

SKULL

protective case for the brain, smell, hearing, and vision. The two main parts: the cranium and the facial bones. The base of the skull is larger than the sides and top of the skull. The foramen magnum, the opening for the spinal cord, is at the base of the skull. The foramen magnum is the opening for the spinal cord.

10. MAXILLA
11. MANDIBLE
12. TEETH
13. OCCIPITAL BONE
14. HYOID BONE

Ultrasound EVALUATION OF SPINE

دکتر محمد رضا آریانی

فلوشیپ درد



- 1.INTRODUCTION
- 2.SONOANATOMY
- 3.TECHNIQUE



INTRODUCTION



- The **ultrasound** is of particular interest in medicine, especially in the field of pain intervention
- Pain injection initially was performed with the help of landmarks which caused many faults and complications.

FLUROSCOPY

- However, the fact that x-rays hazard always exists in these cases attracted the specialist's attention to the ultrasound



advantages for ultrasound compare to fluoroscopy

- presentation of vessels and tissues
- pleural movements
- the portability of ultrasound which the probe easily moves by interventionist and gives the axial and longitudinal view
- unlike fluoroscopy there is no need for assistant help to move the C-ARM and makes it applicable in the outpatient and its feasibility in cases where the patient cannot position properly as a result of internal or anatomical problems.





- 1.INJECTION
- 2.DIAGNOSIS



- there is still insufficient clinical evidence to prove safety of the ultrasound as a sole image guide intervention.





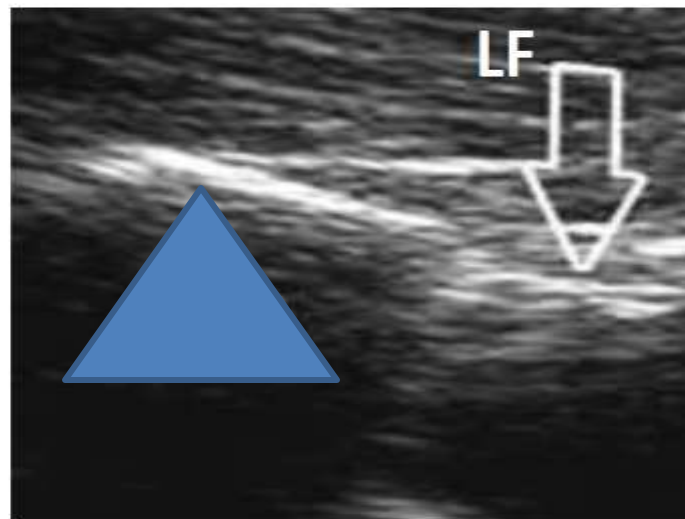
- For simple and safe spinal cord injections, you need to have enough information about **spinal anatomy**. Then you should be able to follow the anatomy on the ultrasound screen, the science of familiarity with **sonoanatomy** is the basis of ultrasound-driven spinal injections.

- 
- A human skeleton is shown in the top left corner of the slide, with the skull and upper torso visible.
- Position of choice: lateral decubitus or prone
 - • Probe of choice: **curved-array, low-frequency**
 - (2–5 MHz) probe for **wide field** of view and
 - **deeper penetration**
 - • 2 basic planes: **sagittal, transverse**





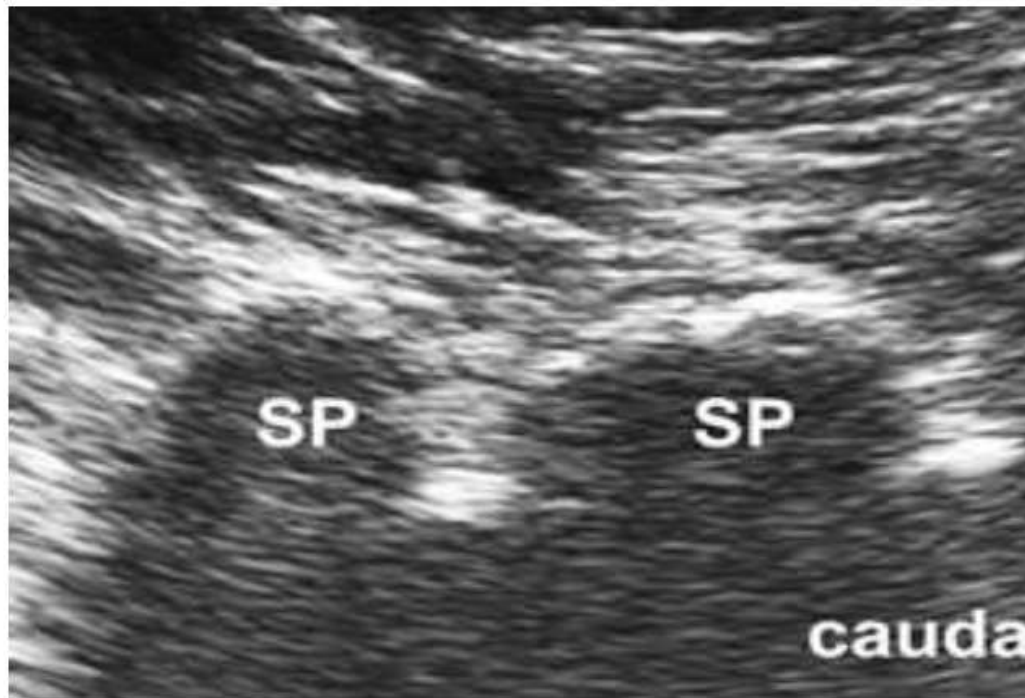
Connective tissue structures, such as ligaments and fascial membranes, also are hyperechoic with acoustic impedance is less than bone, so deeper structures can still be imaged.



Important Remind

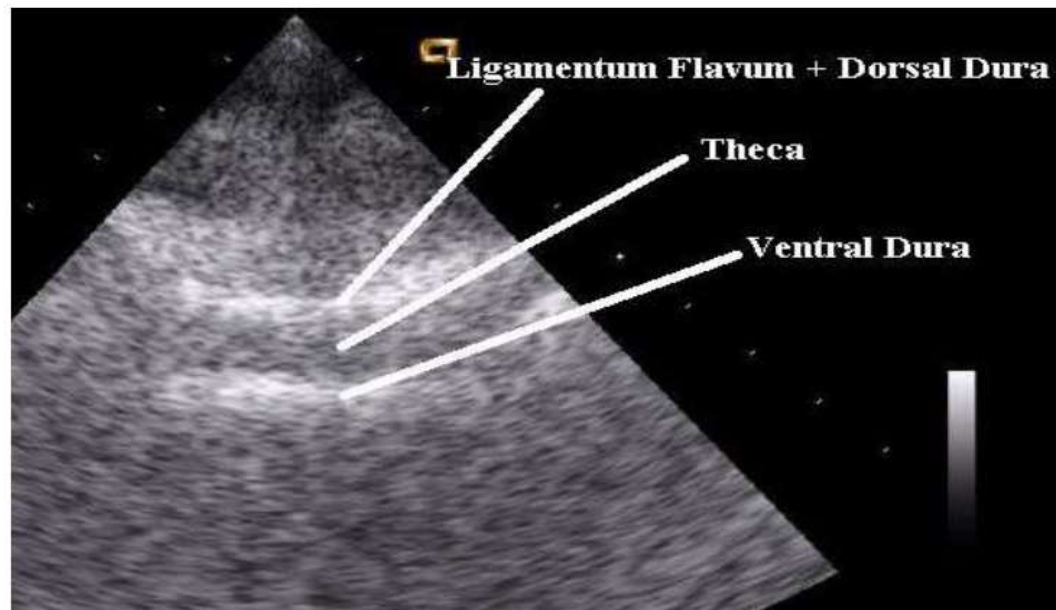
Bony surfaces appear as hyperechoic (white) linear structures

Dense acoustic shadowing (black) beneath that completely obscures any deeper structures.





Fat and fluid have very low acoustic impedance
and are hypoechoic (dark).

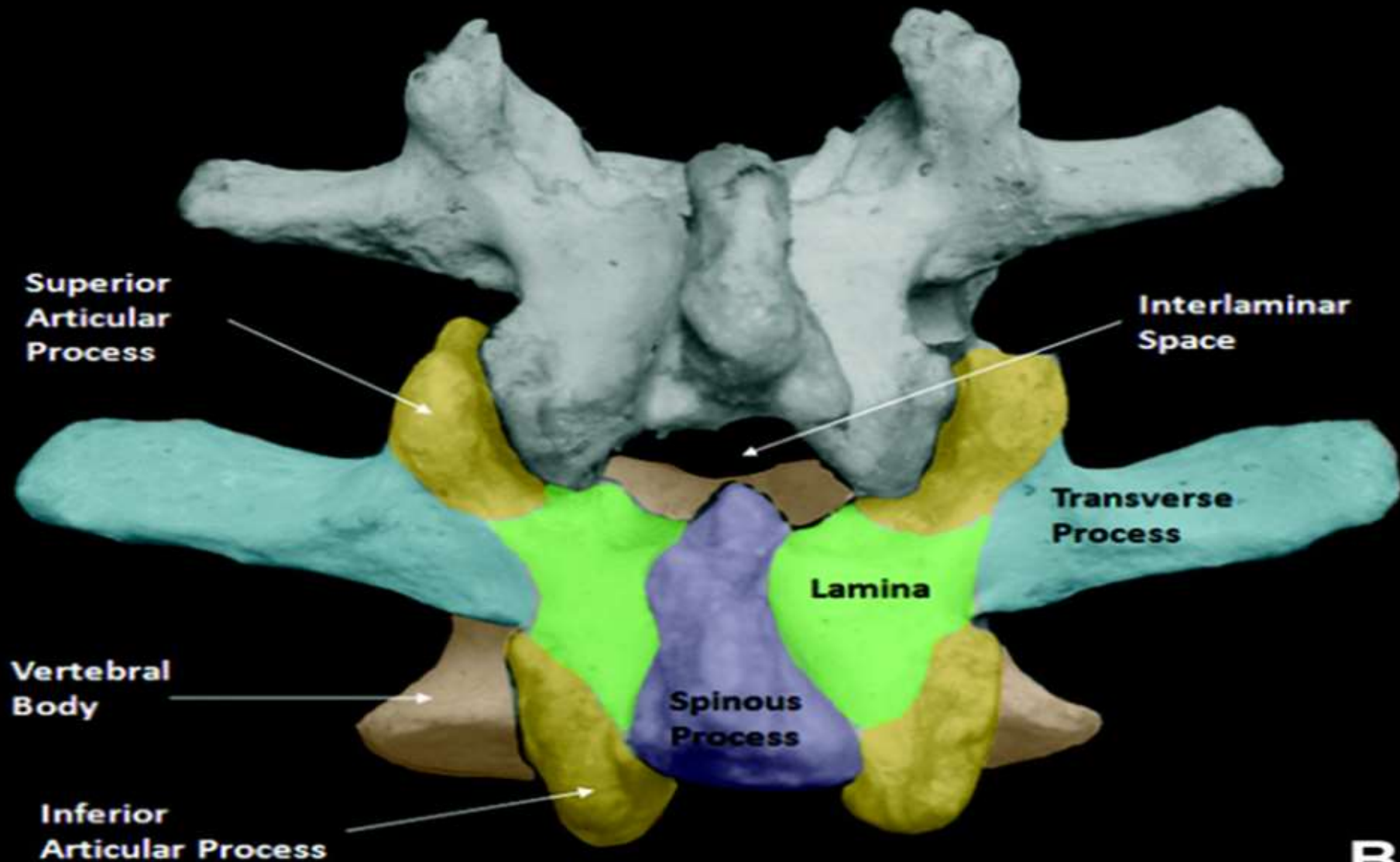




Sagittal view & neuraxial content through the acoustic window from posterior to anterior	Echogenicity
Flavum ligament*	Hyperechoic
Epidural space	Hypoechoic
Posterior dura*	Hyperechoic
CSF#	Anechoic
Anterior complex"	Hyperechoic

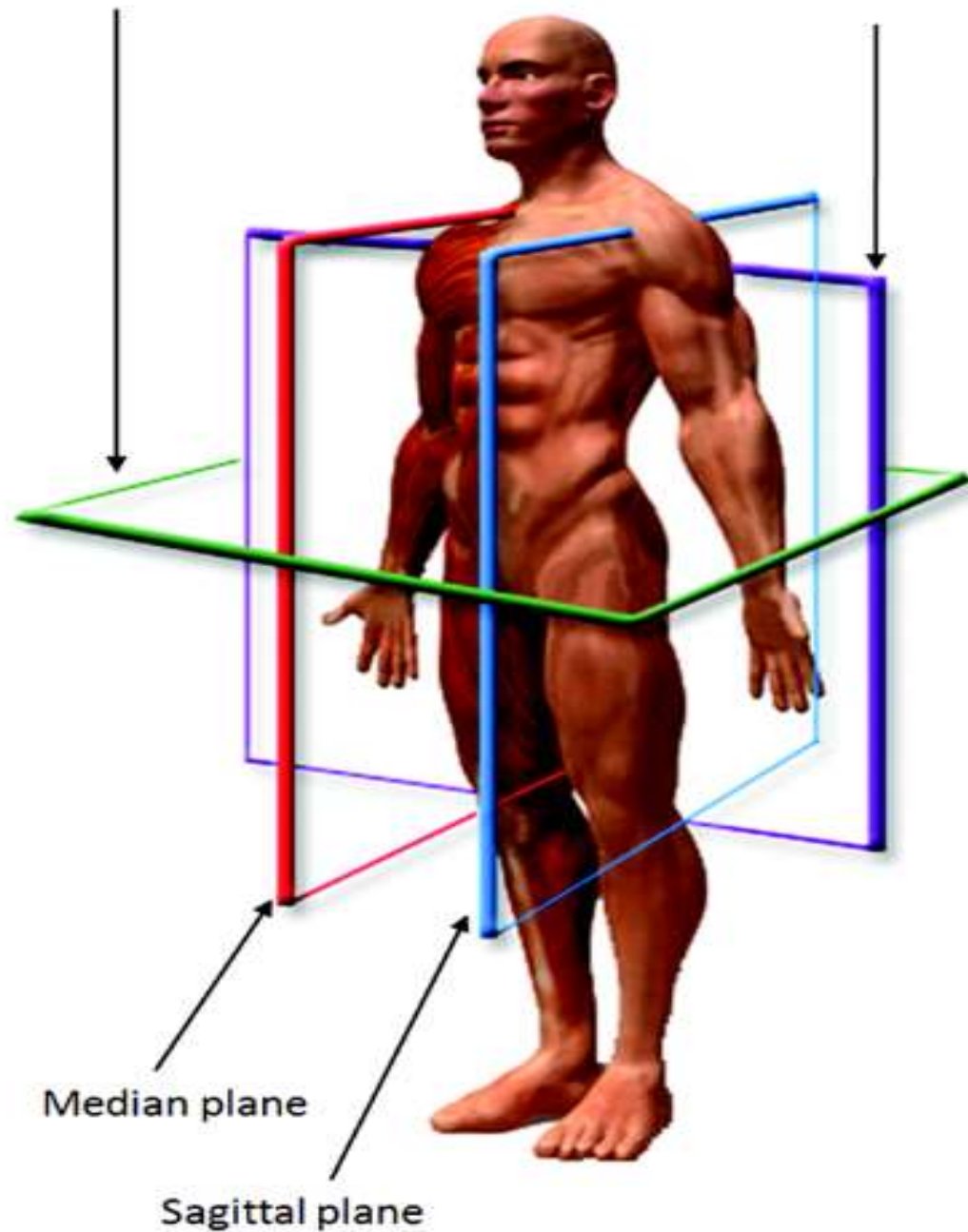


SONOANATOMY



Transverse plane

Coronal plane



Paramedian Sagittal



Paramedian Sagittal Oblique



Transverse



Ultrasound Scanning

Starting laterally in the Transverse processes (TP)



walk off medially over Articular processes (AP)



Laminae



until at midline



Spinous processes (SP)



are reached.

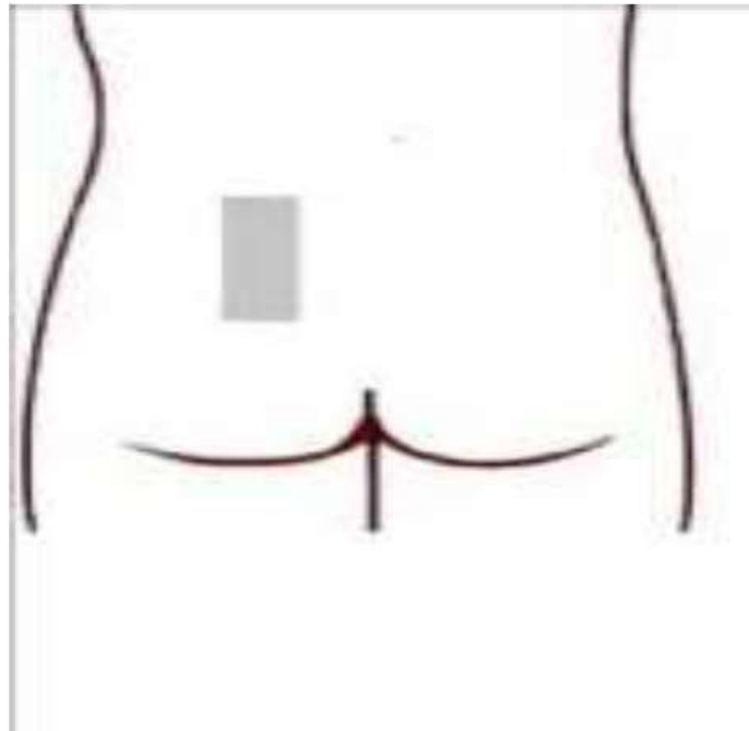


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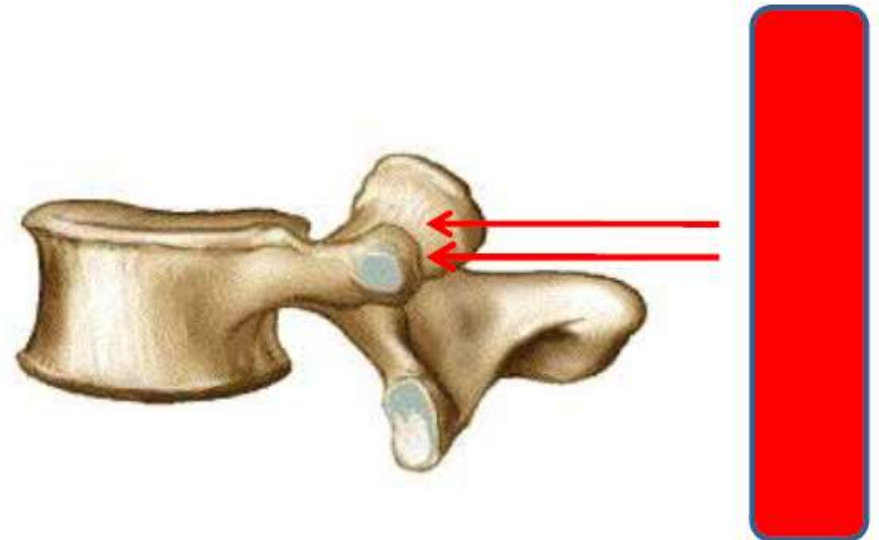
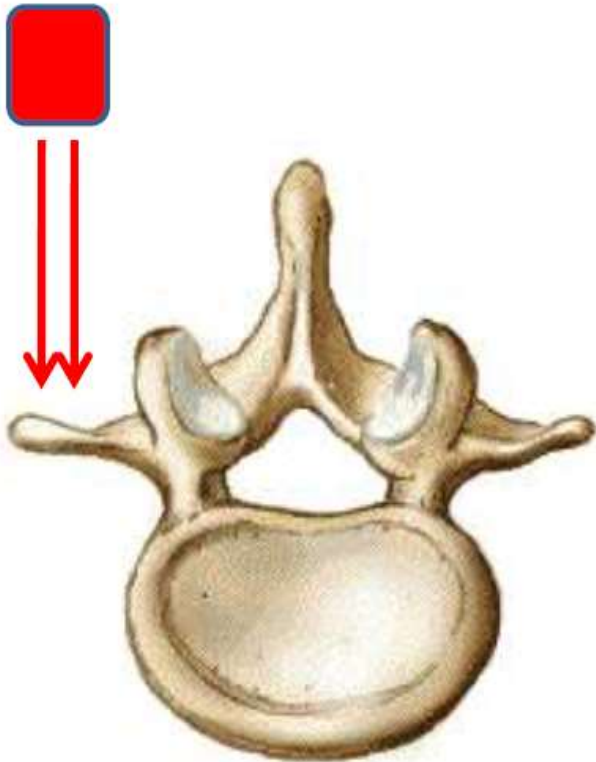
Paramedian Sagittal View

• Transverse Process View

- Place probe in a PS orientation 3–4 cm from the midline.

