Spinal Sonography and its Application for Obstetric Neuraxial Blocks

Core Topics Birmingham
October 2019
Dr Jane Pilsbury

Association of Anaesthetists

Learning Objectives

1. Outline the evidence supporting the use of spinal sonography for central neuraxial blocks.

2. Interpret the basic images necessary to perform spinal sonography for central neuraxial blocks.

3. Recognise how spinal sonography for central neuraxial blocks can be of value in obstetric practice.

4. Prepare for some of the barriers and pitfalls associated with utilising spinal sonography for obstetric central neuraxial blocks.

Evidence

FORUM

Ability of anaesthetists to identify a marked lumbar interspace

C. R. Broadbent,[1] W. B. Maxwell,[1] R. Ferrie,[1] D. J. Wilson,[2] M. Gawne-Cain[3] and R. Russell[4]

1 Specialist Registrar and 4 Consultant, Nuffield Department of Anaesthetics, John Radcliffe Hospital, Oxford OX3 9DU, UK
2 Consultant, Department of Radiology, Nuffield Orthopaedic Centre, Oxford, UK
3 Senior Registrar, Department of Neuroradiology, Radcliffe Infirmary, Oxford, UK

Summary

Anaesthetists' ability to identify correctly a marked lumbar interspace was assessed in 100 patients undergoing spinal magnetic resonance imaging scans. Using ink, one anaesthetist marked an interspace on the lower spine and attempted to identify its level with the patient in the sitting position. A second anaesthetist attempted to identify the level with the patient in the flexed lateral position. A marker capsule was taped over the ink mark and a routine scan performed. The actual level of markers ranged from one space below to four spaces above the level at which the anaesthetist believed it to be. The marker was one space higher than assumed in 51% of cases and was identified correctly in only 29%. Accuracy was unaffected by patient position (sitting or lateral), although it was impaired by obesity ($p = 0.001$) and positioning of the markers high on the lower back ($p < 0.001$). The spinal cord terminated below L_1 in 19% of patients. This, together with the risk of accidentally selecting a higher interspace than intended for intrathecal injection, implies that spinal cord trauma is more likely when higher interspaces are selected.

Keywords *Anatomy*: vertebral column. *Anaesthetic techniques, regional*: spinal; subarachnoid; epidural. *Measurement techniques*: magnetic resonance imaging.

Correspondence to: Dr C. R. Broadbent, Department of Anaesthetics, Derby City General Hospital, Uttoxeter Road, Derby DE22 3NE, UK.
Accepted: 17 April 2000

- Broadbent et al. 2000
- 2/3 anaesthetists incorrectly identified lumbar level.
- 51% were 1 space higher
- 15% 2 spaces higher

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Evidence

Efficacy of Ultrasound Imaging in Obstetric Epidural Anesthesia

Thomas Grau, MD,*
Rudiger Wolfgang Leipold, MD,†
Renate Conradi, MD,‡
Eike Martin, MD, PhD, FANZCA,§
Johann Motsch, MD, PhD‖

Department of Anaesthesiology, University Clinic of Heidelberg, Heidelberg, Germany

- Randomised prospective study
- Used US to identify space, depth and angulation

Results:

- Reduced rate puncture attempts
- Higher rate of complete analgesia
- Less discomfort during insertion

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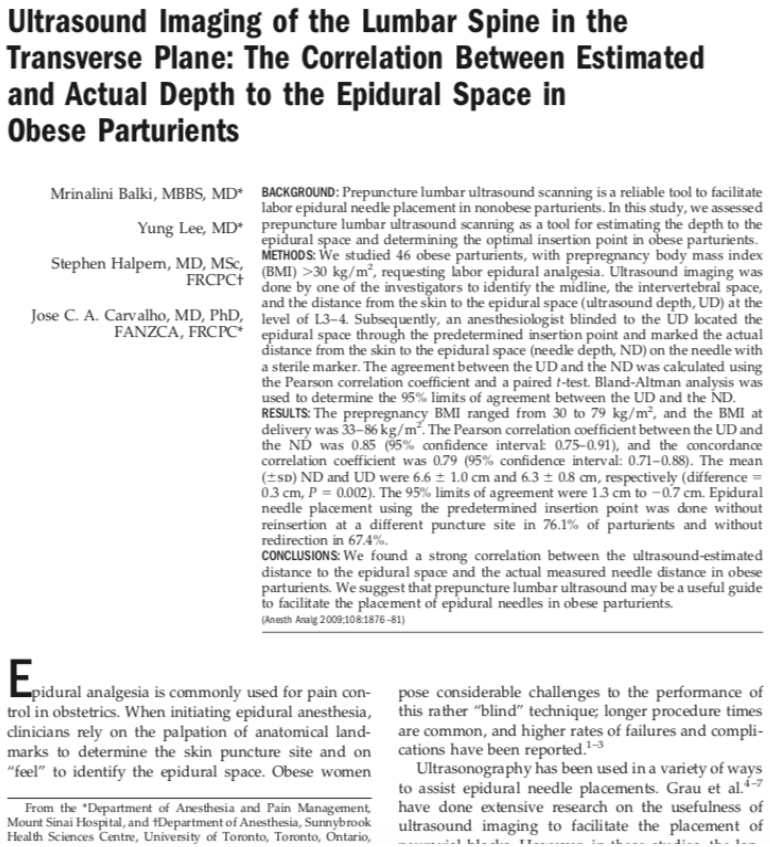
Evidence



Ultrasound Imaging of the Lumbar Spine in the Transverse Plane: The Correlation Between Estimated and Actual Depth to the Epidural Space in Obese Parturients

Mrinalini Balki, MBBS, MD*
Yung Lee, MD*
Stephen Halpern, MD, MSc, FRCPC†
Jose C. A. Carvalho, MD, PhD, FANZCA, FRCPC*

BACKGROUND: Prepuncture lumbar ultrasound scanning is a reliable tool to facilitate labor epidural needle placement in nonobese parturients. In this study, we assessed prepuncture lumbar ultrasound scanning as a tool for estimating the depth to the epidural space and determining the optimal insertion point in obese parturients.
METHODS: We studied 46 obese parturients, with prepregnancy body mass index (BMI) >30 kg/m^2, requesting labor epidural analgesia. Ultrasound imaging was done by one of the investigators to identify the midline, the intervertebral space, and the distance from the skin to the epidural space (ultrasound depth, UD) at the level of L3–4. Subsequently, an anesthesiologist blinded to the UD located the epidural space through the predetermined insertion point and marked the actual distance from the skin to the epidural space (needle depth, ND) on the needle with a sterile marker. The agreement between the UD and the ND was calculated using the Pearson correlation coefficient and a paired *t*-test. Bland-Altman analysis was used to determine the 95% limits of agreement between the UD and the ND.
RESULTS: The prepregnancy BMI ranged from 30 to 79 kg/m^2, and the BMI at delivery was 33–86 kg/m^2. The Pearson correlation coefficient between the UD and the ND was 0.85 (95% confidence interval: 0.75–0.91), and the concordance correlation coefficient was 0.79 (95% confidence interval: 0.71–0.88). The mean (±SD) ND and UD were 6.6 ± 1.0 cm and 6.3 ± 0.8 cm, respectively (difference = 0.3 cm, $P = 0.002$). The 95% limits of agreement were 1.3 cm to −0.7 cm. Epidural needle placement using the predetermined insertion point was done without reinsertion at a different puncture site in 76.1% of parturients and without redirection in 67.4%.
CONCLUSIONS: We found a strong correlation between the ultrasound-estimated distance to the epidural space and the actual measured needle distance in obese parturients. We suggest that prepuncture lumbar ultrasound may be a useful guide to facilitate the placement of epidural needles in obese parturients.
(Anesth Analg 2009;108:1876–81)

Epidural analgesia is commonly used for pain control in obstetrics. When initiating epidural anesthesia, clinicians rely on the palpation of anatomical landmarks to determine the skin puncture site and on "feel" to identify the epidural space. Obese women pose considerable challenges to the performance of this rather "blind" technique; longer procedure times are common, and higher rates of failures and complications have been reported.[1–3]

Ultrasonography has been used in a variety of ways to assist epidural needle placements. Grau et al.[4–7] have done extensive research on the usefulness of ultrasound imaging to facilitate the placement of

From the *Department of Anesthesia and Pain Management, Mount Sinai Hospital, and †Department of Anesthesia, Sunnybrook Health Sciences Centre, University of Toronto, Toronto, Ontario,

- 55 patient with BMI >30.
- Pre-procedure scan to measure depth and then mark insertion point
- Good correlation between measured and actual depth
- 76% first pass
- 67% no needle redirections

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Evidence

International Journal of Obstetric Anesthesia (2010) **19**, 373–378
0959-289X/$ - see front matter
doi:10.1016/j.ijoa.2010.04.002

