CERVICAL SPONDYLOSIS AND CERVICAL SPONDYLOTIC MYELOPATHY

A NEUROSURGEON'S VIEW

A Preventable Journey to a wheelchair bound-life…

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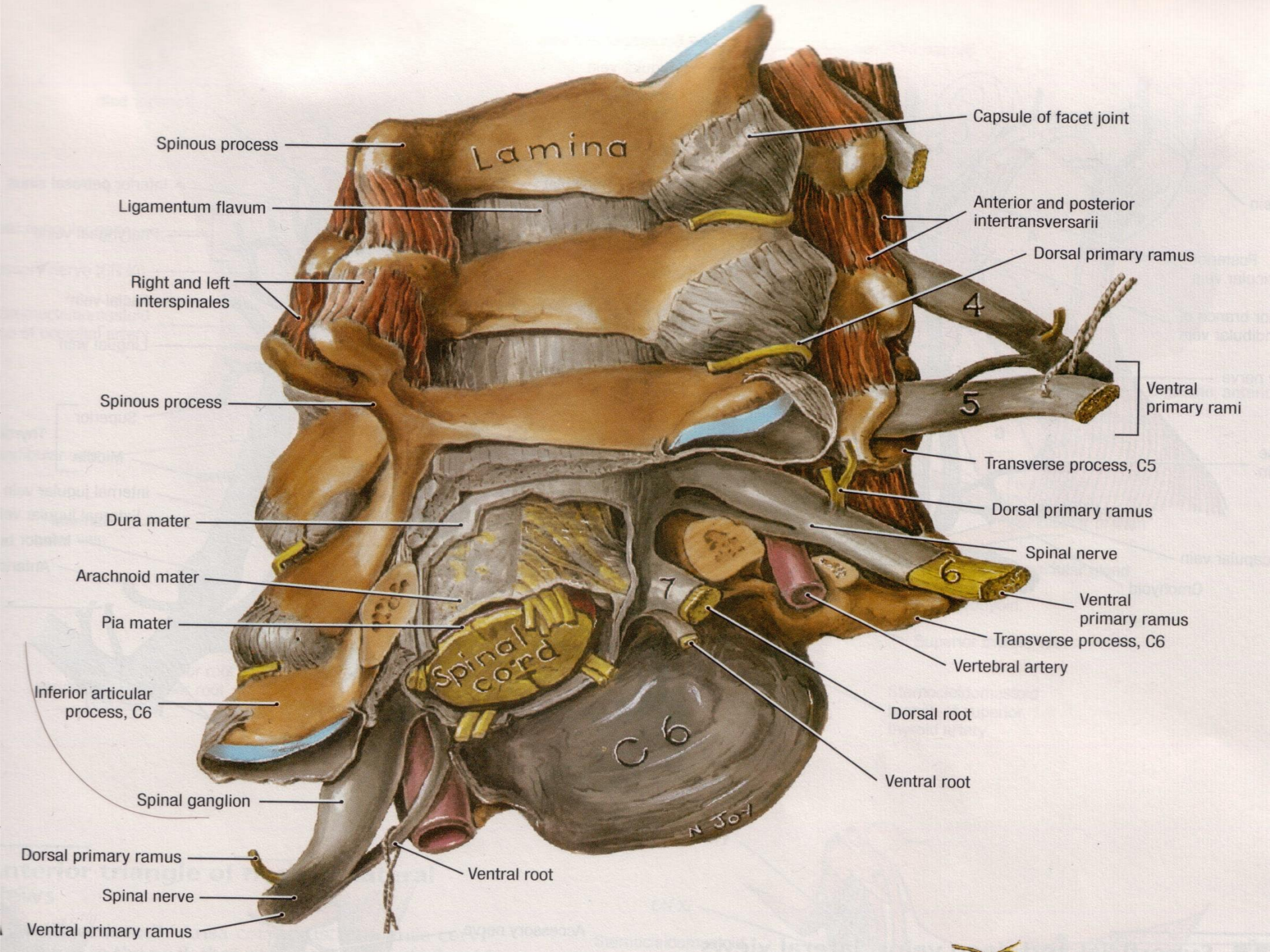
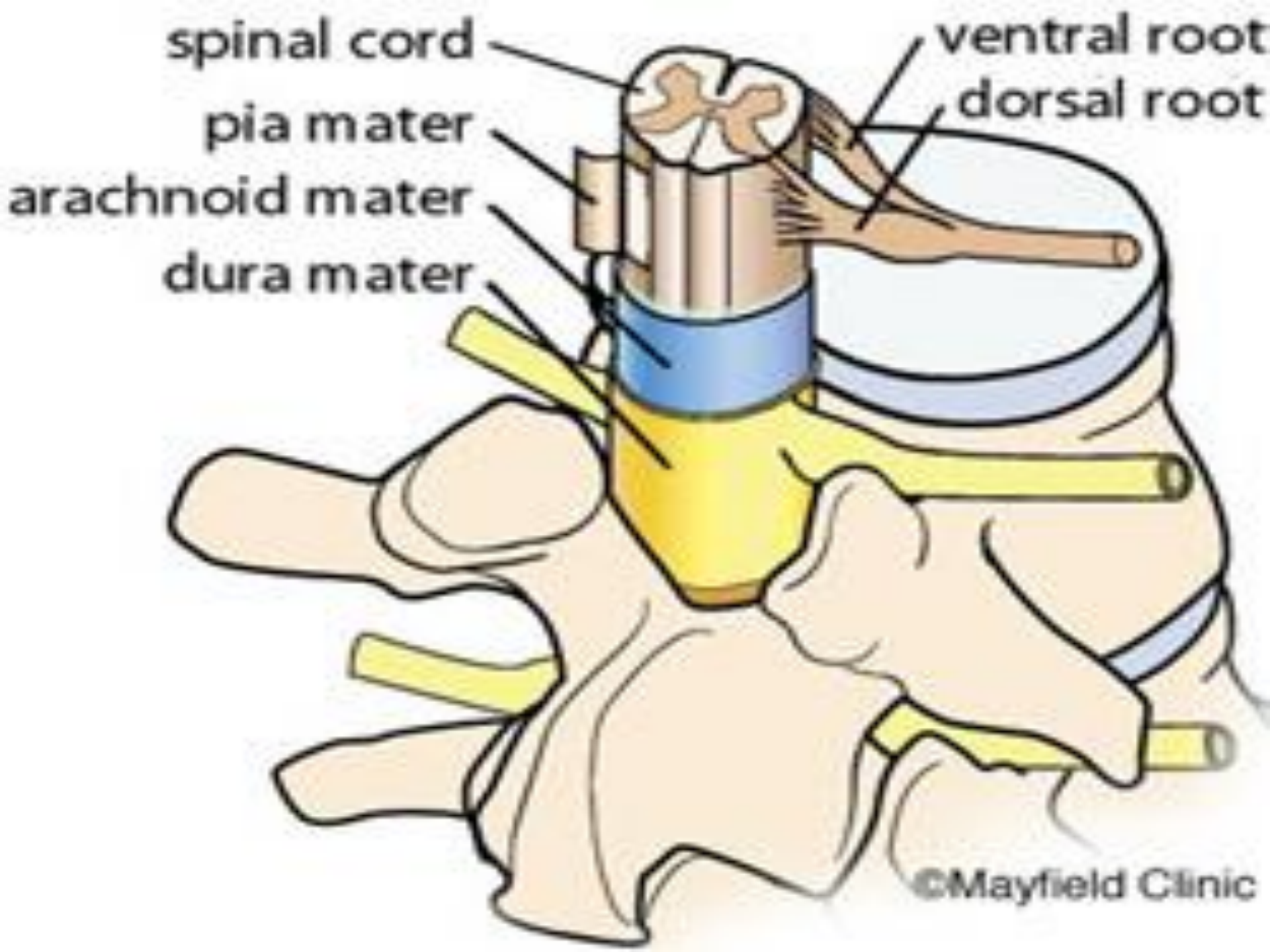
F.C.S (Neurosurgery)

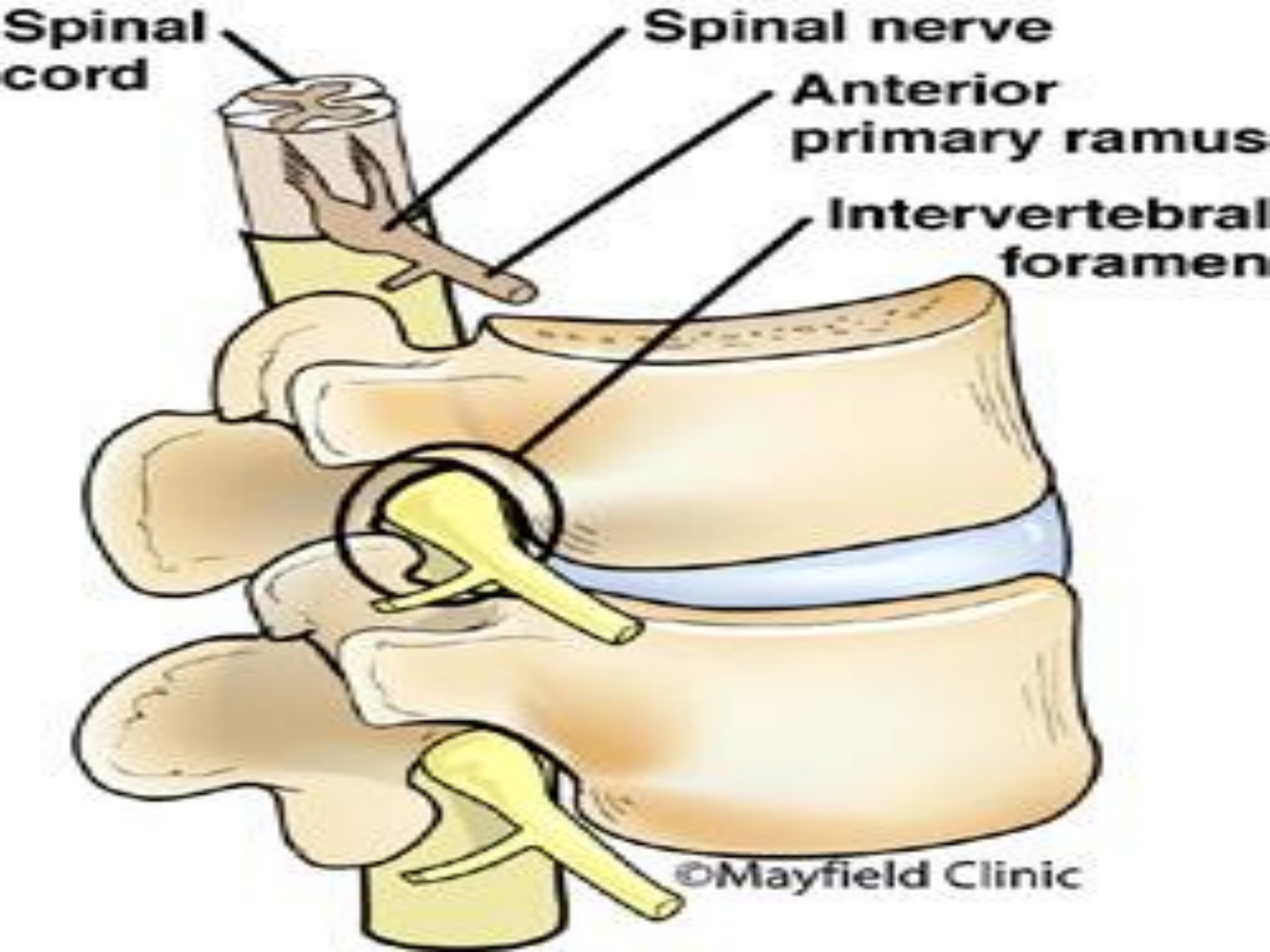
Cervical Spondylosis

- Spinal Osteoarthritis / Spinal Arthritis
- Degenerative cervical disc disease
- 90% of the world population above 65 but about 10% only have symptoms
  - <40 years: 25%
  - >40 years: 50%

ANATOMY


Spinous process
Lamina
Capsule of facet joint
Ligamentum flavum
Anterior and posterior intertransversarii
Dorsal primary ramus
Right and left interspinales
4
5
Ventral primary rami
Spinous process
Transverse process, C5
Dorsal primary ramus
Dura mater
Spinal nerve
Arachnoid mater
6
7
Ventral primary ramus
Pia mater
Transverse process, C6
Spinal cord
Vertebral artery
Inferior articular process, C6
Dorsal root
C6
Ventral root
Spinal ganglion
N Joh
Dorsal primary ramus
Ventral root
Spinal nerve
Ventral primary ramus


spinal cord
pia mater
arachnoid mater
dura mater
ventral root
dorsal root
©Mayfield Clinic


Spinal cord
Spinal nerve
Anterior primary ramus
Intervertebral foramen
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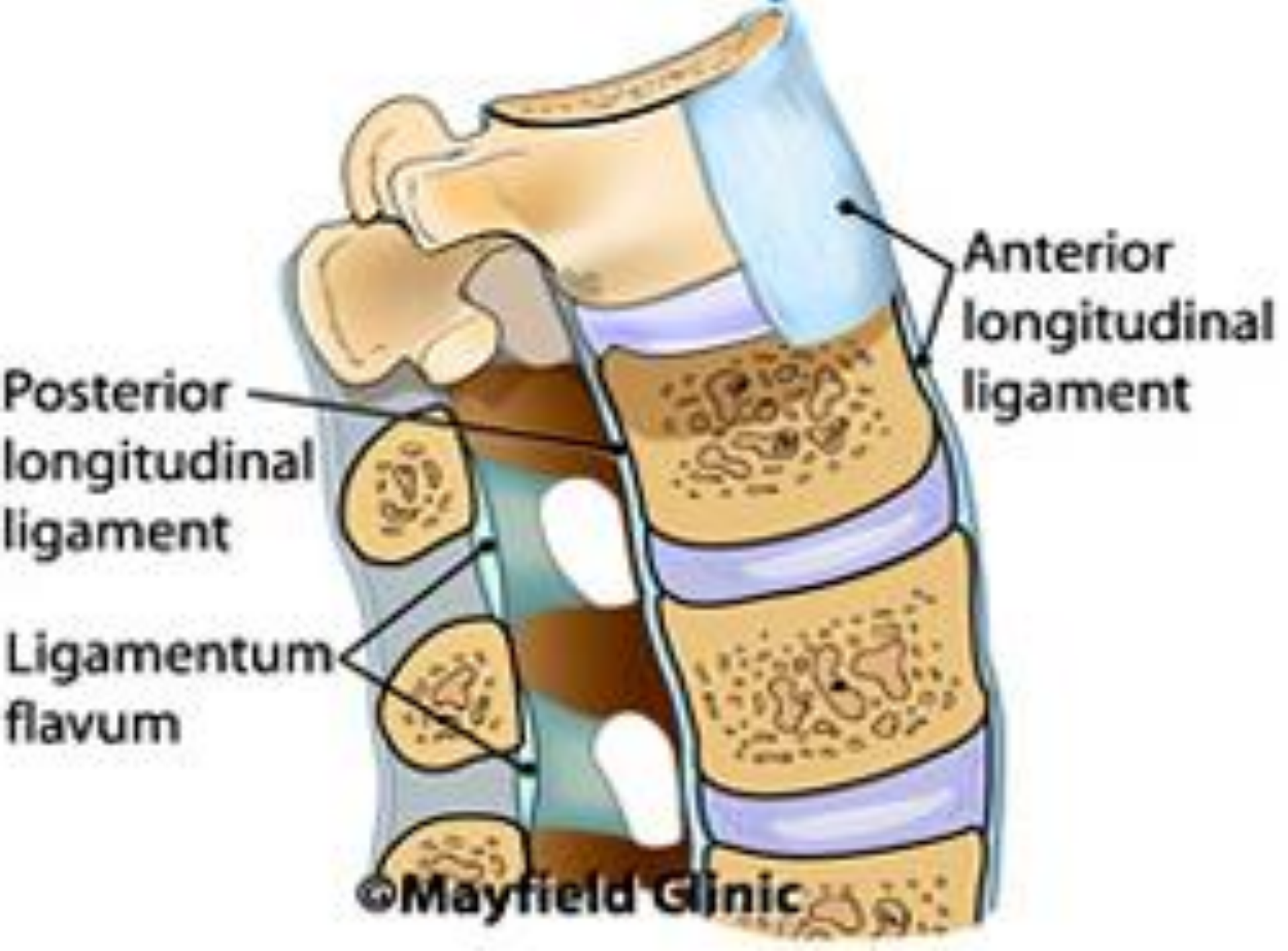
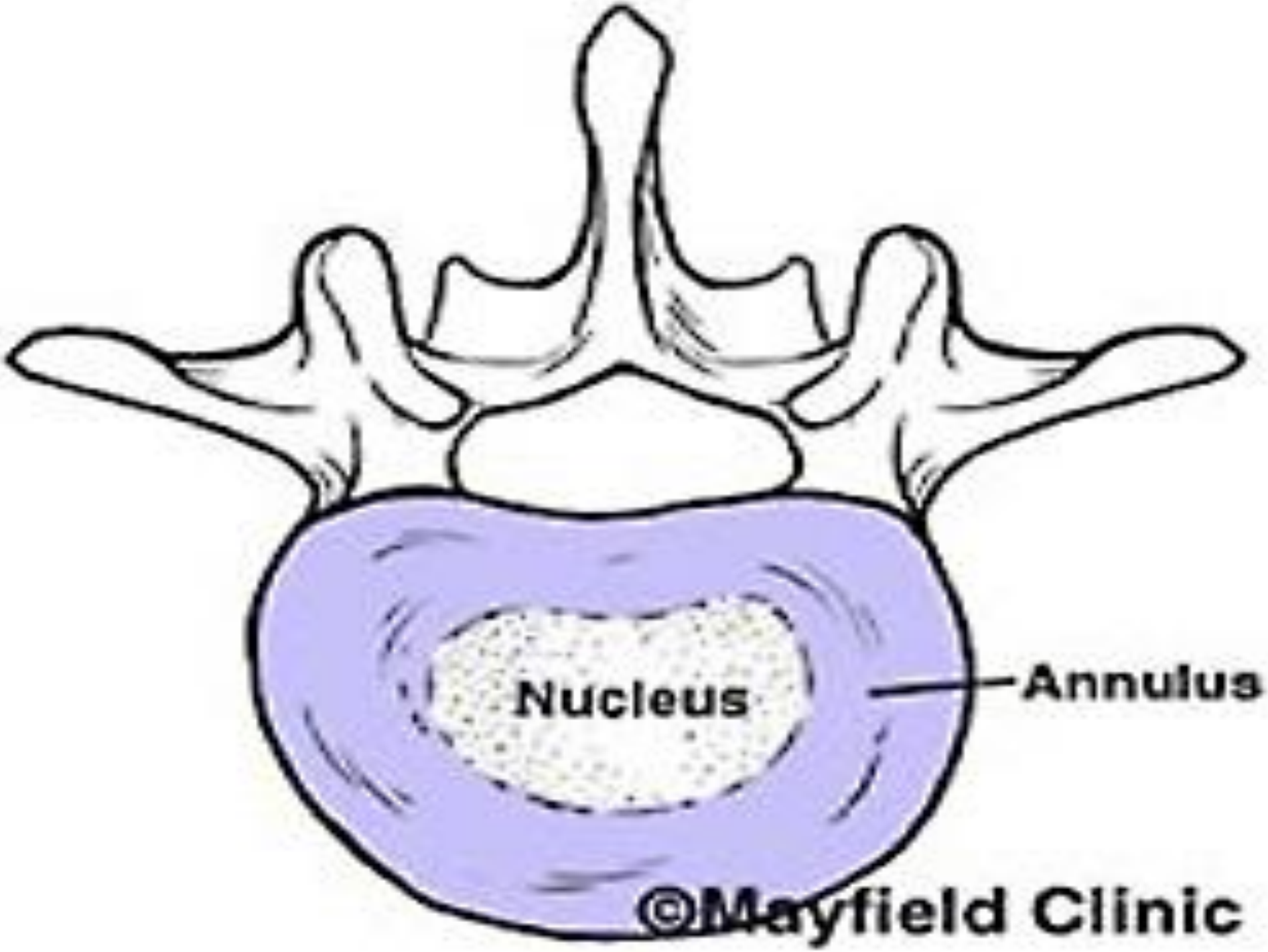
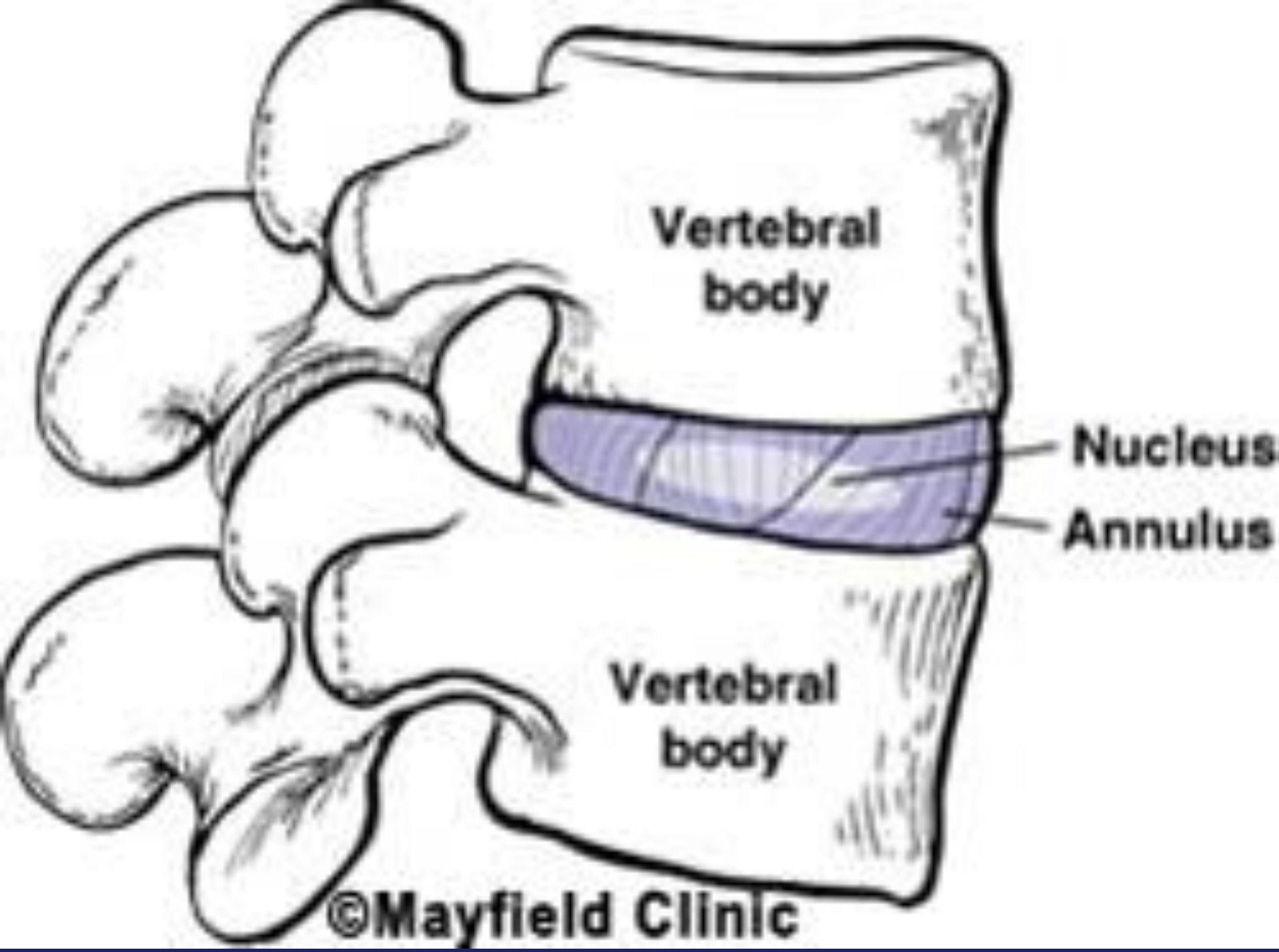

Anterior
longitudinal
ligament
Posterior
longitudinal
ligament
Ligamentum
flavum
©Mayfield Clinic


Nucleus
Annulus
©Mayfield Clinic


Vertebral body
Nucleus
Annulus
Vertebral body
©Mayfield Clinic

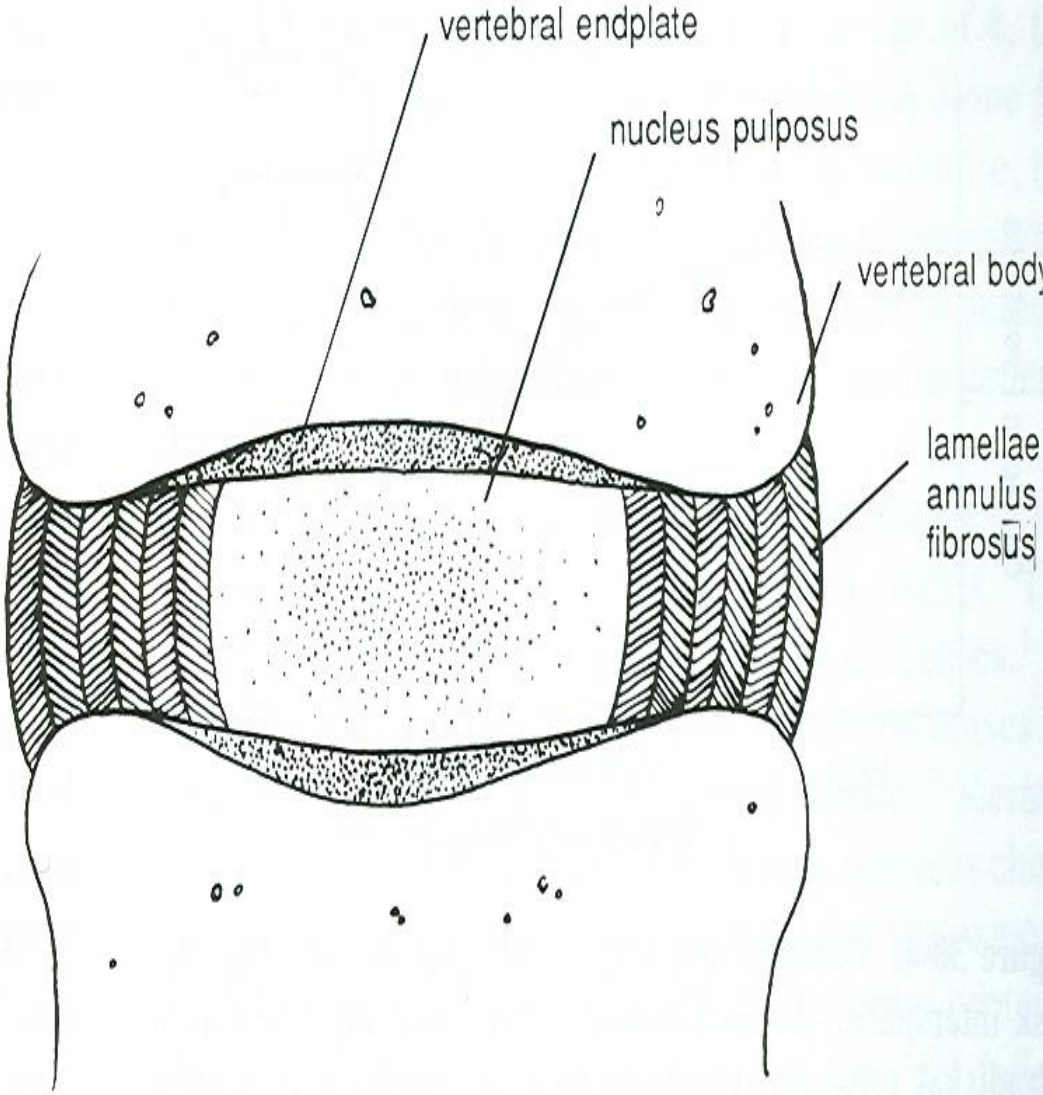


Figure 30-2. The structure of the intervertebral disk is demonstrated with the alternating lamellae of collagen in the annulus and the centrally located nucleus pulposus.