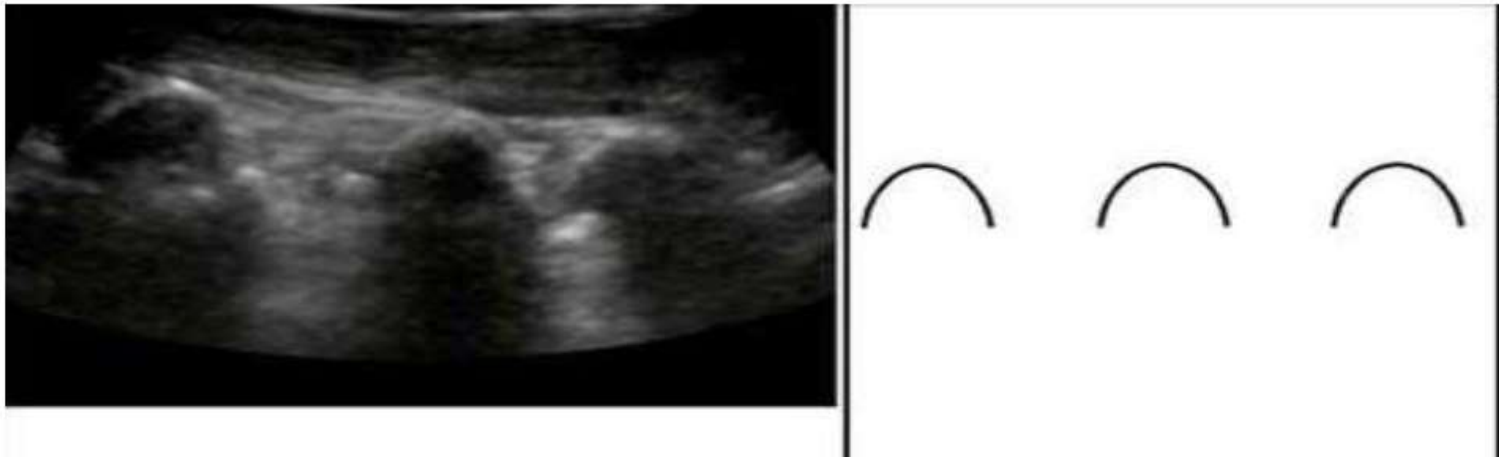


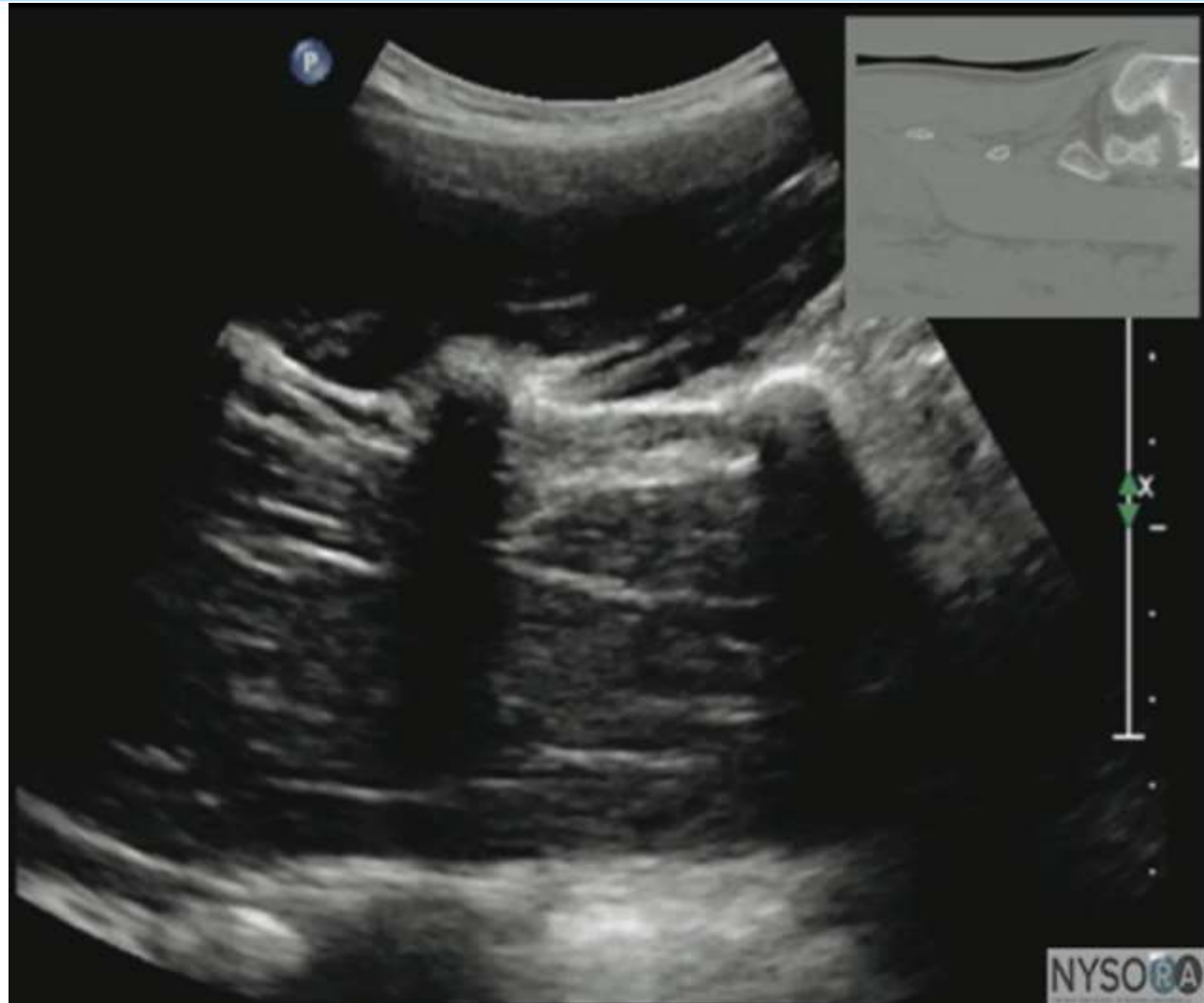
Transverse process view



Transverse process view

- **Trident sign**, represented by the finger-like acoustic shadows of the transverse processes

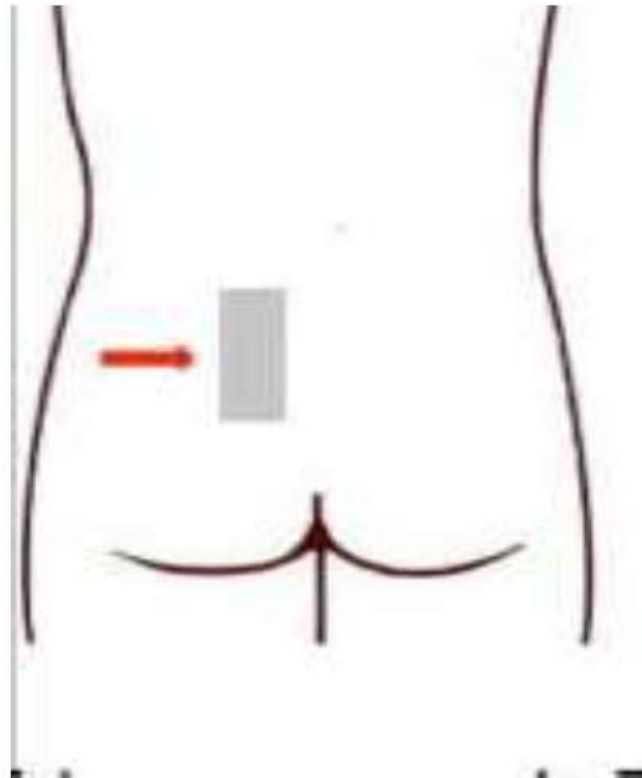




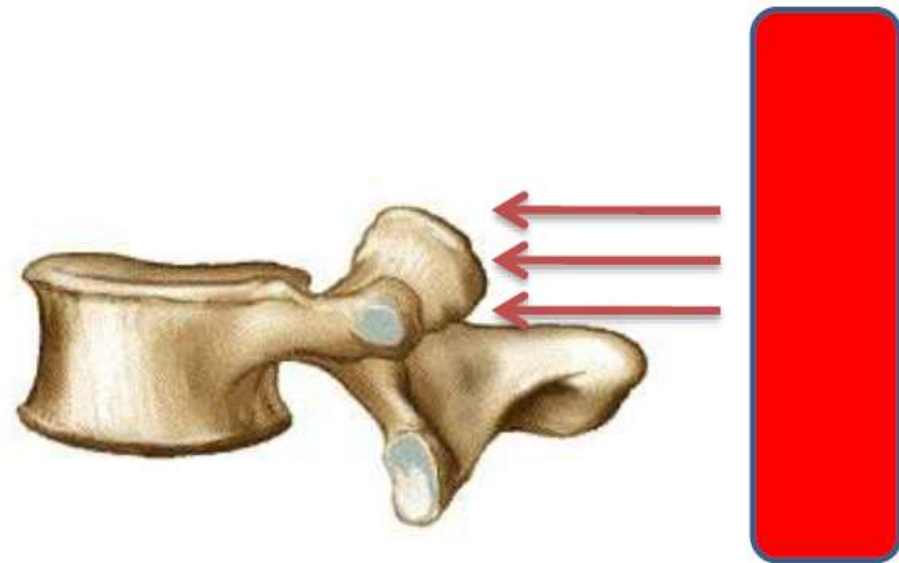
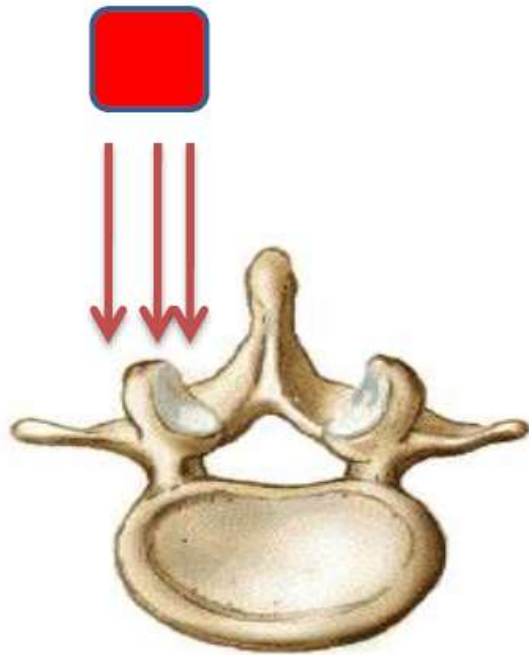


Articular process view

Slide the probe medially toward the midline while maintaining a PS orientation.

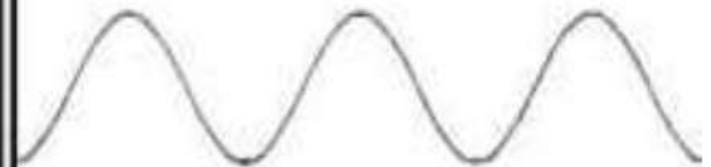
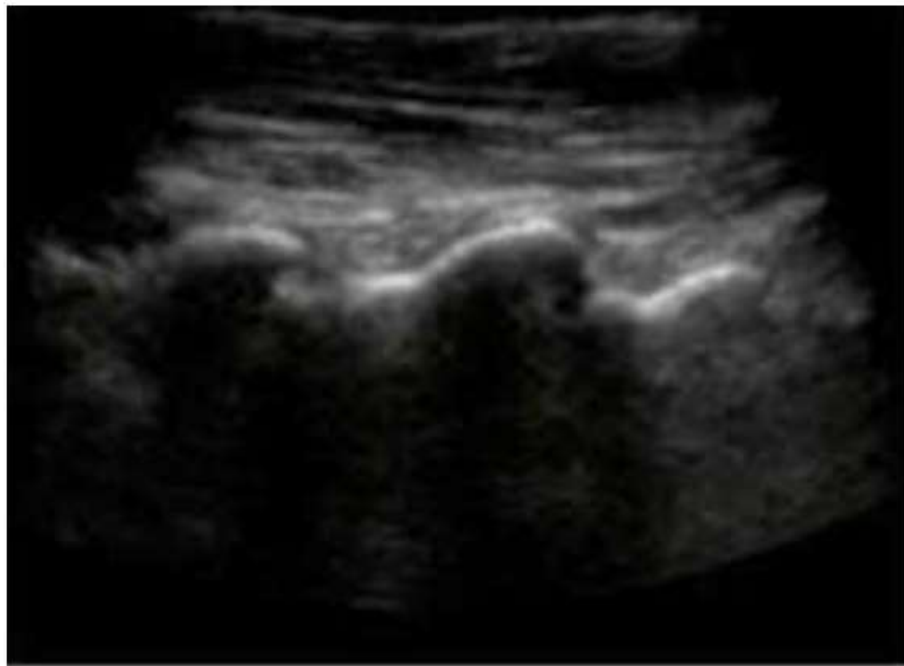


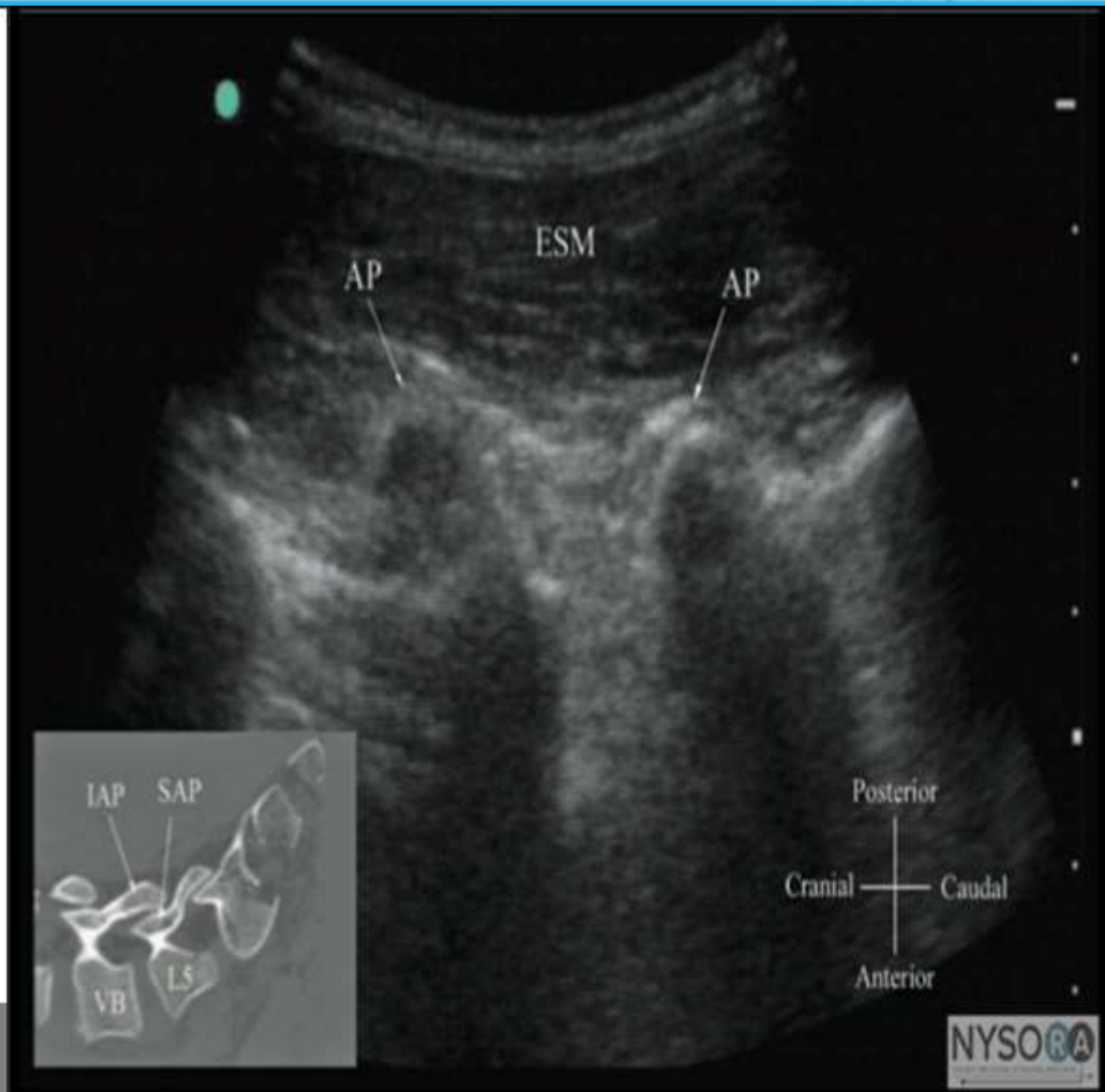
Articular process view



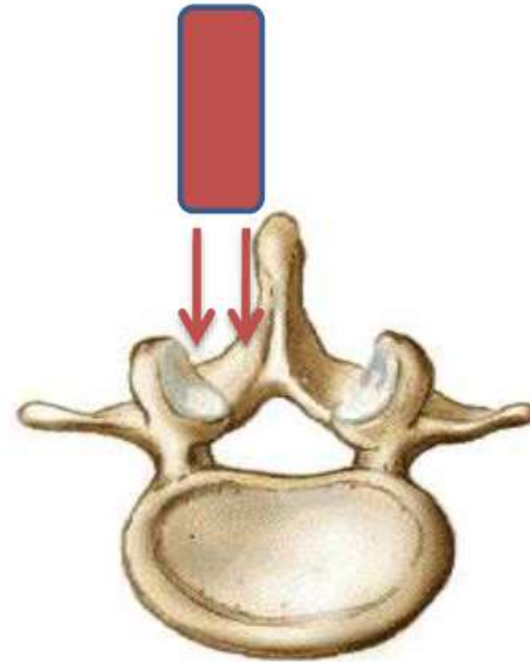
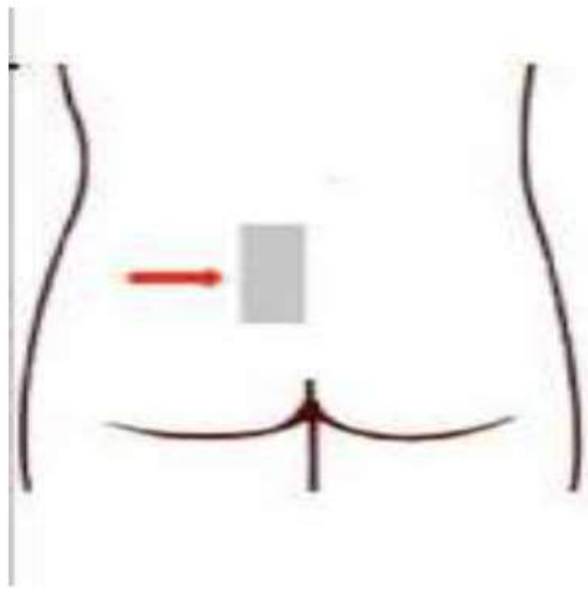
Articular process view

- Rounded “humps” of the facet joints between superior and inferior articular processes