ELSEVIER
www.obstetanesthesia.com

ORIGINAL ARTICLE

Ultrasound decreases the failed labor epidural rate in resident trainees

M.C. Vallejo, A.L. Phelps, S. Singh, S.L. Orebaugh, N. Sah
Magee-Womens Hospital, St. Margaret's Hospital, and Southside Hospital, Department of Anesthesiology, University of Pittsburgh, and Duquesne University, School of Business, Pittsburgh, PA, USA

ABSTRACT
Background: Epidural analgesia is widely used for pain relief during labor. The purpose of this study was to determine if ultrasound measurement of the depth from skin to epidural space before the epidural technique decreases the failure rate of labor analgesia. A secondary objective was to correlate ultrasound depth to the epidural space with actual depth of the needle at placement.
Methods: In this prospective, randomized, non-blinded study, 370 parturients requesting labor epidural analgesia were randomized to receive their epidural technique by first year anesthesia residents with or without prior ultrasound determination of epidural space depth. Outcome variables included the incidence of epidural catheter replacement for failed analgesia and the number of epidural attempts and accidental dural punctures.
Results: The ultrasound group had fewer epidural catheter replacements ($P < 0.02$), and epidural placement attempts ($P < 0.01$) compared to the control group. Pearson's correlation coefficients comparing the actual versus ultrasound estimated depth to the epidural space in the longitudinal median and transverse planes were 0.914 and 0.909, respectively. Pearson's correlation coefficient comparing the ultrasound estimated depths to the epidural space in the transverse and longitudinal median planes was 0.940. No significant differences were noted with respect to staff interventions, top-ups, accidental dural punctures, and delivery outcome.
Conclusions: Ultrasound measurement of the epidural space depth before epidural technique placement decreases the rate of epidural catheter replacements for failed labor analgesia, and reduces the number of epidural attempts when performed by first year residents and compared to attempts without ultrasound guidance.

Keywords: Ultrasound; Labor epidural; Failed epidural; Resident trainees

- Randomised non-blinded study
- Expert performed the scan
- Novice anaesthtists performed EFL

Results:

- US led to significantly reduced number of attempts
- BUT expert scanner!

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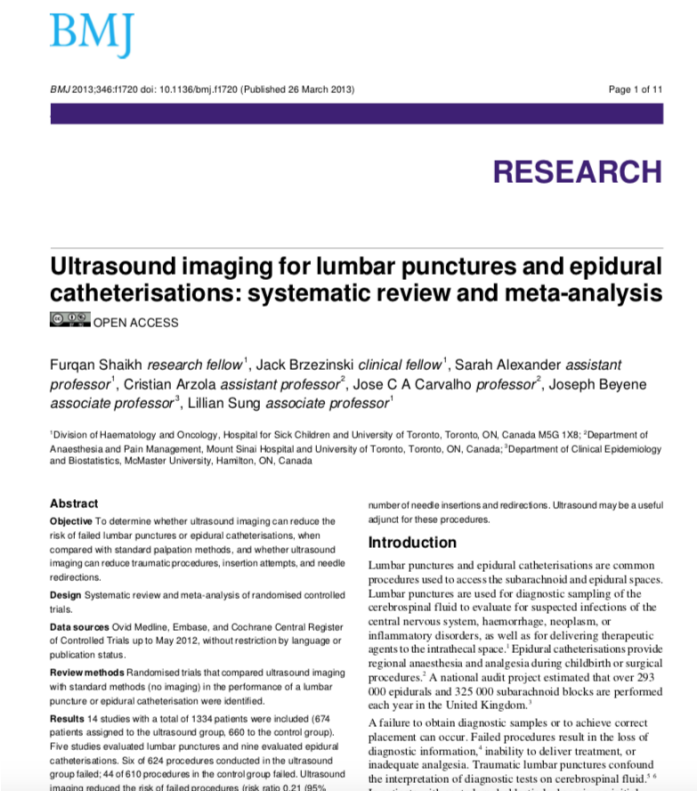
Evidence



BMJ

BMJ 2013;346:f1720 doi: 10.1136/bmj.f1720 (Published 26 March 2013)

RESEARCH

Ultrasound imaging for lumbar punctures and epidural catheterisations: systematic review and meta-analysis

OPEN ACCESS

Furqan Shaikh *research fellow*[1], Jack Brzezinski *clinical fellow*[1], Sarah Alexander *assistant professor*[1], Cristian Arzola *assistant professor*[2], Jose C A Carvalho *professor*[2], Joseph Beyene *associate professor*[3], Lillian Sung *associate professor*[1]

[1]Division of Haematology and Oncology, Hospital for Sick Children and University of Toronto, Toronto, ON, Canada M5G 1X8; [2]Department of Anaesthesia and Pain Management, Mount Sinai Hospital and University of Toronto, Toronto, ON, Canada; [3]Department of Clinical Epidemiology and Biostatistics, McMaster University, Hamilton, ON, Canada

Abstract

Objective To determine whether ultrasound imaging can reduce the risk of failed lumbar punctures or epidural catheterisations, when compared with standard palpation methods, and whether ultrasound imaging can reduce traumatic procedures, insertion attempts, and needle redirections.

Design Systematic review and meta-analysis of randomised controlled trials.

Data sources Ovid Medline, Embase, and Cochrane Central Register of Controlled Trials up to May 2012, without restriction by language or publication status.

Review methods Randomised trials that compared ultrasound imaging with standard methods (no imaging) in the performance of a lumbar puncture or epidural catheterisation were identified.

Results 14 studies with a total of 1334 patients were included (674 patients assigned to the ultrasound group, 660 to the control group). Five studies evaluated lumbar punctures and nine evaluated epidural catheterisations. Six of 624 procedures conducted in the ultrasound group failed; 44 of 610 procedures in the control group failed. Ultrasound imaging reduced the risk of failed procedures (risk ratio 0.21 (95%

number of needle insertions and redirections. Ultrasound may be a useful adjunct for these procedures.

Introduction

Lumbar punctures and epidural catheterisations are common procedures used to access the subarachnoid and epidural spaces. Lumbar punctures are used for diagnostic sampling of the cerebrospinal fluid to evaluate for suspected infections of the central nervous system, haemorrhage, neoplasm, or inflammatory disorders, as well as for delivering therapeutic agents to the intrathecal space.[1] Epidural catheterisations provide regional anaesthesia and analgesia during childbirth or surgical procedures.[2] A national audit project estimated that over 293 000 epidurals and 325 000 subarachnoid blocks are performed each year in the United Kingdom.[3]

A failure to obtain diagnostic samples or to achieve correct placement can occur. Failed procedures result in the loss of diagnostic information,[4] inability to deliver treatment, or inadequate analgesia. Traumatic lumbar punctures confound the interpretation of diagnostic tests on cerebrospinal fluid.[5,6]

Systemic review found:

- Reduced rate of failed procedures
- Reduced rate of traumatic procedures
- Reduced number of insertion attempts
- Reduced number of needle redirections

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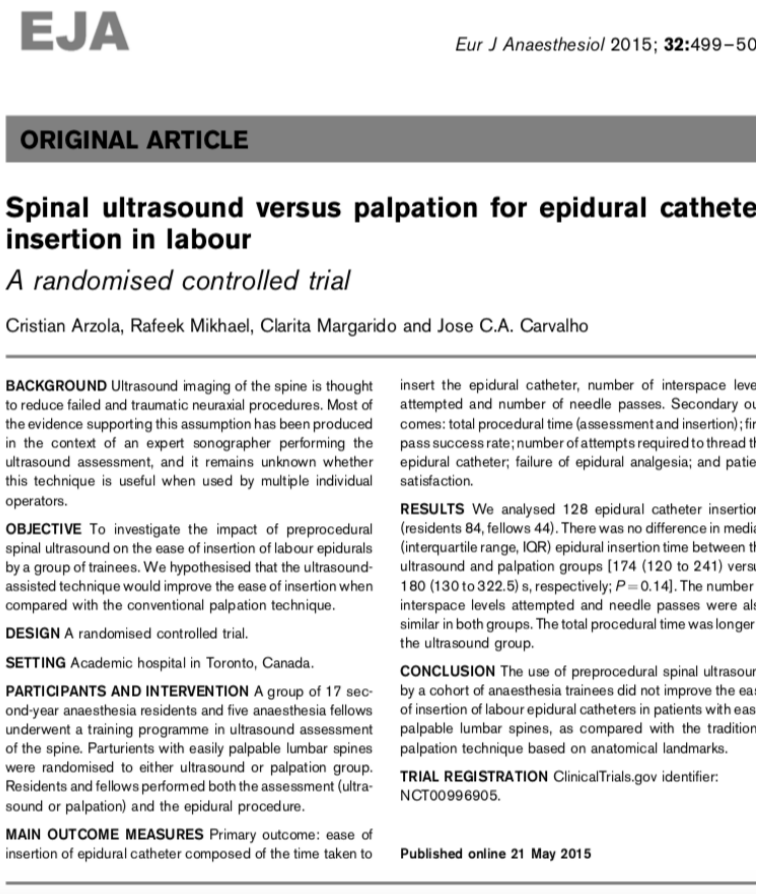
Evidence



EJA

Eur J Anaesthesiol 2015; **32**:499–50

ORIGINAL ARTICLE

Spinal ultrasound versus palpation for epidural cathete insertion in labour

A randomised controlled trial

Cristian Arzola, Rafeek Mikhael, Clarita Margarido and Jose C.A. Carvalho

BACKGROUND Ultrasound imaging of the spine is thought to reduce failed and traumatic neuraxial procedures. Most of the evidence supporting this assumption has been produced in the context of an expert sonographer performing the ultrasound assessment, and it remains unknown whether this technique is useful when used by multiple individual operators.