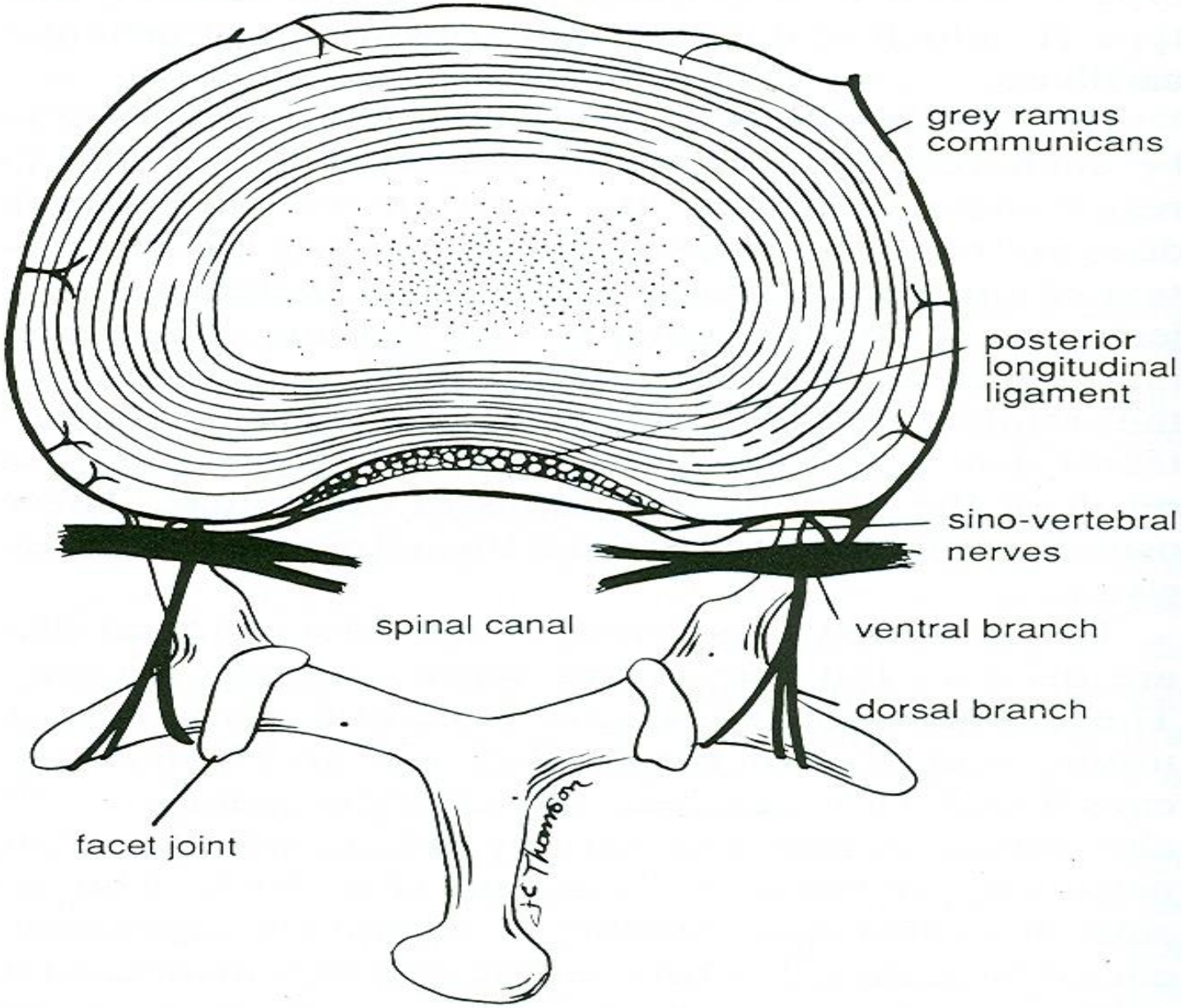
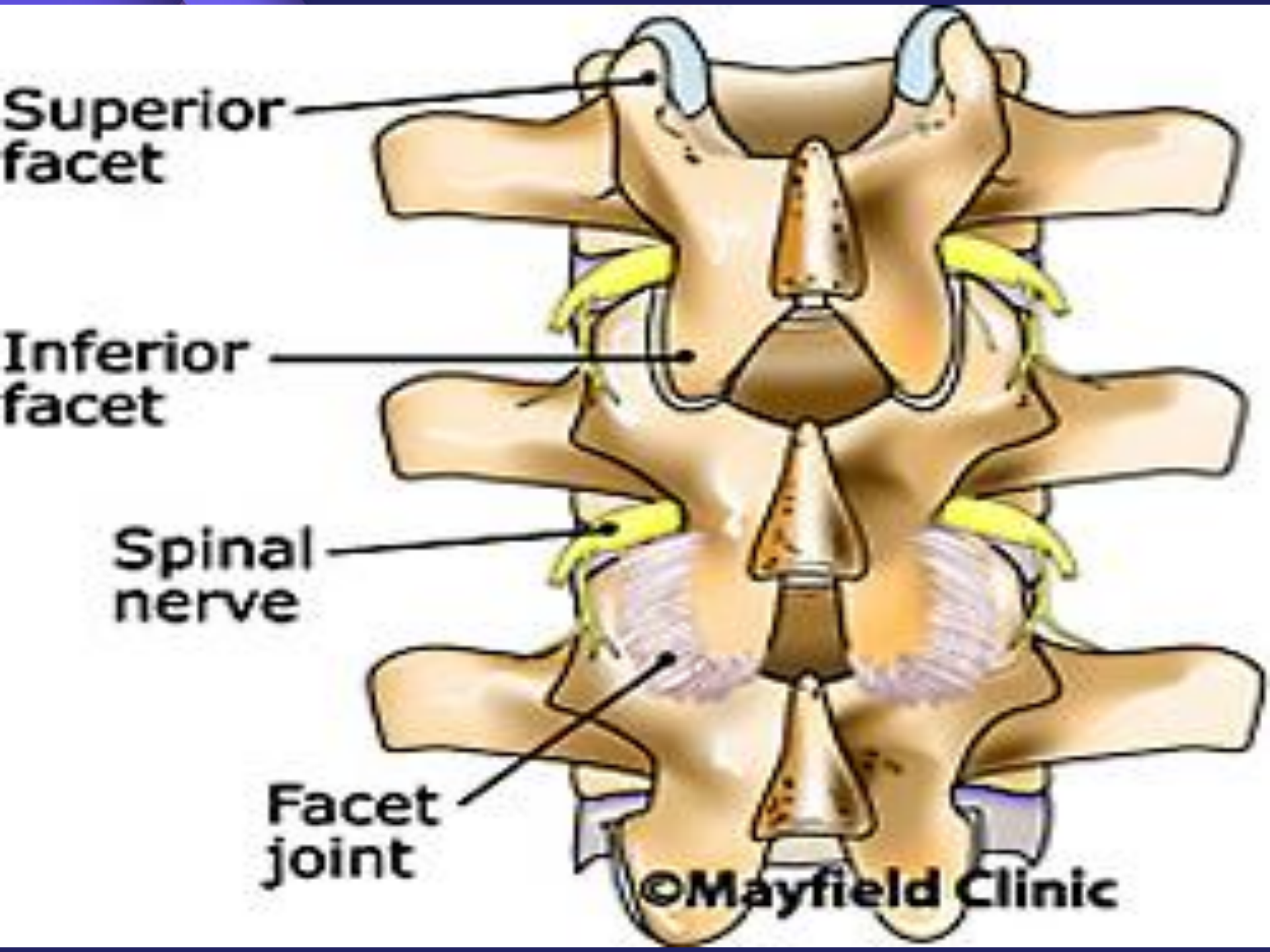
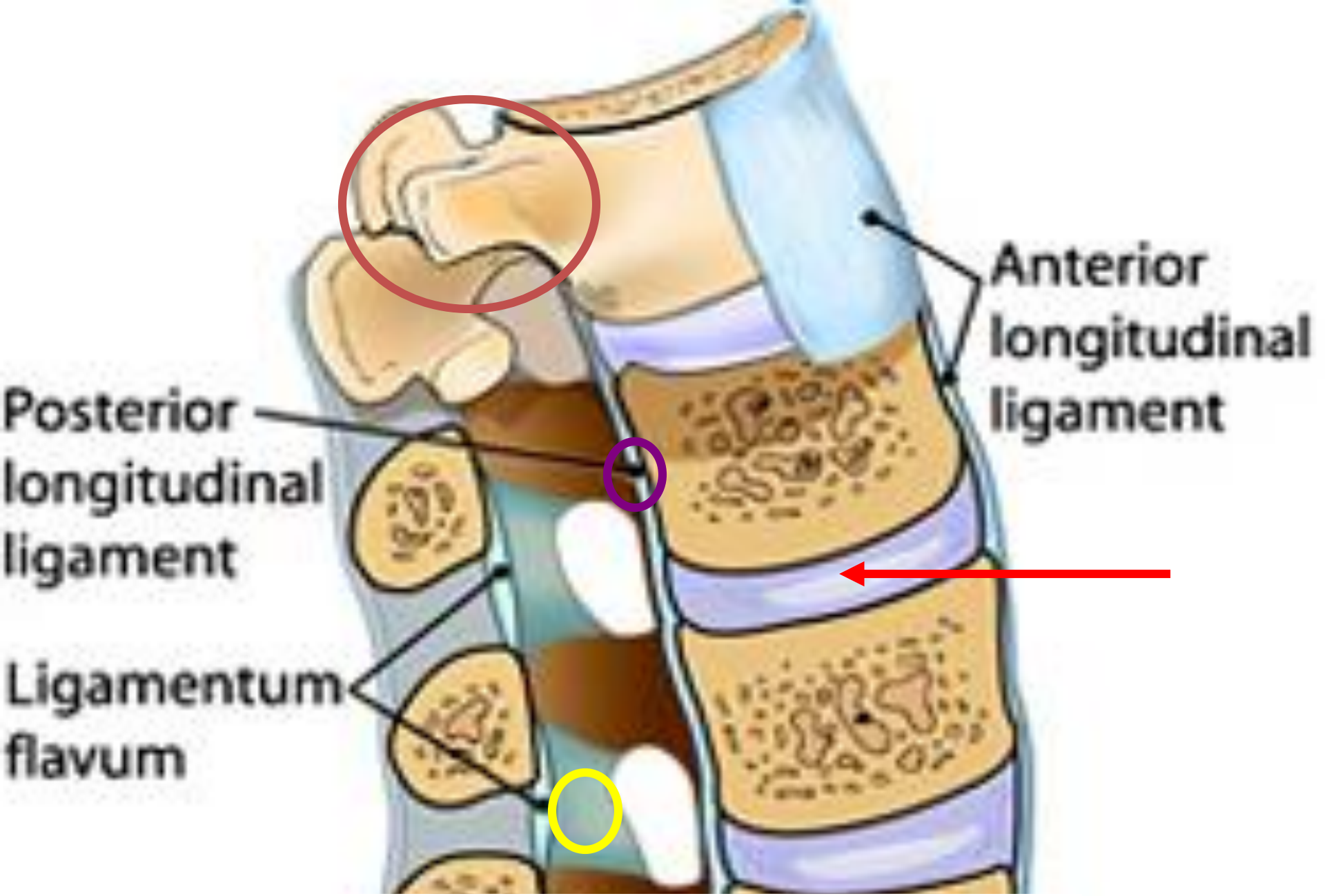
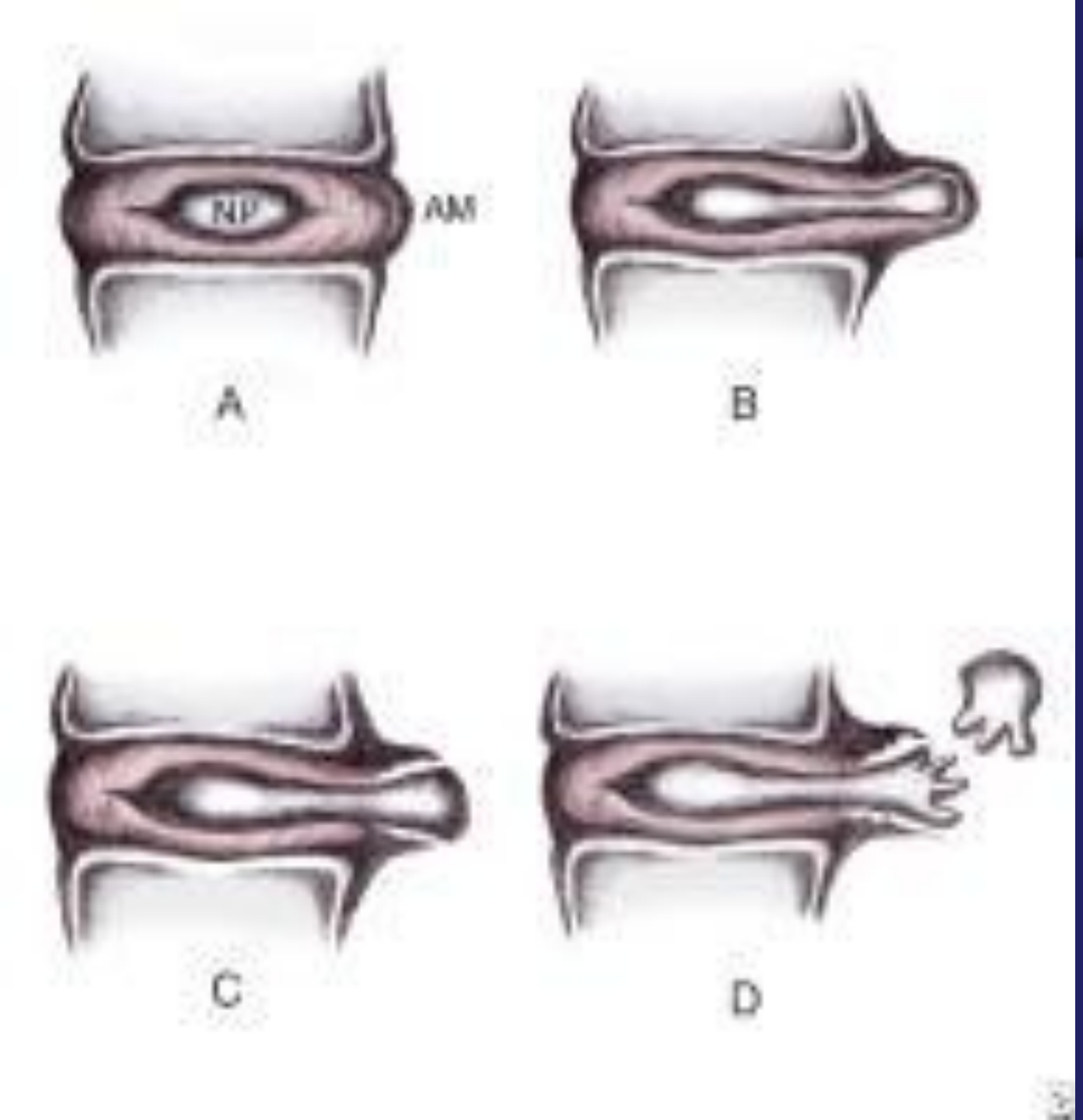


Figure 30-5. Diagram of the innervation of the intervertebral disk.


Superior facet
Inferior facet
Spinal nerve
Facet joint
©Mayfield Clinic


Anterior
longitudinal
ligament
Posterior
longitudinal
ligament
Ligamentum
flavum


NP
AM
A
B
C
D

Cervical Spondylosis : Definition

- Age related degeneration of the cervical spine
- “Osteoarthritis”
- Most common in persons over 40
- Most common cause for myelopathy in persons over 55
- Male > Female

PATHOPHYSIOLOGY

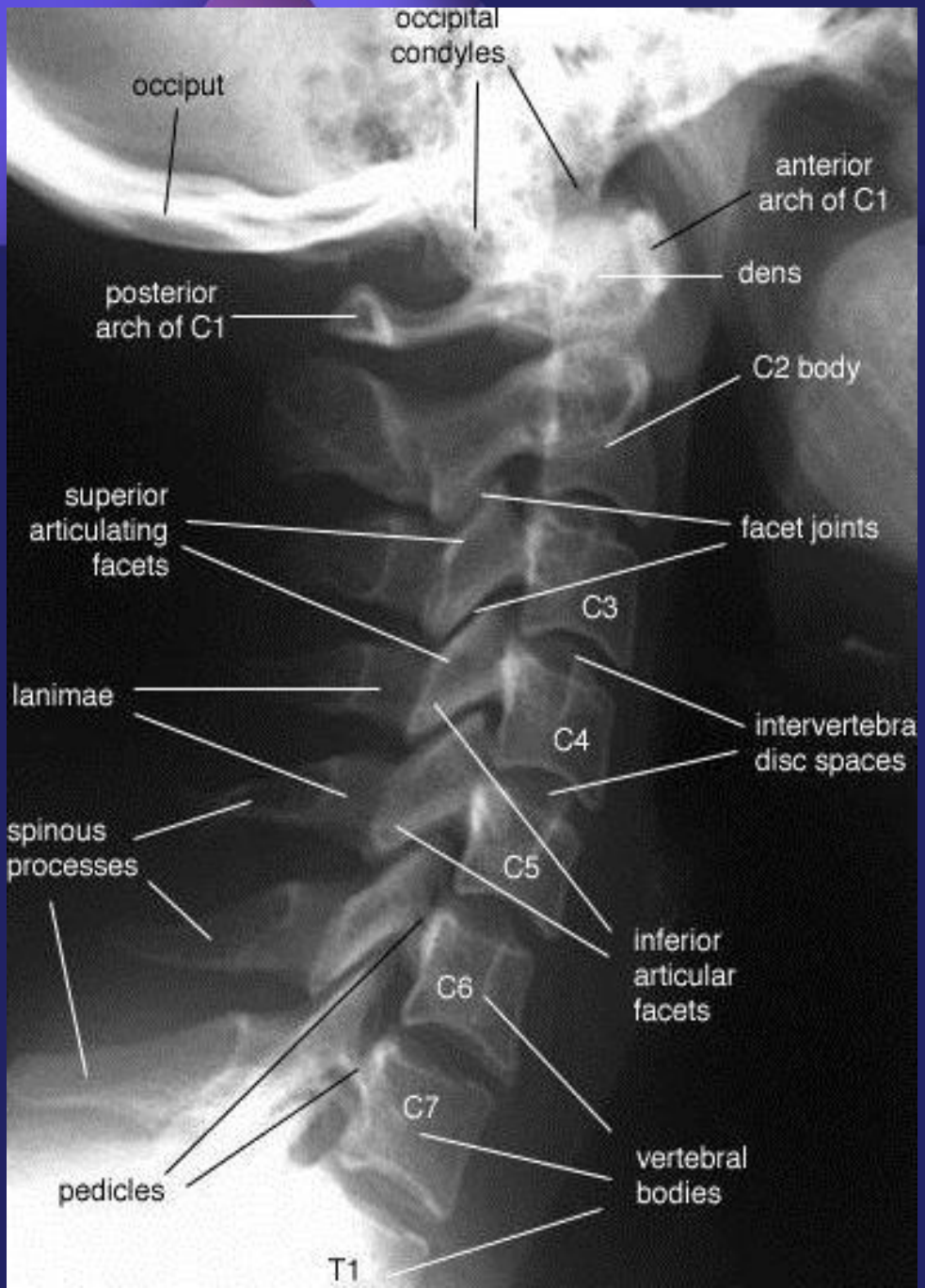
PATHOPHYSIOLOGY

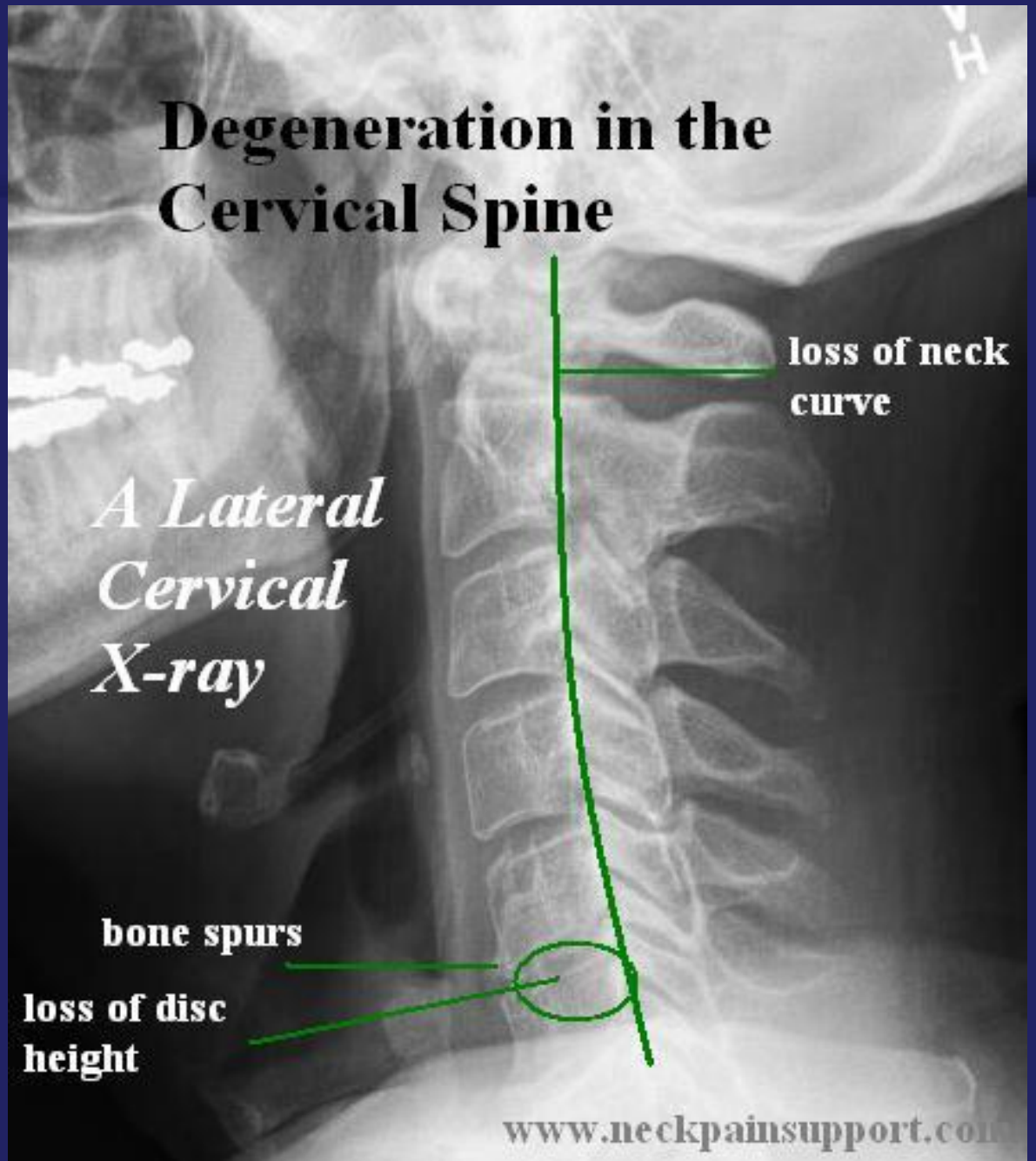
- Intervertebral discs lose hydration and elasticity with age - leading to cracks and fissures.
- The surrounding ligaments also lose their elastic properties and develop traction spurs.
- The disk subsequently collapses as a result of biomechanical incompetence, causing the annulus to bulge outward.
- As the disk space narrows, the annulus bulges, and the facets override.
- This change, in turn, increases motion at that spinal segment and further hastens the damage to the disk.
- Annulus fissures and herniation may occur.
- Acute disk herniation may complicate chronic spondylotic changes.

Cervical Spondylosis

- Hyper-mobility/ Instability of spinal segments
- Irritation/inflammation of heavily innervated vertebral body endplates
- Direct compression of cervical nerve root or spinal cord
- Repetitive trauma to cord or roots
- Ischemic change to the cord

X -Ray Cervical Spondylosis




Degeneration in the Cervical Spine
A Lateral Cervical X-ray
loss of neck curve
bone spurs
loss of disc height
www.neckpainsupport.com

ACUTE HYPERFLEXION ROTATION (OR BOTH)

- Rupture of Disc annulus and PLL
- Nucleolus herniate into spinal cord
- Cord or Nerve Root compression

Cervical Spondylosis - Pathology

An x-ray of the neck (side view) showing cervical spondylosis

- Age Related Degeneration and Dehydration of intervertebal Disks
- Decreased cartilage between adjacent vertebral bodies
- Developmental laxity in the spinal supportive ligaments
- Hyper-mobility of spinal segment
- Bone-on bone apposition propagates bone spur formation which narrow the cervical spinal canal and may compress the cervical nerve roots and spinal cord

Cervical Spondylosis

Spondylitic change with bone spur/disk complex formation

Developmental narrowing of spinal canal with compression of spinal cord and nerve roots

Cervical Spondylosis – Clinical Presentation

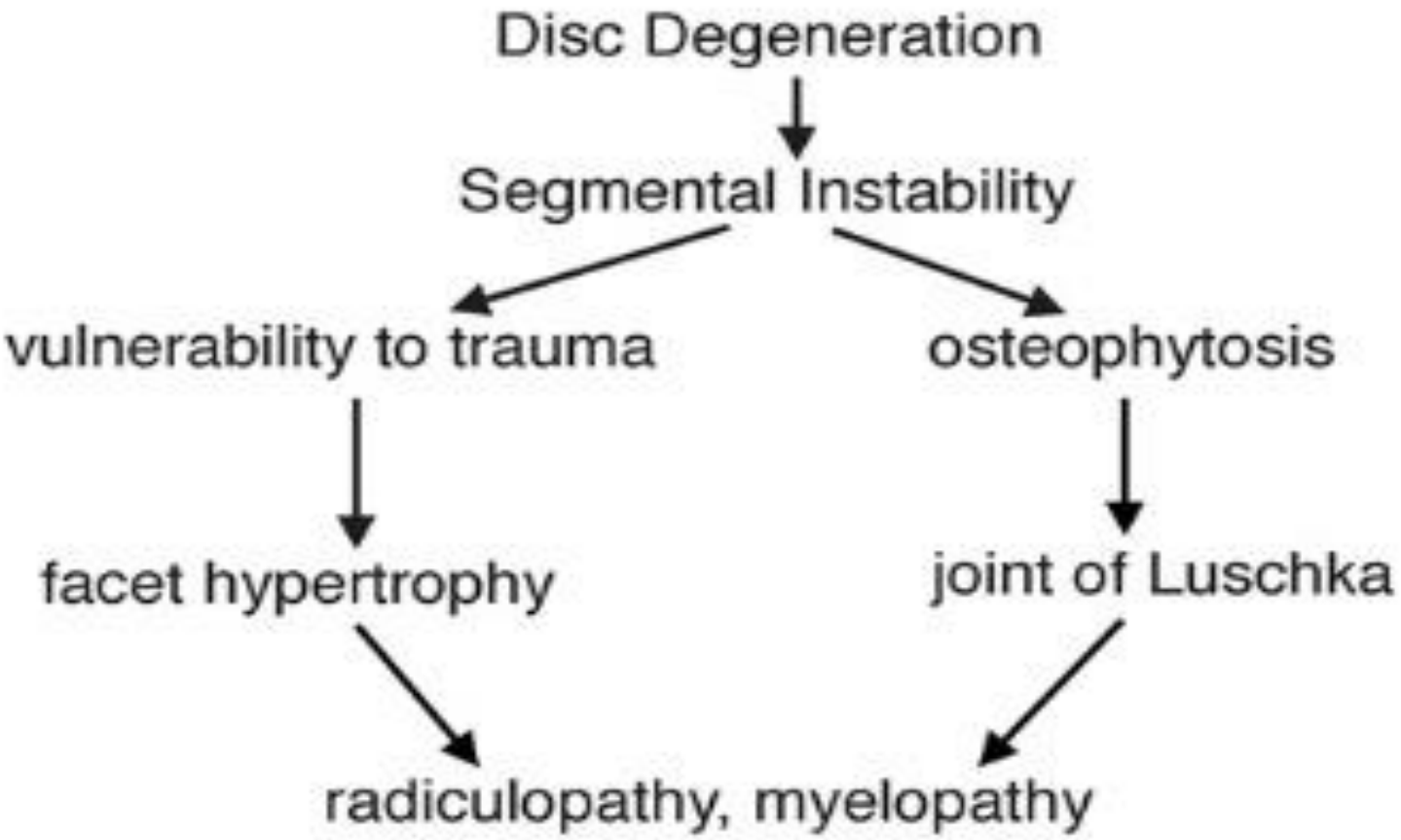
Mechanical

- Pain
- Stiffness
- Muscle Spasm
- "Pop and Crack"

Neurologic

- Nerve Root Compression
- Spinal Cord Compression

Progression in Cervical Spondylosis



Clinical Symptoms and Signs

Symptoms or signs	Cases	Percentage
Headache	355	27.8
Dizziness	696	54.5
Neck stiffness	139	12.3
Nausea and vomiting	181	14.2
Weakness and tingling in the neck and/or arms	655	51.3
Pain in the back, neck, and/or arms	1,106	86.7
Vertigo and instability of walking	188	14.7

Cervical Spondylosis

Causes

Cumulation of all these -

Bumps, Fall, Injuries, Accidents, Bad posture, Sitting and looking down, Forward position, Incorrect sleep position

- Congenitally narrow vertebral canal
- Athletic person :Rugby, horse riding, soccer
- Genetic

Cervical Spondylosis- Presentation with "Headache"

Kyphotic Angular deformity creates added stress on the paraspinal muscles and causes severe myofascial pain and spasm and often produces suboccipital headaches where the paraspinal muscles insert on the base of the skull.

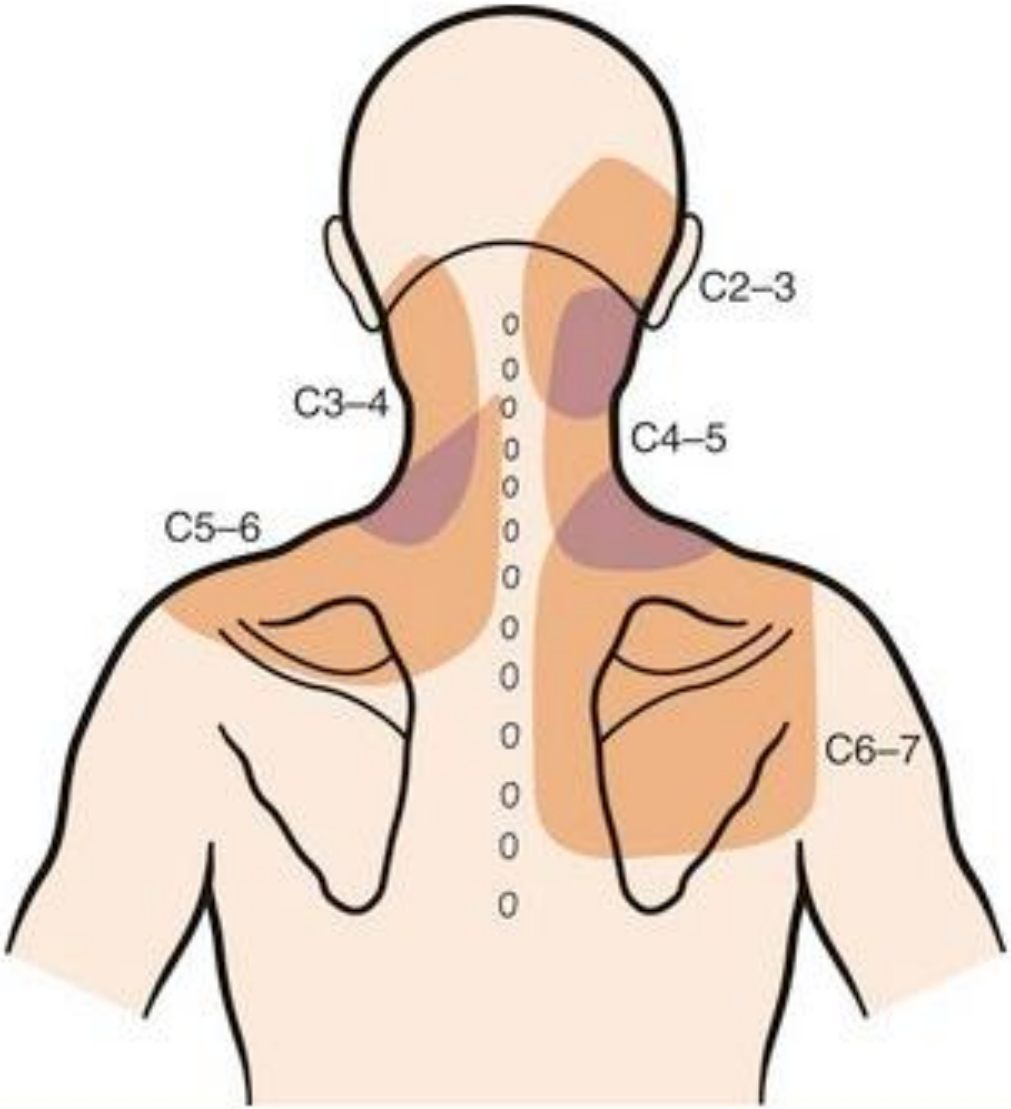
For this reason, some degenerative cervical spine disease can present with "headache".

