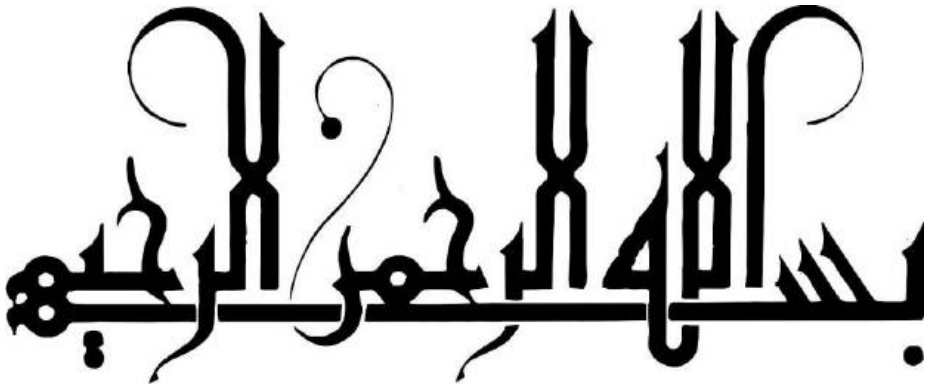
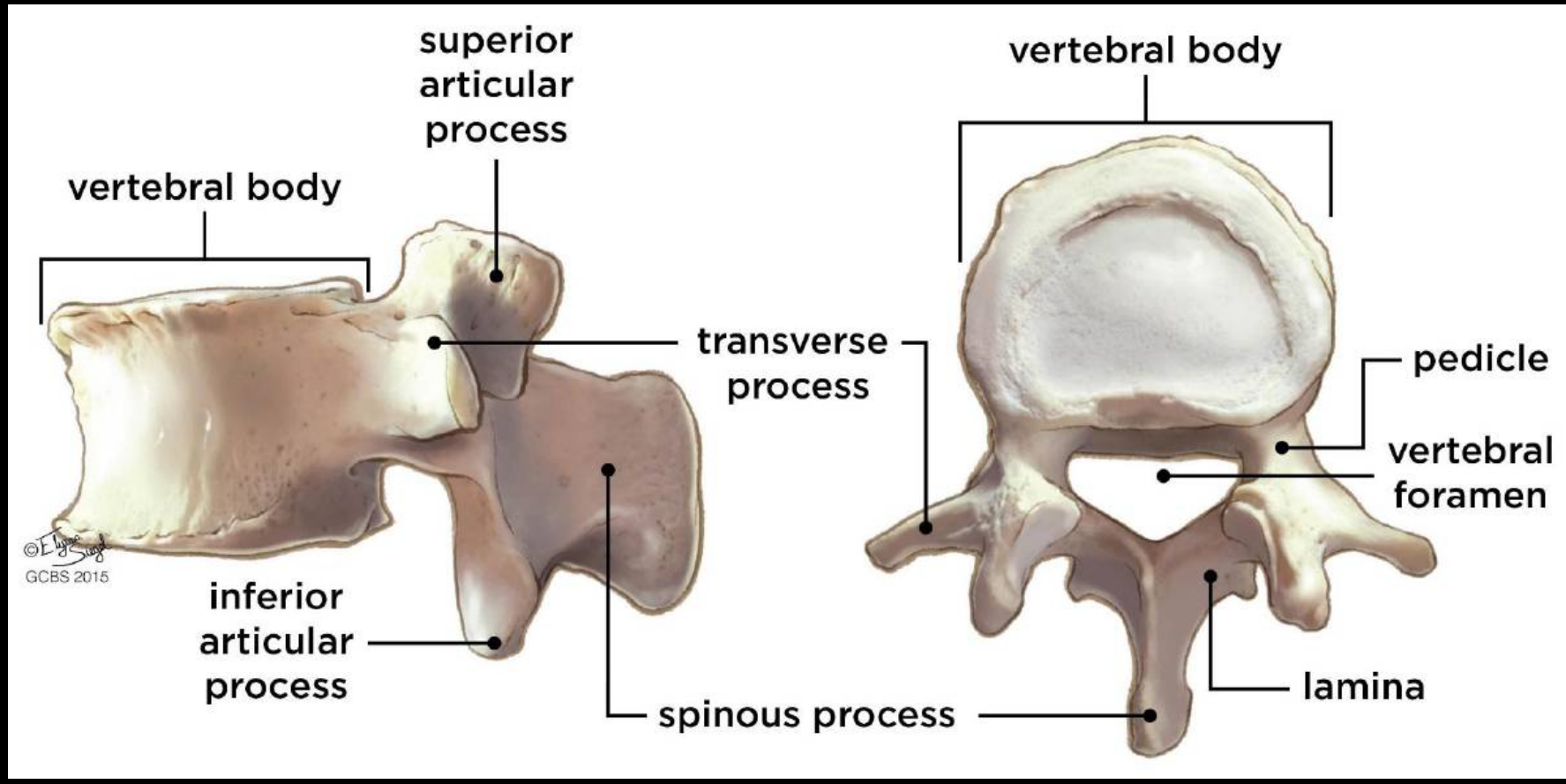
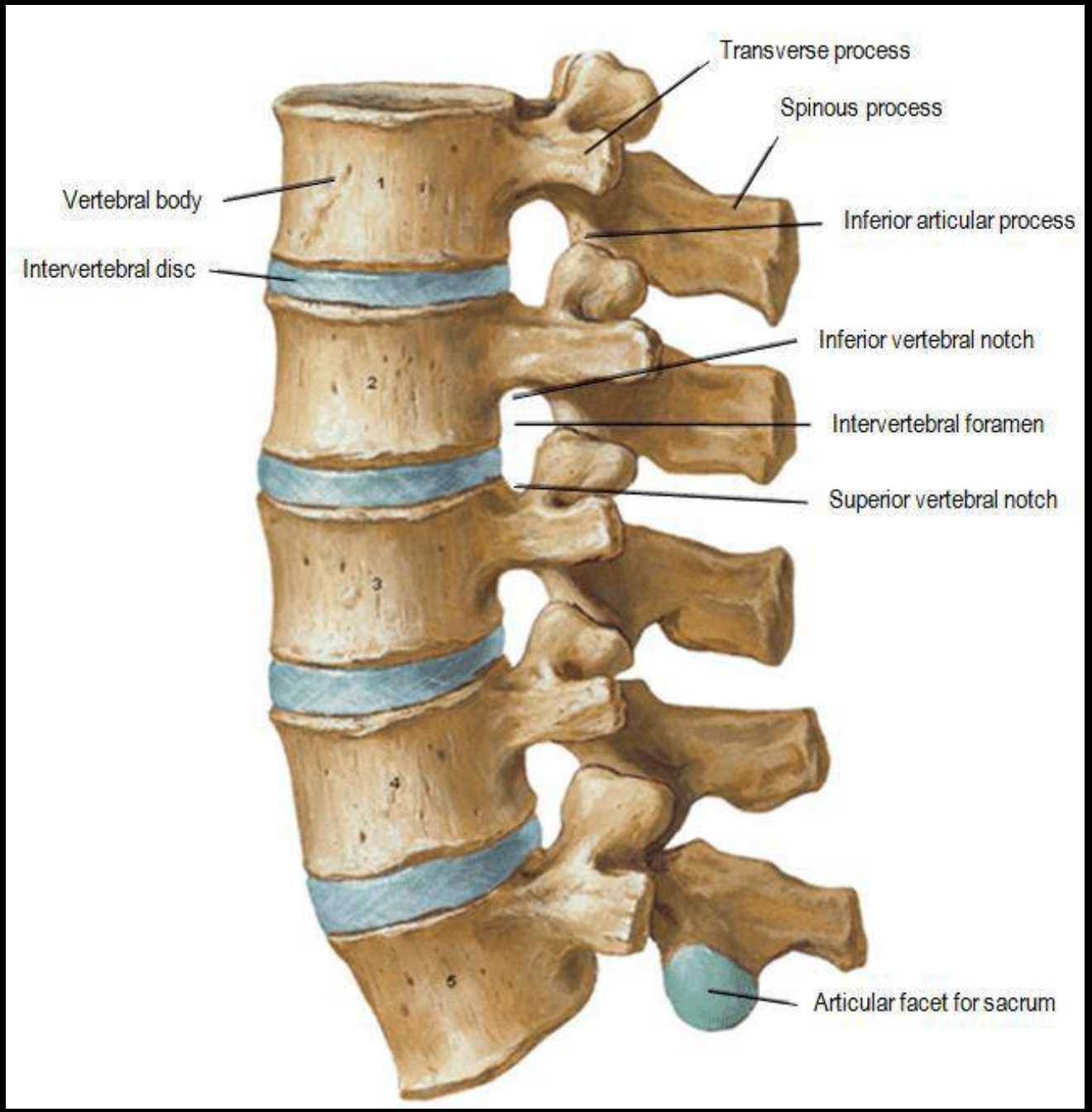

بسم الله الرحمن الرحيم

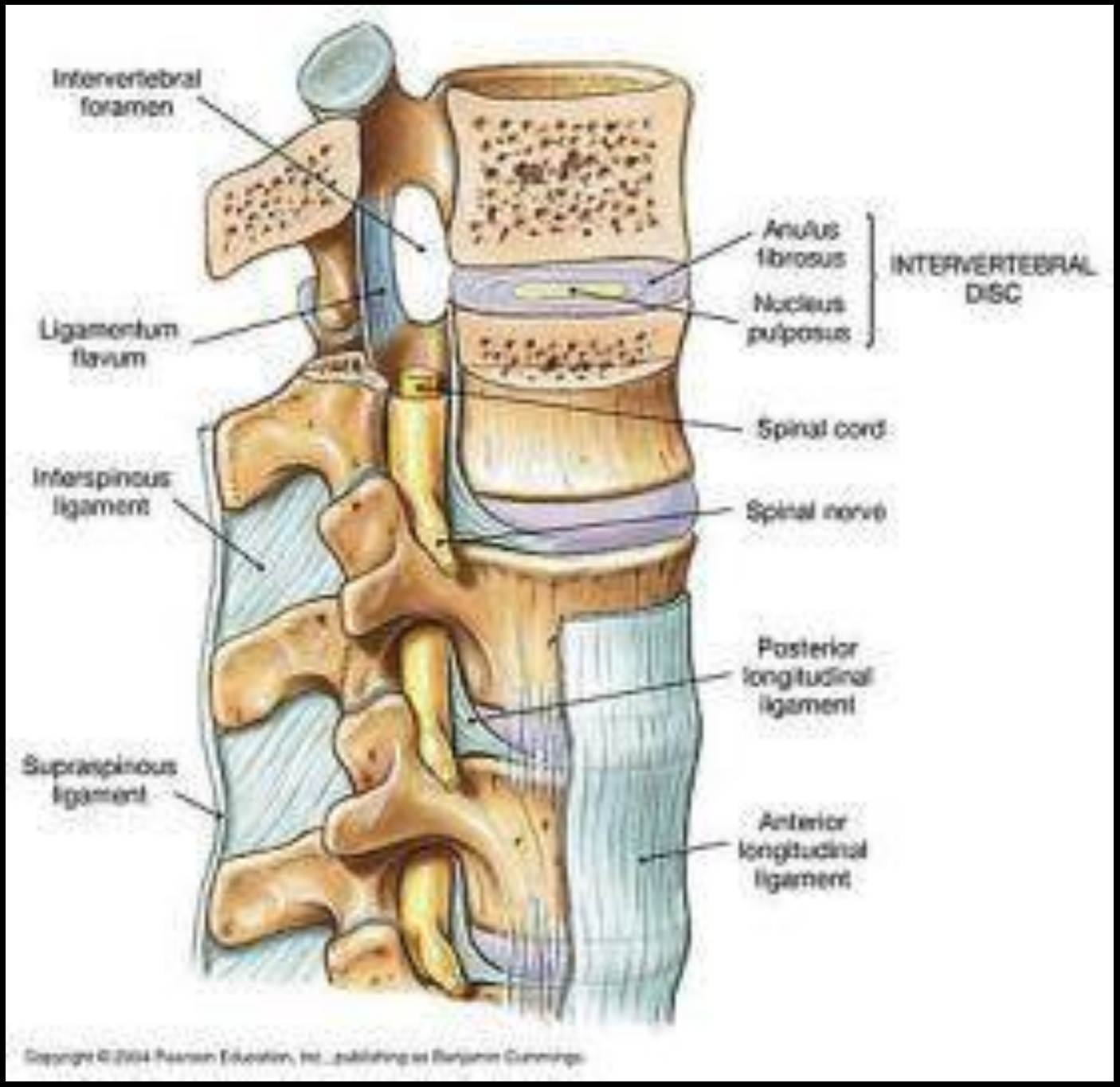
Spine Trauma

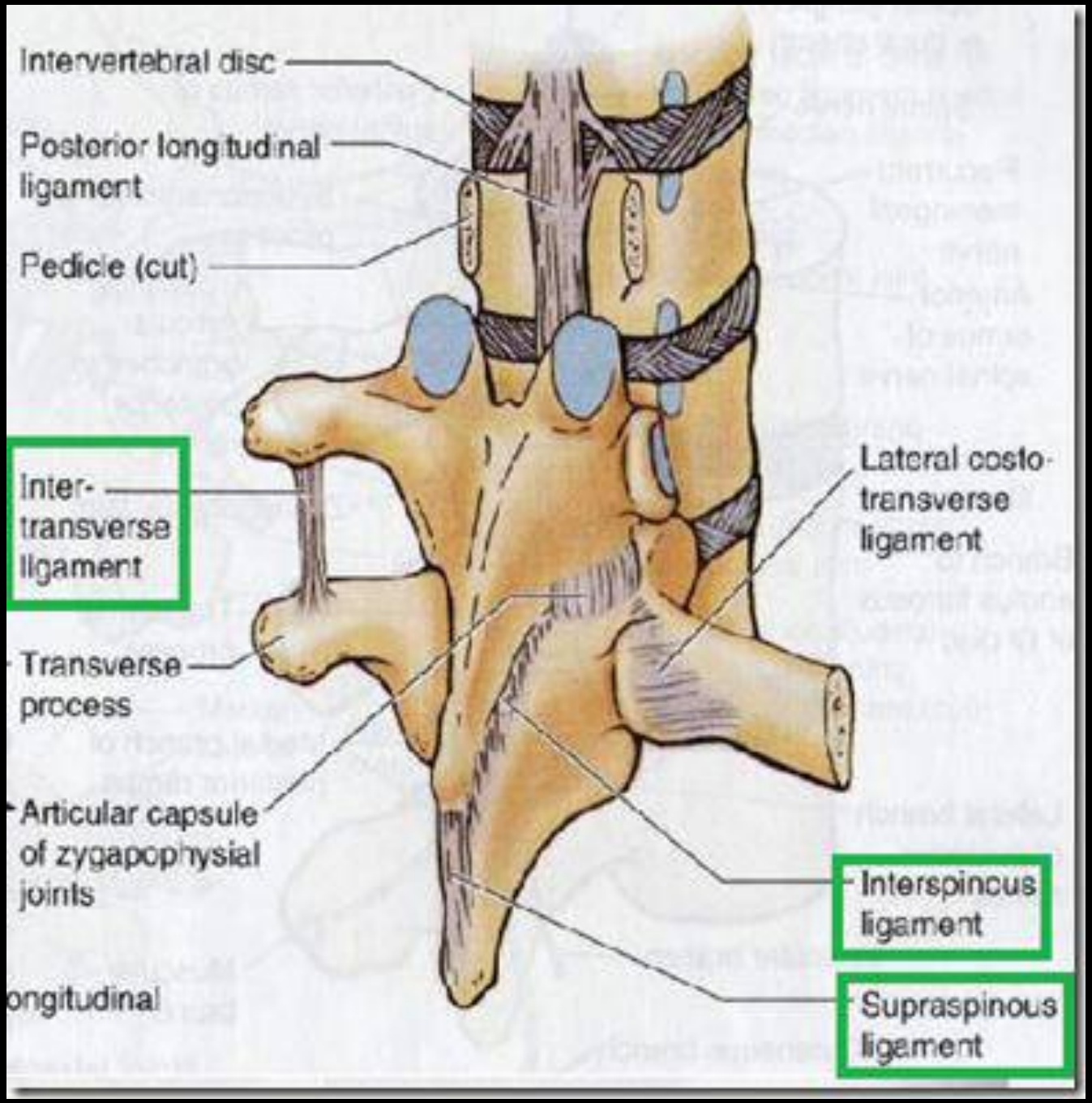
M. Esmaielnia , M.D , Neurosurgeon
(Board Certified)
Sabzevar University of Medical Sciences
99.12.11

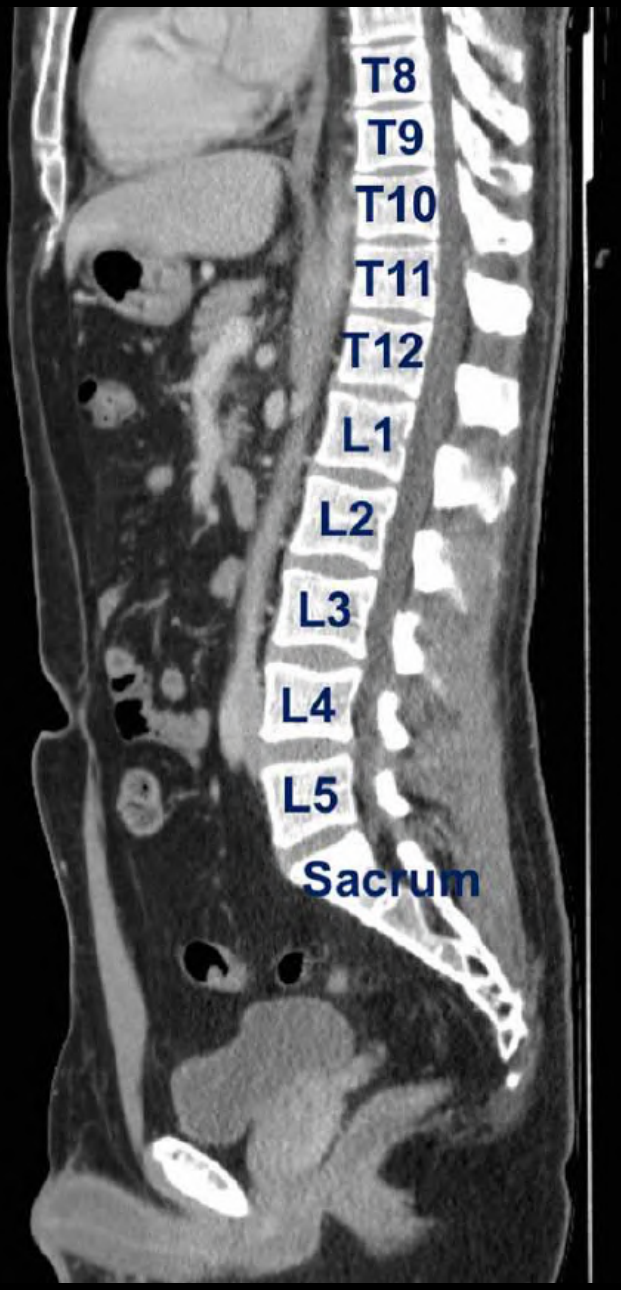
ANATOMY

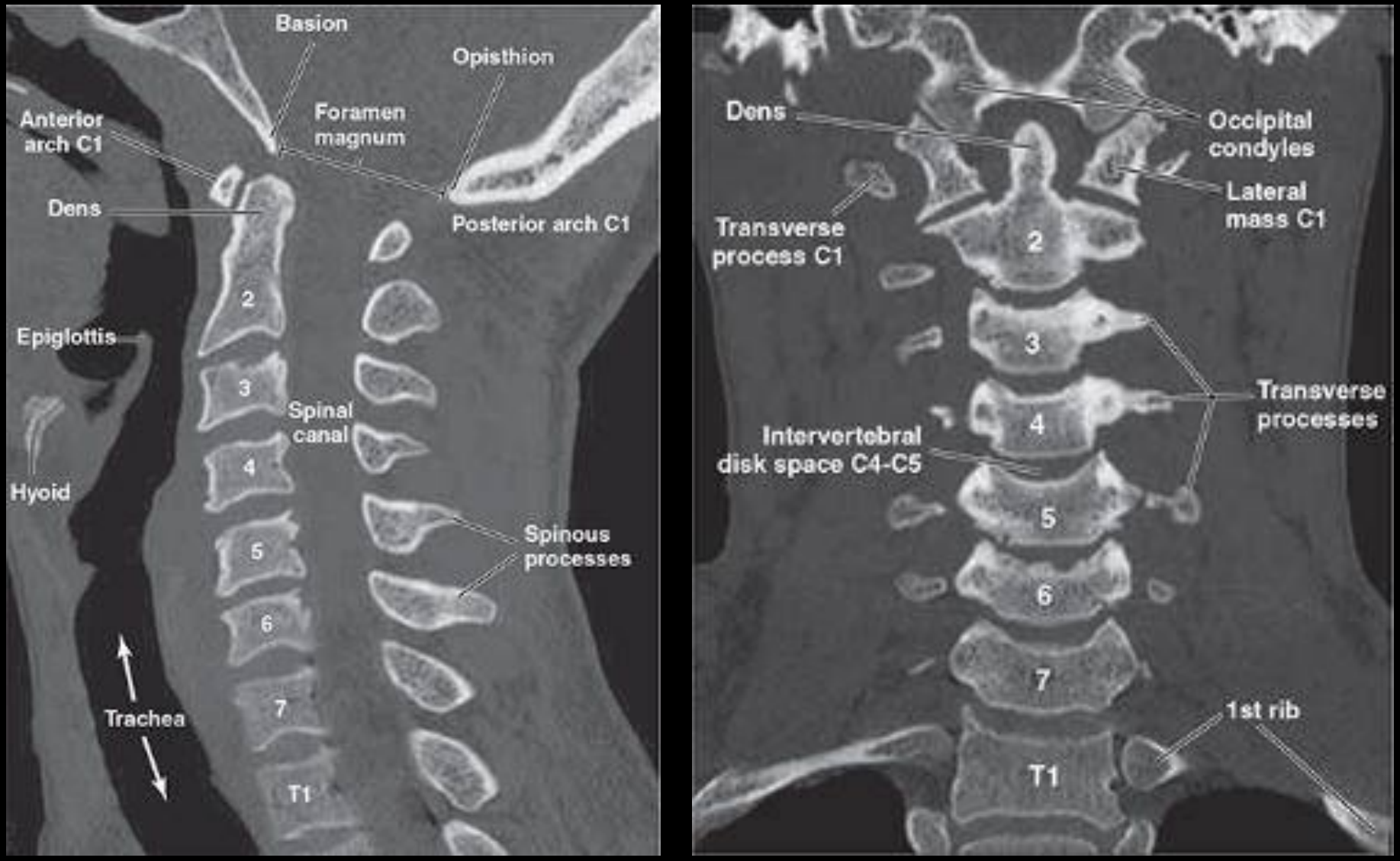

superior
articular
process
vertebral body
transverse
process
inferior
articular
process
spinous process
vertebral body
pedicle
vertebral
foramen
lamina
©E Lynn Singh
GCBS 2015

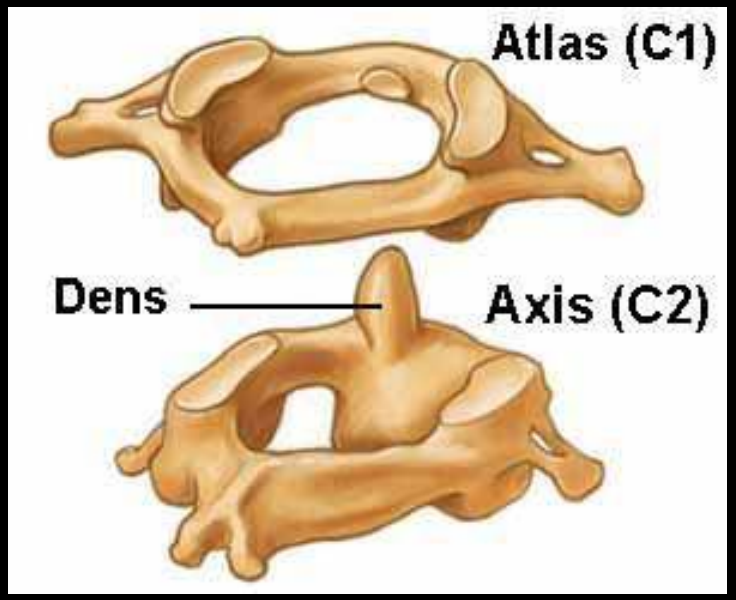

Transverse process
Spinous process
Vertebral body
Inferior articular process
Intervertebral disc
Inferior vertebral notch
Intervertebral foramen
Superior vertebral notch
Articular facet for sacrum

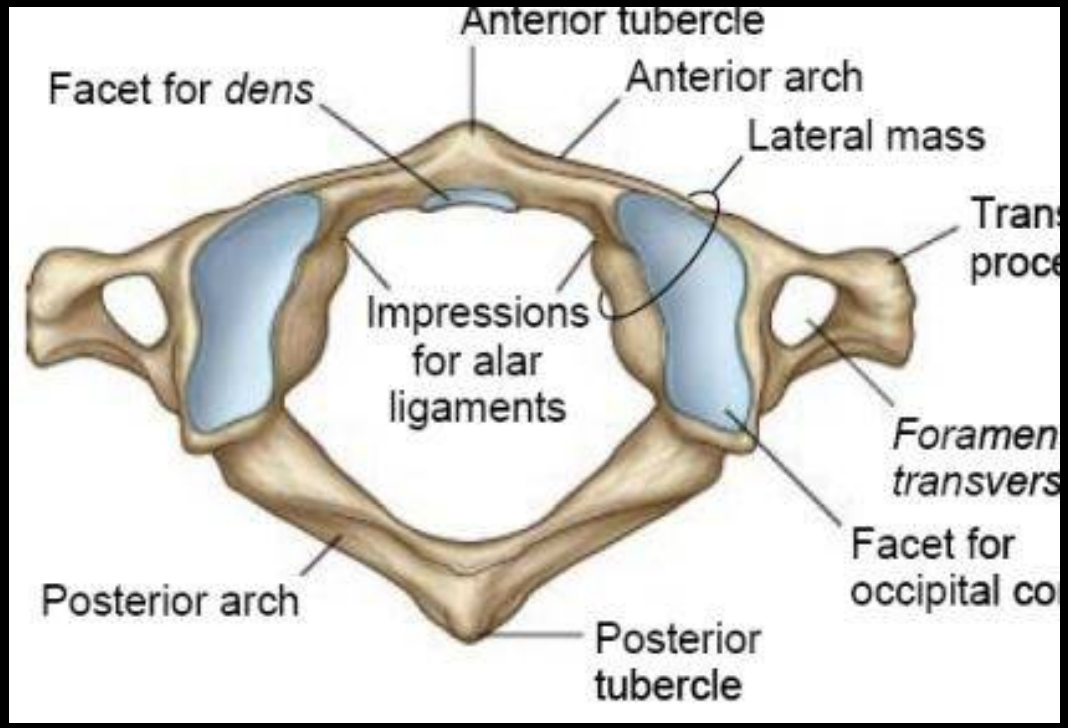


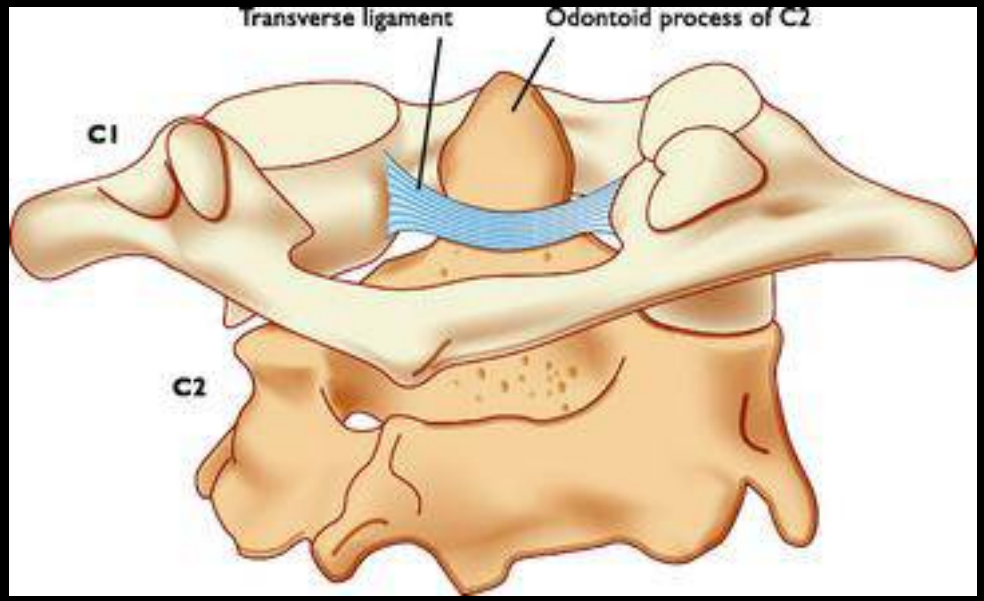

Intervertebral disc
Posterior longitudinal ligament
Pedicle (cut)
Inter-transverse ligament
Lateral costo-transverse ligament
Transverse process
Articular capsule of zygapophysial joints
Interspinous ligament
ongitudinal
Supraspinous ligament


T8
T9
T10
T11
T12
L1
L2
L3
L4
L5
Sacrum


Basion
Opisthion
Anterior arch C1
Foramen magnum
Dens
Posterior arch C1
2
Epiglottis
3
Spinal canal
4
Hyoid
5
Spinous processes
6
Trachea
7
T1
Dens
Occipital condyles
Lateral mass C1
Transverse process C1
2
3
Transverse processes
4
Intervertebral disk space C4-C5
5
6
7
1st rib
T1

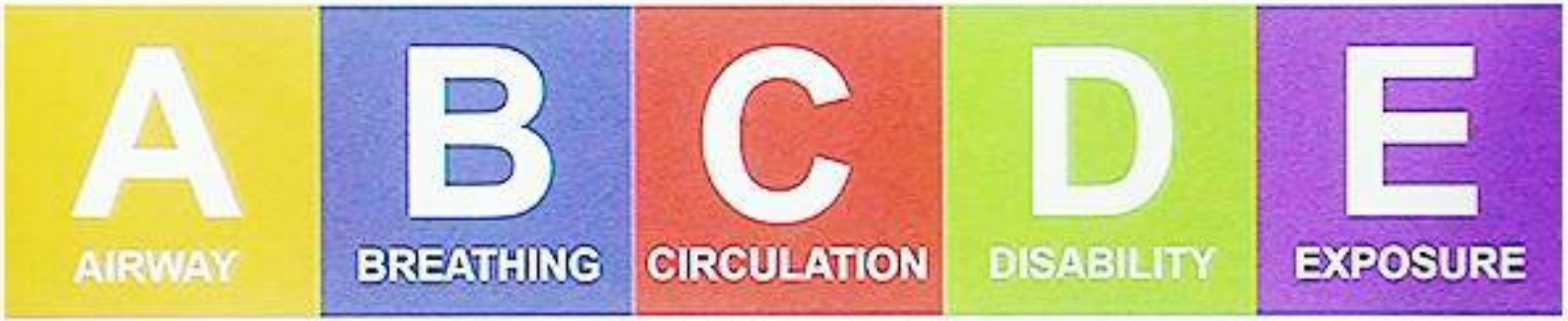

Atlas (C1)
Dens
Axis (C2)


Anterior tubercle
Facet for *dens*
Anterior arch
Lateral mass
Impressions for alar ligaments
Posterior arch
Posterior tubercle
Facet for occipital co


Transverse ligament
Odontoid process of C2
C1
C2

Initial Assessment and Management

Primary Survey



ABCDE IN TRAUMA

TRAUMA: The acute management of a trauma victim follows a linear algorithm that should be performed in the same order every time: **ABCDE,** 1° survey, 2° survey.

ABCs AND THE 1° SURVEY

Ac: Airway maintenance with Cervical spine control:

Check the patency of the airway first, and then give supplemental O2 via nasal cannula, face mask, airway adjunct (nasopharyngeal or oropharyngeal airway), or bag-valve mask (Ambu-Bag) as appropriate.

Indications for intubation include impending airway compromise, a Glasgow Coma Scale (GCS) score of = 8, ↓ mental status, apnea, and severe closed-head injuries.

A surgical airway (cricothyroidotomy) should be performed in the setting of significant maxillofacial trauma.

B: Breathing with ventilation:

Quickly evaluate for **causes of impending cardiopulmonary death**— e.g. tension pneumothorax, cardiac tamponade, open pneumothorax, massive hemothorax, or airway obstruction.

C: Circulation with hemorrhage control:

Resuscitation: Think short and fat IV lines—e.g. two large-bore (16- or 18-gauge) antecubital lines.

A good rule of thumb is to give three times as much isotonic fluid (NS or LR) as the estimated blood lost.

D: Disability—determined by a brief neurologic examination:

AVPU system: A = **A**lert; **V** = responds to **V**ocal stimuli; **P** = responds to **P**ainful stimuli; **U** = **U**nresponsive.

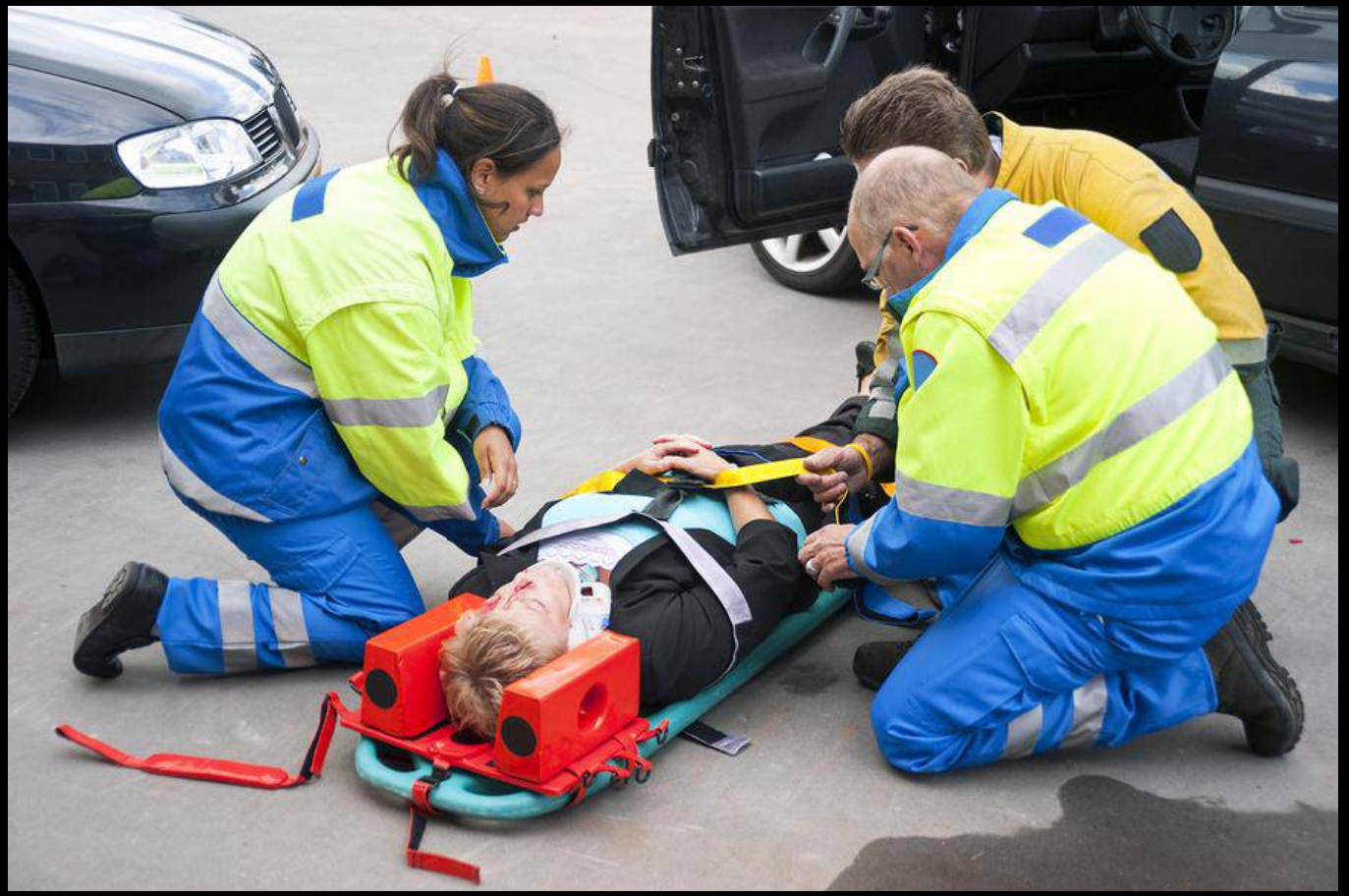
GCS: Based on the **best** response of E + V + M

Initial Assessment and Management

The possibility of a spine injury must be considered in all trauma patients.

Always completely evaluate the spine. A patient with a spine injury at one level has a significant risk for additional injuries at other levels.

The trauma patient should be kept on a hard flat board with straps and pads used for immobilization. A hard cervical collar is kept in place. These steps minimize forces transferred through the spine, and therefore decrease the chance of causing dislocation, subluxation, or neural compression during transport to the trauma bay.