OBJECTIVE To investigate the impact of preprocedural spinal ultrasound on the ease of insertion of labour epidurals by a group of trainees. We hypothesised that the ultrasound-assisted technique would improve the ease of insertion when compared with the conventional palpation technique.

DESIGN A randomised controlled trial.

SETTING Academic hospital in Toronto, Canada.

PARTICIPANTS AND INTERVENTION A group of 17 second-year anaesthesia residents and five anaesthesia fellows underwent a training programme in ultrasound assessment of the spine. Parturients with easily palpable lumbar spines were randomised to either ultrasound or palpation group. Residents and fellows performed both the assessment (ultrasound or palpation) and the epidural procedure.

MAIN OUTCOME MEASURES Primary outcome: ease of insertion of epidural catheter composed of the time taken to insert the epidural catheter, number of interspace leve attempted and number of needle passes. Secondary ou comes: total procedural time (assessment and insertion); fir pass success rate; number of attempts required to thread th epidural catheter; failure of epidural analgesia; and patie satisfaction.

RESULTS We analysed 128 epidural catheter insertio (residents 84, fellows 44). There was no difference in medi (interquartile range, IQR) epidural insertion time between th ultrasound and palpation groups [174 (120 to 241) versu 180 (130 to 322.5) s, respectively; $P = 0.14$]. The number interspace levels attempted and needle passes were als similar in both groups. The total procedural time was longer the ultrasound group.

CONCLUSION The use of preprocedural spinal ultrasour by a cohort of anaesthesia trainees did not improve the eas of insertion of labour epidural catheters in patients with eas palpable lumbar spines, as compared with the tradition palpation technique based on anatomical landmarks.

TRIAL REGISTRATION ClinicalTrials.gov identifier: NCT00996905.

Published online 21 May 2015

Trainees and fellow underwent a training programme in US.

Randomised to US or palpation for patients with easily palpable backs.

Results:

- No difference in mean insertion time, 1st pass rates, number of attempts.
- Total time was longer in US group.

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Ultrasound-guided catheterisation of the epidural space

Interventional procedures guidance [IPG249] Published date: January 2008 Register an interest

Guidance

1 Guidance

1.1 Evidence on ultrasound-guided catheterisation of the epidural space is limited in amount, but suggests that it is safe and may be helpful in achieving correct placement. The procedure may be used provided that normal arrangements are in place for clinical governance, consent and audit. Normal consent should include informing patients about the possibility of rare but serious complications of catheterisation of the epidural space.

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Equipment

Curved linear probe

Low frequency 2-5 MHz

Pen

Hub of a needle

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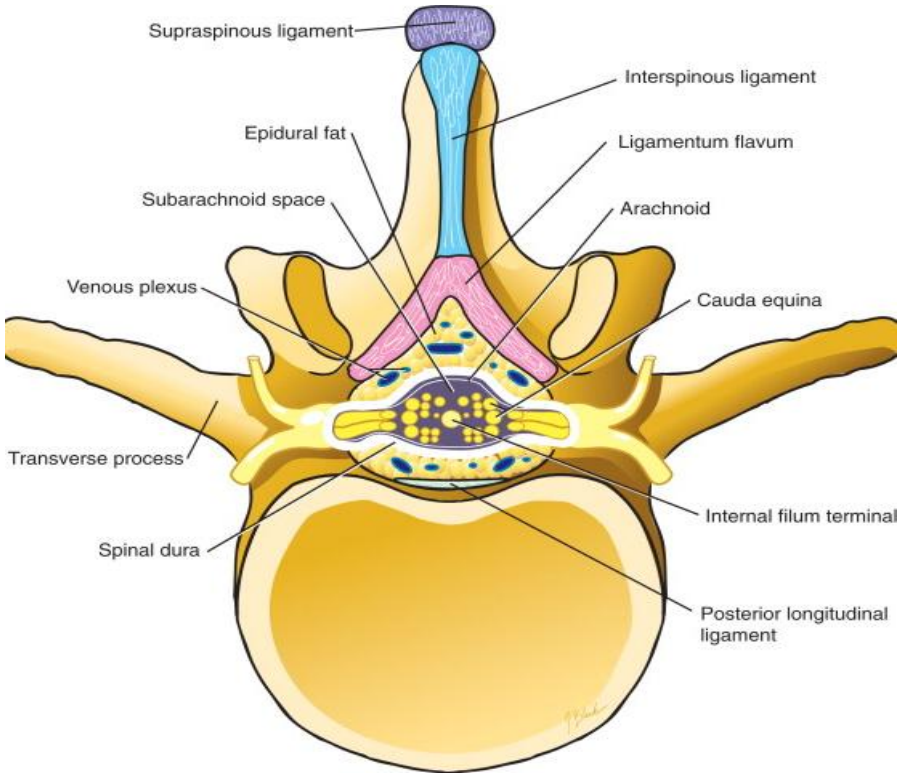
Anatomy



Posterior complex:

-Ligamentum flavum

-Epidural space

-Posterior dura

Anterior complex:

-Anterior dura

-Epidural space

-Posterior longitudinal ligament

-Posterior surface of vertebral body

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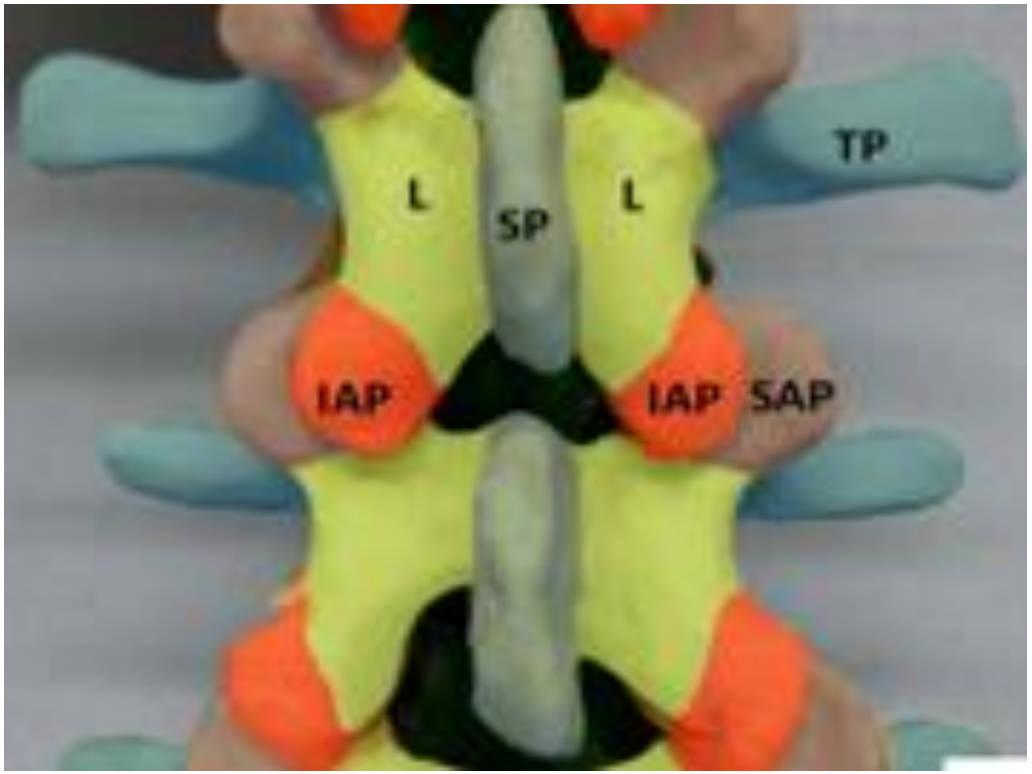
Anatomy