Cervical Spondylosis

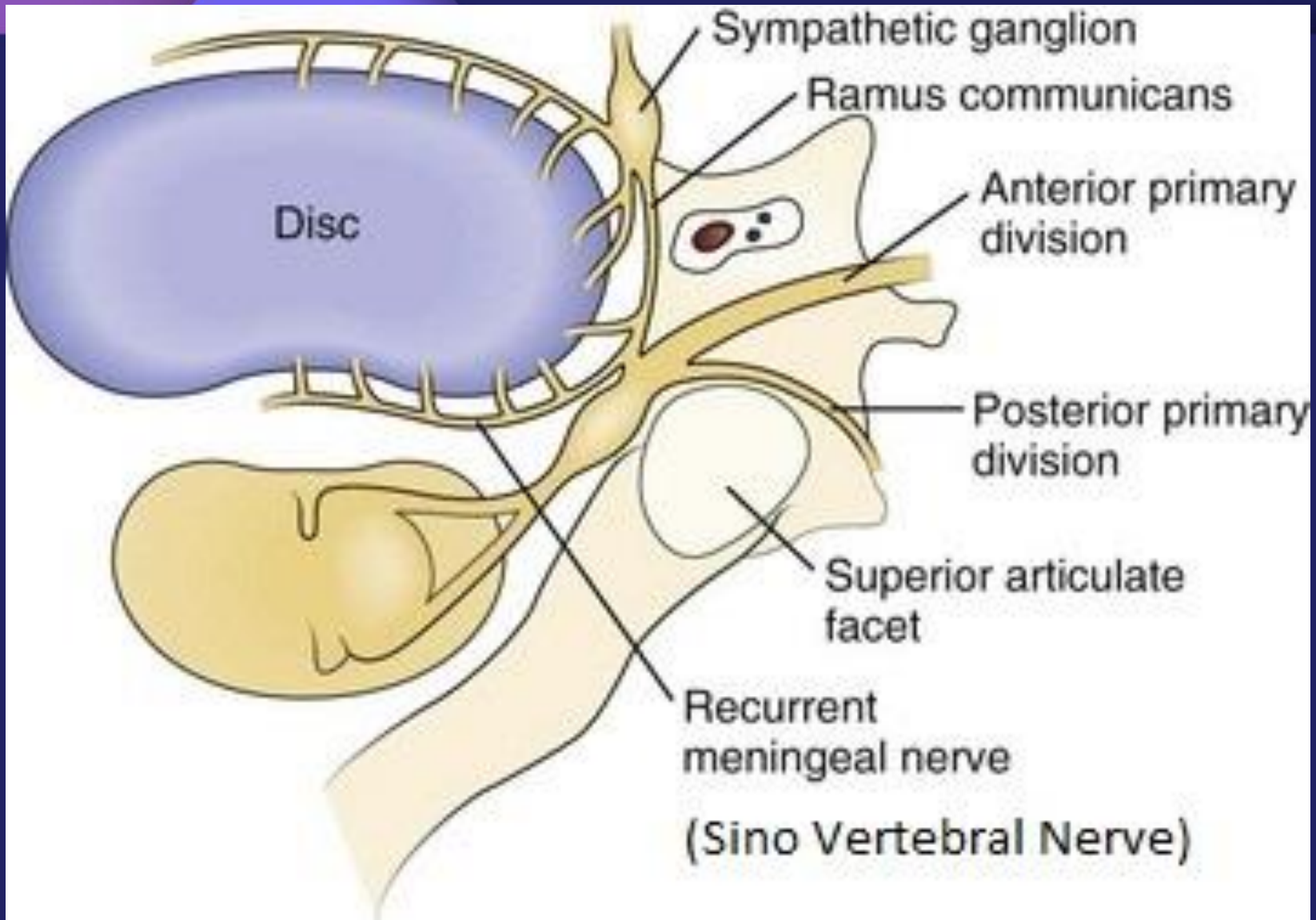
3 Clinical Syndromes:

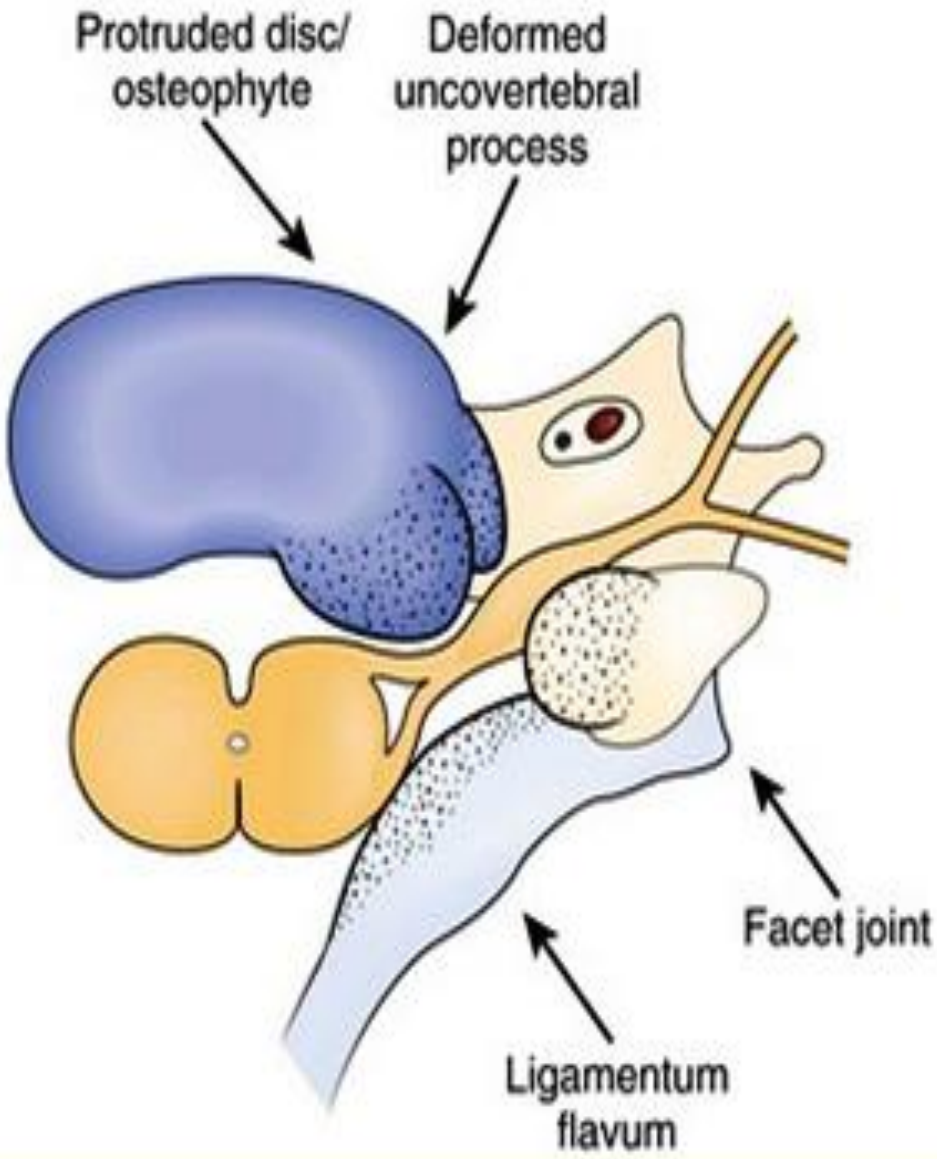
- Axial neck pain
- Cervical Radiculopathy
- Cervical Myelopathy

Neck Pain



Composite map of axial pain patterns from facet joints at C2-3 to C6-7.


Sympathetic ganglion
Ramus communicans
Disc
Anterior primary division
Posterior primary division
Superior articulate facet
Recurrent meningeal nerve
(Sino Vertebral Nerve)



Nerve root compression in lateral spinal canal from disc, uncovertebral joint, or facet joint pathology can lead to cervical radiculopathy.

Cervical Radiculopathy

- C_6/C_7 most common
- Radicular pain: compression of inflamed or irritated nerve root
- Increase substance P in Dorsal nerve root ⟶ Neurogenic pain mediator
- Mechanical deformation of the Dorsal nerve root cause reduction of blood flow to the sensory nerve cells bodies resulting in pain
- Local inflammatory mediators; examples TNFα causing pain

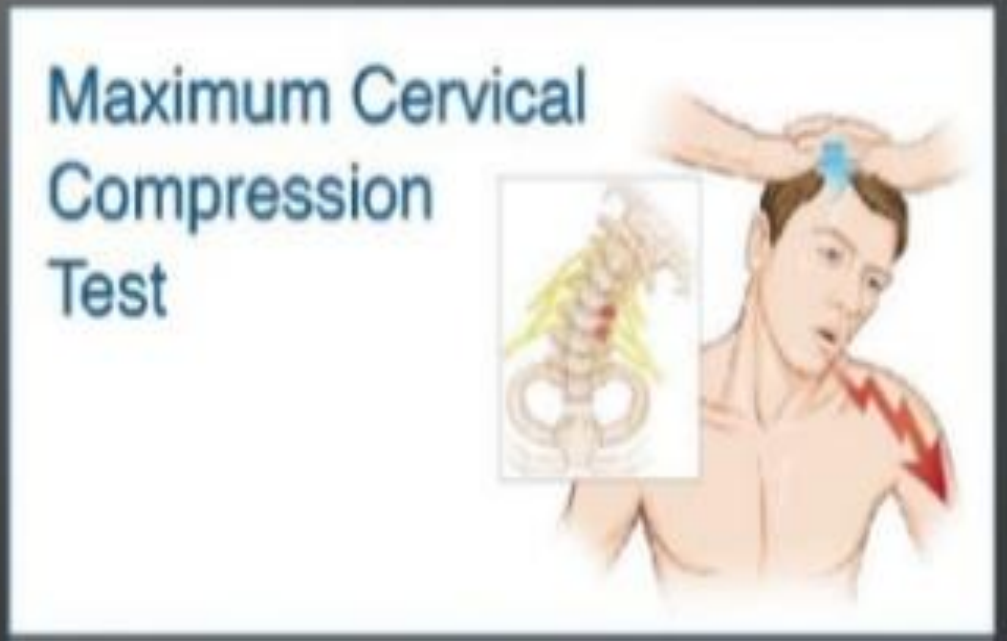
On Examination

Table 1. Physical Findings Associated with Cervical Radiculopathy.*

Disk Level	Root	Pain Distribution	Weakness	Sensory Loss	Reflex Loss
C4–C5	C5	Medial scapular border, lateral upper arm to elbow	Deltoid, supraspinatus, infraspinatus	Lateral upper arm	Supinator reflex
C5–C6	C6	Lateral forearm, thumb and index finger	Biceps, brachioradialis, wrist extensors	Thumb and index finger	Biceps reflex
C6–C7	C7	Medial scapula, posterior arm, dorsum of forearm, third finger	Triceps, wrist flexors, finger extensors	Posterior forearm, third finger	Triceps reflex
C7–T1	C8	Shoulder, ulnar side of forearm, fifth finger	Thumb flexors, abductors, intrinsic hand muscles	Fifth finger	—

Spurling' sign

Pushing down on top of head, with neck in extension (chin up) and head leaning toward symptomatic side elicits pain, typically toward or down the arm (positive Spurling's sign); 90% specific, 45% sensitive.

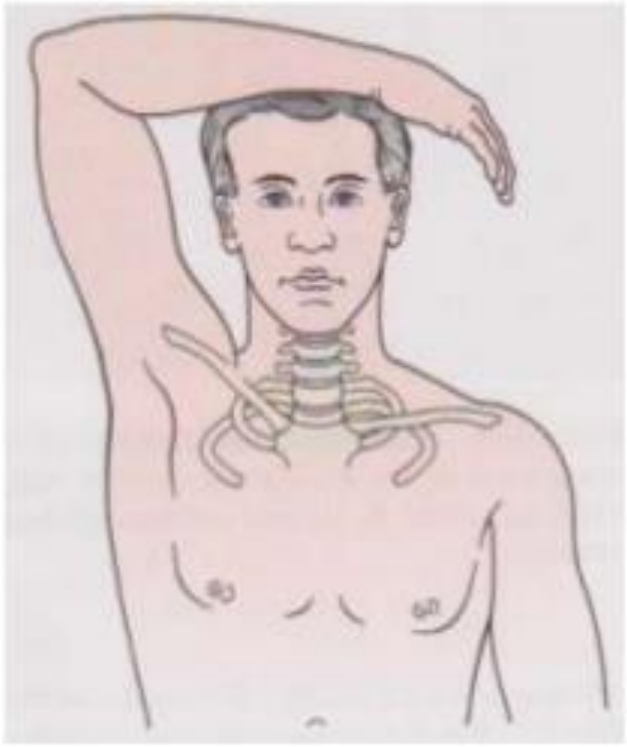


Shoulder Abduction Test for Radiculopathy

Physical Exam

Shoulder abduction test/ Shoulder abduction relief sign/Bakody's sign

- Active/passive abduction of ipsilateral shoulder
- Relief of radicular symptoms
- takes stretch off of the affected nerve root and may decrease or relieve radicular symptoms



Autumn dry leaves
Oil on canvas
1994
73 x 107 cm

CERVICAL SPONDYLOTIC MYELOPATHY

Definition

CERVICAL SPONDYLOTIC MYELOPATHY is a neurological disorder caused by the narrowing of the spinal canal as a result of degenerative changes in the cervical spine.

- Symptoms and signs may be subtle in early manifestations
- Can be easily missed or incorrectly diagnosed as the natural process of ageing

Cervical Spondylotic Myelopathy

- Result of degenerative changes
  - ligamentum flavum hypertrophy or buckling,
  - facet joint hypertrophy
  - disc protrusion
  - posterior spondylotic ridges
- overall reduction in canal diameter
- cord compression

TABLE 1

Clinical Presentation of Cervical Spondylotic Myelopathy

Common symptoms
Clumsy or weak hands
Leg weakness or stiffness
Neck stiffness
Pain in shoulders or arms
Unsteady gait
Common signs
Atrophy of the hand musculature
Hyperreflexia
Lhermitte's sign (electric shock-like sensation down the center of the back following flexion of the neck)
Sensory loss

Cervical Spondylotic Myelopathy (CSM)

Subtle changes in balance or hand dexterity

Clumsiness or slowness with activities:

- Buttoning buttons
- Using keys
- Change in handwriting
- Difficulty with common tasks using computer keyboard
- Pushing buttons on a cellphone
- Texting Messages

Balance Problem

- Recent necessity to use handrail while negotiating stairs
- Paresthesia and weakness in upper limbs
- May have concomitant radicular signs & Symptoms
- Change in bowel or bladder dysfunction

Myelopathy Hand

- Test of hand dexterity - 15 seconds grip and release test
- Loss of Motor Strength
- Sensory Changes
- Wasting of the intrinsic muscles
- Spasticity

Myelopathy Hand

Finger Escape Signs

Ulnar two digits drift into abduction and flexion after the patient hold the hand in the extended position

Sensory

- Vibration in upper & lower limbs

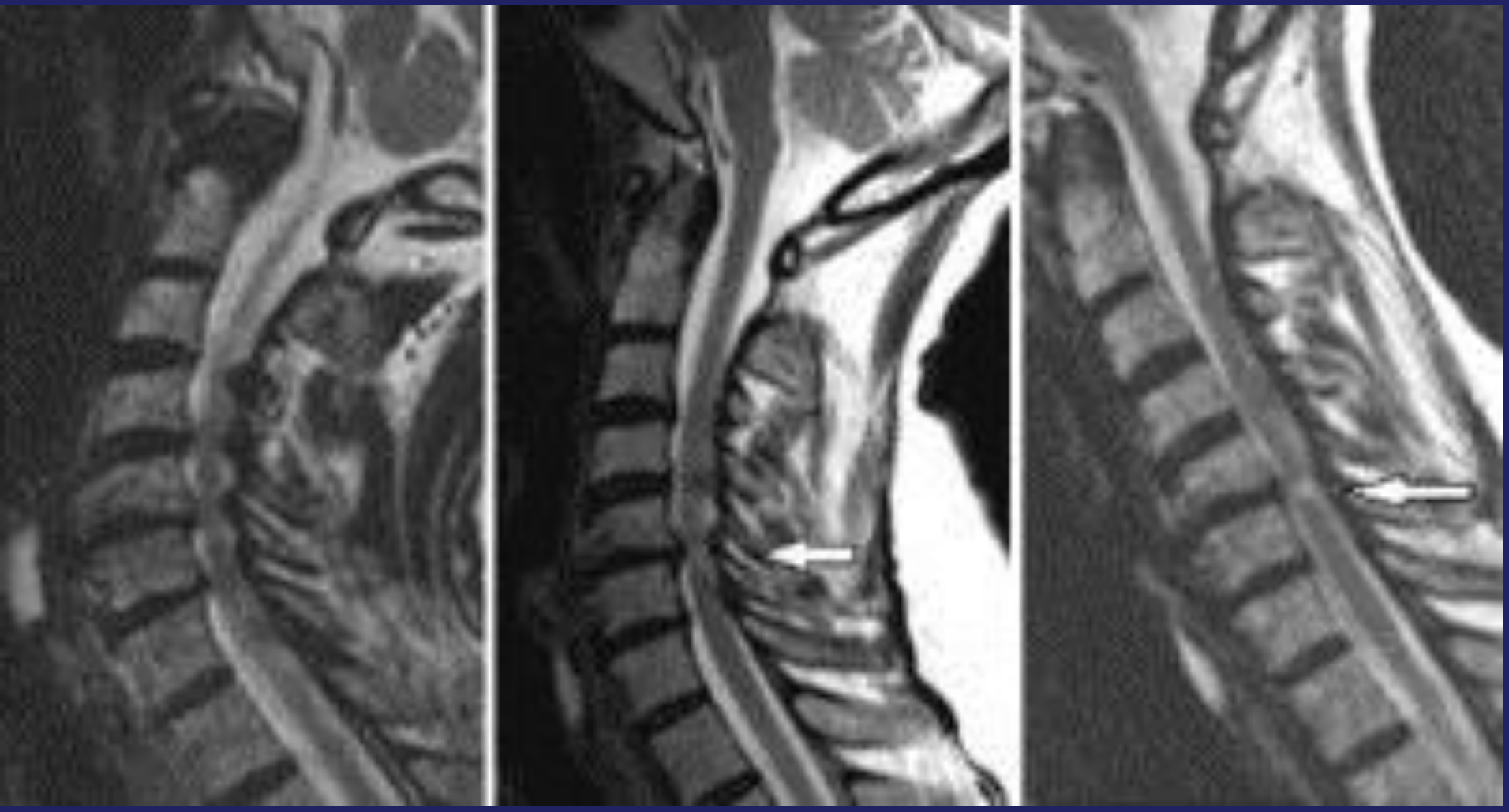
- Hyper reflexia – Abnormal long tract signs
- Hoffmans
- Babinski

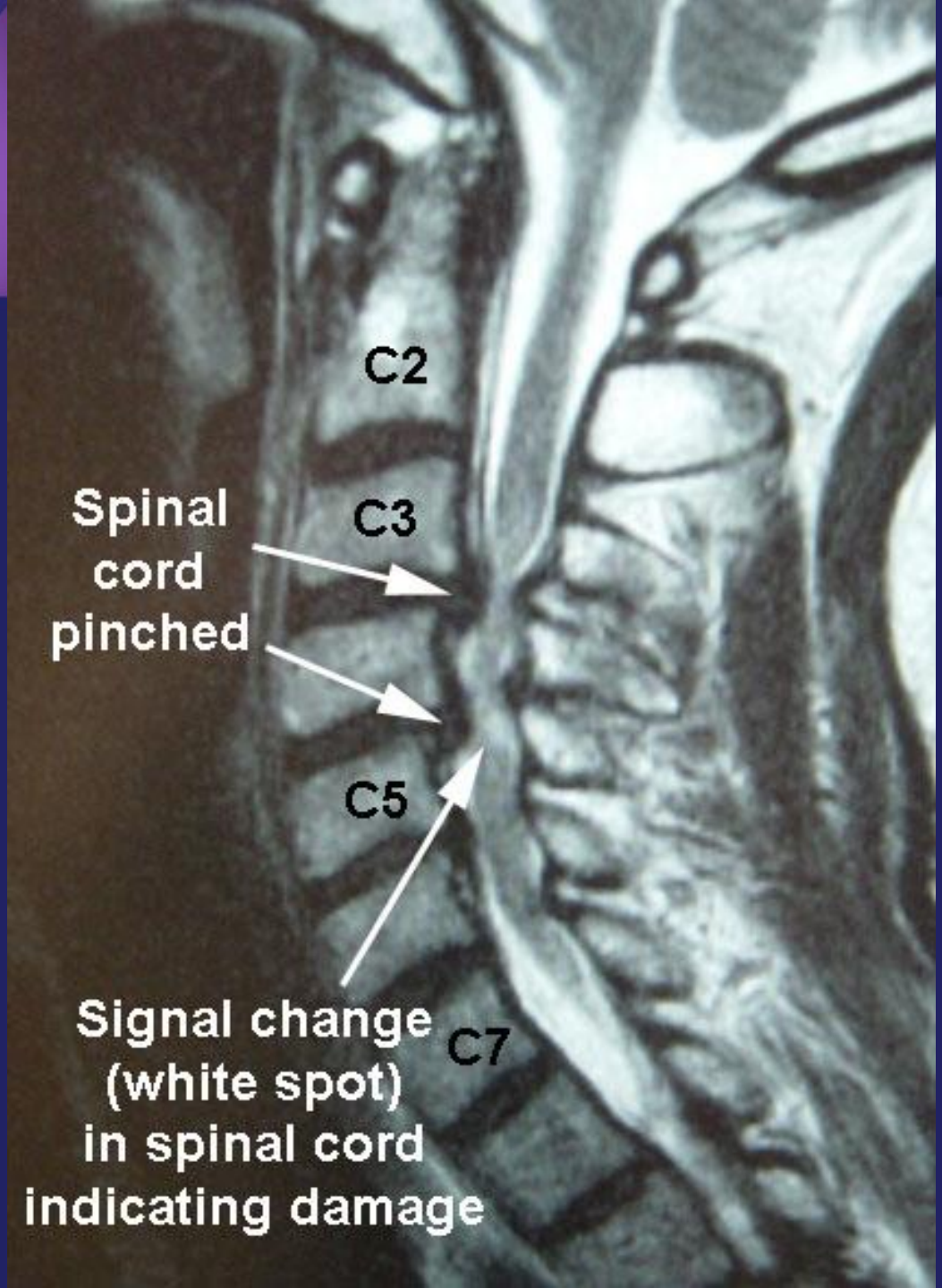
Cervical Spondylotic Myelopathy (CSM) - Evaluations

- Plain Xray C.Spine. AP + LAT views
- Narrowing of Disc Space
- Facet Joint Arthrosis
- Bone Spurs
- Ossification of Post Longitudinal ligament (OPLL)
- Kyphotic Alignment
- PAVLOV Ratio – For Stenosis
- Flexion Extension Views + Oblique Views

MRI Cervical Spine

- Disc Herniation
- Facet Joint Hypertrophy
- Folding of Ligamentum Flavum
- Cord Oedema/ Signal Changes
- Sagittal diameter of cord




C2
C3
Spinal cord pinched
C5
Signal change (white spot) in spinal cord indicating damage
C7

Clinical Equipoise Case

- 57yo female
- Clumsy hands
- Gait instability
- 3 levels of compression

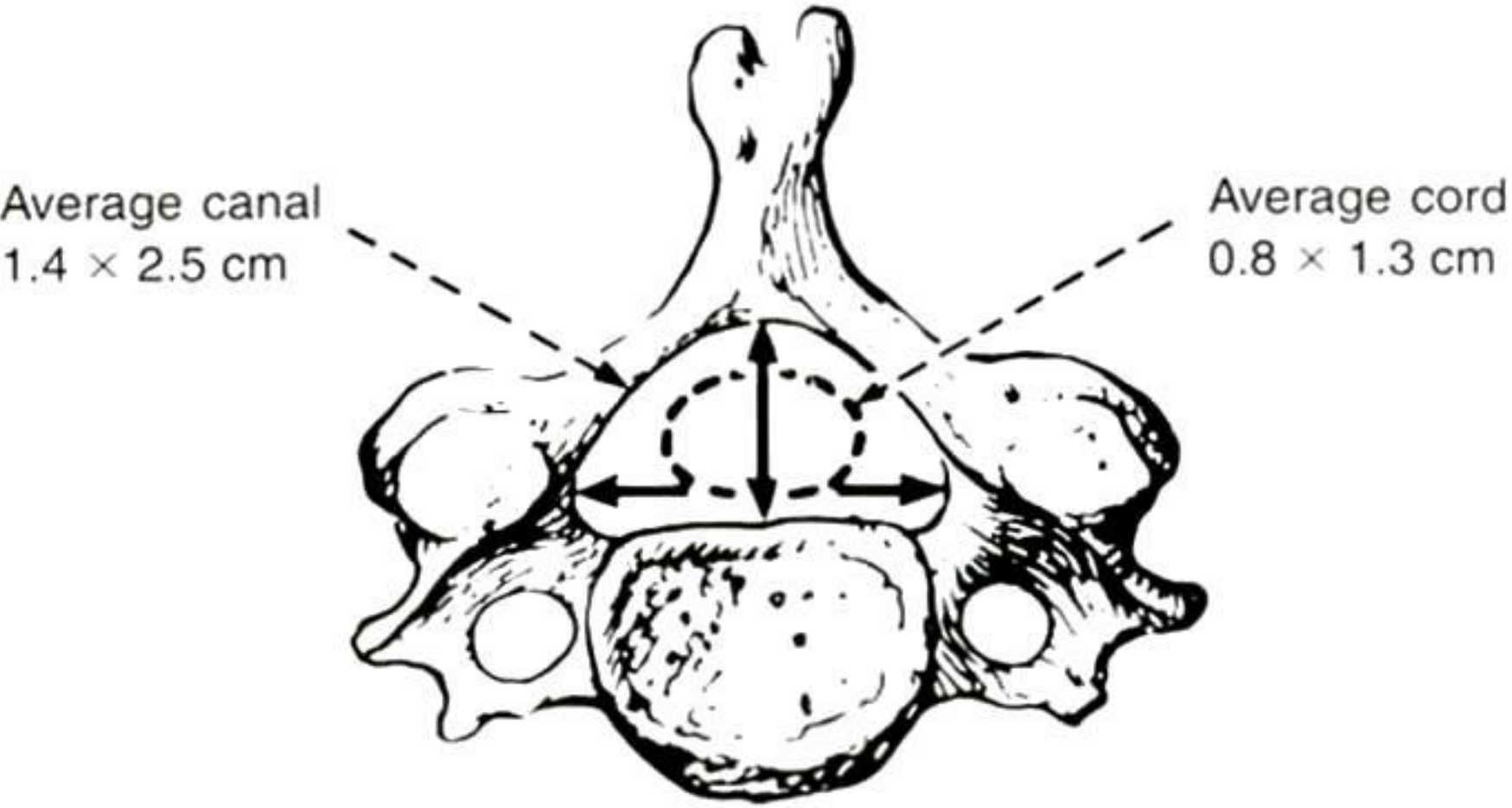
CT Scan C. Spine

- Presence of bone spurs
- Or any ossification of post longitudinal ligament (OPLL)

CT Scan Neck

Canal Stenosis

- Absolute Stenosis Sagittal Canal Diameter <10mm
- Critical Stenosis < 8mm
- Relative Stenosis < 13mm
- Normal diameter 17 – 18 mm
- Genetic Variation



The dimensions of the cervical spinal canal and spinal cord at C5.