Cervical Collar - Emergency - A girl treated by a paramedic

Cervical spine

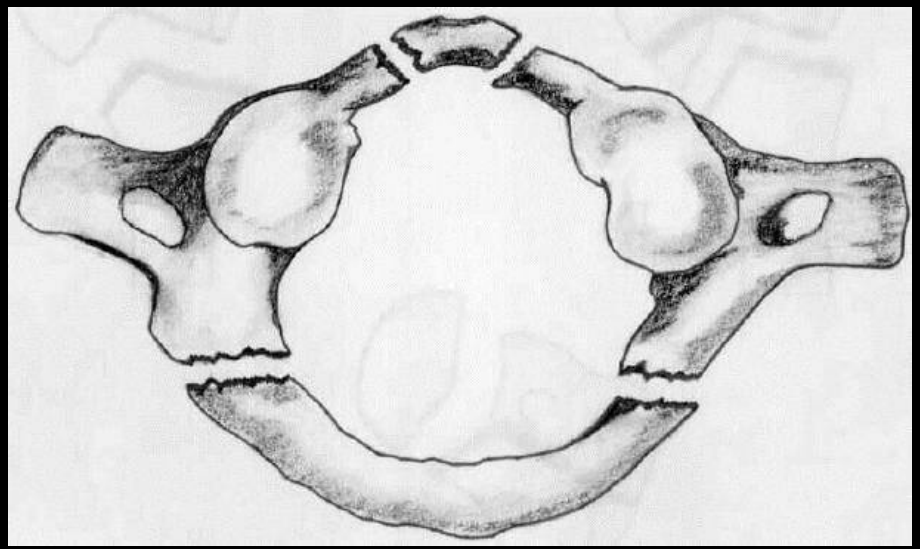
The cervical spine is more mobile than the thoracolumbar spine.

The mass of the head transmits significant forces to the cervical spine during abrupt acceleration or deceleration, increasing risk for injury.

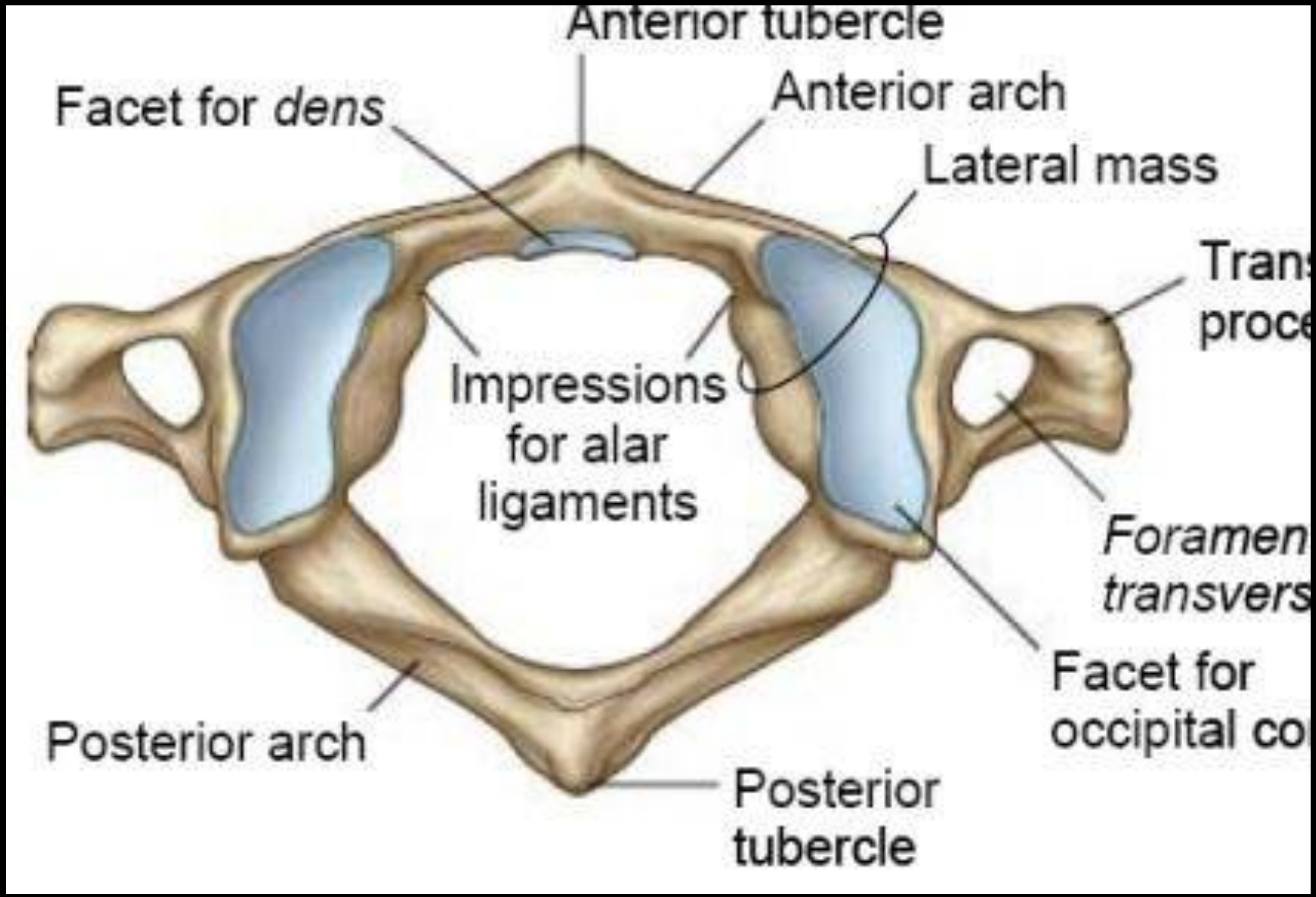
C 1

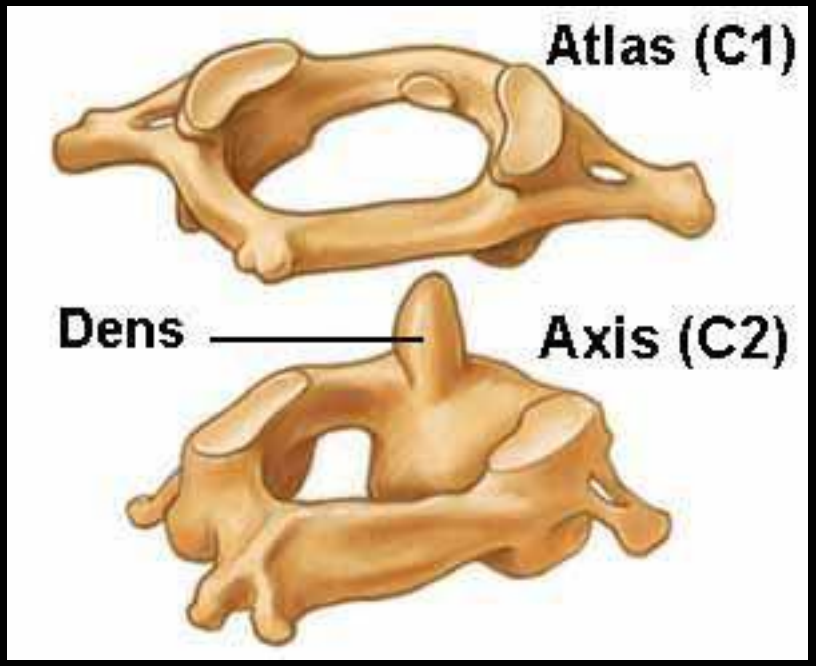
Jefferson fracture

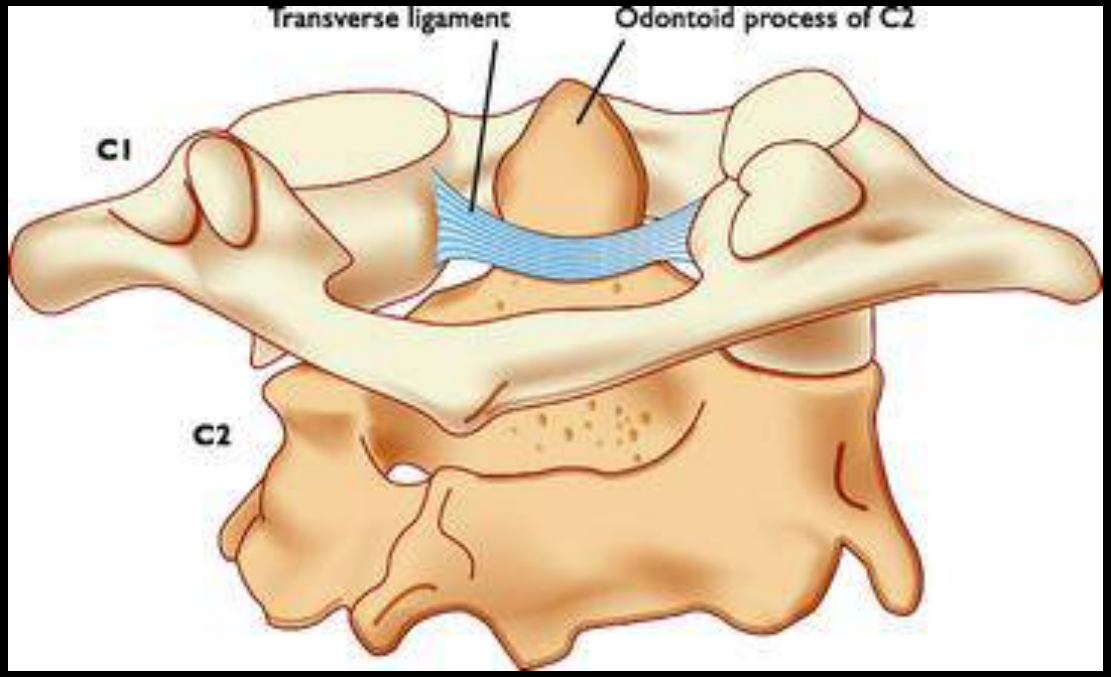
A Jefferson fracture is a bursting fracture of the ring of C1 (the atlas) due to compression forces. There are usually two or more fractures through the ring of C1.

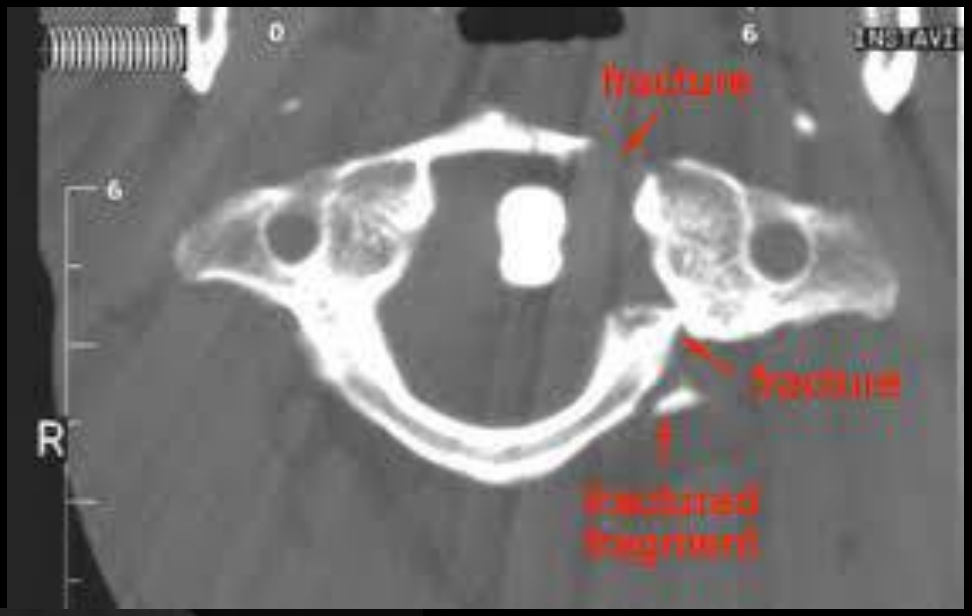


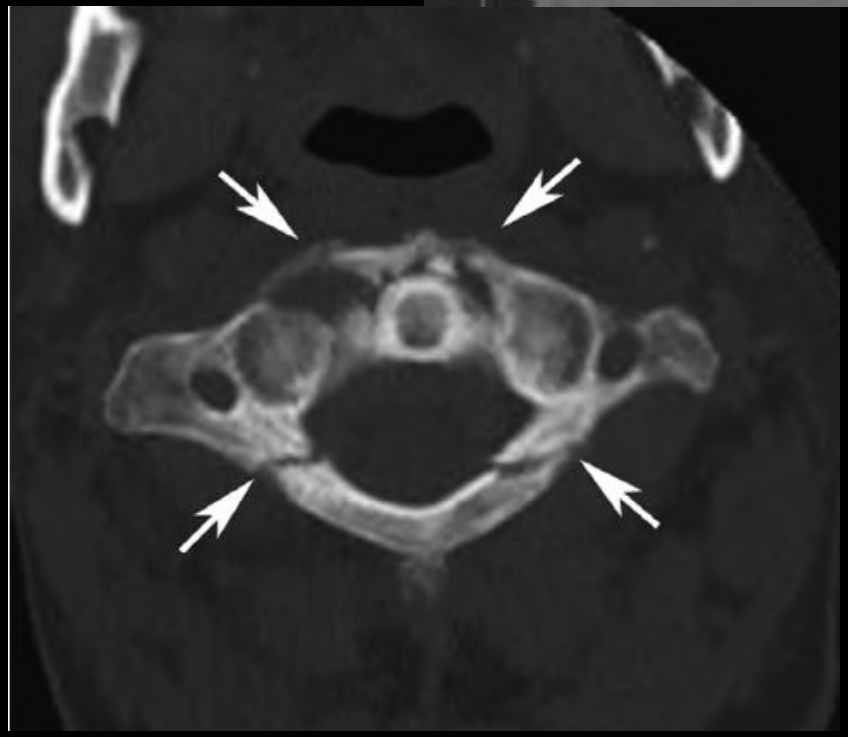
Sir Geoffrey Jefferson (1886–1961)

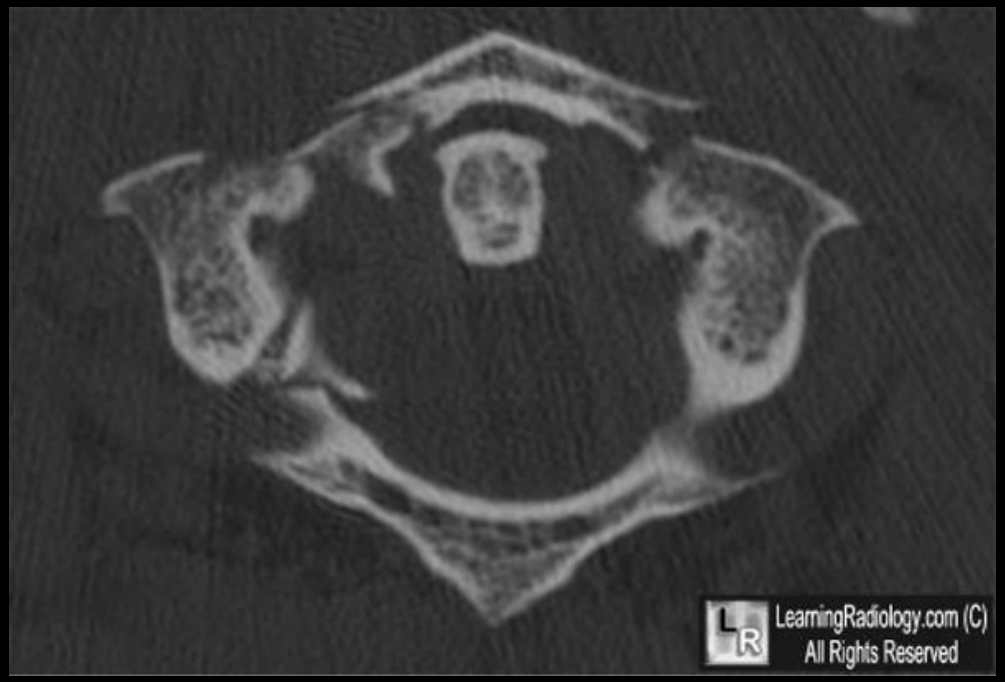

Anterior tubercle
Facet for *dens*
Anterior arch
Lateral mass
Impressions for alar ligaments
Posterior arch
Posterior tubercle
Facet for occipital co
Foramen transvers


Atlas (C1)
Dens
Axis (C2)


Transverse ligament
Odontoid process of C2
C1
C2


fracture
fracture
fractured fragment
R




LearningRadiology.com (C)
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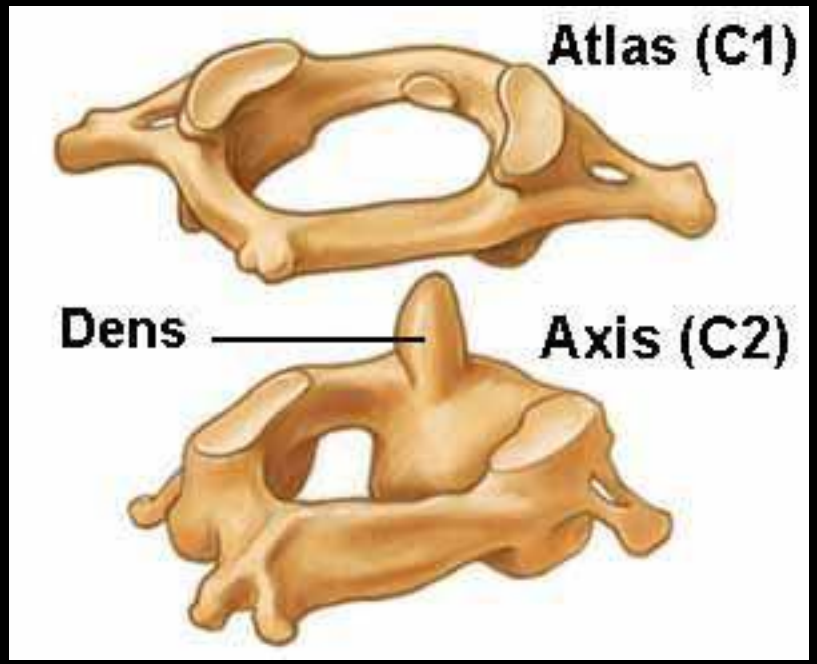
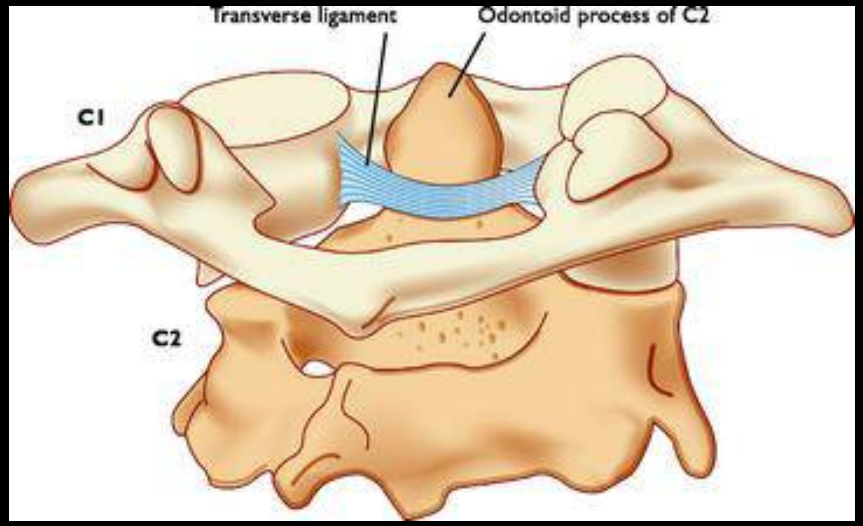
C 2

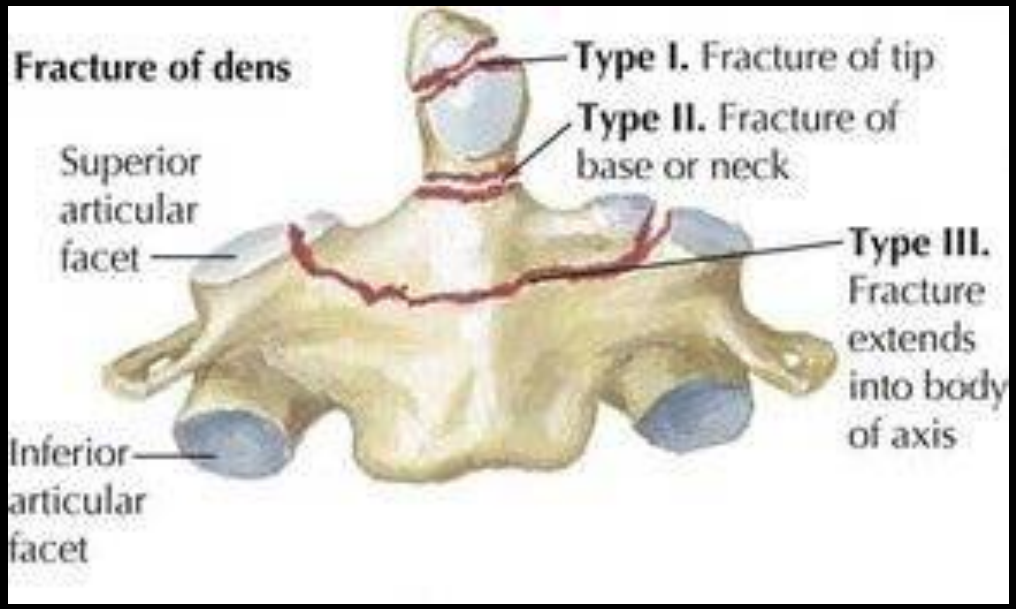
Odontoid Fractures

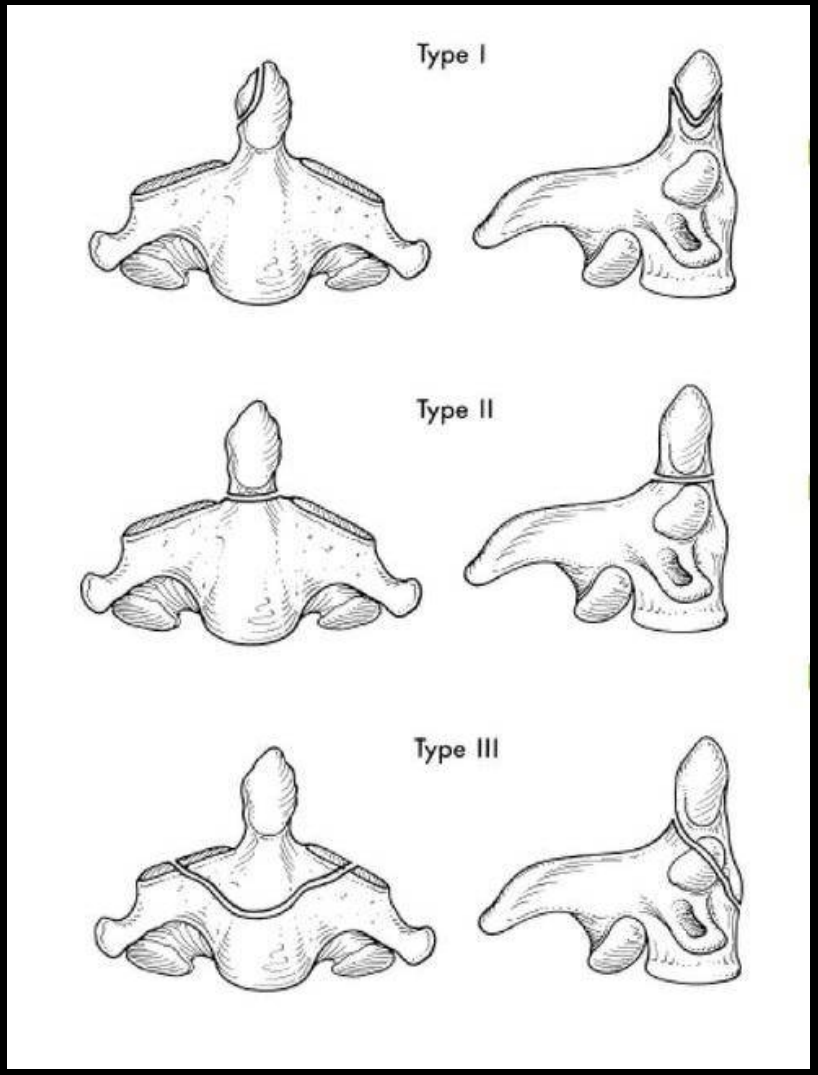
The odontoid process, or dens, is the large ellipse of bone arising anteriorly from C2 (the axis) and projecting up through the ring of C1 (the atlas).



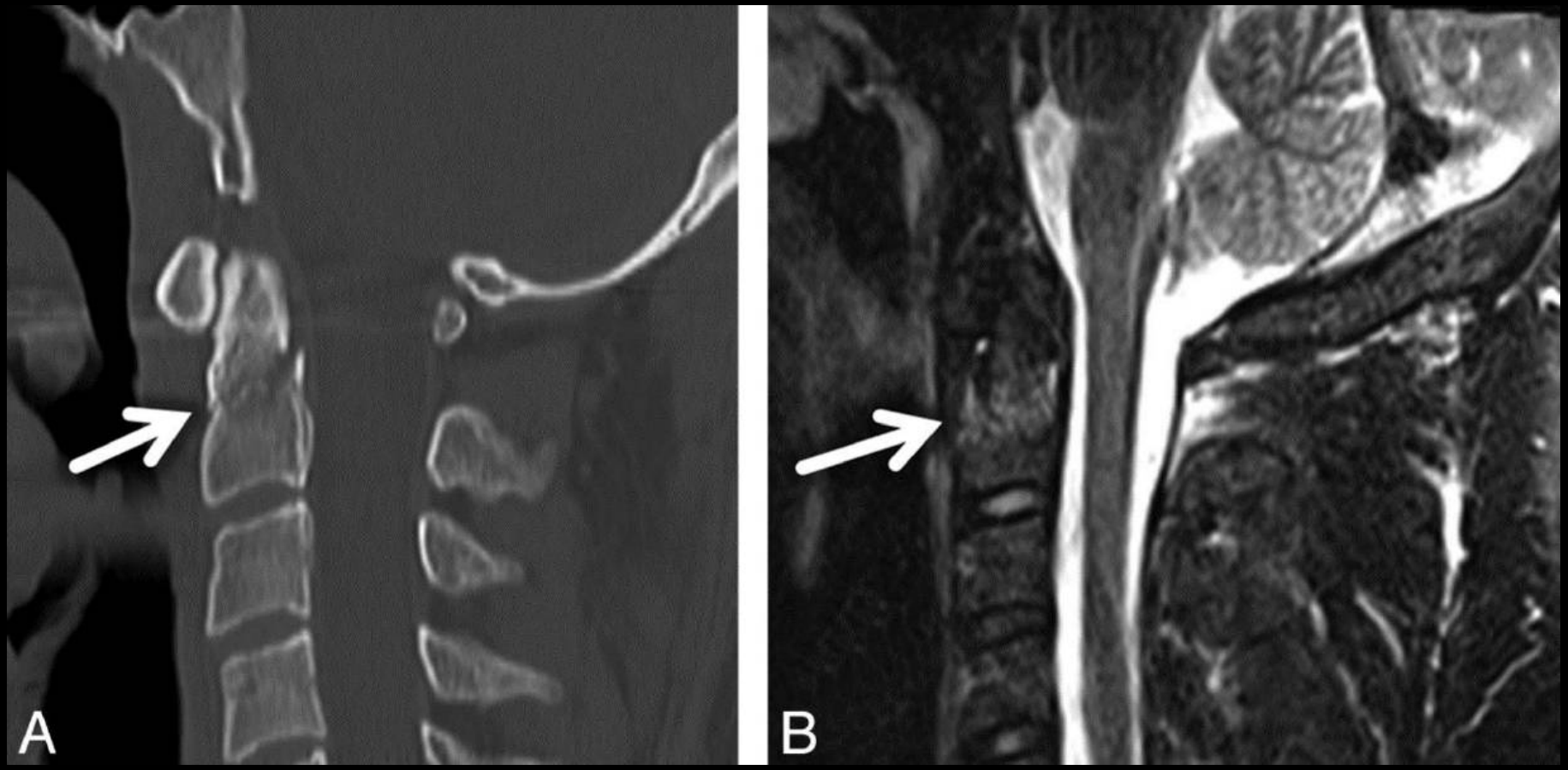


Odontoid fractures are classified as type I, II, or III. A type I fracture involves the tip only. A type II fracture passes through the base of the odontoid process. A type III fracture passes through the body of C2.





Type 1 odontoid fracture

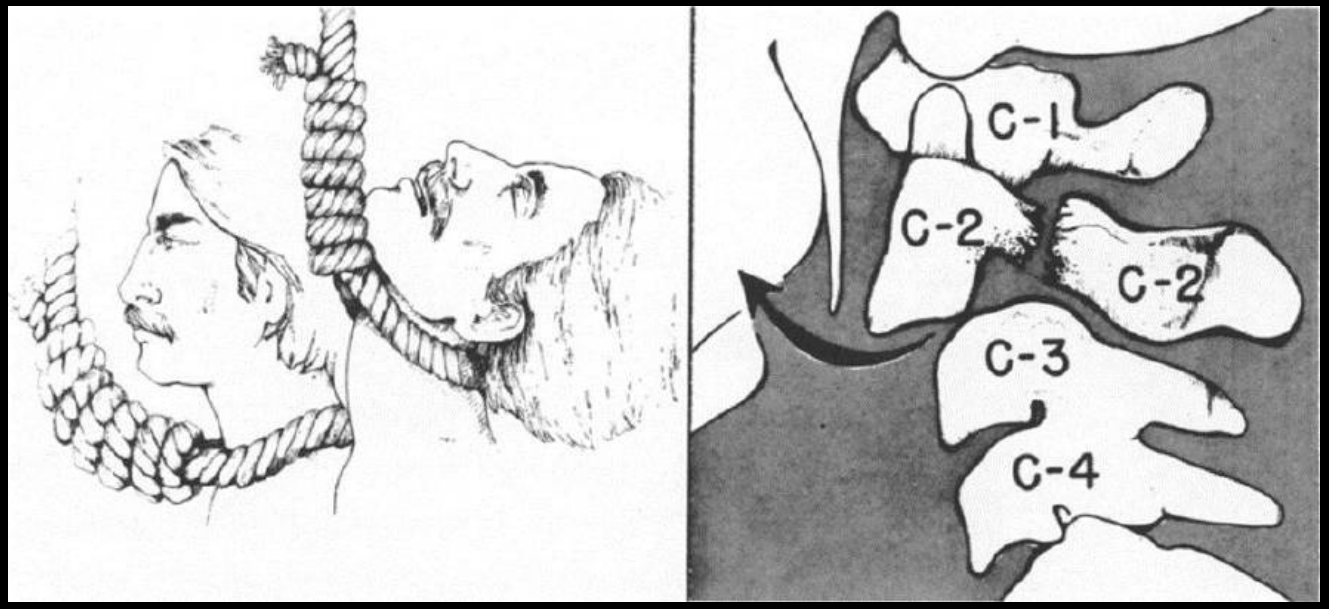


Type II

Hangman’s Fracture

Hangman's Fracture

Traditionally considered a hyperextension/distraction injury from placement of the noose under the angle of the jaw, hangman's fractures also may occur with hyperextension/compression, as with diving accidents. The injury is defined by bilateral C2 pars interarticularis fractures. The pars interarticularis is the bone between superior and inferior facet joints. Thus, the posterior bony connection between C1 and C3 is lost.

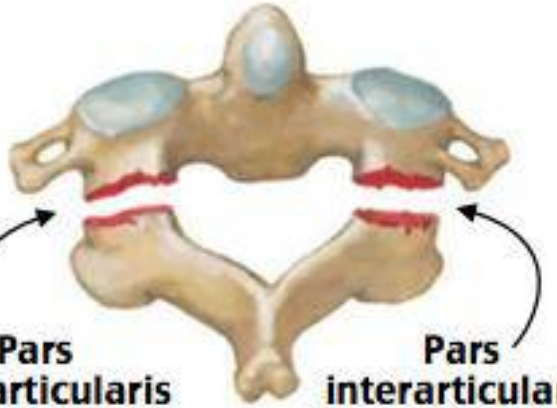


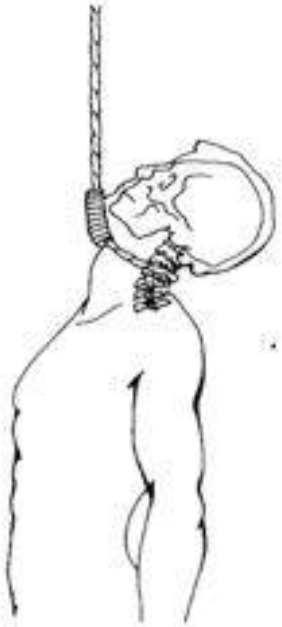

Hangman fracture
Fracture through neural arch of axis
Superior articular facet
Inferior articular facet

Hangman Fracture

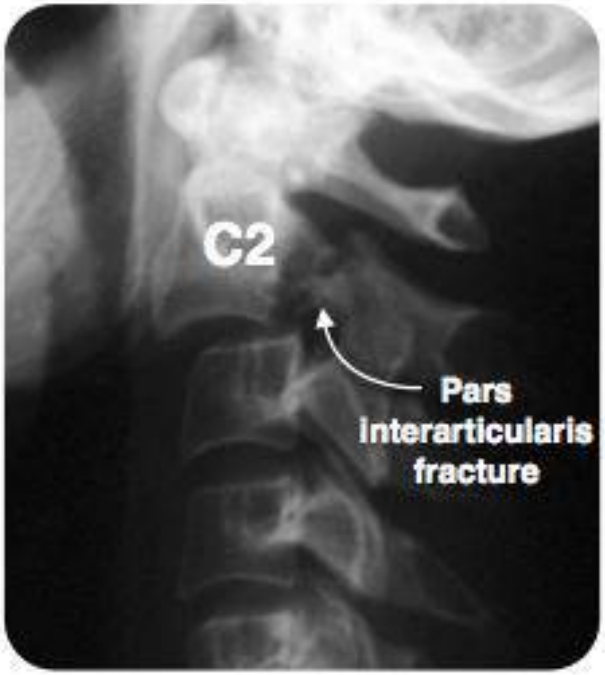
→ Traumatic spondylolisthesis of axis

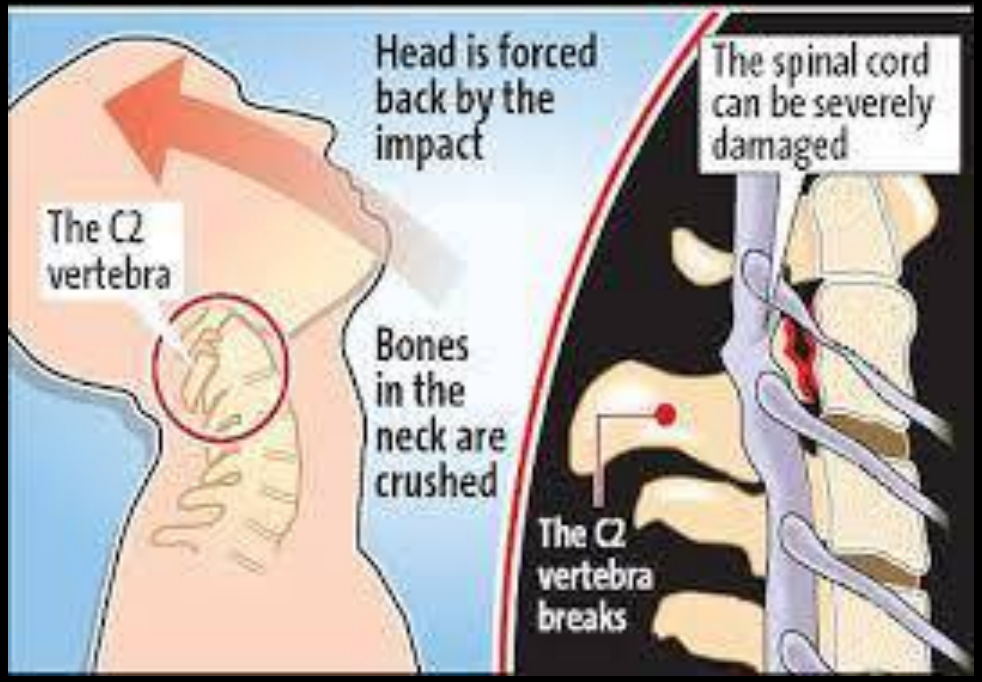
Hyperextension

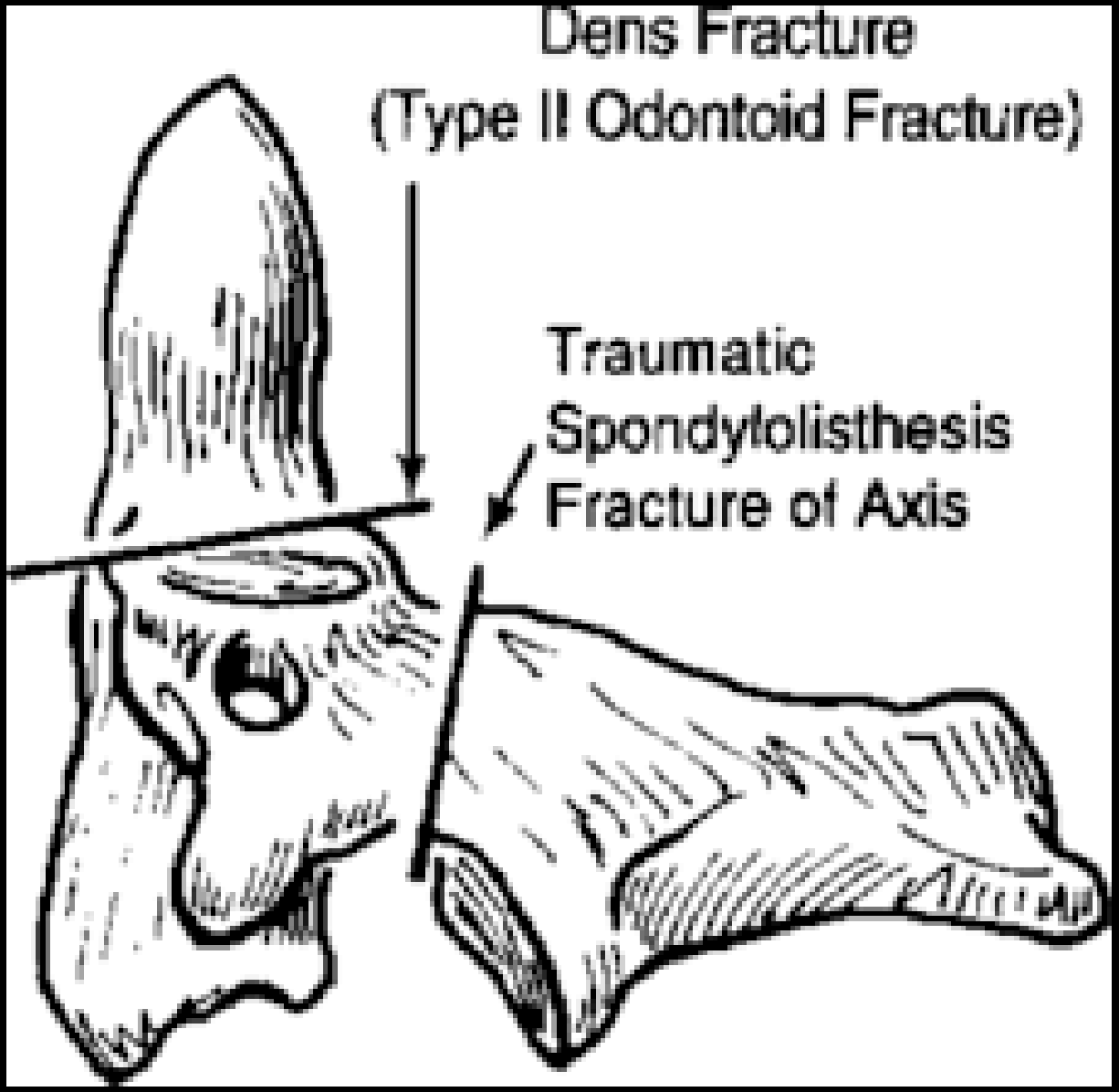




Judicial hangings

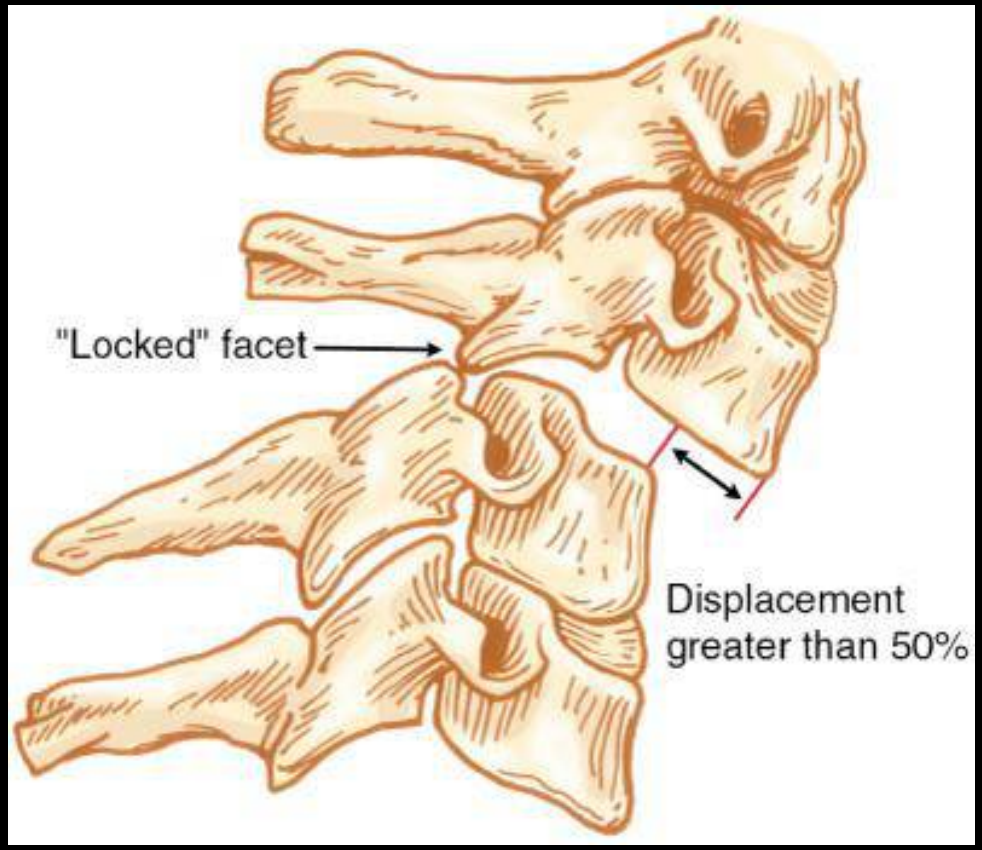



Head is forced back by the impact
The C2 vertebra
Bones in the neck are crushed
The spinal cord can be severely damaged
The C2 vertebra breaks