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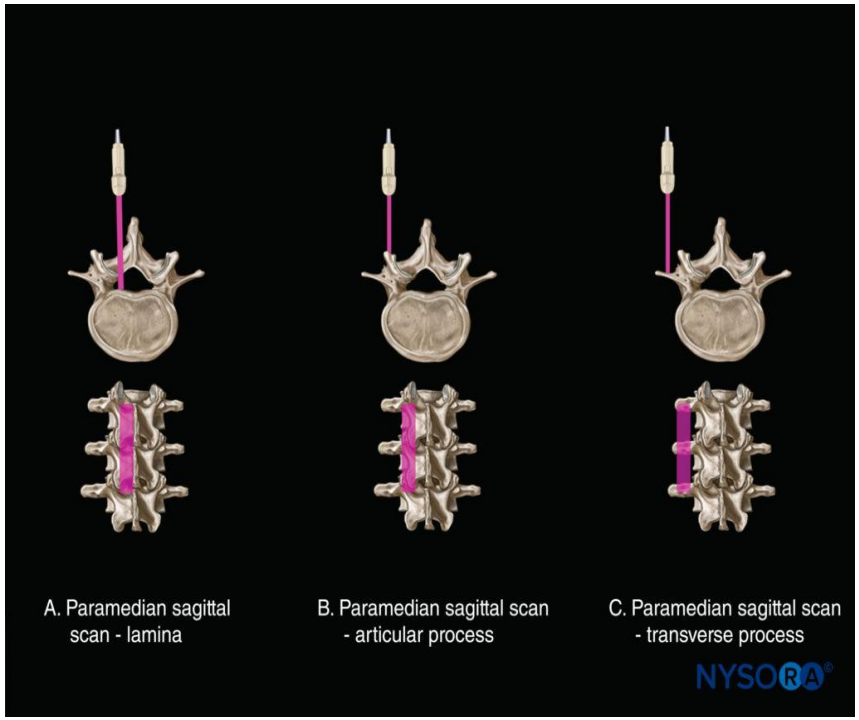
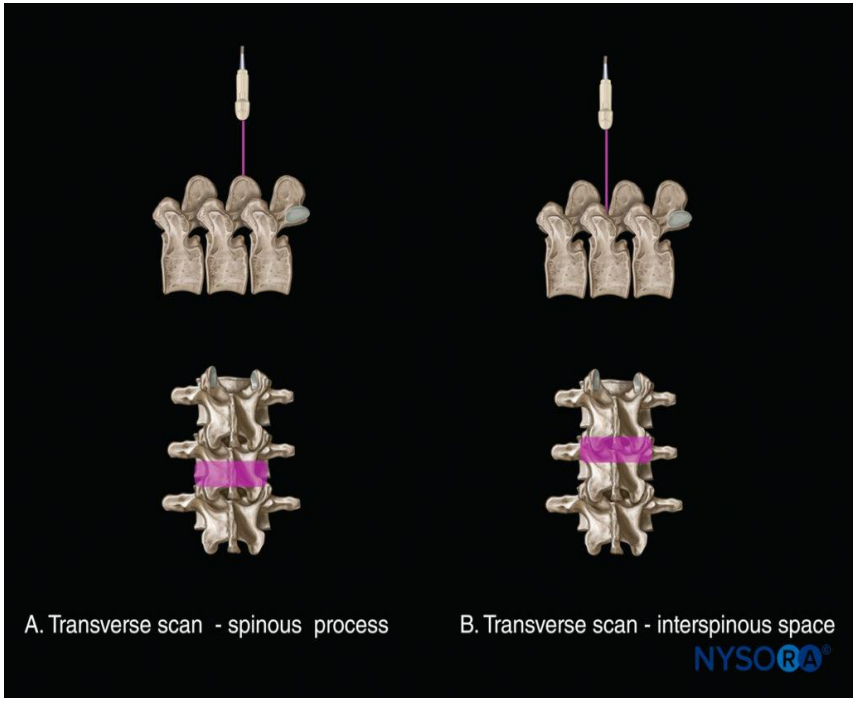
5 views

Paramedian sagittal scan



Transverse scan



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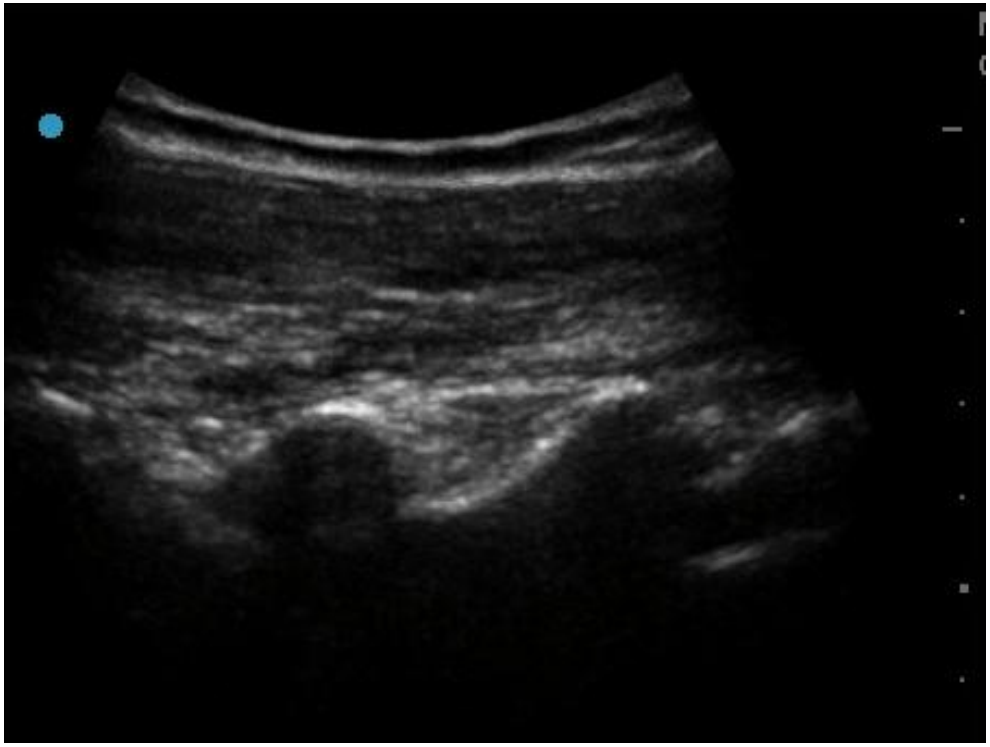
Paramedian Sagittal Lamina View



Horses-head view

Interlaminar spaces produce an acoustic window through which neuraxial structures can be seen.

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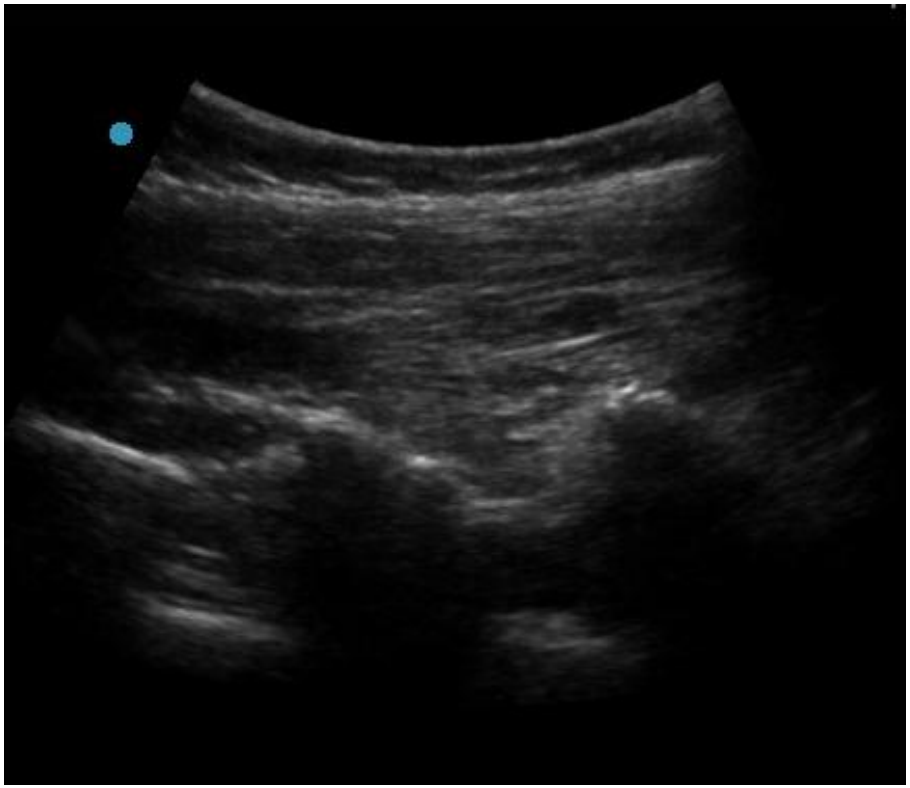
Paramedian Sagittal Lamina Oblique View



Move probe obliquely to visualise neuraxial structures:

- Posterior complex
- Intrathecal space
- Anterior complex

Can use this view to measure depth.