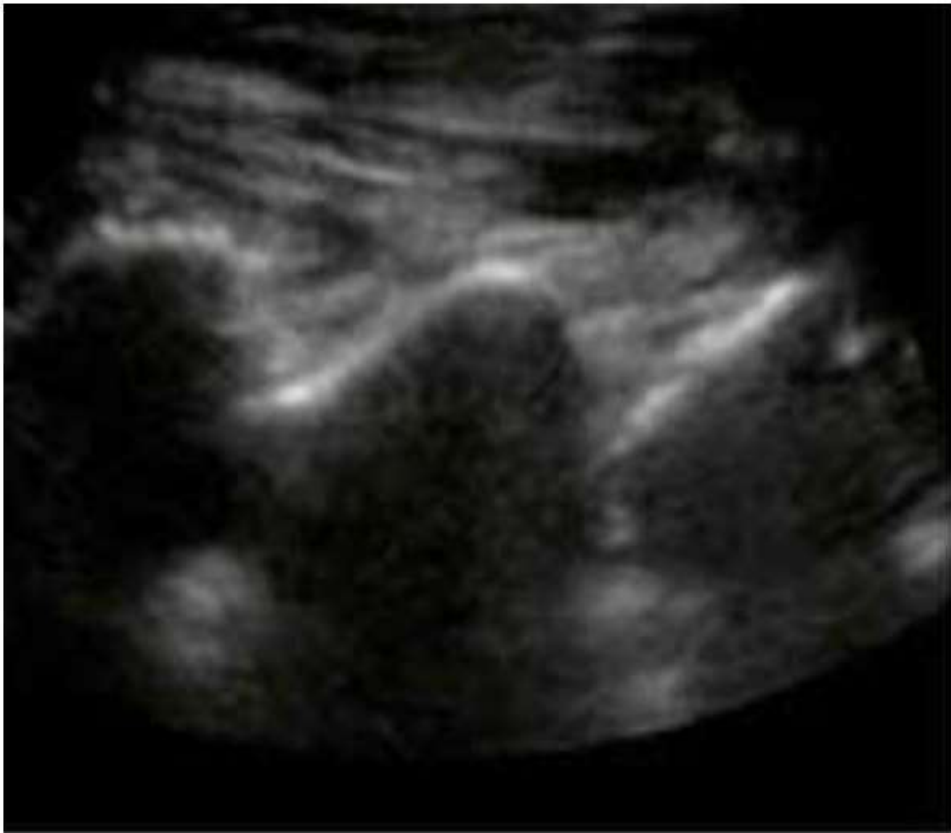


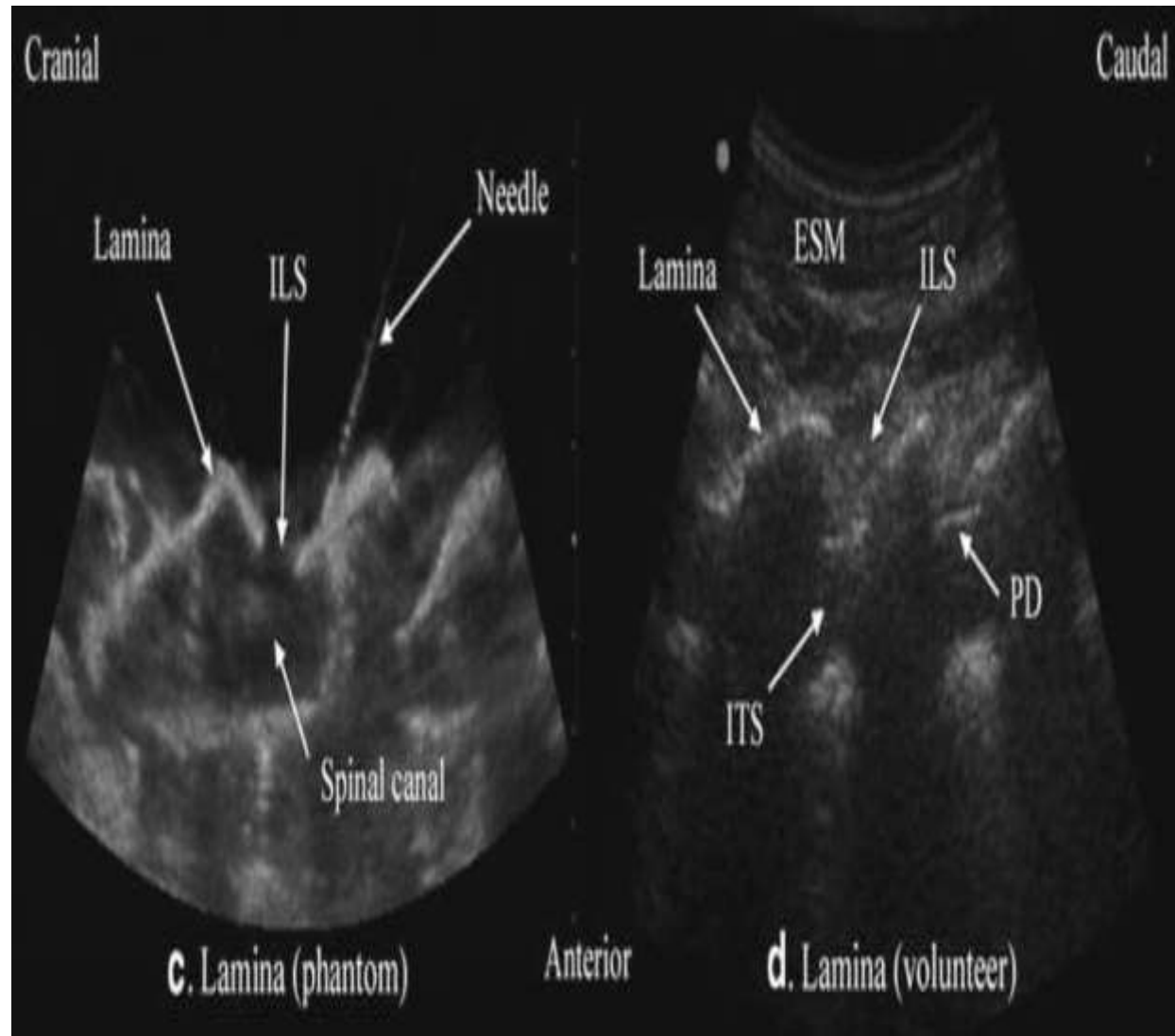
Parmedian Sagittal Laminal View



Parmedian Sagital Laminar View

- “Horse Head” / “Sawtooth”
- The hyperechoic bone is not continuous, due to the interlaminar space.
- This space allows visualization of the posterior and anterior complexes.



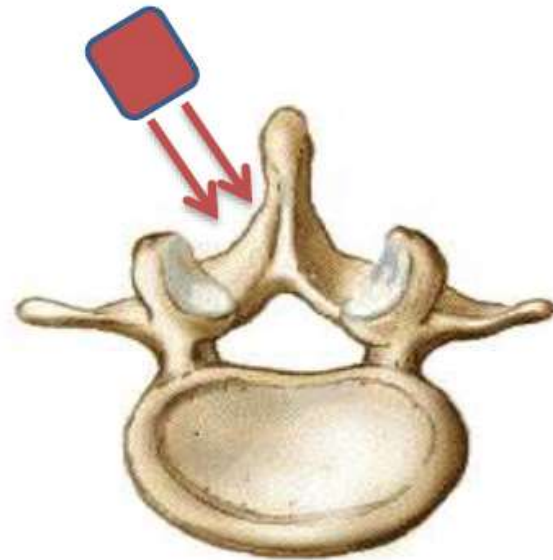
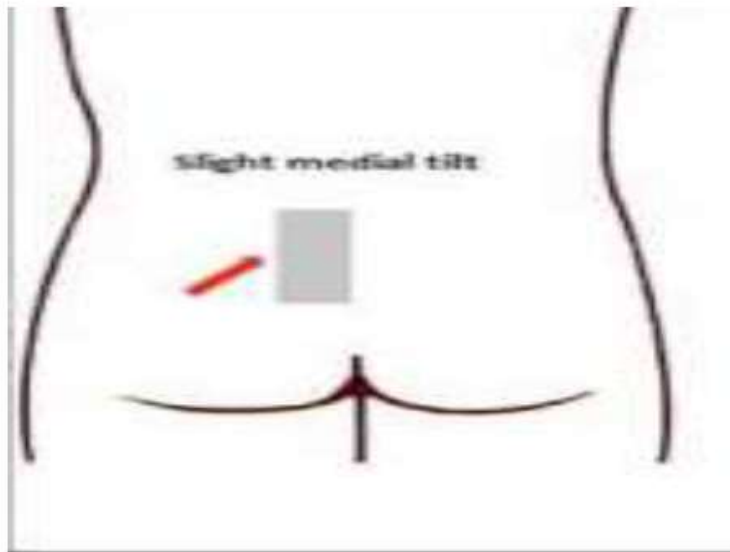


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Paramedian sagittal oblique view

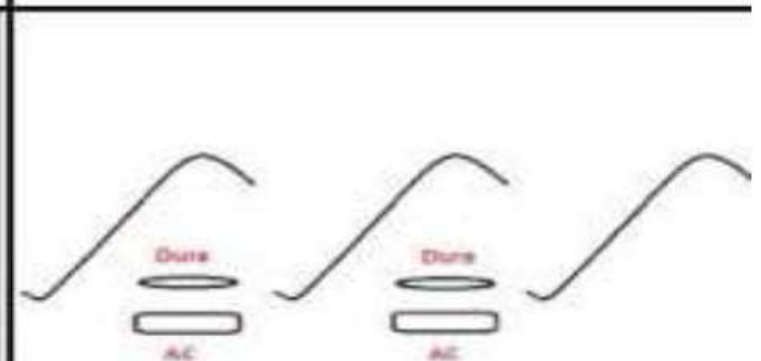
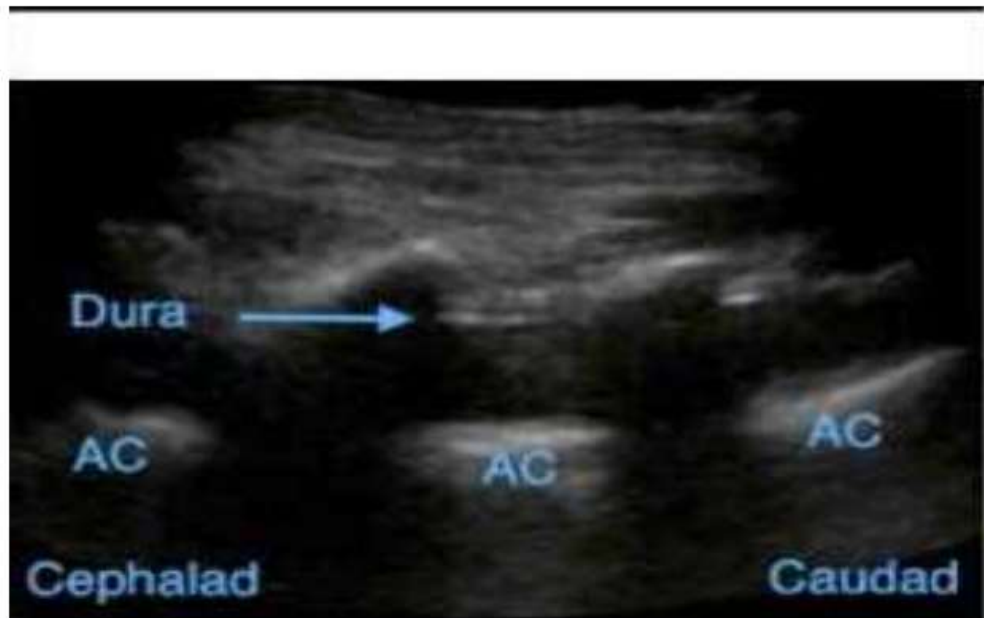
Paramedian sagittal oblique view

- Having obtained the PS articular process view, tilt the probe toward the midline to obtain the PS oblique view.
- Additional small sliding and tilting movements of the probe may be required to optimize the view.



Paramedian sagittal oblique view

- “Sawtooth” appearance of the laminae
- Posterior complex (ligamentum flavum, epidural space and posterior dura)
- Anterior complex (anterior dura, posterior longitudinal ligament, vertebral body)





PHILIPS

Posterior

Spine

C5-2

23Hz

7cm

2D

F1

Gn 50

232dB/C5

D/3/2

Lamina

Interlaminar space

Ligamentum flavum

ESM

Epidural space

L3

L4

L5

Posterior dura

Intrathecal space

Cauda equina

Anterior complex

Acoustic shadow
of lamina



Cranial

Anterior

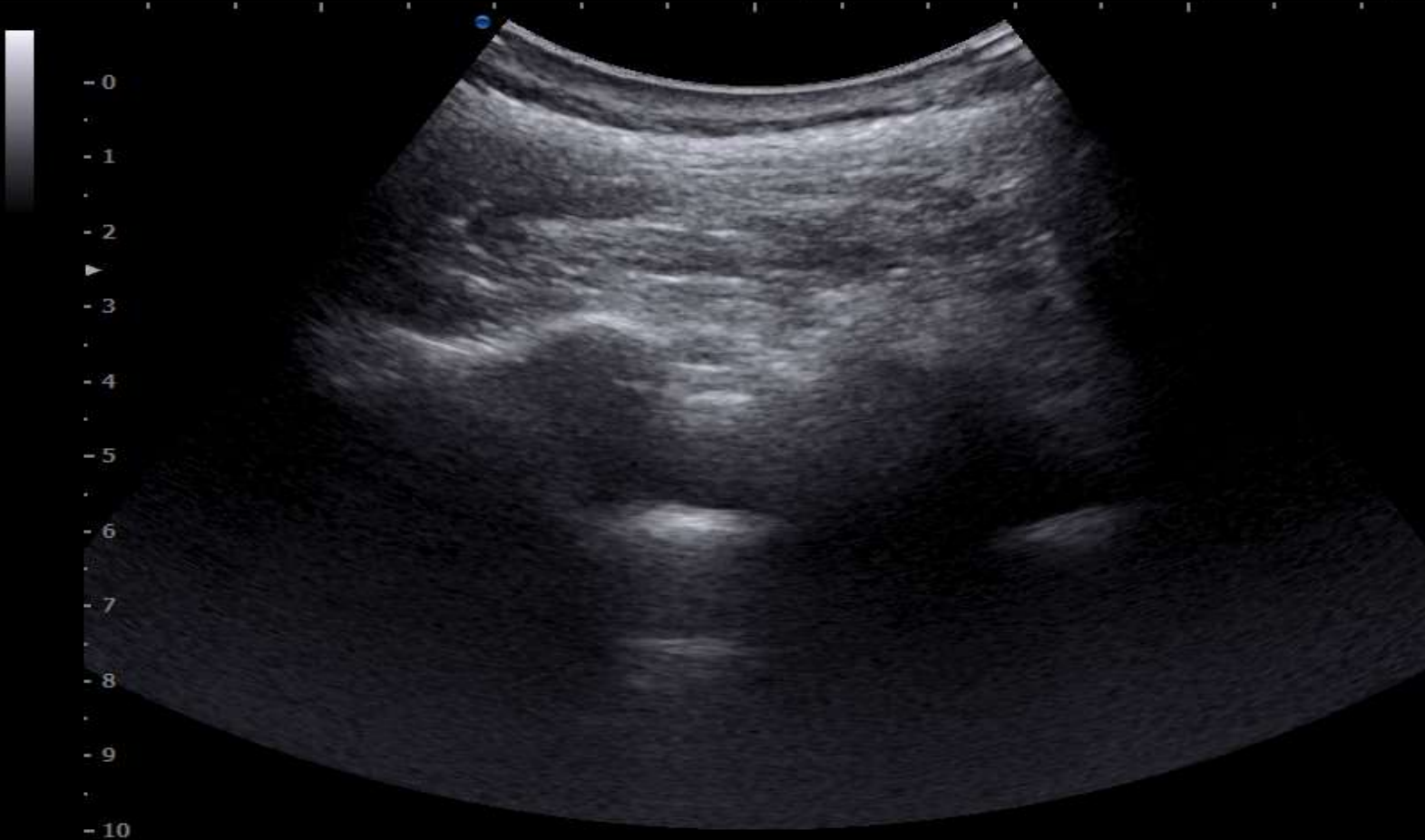
Caudal



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Dr. Abootorabi
Anesthesiology : Superfi...

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FR19

P75

THI On

HGen

4.0M

BG33

DR65

MI 1.1

TIS 0.2

TIB 0.2



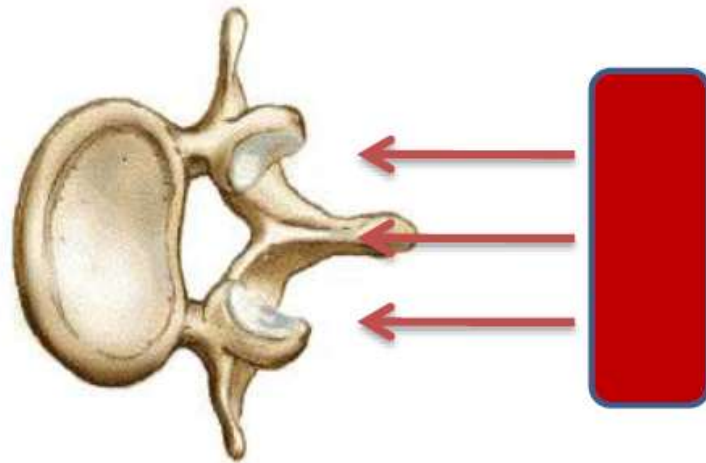


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Transverse View

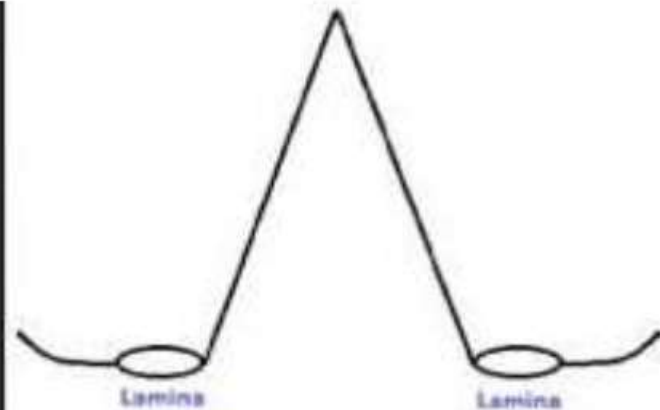
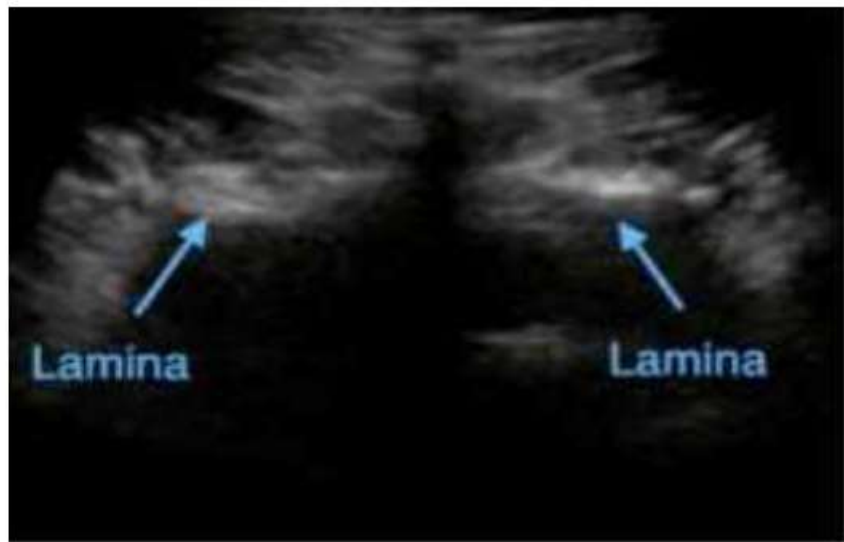
Transverse Spinous Process View

- Rotate the probe 90 degrees into a transverse orientation and slide it cephalad or caudad as required to obtain transverse interlaminar views of the desired interspaces.
- The probe may have to be tilted in a cephalad direction to optimize the view.