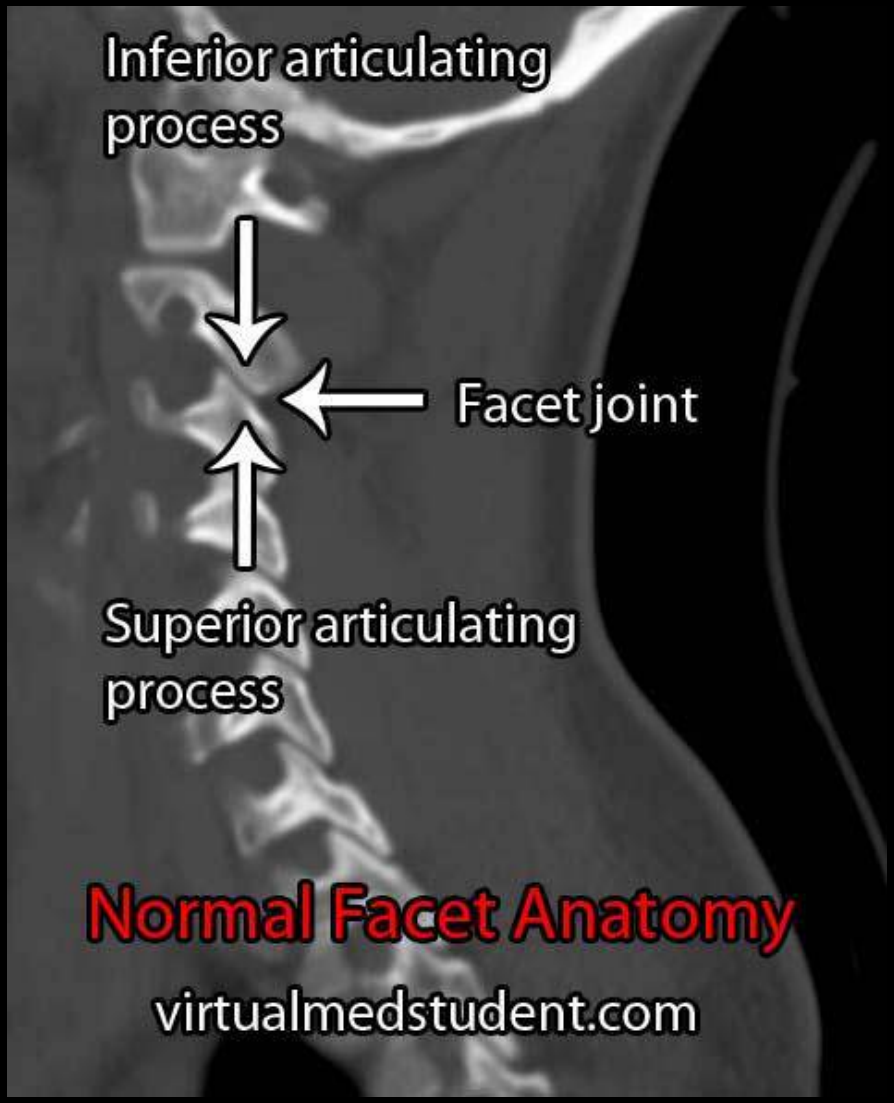

Dens Fracture
(Type II Odontoid Fracture)
Traumatic
Spondylolisthesis
Fracture of Axis

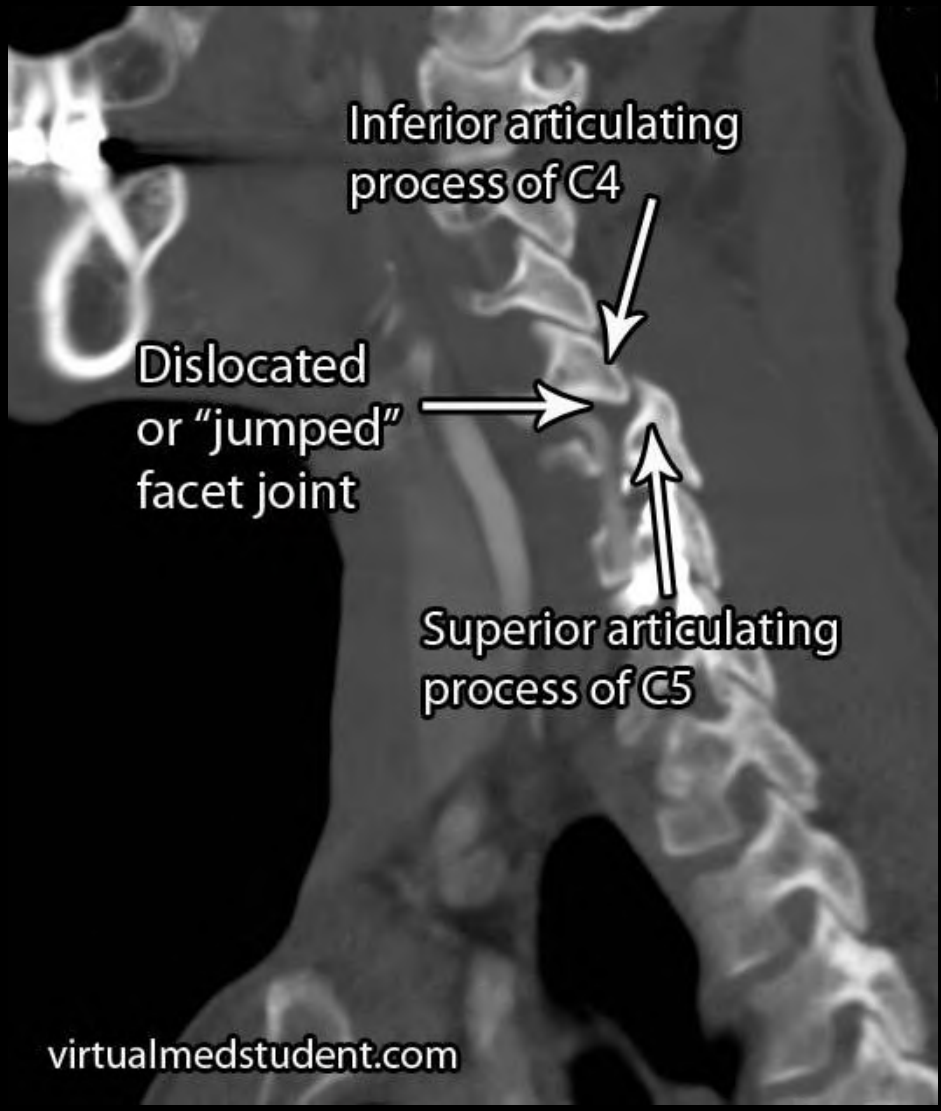
Jumped Facets - Hyperflexion Injury

In a hyperflexion injury, the superior facet can “jump” over the inferior facet of the level above if the joint capsule is torn.




Sensation 16
Ex: 1
SAGITAL MPR 3MIN
Se: 603/6
Im: 4/19
Sag: L14.6 (COI)
Acc:
2006 Dec 28
Acq Tm: 22:17:26.345709
PRE CONTRAST
Tilt: 0
512 x 512
B70s
A
P
120.0 kV
0.0 mA
Tilt: 0.0
0.0 s
Lin:DCM / Lin:DCM / Id:ID
W:1500 L:450
DFOV: 13.5 x 13.5cm


Inferior articulating process
Facet joint
Superior articulating process
Normal Facet Anatomy
virtualmedstudent.com


Inferior articulating process of C4
Dislocated or "jumped" facet joint
Superior articulating process of C5
virtualmedstudent.com


SR


ANATOMIE
UMANA


Head 1.0 Vol
Oblique (Косая

Patients with unilateral injury usually are neurologically intact. Those with bilateral injury, however, typically suffer from spinal cord damage, since the anteroposterior diameter of the spinal canal is compromised by bilateral injury, leading to spinal cord compression.

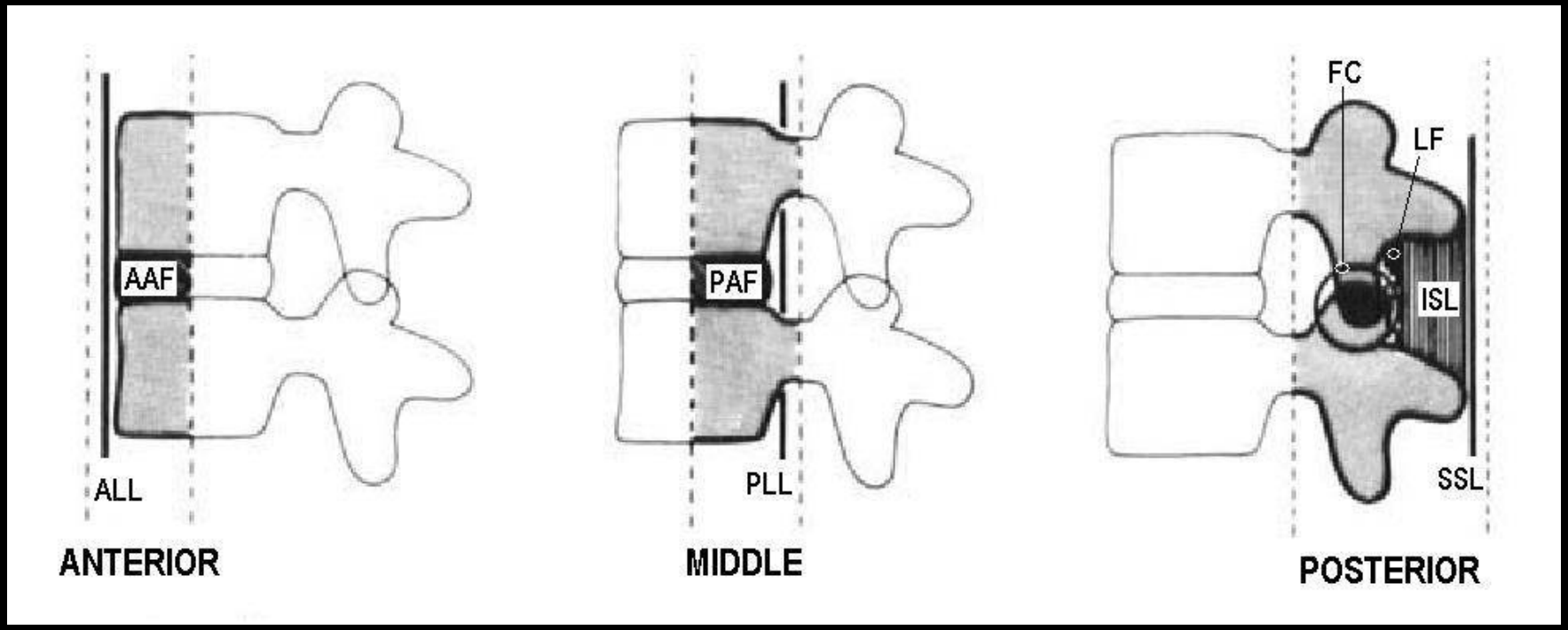
Thoracolumbar Injury

Francis Denis

French origin US orthopedic surgeon (1946). He is well known for his three-column injury concept, some spine-related scales and classification system for spinal trauma.

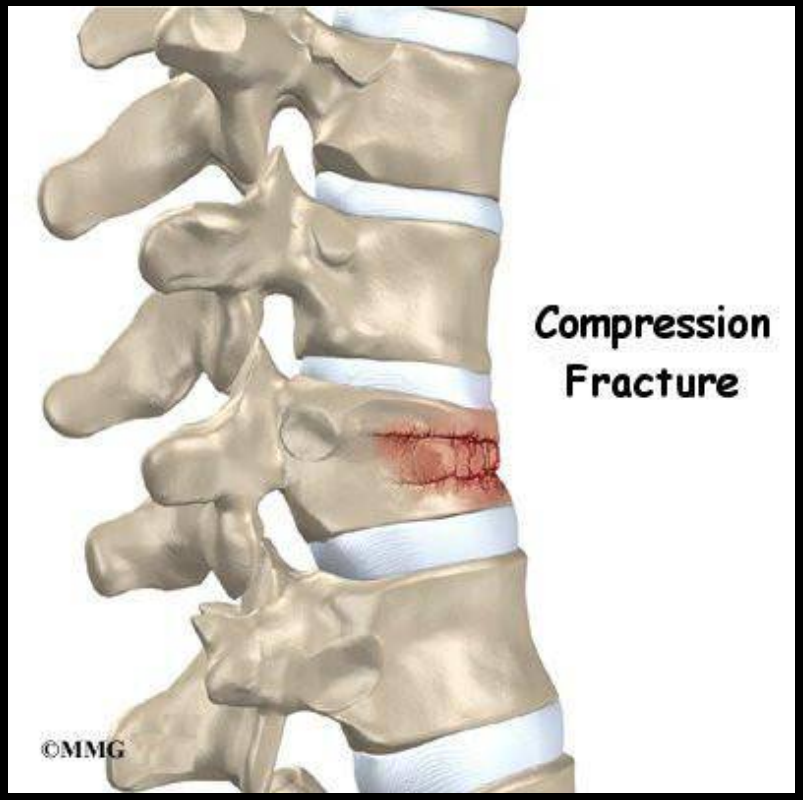
Denis' Three-column model

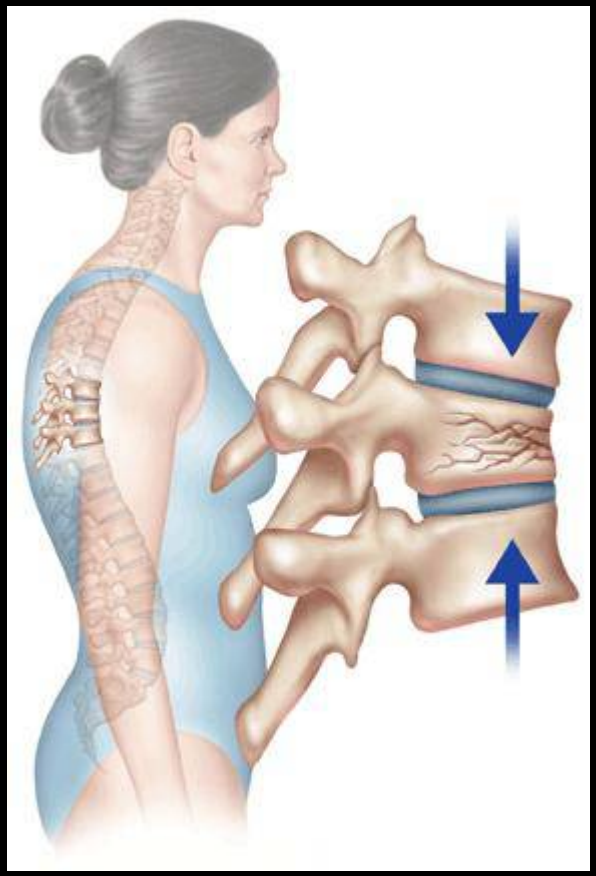
A **three-column model** is useful for categorizing thoracolumbar injuries.The anterior longitudinal ligament and the anterior half of the vertebral body constitute the anterior column. The posterior half of the vertebral body and the posterior longitudinal ligament constitute the middle column. The pedicles, facet joints, laminae, spinous processes, and interspinous ligaments constitute the posterior column.

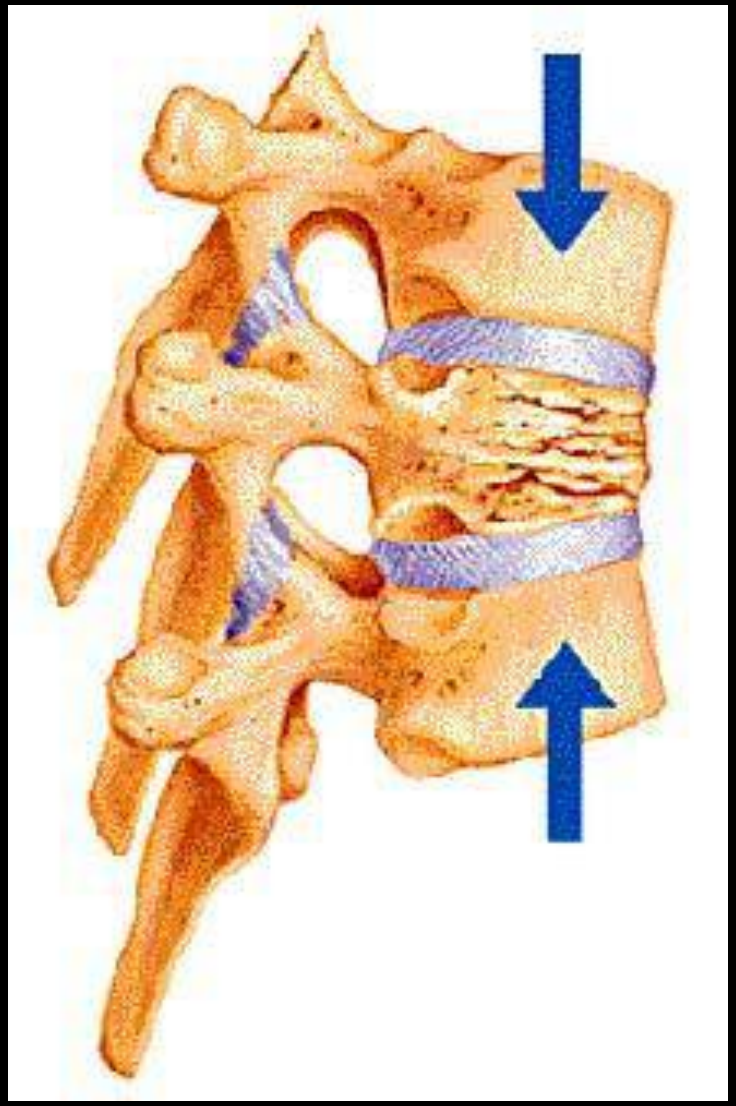


Compression Fracture

Compression fracture is a compression/flexion injury causing failure of the anterior column only. It is stable and not associated with neurologic deficit, although the patient may still have significant pain.

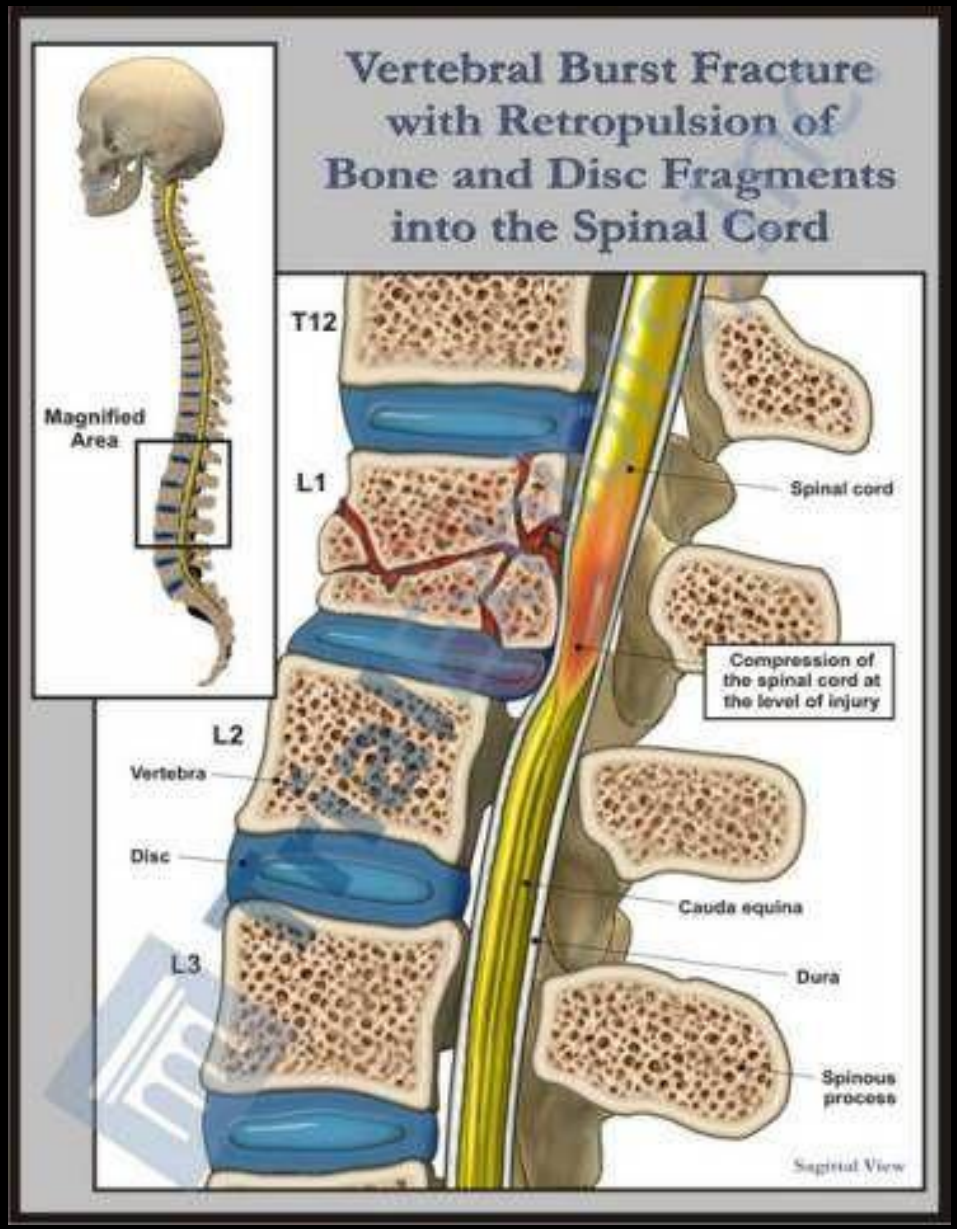


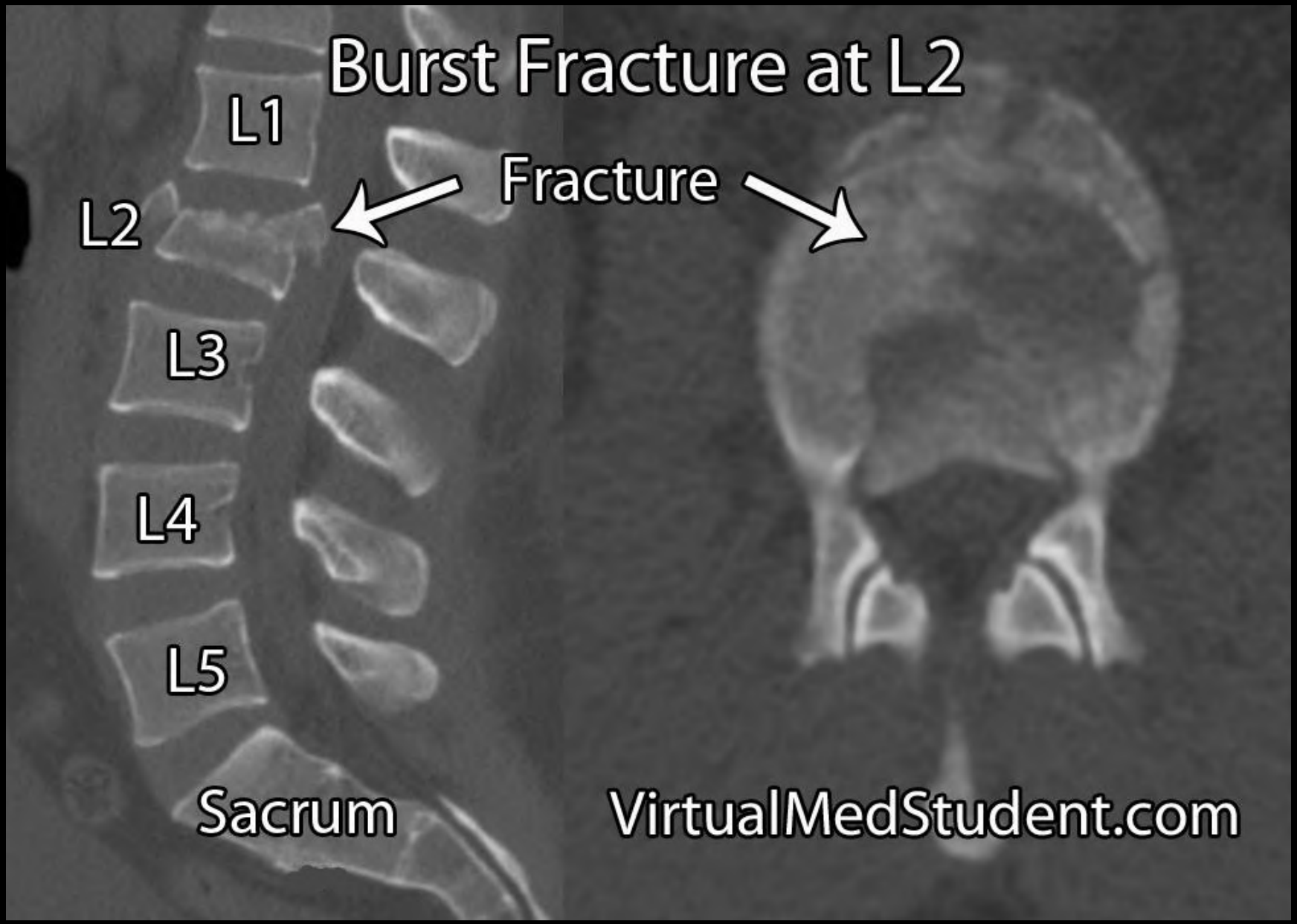




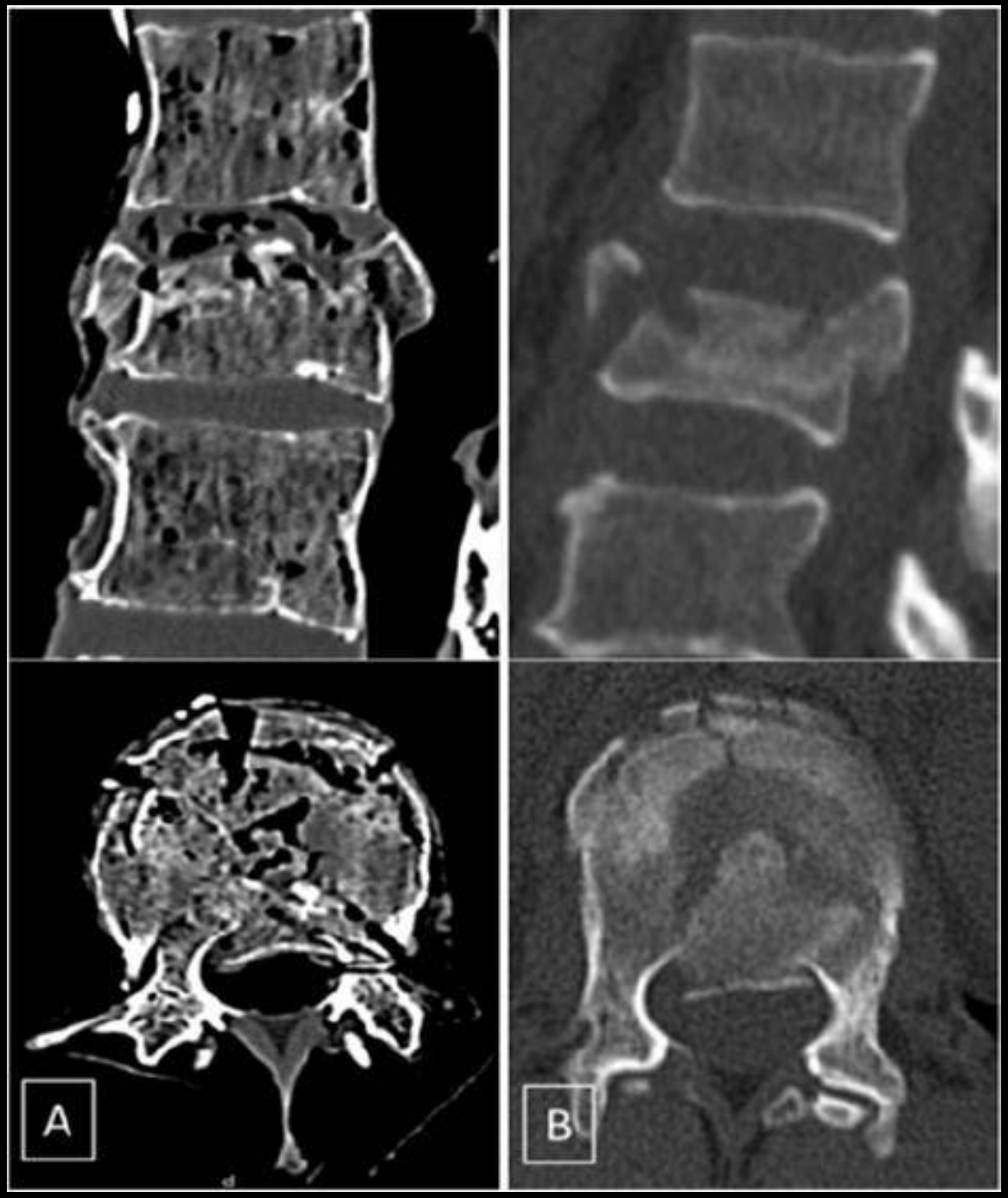
Burst Fracture

Burst fracture is a pure axial compression injury causing failure of the anterior and middle columns. It is unstable, and perhaps half of patients have neurologic deficit due to compression of the cord or cauda equina from bone fragments retropulsed into the spinal canal.




Burst Fracture at L2
L1
Fracture
L2
L3
L4
L5
Sacrum
VirtualMedStudent.com

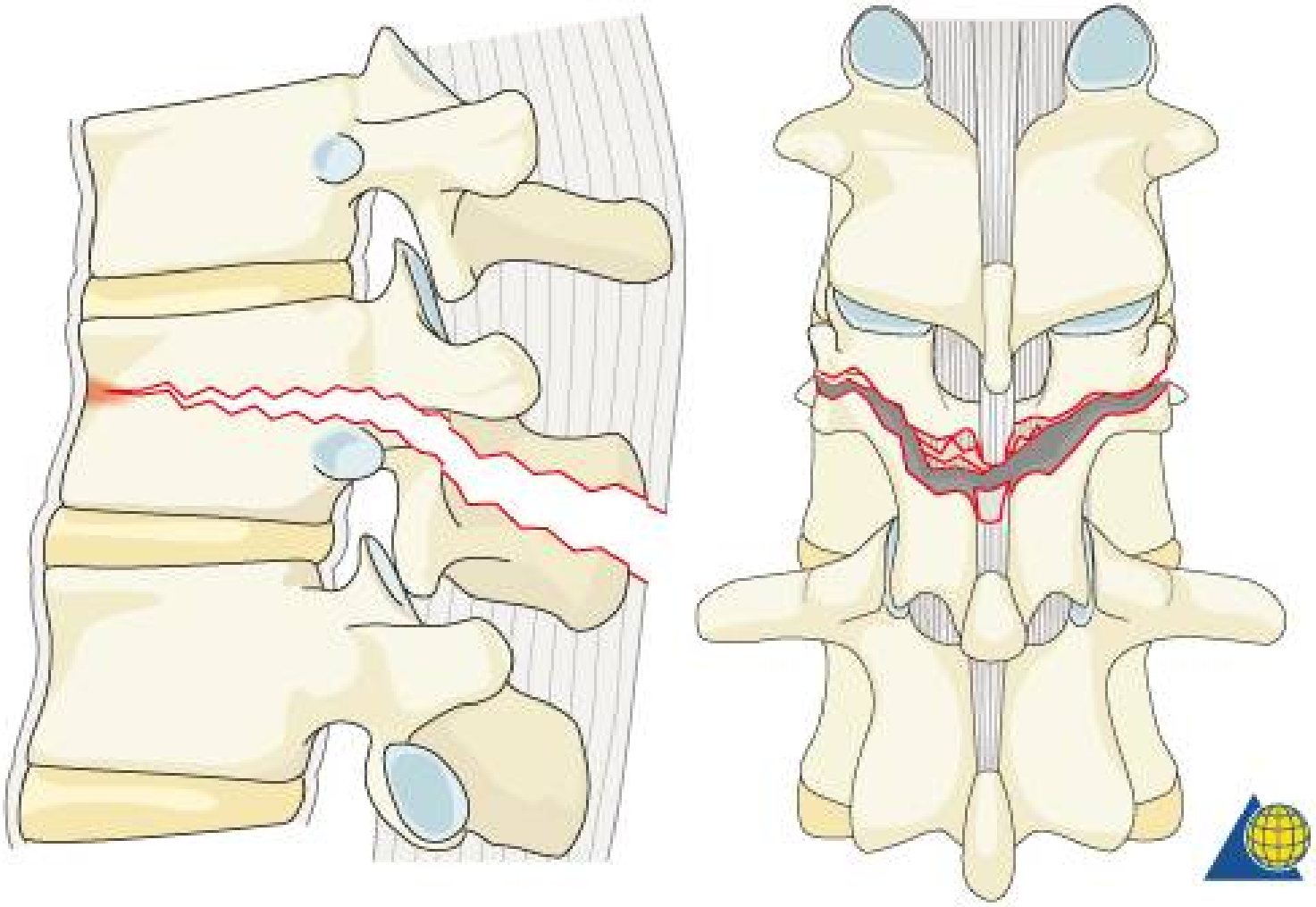

32
W 4000 : L 700


A
B

Chance Fracture

Chance fracture is a flexion-distraction injury causing failure of the middle and posterior columns, sometimes with anterior wedging.