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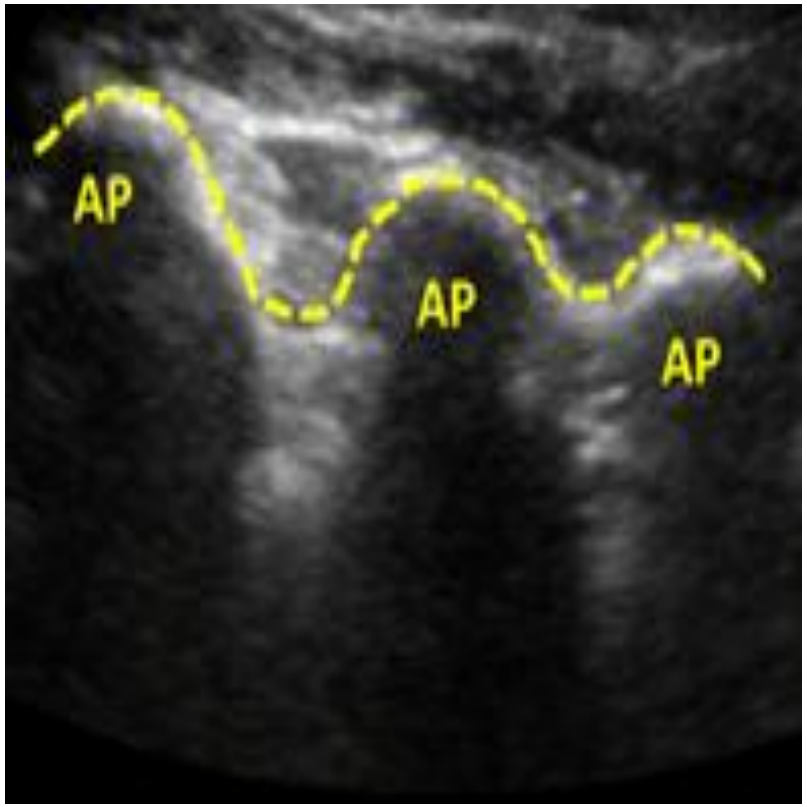
Paramedian Sagittal Articular Process View



Camel-hump view

Continuous hyperechogenic line

No gaps, therefore can't visualise neuraxial structures

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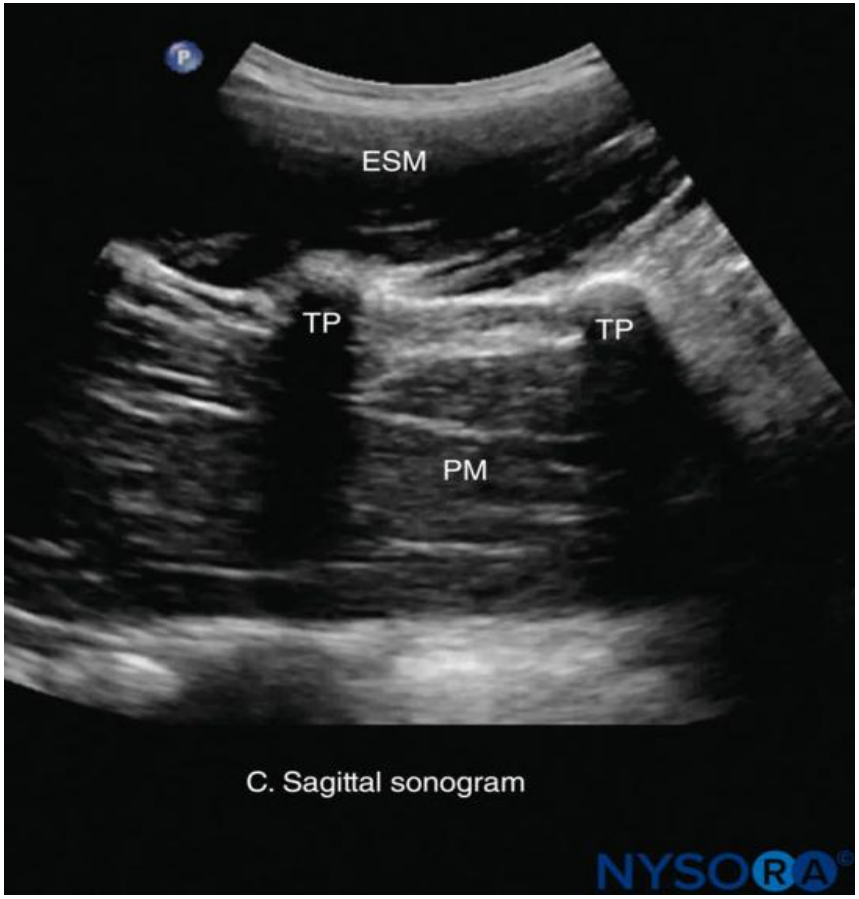
Paramedian Sagittal Transverse Process View