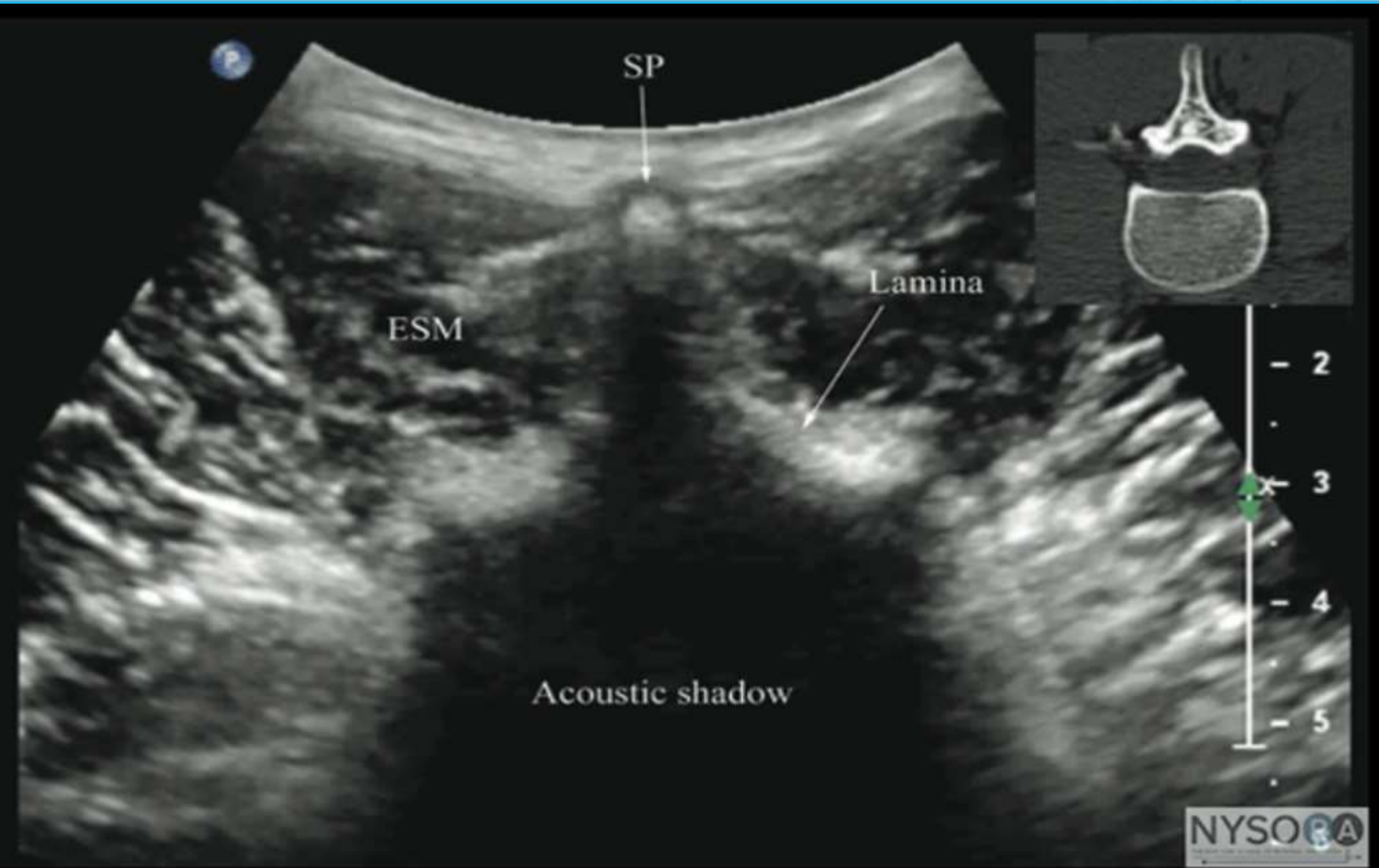


Transverse Spinous Process View

- A distinct midline shadow is cast by the spinous process
- Note the lamina are visible.
- But the anterior and posterior complexes are obscured

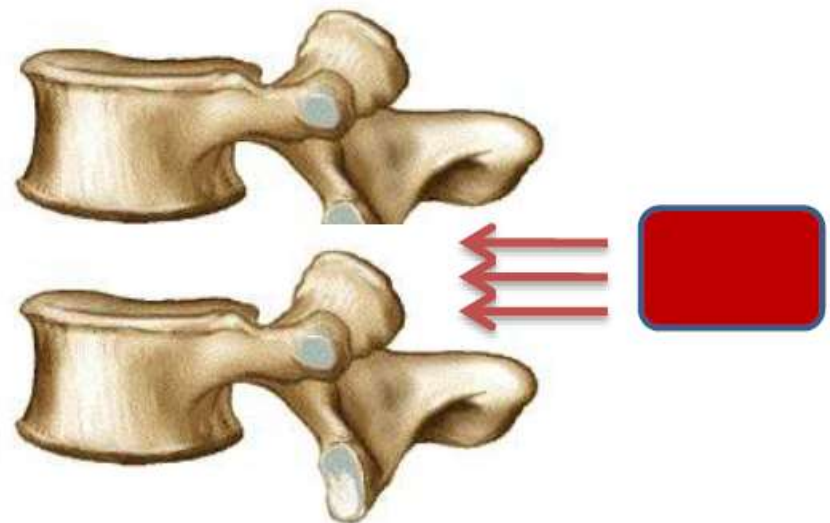
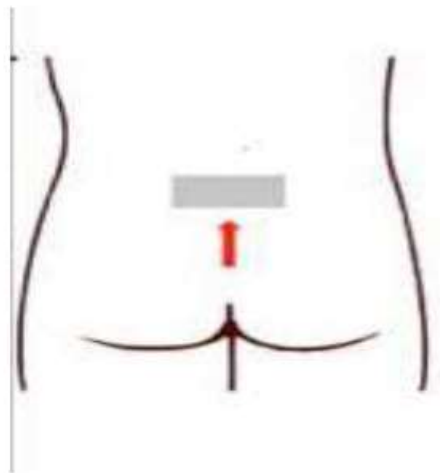








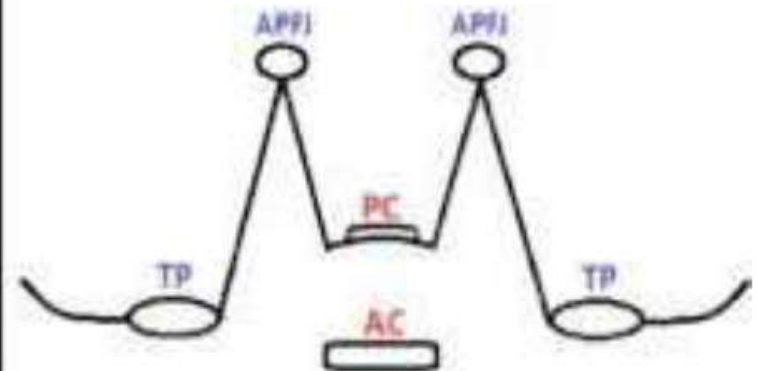
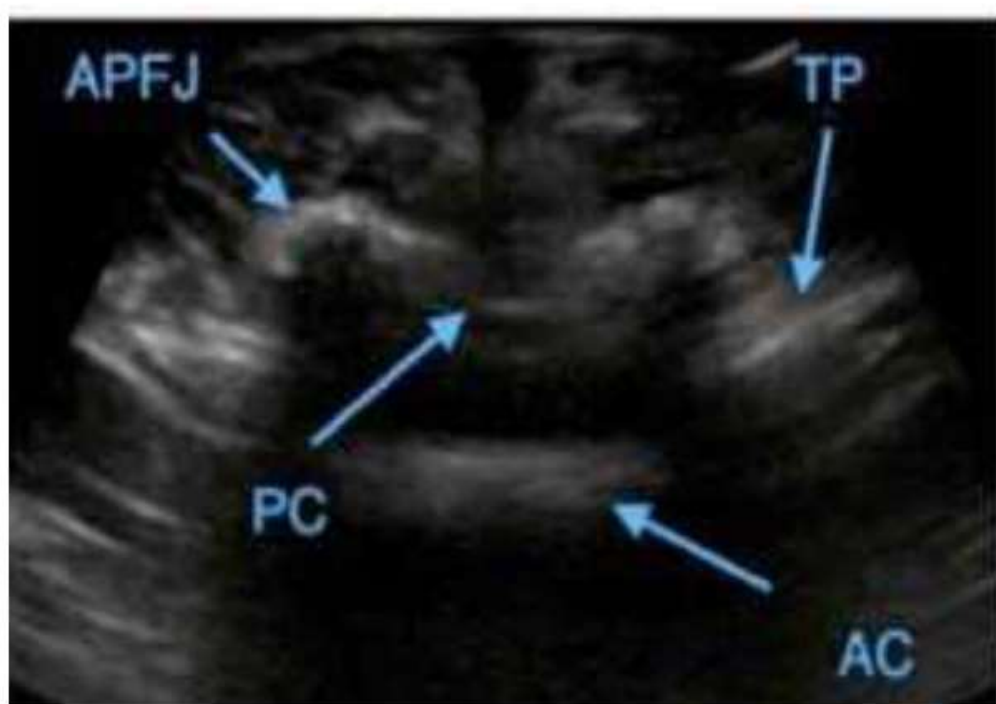
Transverse Interlaminar view

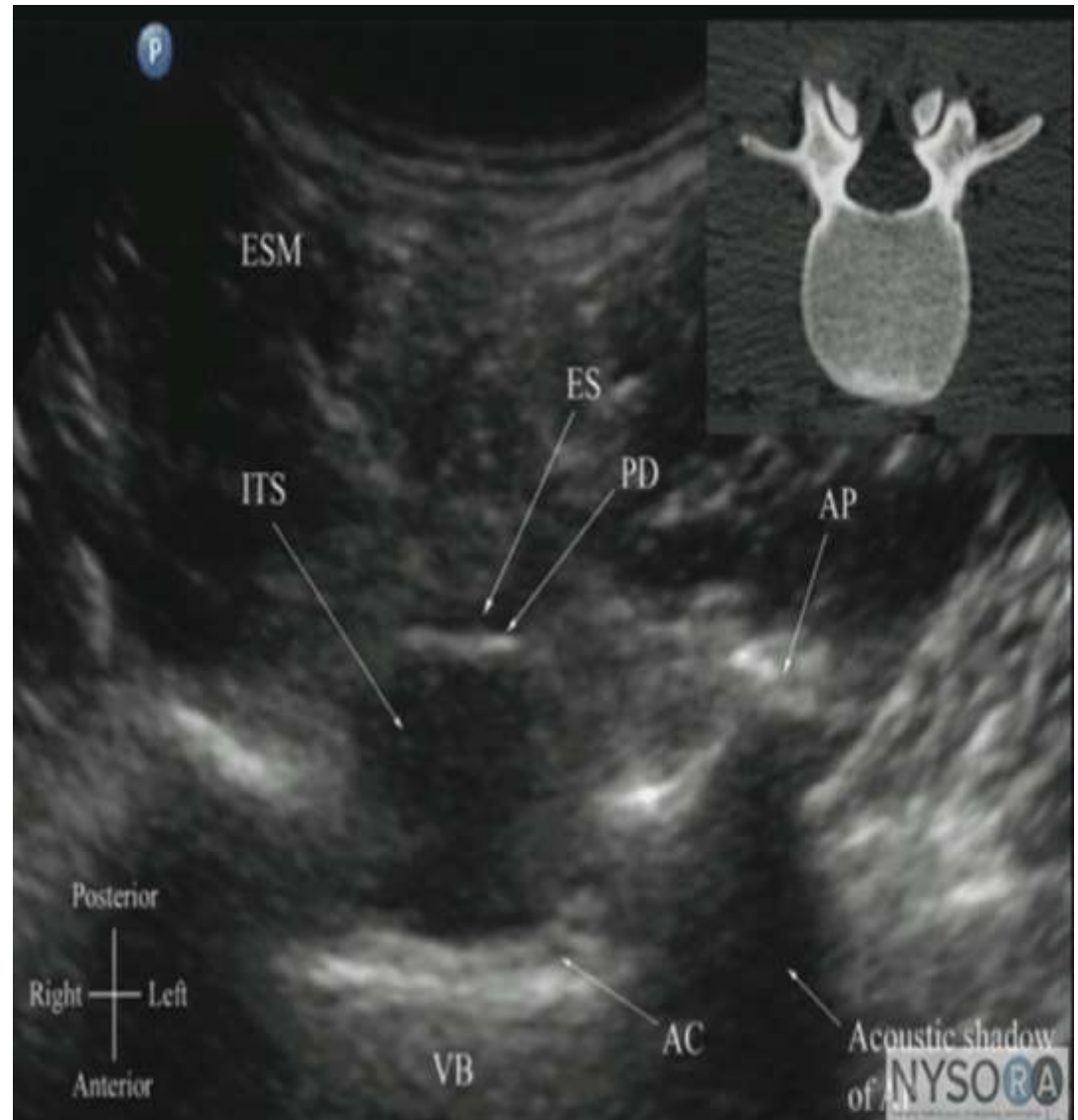


Transverse Interlaminar view

“Flying Bat”

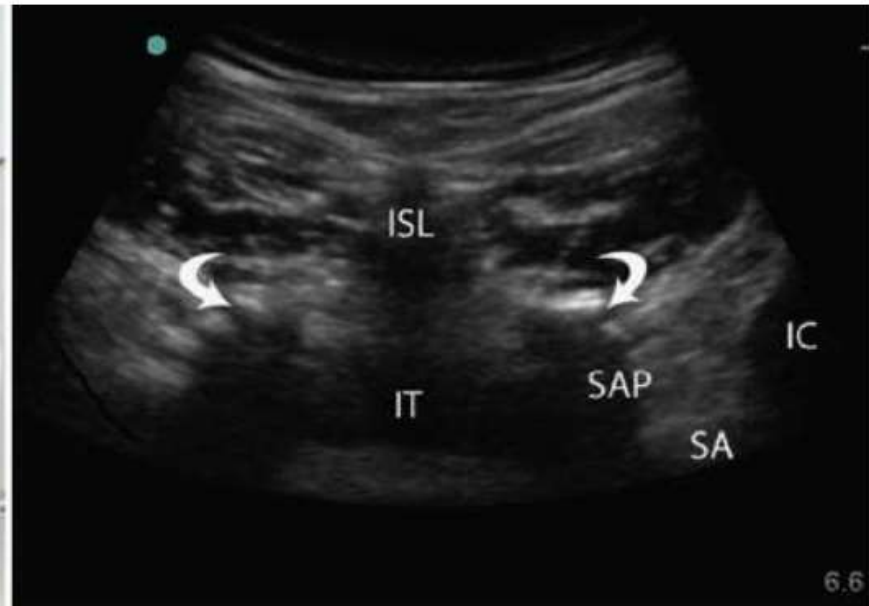
- The articular processes/facet joints (APFJ) and transverse process (TP) are visible.
- Tilting the probe will highlight the posterior and anterior complexes (PC / AC)

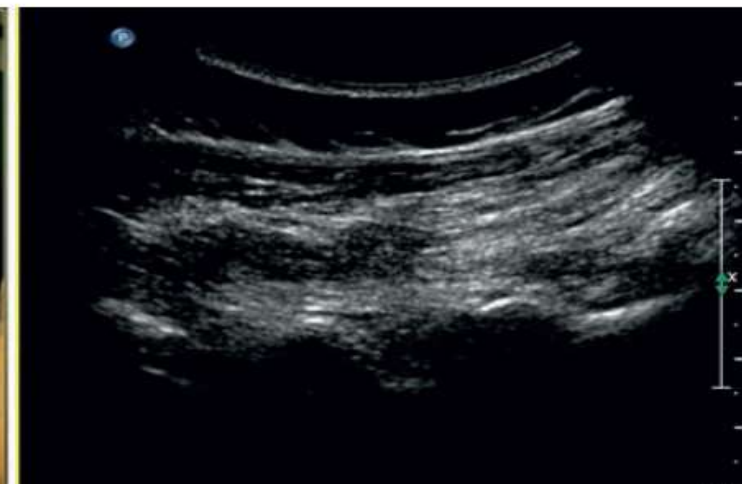
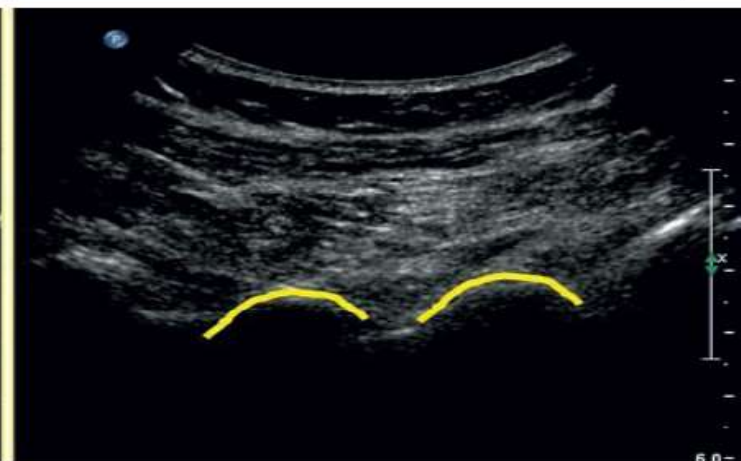
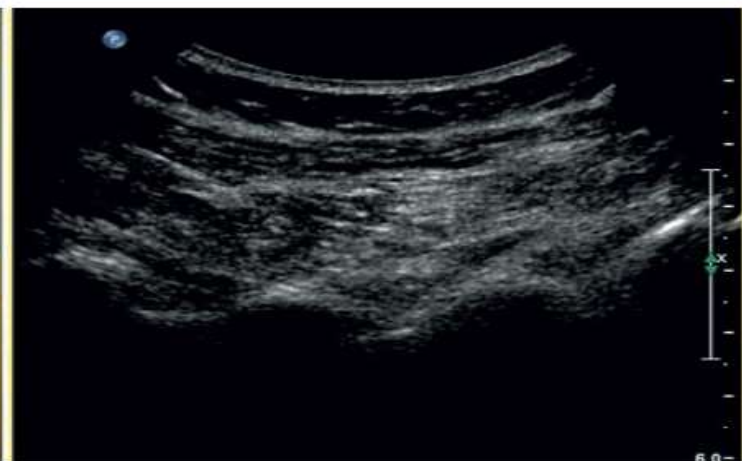


