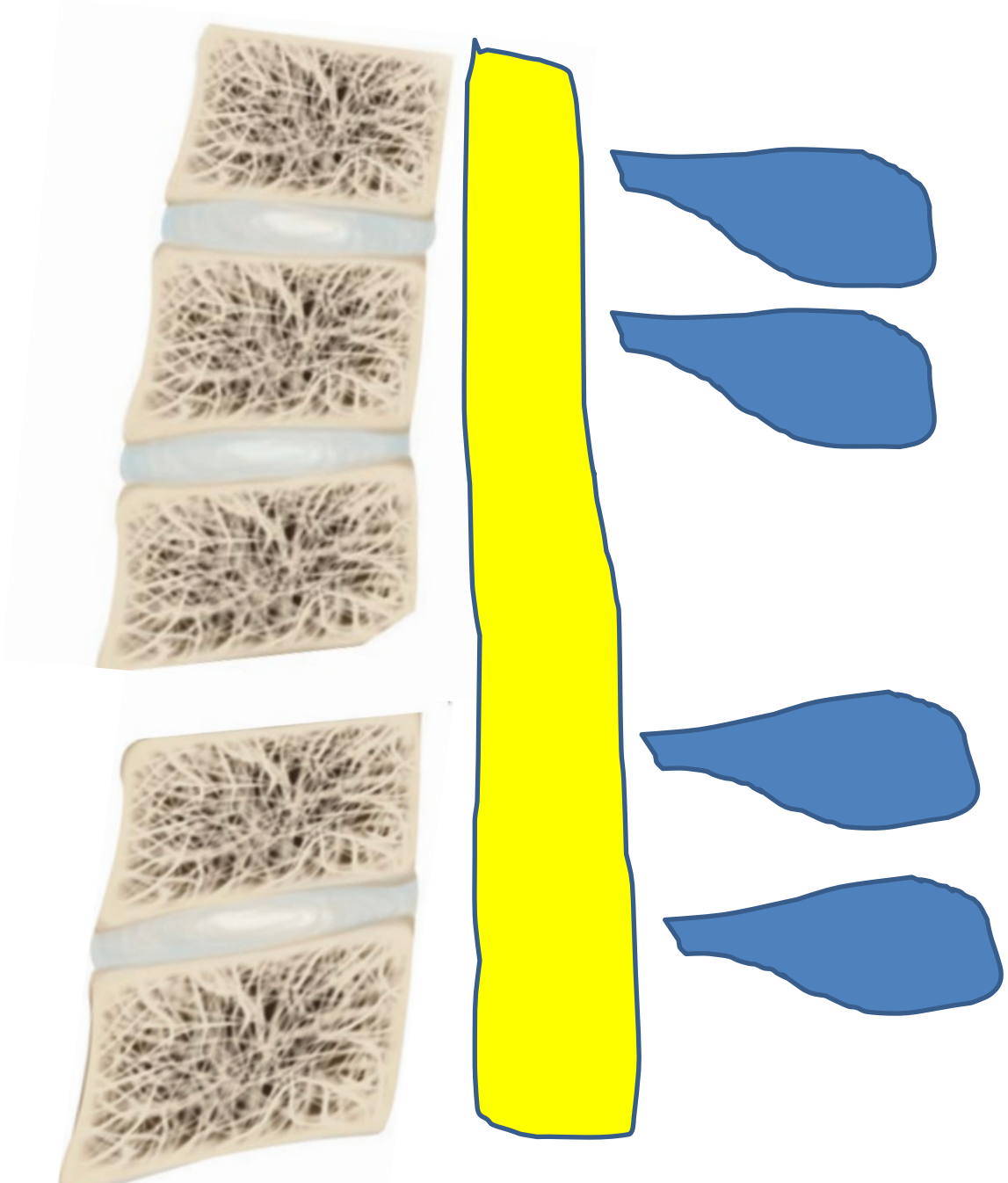
May need combined anterior-posterior approach if cord compression is severe (>60% canal compression) or if poor bone quality, severe structural kyphosis etc...





CONCLUSIONS

- Cervical Instability most commonly presents with axial neck pain and myelopathy symptoms (to a lesser degree radiculopathy or combined myeloradiculopathy).
- Suspected cervical instability should be imaged with Flexion/Extension cervical x-rays.
- If confirmed, MRI should be considered to quantify cord compression etc.
- If >3mm of motion on flexion/extension, neurological deficit or cord compression on MRI, consider surgical consult.

"I'm afraid I have bad news for you."