Acute Hypertension

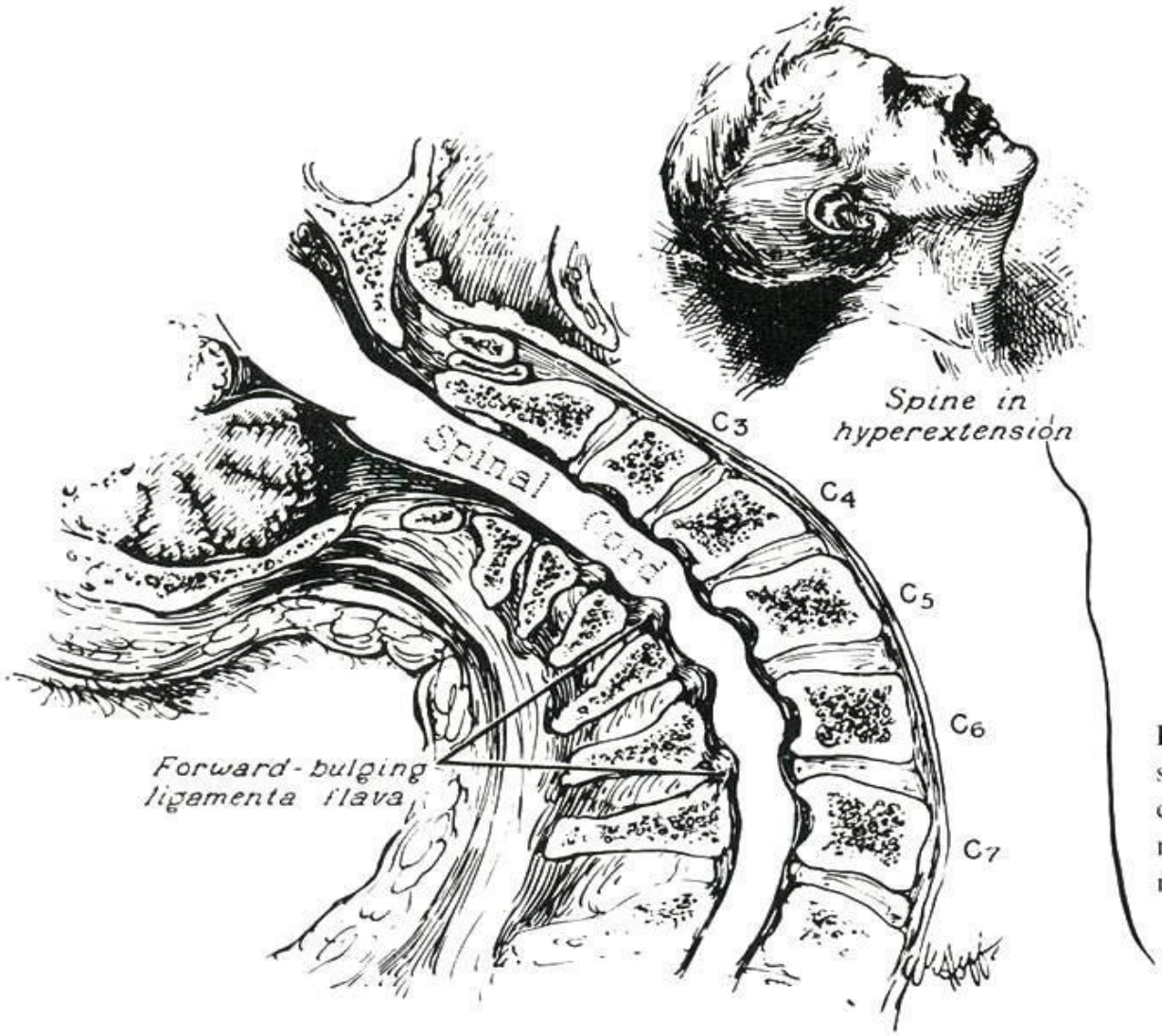
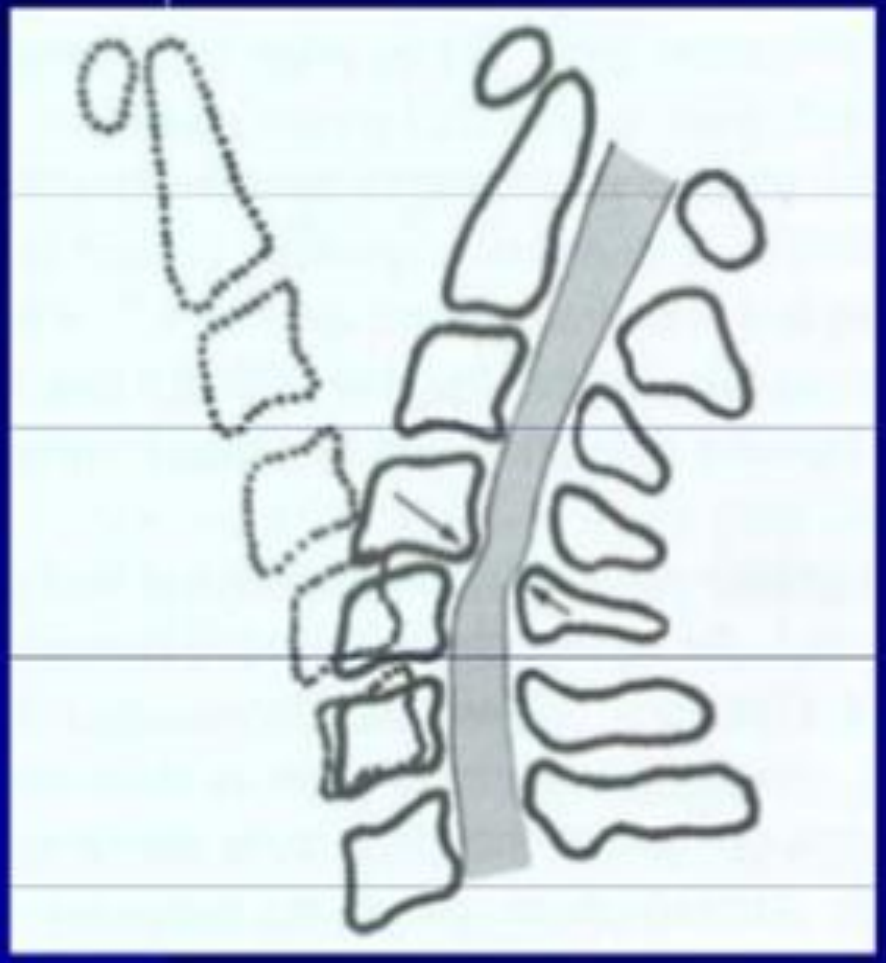


Figure 381-3 Acute hyperextension causes segmental narrowing, especially at the lower cervical segments. The central cord syndrome may result. (From Schneider et al.,[15] with permission.)

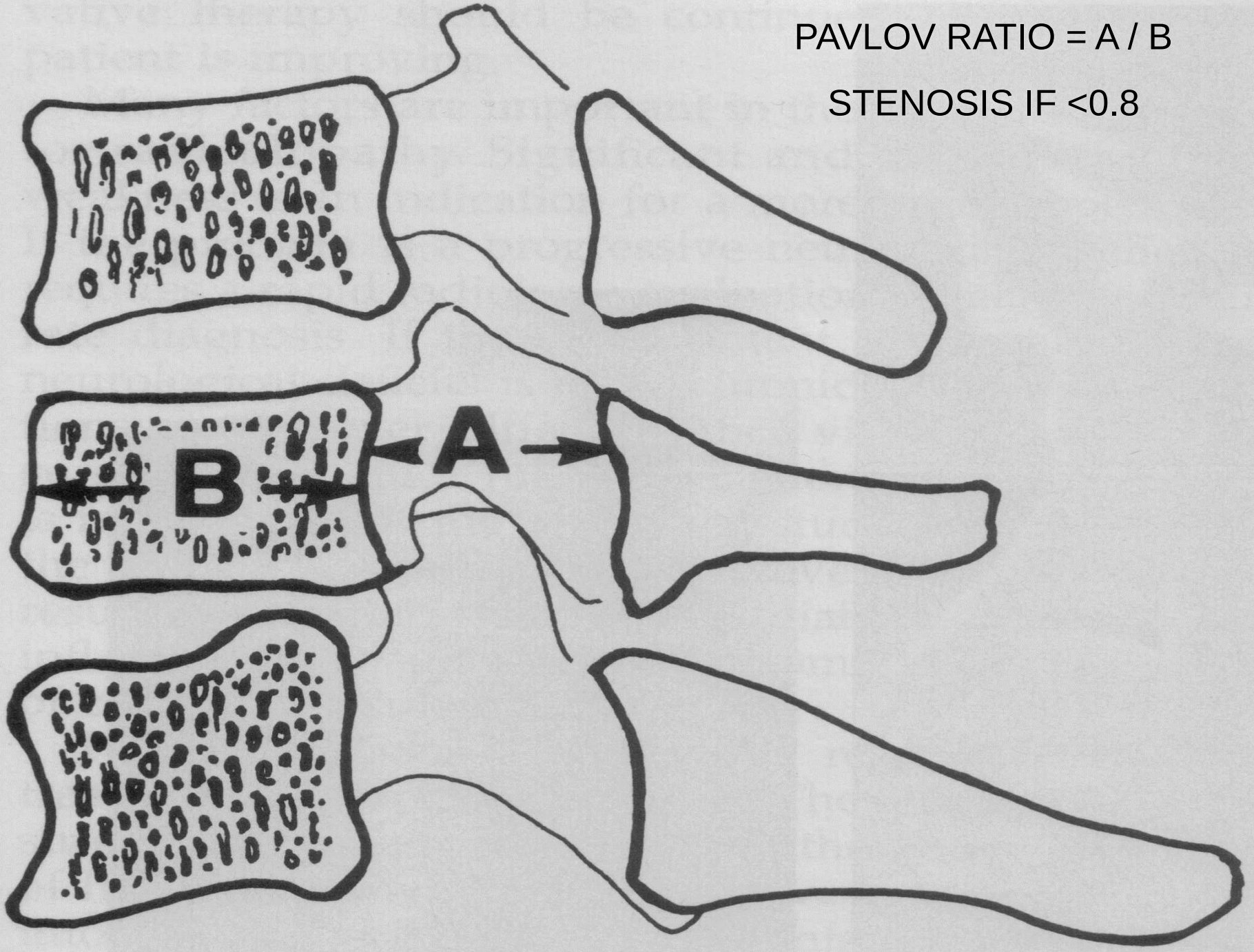
Pincer mechanism in extension



Pinching forces compromise micro circulation -> Ischemia in watershed area Edema and cavitation.

PAVLOV RATIO = A / B

STENOSIS IF <0.8



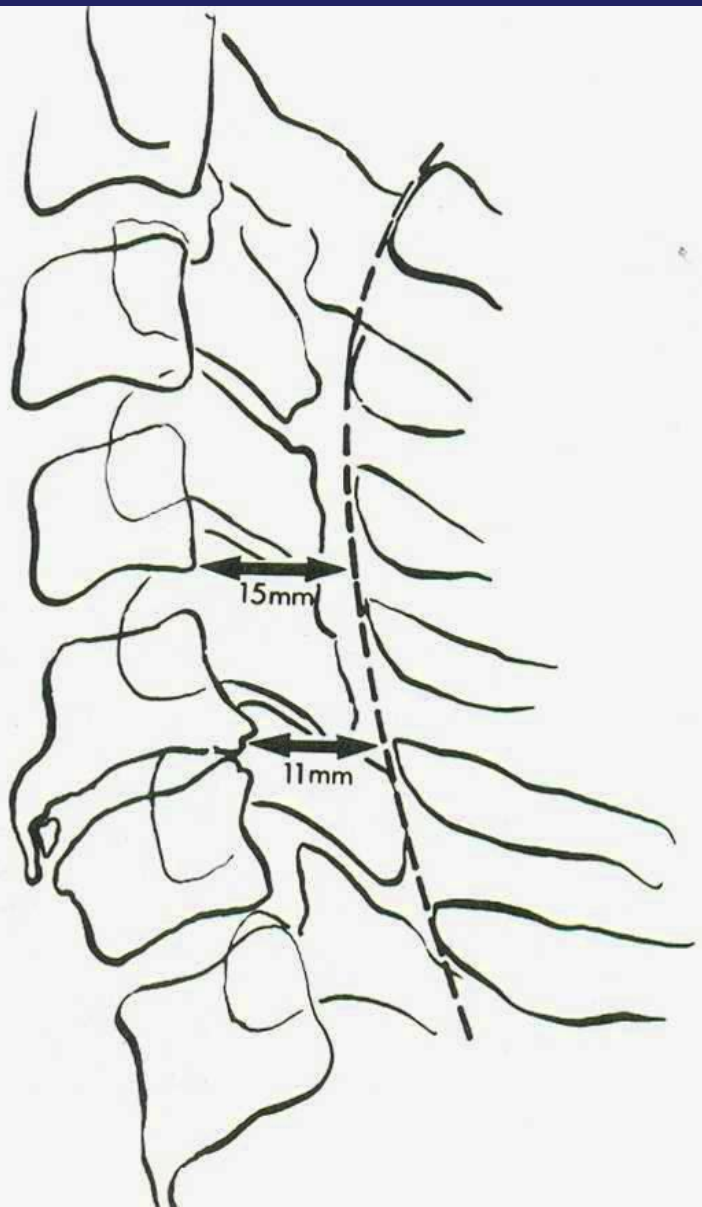


Figure 381-4 A lateral cervical spine film and the corresponding diagram. Note the method for measuring the anteroposterior diameter of the spinal canal, and the prominent spondylotic ridge

Diagnosis of CSM

- History
- Physical Examination
- Imaging
- For each individual patient

On examination

Pathologic long tract signs :-

- Hoffman's
- Babinski
- Clonus
- Finger Escape
- L'hermitte's Signs
- Hypereflexia

CSM

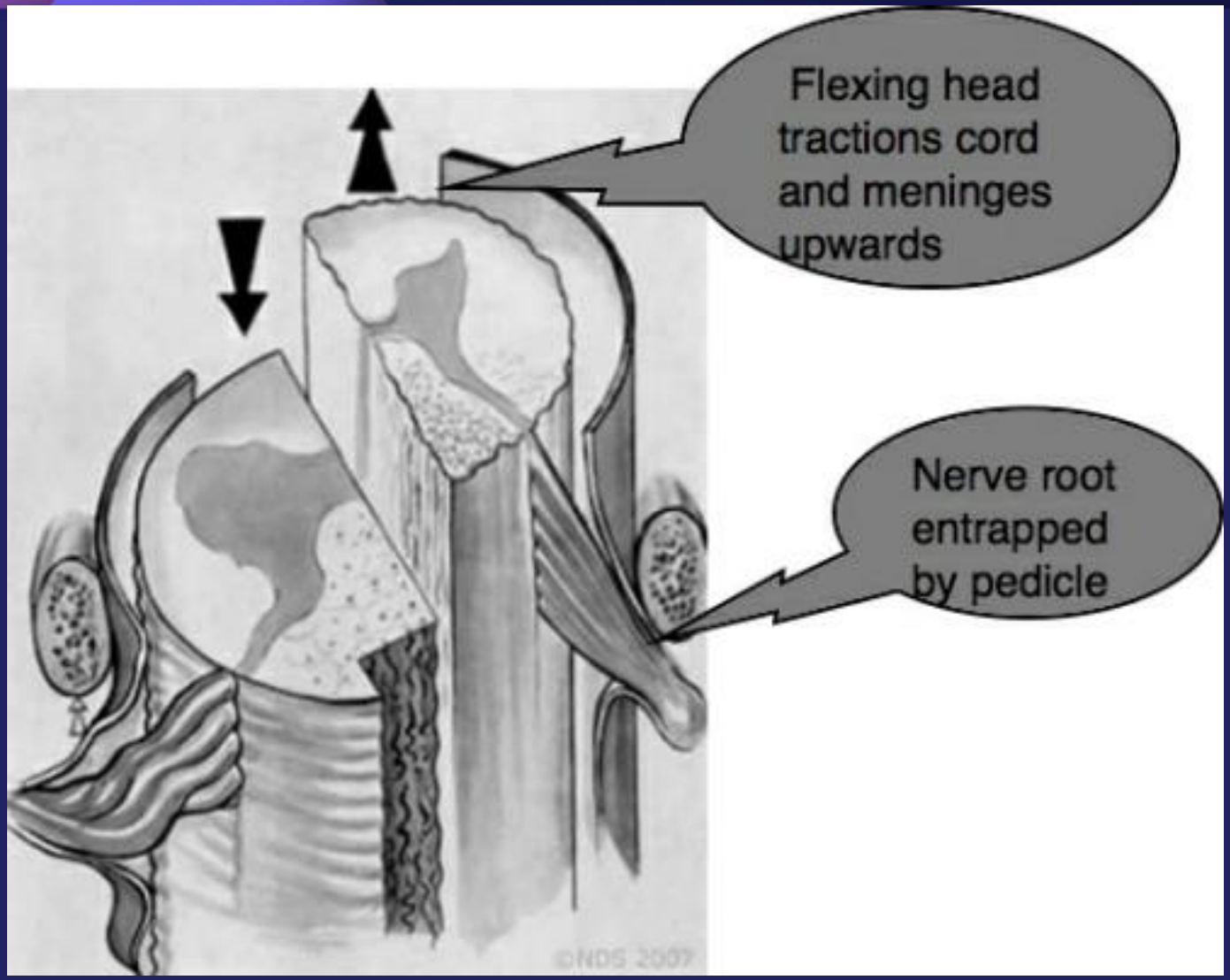
Hoffmann's Sign

The test is done by tapping or flicking the nail of the middle or ring finger to produce flexion of the index finger to the thumb.

CSM

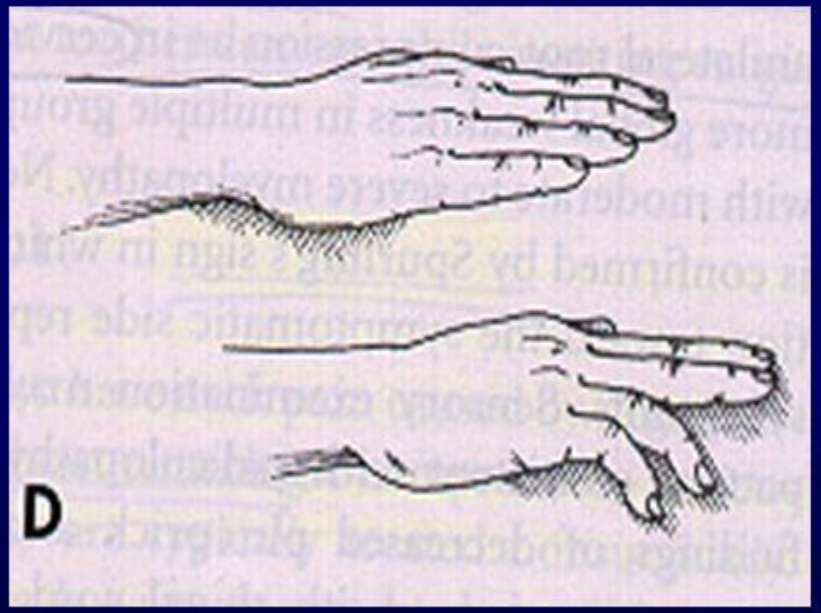
L'hermitte's Signs

Neck flexion causing electric shock sensation and paraesthesia radiating to the upper and lower extremities


Flexing head tractions cord and meninges upwards
Nerve root entrapped by pedicle
©NDS 2007

Finger Escape Sign
Myelopathy

- **Hold fingers adducted and extended**
- **Small & ring fingers fall into flexion abduction**
  - Usually within 30 seconds



Natural History

- Several studies – Mixed Course
- Not clearly defined
- Tendency to progress to more severe disease
  - Quiescent period
  - Slow stepwise decline
  - Stable neurological dysfunction and a rapid decline

- The natural history of is one of the stepwise progression.

- Early recognition and treatment is essential for optimum patient outcome before irreversible spinal cord damage.

Cervical Spondylotic Myelopathy

Differential diagnosis

- Amyotrophic Lateral Sclerosis
- Multiple Sclerosis
- Carpal Tunnel Syndrome
- Syringomyelia
- Guillian Barre Syndrome
- Spino Cerebellar degeneration
- Traumatic myelopathy

Progression of Cervical Spondylosis to Cervical Spondylotic Myelopathy

Several studies

- Highly variable and difficult to predict
- Relatively benign form to severe disease with neurological deficit

Syndromes seen in CSM patients

Complete lesions:

Transverse lesion syndrome

Incomplete lesions:

- Motor system syndrome:
- Central cord syndrome:
- Brown-Sequard syndrome
- Brachialgia and Cord syndrome

Indication for Surgery

- Patient Age
- Baseline Function
- Rate of Deterioration
- Severity of Symptoms
- Overall Health and Morbidity

Indication for Surgery

- Ongoing Symptoms refractory to conservative treatment
- Progressive symptoms bowel and bladder dysfunction
- Overt weakness

Surgery

- To prevent further decline
- May not result in substantial spontaneous improvement
- Early surgery for patients with myelomalacia or severe radiographic stenosis
- Intramedullary high signal changes -> poor prognosis

Myelopathy V/S Radiculopathy

Myelopathy : Any pathological condition of the spinal cord

- Upper motor neuron signs
- Motor weakness, positive Babinski sign, spasticity, hypereflexia, clonus

Radiculopathy: Pathological condition of a spinal nerve root

- Lower motor neuron sign
- Motor weakness, Muscle fasciculation, Muscle atrophy, hyporeflexia

Prognosis

- Condition does not improve without surgery.
- It tends to be progressive and get worse in a stepwise detoriation with period of stable symtoms

Nurick Classification

Grade 0	Root signs and symptoms. No evidence of spinal cord involvement
Grade 1	Signs of spinal cord involvement, but no difficulty walking
Grade 2	Slight difficulty walking that does not prevent full-time employment
Grade 3	Difficulty walking that prevents full-time employment or the ability to perform all housework, but that was not severe enough to require someone else help to walk
Grade 4	Able to walk with someone else's help or the aid of a frame
Grade 5	Chair bound or bedridden

Saggital CT reconstruction:

Osteophyte present C3/4

NON-SURGICAL TREATMENT

- Usually steady deterioration
- Trail of non-surgical management indicated in non-acute patients

Various modalities:

- Medications
- Immobilization
- Physiotherapy
- Traction
- Manual therapies
- Cervical exercises
- Passive modalities
- Occupational therapy
- Recreational Therapy
- Lifestyle changes
- Other modalities

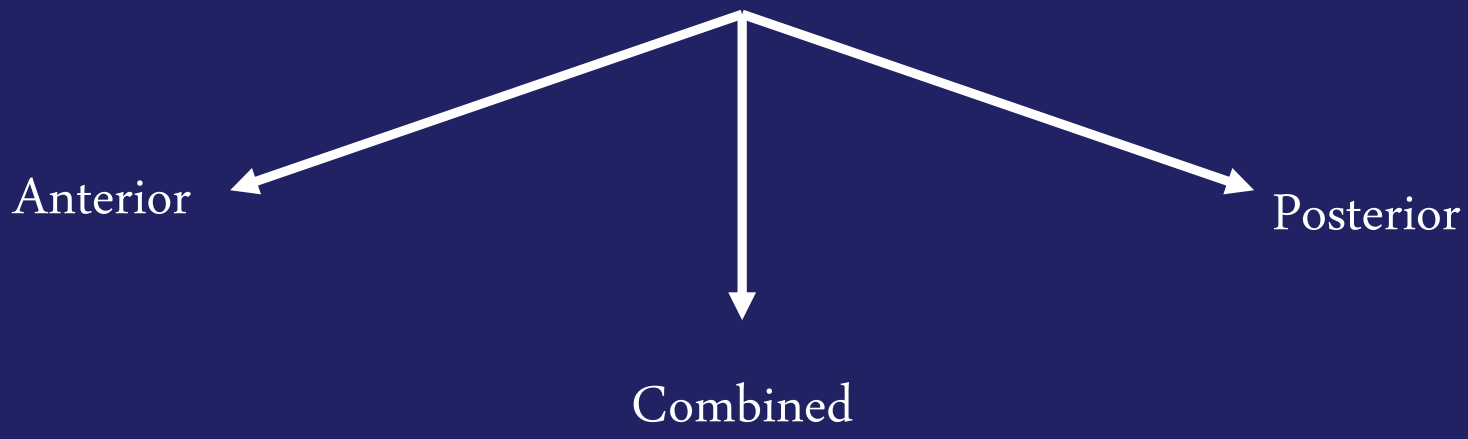
SURGICAL TREATMENT

Controversial

Indications

Goals

Approaches



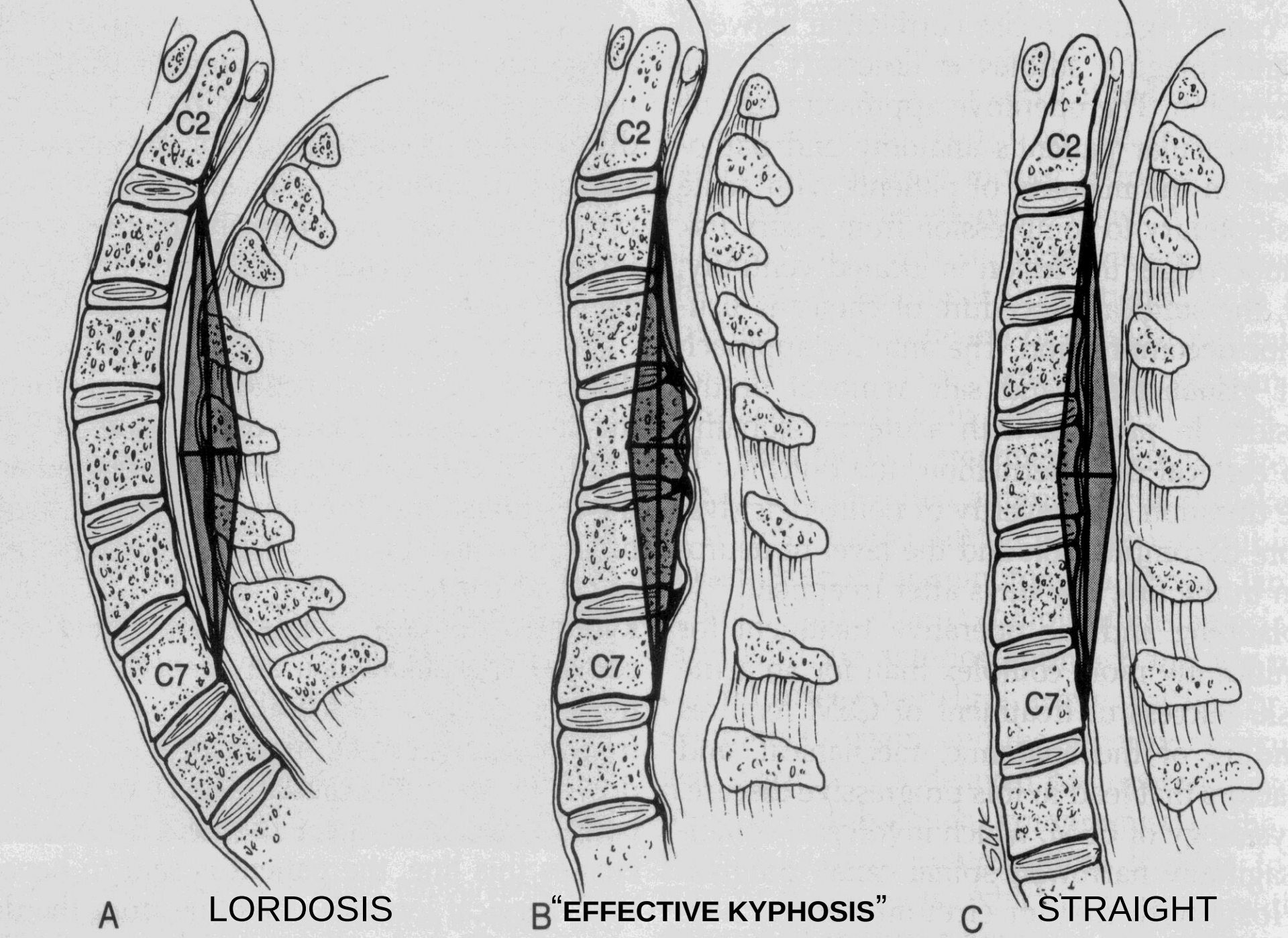
ISOLATED NECKPAIN

IS NOT

AN INDICATION

FOR

SURGERY


C2
C7
A
LORDOSIS
C2
C7
B
"EFFECTIVE KYPHOSIS"
C2
C7
SUK
C
STRAIGHT

ANTERIOR APPROACHES

Anterior Cervical Discectomy without graft fusion

Anterior Cervical Discectomy with graft fusion

Anterior cervical Discectomy with graft fusion and plating

Discectomy & Corpectomy with graft fusion +/- plating

Interbody fusion with cages

Oblique Corpectomy

Prosthetics

POSTERIOR APPROACHES

Laminectomy

Hemi-Laminectomy

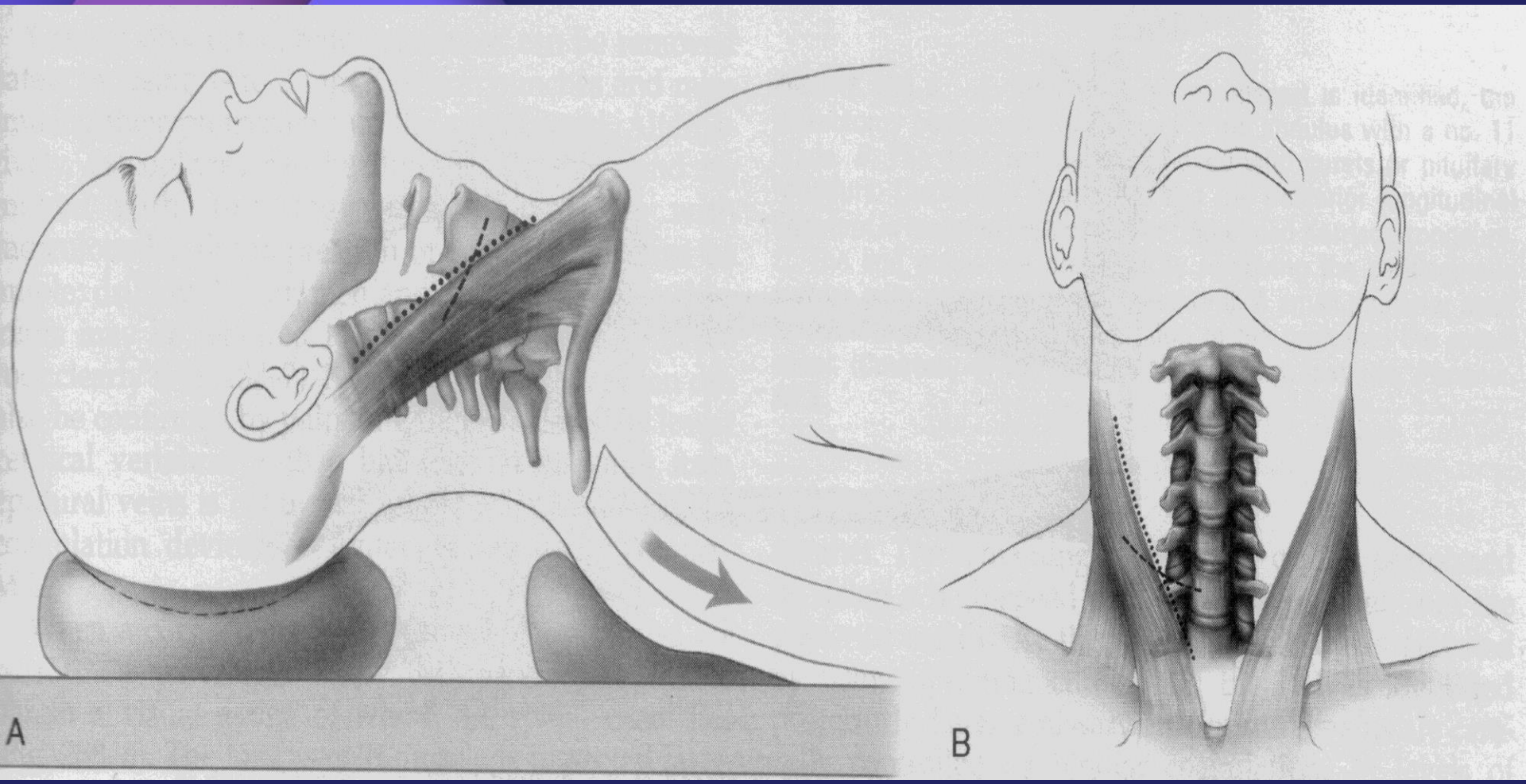
Laminoplasty

Keyhole Foraminotomy / Lamino-foraminotomy

+/- posterior spinal fusion

Posterior cervical stabilization:

Spinous process wiring / Interfacet wiring / Facet wiring / Lateral Mass plates


A
B

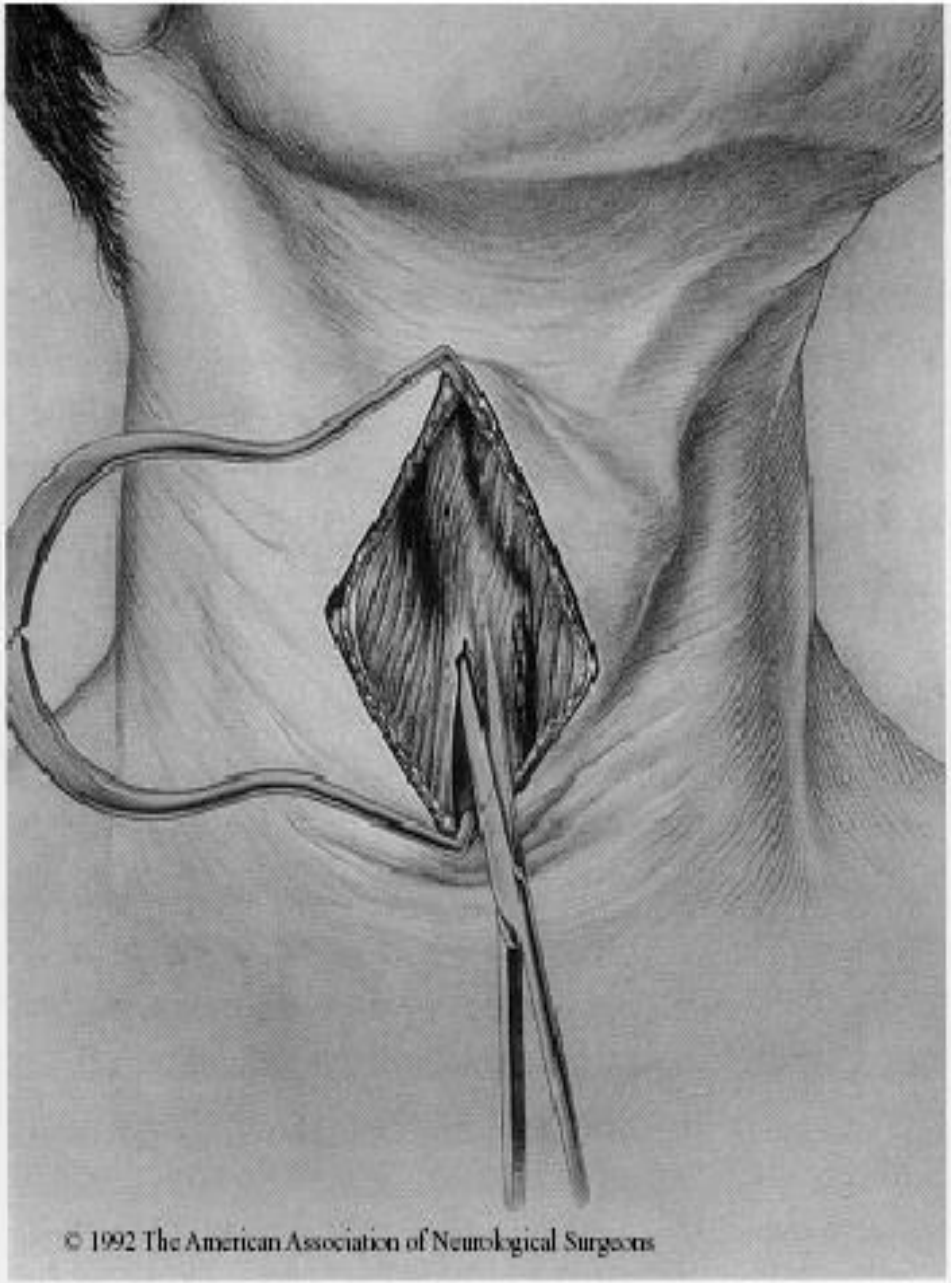


Figure 3. The skin edges are retracted vertically with a single-toothed self-retaining retractor.

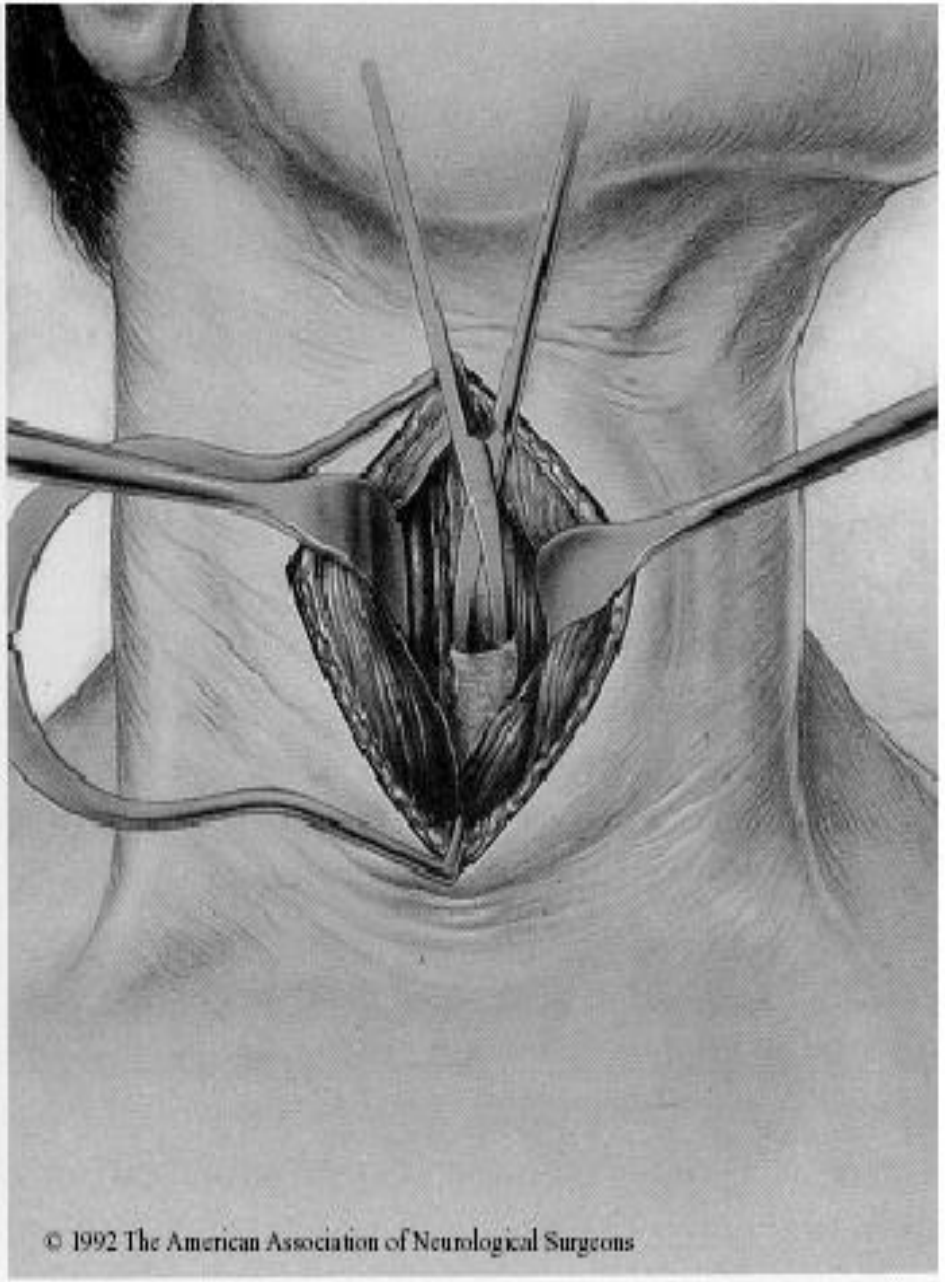
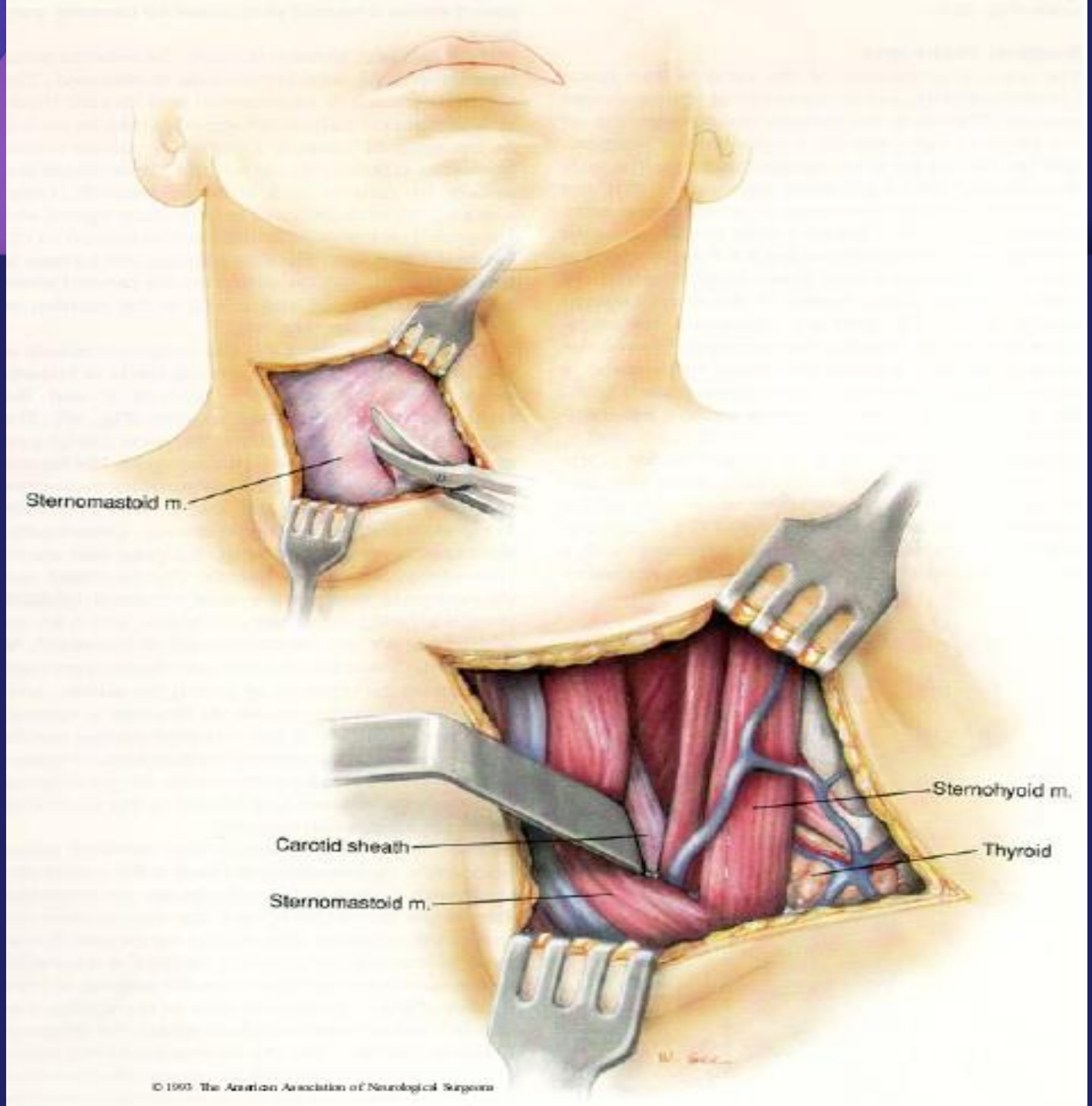


Figure 4. Dissection along the carotid-esophageal cleavage plane.



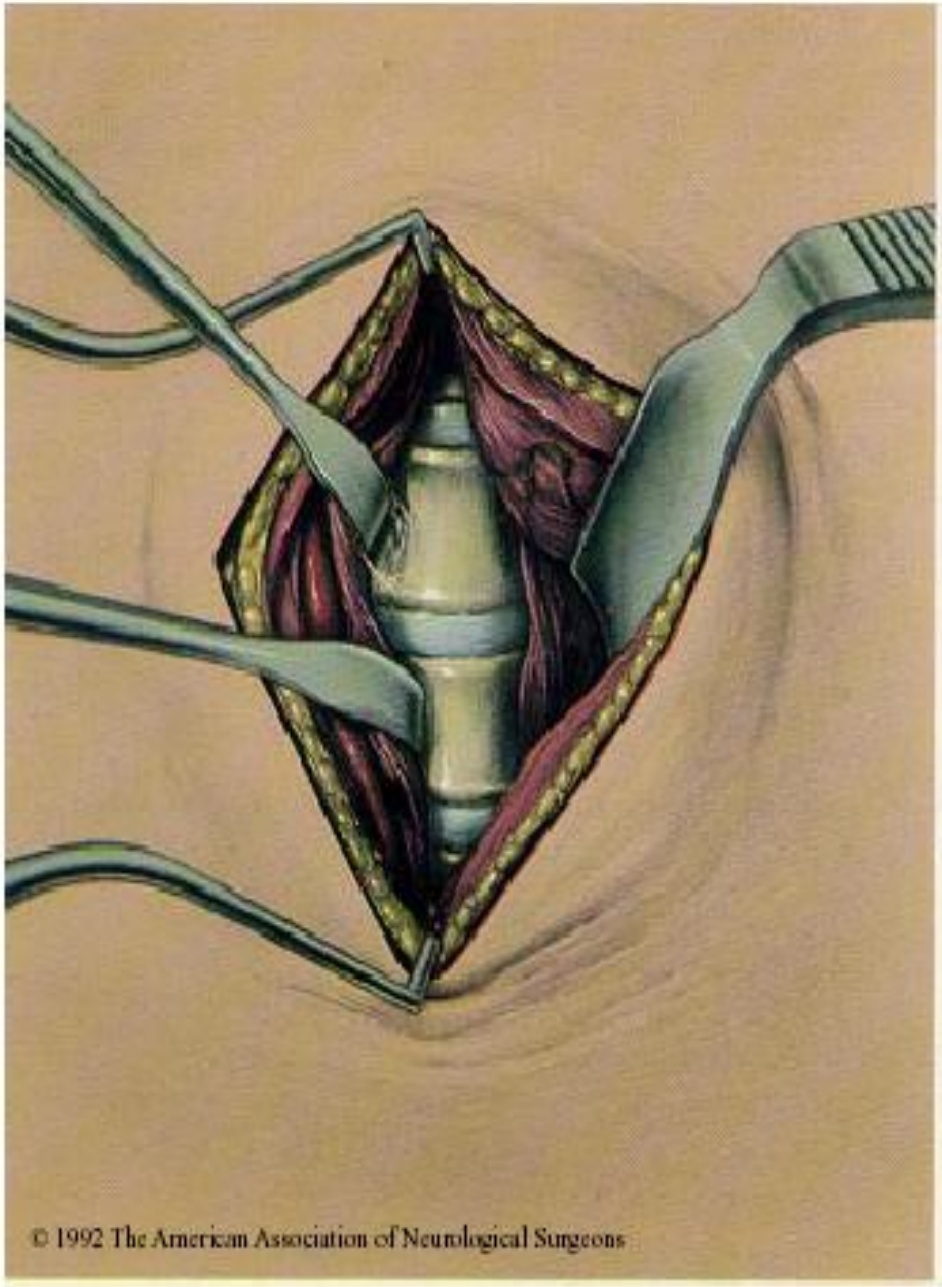


Figure 5. Dissection of the longus colli muscles away from the vertebral bodies.

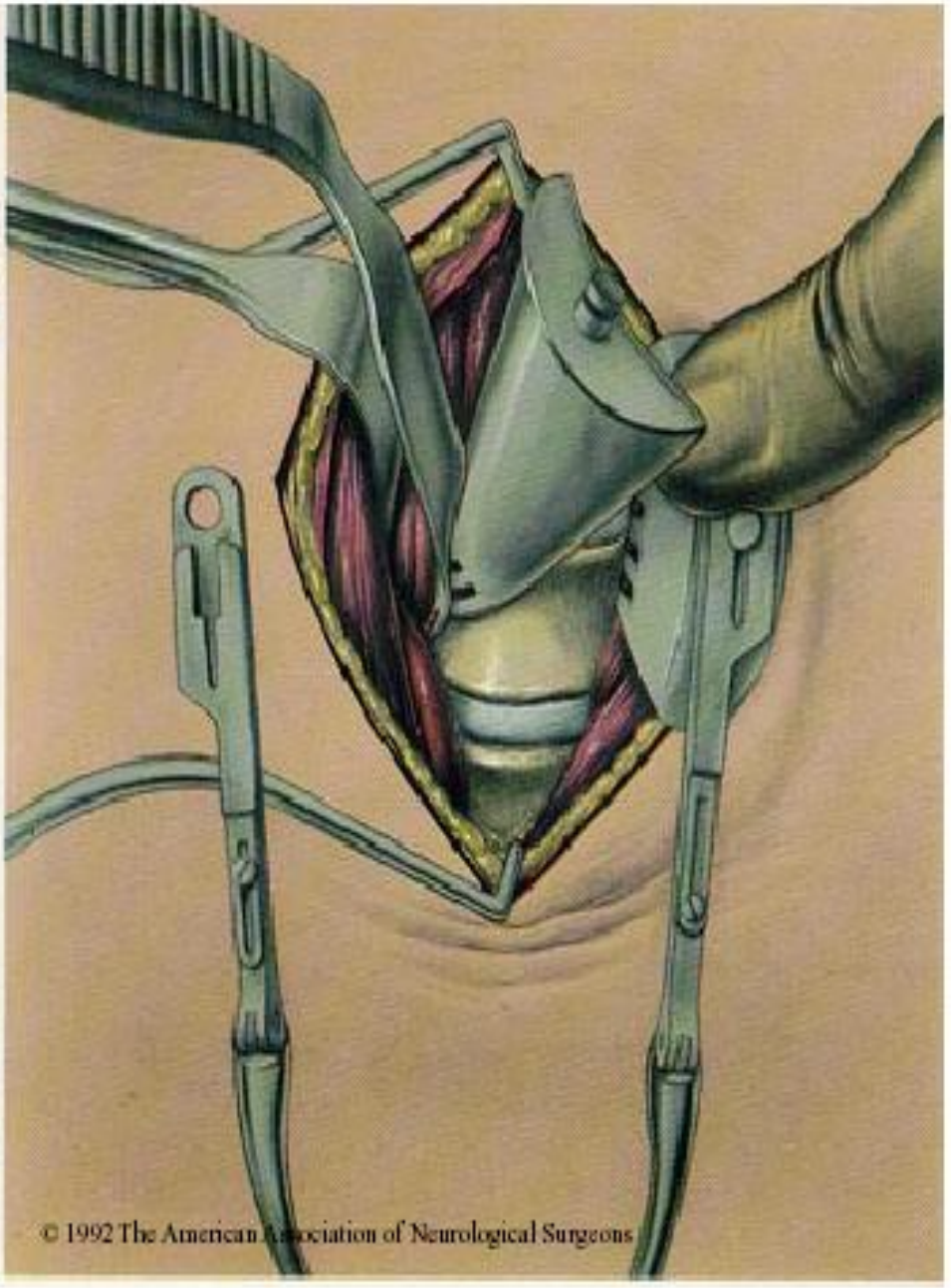
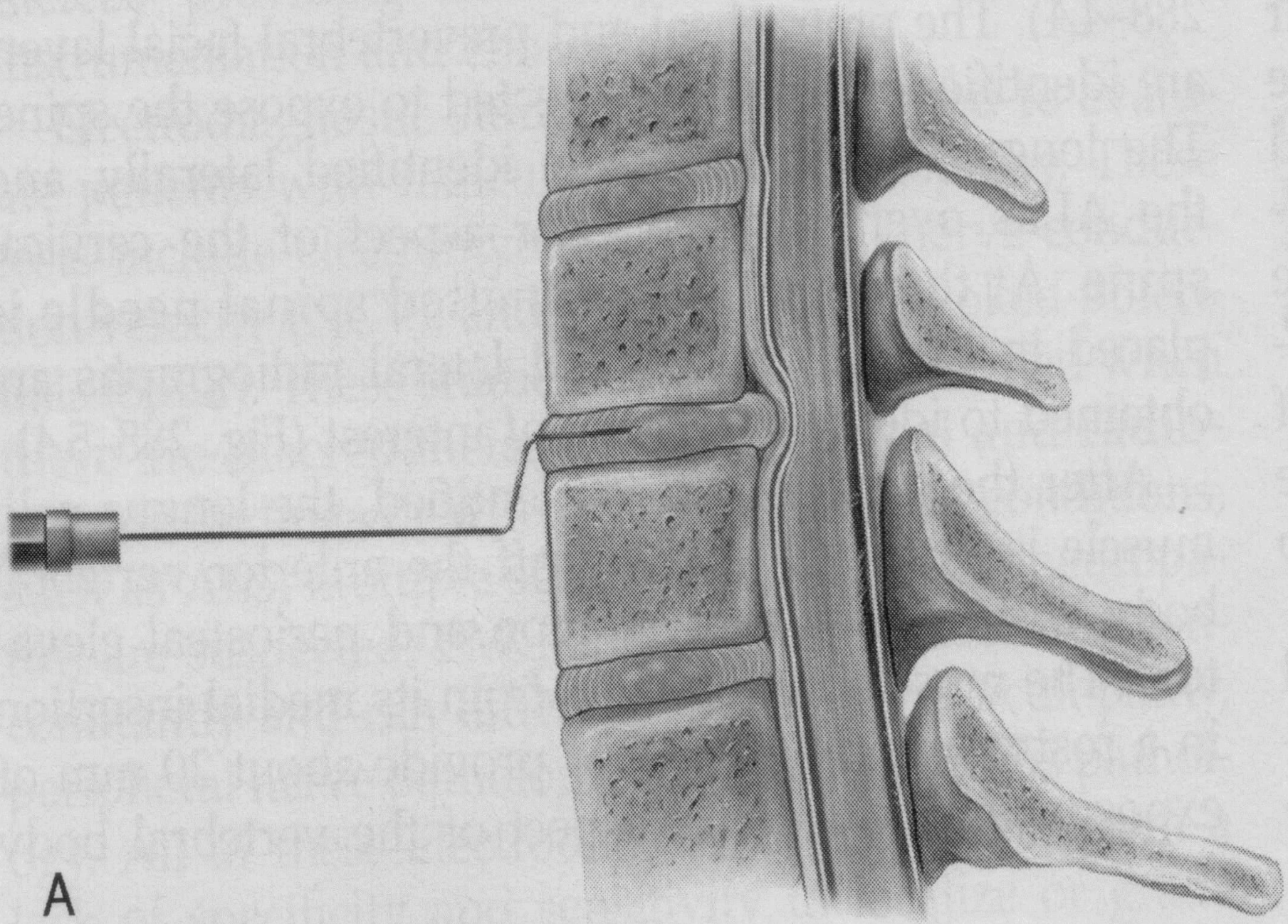