It was first described by George Quentin Chance, a radiologist from Manchester, UK, in 1948.



Typical injury is from a lap seat-belt hyperflexion with associated abdominal injury. It often is unstable and associated with neurologic deficit.

WHAT COULD HAPPEN IN A CRASH WHEN YOU ARE STRAPPED IN USING A LAP BELT

In a crash, a lap belt would cause the body to be propelled forward and jackknifed over the safety strap, causing serious abdominal and spinal injuries. The lap belt has been associated with injuries to the vertebrae, liver, spleen, bladder, intestines, kidneys and the spinal cord, which can cause paralysis.

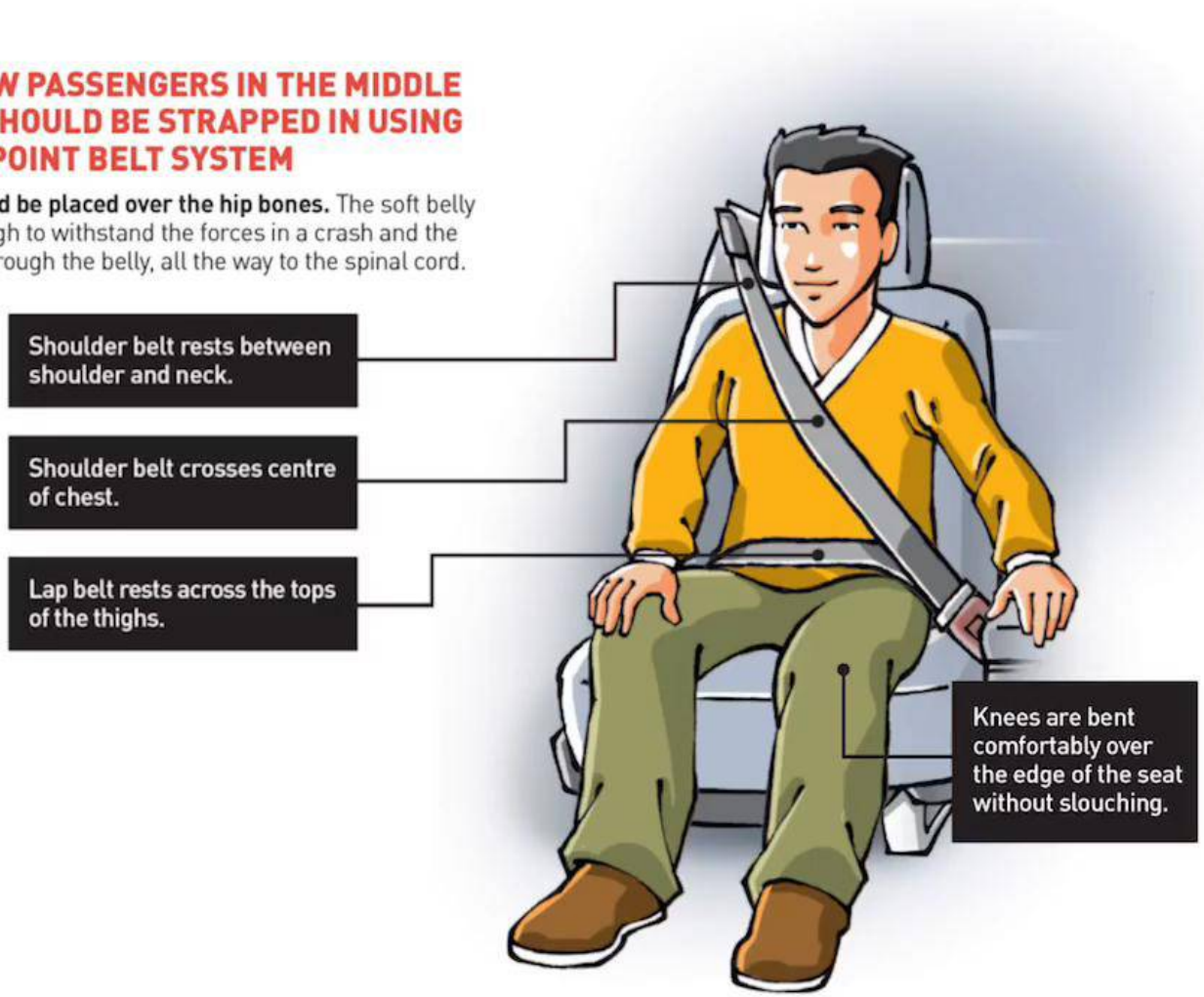
The impact during a collision will cause the head to strike the front seat, or thrown forward and possibly impact the floor, causing head, or facial injuries.

The ensuing whiplash, where the body is thrown back into the seat, could snap the victim's neck.

NEW STRAITS TIMES ESTABLISHED 1845

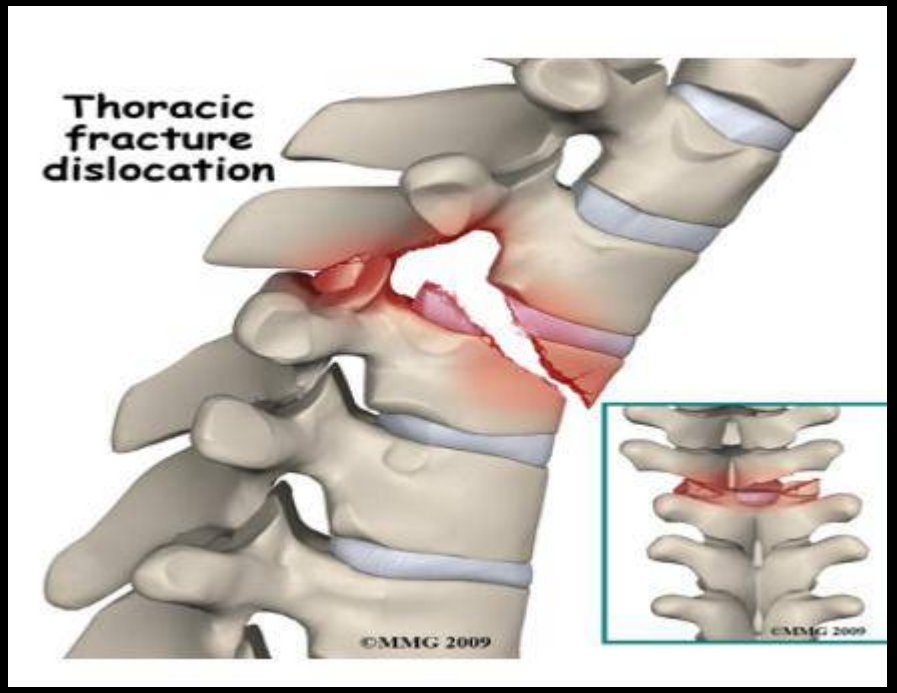
BELT UP! HOW PASSENGERS IN THE MIDDLE BACK SEAT SHOULD BE STRAPPED IN USING THE THREE-POINT BELT SYSTEM

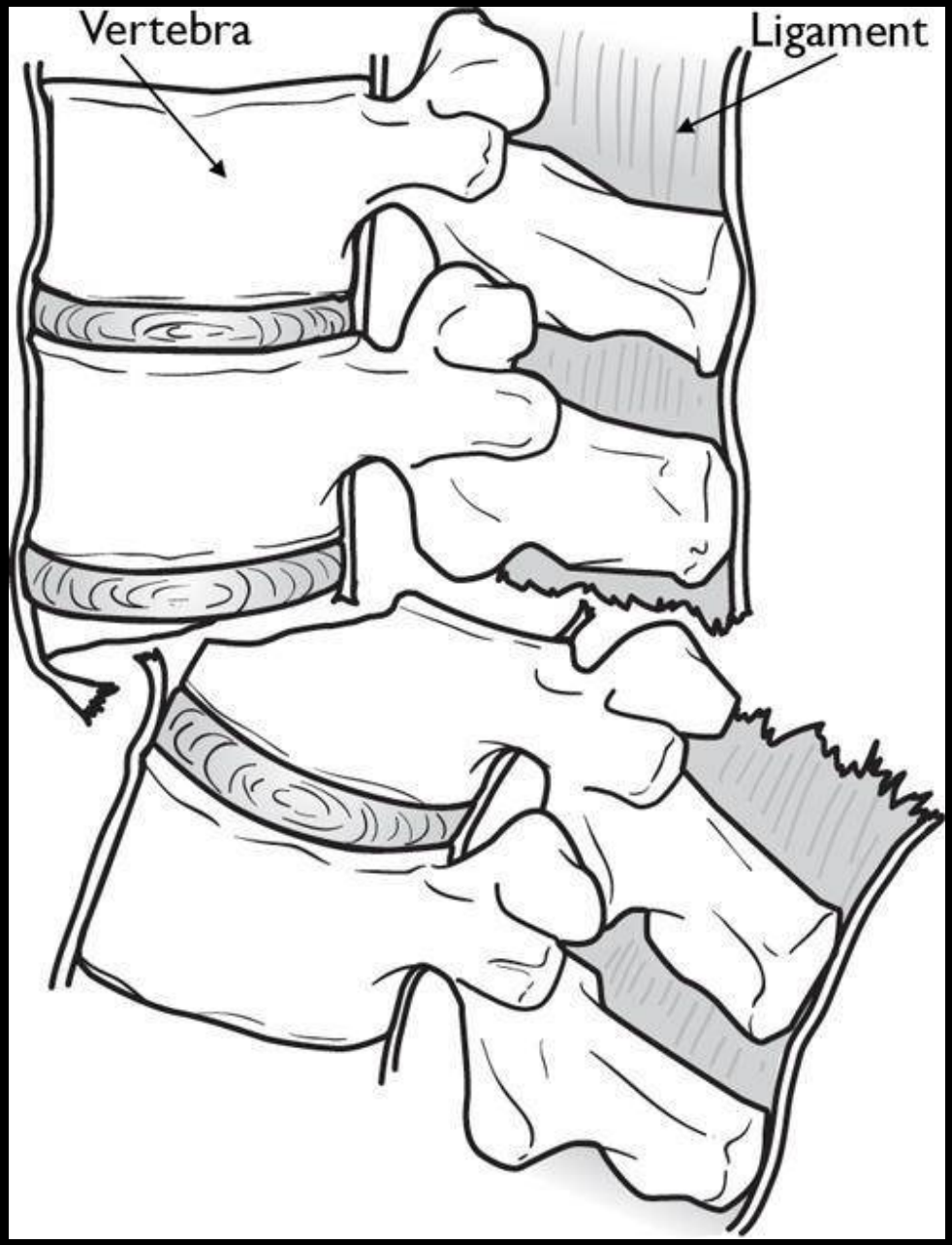
The lap belt should be placed over the hip bones. The soft belly is not strong enough to withstand the forces in a crash and the strap would cut through the belly, all the way to the spinal cord.

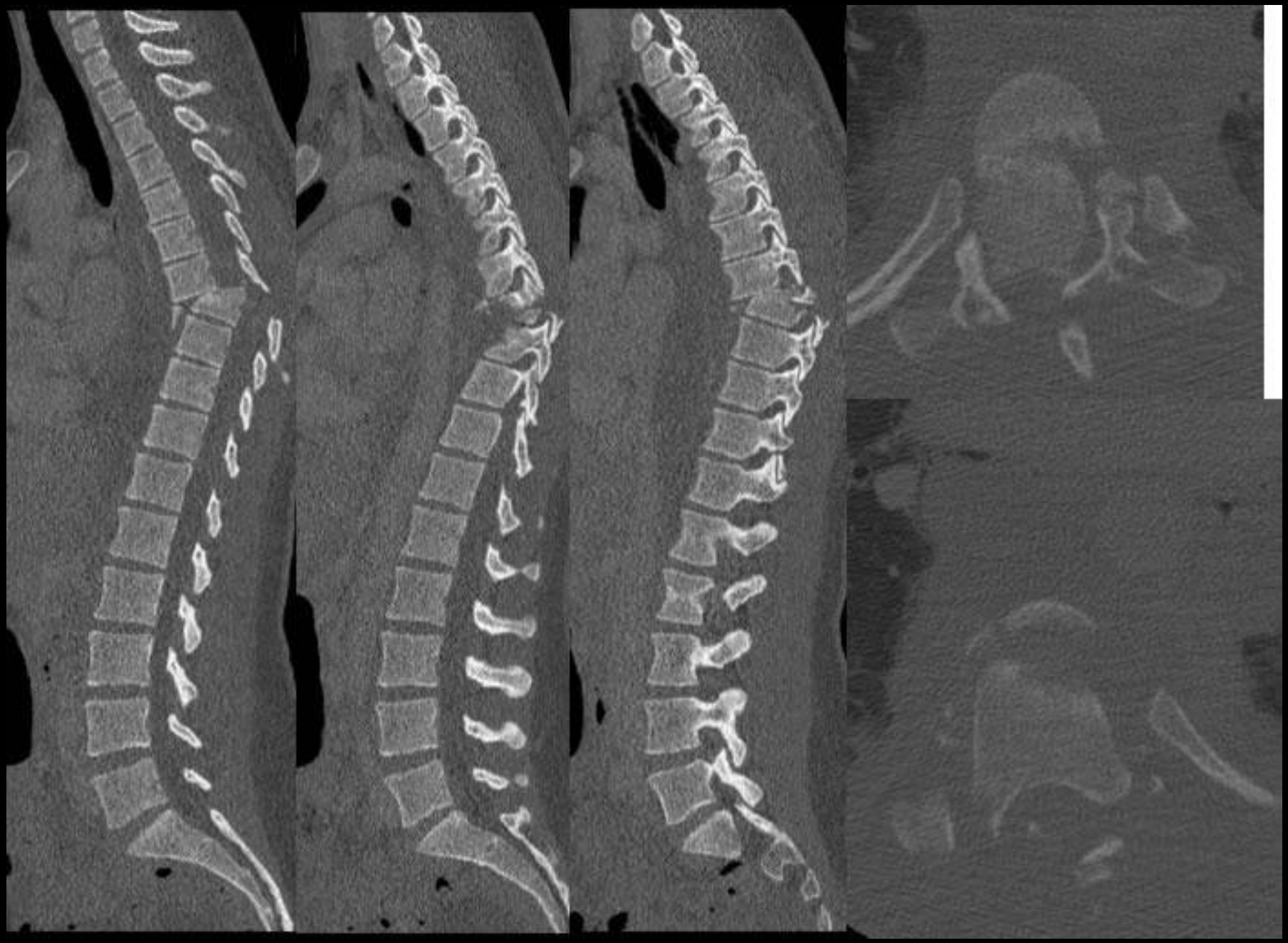


Fracture-Dislocation

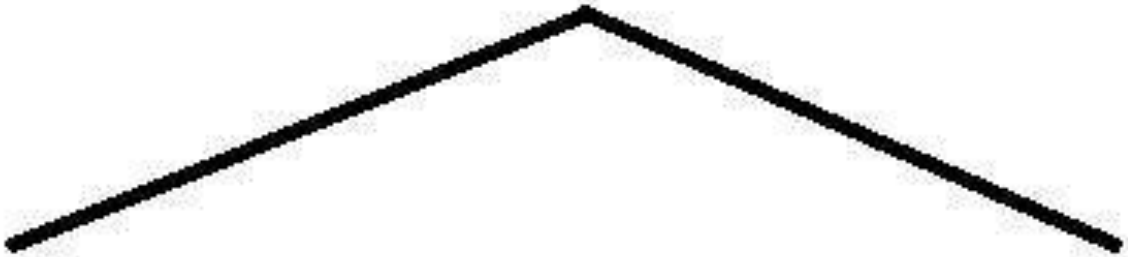
Fracture-dislocation is failure of the anterior, middle, and posterior columns caused by flexion/distraction, shear, or compression forces. Neurologic deficit can result from retropulsion of middle column bone fragments into the spinal canal, or from subluxation causing decreased canal diameter .




Vertebra
Ligament



Denis Classification of Spinal Trauma



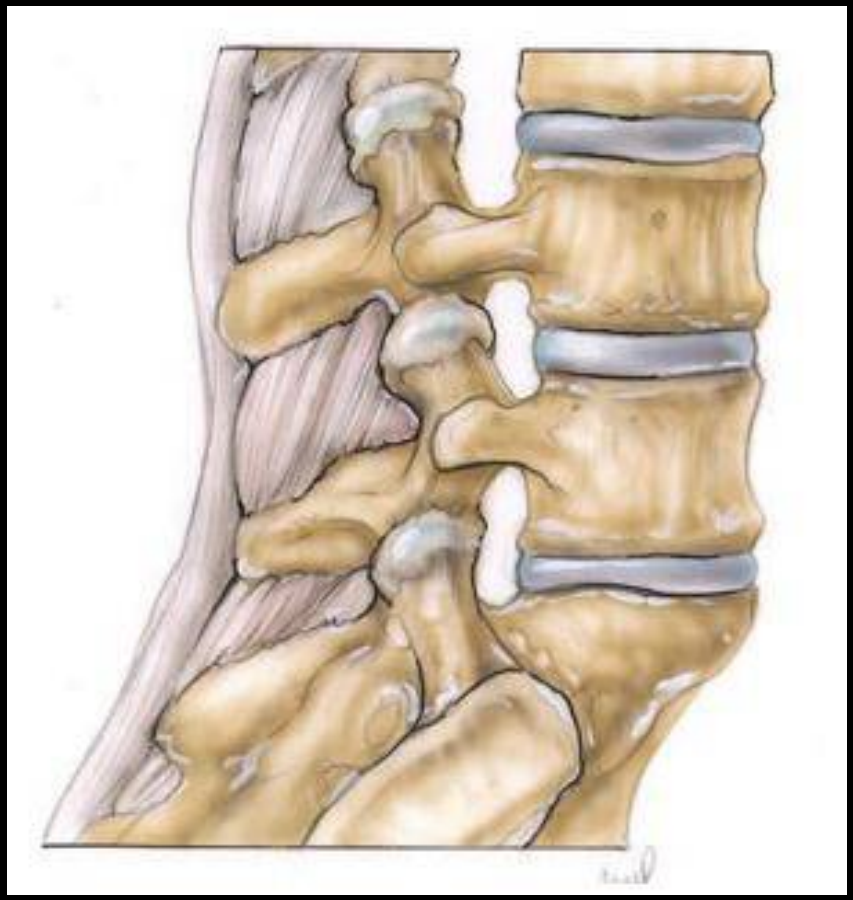
Major Injuries

COMPRESSION
BURST
SEAT-BELT-TYPE
FRACTURE-DISLOCATION

Minor Injuries

transverse processes fx
articular process fx
pars interarticularis fx
spinous process fx

Lumbar Laminectomy



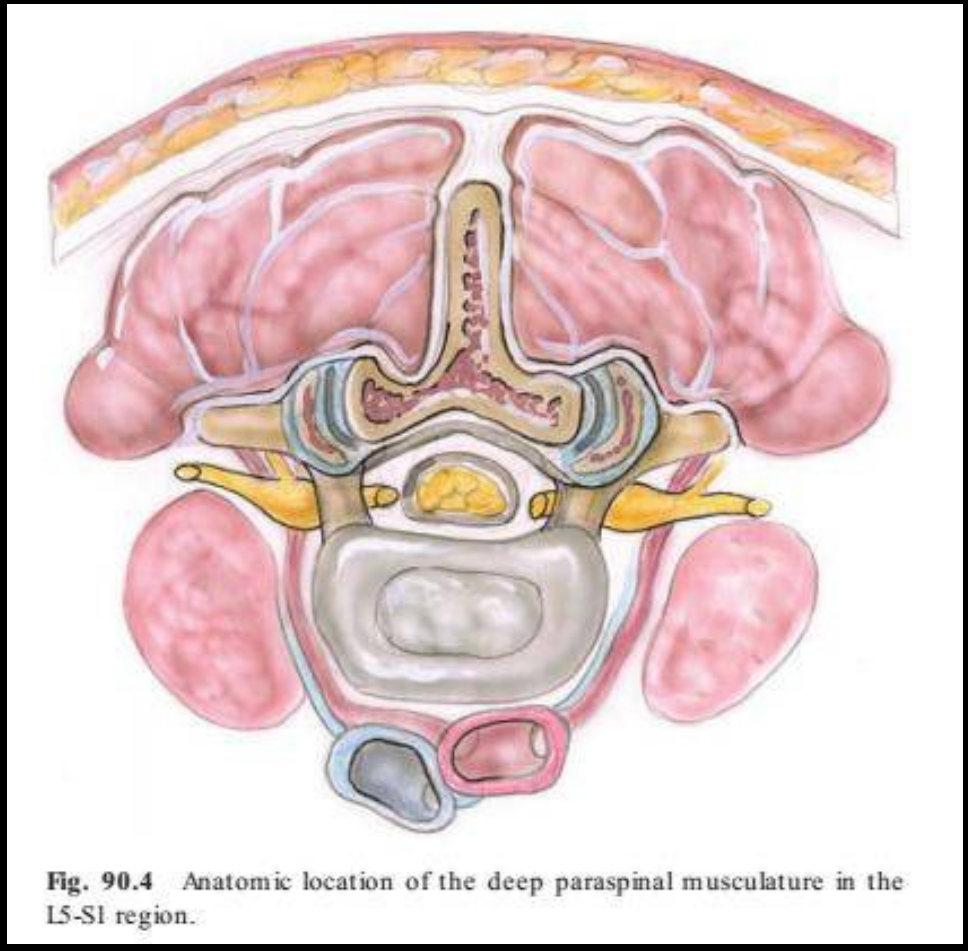


Fig. 90.4 Anatomic location of the deep paraspinal musculature in the L5-S1 region.

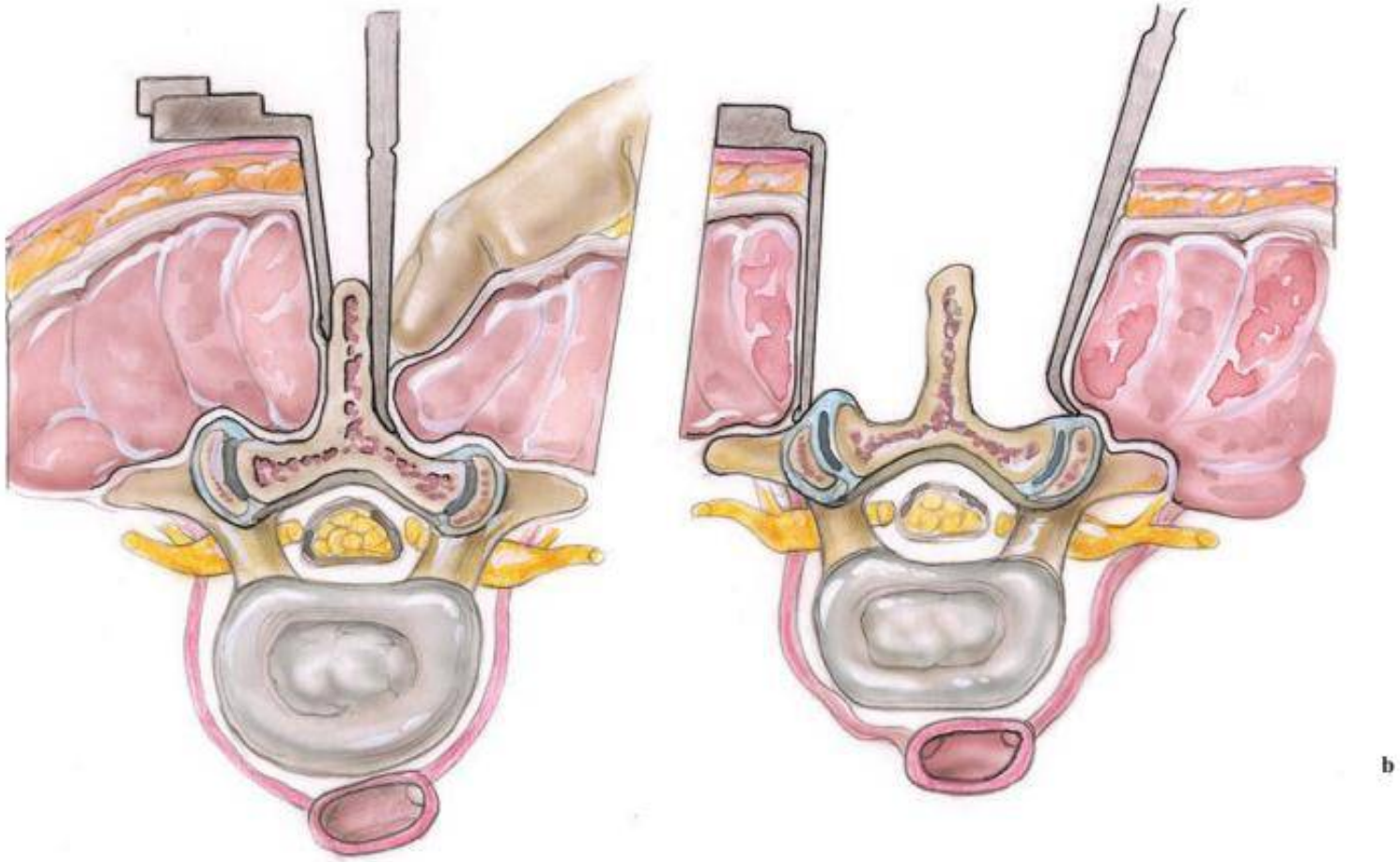


Fig. 90.5 **(a)** The paraspinal muscles are stripped superficial to deep from their attachment locations on the periosteum. **(b)** The laminar attachments are swept from medial to lateral to expose the facet.

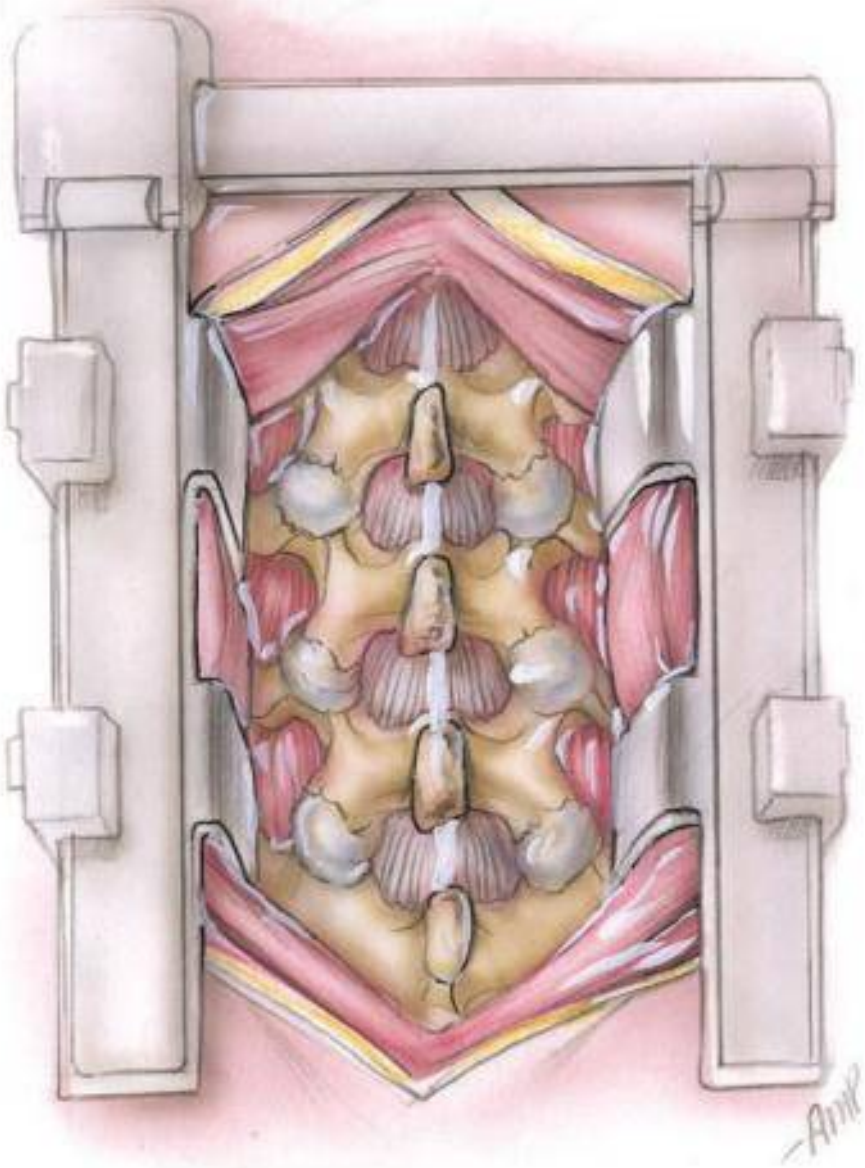
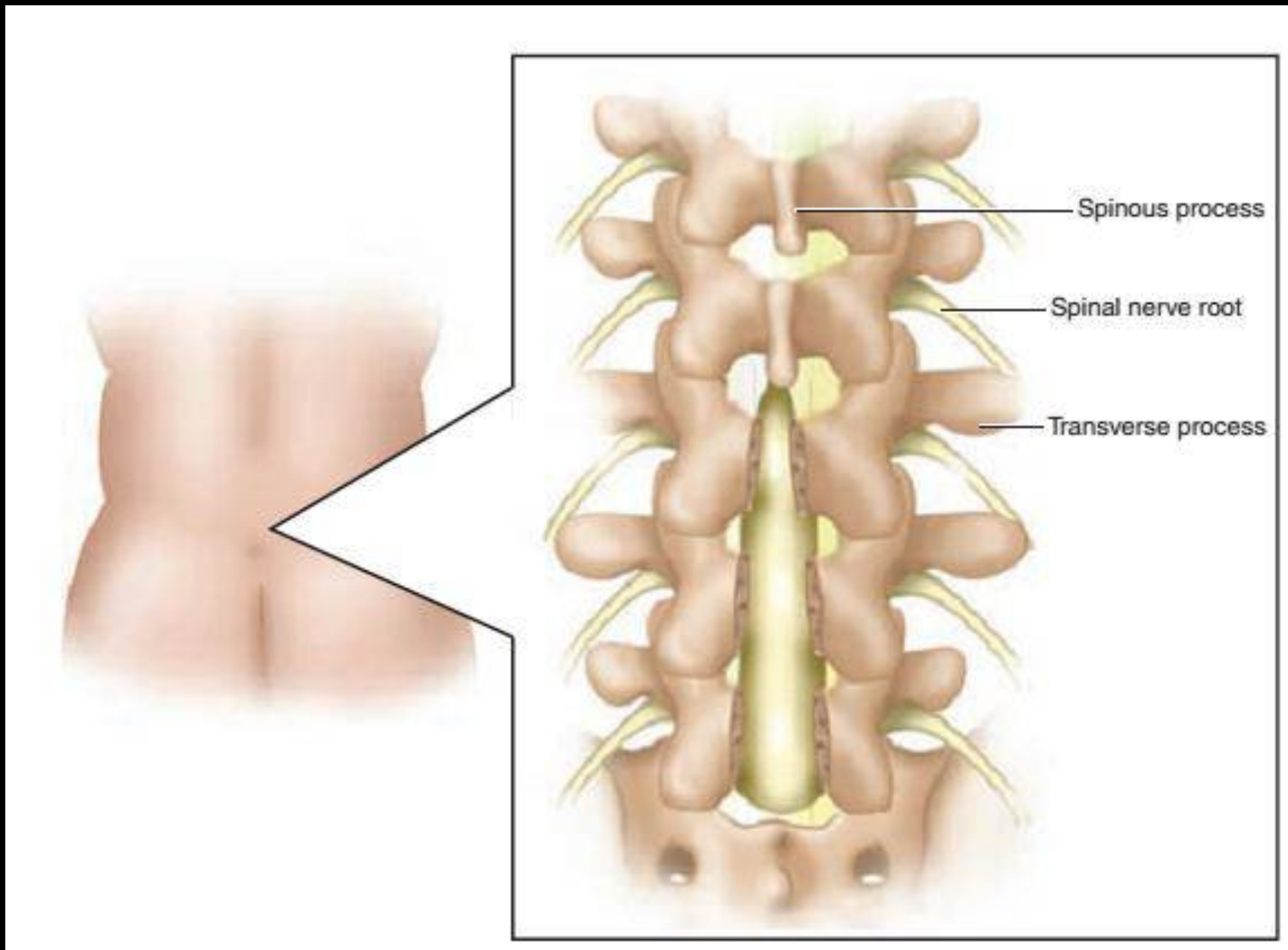


Fig. 90.6 After dissection and retraction of the paraspinal muscles, a full view of the dorsal aspect of the lumbar spine is available.