Trident sign

Finger like acoustic shadows

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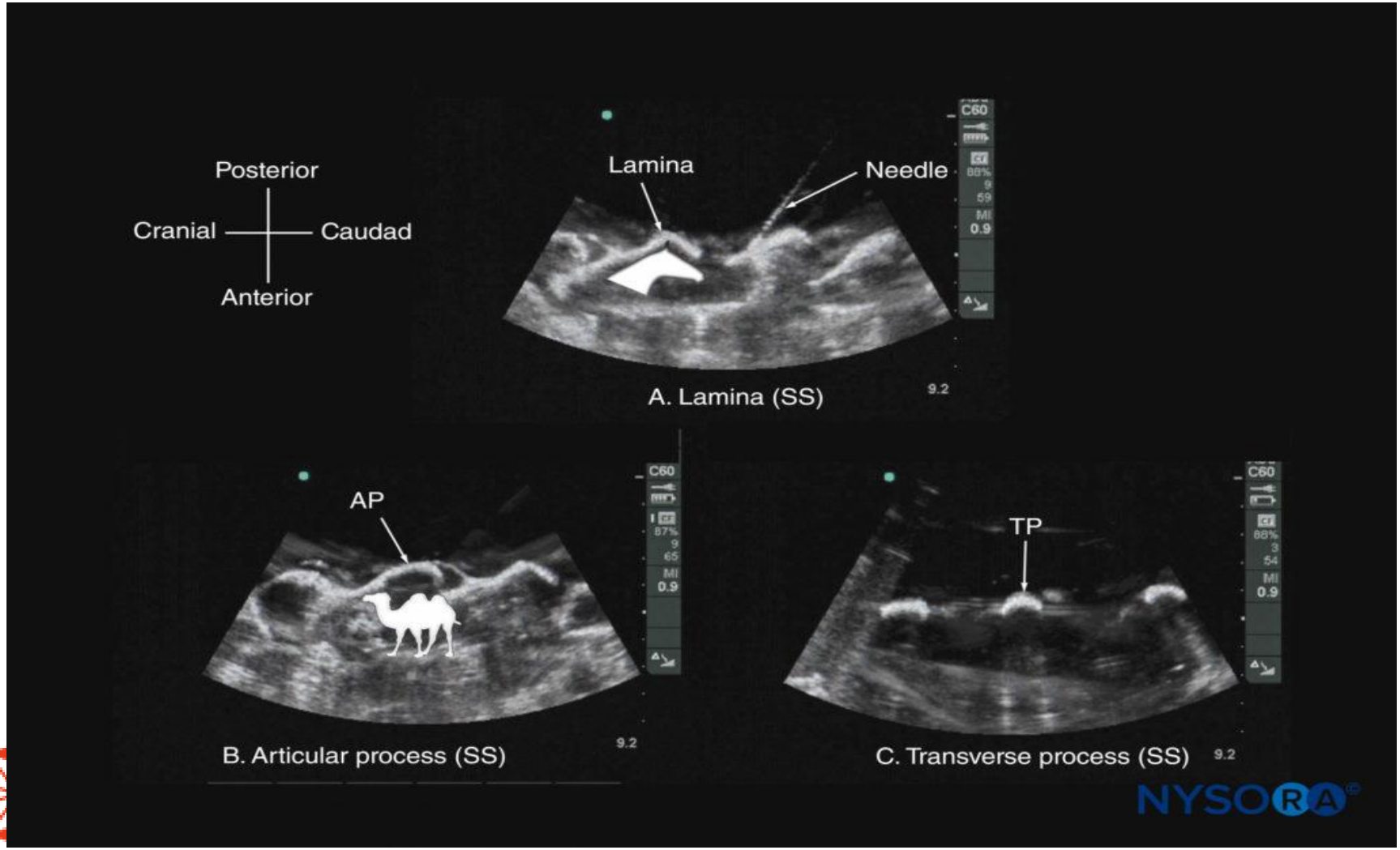
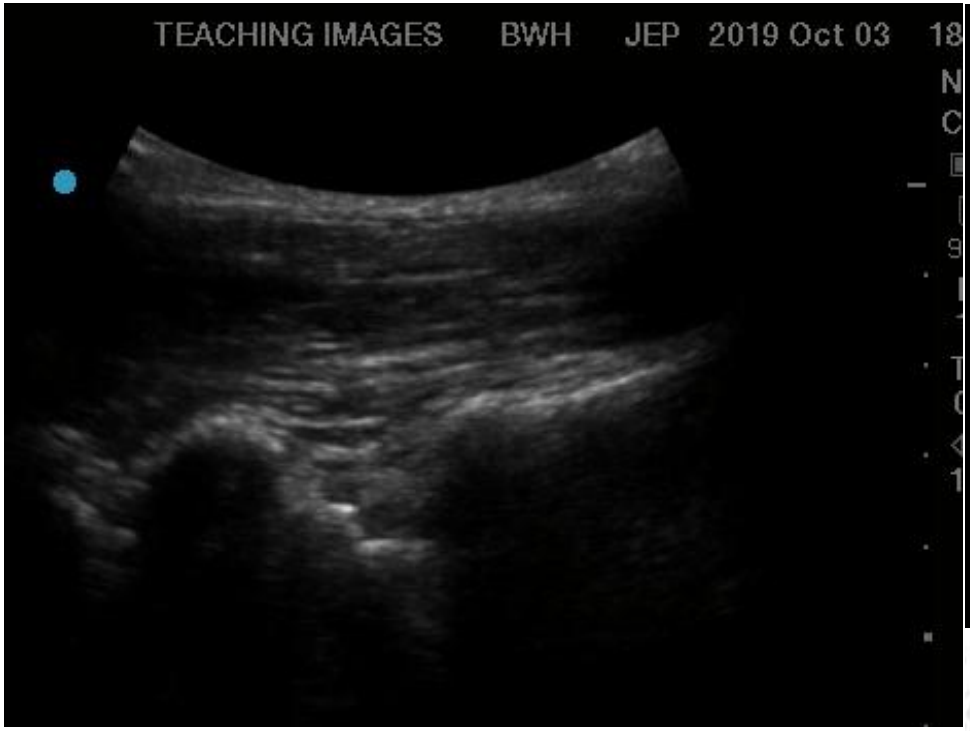
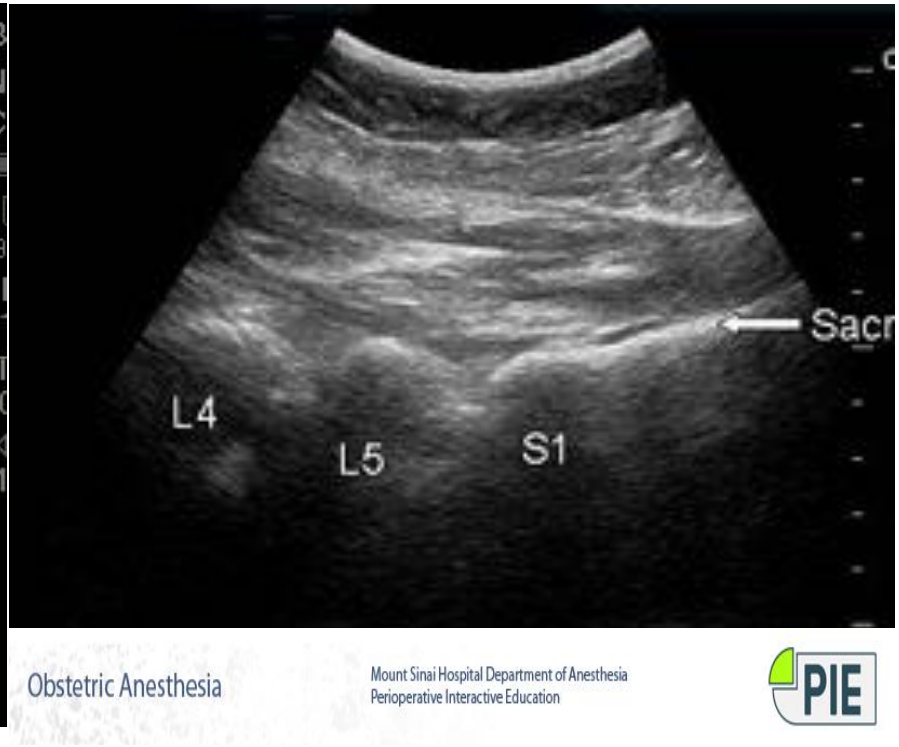
Sagittal Views



L5-S1 View





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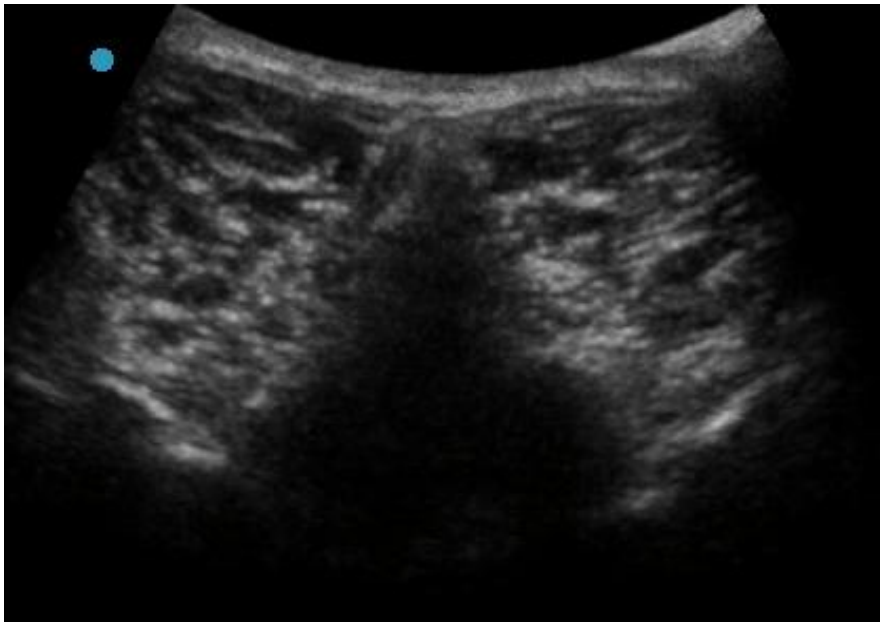
Transverse Spinous Process View



- Tower sign
- Acoustic shadow produced by spinous process.
- Useful view for locating midline in those with no palpable landmarks.

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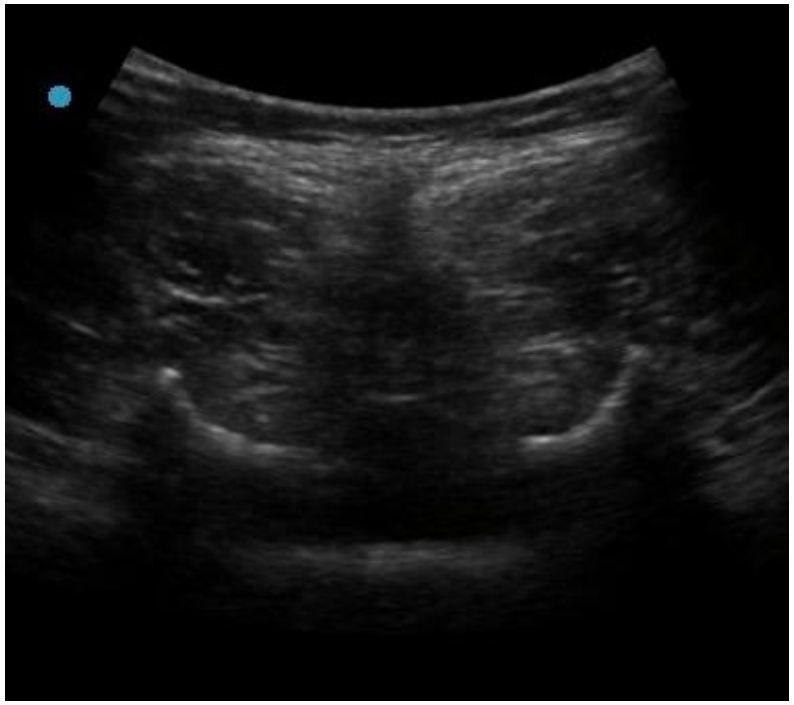
Transverse Interspinous View