Figure 6. Application of self-retaining retractors.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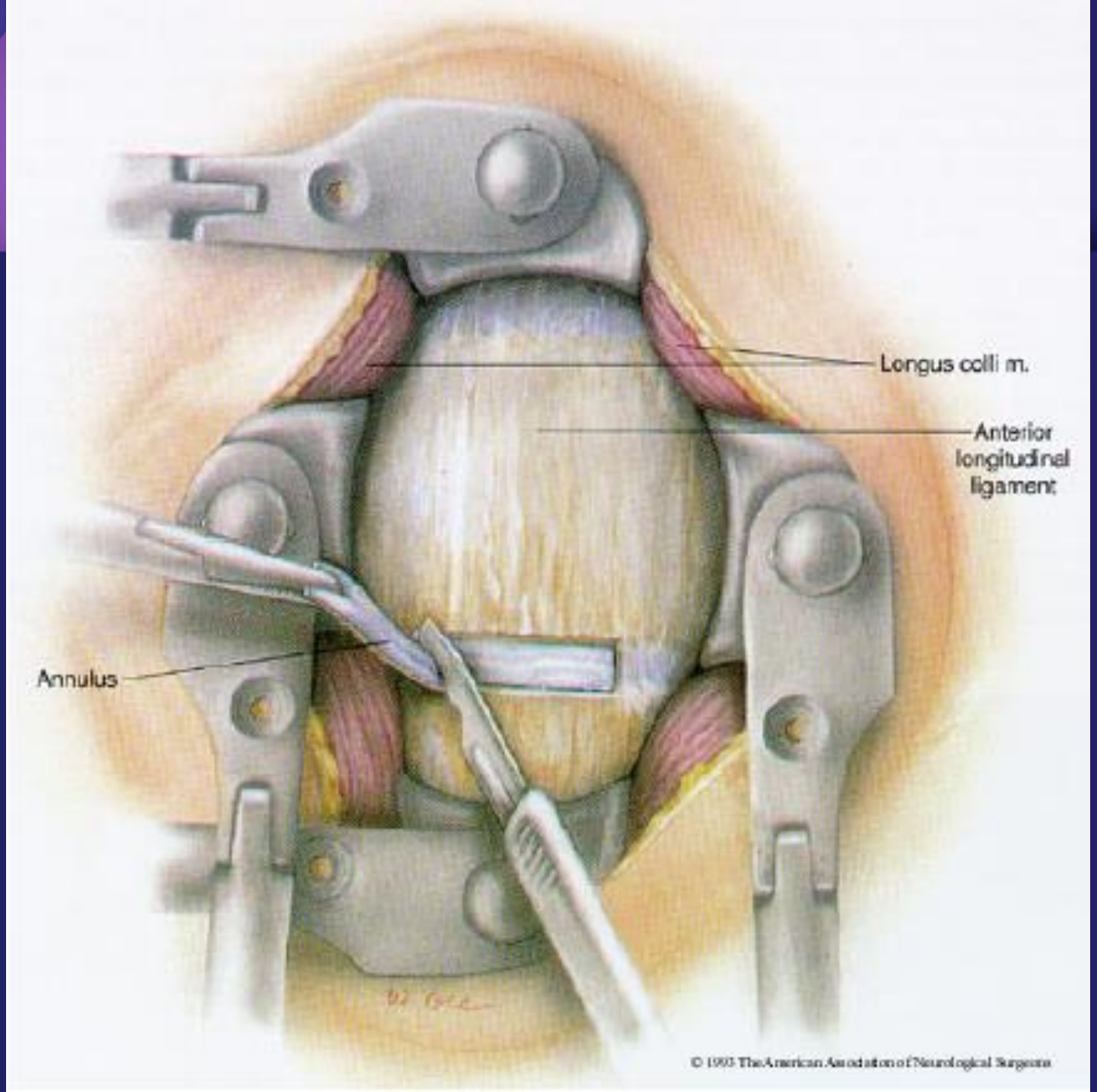
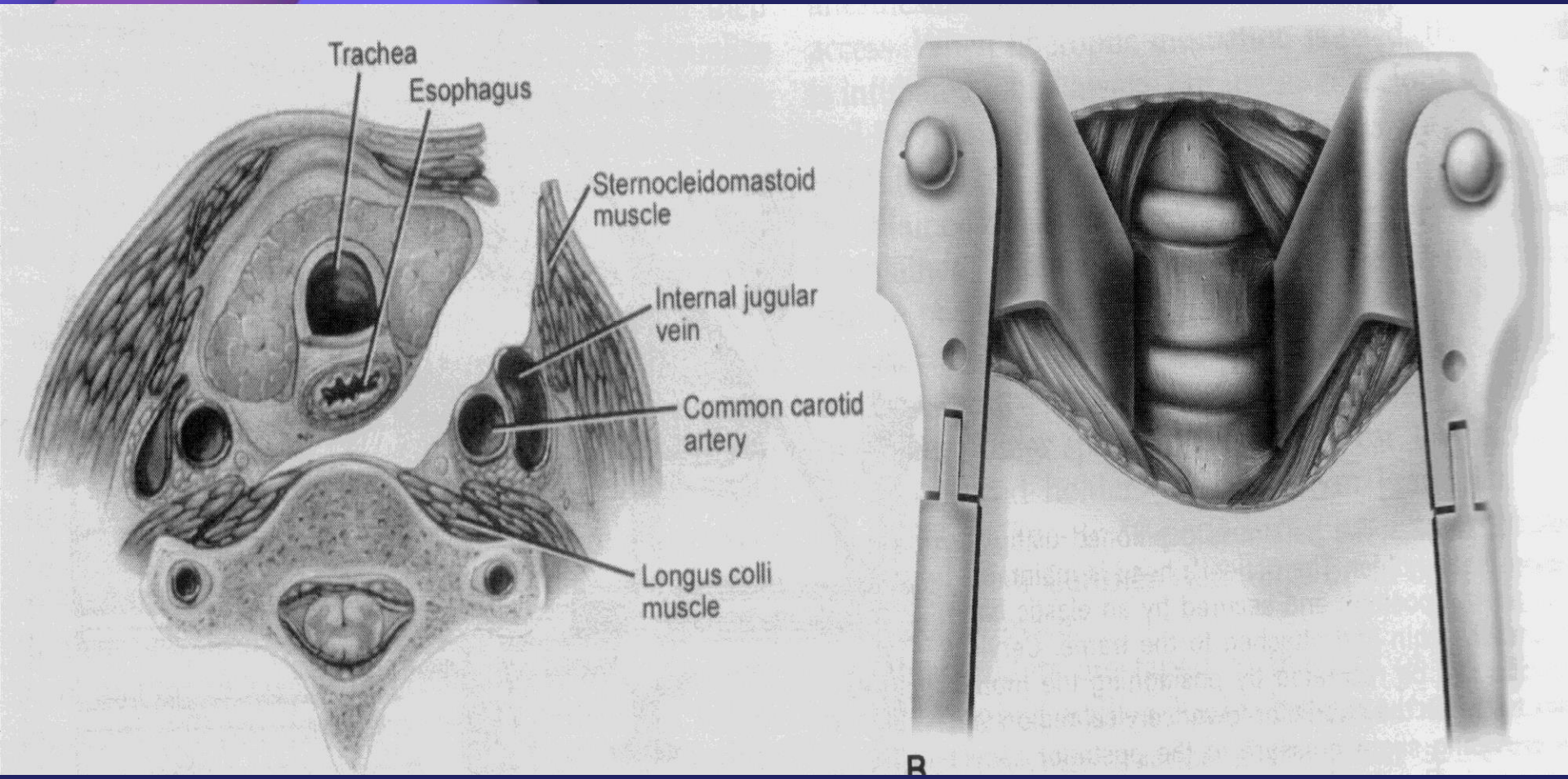
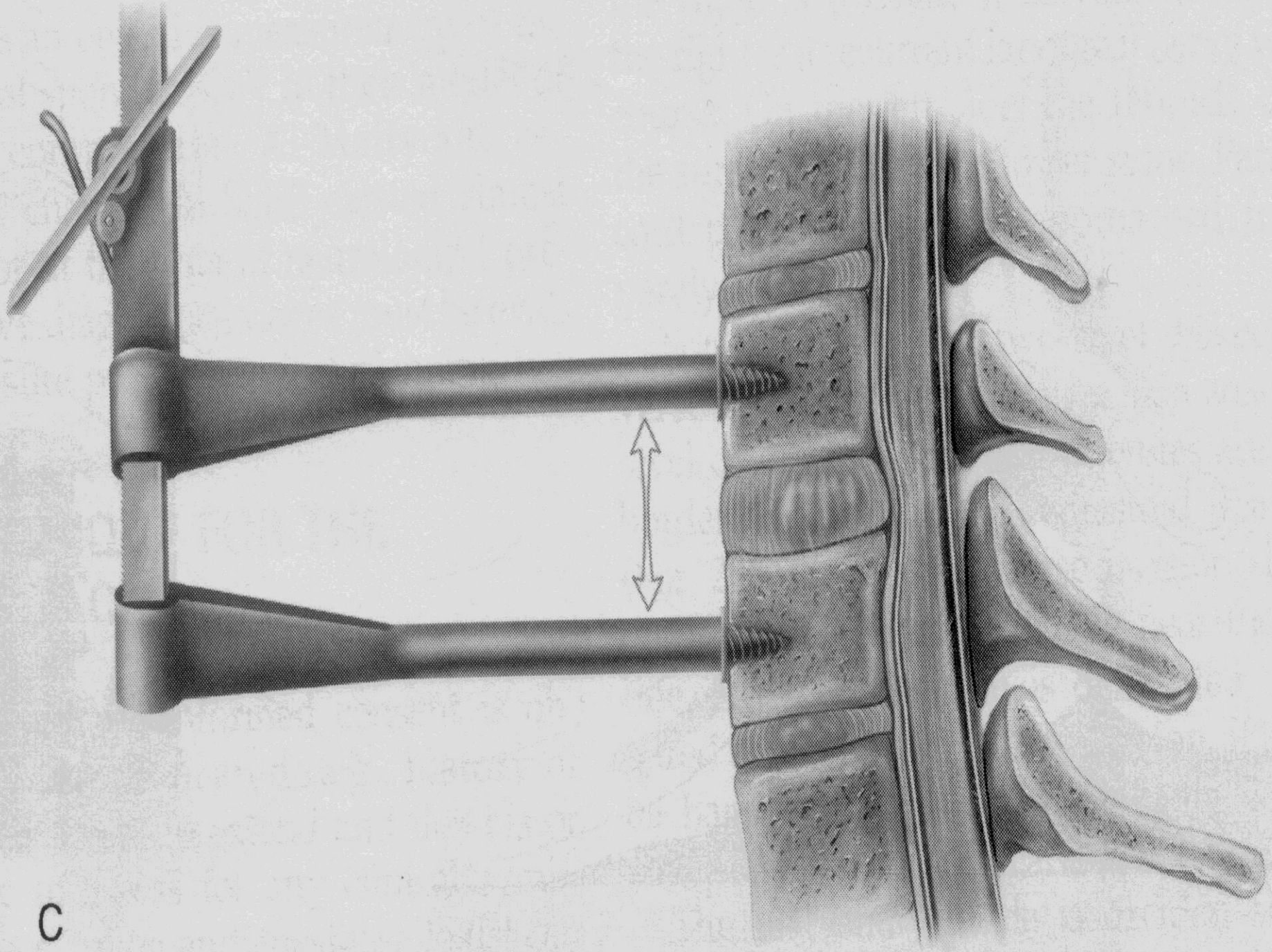



Trachea
Esophagus
Sternocleidomastoid muscle
Internal jugular vein
Common carotid artery
Longus colli muscle
B

B



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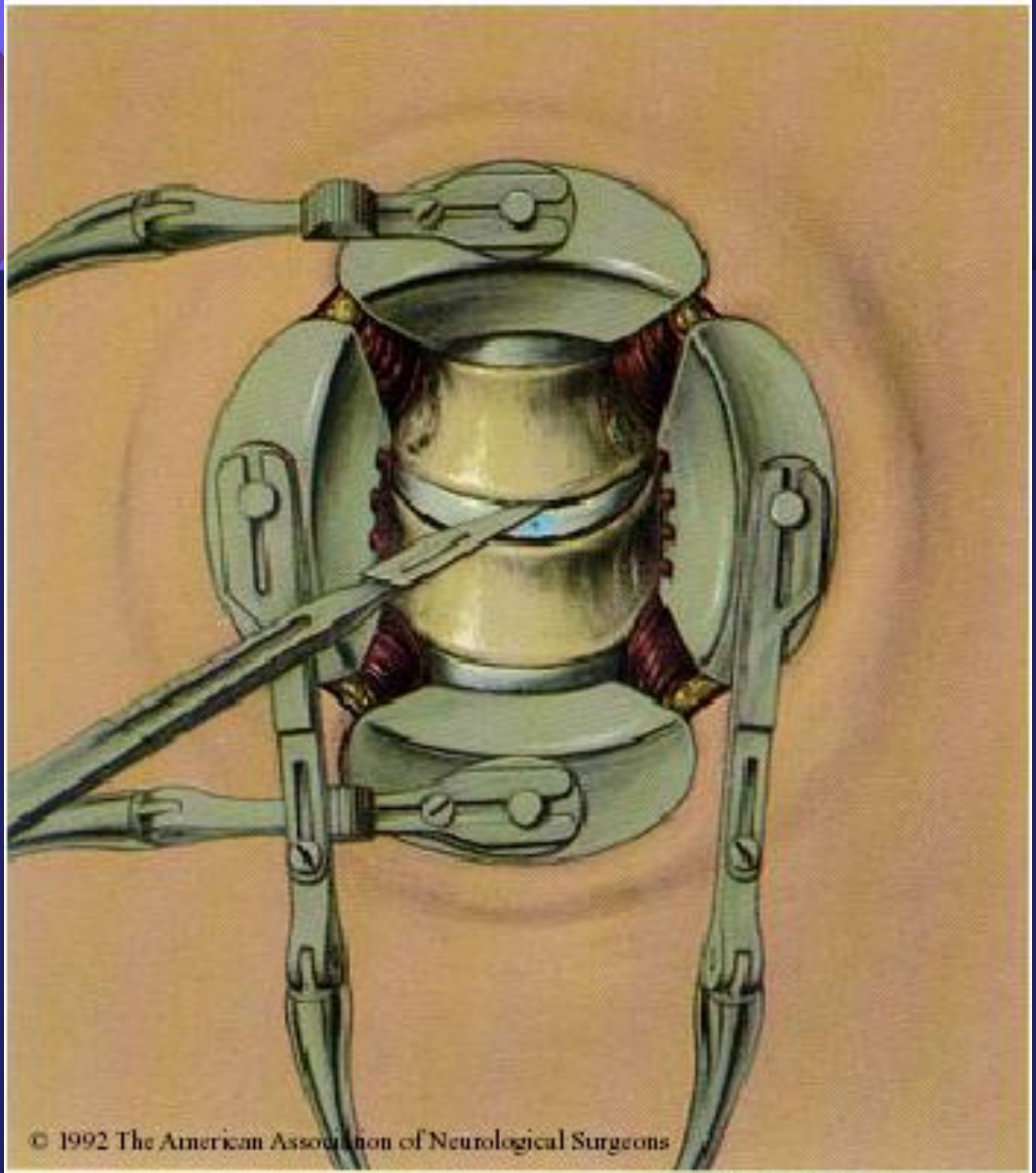
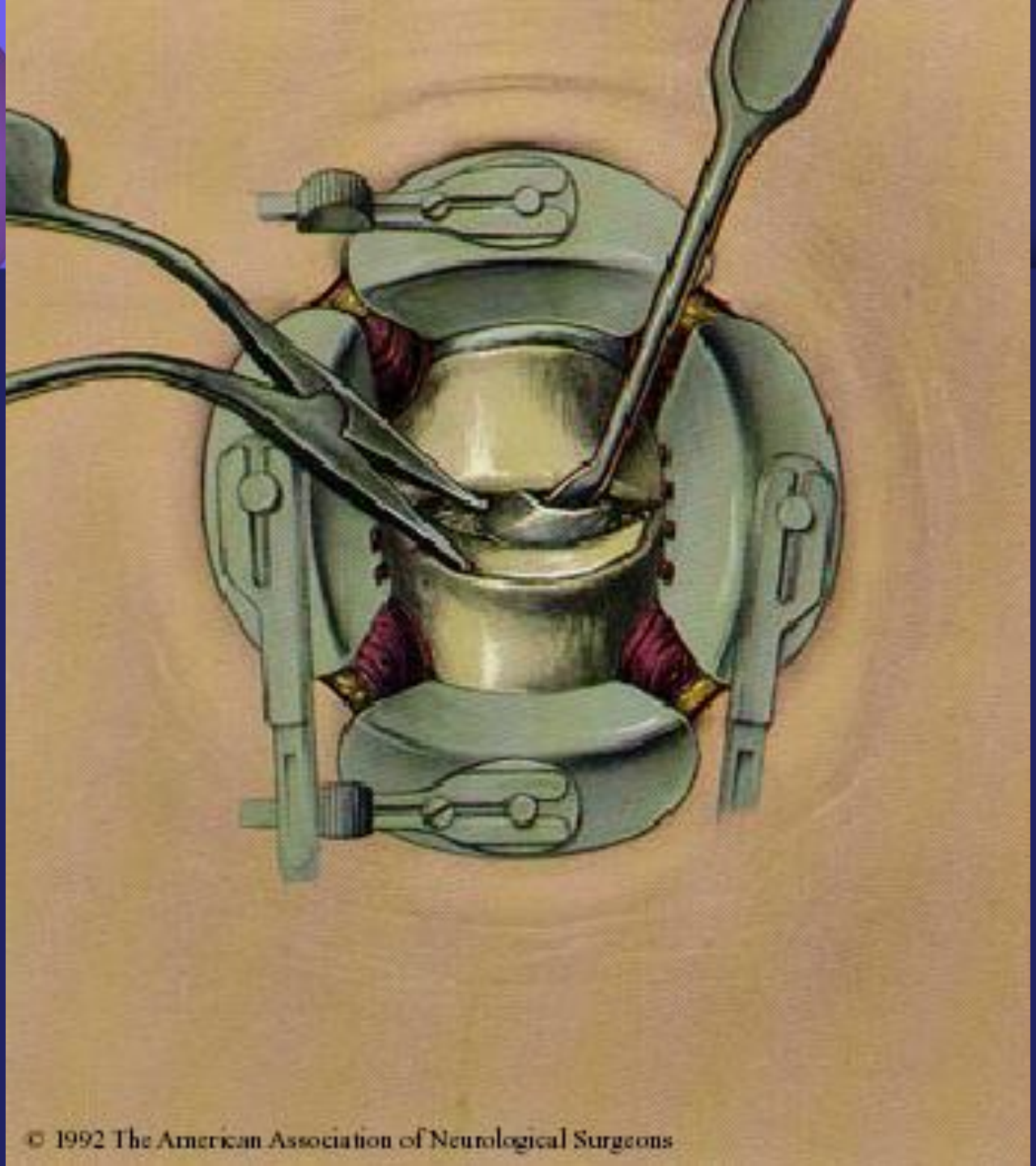
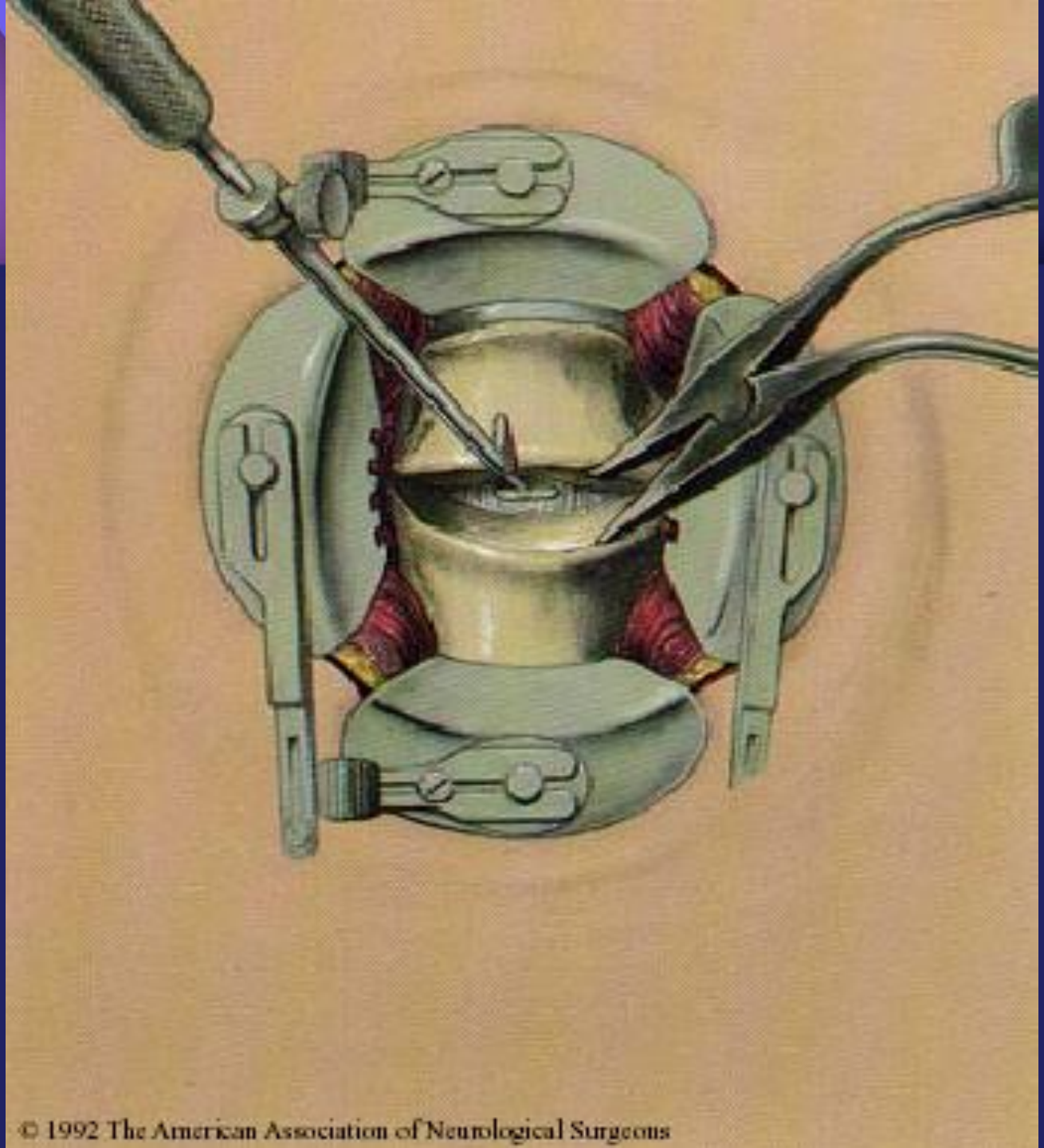

© 1992 The American Association of Neurological Surgeons





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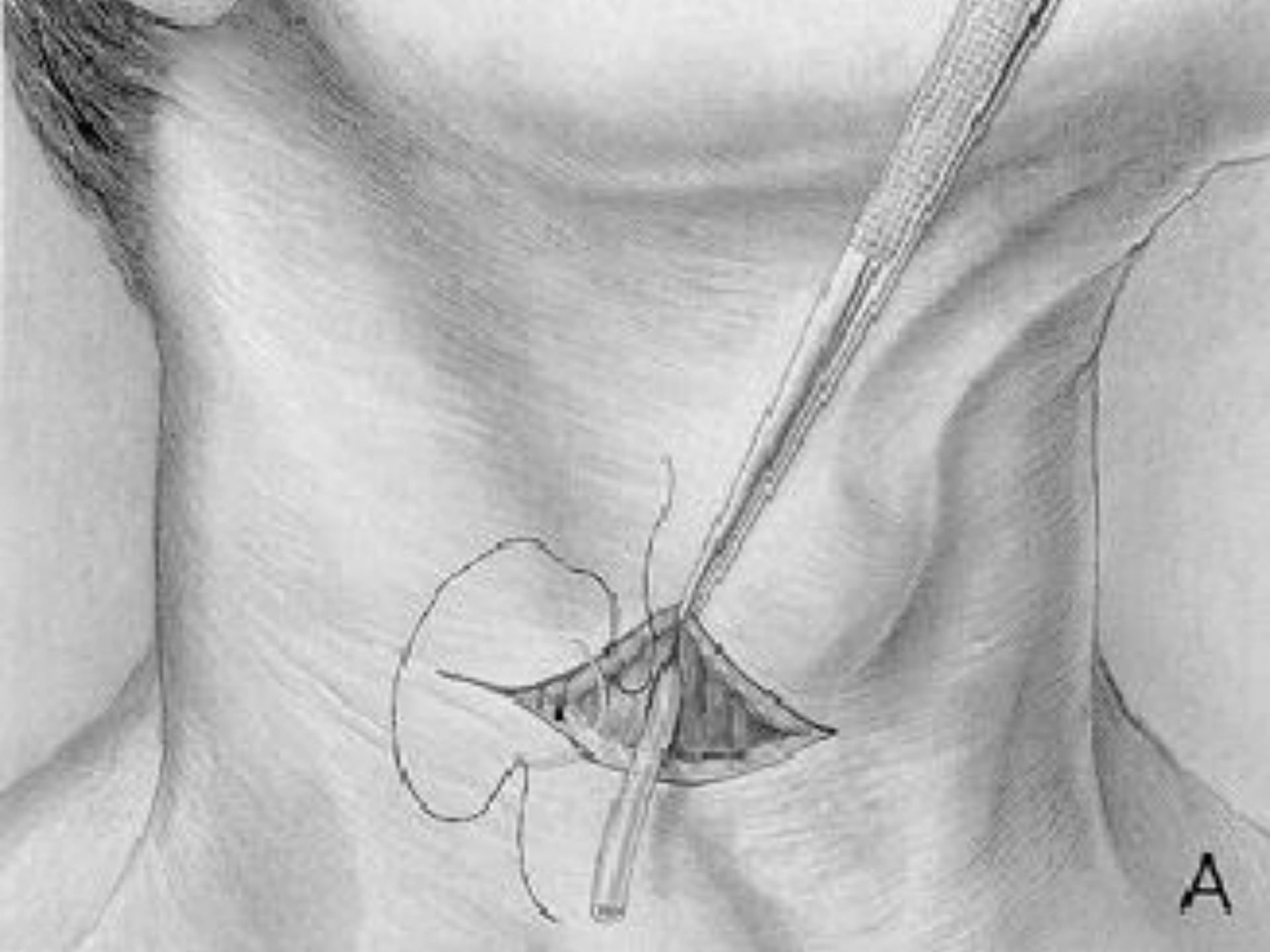
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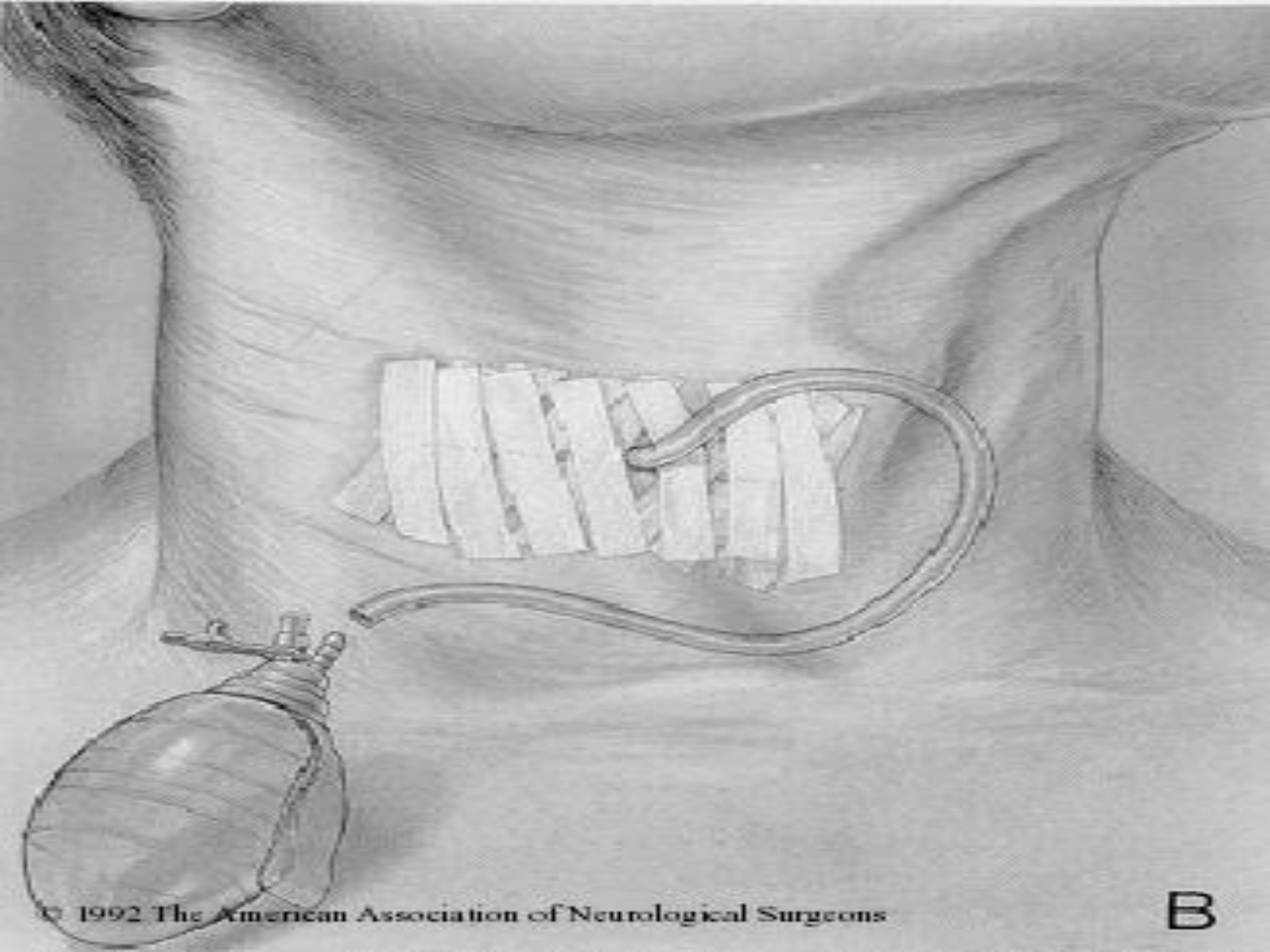
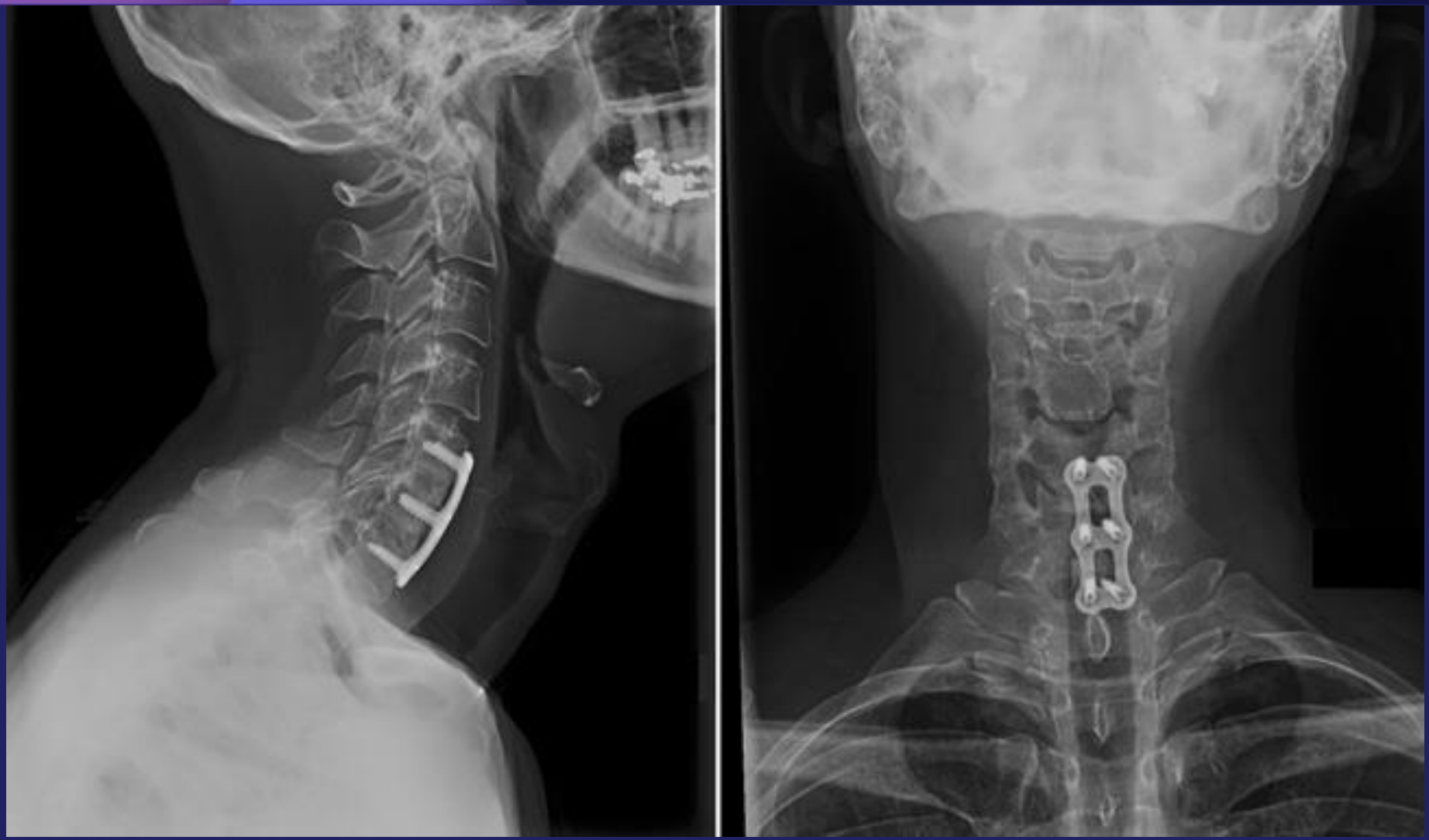

