Ultrasound for interventional pain procedures

I. Evansa,
E. Vasilevskis, M. Aron,
I. Panichin, I. Logina, I.Vanags

Riga Stradinsh University Hospital
Pain Department
Latvia

Why Ultrasound?

Advantages

- No radiation exposure
- Mobility
- Prescan/real-time visualisation
- Soft tissue, nerves, blood vessel visualisation

Disadvantages

- Bony artifacts (acoustic shadow)
- Narrow imaging window
- Angle of needle insertion
- Limited resolution in deep layers (obesity)

Ultrasound - guided lumbar spine injections

- Facet joint block
- Facet medial branch block
- Nerve root injections
- Epidural streroid injections??

Facet lumbar medial branch block with fluoroscopy control

Greher M et al. Anesthesiology 2004

- 5 patients (28 injections)
- 90% success rate

Shim JK et al. Reg Anesth Pain Med 2006

- 20 patients (101 injections)
- 95% success rate

Limitations: mean weight and BMI was only 51 kg and 22.8 kg/m2

US cannot be recommended as solo imaging technique in obese patients

Facet joint block

Galiano K et al. Reg Anesth Pain Med 2007

- 40 patients
- 20 pts US/20 pts CT facet joint block
- 85% (17/20) success rate in US group
- Both groups showed a significant benefit ($p<0.01$) from facet joint injections

In 2 patients with BMI of 28.3 and 32.9 kg/m^2 facet joint could not be visualized

Facet joint block

Gofeld M et al. Reg Anesth Pain Med 2012

- 5 cadavers/50 injections with fluoroscopy control
- intra-articular spread of the contrast
- 88% success rate

Ultrasound may be a viable alternative to fluoroscopy or computed tomography as a guidance method for lumbar facet joint injections

Selective nerve root blocks

Chumnanvei S et al. J Med Assoc Thai 2011

- 40 pts/78 injections
- Firstly, needle-tip was located at the desired optimal landmark under ultrasound guidance and then subsequently fluoroscopic confirmation of needle-tip position was done
- Mean of the accuracy of needle-tip 62.82%
  (95% CI ranged from 51.13 to 73.50%)
- The age older than 65 years old was significantly associated with the poor accuracy under ultrasound guidance
  ($p = 0.0095$)

Larger prospective clinical study is needed

Ultrasound for lumbar epidural steroid injections : is it possible?

- US has proven useful in regional and labor related anesthesia
- No studies of interlaminar epidural steroid injection under US guidance have appeared in the literature

Pain Physician 2009; 12:163-188 • ISSN 1533-3159

Systematic Review

Lumbar Interlaminar Epidural Injections in Managing Chronic Low Back and Lower Extremity Pain: A Systematic Review

Allan T. Parr, MD[1], Sudhir Diwan, MD[2], and Salahadin Abdi, MD, PhD[3]

- A comprehensive literature search was conducted which included the search of databases including PubMed and EMBASE from 1966 through November 2008
- The available literature included only blind epidural injections without fluoroscopy
- Studies performed under fluoroscopy were given priority

The limitations of this study include - lack of fluoroscopic procedures..

Anesthesiology 2010; 112:810–33

Practice Guidelines for Chronic Pain Management

*An Updated Report by the American Society of Anesthesiologists Task Force on Chronic Pain Management and the American Society of Regional Anesthesia and Pain Medicine**

Epidural steroids with or without local anesthetics:

- Potential complications mostly occuring with transforaminal approach
- Transforaminal epidural injections should be performed with appropriate image guidance to confirm correct needle position and spread of contrast before injecting a therapeutic substance
- Image guidance may be considered for interlaminar epidural injections to confirm correct needle position and spread of contrast before injecting a therapeutic substance

Consultant Survey Responses

Table 2. Continued

	N	Percent Responding to Each Item: Strongly Agree	Agree	Equivocal	Disagree	Strongly Disagree
Epidural steroids with or without local anesthetics						
29. Epidural steroid injections with or without local anesthetics for radicular pain or radiculopathy	78	65.4*	33.3	1.3	0.0	0.0
30. Image guidance (*e.g.*, fluoroscopy) for transforaminal epidural injections	78	89.7*	6.4	2.6	0.0	1.3
31. Image guidance (*e.g.*, fluoroscopy) for interlaminar epidural injections	78	50.0*	28.2	15.4	5.1	1.3

* Median

- Can we use ultrasound for interlaminar ESI if fluoroscopic guidance not available??
- At least at lumbar spine level??
- Will outcomes be similar to Fluoroscopic guided ESI??