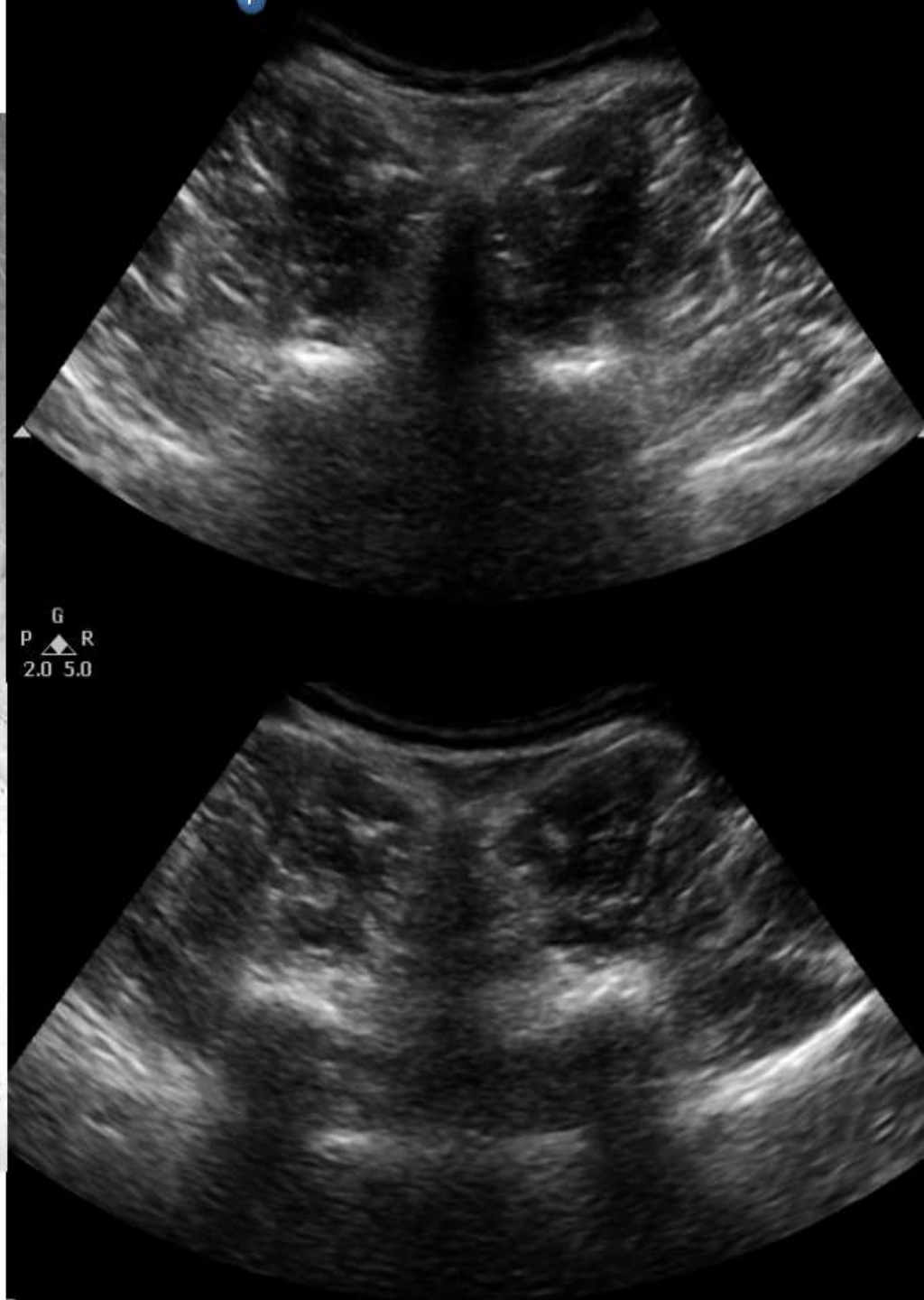
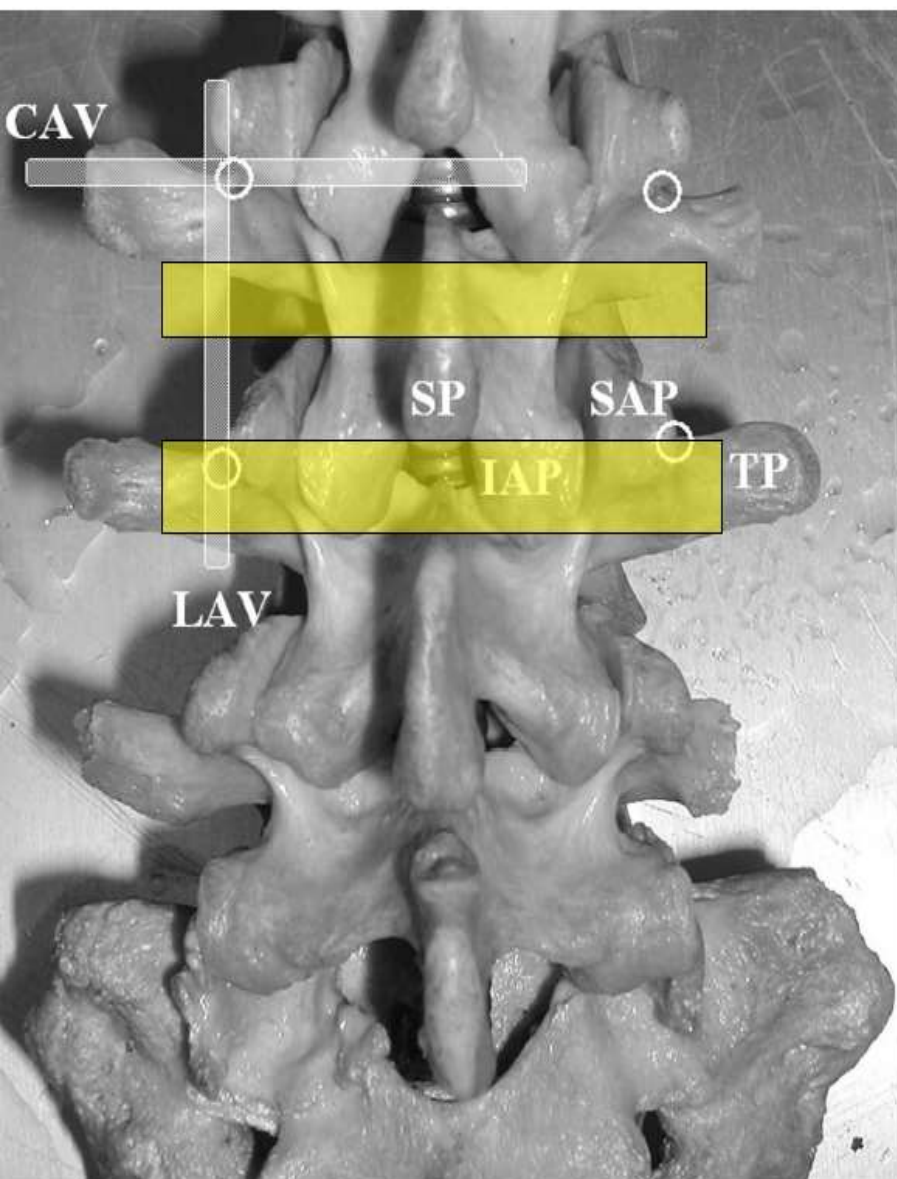


Transverse Interlaminar view

- hypoechoic L5/S1 interspinous ligament (ISL)
- L5/S1 zygapophysial joints (*curved arrows*)
- *the intrathecal space (IT)*
- *the S1 superior articular process (SAP)*
- the sacral ala (SA)
- the iliac crest (IC).









- ❑ The absence of radiation exposure
- ❑ Equipment
- ❑ Bedside setting
- ❑ Time procedure



Limitations



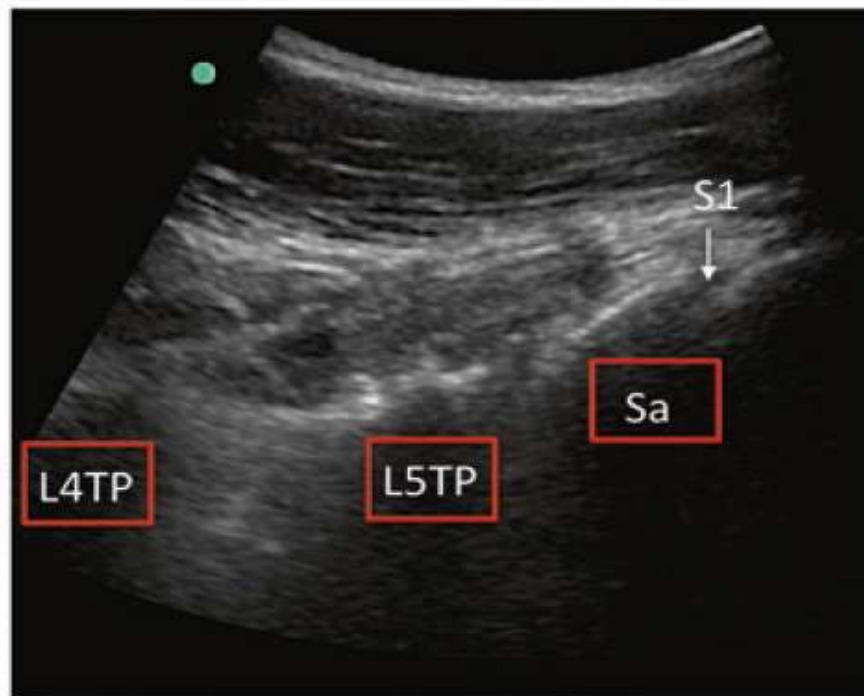
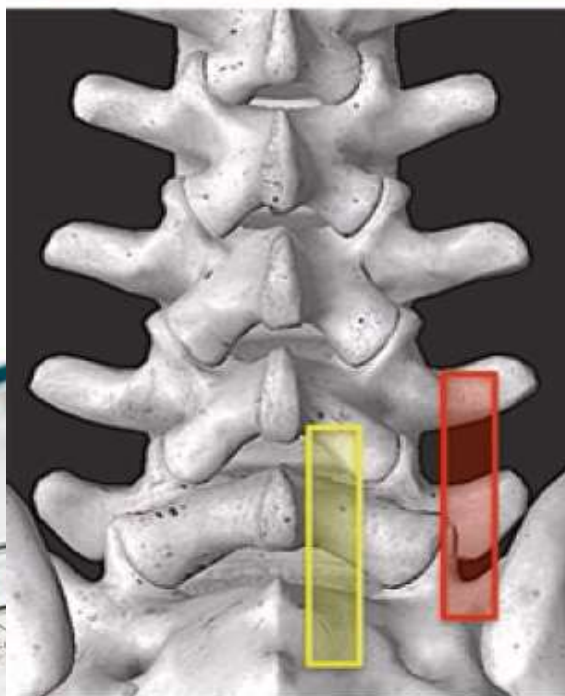
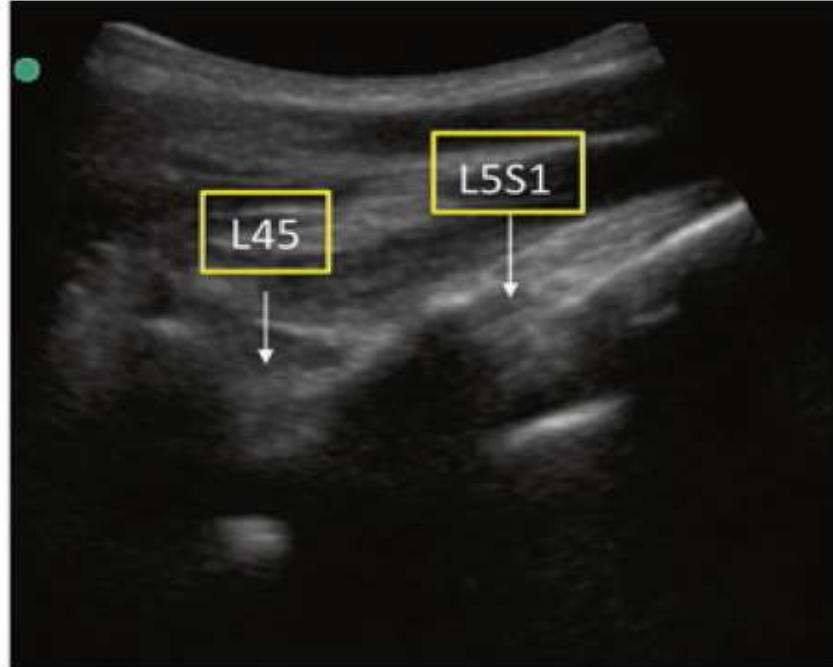
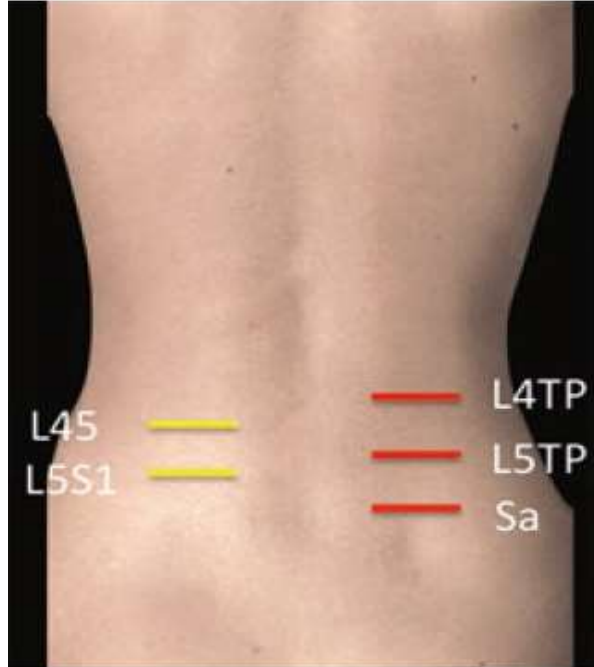
1. Obesity
2. Intravascular injection
3. Post surgery



How to Count the Level

Sagittal View





Ultrasound-Guided Lumbar Transforaminal Injections





- ❑ The transforaminal epidural steroid injection preferentially delivers injectate to the ventral epidural space.
- ❑ Optimally, the medication is placed at the suspected pathologic site that correlates anatomically with the patient's clinical and radiographic presentation.

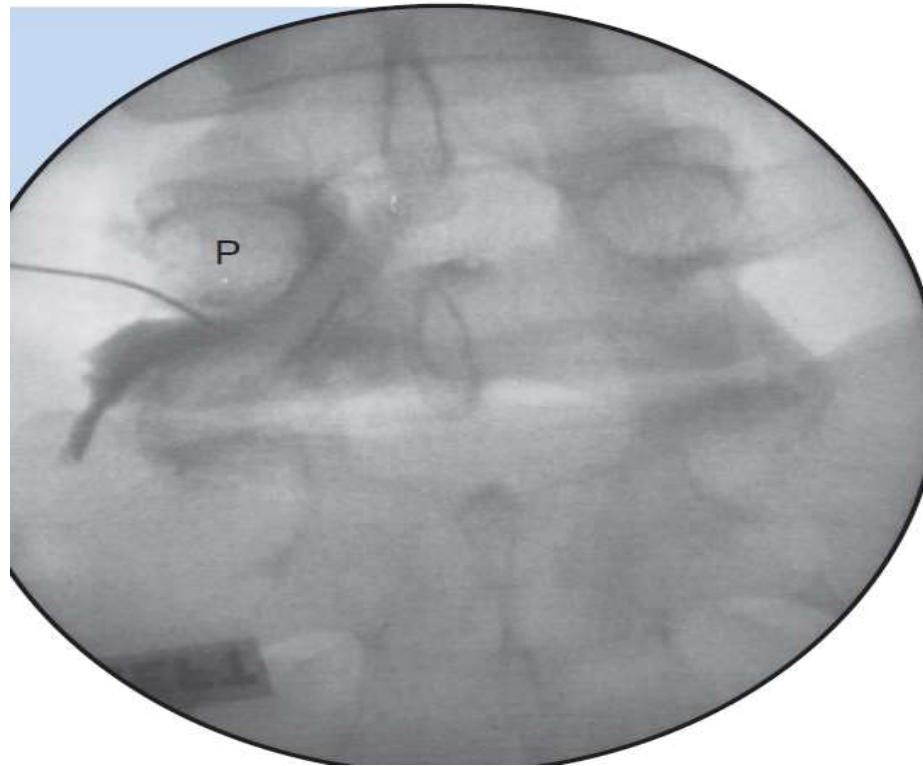


- ❑ Lumbar transforaminal injection is a commonly performed procedure to treat spinal radicular pain.
- ❑ Typically, these injections are administered under fluoroscopy or computed tomography.

Although considered relatively safe, several case reports of devastating neurological complication



Historically, the transforaminal approach to epidural steroid injection was accomplished with a traditional supraneural (subpedicular) needle position.



All reported events of permanent neurological damage were linked to the injections of **nonsoluble particulate** steroids. Current recommendations for safer and more accurate techniques include the adoption of radiopaque real-time and/or digital subtraction contrast injection prior to the instillation of a steroid.

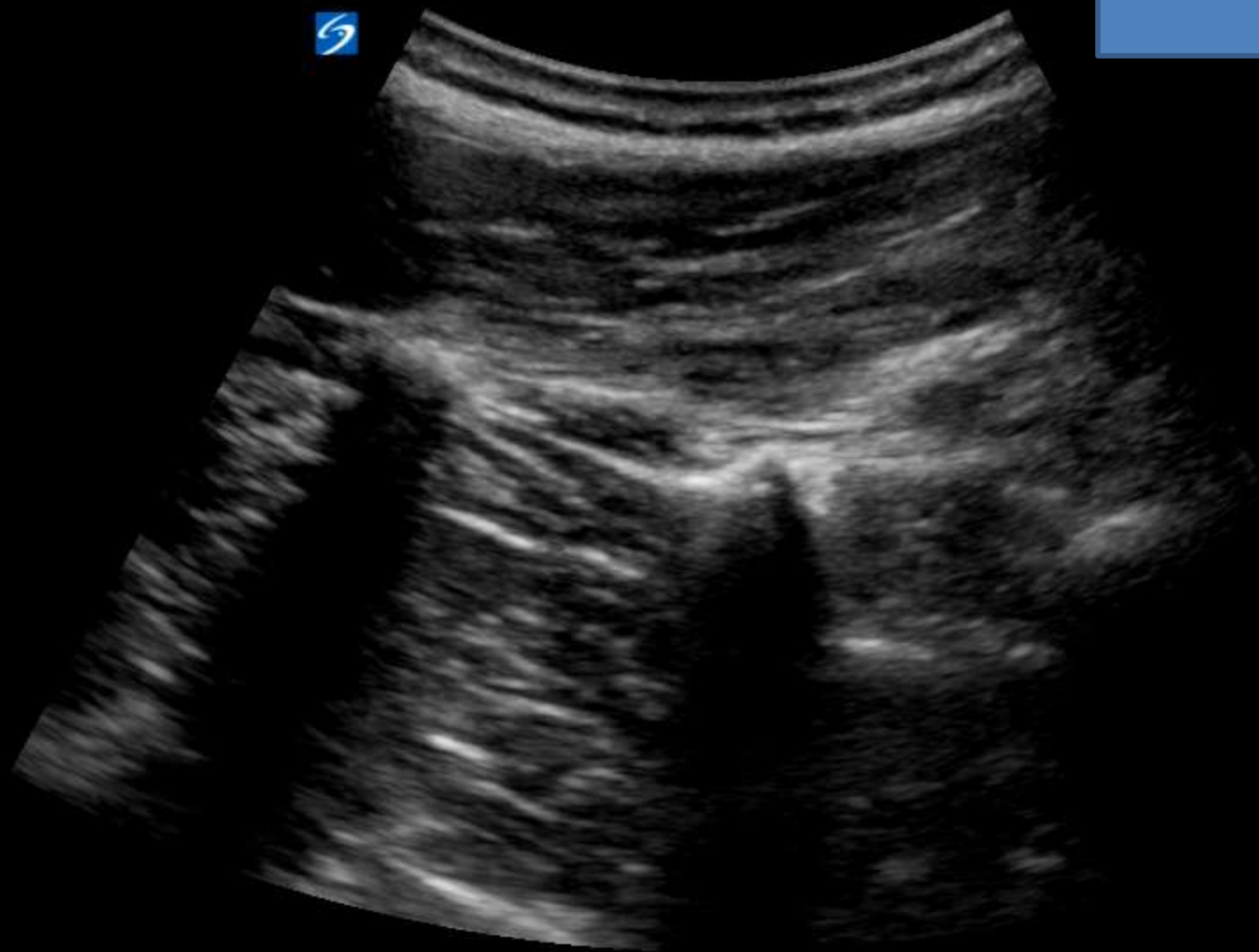


- ❑ The scanning was performed in the SAGITAL (PARAMEDIAN)
- ❑ The operator announced the level of injection.