Spinous process
Spinal nerve root
Transverse process

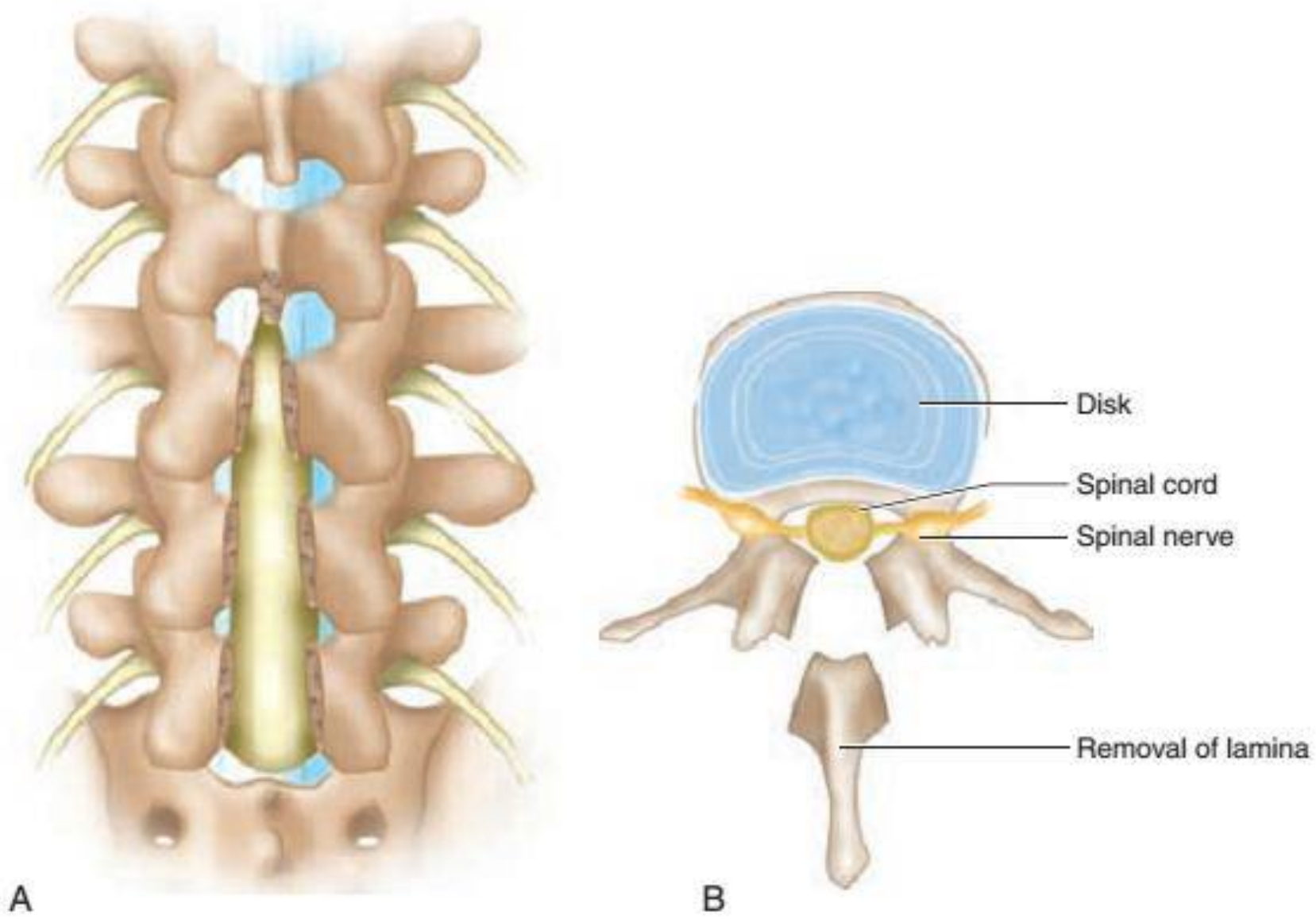
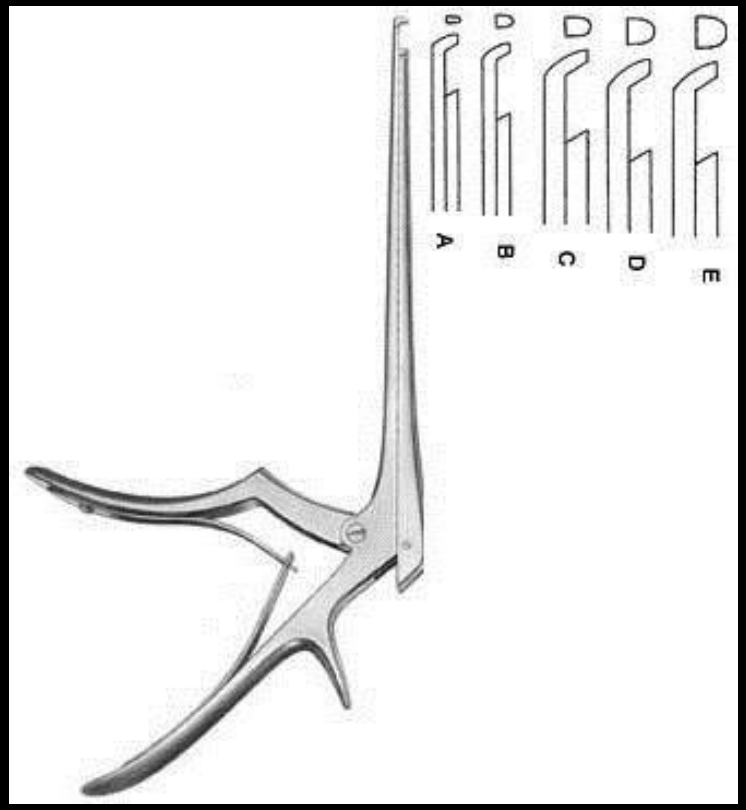
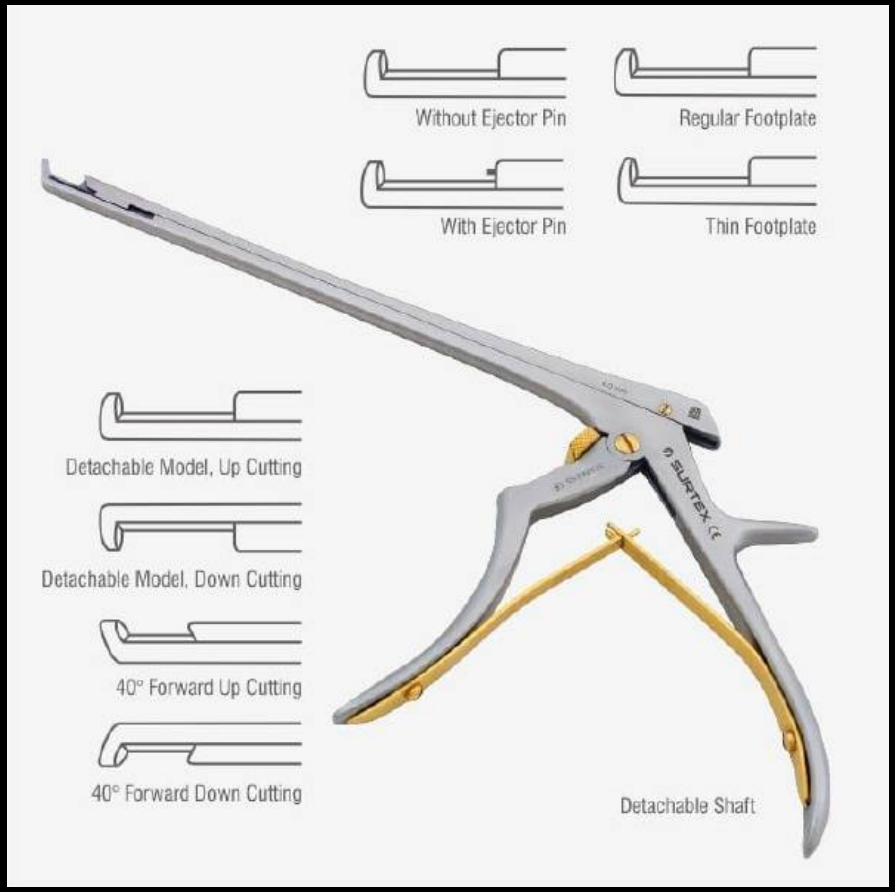


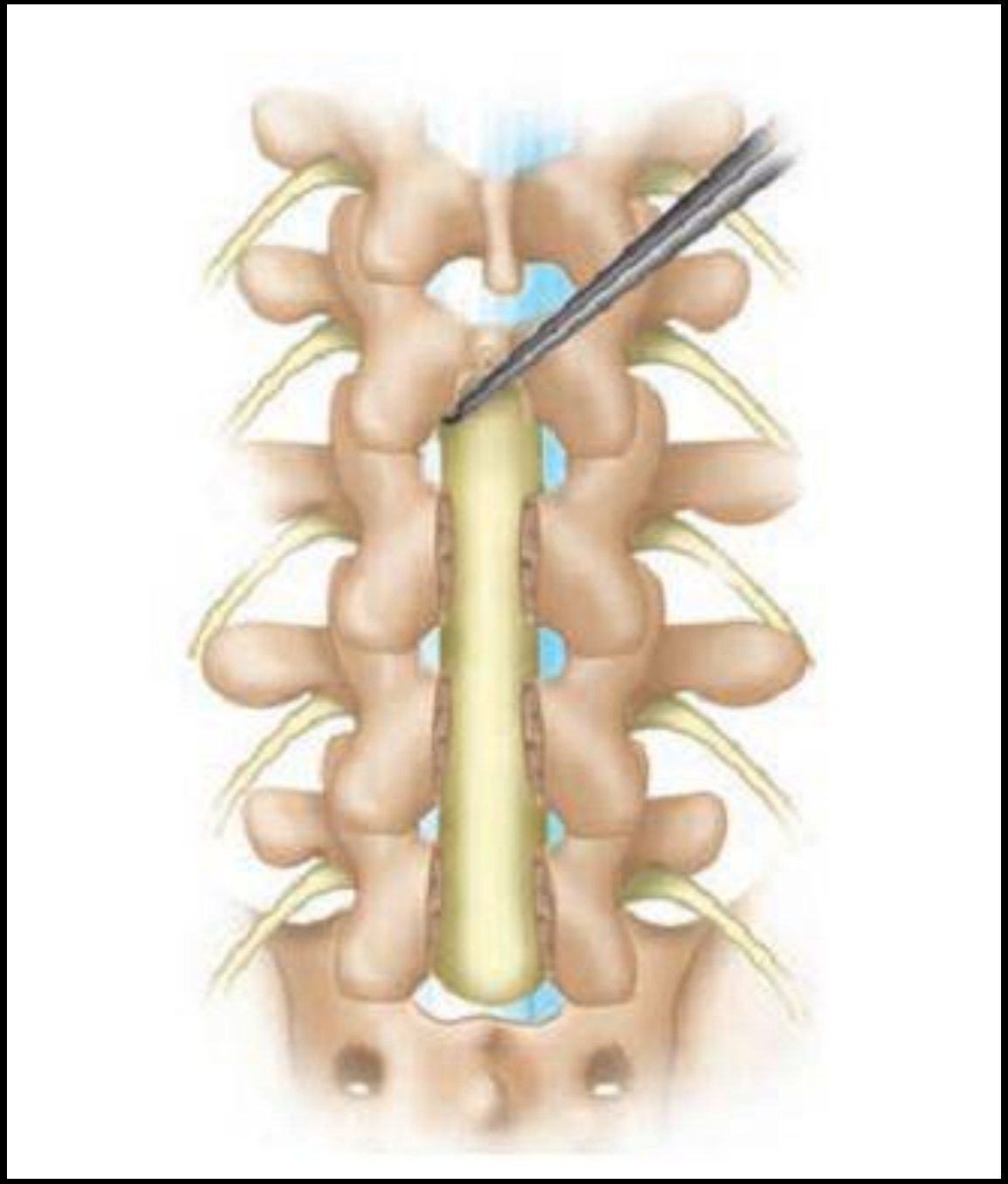
FIGURE 70-3

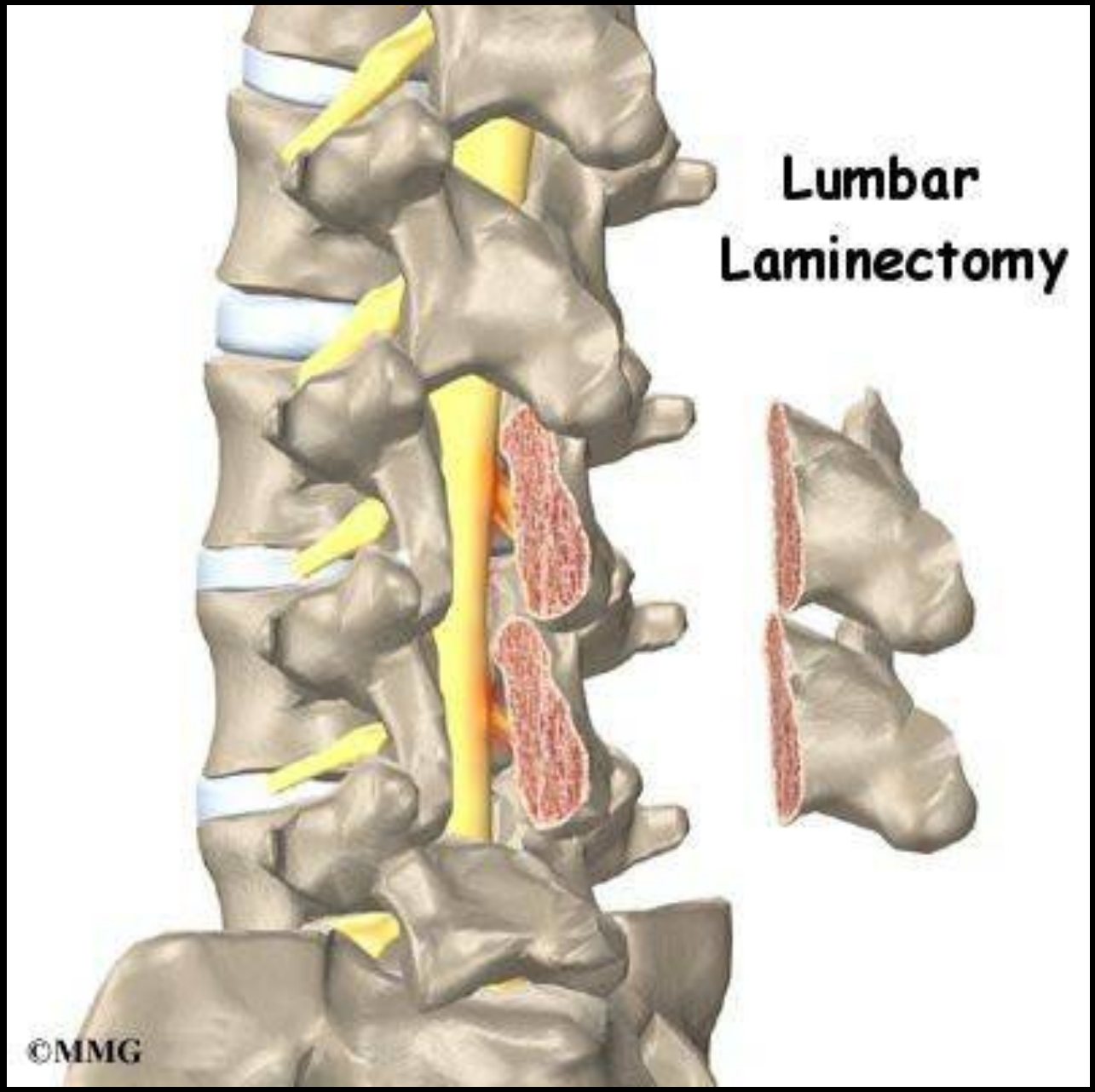
Kerrison Punch

Kerrison punch is surgical instrument surgeons may use and is designed to cut bones. The hard metal surface has a sharp notched end that allows smooth cuts during spinal or neurosurgery.

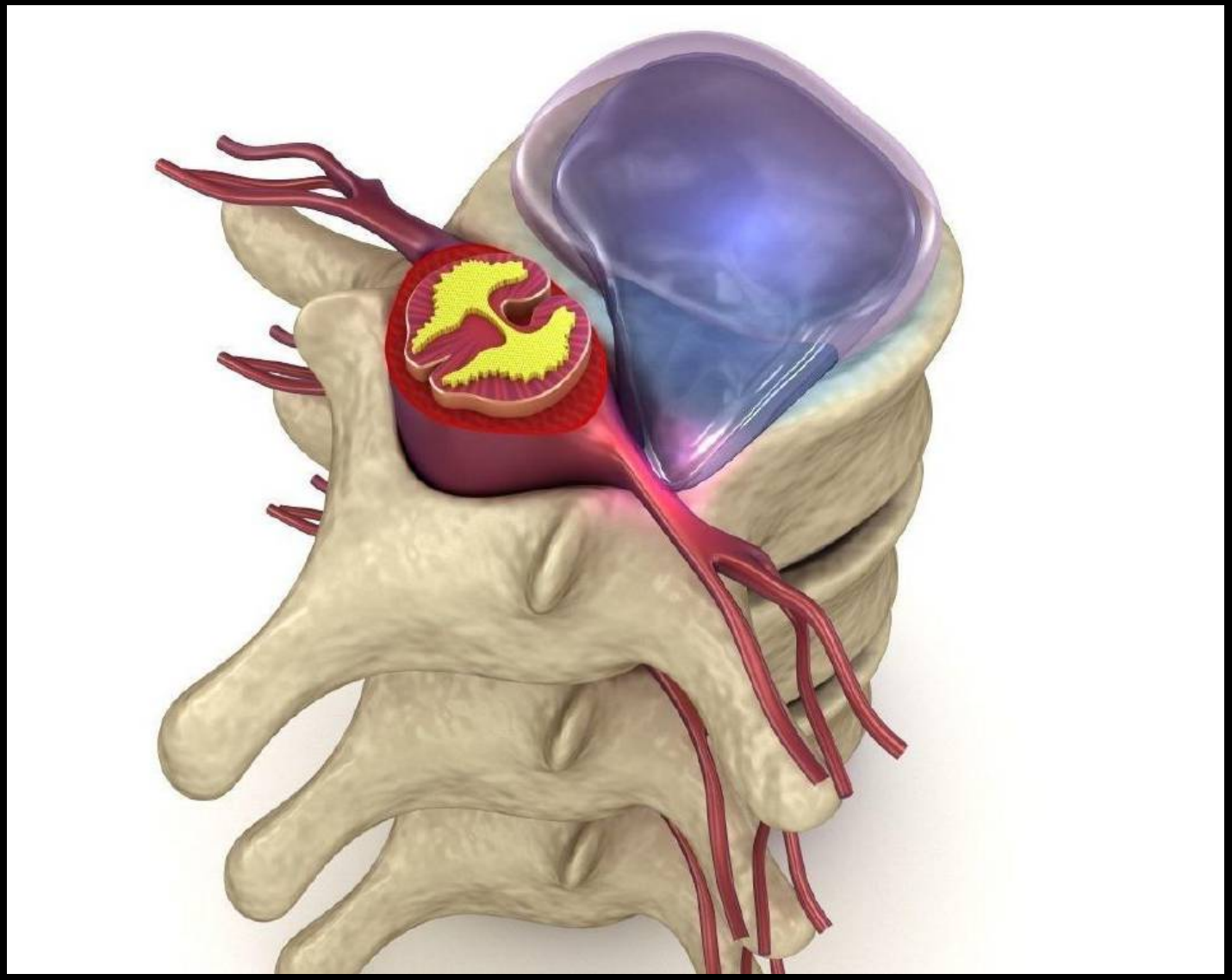


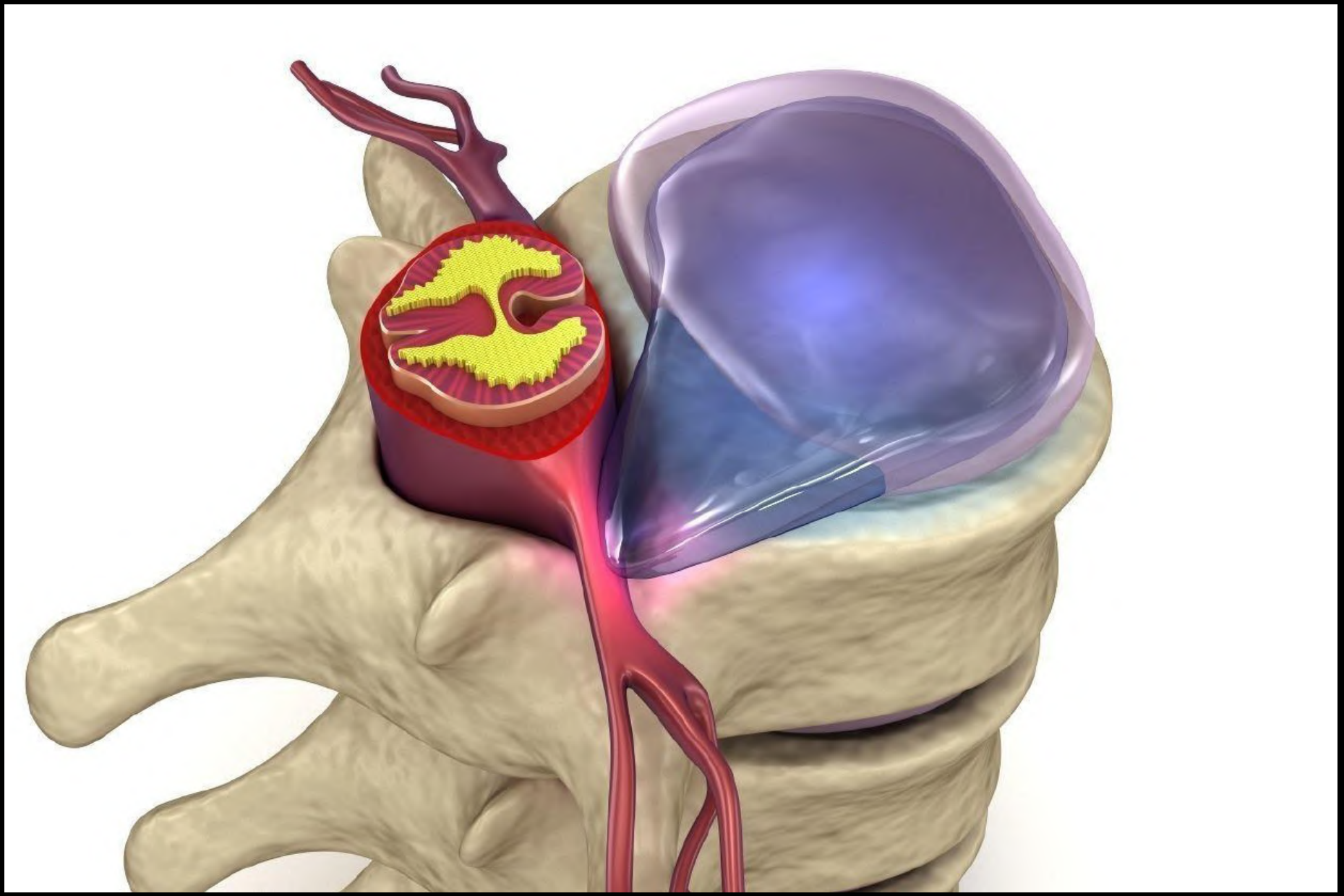


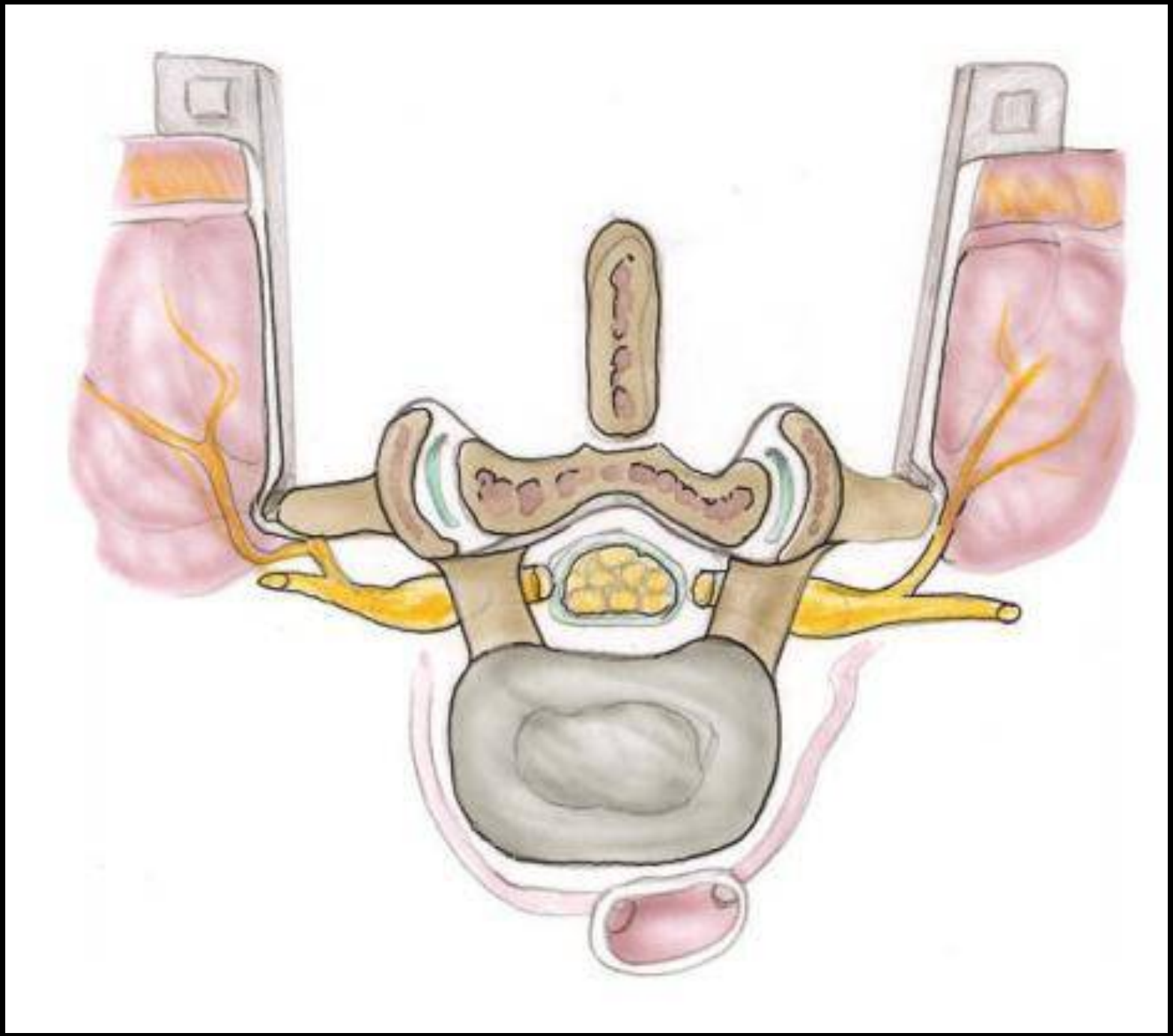


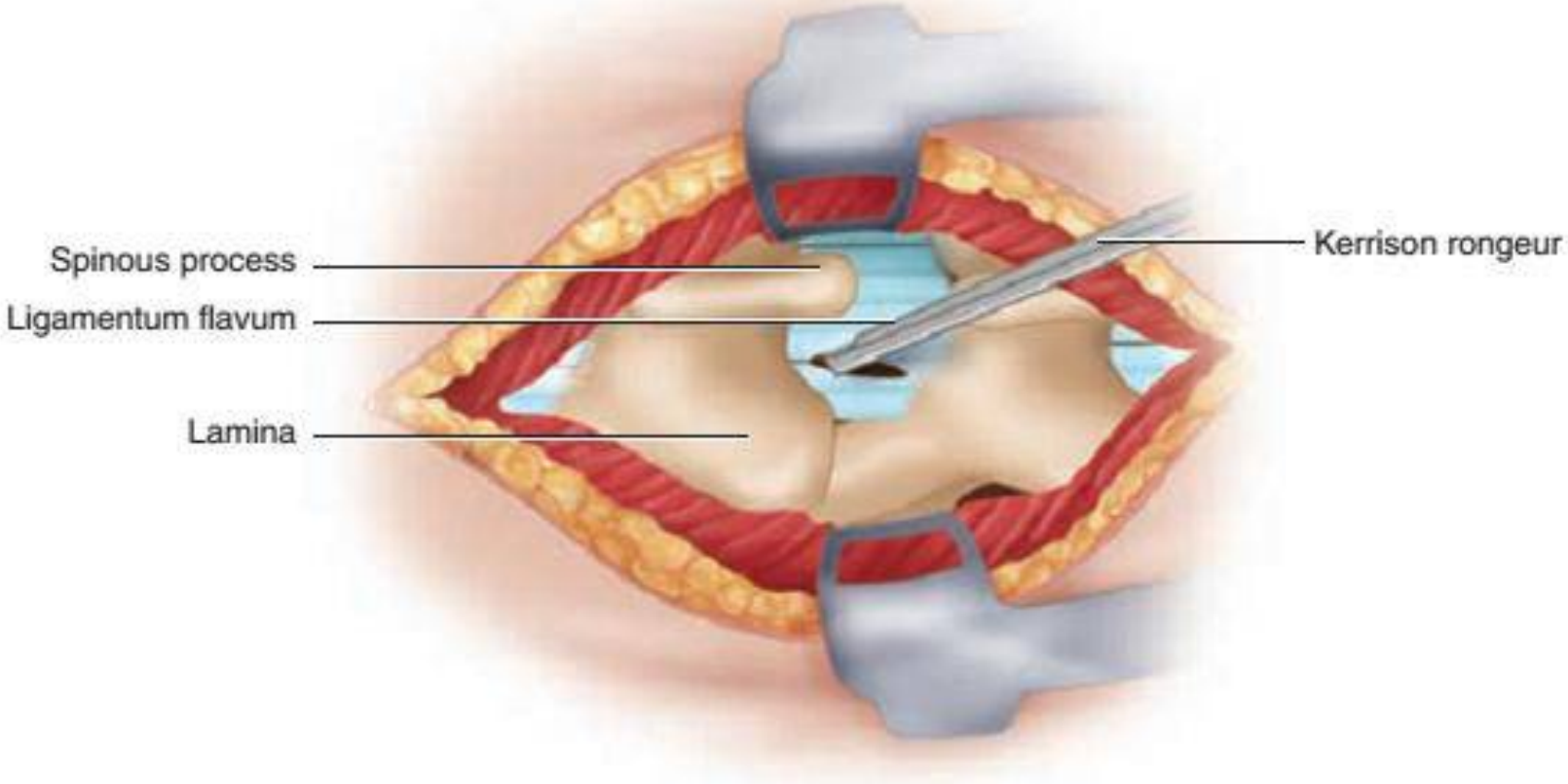

Lumbar
Laminectomy
©MMG

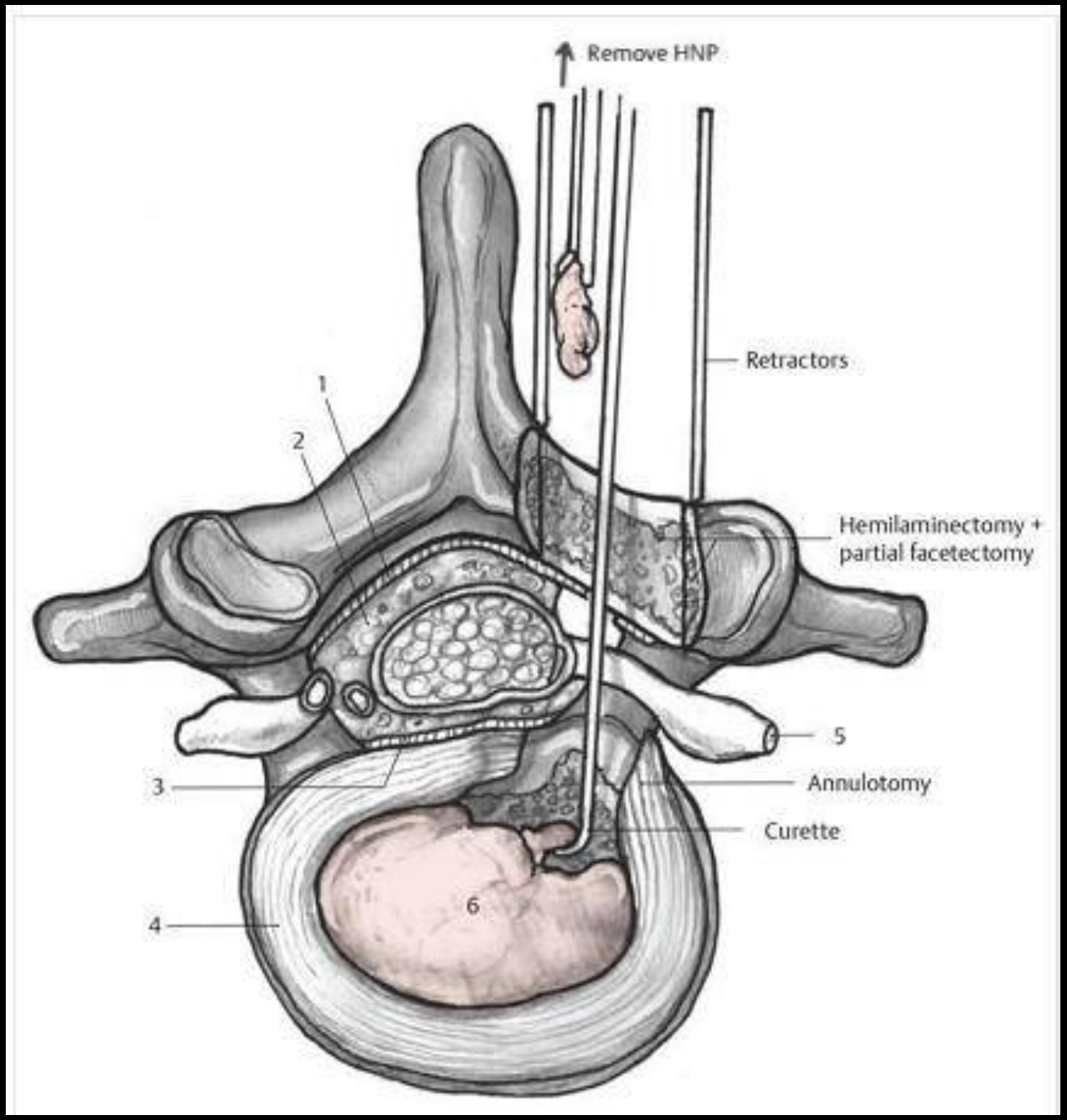
Lumbar Diskectomy

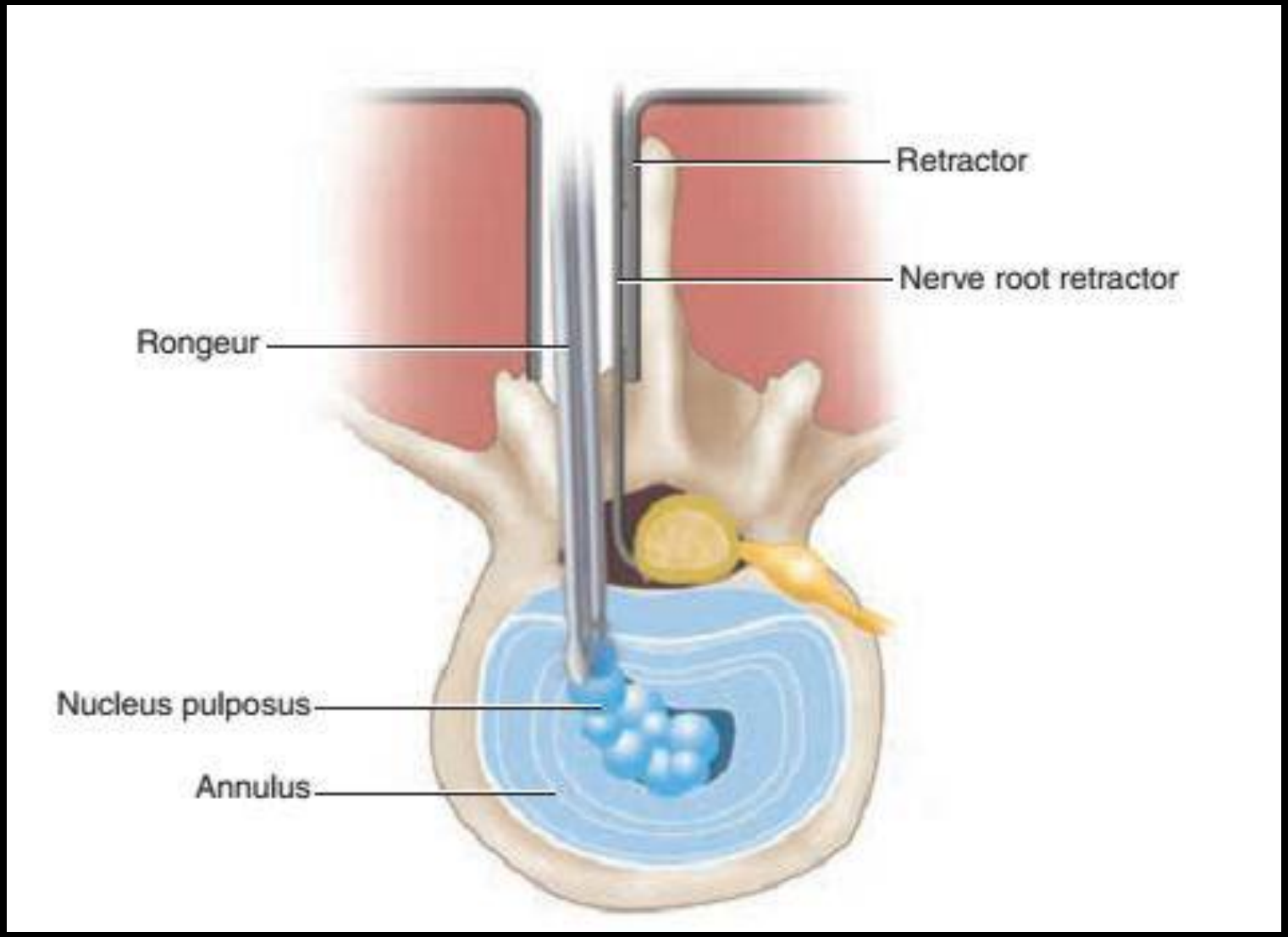




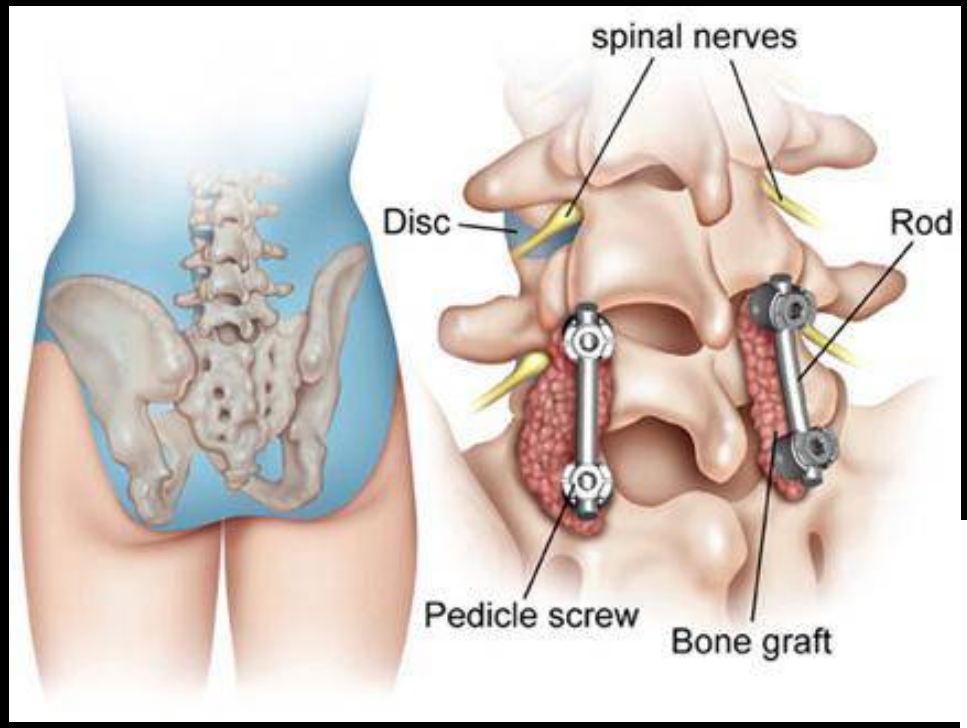


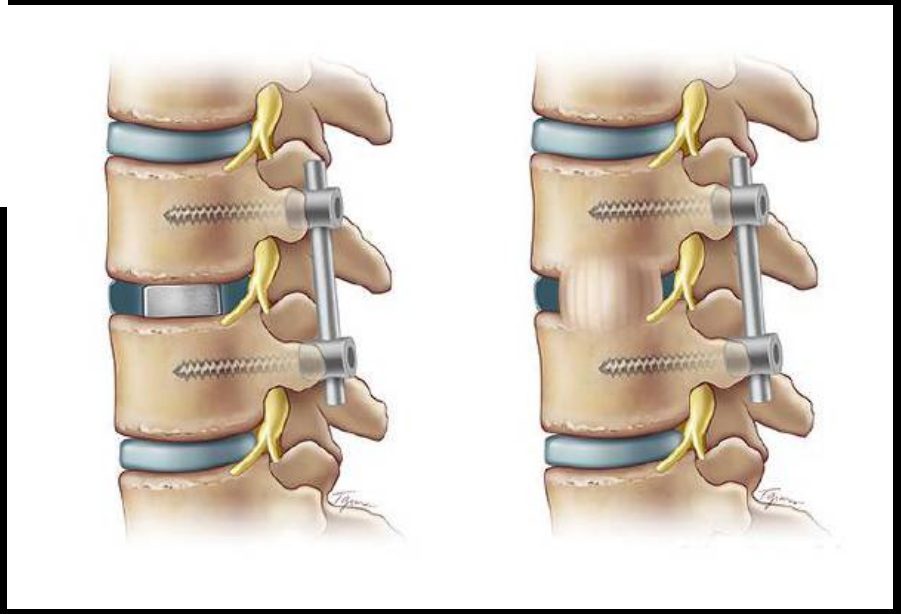

Spinous process
Ligamentum flavum
Lamina
Kerrison rongeur

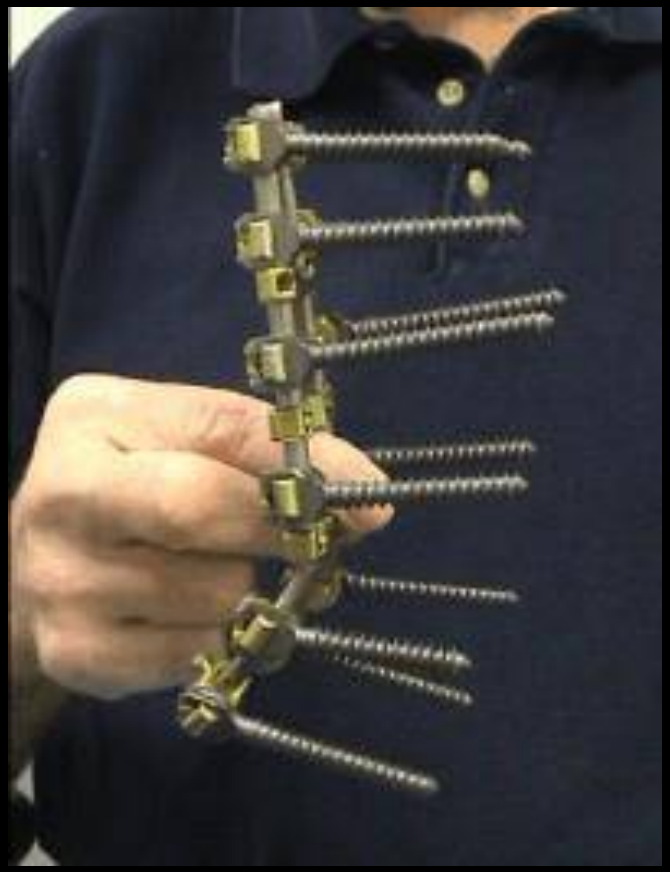

Remove HNP
Retractors
1
2
Hemilaminectomy +
partial facetectomy
5
3
Annulotomy
Curette
6
4