© 1992 The American Association of Neurological Surgeons
B



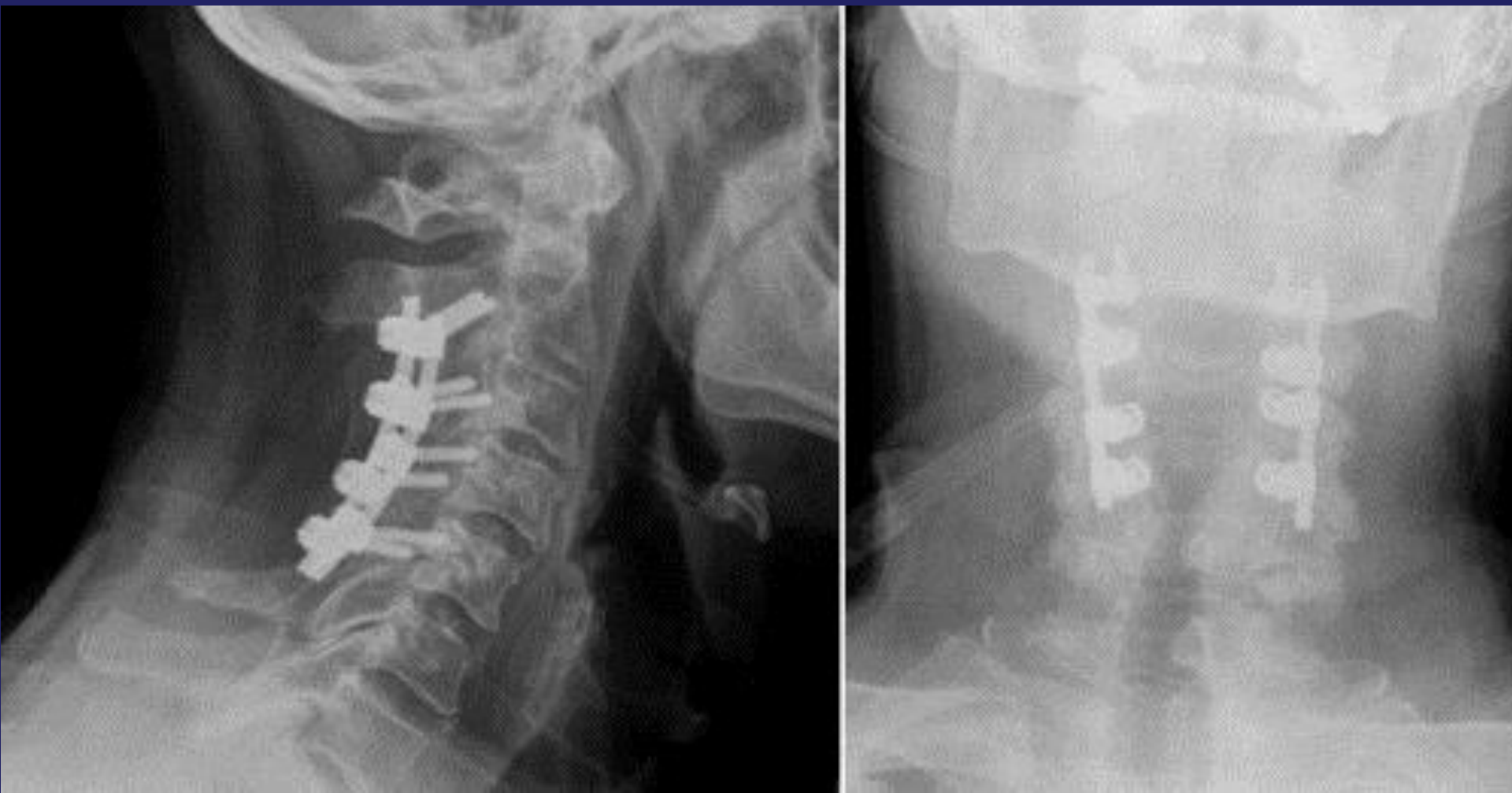
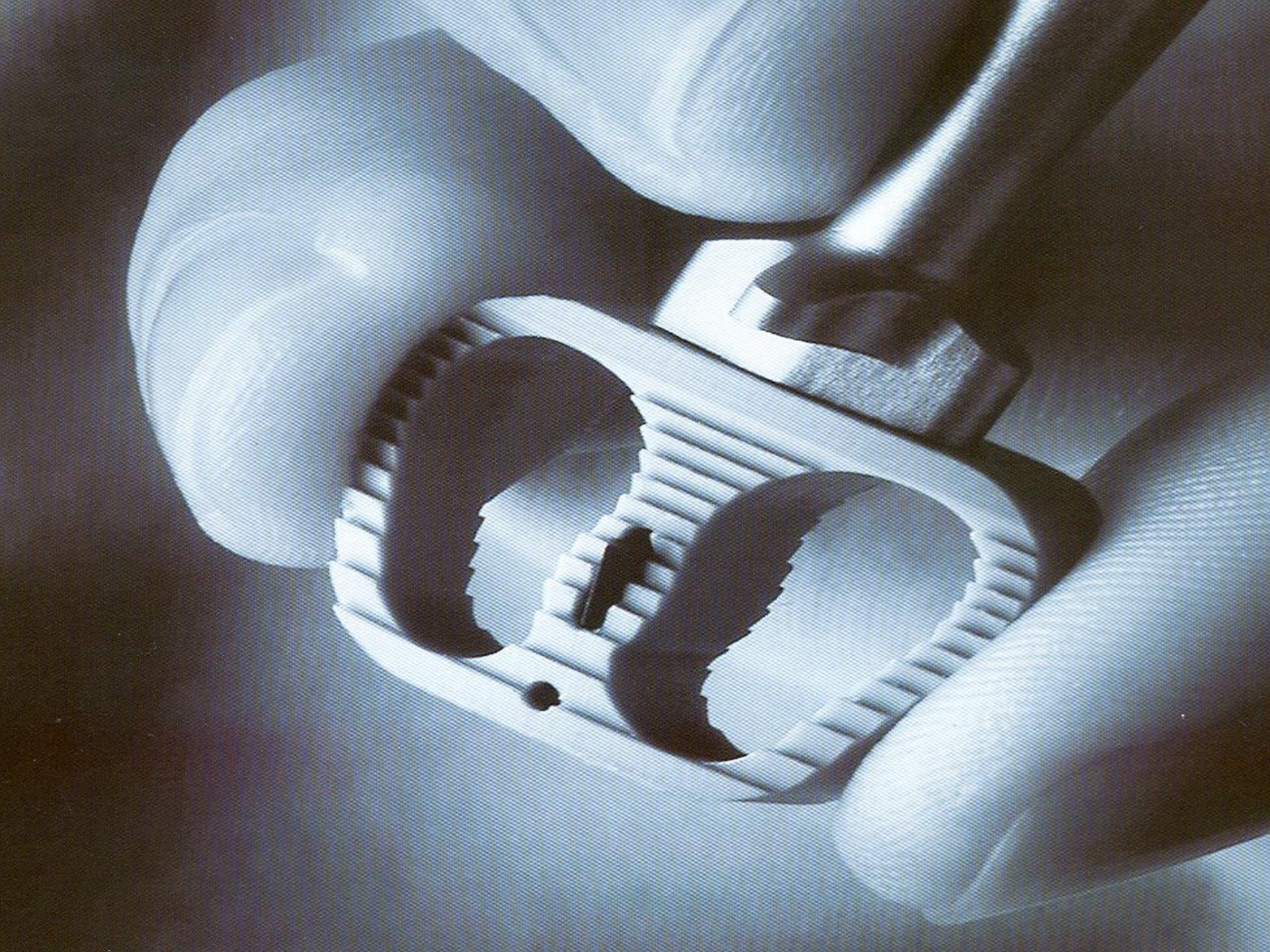


Figure 5. This radiograph, taken 12 months postoperatively, shows single-level ACDF with plating.

Figure 5. Recent improvements in interbody cage design in Europe, such as this Rabea cage (Signus Medizintechnik, Alzenau, Germany), now usually allow the use of local cancellous autograft without supplemental anterior fixation for single-level fusions.

Peek Cages



CORPECTOMY

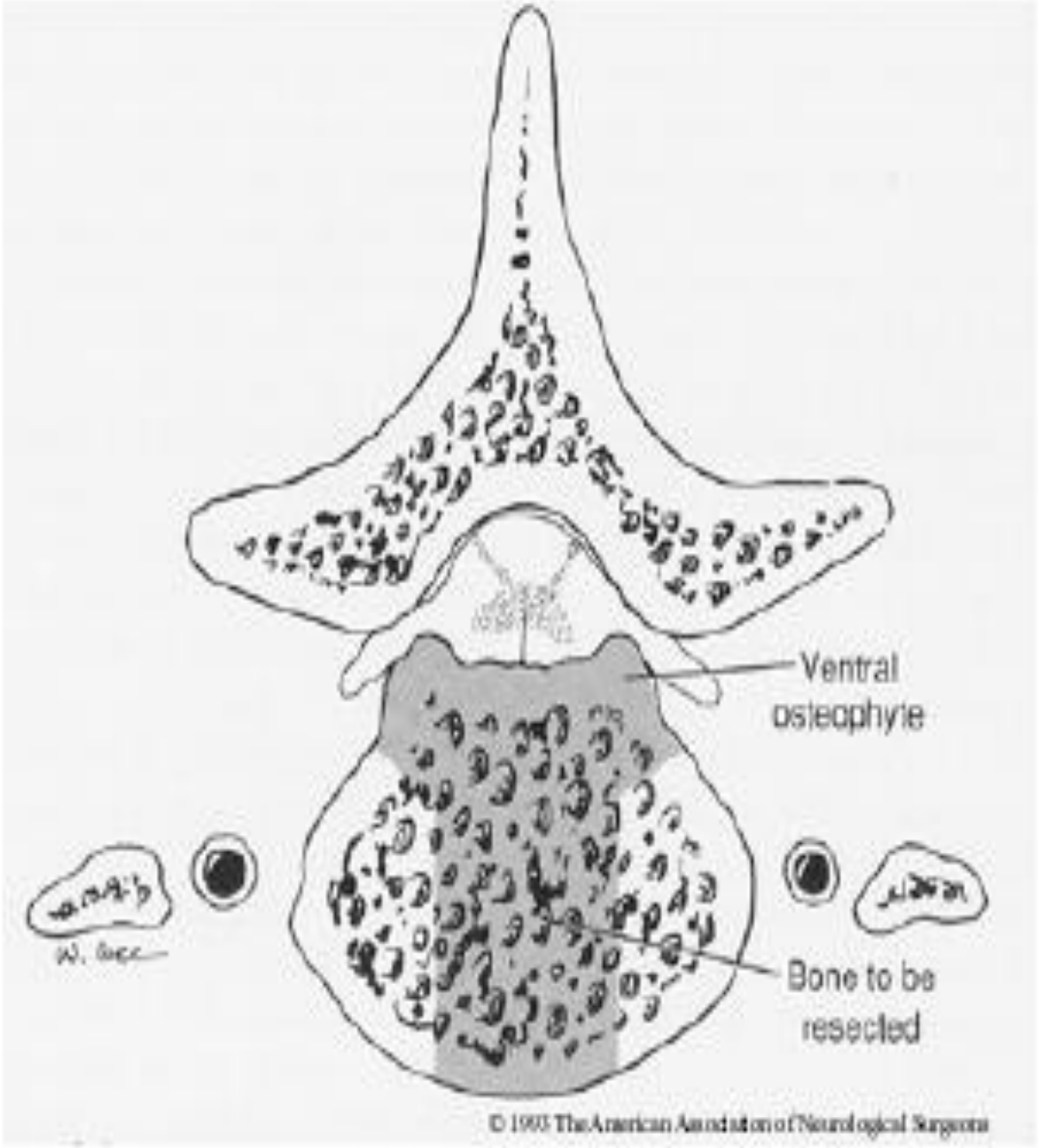
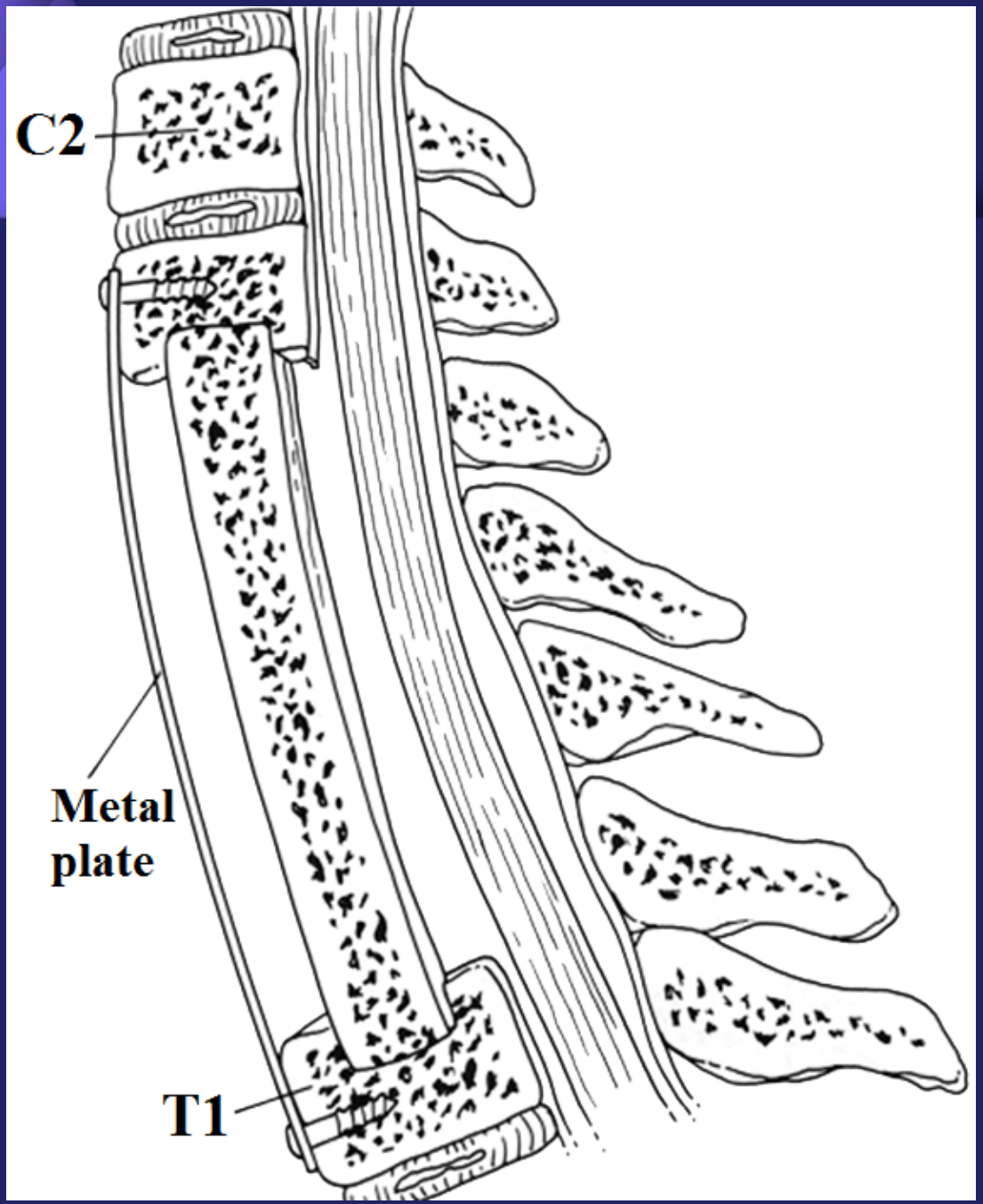
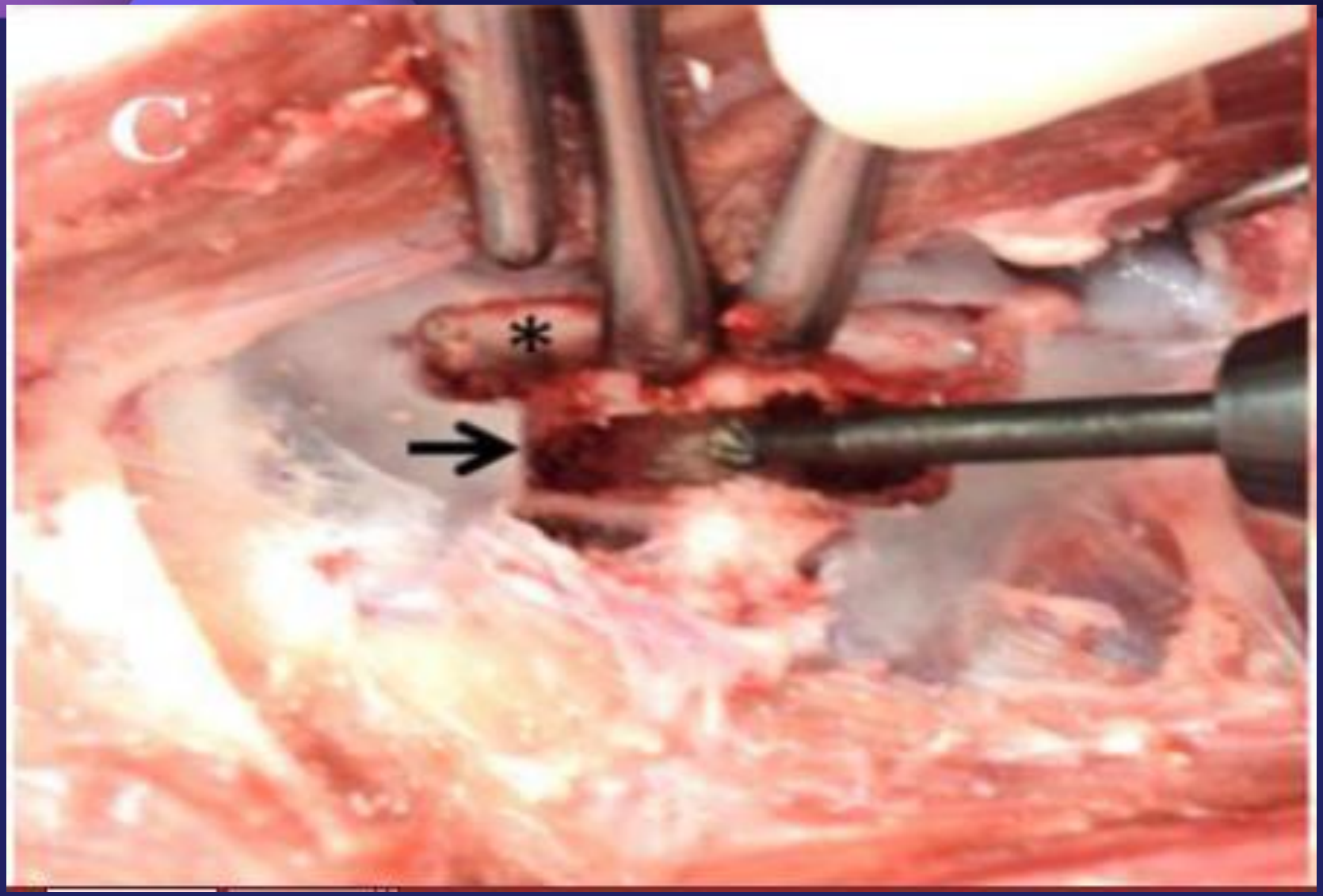


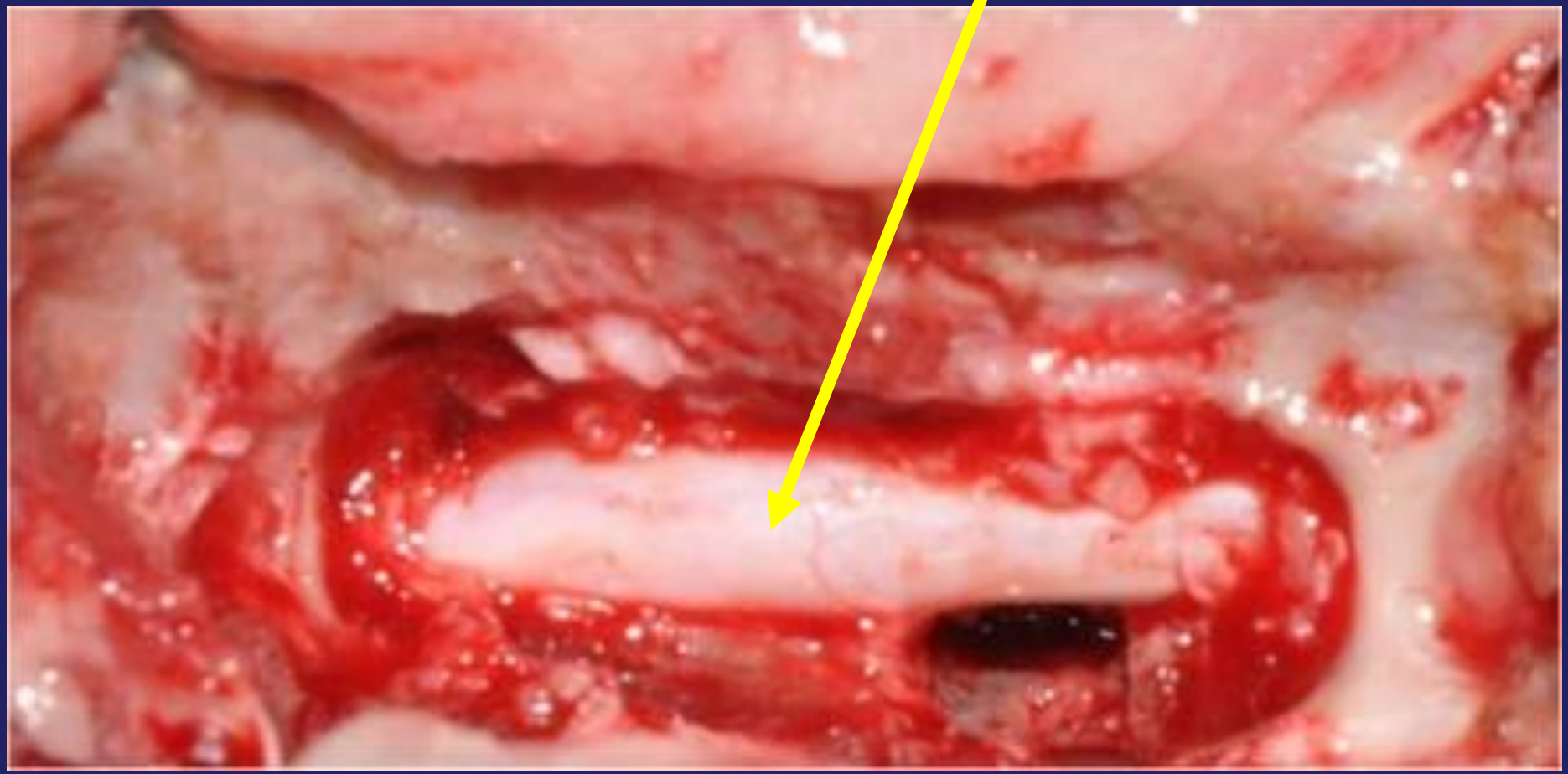
Figure 8. Axial diagram of the extent of discectomy and osteophyte resection required for adequate decompression. Note that uncinate spurs are removed along with the lateral vertebral body surface that forms the medial floor of the foramen.


C2
Metal plate
T1

Corpectomy

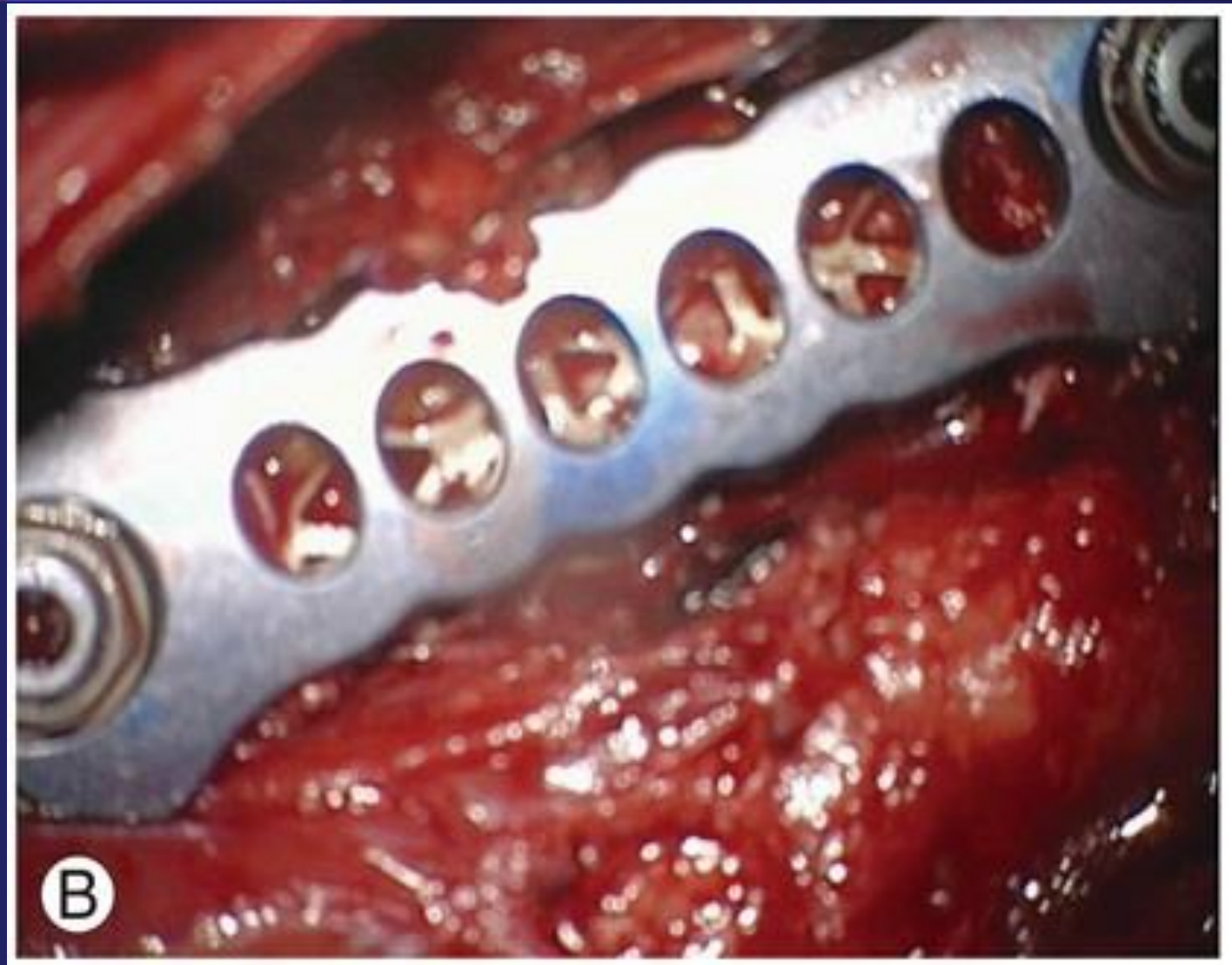


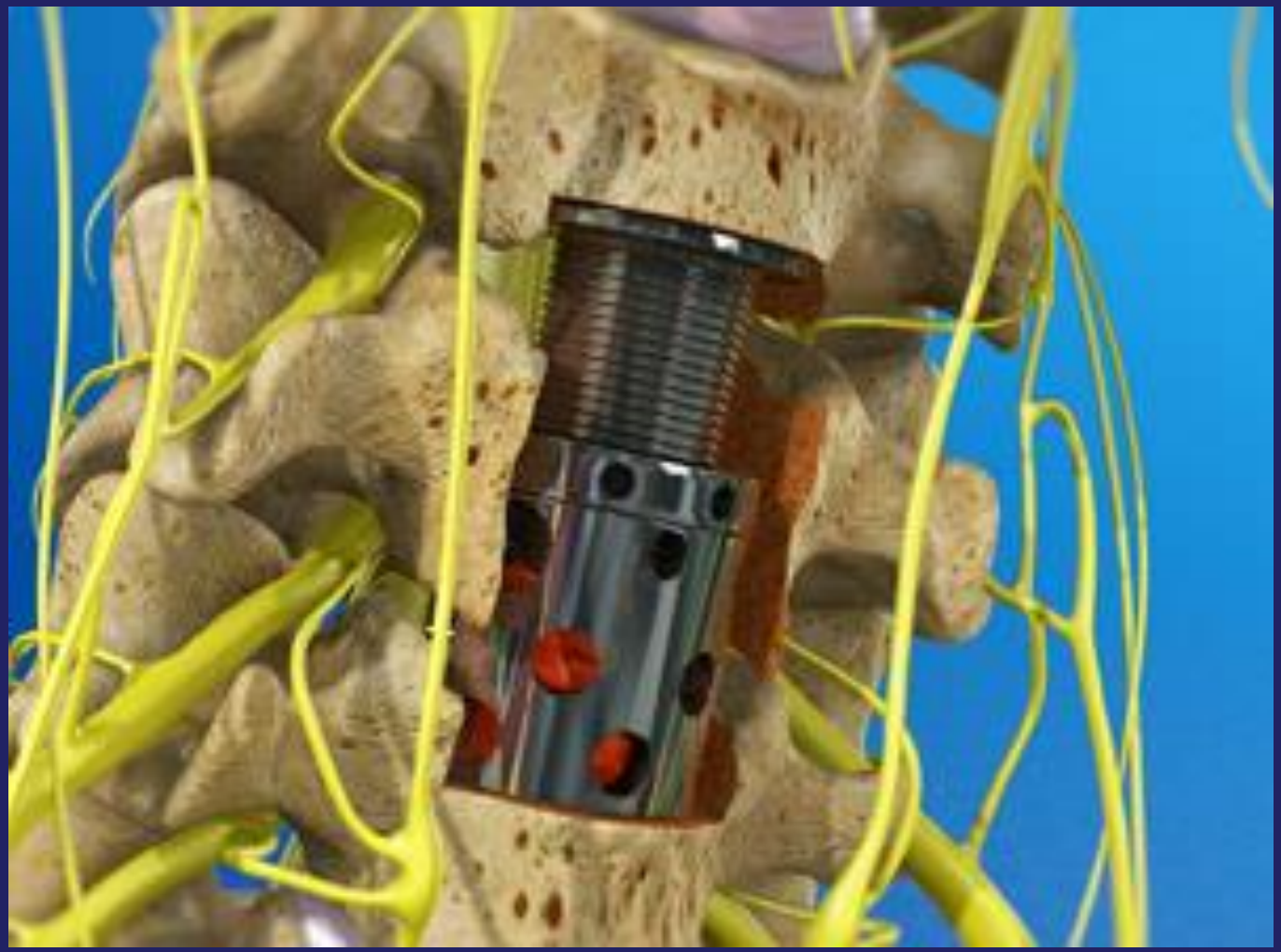
Corpectomy



Corpectomy & Prosthesis

Plating






Anterior Cervical Corpectomy


a

Figure 6. Radiograph showing a two-level corpectomy with anterior plate, 14 months postoperatively.

Figure 1. Posterolaterally herniated cervical disc compressing a nerve root.