The ultrasound transducer was positioned at the short axis paramedian view between 2 adjacent transverse processes, so the sonogram reflected the spinous process, lamina, and dorsal part of the vertebral body



VIDEO

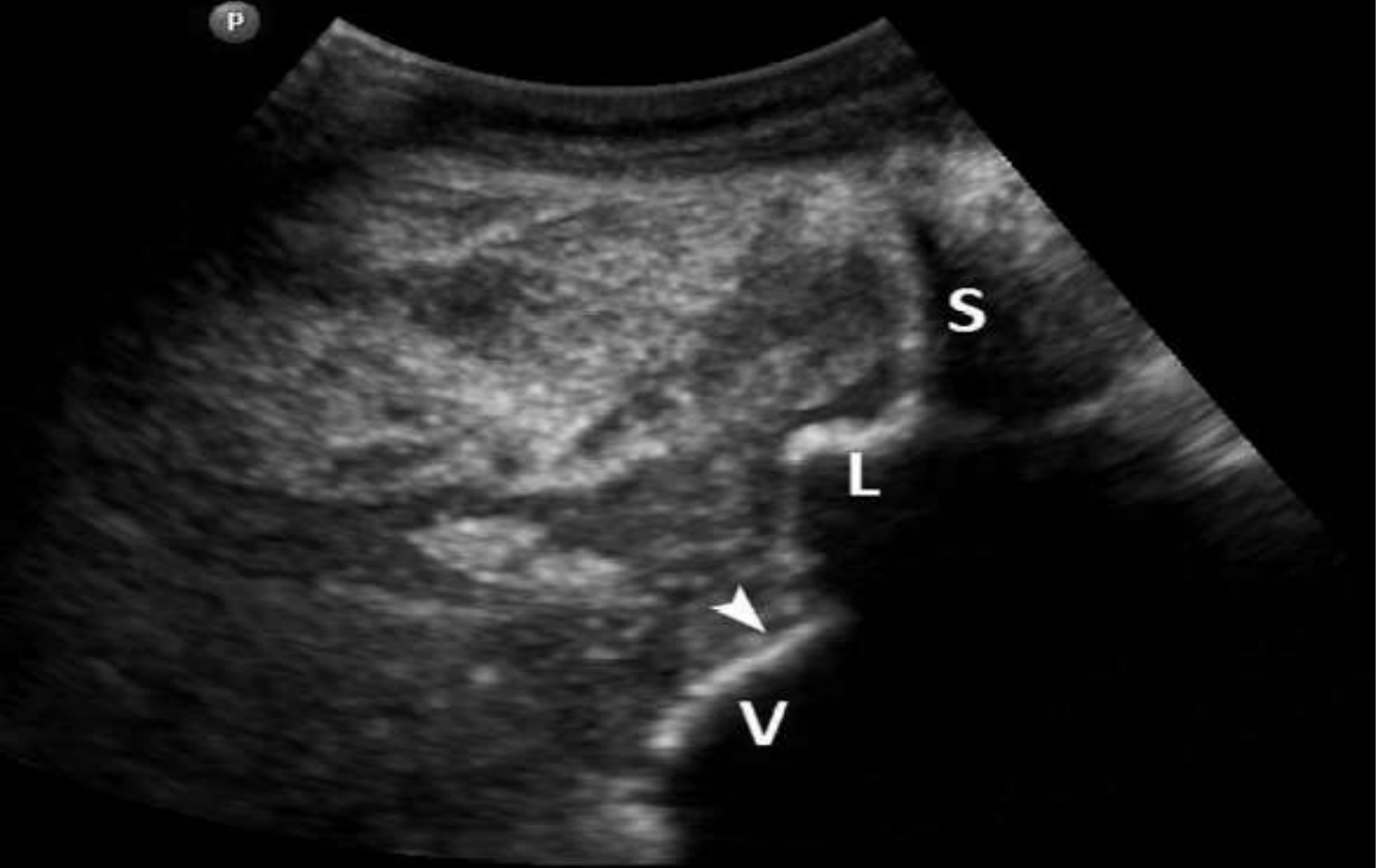


8.7 cm

SonoSite

C60xp/5-2 Abdomen
MI: 1.1 TIS: 0.2

2D: G: 50
Gen DR: 0
MB
THI





❑ Quincke-type spinal needles were inserted by using the in-plane approach, aiming to for the **most medially visible shadow** of the vertebral body.

❑ Once the needle touched the bone surface, 1 mL of Dye was injected. Then anteroposterior and lateral fluoroscopy was performed.









Ultrasound-Guided Lumbar Transforaminal Injections: Feasibility and Validation Study

- Corresponding Author: Michael Gofeld, MD.

Methods. We addressed the procedural accuracy of ultrasound-guided lumbar transforaminal injections and proposed anatomically sound approach. Fluoroscopic validation was performed.

Results. Out of 50 planned injections 46 procedures were performed. L5/S1 foraminal access was impossible in four cases (8%). Fluoroscopy confirmed the correct foraminal placement in all 46 injections (100%). The contrast spread pattern was intraforaminal in 42 cases (91.3%) and extraforaminal (nerve root) in four cases (8.7%). When intraforaminal pattern was detected on anteroposterior image, lateral fluoroscopy demonstrated ventral epidural flow in all occasions. In three cases, intravascular injection was detected (6.5%)

Conclusion. Ultrasound-guided lumbar transforaminal injections are accurate and feasible in the preclinical setting.





Ultrasound-Guided Lumbar Transforaminal Epidural Injections; A Single Center Fluoroscopic Validation Study

Document Type: Original Article

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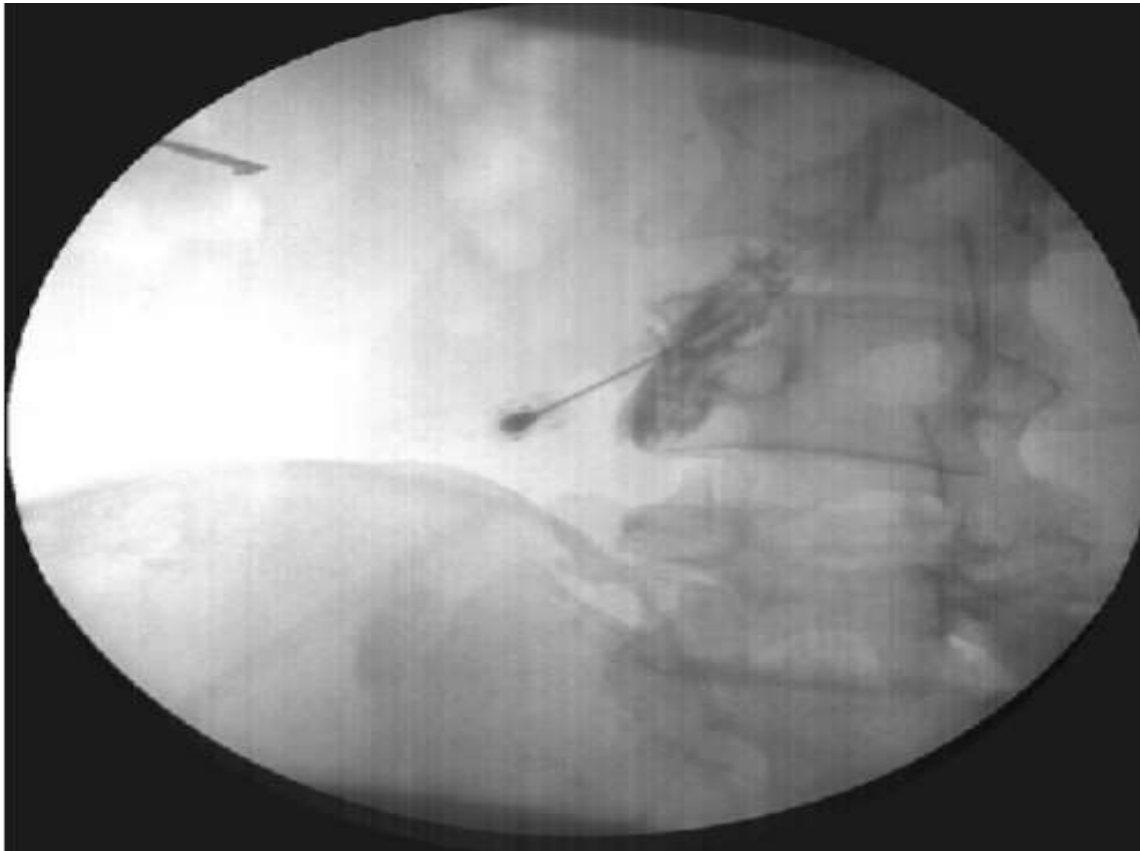
² Anesthesiology Research Center, Shahid Beheshti University of Medical Sciences, Tehran, Iran

 10.29252/BEAT-070307

accuracy of ultrasound- guided lumbar transforaminal injections approach. Results: The accuracy of ultrasound-guided interventions was 90% as confirmed by fluoroscopy. There were 2 failed cases at the L4-L5 level in the US-guided. The success rate in L5-S1 level was 100%, in L4-L5 level was 80% and in L3-L4 level was 100%. No complications were noted. Conclusion: Ultrasound-guided lumbar transforaminal epidural injections are accurate and feasible in clinical setting with an accuracy of 90% and no complications.



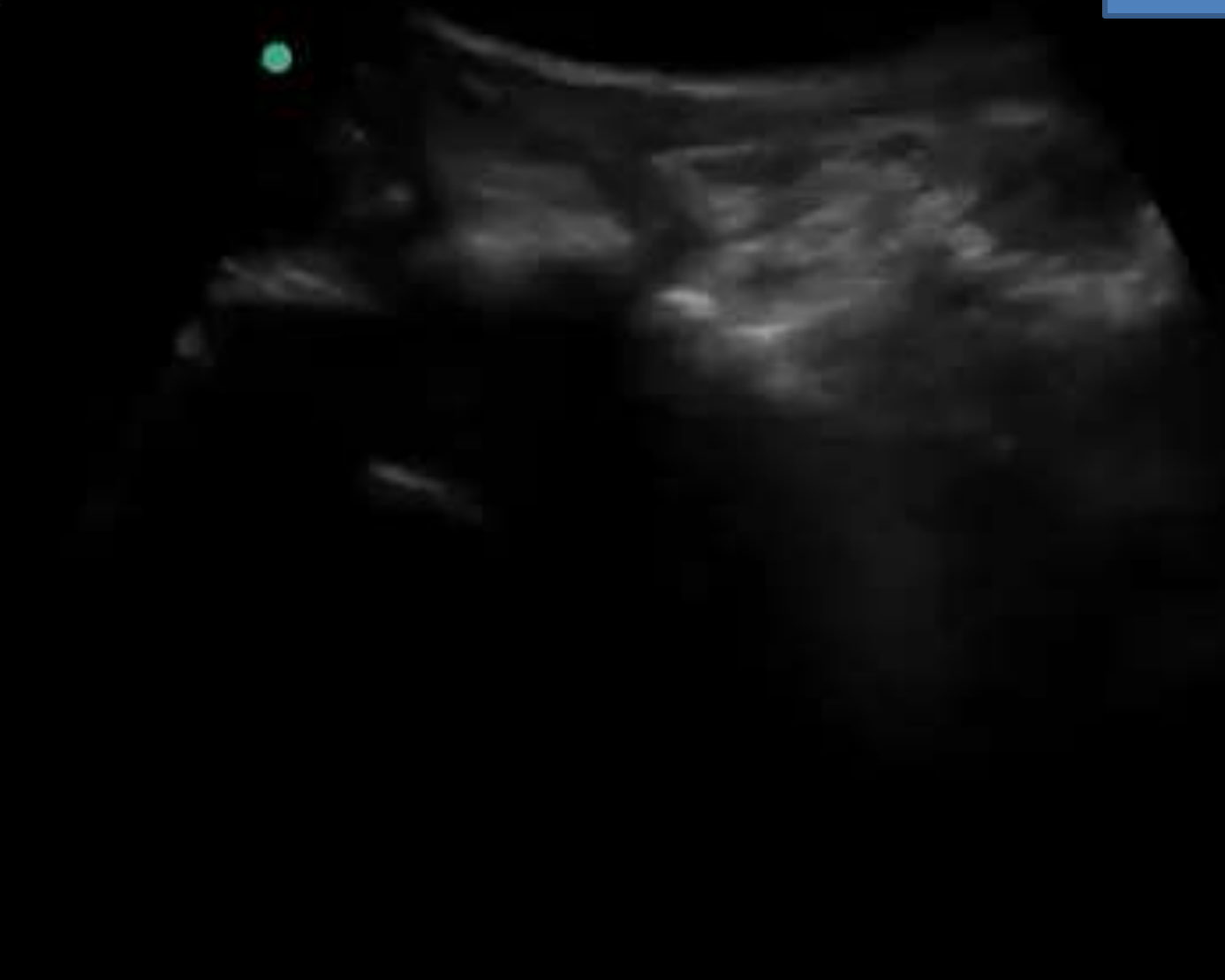
(Psoas Muscle)





Gen THI
S MB

VIDEO



89%
MI
0.8
TIS
0.2
A
B

6.6



Gen



0



Guide



MB On



On

Page 1/3

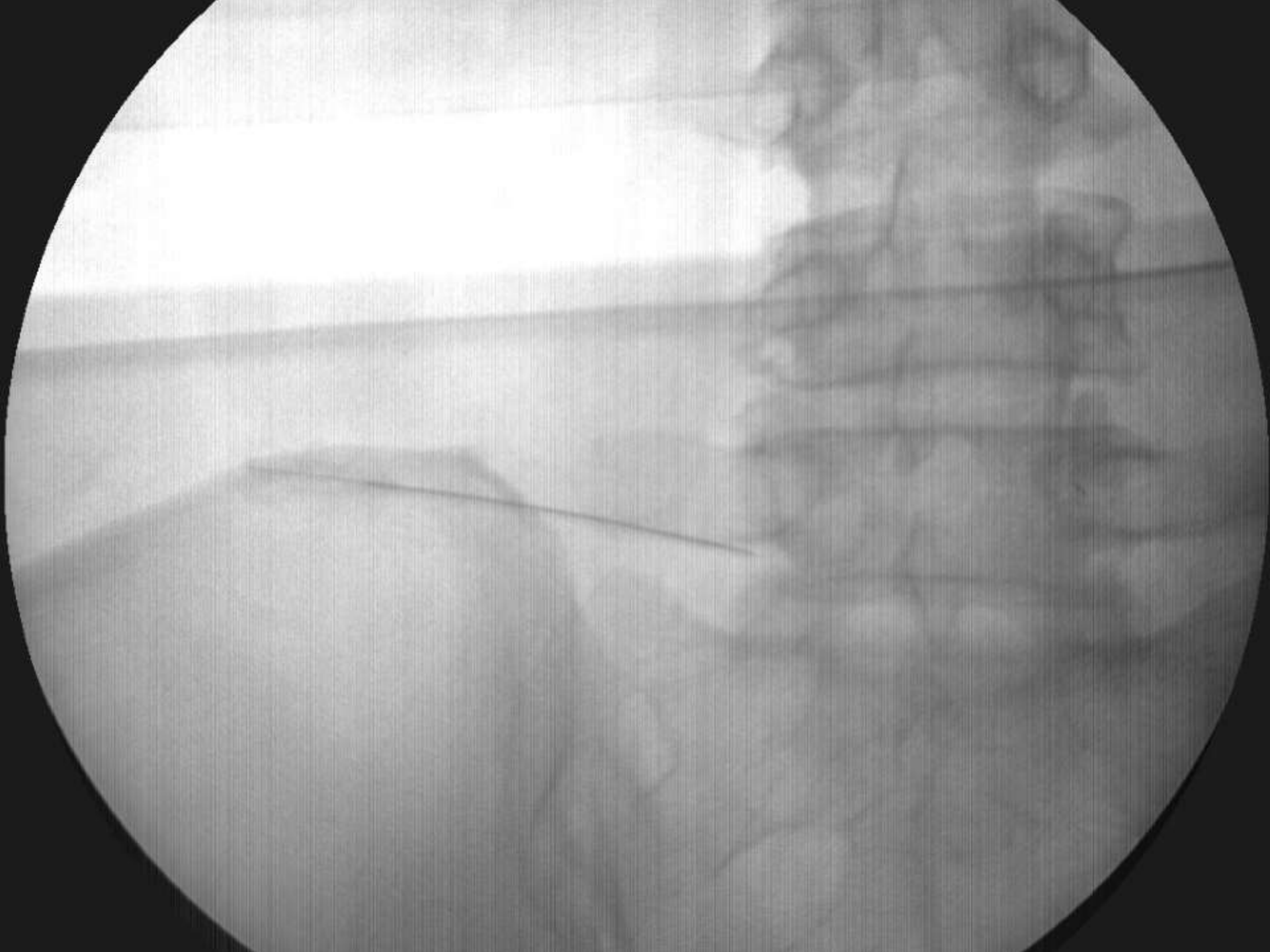


8.7 cm

SonoSite

C60xp/5-2 Abdomen
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MB
THI



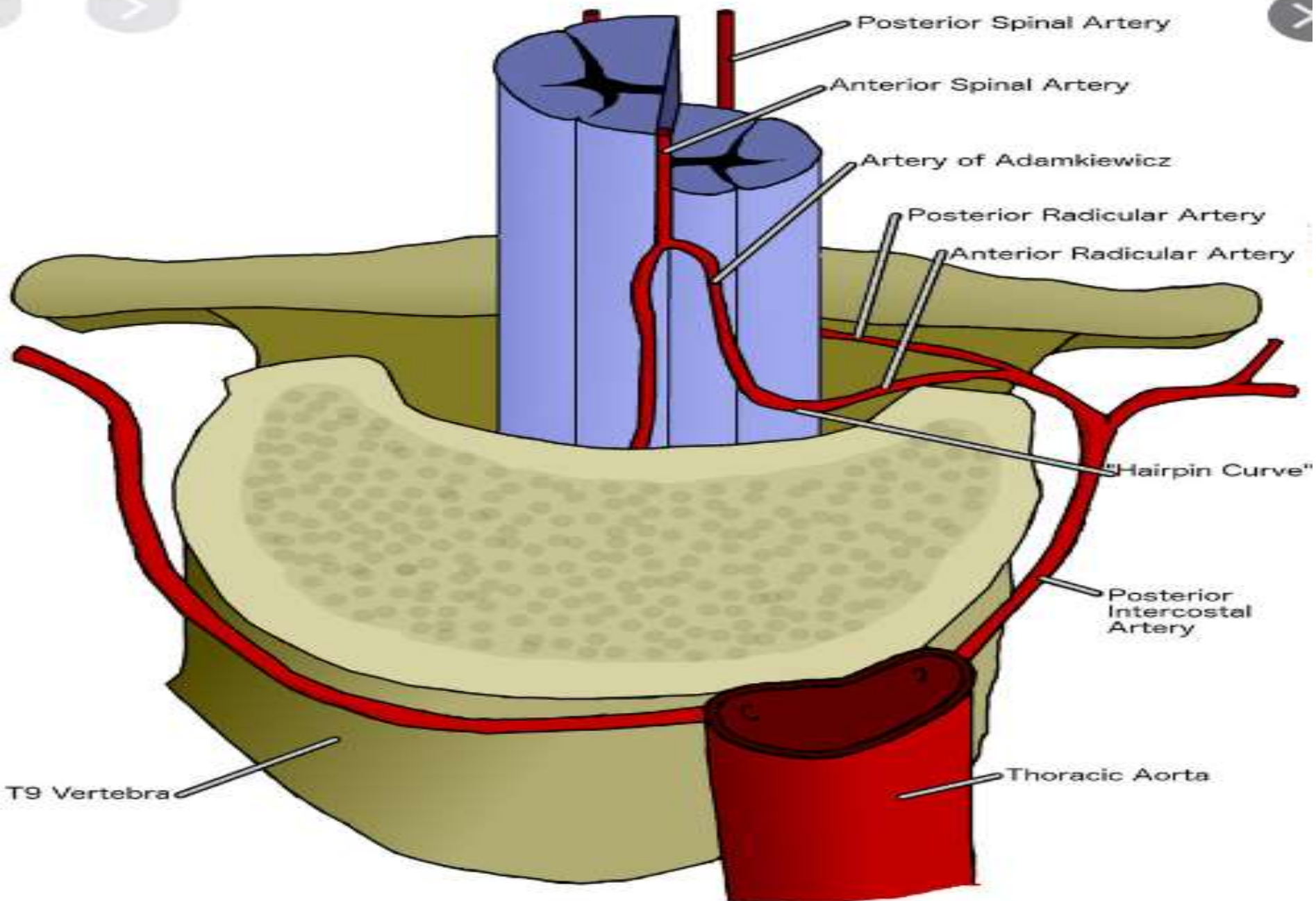


Postepidural steroidinjection paraplegia



Within the spinal canal, there is an arterial and venous network, both anteriorly and posteriorly, which is formed from the spinal arteries that enter at each vertebral level via the intervertebral foramina. The spinal arteries originate from the vertebral arteries, as well as the aorta. These arteries then anastomose with the artery of **Adamkiewicz** and run along the surface of the spinal cord,





The artery of Adamkiewicz, also known as the anterior segmental medullary artery or the arteria radicularis magna (ARM), provides blood supply to the lower two-thirds of the spinal cord via the ASA. It typically arises from a left posterior intercostal artery (in 69–85% of cases). **It may enter the spinal canal at any intervertebral foramen from T8–L3** (with the highest incidence at T10), although it has been documented that the artery may enter at a broader range of levels from T2 to L5.