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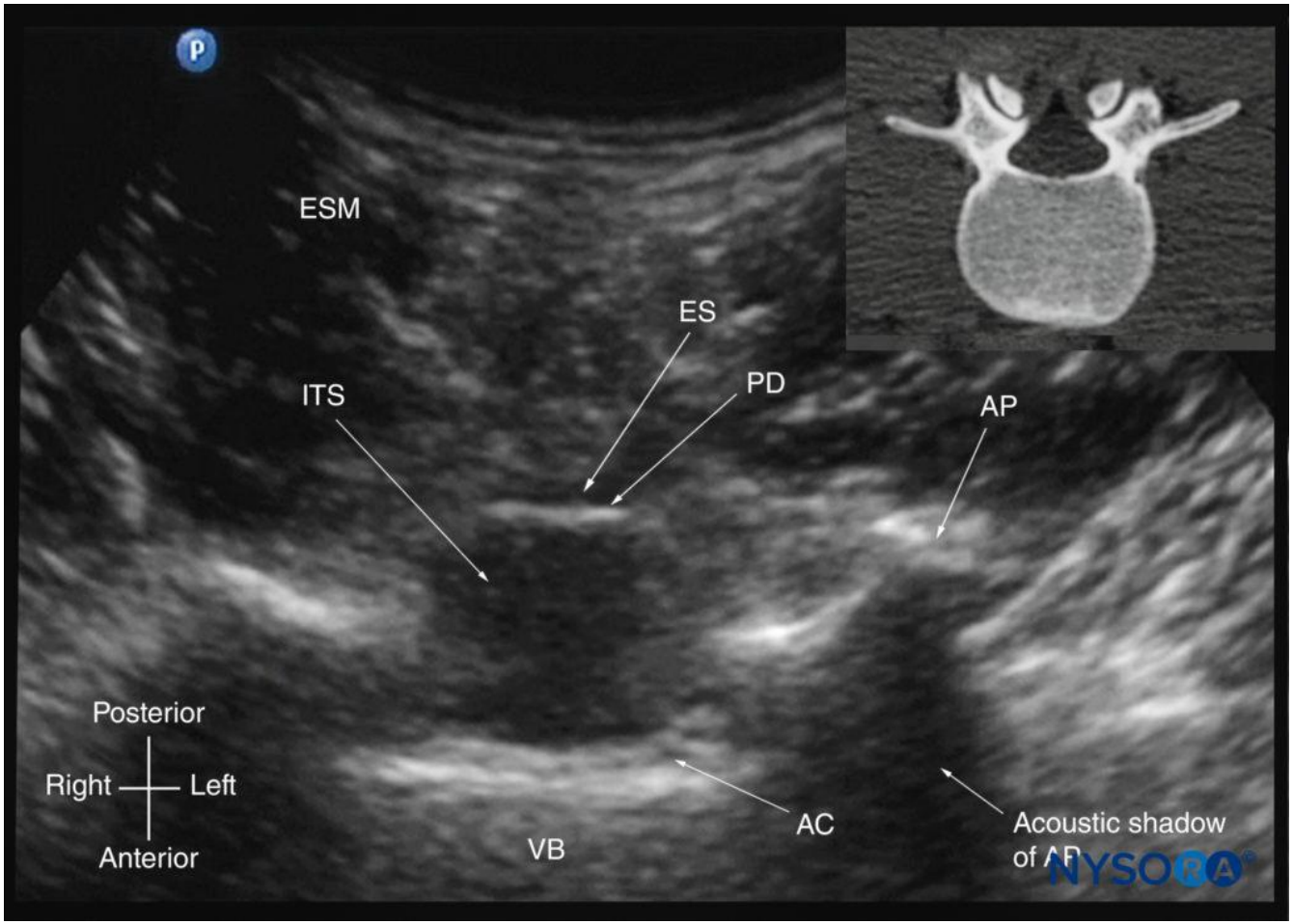
Bat's wing sign

Used to:

- Find best needle trajectory
- Identify rotational deformity of spine
- Locate epidural space
- Measure depth

Transverse Interspinous View



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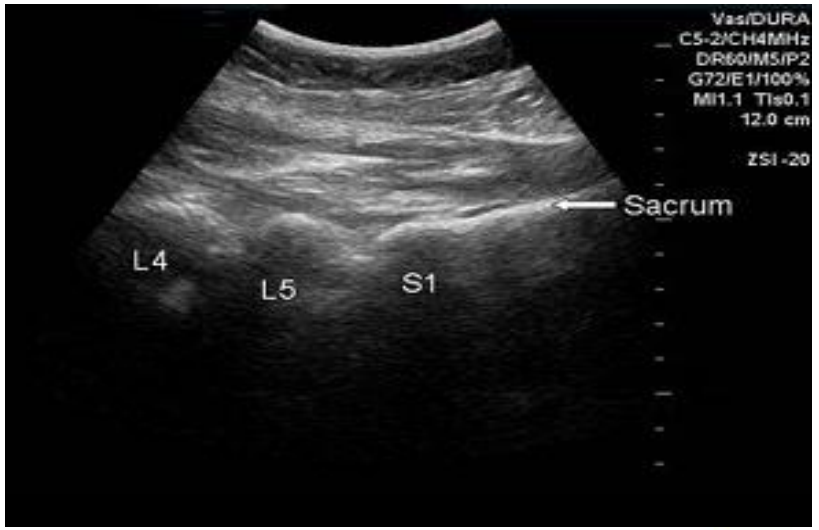
Technique

- Place probe 2cm paramedian over sacrum/lower lumbar region and identify the sacrum and adjust US settings.

- Locate L5-S1 interspace.



Technique

Move the the probe cephalad, identify and mark L4-5 and L3-4.

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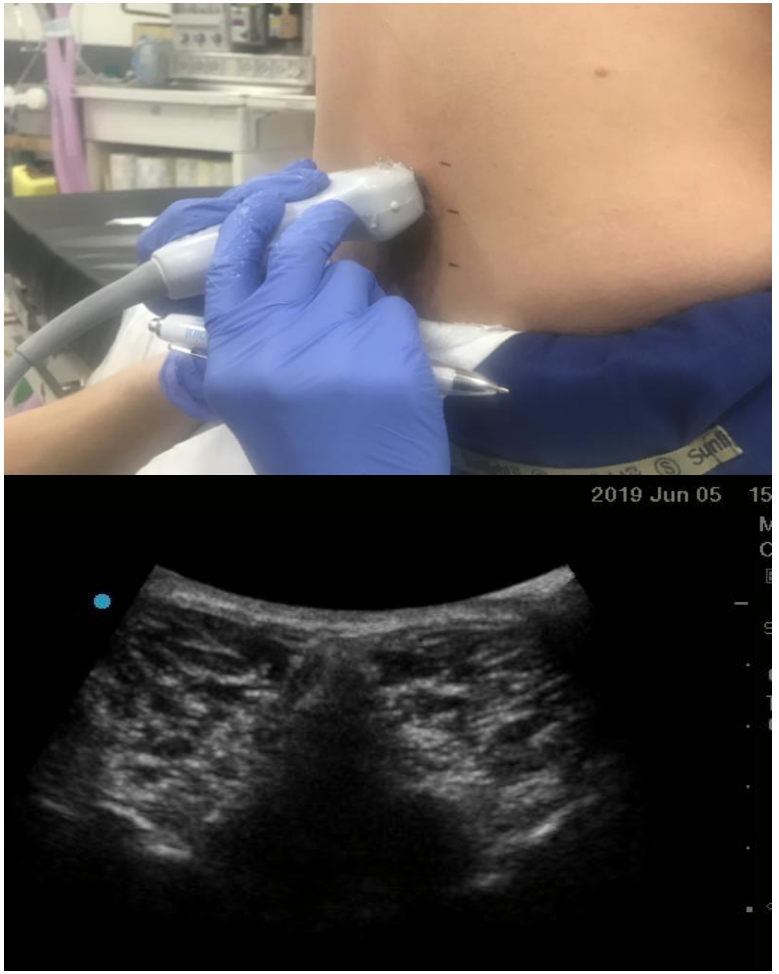
Technique

Rotate the probe 90^{o} into transverse orientation and look for the tower sign.