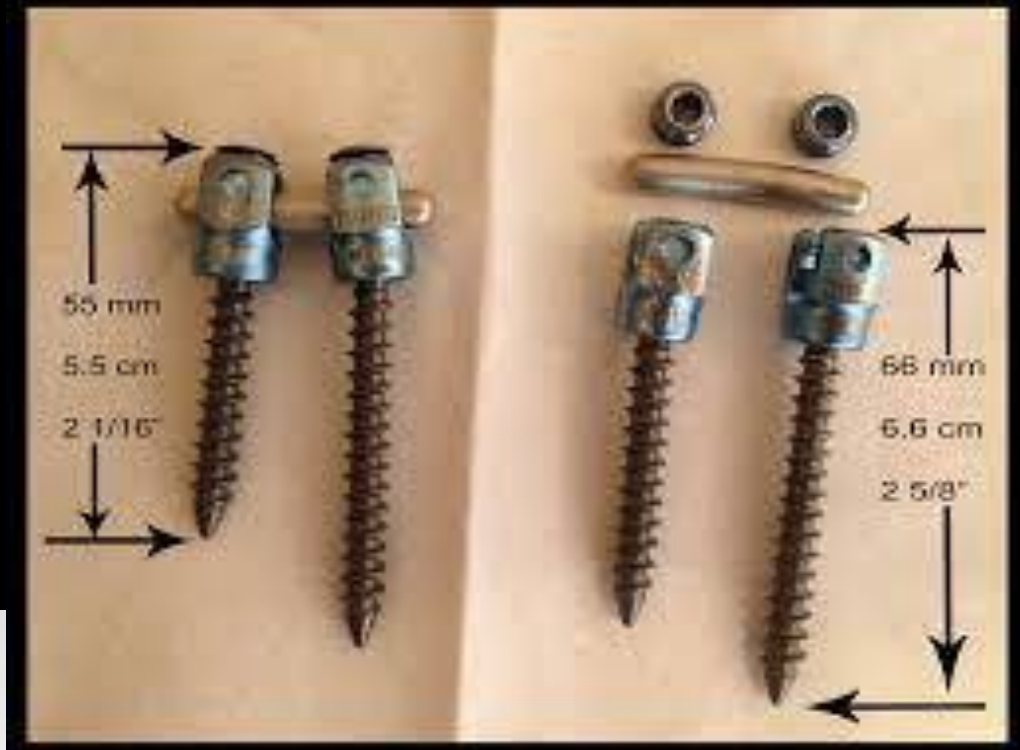

Retractor
Nerve root retractor
Rongeur
Nucleus pulposus
Annulus

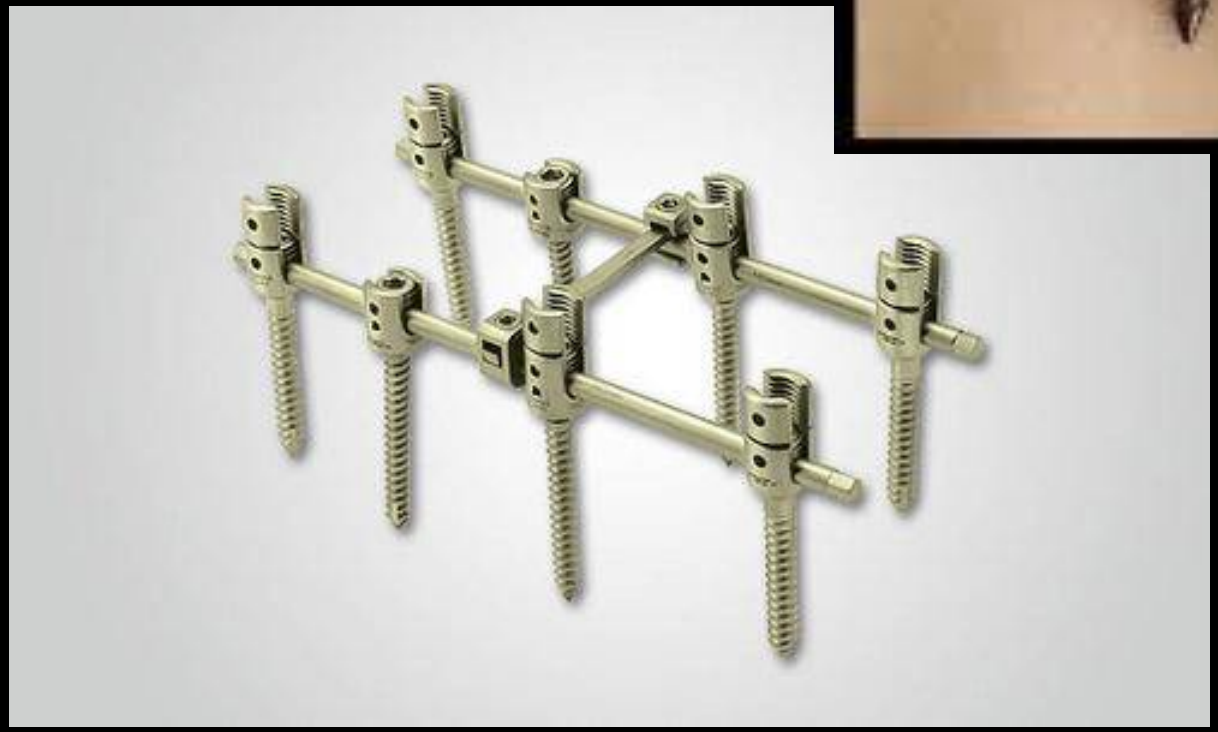
lumbar Pedicle Screw Placement

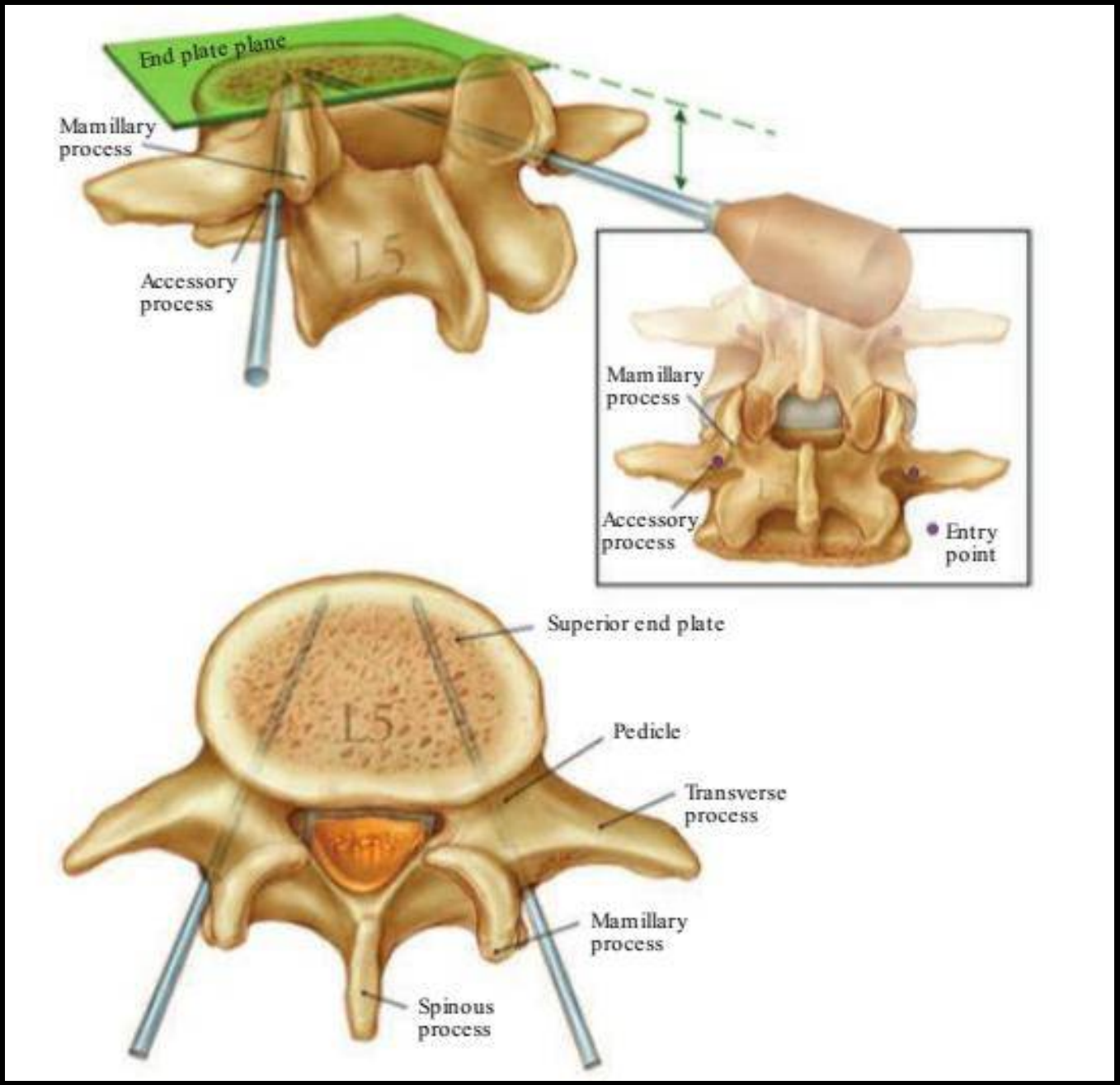


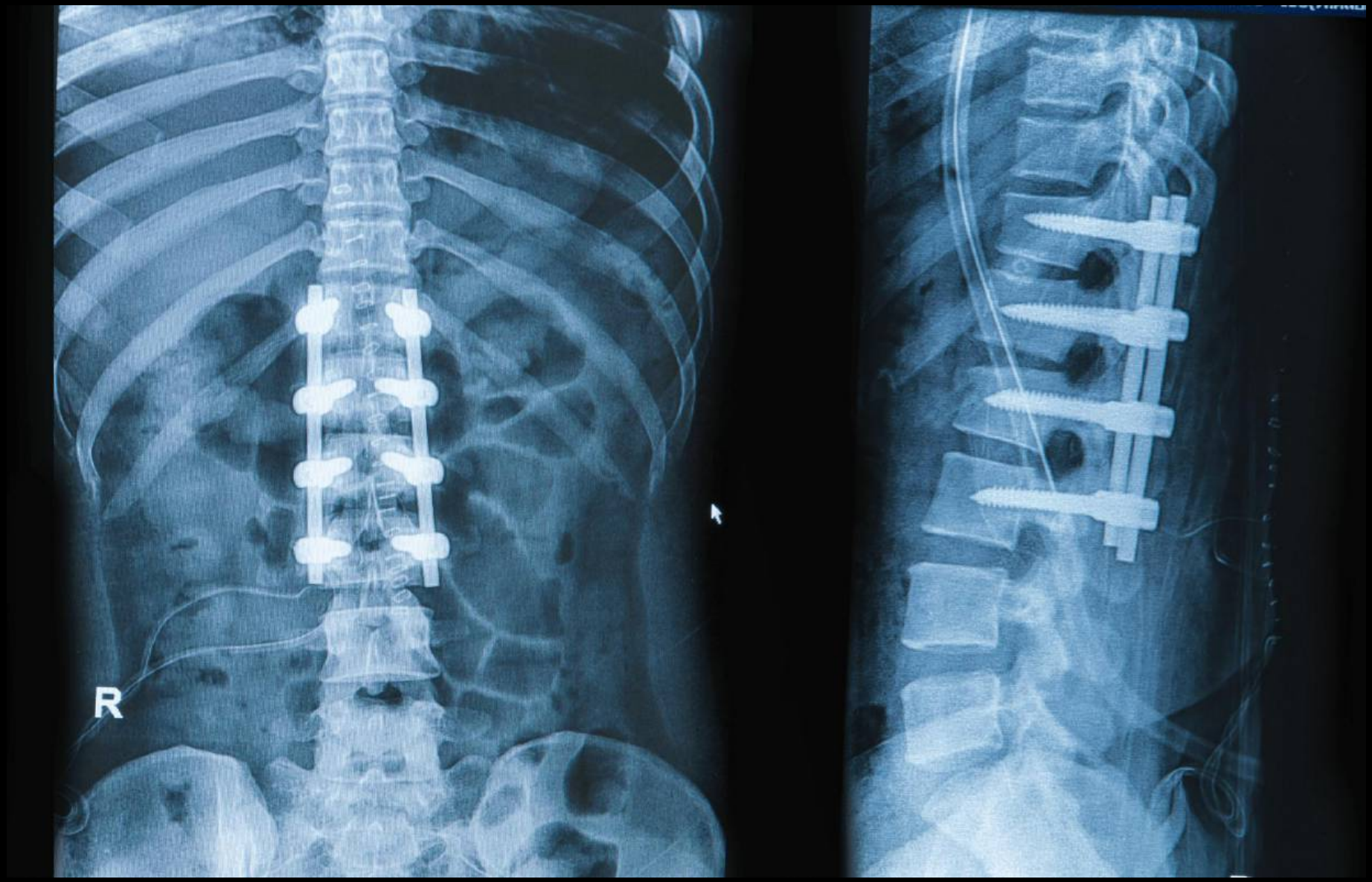


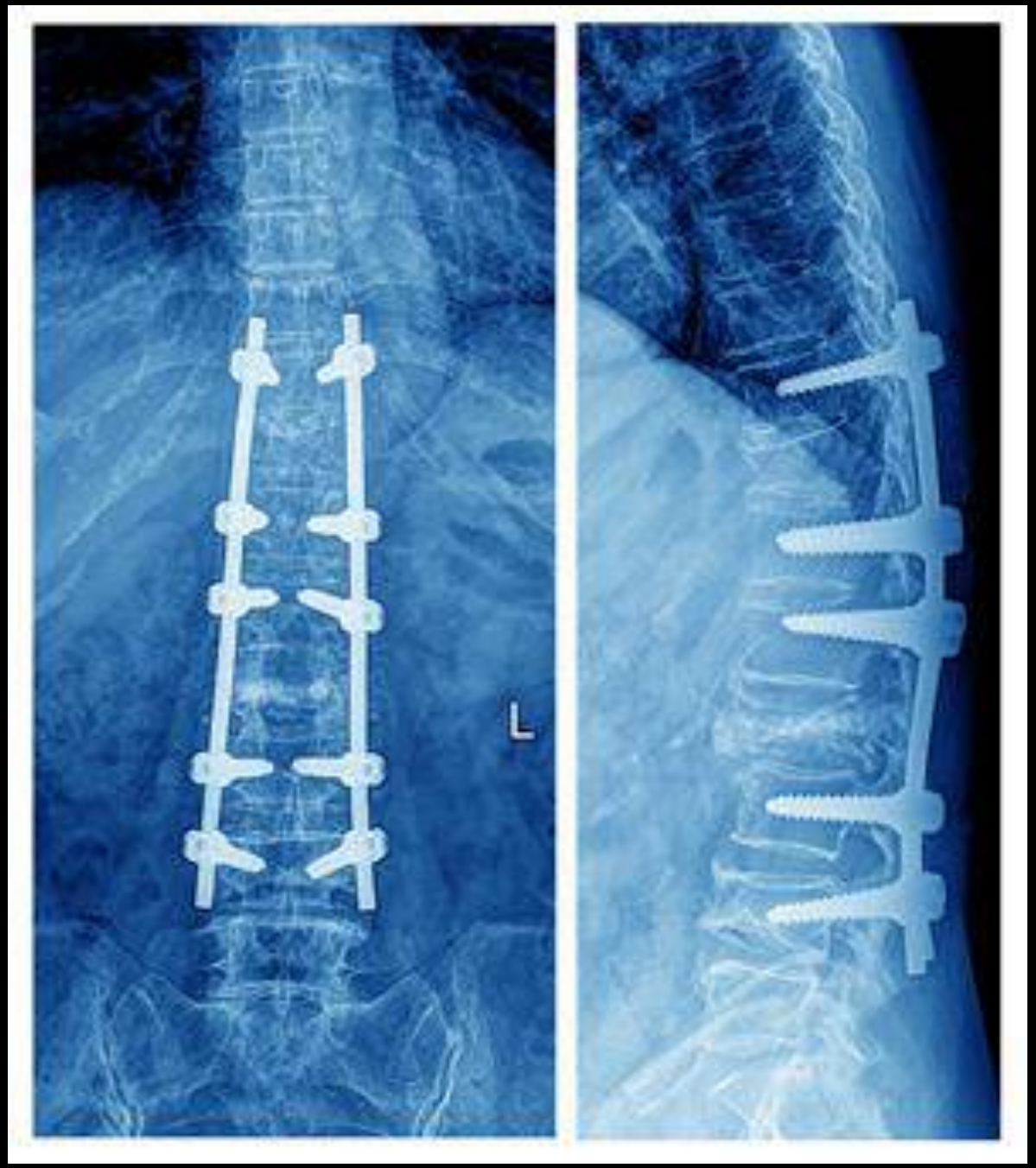



55 mm
5.5 cm
2 1/16"
66 mm
6.6 cm
2 5/8"




End plate plane
Mamillary process
Accessory process
L5
Mamillary process
Accessory process
Entry point
Superior end plate
L5
Pedicle
Transverse process
Mamillary process
Spinous process


R


L

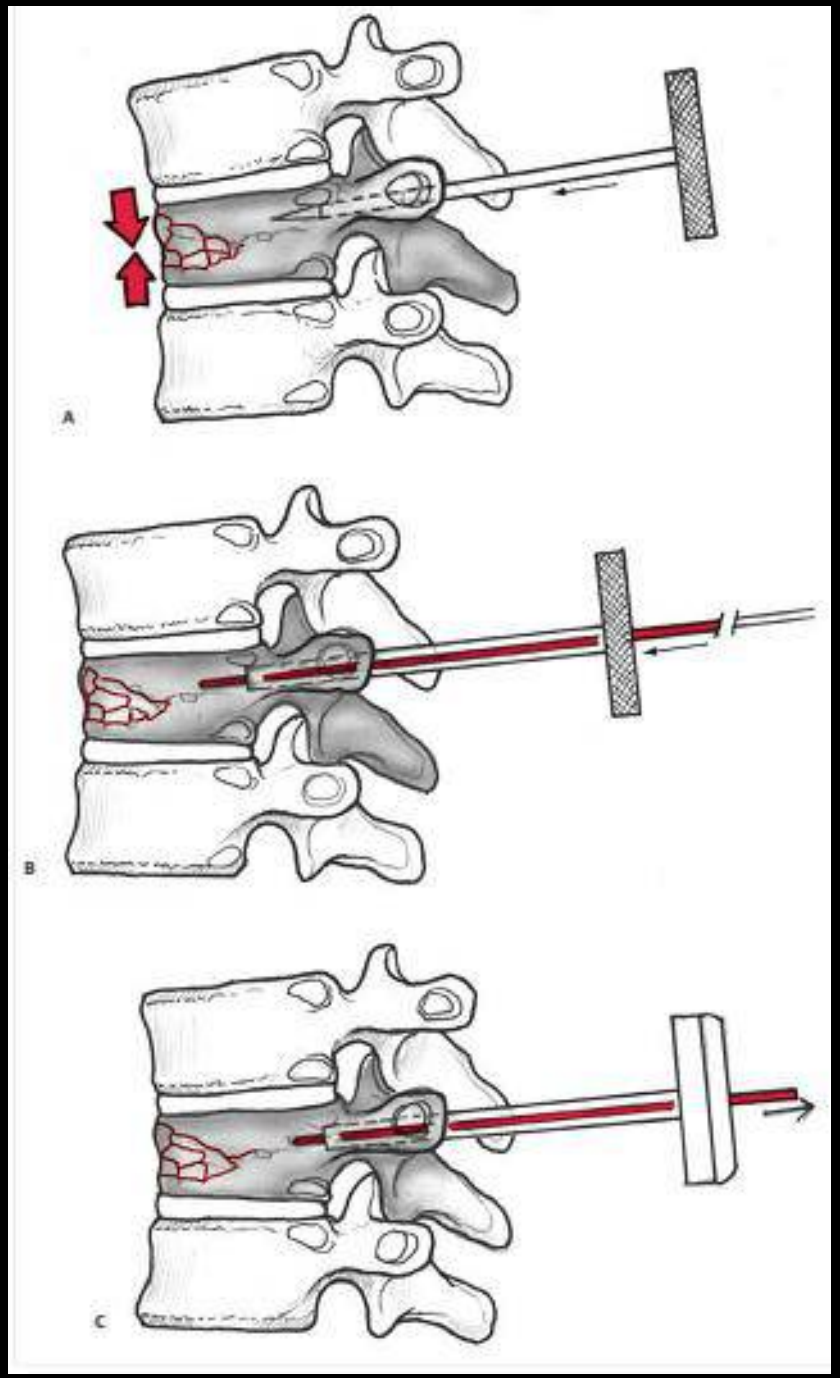
Vertebroplasty

Summary of the key steps of the vertebroplasty procedure.

(A) Step 1: In troduction of the Jamshidi needle in to the pedicle. Note the compression fracture in red with arrows indicating vector of compression.

(B) Step 2: Guidewire placement (or biopsy needle) through Jamshidi needle.

(C) Ste p 3: Placement of working channel and insertion of cement at the level of the fracture.



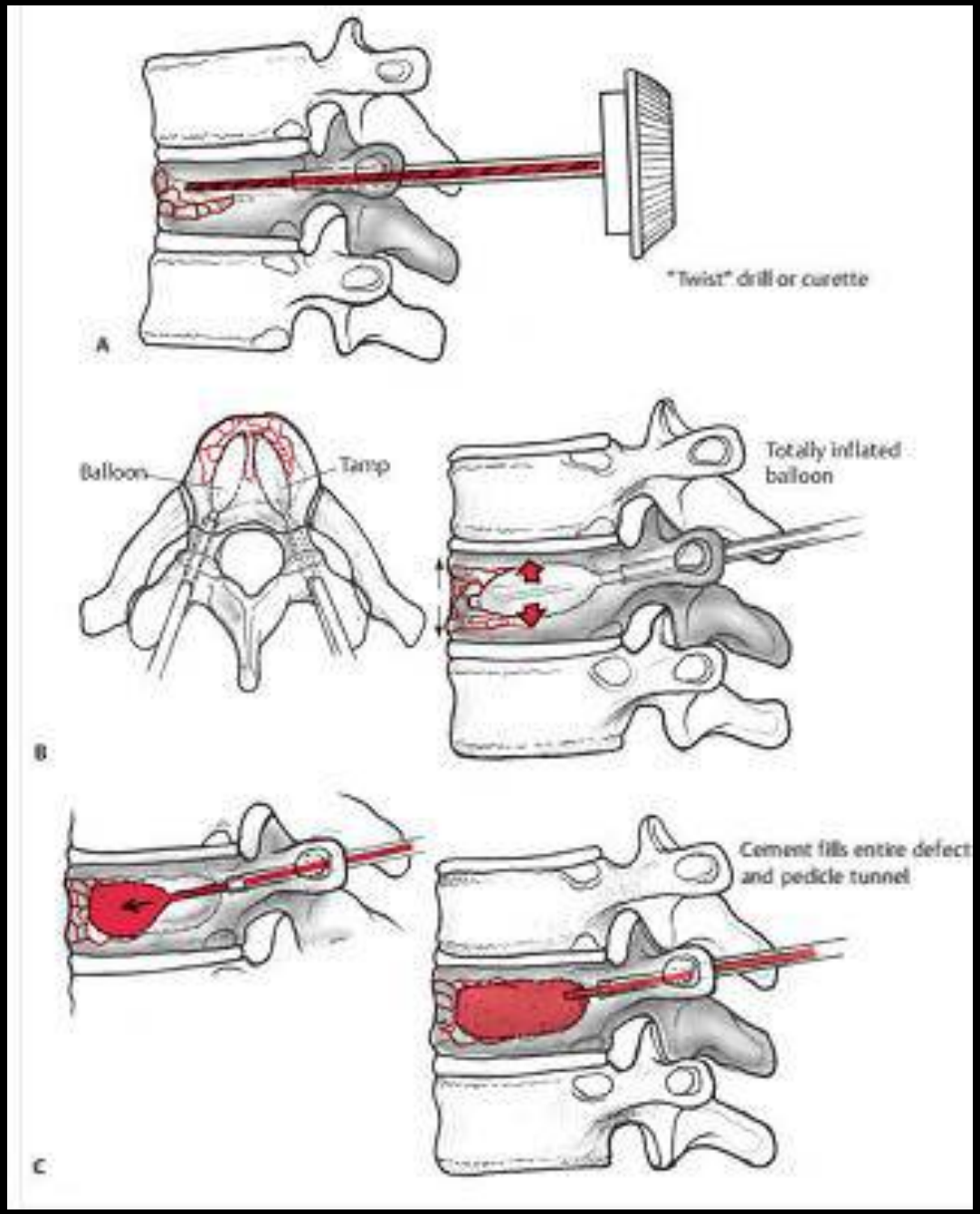
kyphoplasty

Summary of the key steps of the kyphoplasty procedure.

(A) Specially designed curette introduced through the working cannula to score the bone in the region.

(B) In troduction of kyphoplasty balloons bilaterally with balloon inflation and height restoration.

(C) Partial then full injection of cement in to vertebral body cavity that has been created after balloon inflation.



Cervical Laminectomy

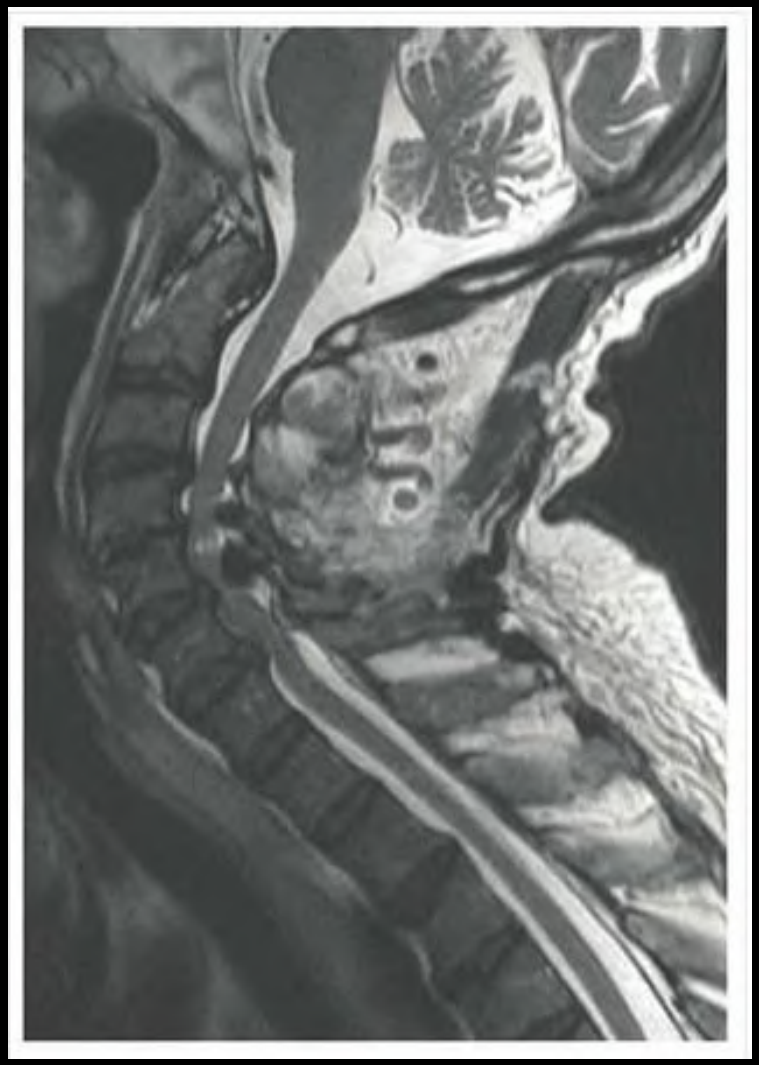


FIGURE 61-1

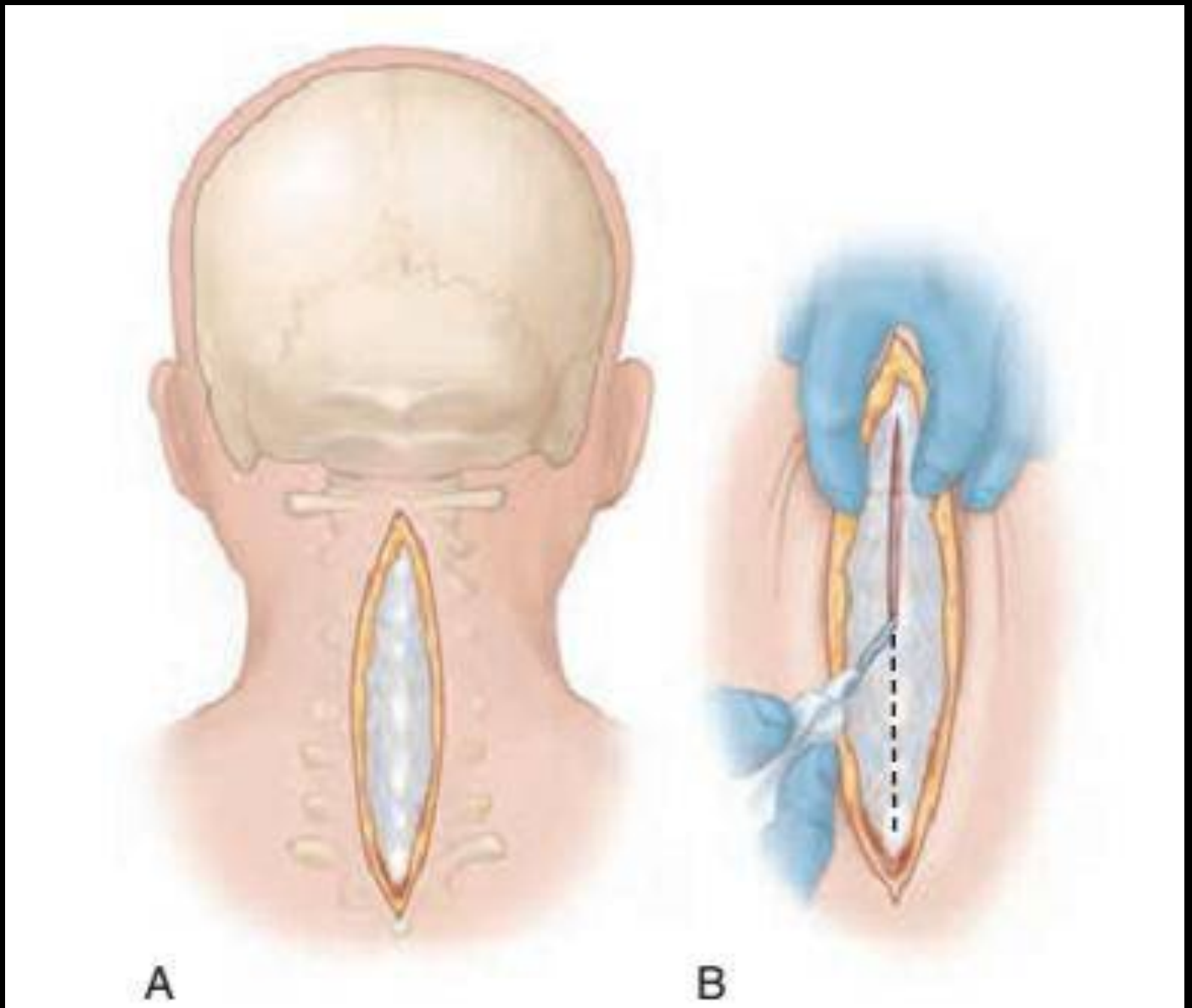
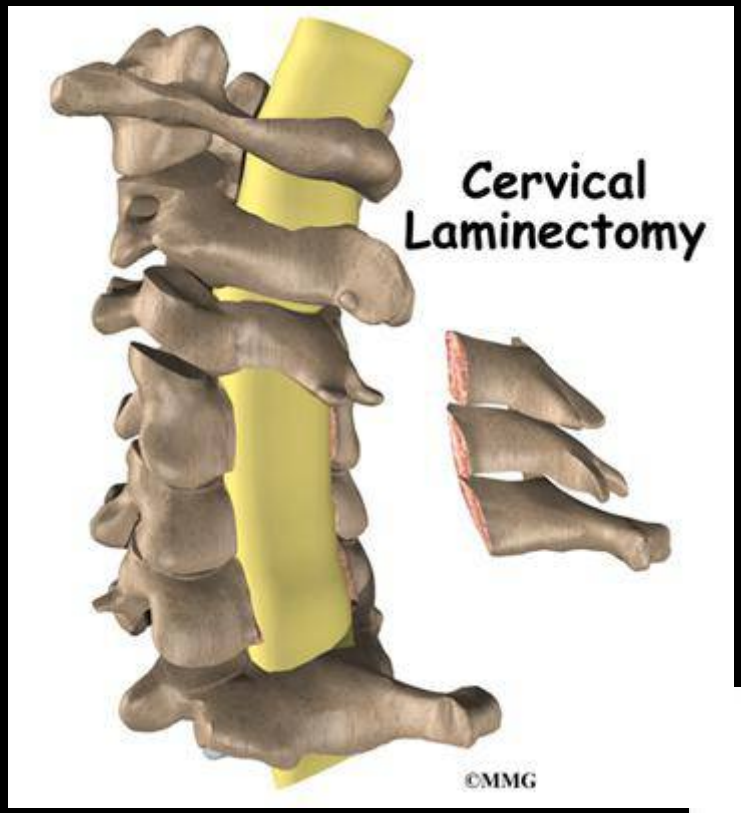
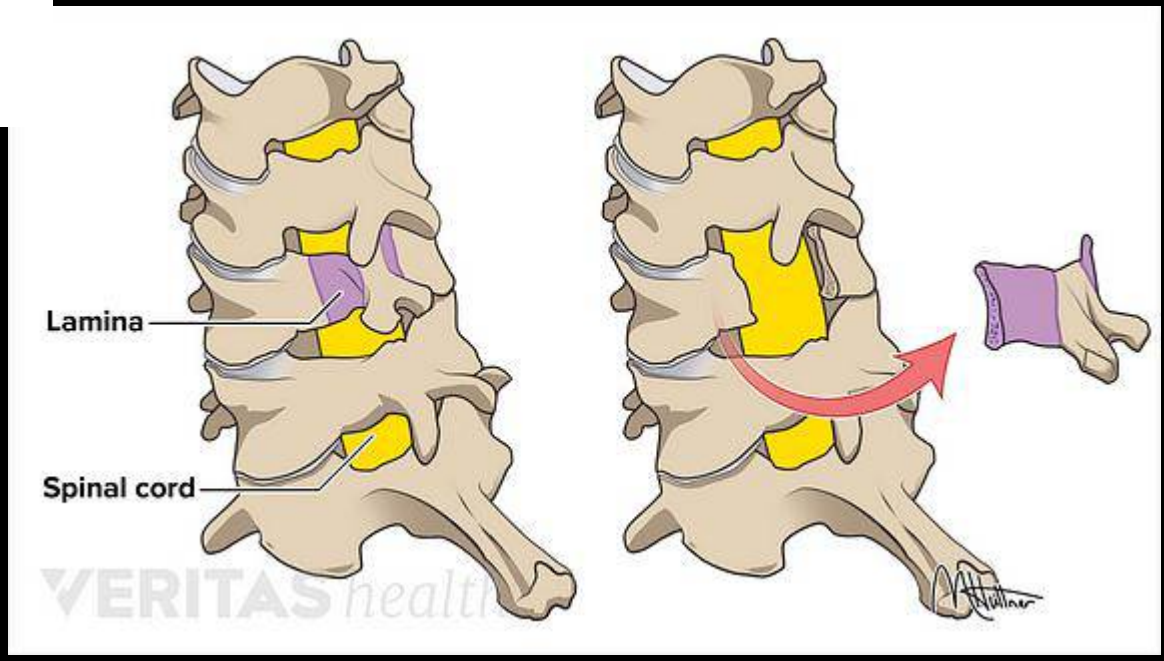
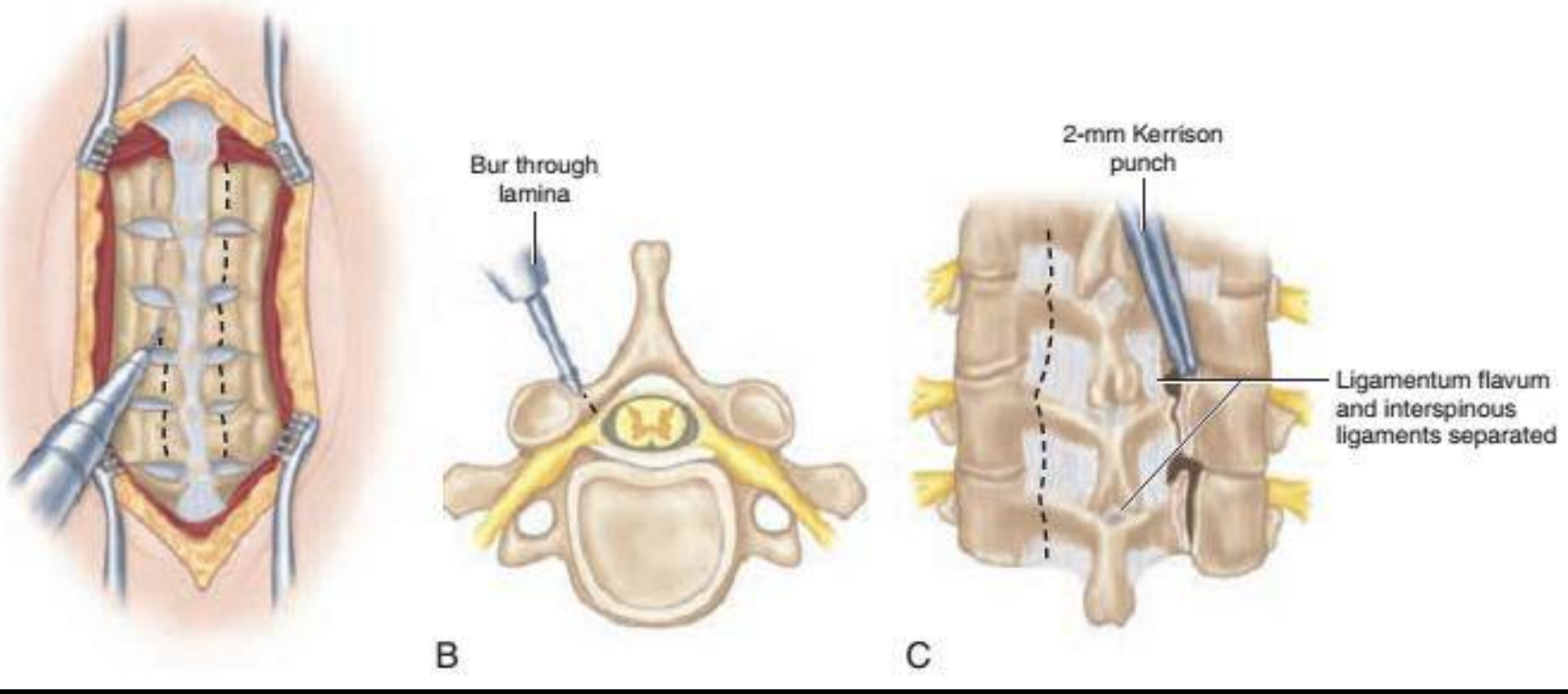
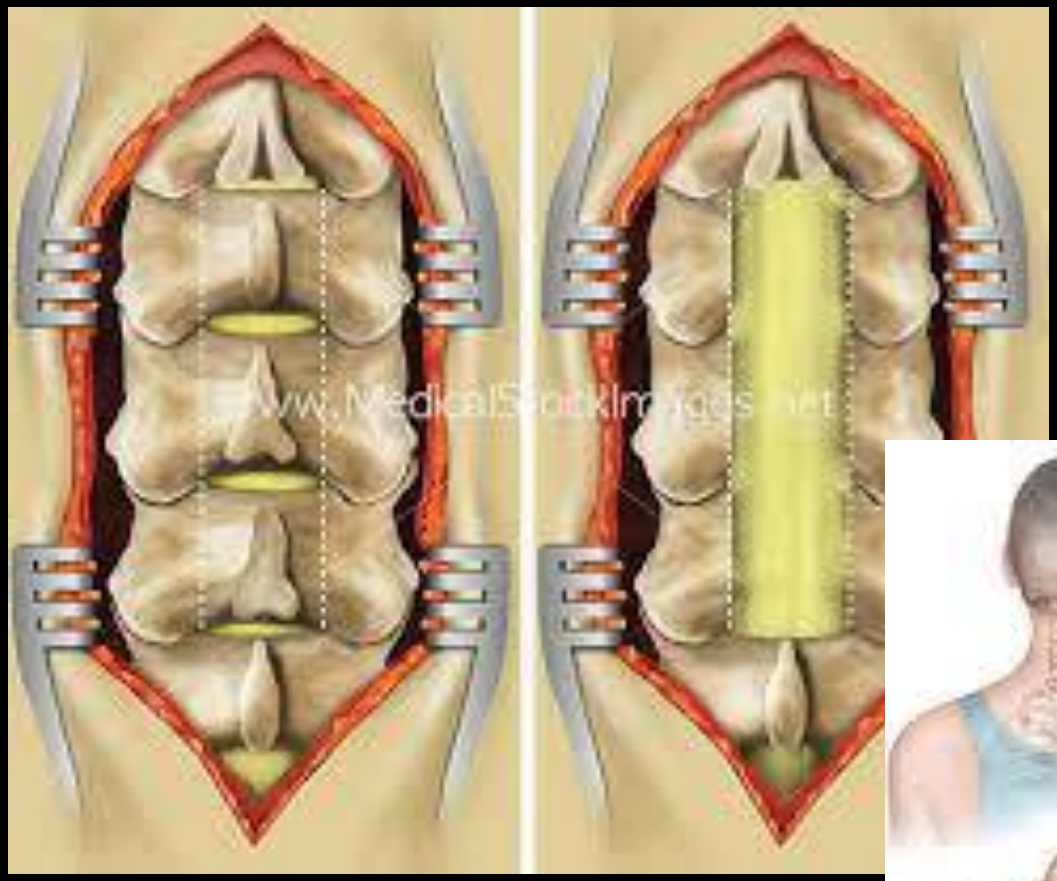