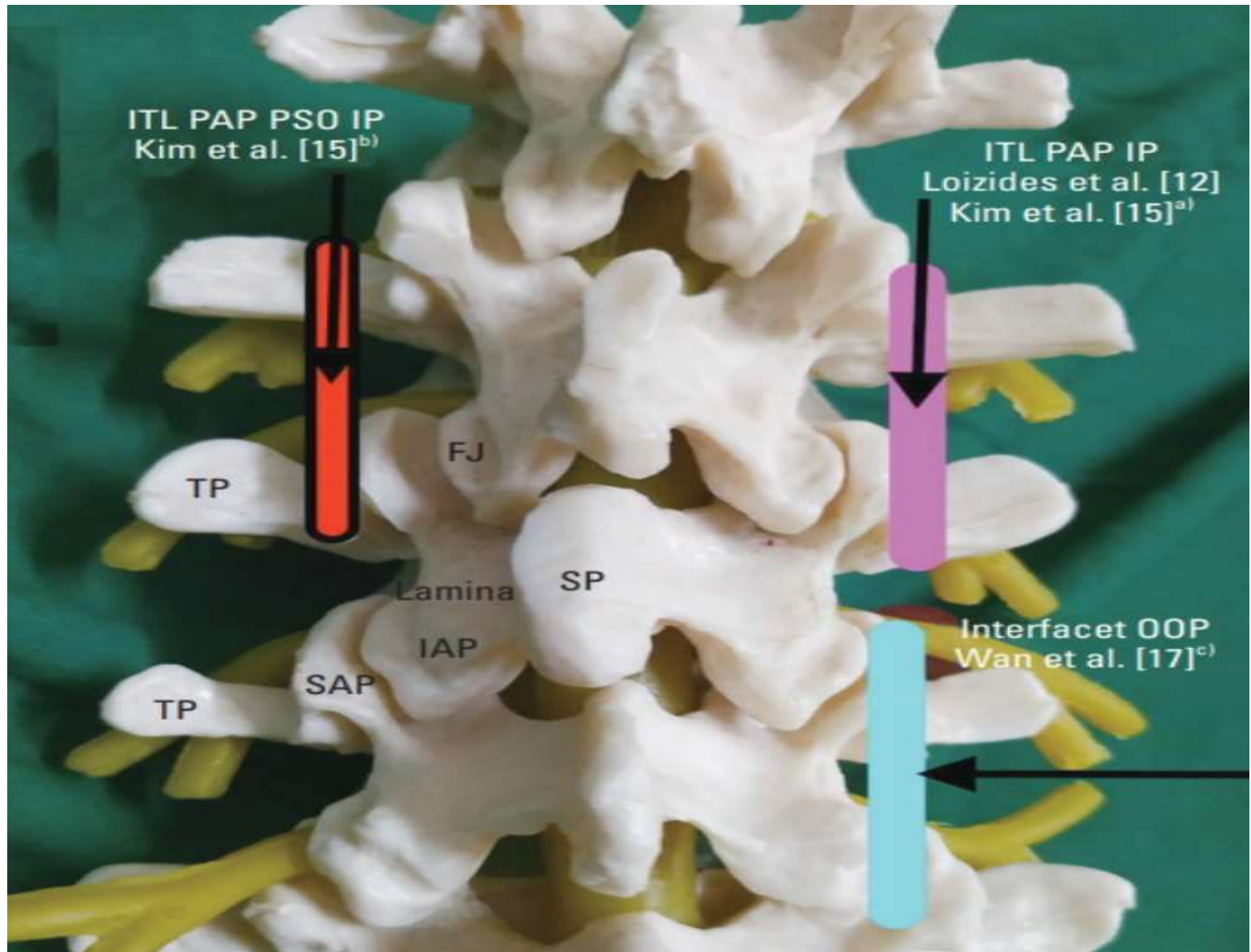
To avoid the artery of Adamkiewicz during a transforaminal epidural steroid injection, entering the inferior portion of the foramen is of utmost importance

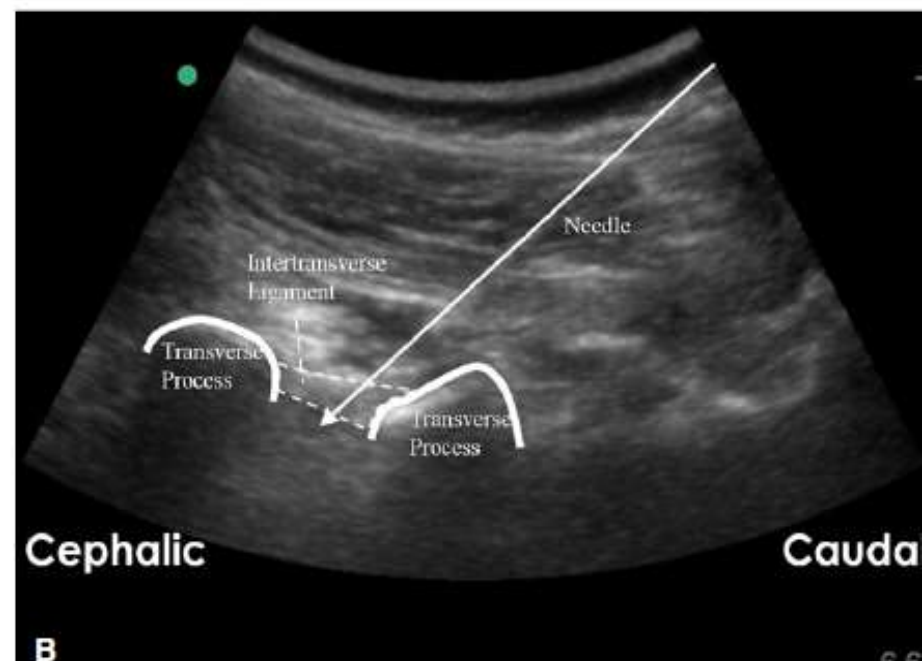
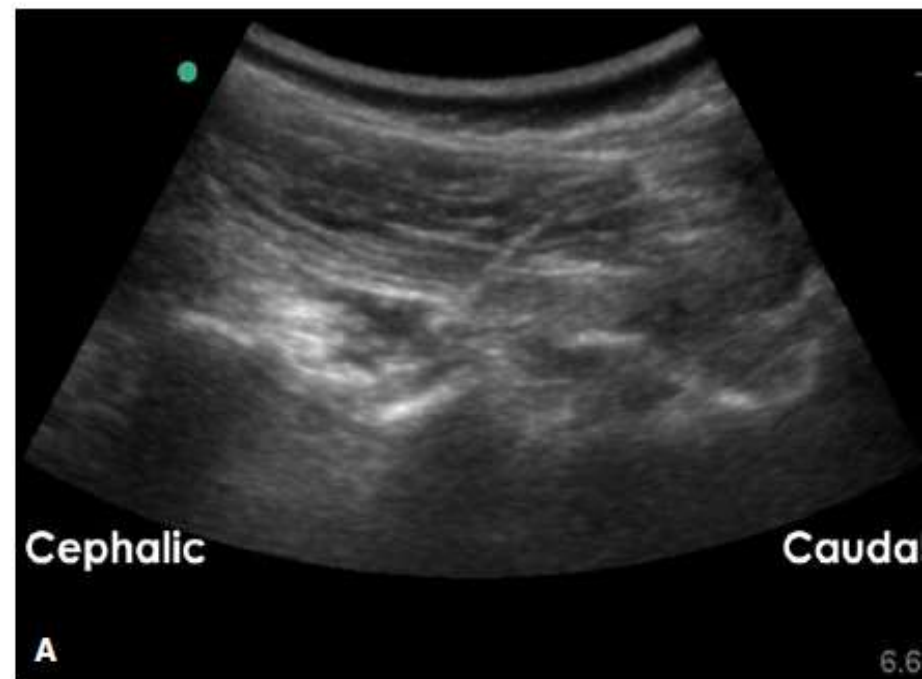
A retrospective study performed by Murthy et al demonstrated that the artery of Adamkiewicz was located in the superior one-half of the foramen in 97% of patients.

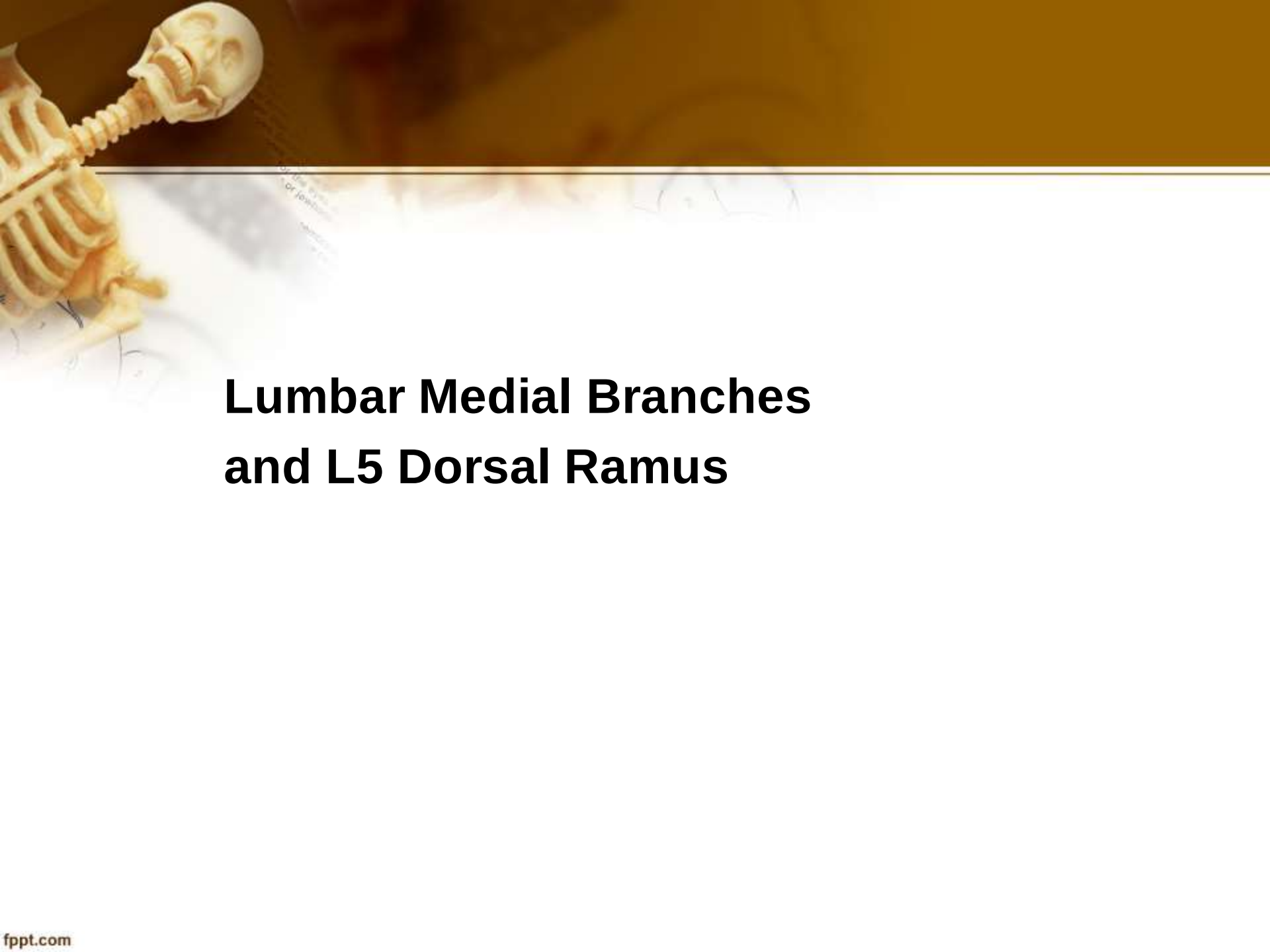
and **only 2%** of the time was it located in the lower one-third.



OTHER APPROACH







Lumbar Medial Branches and L5 Dorsal Ramus



The contribution of lumbar facets to low back pain ranges

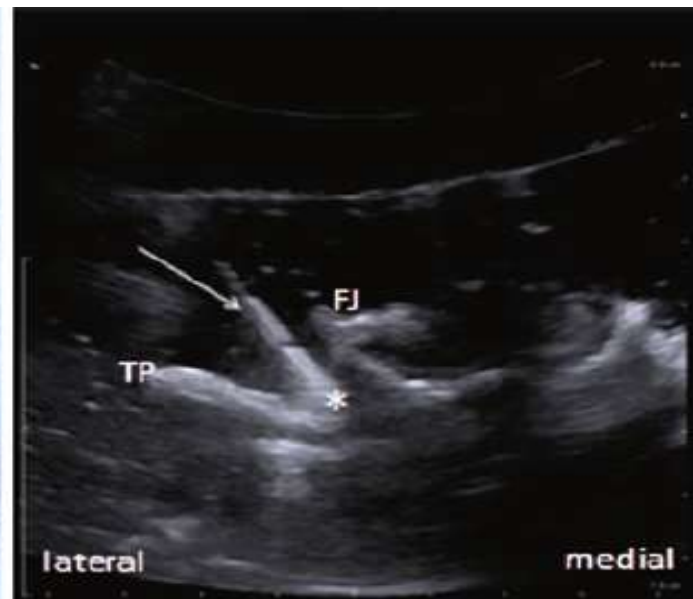
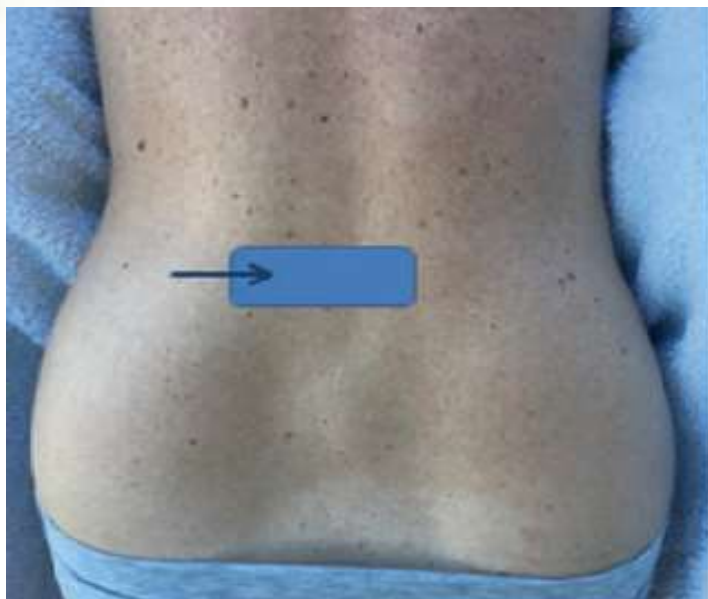
between 25% and 45%.

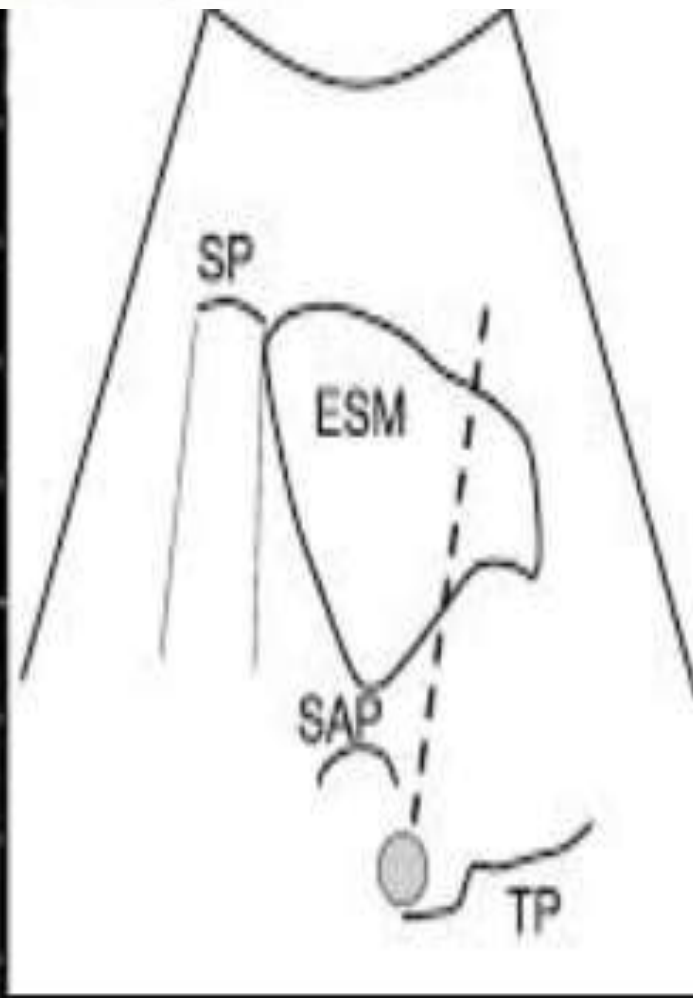


The target for medial branch is the **junction of SAP with the cephalad border of TP.** The most important exercise here is to understand the sonographic feature of transverse process (TP) and how to determine the most cephalad border TP is bone and cast an anechoic shadow deep in the scan

If one is not sure, move the transducer cephalad and one can tell the difference.