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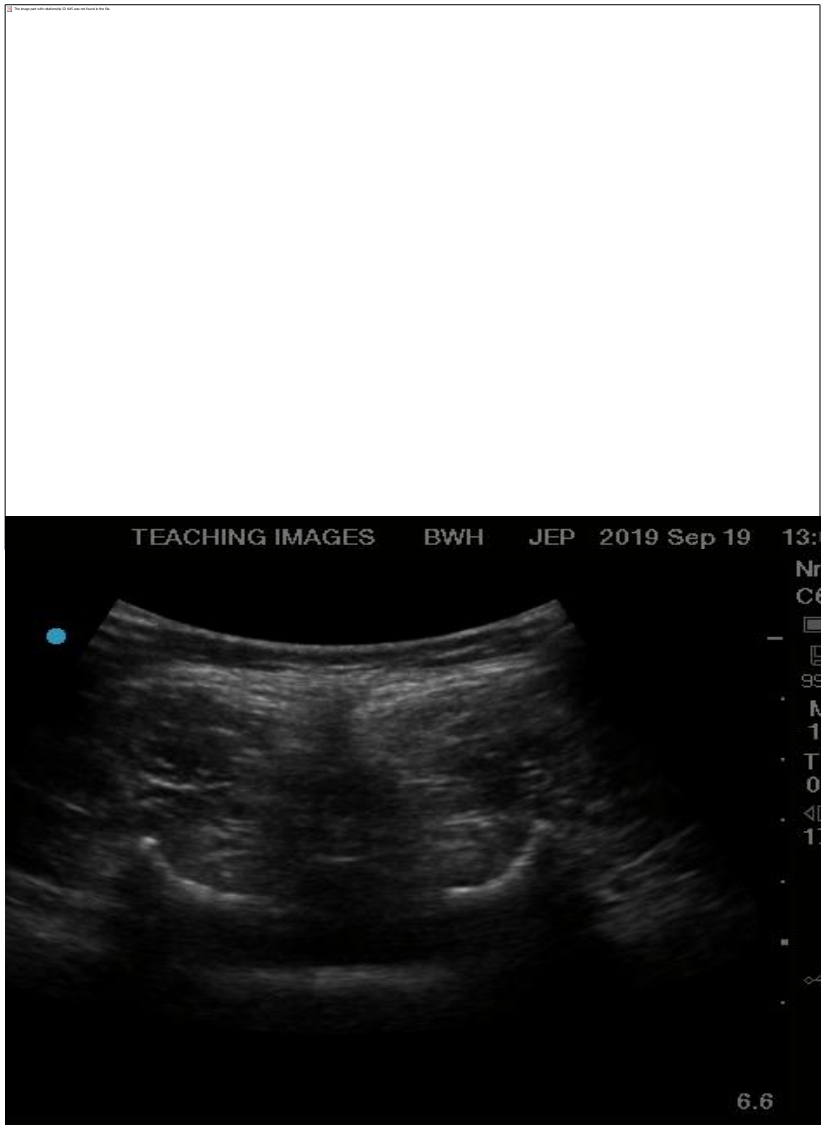
Technique

Move probe cephalad/caudad to obtain TI view.

When TI view is obtained tilt probe to obtain best possible view.

Mark midline of probes long and short edges.



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Technique

Remove probe and indent skin with needle hub where these lines intersect.

Clean skin and proceed with regional.
N.B. Do not reposition patient!

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Uses

- Accurately locate insertion point (high BMI).
- Accurately determine optimal needle trajectory (scoliosis).
- Predicts depth to epidural space.
- Selection of appropriate needle length.
- Offers reassurance to patients who have had previous difficult insertions.
- Used in pre-op clinic.
- Teaching aid.
- Can (nearly) always find you mid-line!

Pitfalls and Barriers

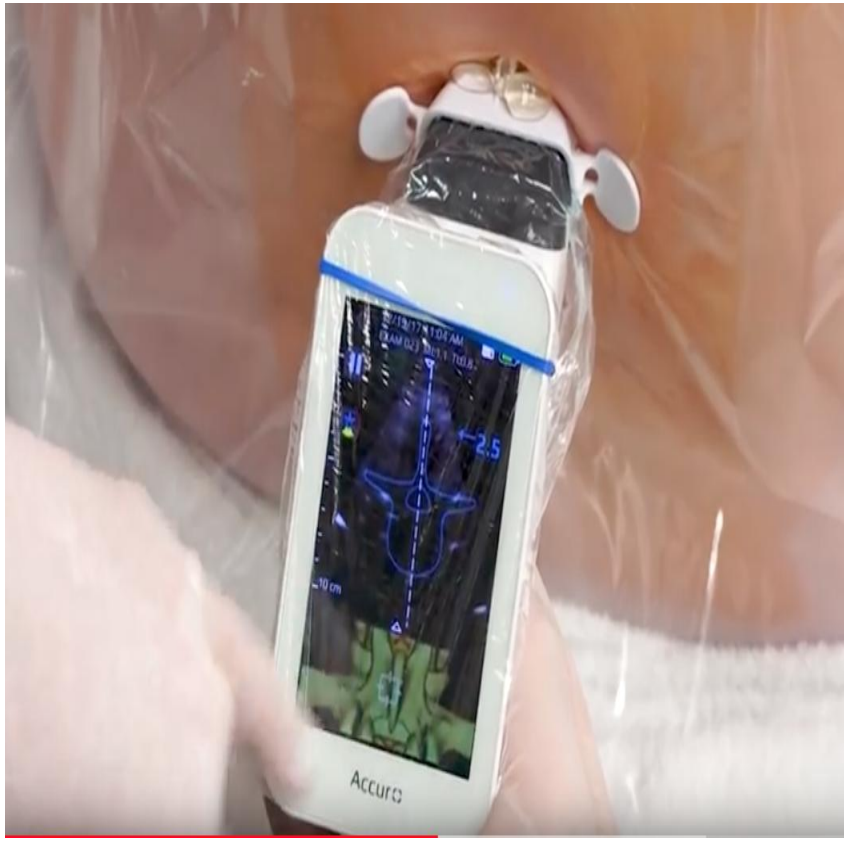
- Learning curve.
- Maintaining skills.
- Lack of equipment.
- Perceived unnecessary use of theatre time.
- Can’t just get it out for “difficult backs”.
- Very slim patients.
- Moving patients once scanned.

The Future

Will ultrasound for CNB become the gold-standard?

Real-time scanning?

Automated devices?



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Summary

- Good evidence to support the use of ultrasound for central neuraxial anaesthesia in obstetric practice.
- Steep learning curve, but the technique is really helpful in a number of clinical situations.
- 5 views relevant to the technique.
- You can always find midline (well, nearly always).

References

- Arzola C, Mikheal R, Margarido C, Carvalho JC. Spinal ultrasound versus palpation for epidural catheter insertion in labour: A randomised controlled trial. *Eur J Anaes* 2015; 32(7):499-505.
- Balki M, Lee, Y;, Halpern,S., Carvalho, J. Ultrasound Imaging of the Lumbar Spine in the Transverse Plane: The Correlation Between Estimated and Actual Depth to the Epidural Space in Obese Parturients. *Anesthesia & Analgesia*: 2009 (108); 1876-1881.
- Braodbent CR, Maxwell WB, Ferrie R et al. Ability of an anaesthetist to identify a marked lumbar interspace. *Anaesthesia* 2000; 55(11): 1122-1126.
- Grau T, Leipold RW, Conradi R, Martin E, Motsch J. Efficacy of ultrasound imaging in obstetric epidural anesthesia. *J ClinAnesth* 2002;14:169–75.
- NICE. 2008. Ultrasound-guided catheterisation of the epidural space. Interventional procedures guidance accessed: nice.org.uk/guidance/ipg249
- Ortega-Romero A, Domingo-Rufes T, del-Olmo C, et al. Ultrasound-guided interventional procedures for lumbar pain. *Techniques in Regional Anaesthesia and Pain Management* 2013; 17(3):96-106.
- Shaikh, Brzezinski, Alexander, et al. Ultrasound imaging for lumbar punctures and epidural catheterisations: systematic review and meta-analysis. *BMJ* 2013;346:f1720 .
- Vallejo MC, Phelps AL, Singh S, Sah N. Ultrasound decreases the failed labor epidural rate in resident anaesthetists. *IJOA* 2010; 19(4):373-8.
- https://pie.med.utoronto.ca/OBAnesthesia/OBAnesthesia_content/OBA_spinalUltrasound_module.html
- https://www.nysora.com/techniques/neuraxial-and-perineuraxial-techniques/spinal-sonography-and-applications-of-ultrasound-for-central-neuraxial-blocks/

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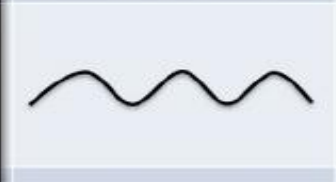
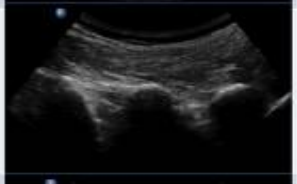
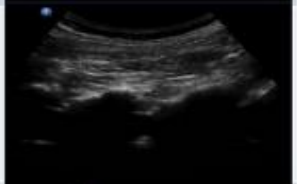
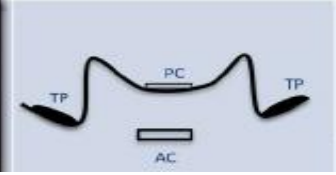
5 Images Summary

View	Probe orientation	Pattern recognition image	Ultrasound view	Notes
Paramedian Sagittal Transverse Process View				The "trident sign" represents finger-like shadowing behind the transverse processes.
Paramedian Sagittal Articular Process View				"Camel humps" represent continuous hyperechoic bone,due to vertebrae being connected by articular processes.
Paramedian Sagittal Laminar View				"Sawtooth" or "Horse Heads" represent the laminaes,the hiperechoic bone is not continuos and the interlaminar space allows visualization of the posterior and anterior complex.
Paramedian Sagittal Oblique View				Slight medial tilt optimizes the view of the posterior and anterior complexes.The dura is seen as a thin hyperechoic line.
Tranverse Interlaminar view				The articular processes/facet joints and transverse processes (TP) are visible.Tilting the probe will highlight the posterior (PC) and anterior(AC) complexes.

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