Foraminotomy

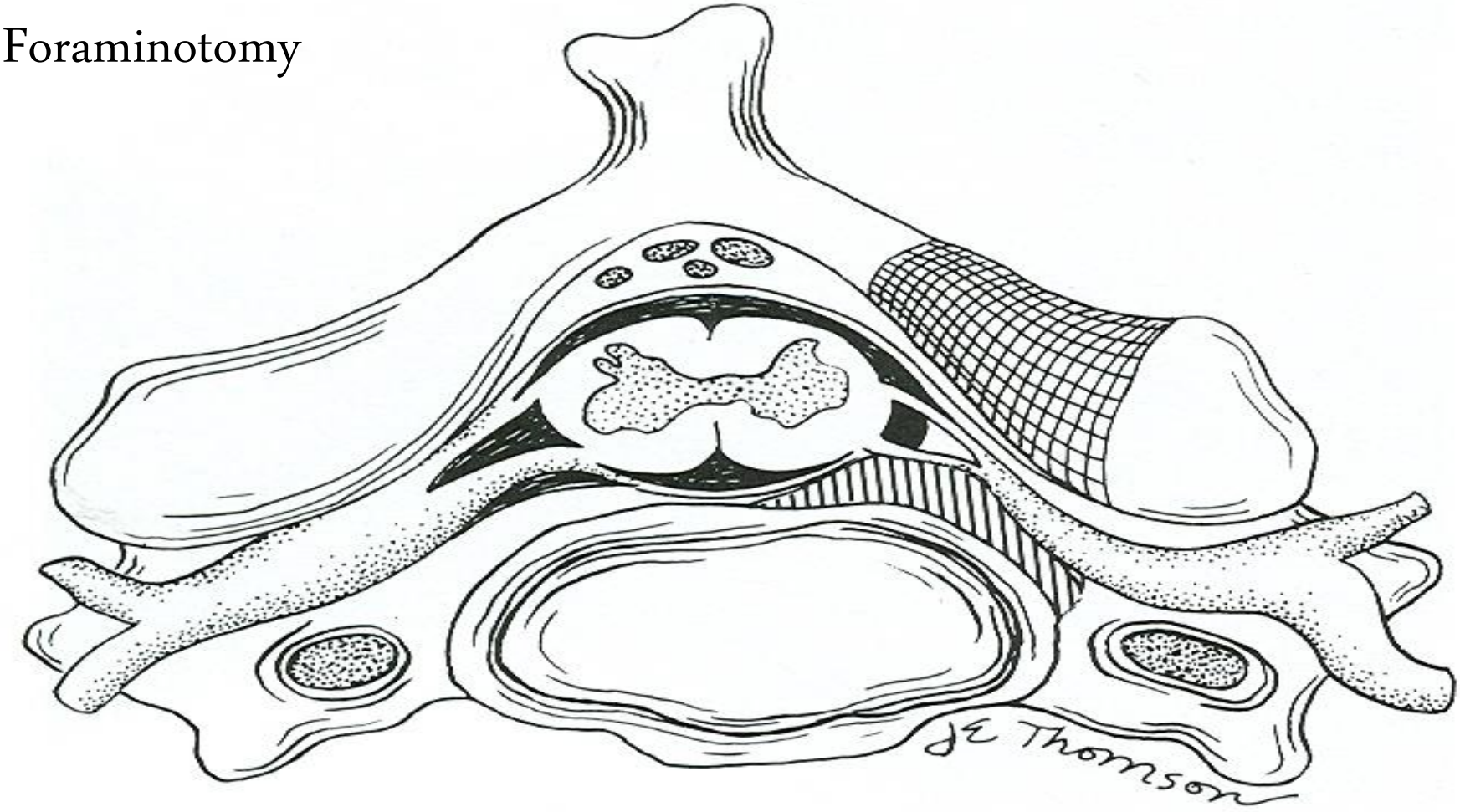
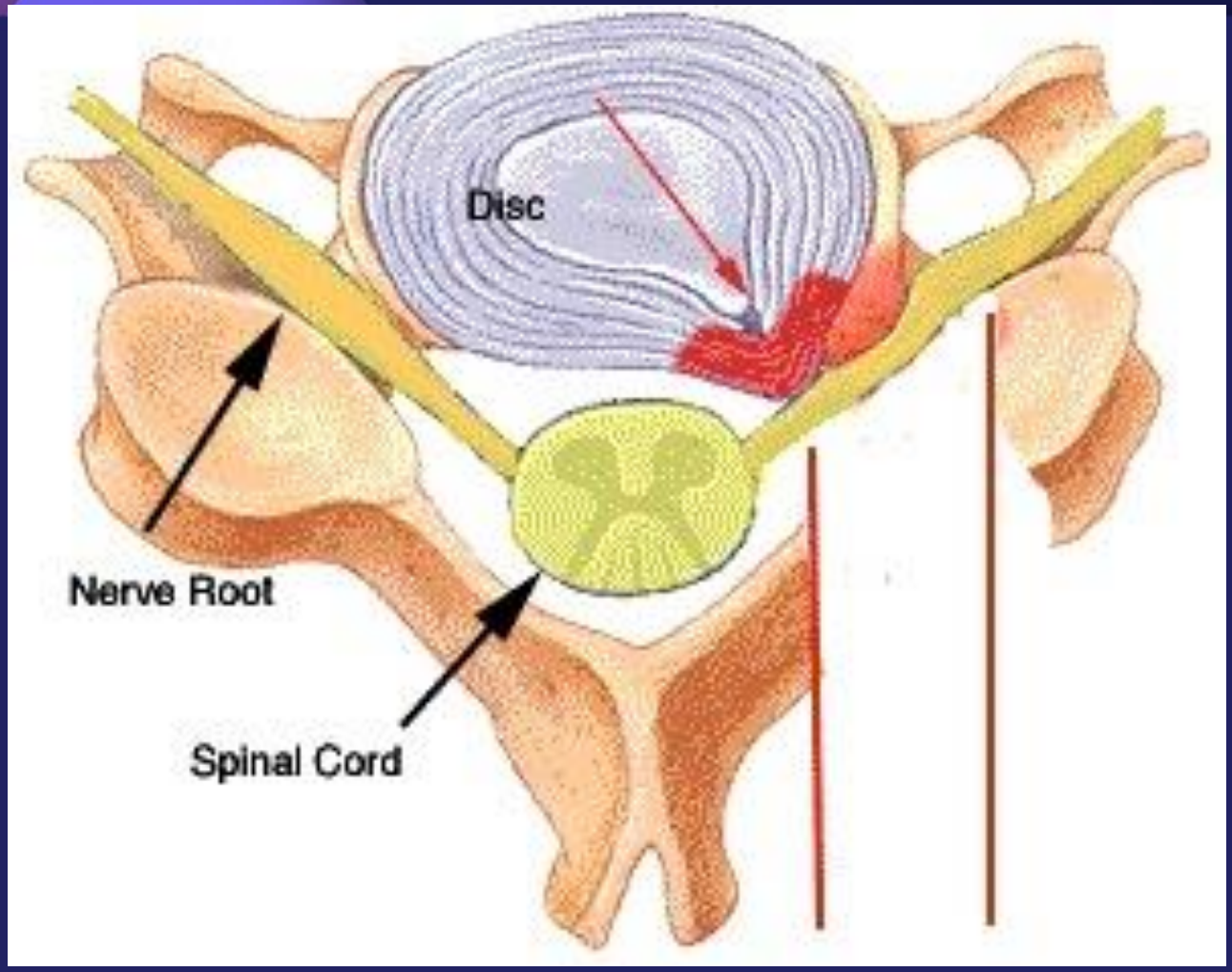


Figure 33-3. The cross-hatched area in this axial view drawing demonstrates the amount of bone that is removed during posterolateral foraminotomy. As a result, this procedure is most appropriate to address disk herniation or osteophyte that is located in the posterolateral region, as demonstrated by the striped area in the drawing.

Disc Herniation With Nerve Root Compression



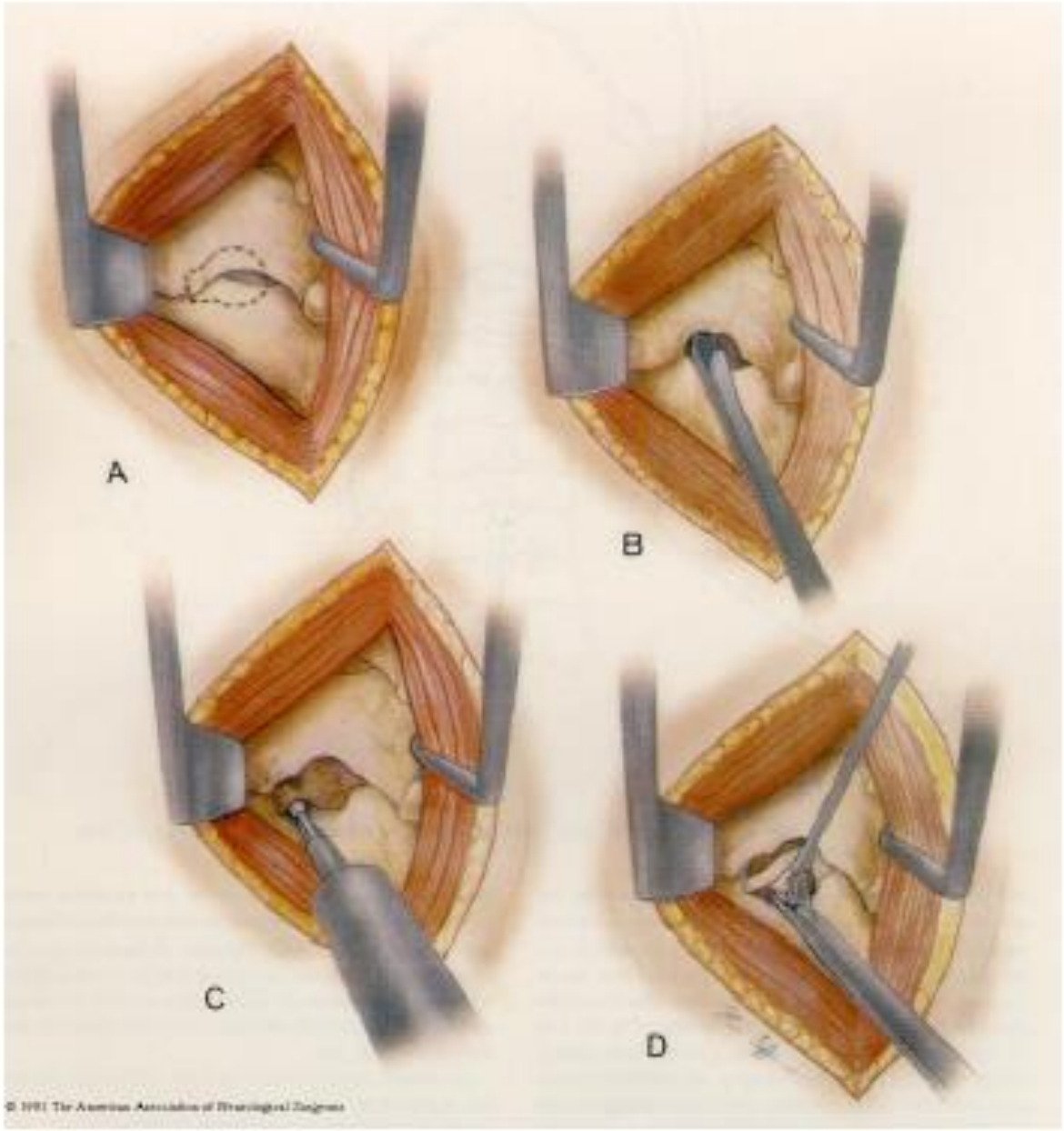
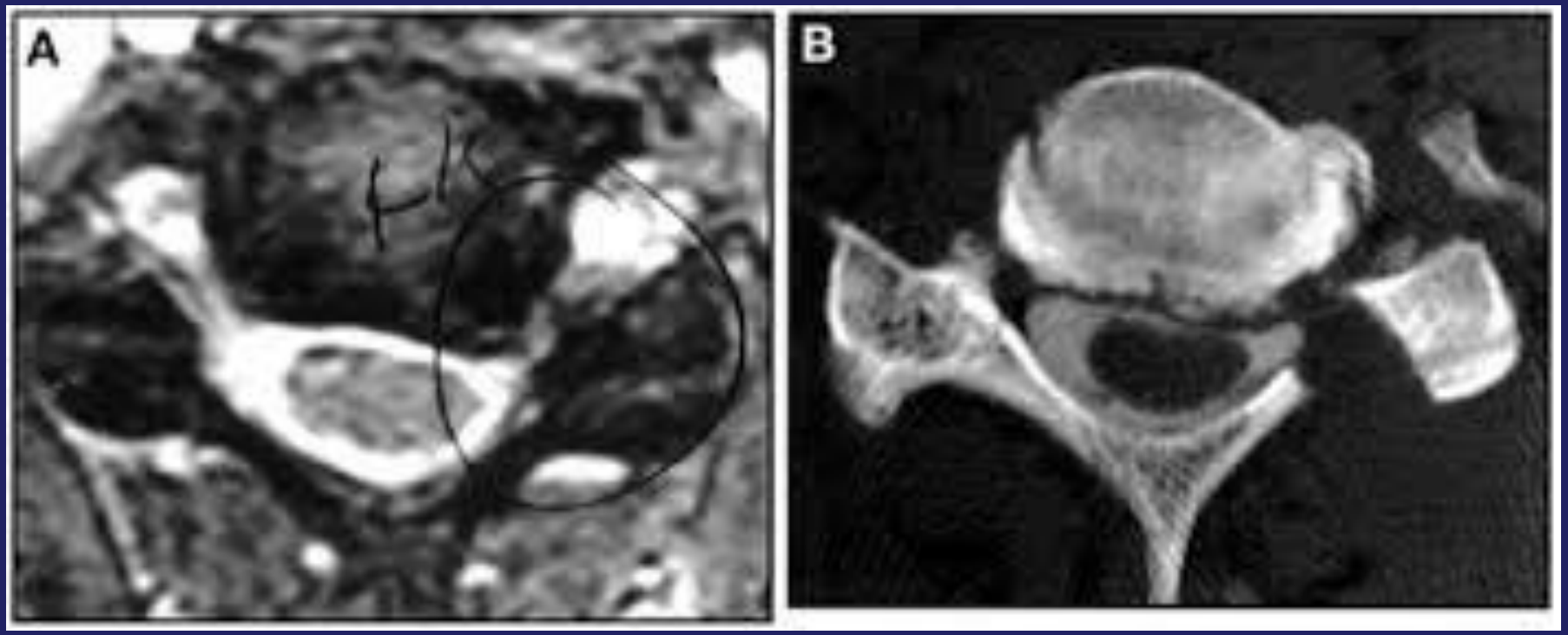
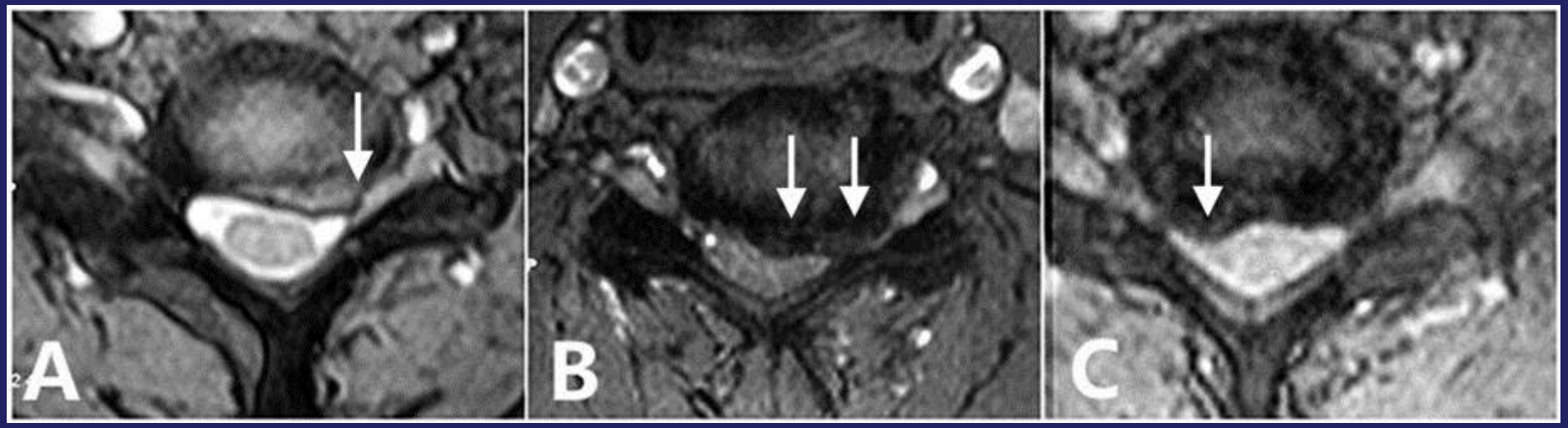


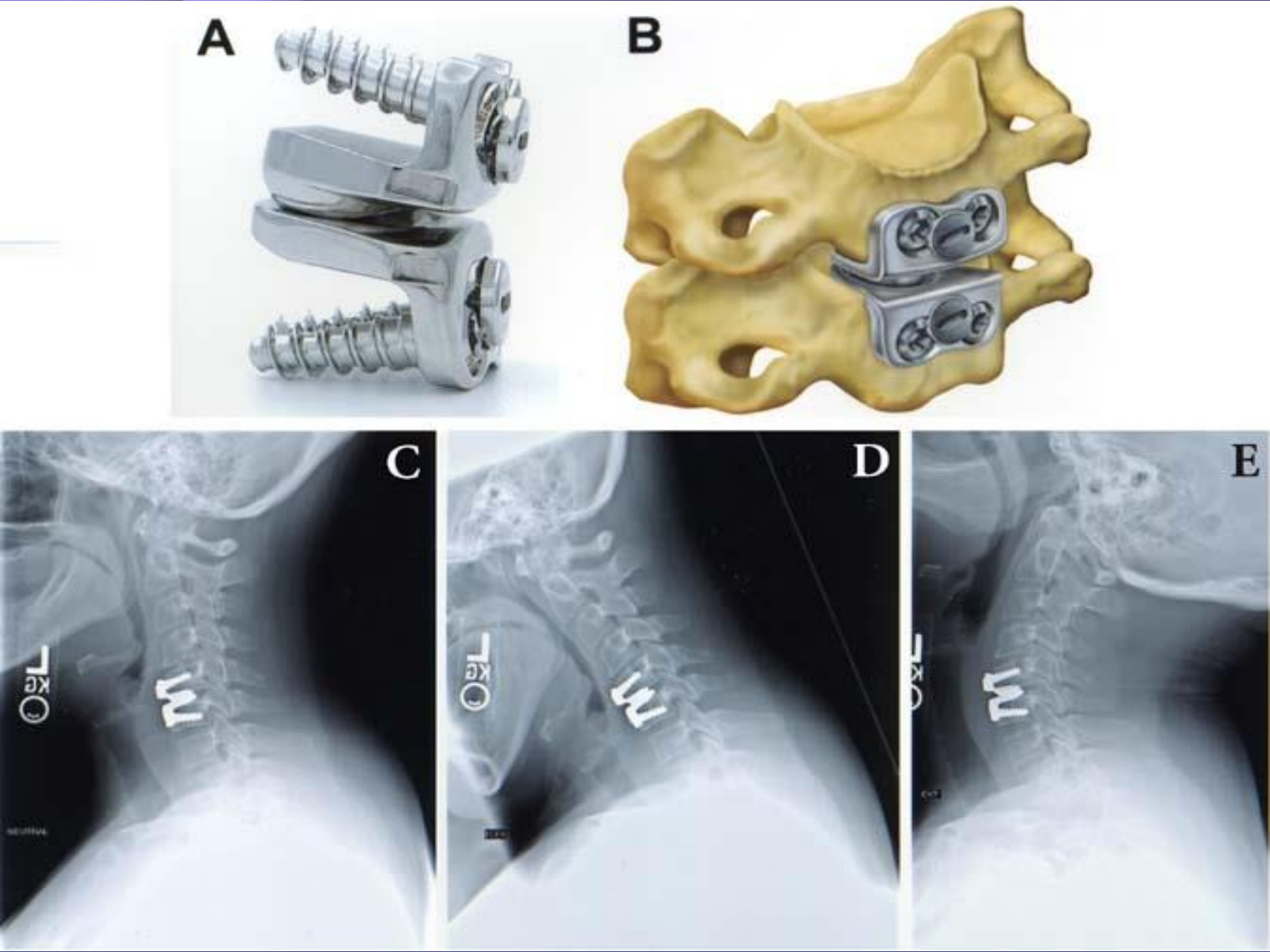
Figure 3. A, the paravertebral muscles have been stripped away from the laminae and spinous processes of C-6 and C-7 and a self-retaining retractor has been inserted. The area within the dotted keyhole line represents the extent of bone removal. **B**, a portion of the inferior edge of the superior lamina is removed with Kerrison rongeurs. **C**, the medial aspect of the facet joint is drilled away using a diamond burr. **D**, herniated disc material is removed from under the axilla of the C-7 nerve root.

Foraminotomy





Axial T2-weighted MRI


A
B
C
D
E

LAMINOPLASTY

- Popular technique for the treatment of cervical myelopathy due to multilevel canal stenosis
- Many variations
- Open door cervical Expansile laminoplasty

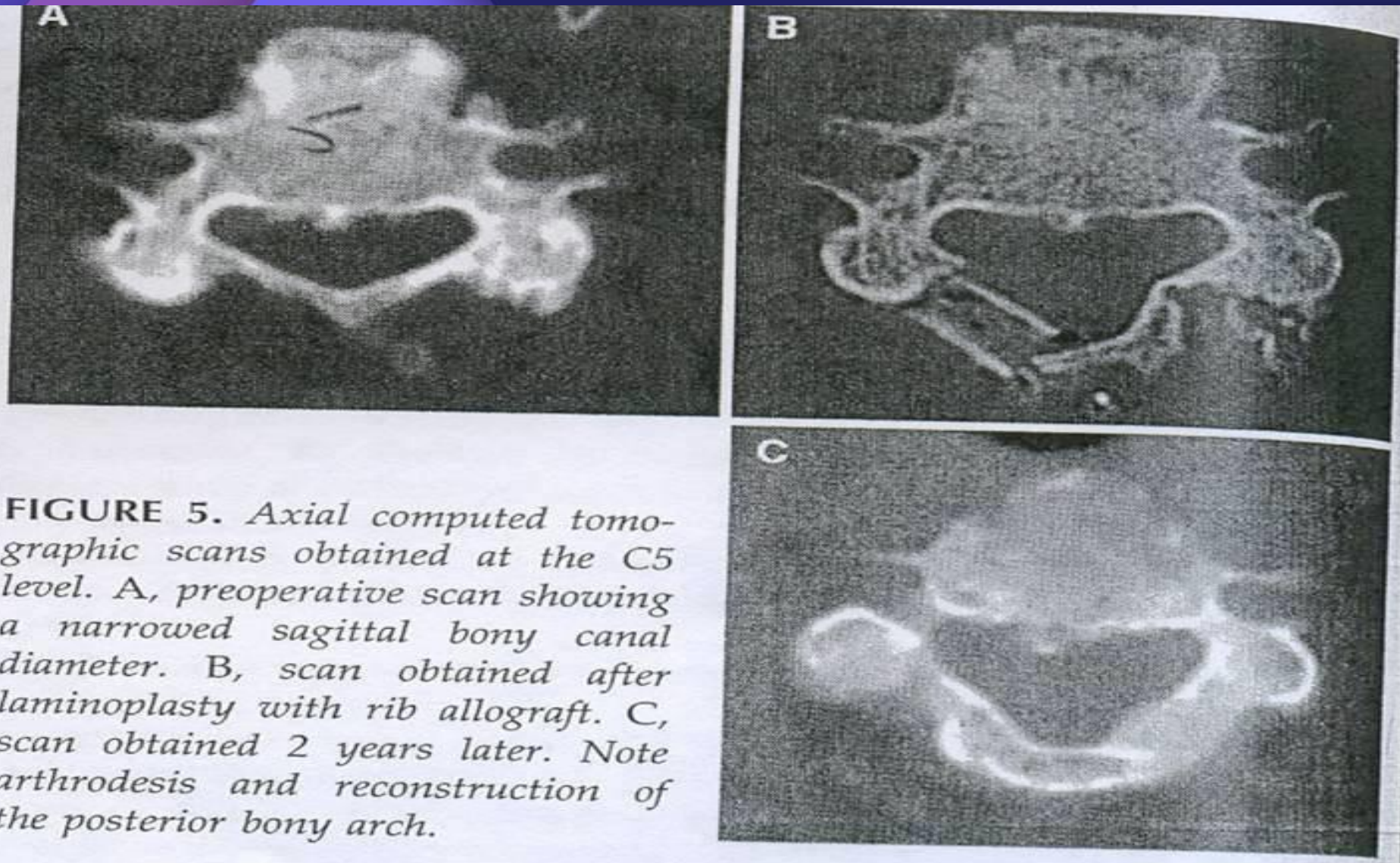
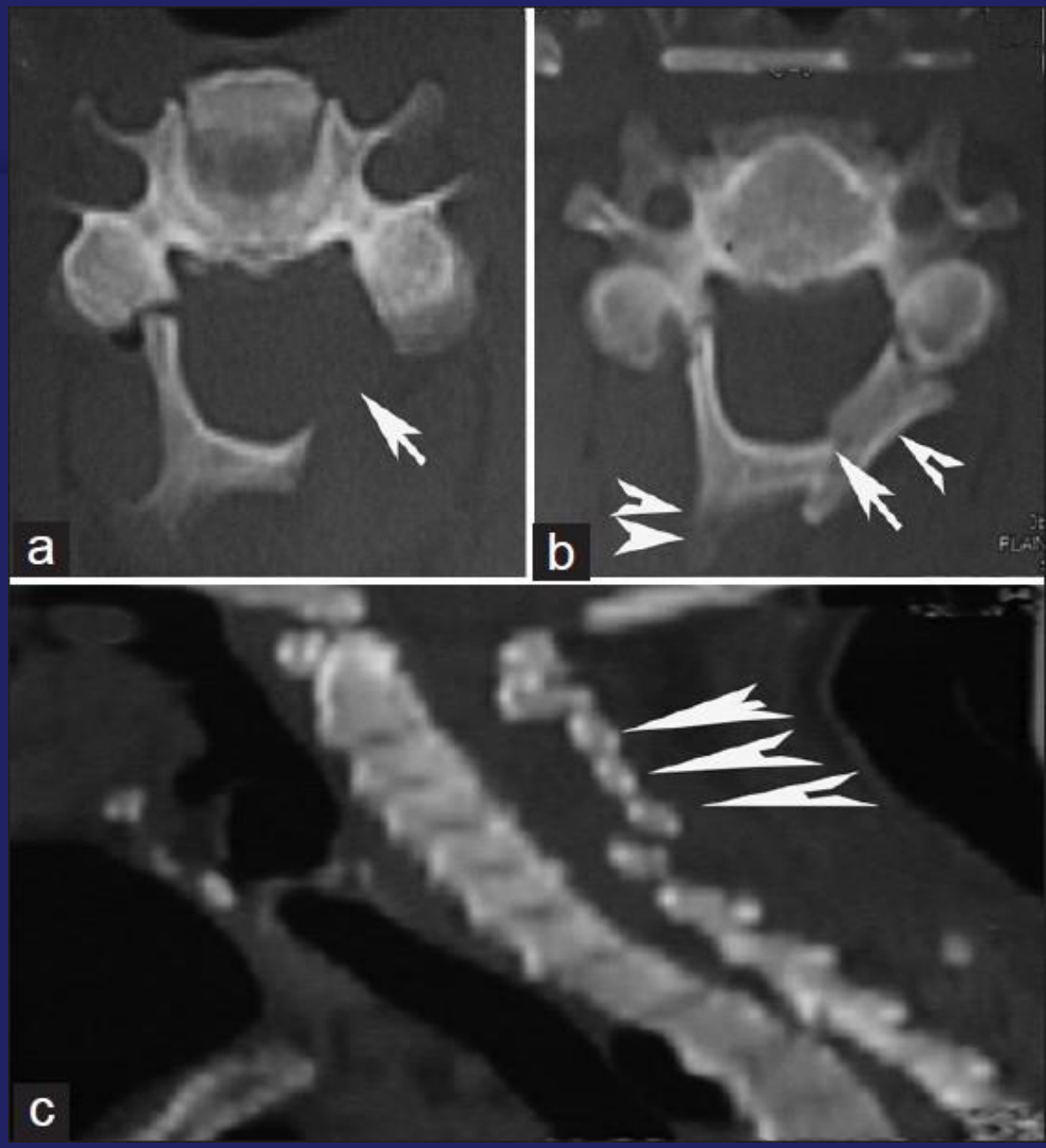


FIGURE 5. *Axial computed tomographic scans obtained at the C5 level. A, preoperative scan showing a narrowed sagittal bony canal diameter. B, scan obtained after laminoplasty with rib allograft. C, scan obtained 2 years later. Note arthrodesis and reconstruction of the posterior bony arch.*

Expansile Laminoplasty



Summary

- Cervical Spondylosis and the progression to Cervical Spondylotic Myelopathy is highly variable and difficult to predict.
- 3 clinical syndromes of Cervical Spondylosis are:
  1) Axial Neck Pain
  2) Radiculopathy
  3) Myelopathy
- It is important to diagnose Cervical Myelopathy early (50% improved surgery v/s 16% late surgery after 1 year)

Summary (cntd)

Cervical Spondylosis

- Osteoarthritis of the neck
- Axial Neck Pain
- Cervical Radiculopathy

Cervical Spondylotic Myelopathy

- Cold Compression
- Myelopathy
- Early Surgical Treatment

Signs

Radiculopathy

- Spurling Sign
- Abduction Test
- Hyporeflexia
- LMN

Myelopathy

- Hoffman Test
- Babinski
- Finger Escape
- L'hermitte's Signs
- Hypereflexia
- Clonus
- UMN

Summary (Cntd)

- Cervical Myelopathy can present in 5 different syndromes.

Investigations

MRI is the investigation of choice, X-Rays C.Spine in flexion, extension for instability. CT Scan occasionally used for bone anatomy.

Diagnosis of CSM

Be aware and suspect CSM

- History
- Examination
- MRI

Diagnose early… Refer early…

A Preventable Journey to a wheelchair bound-life…

“Good surgeons know how to get out of trouble
Better surgeons know how to avoid it.”

Thank you