Inbetween the transverse process, a bright hyperechoic line can be cast by the intertransverse ligament and the fascia overlying the psoas. However, it allows the psoas to be seen





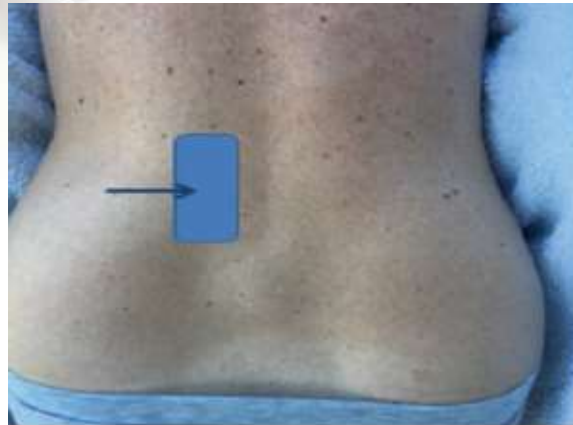
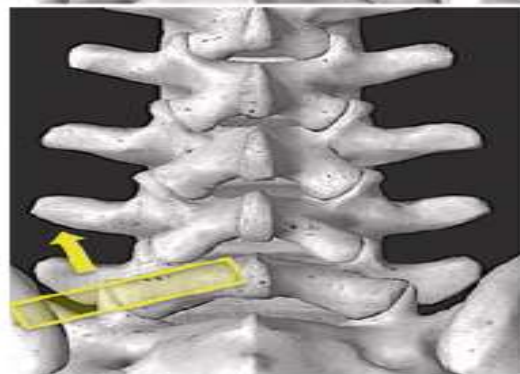
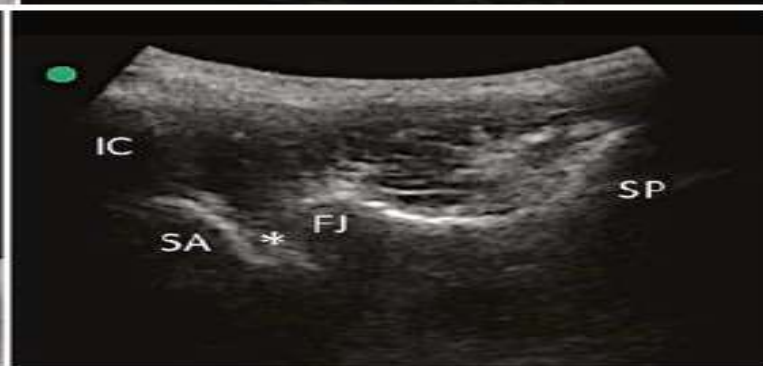
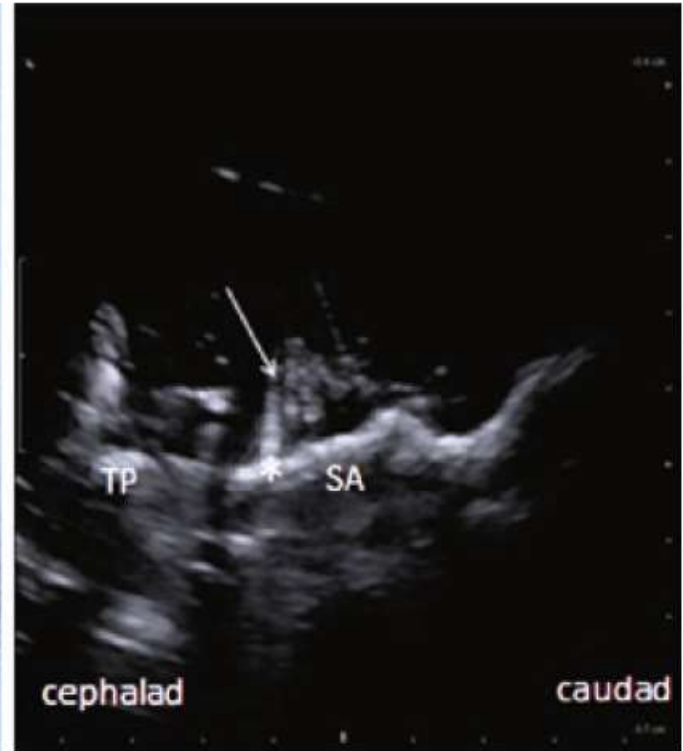


Fig. 14.12 Checking the needle position in the paramedian sagittal transverse process view. (reprinted with permission from Philip Peng Educational Series)









1. Before the use of ultrasound guide facet nerve injection, always check the X-rays to account for lumbarization or sacralization (important for counting) and the presence of spondylolisthesis (which affect the accuracy of target localization).
- 2. Select your patient. The accuracy of the block under ultrasound guidance
- substantially diminished when the body mass index is high.

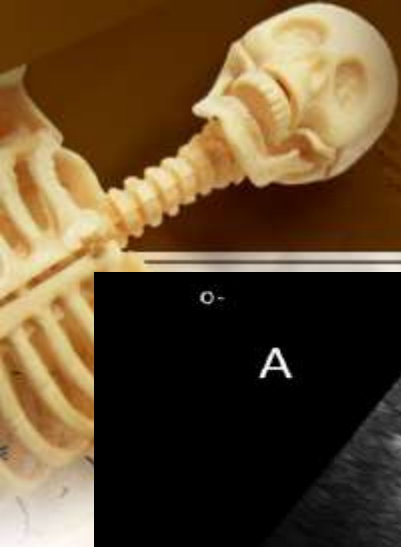


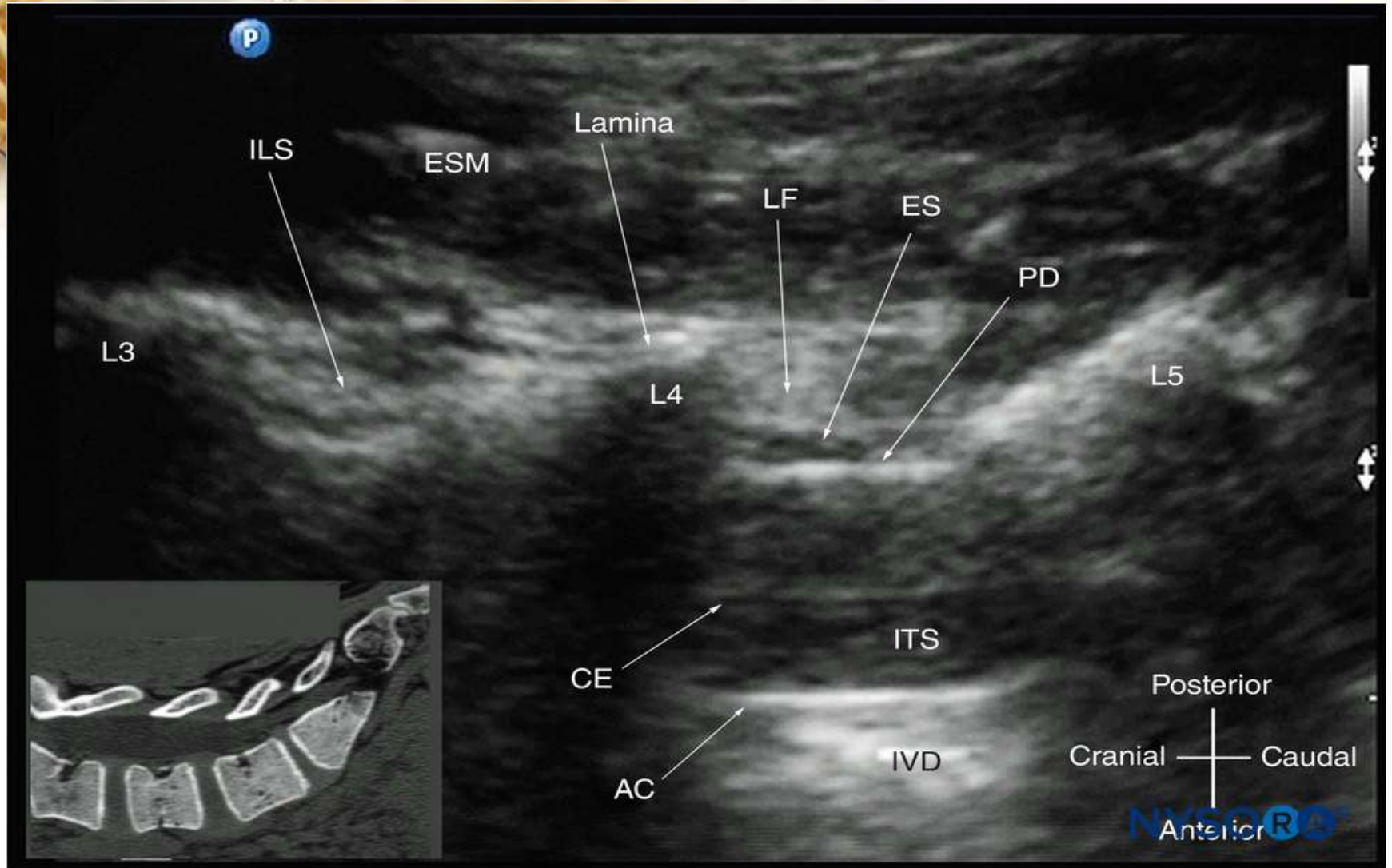
Interlaminar epidural injection

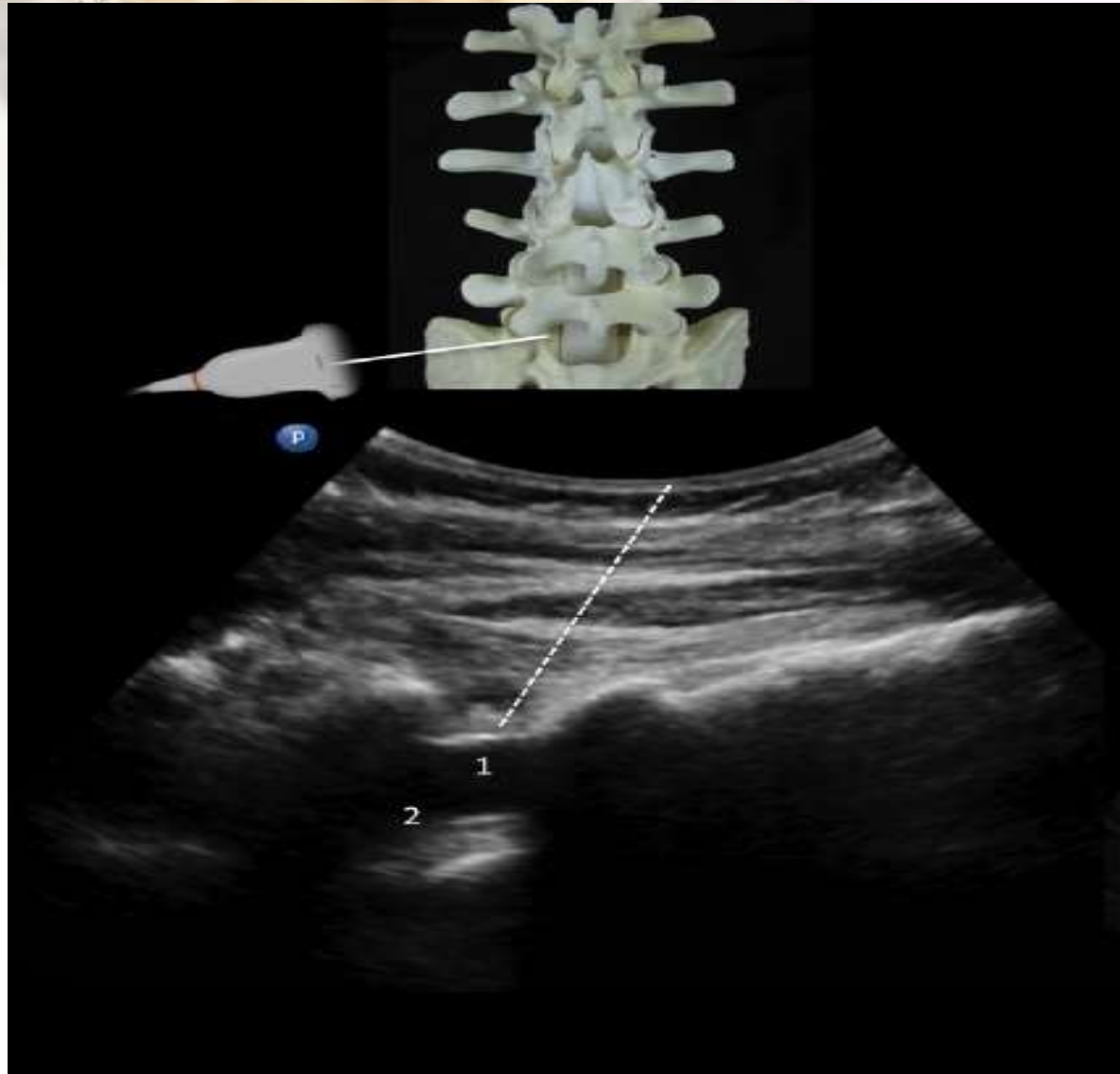
- The epidural injection of corticosteroids is the most commonly performed intervention in pain clinics in world.
- failure **rate of up to 42%** in patients with obesity.(without the use of image control).

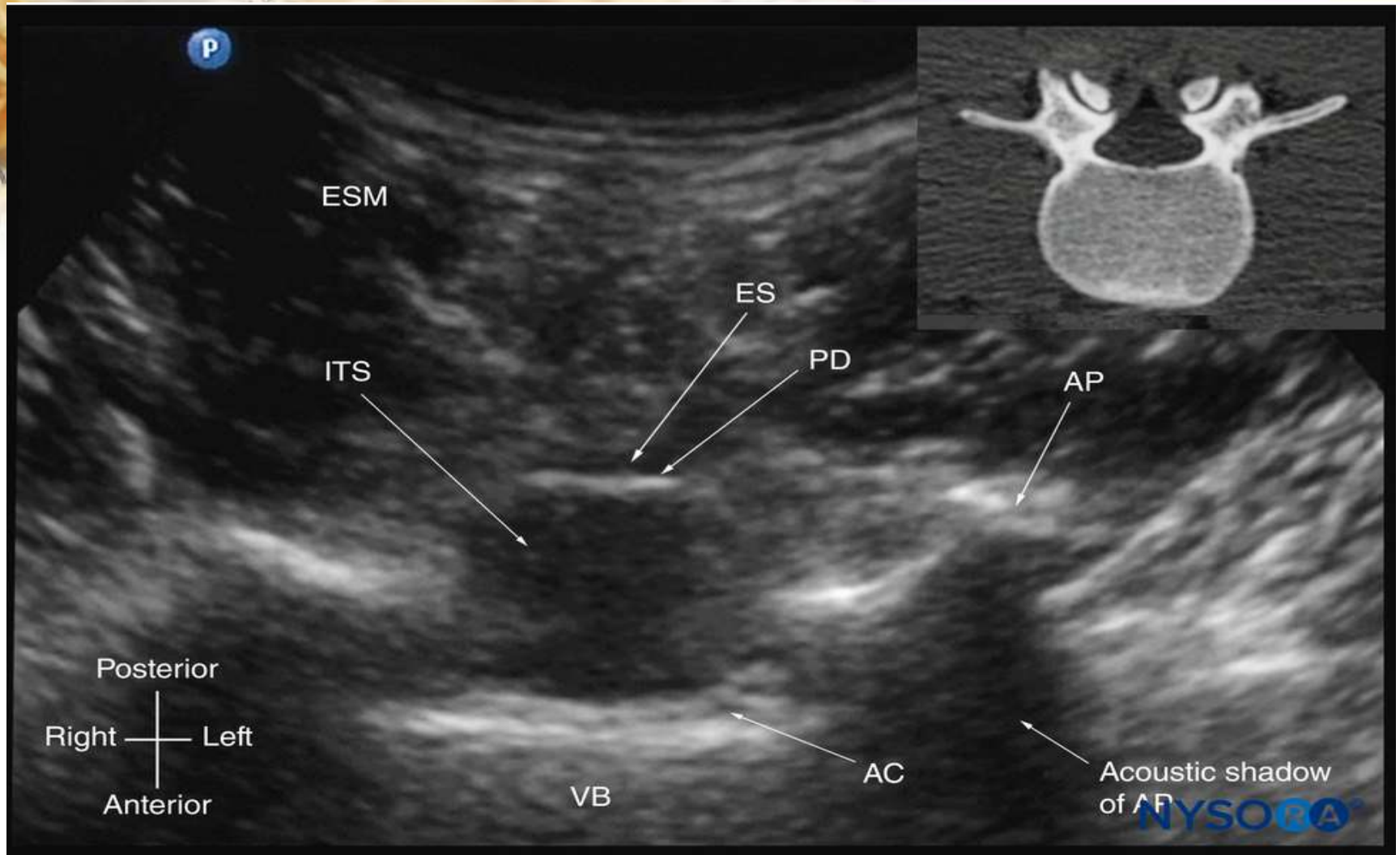
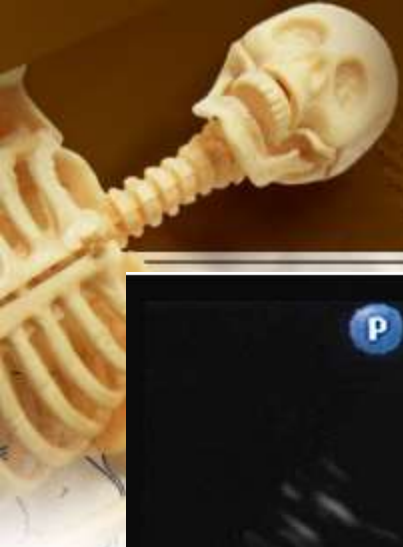


- . ULTRASOUND allows better identification of the medial line and the inter-vertebral level, as well as the needle insertion angle and the required depth.











Caudal Canal Injections

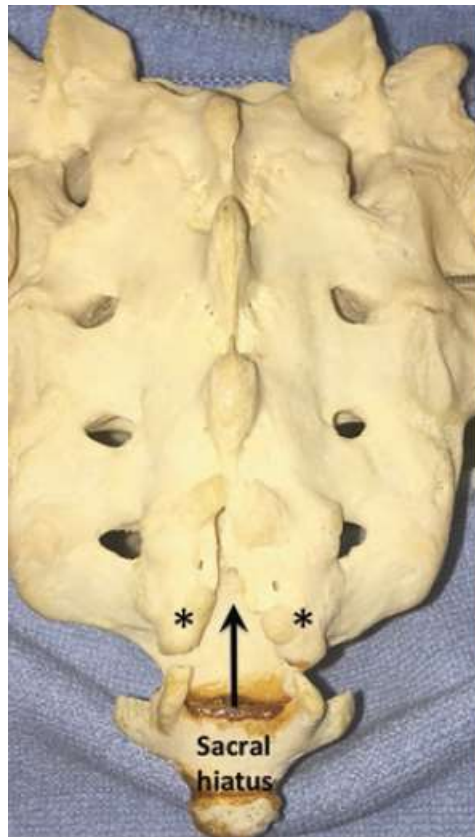
- Caudal canal injections refer to the administration of medications (usually local anesthetics and steroids) into the epidural space via the sacral hiatus.
- **Without image guidance, the success rate could be as low as 75%**
- With ultrasound guidance, the accuracy in caudal epidural needle placement is 100%.



Depending on age, the termination of the thecal sac varies between the lower border of the S1 foramen in adults and the S3 foramen in children.

In 1–5% of patients, the dural sac terminates at S3 or below, an important fact to remember when placing the epidural needle to avoid dural puncture

- Variations in the anatomy of the sacrococcygeal area 10%





- **Patient Selection**

- Chronic low back pain with radicular pain secondary to disc herniation or radiculitis not responding to conservative treatment can be considered for caudal canal injection.
- It is especially useful when there is difficult anatomy in the lumbar spine, such as previous lumbar surgery or degenerative changes, limiting transforaminal or interlaminar access to the epidural space.

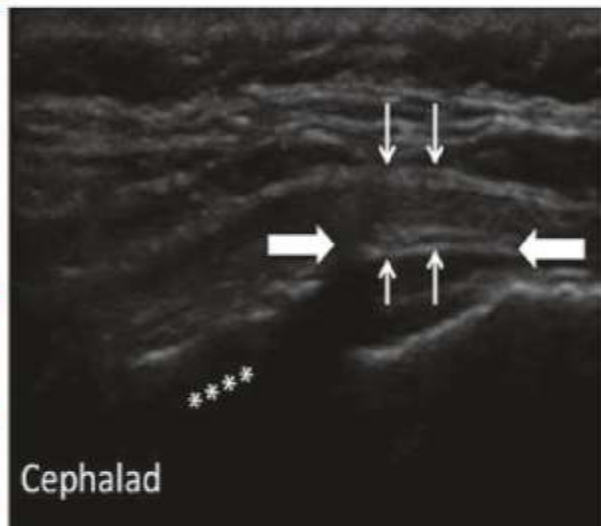


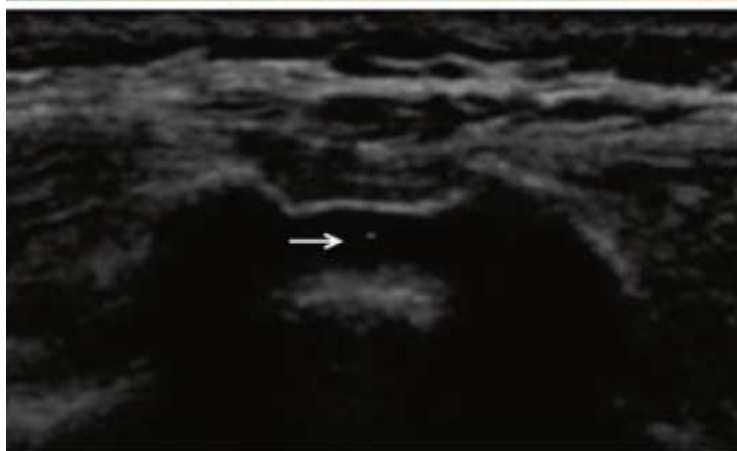
Position: Prone •

Probe: Linear probe is generally used.

A convex probe rarely is needed,

- except in some cases of obese patients.









THANK YOU
FOR YOUR ATTENTION

Product A

- Feature 1
- Feature 2
- Feature 3

Product B

- Feature 1
- Feature 2
- Feature 3