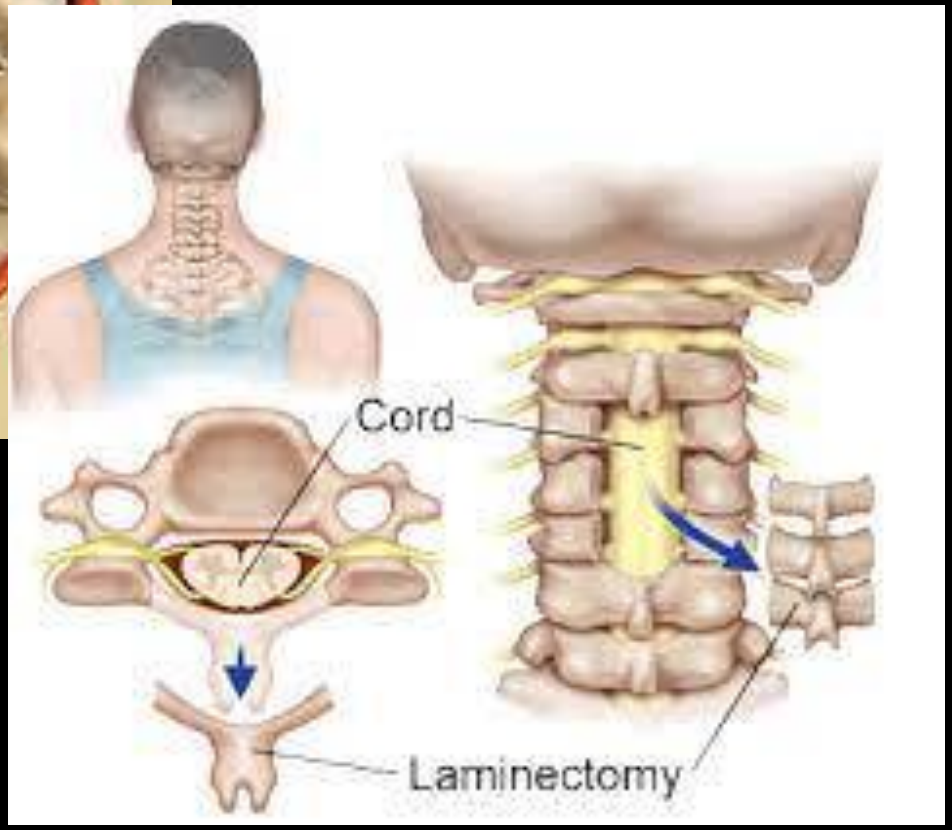
FIGURE 61-2


Cervical
Laminectomy
©MMG


Lamina
Spinal cord


Bur through lamina
2-mm Kerrison punch
Ligamentum flavum and interspinous ligaments separated
A
B
C




Cord
Laminectomy

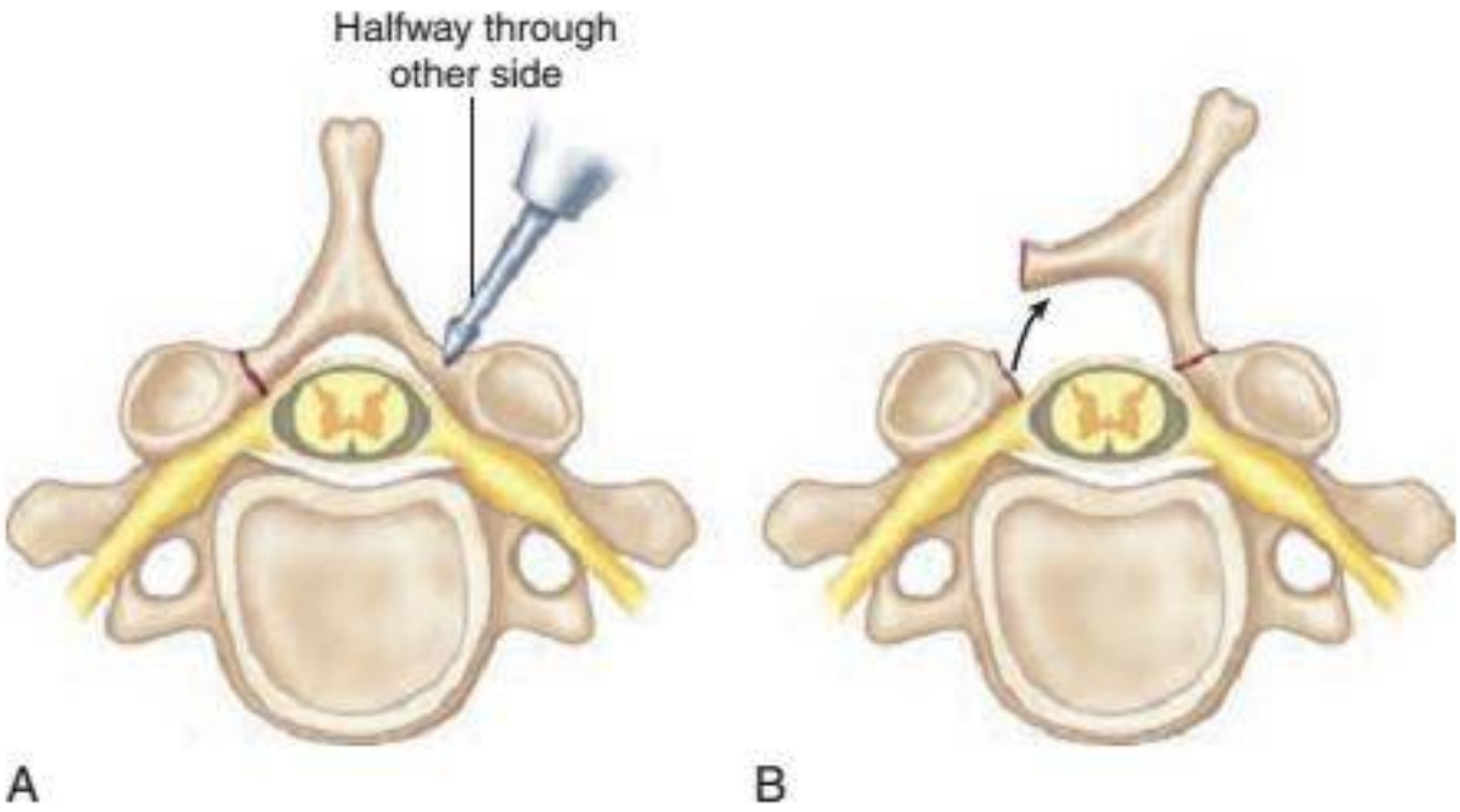
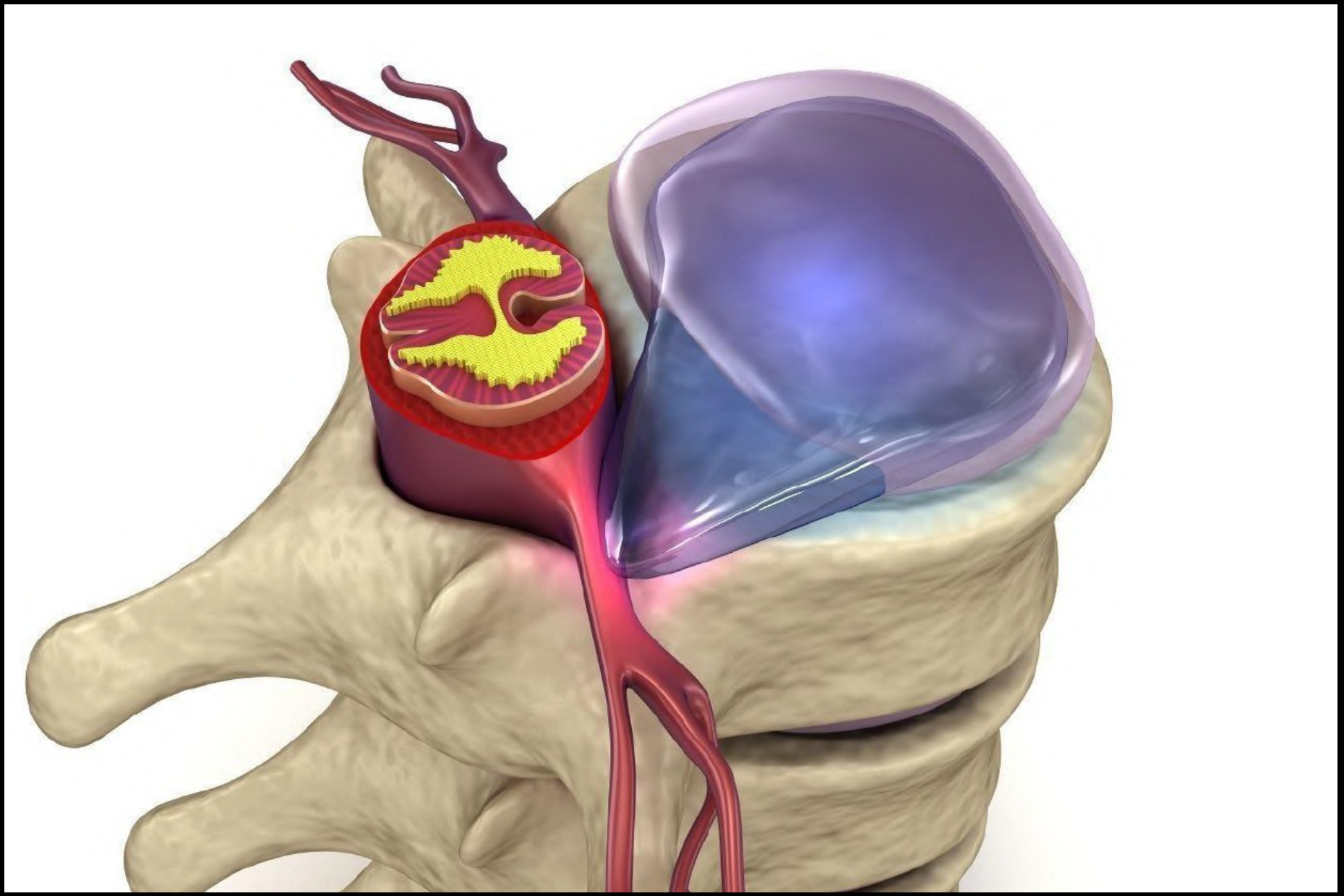
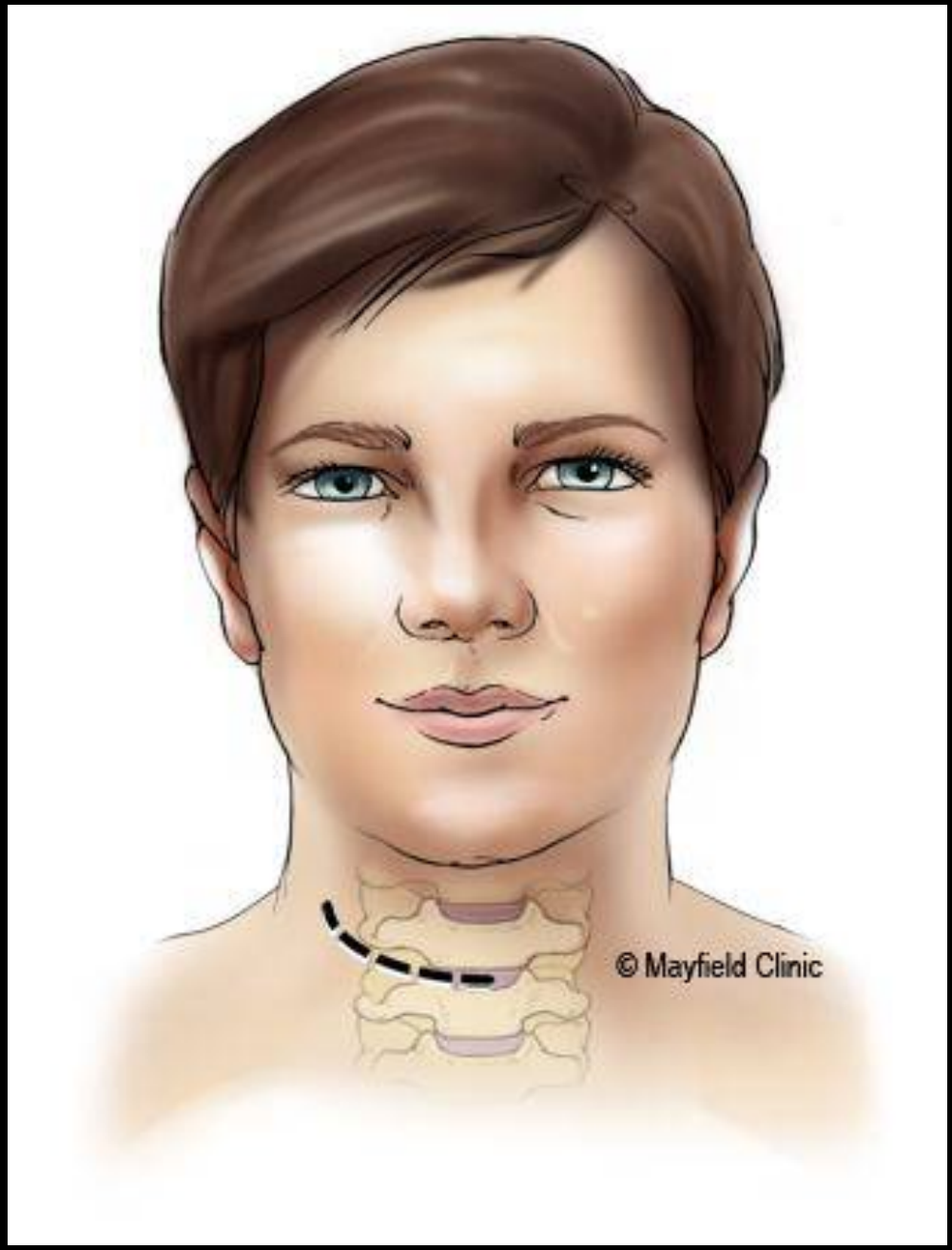


FIGURE 61-4

ACDF
(Anterior Cervical Diskectomy & Fusion)




© Mayfield Clinic

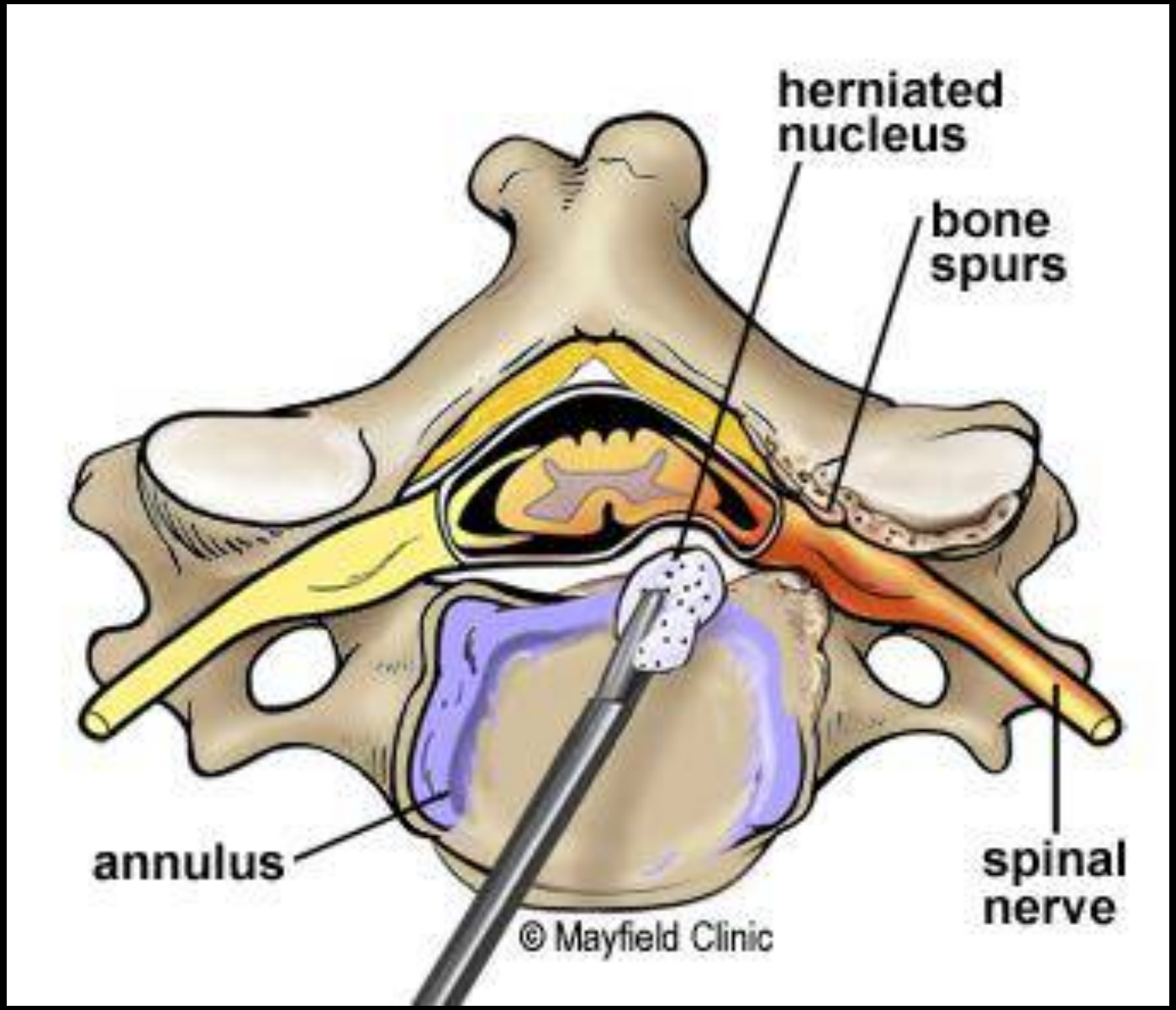
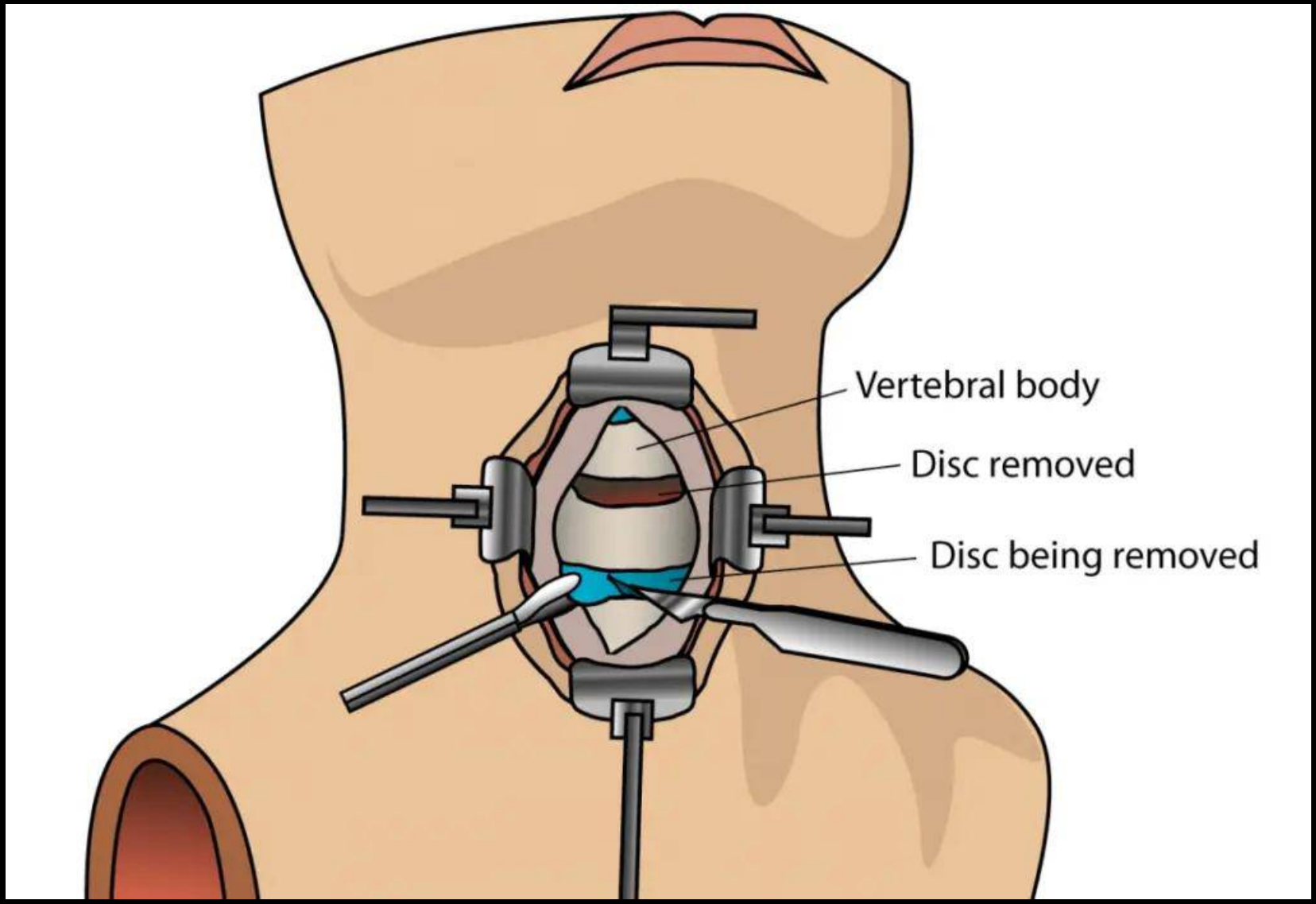

herniated nucleus
bone spurs
annulus
spinal nerve
© Mayfield Clinic

FIGURE 59-1


Vertebral body
Disc removed
Disc being removed

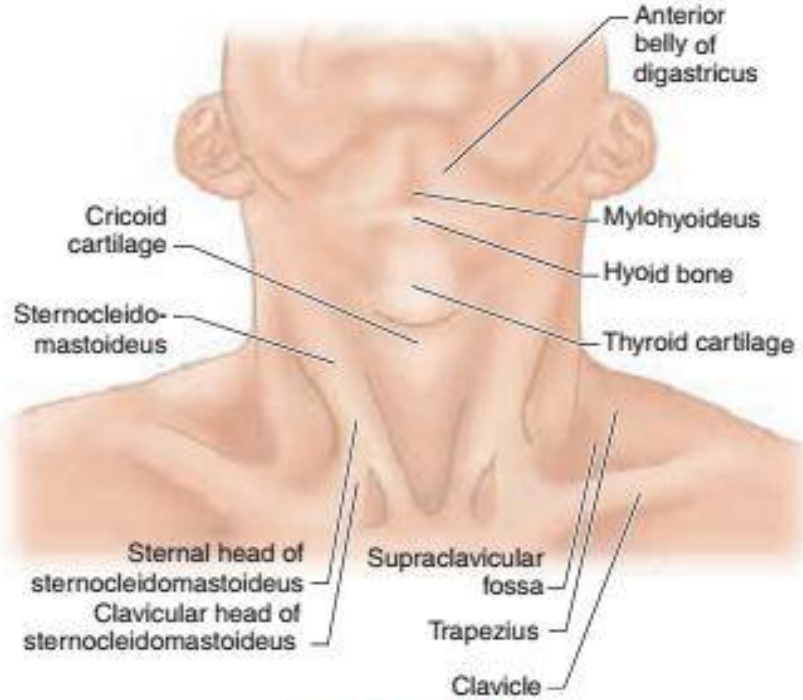


FIGURE 59-2

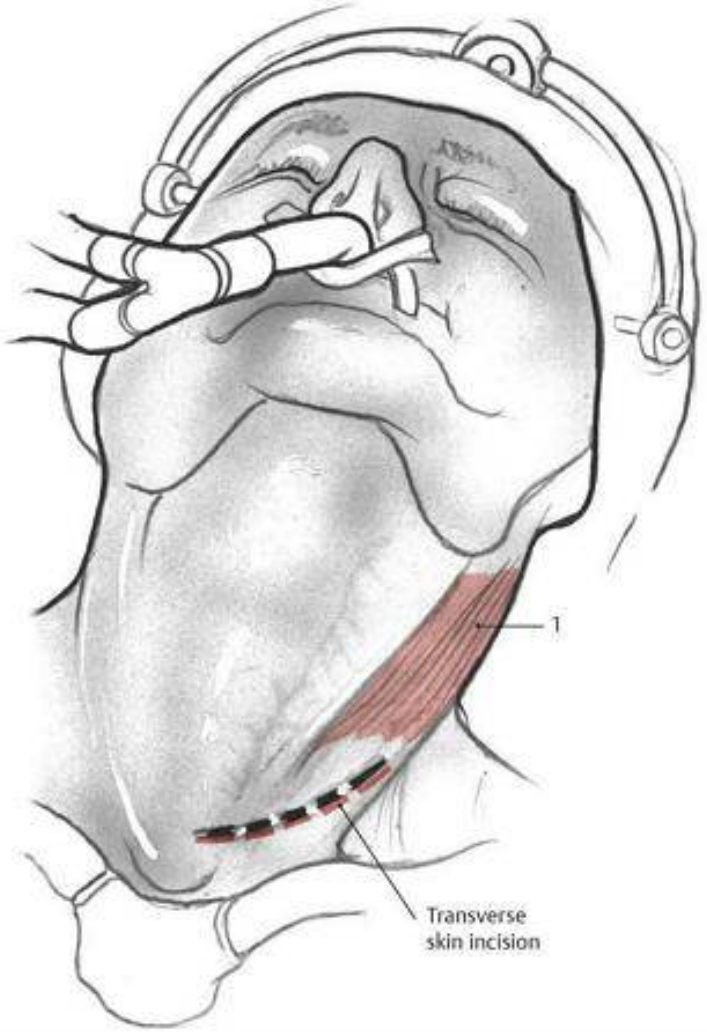
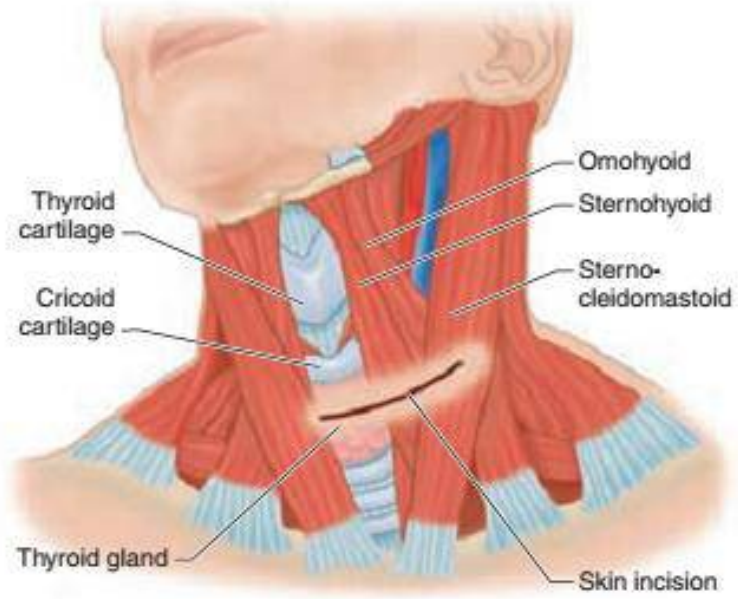
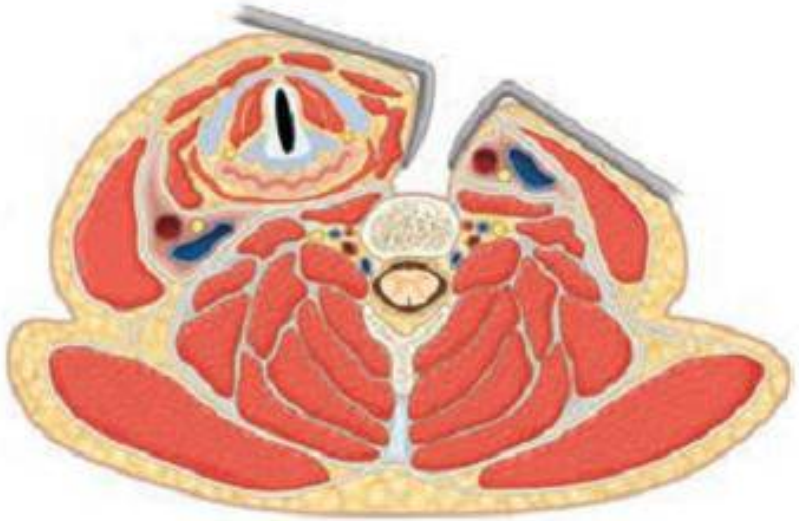


Fig. 7.2 Transverse incision following a skin crease from the medial margin of the sternocleidomastoid muscle to the midline. The incision is centered over the level of interest previously located with anatomic landmarks and later confirmed with fluoroscopy. 1. Sternocleidomastoid muscle.



A



B

FIGURE 59-3

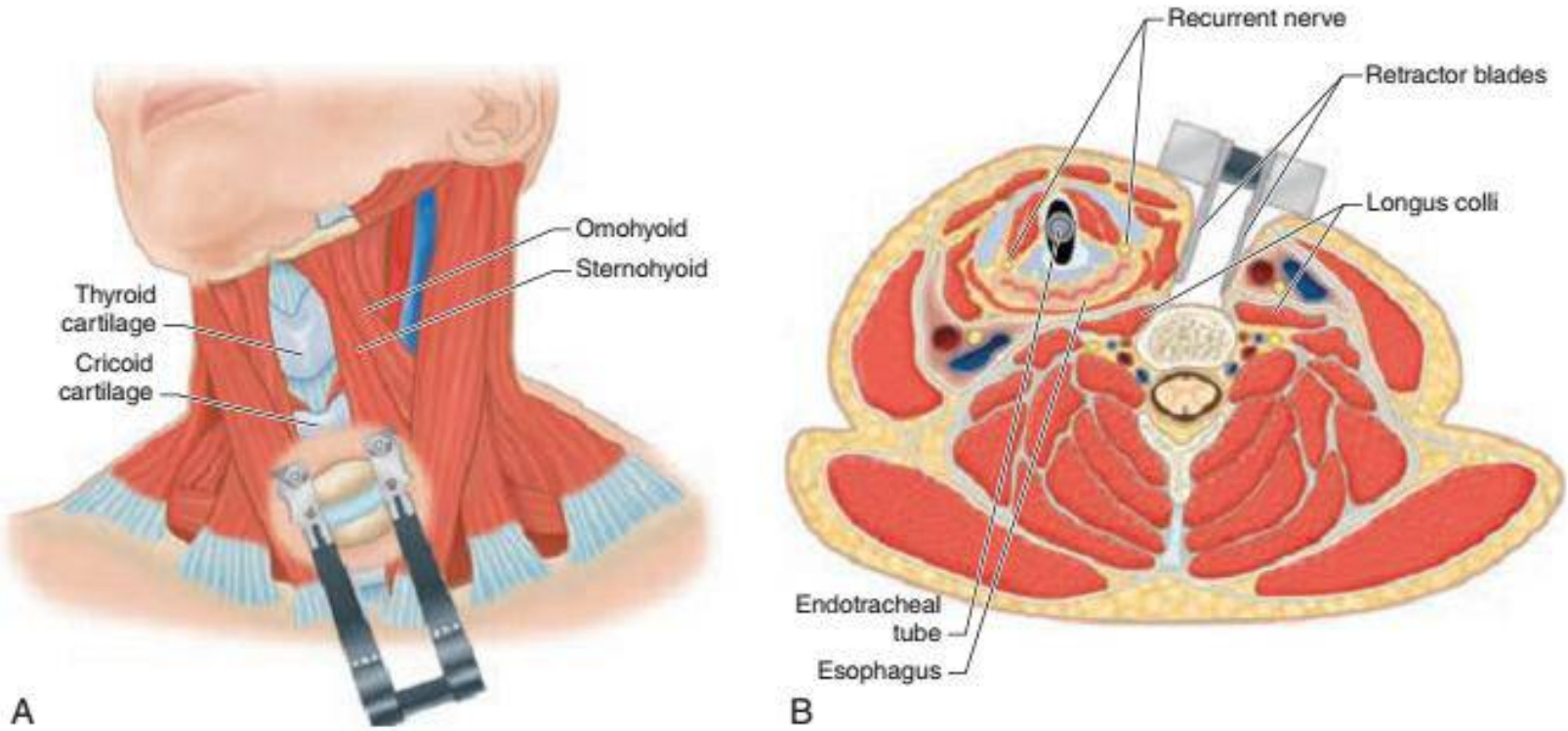
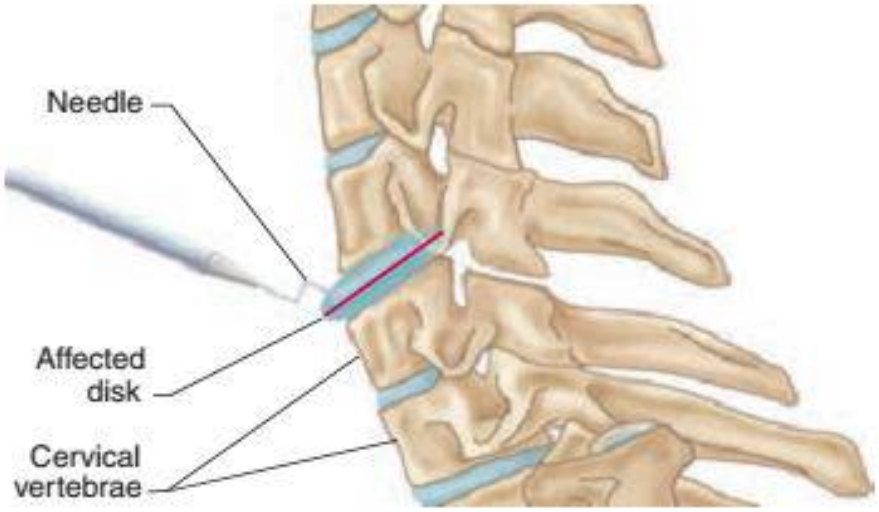

Omohyoid
Sternohyoid
Thyroid cartilage
Cricoid cartilage
A
Recurrent nerve
Retractor blades
Longus colli
Endotracheal tube
Esophagus
B

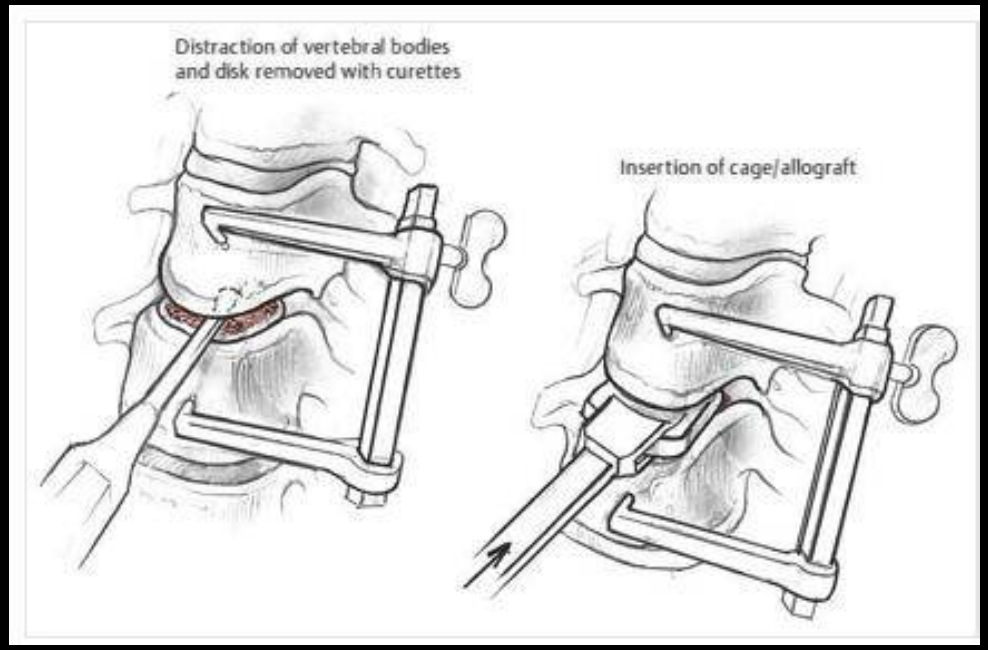
FIGURE 59-5

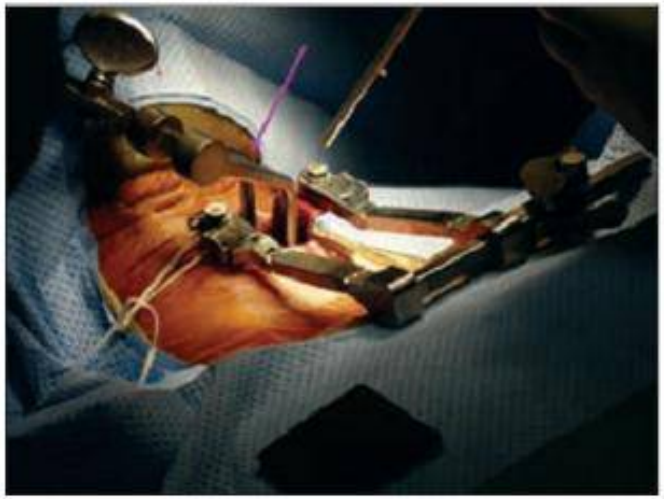


A

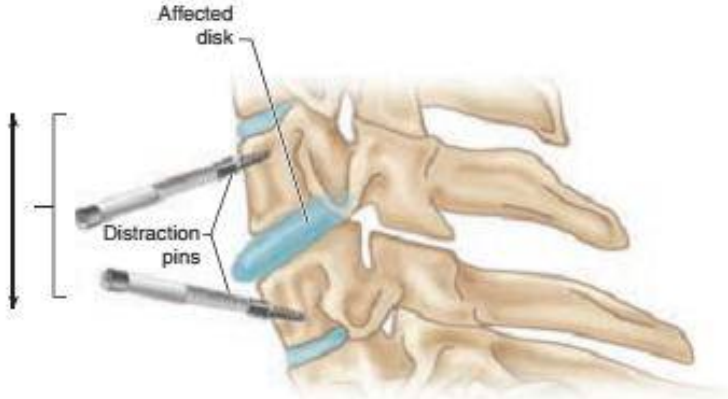
B

FIGURE 59-4



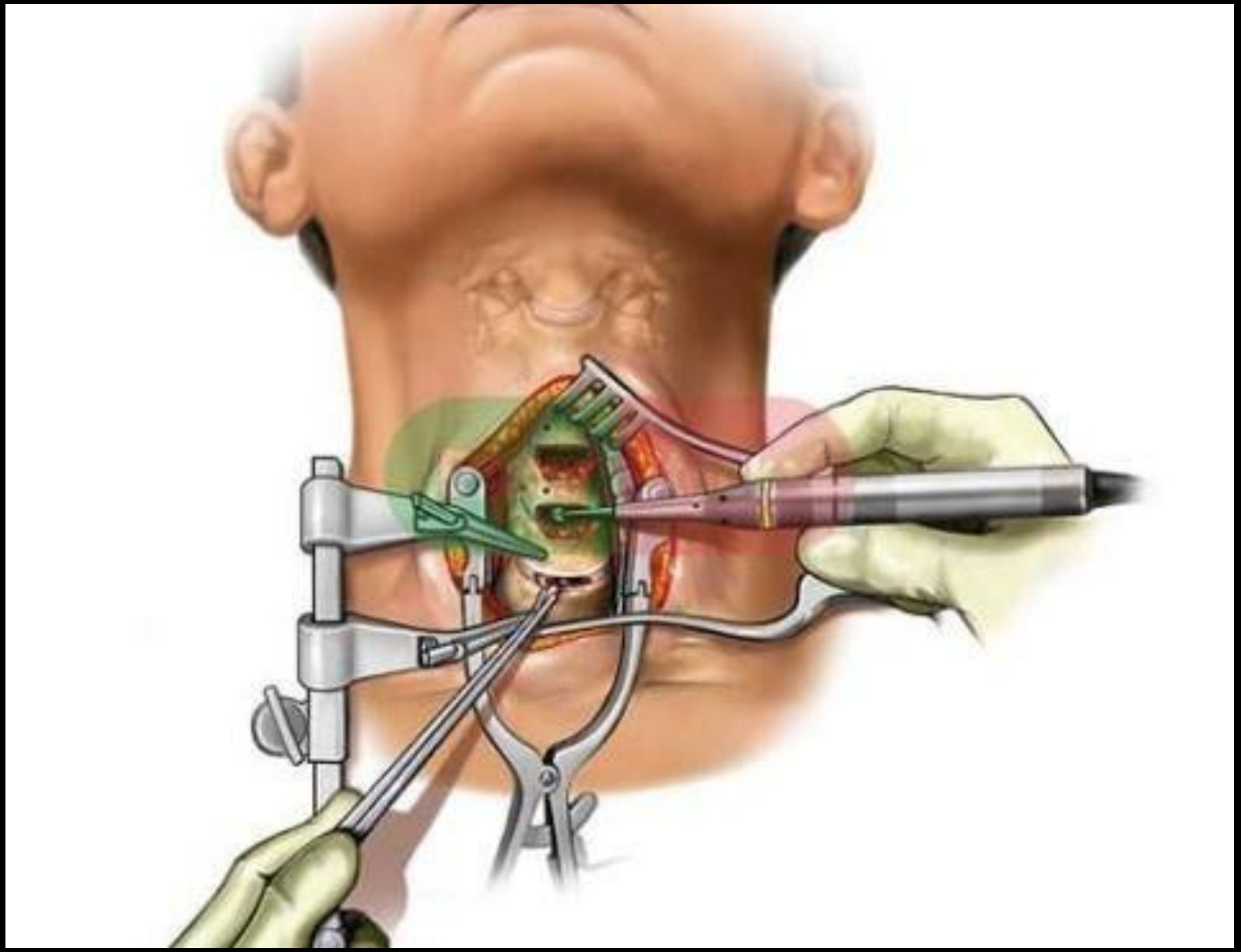


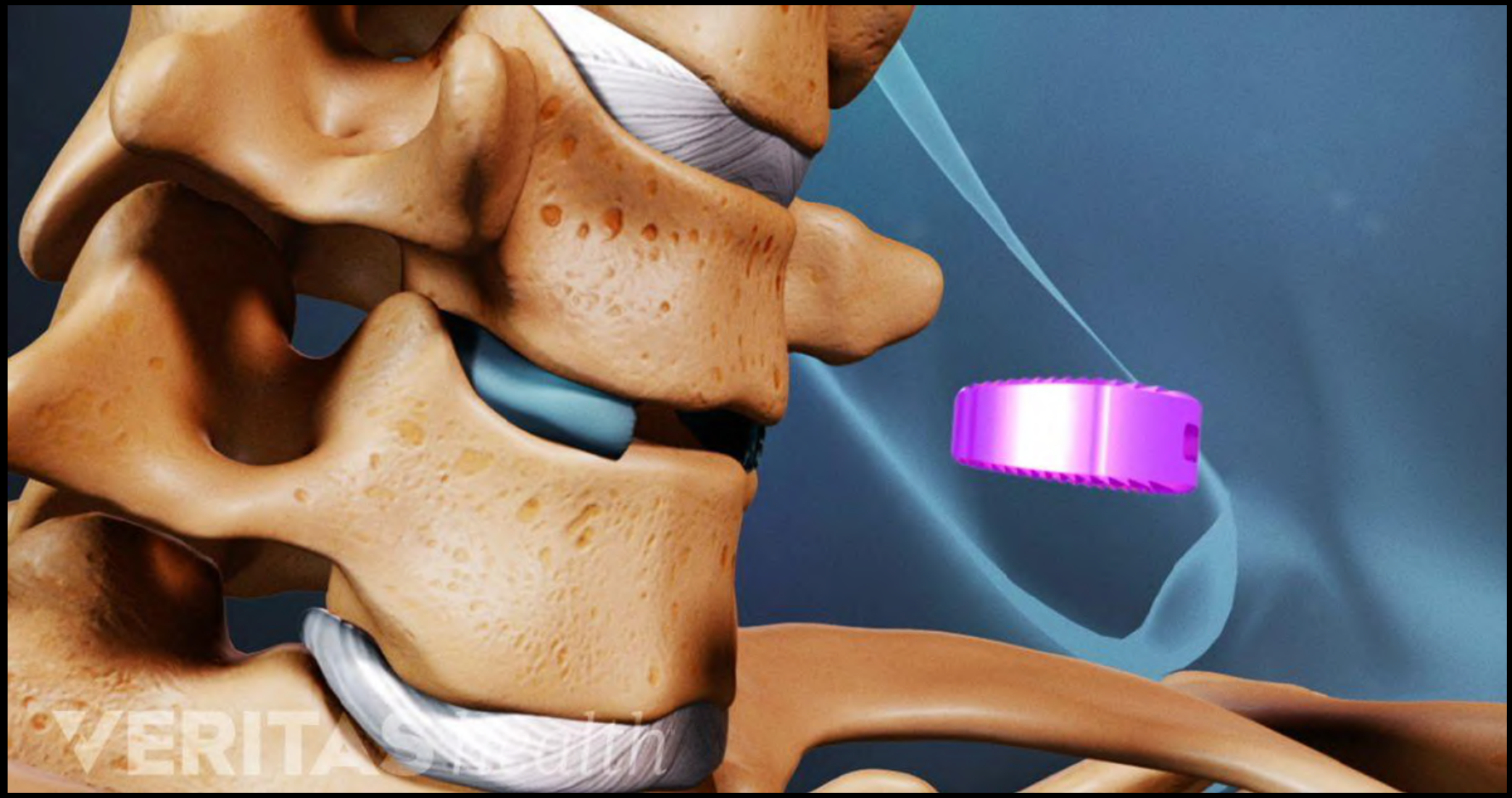
A



B

FIGURE 59-6




VERITAS Studio

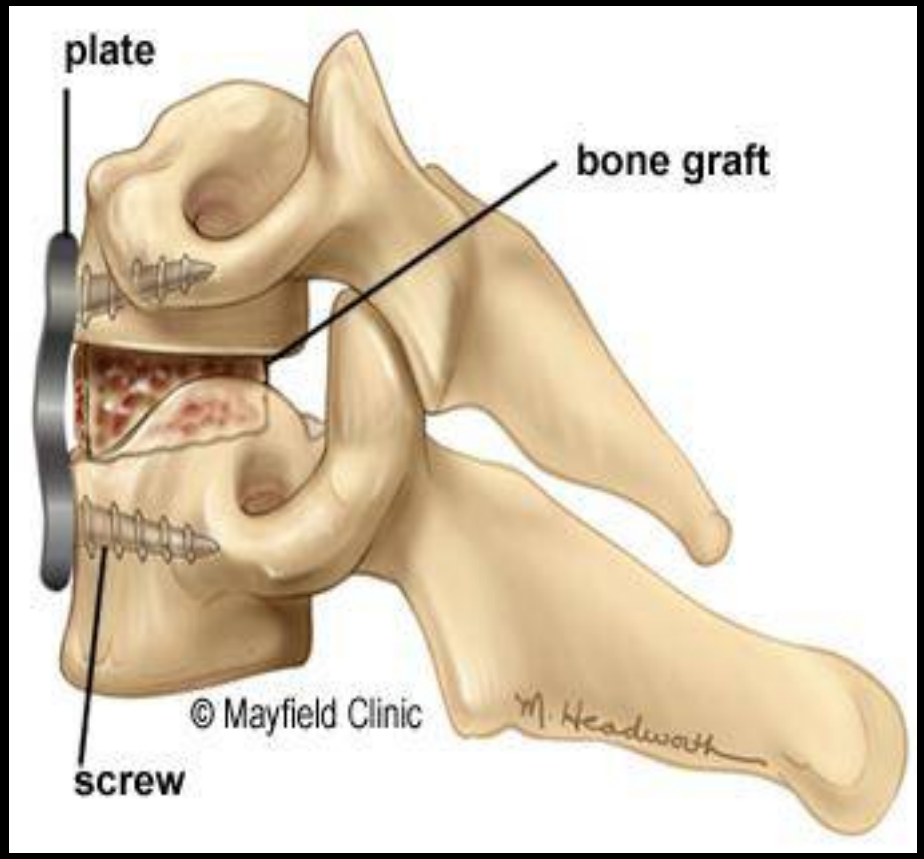
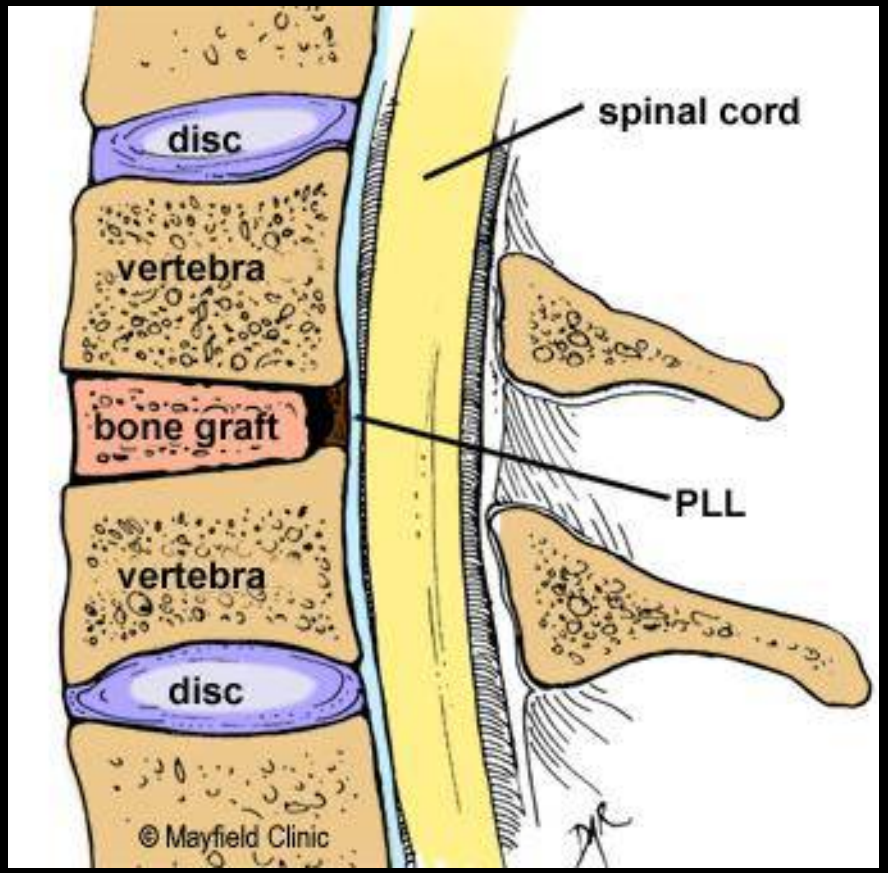
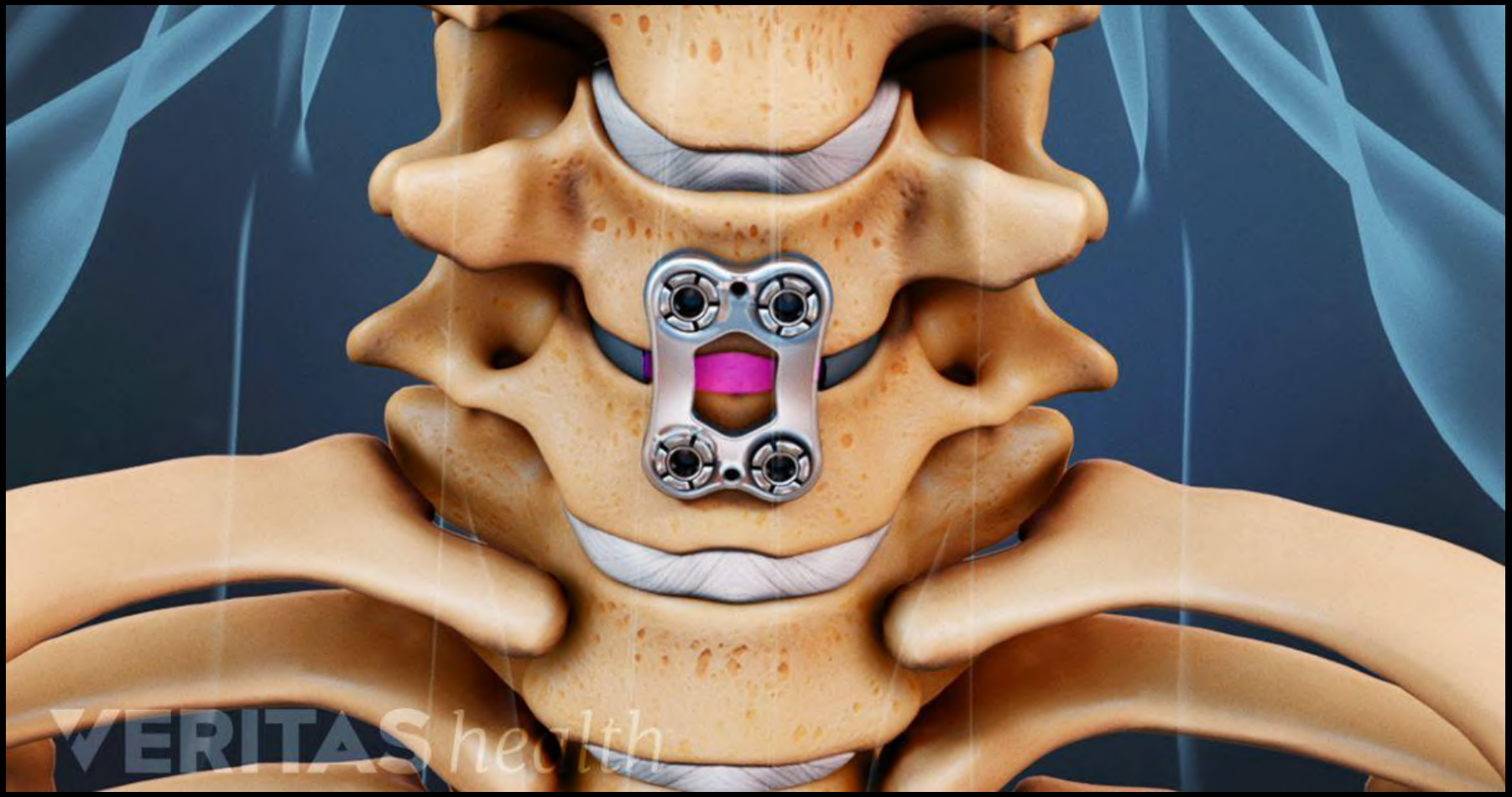
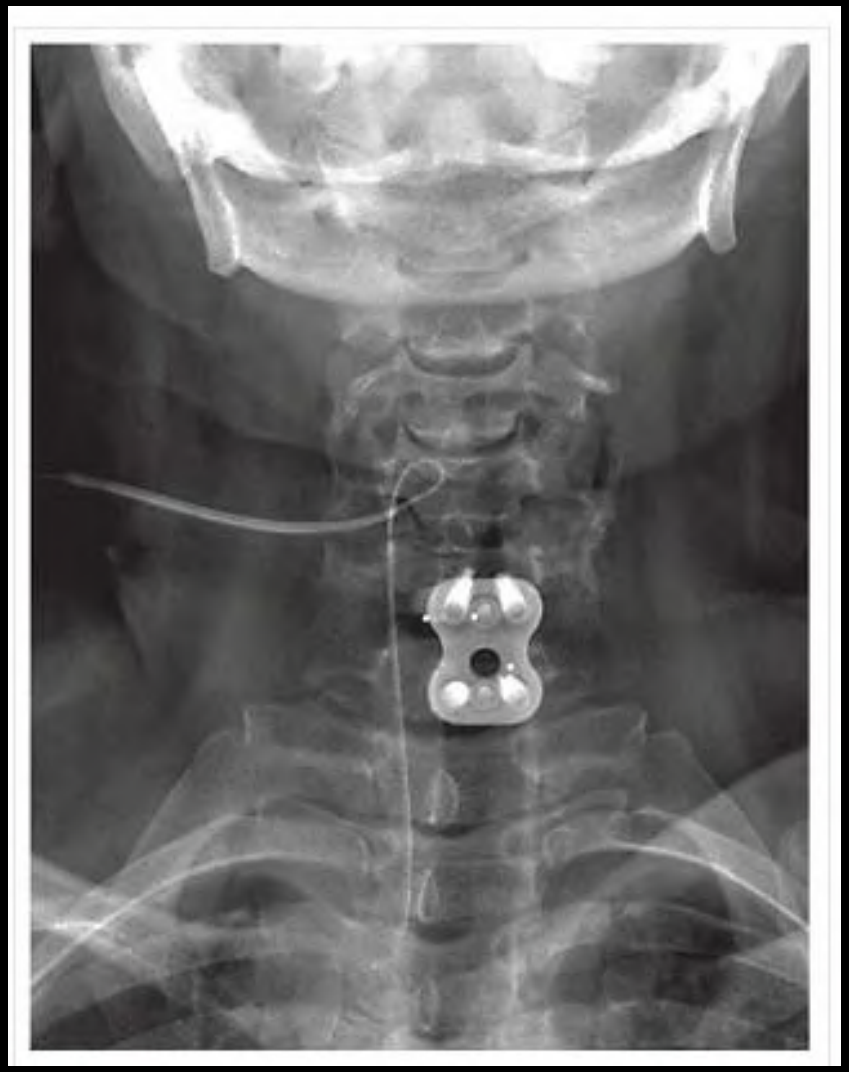


plate
bone graft
screw
© Mayfield Clinic
M. Headworth

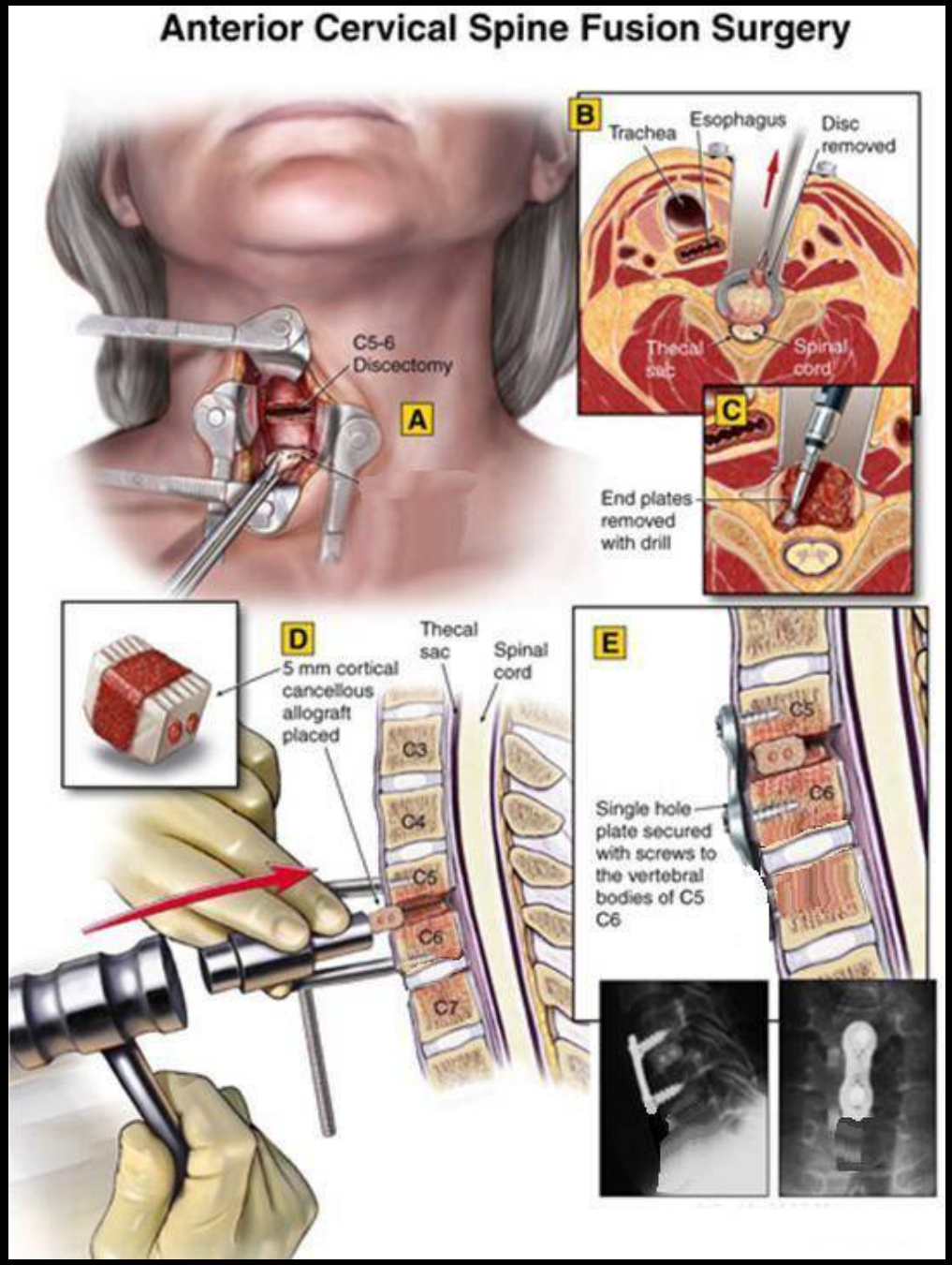

disc
spinal cord
vertebra
bone graft
PLL
vertebra
disc
© Mayfield Clinic


VERITAS health




L
LAT

Anterior Cervical Spine Fusion Surgery

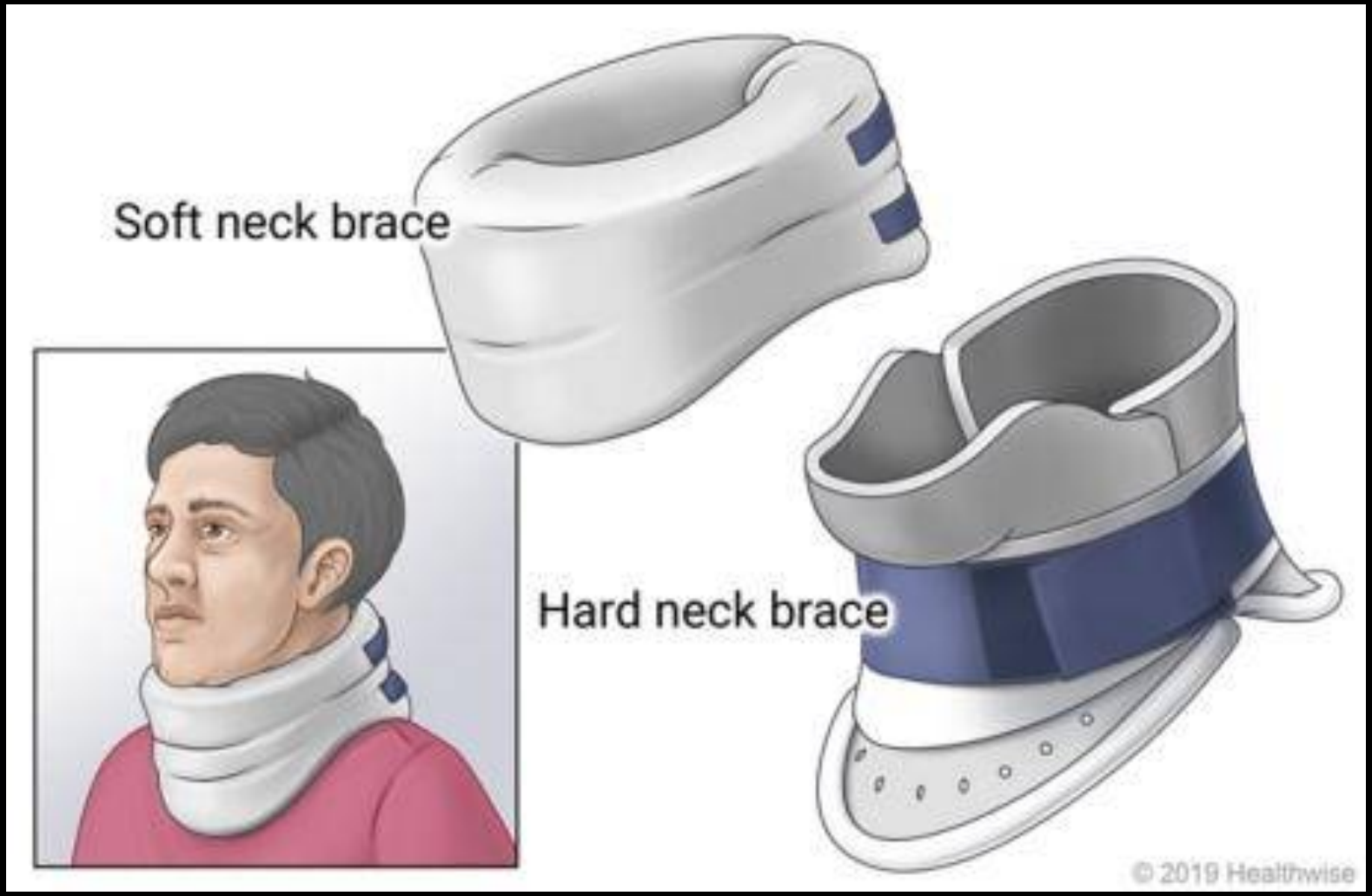


Orthotic Devices

Rigid external orthotic devices can stabilize the spine by decreasing range of motion and minimizing stress transmitted through the spine. Commonly used rigid cervical orthoses include Philadelphia and Miami-J collars.

Halo-vest assemblies provide the most external cervical stabilization.

Lumbar stabilization may be provided by thoracolumbosacral orthoses.


Soft neck brace
Hard neck brace
© 2019 Healthwise

Philadelphia Cervical Collar

Miami J Cervical Collar

C Collars

Philadelphia

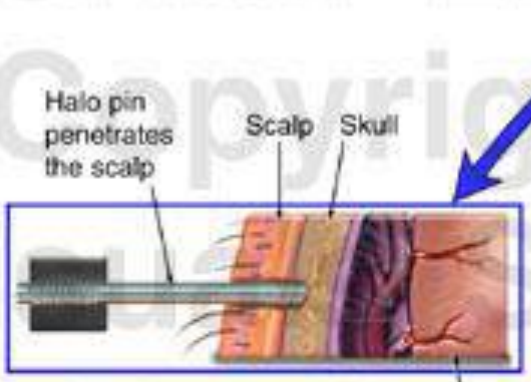
Soft

Miami J

Aspen

Halo-vest

Halo Traction Device



Halo-vest

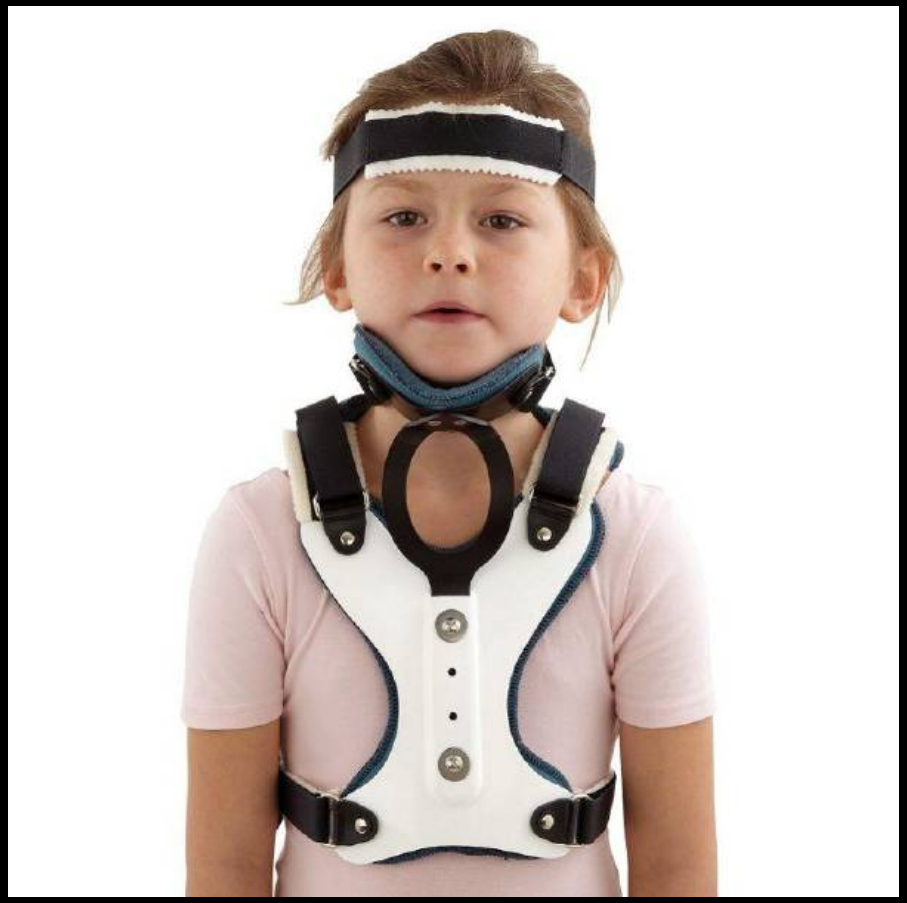
Exhibit# 304121_02XG

TLSO (Thoracic Lumbar Sacral Orthosis)

LSO (Lumbo-Sacral Orthosis)


ITA-MED Co.

Minerva



jewett brace

خدایا چنان کن سرانجام کار
تو خوشنود باشی و ما رستگار