US for neuraxial blocks

Ultrasound-assisted technique

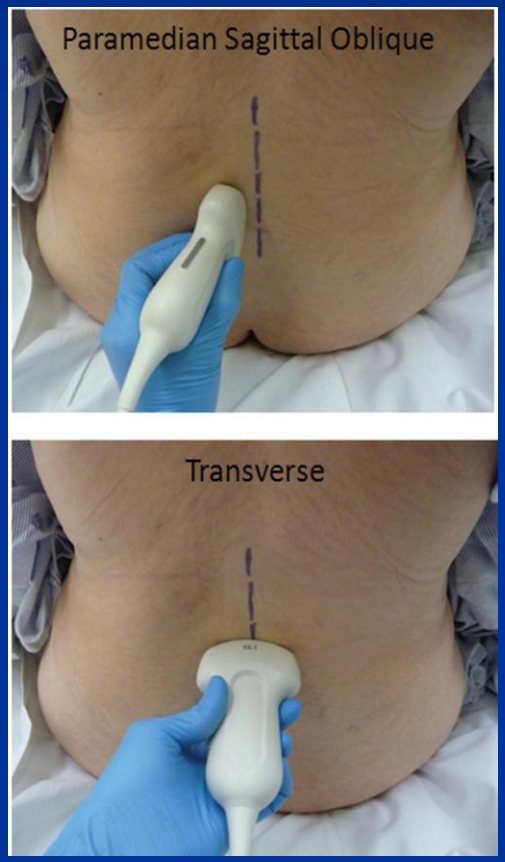
- Preprocedure/ultrasound spine visualization providing useful acoustic window
- Needle insertion is performed using the loss-of-resistance to saline/air technique
- Operator remains “blind” during the actual needle insertion

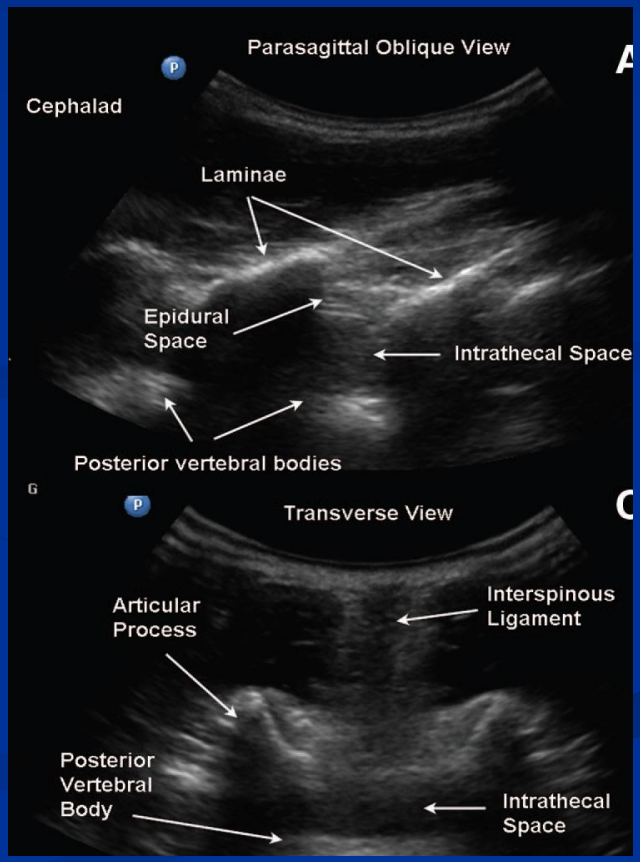
Real-time ultrasound-guided technique

- needle visualisation during procedure (epidurals/spinals)

Ultrasound-assisted neuraxial techniques:

Two scanning planes have been identified to offer useful acoustic windows for the assessment of spinal sonoanatomy :





Ultrasound Imaging for Regional Anesthesia: A Practical Guide Booklet, 3rd edition

Recommendations for US setting

- Curved-array, low-frequency (2–5 MHz) probe
- Depth setting of 7–8 cm is appropriate for most patients
- Depth, focus, and gain settings of the ultrasound machine should be adjusted as needed during the scanning process to produce an optimal image

Location of a specific intervertebral level:

Watson MJ et al. Br J Anaesth 2003

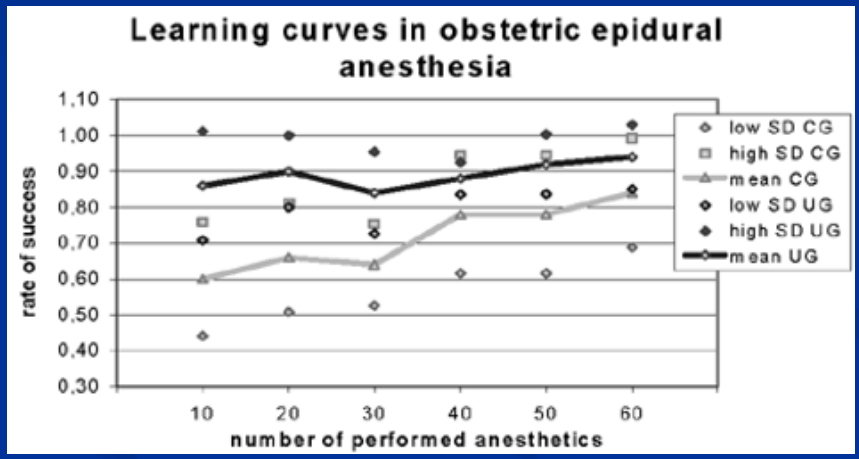
- 17 patients underwent MRI scan of the spine
- The L3–L4 interspace was identified and marked using a linear US transducer
- Agreement between the US/MRI-identified interspace was seen in 76% of patients

Furness G et al. Anaesthesia 2002

- 49 patients underwent lumbar spine X-ray
- The interspaces between L2 and L5 were identified by surface palpation of landmarks/US
- Agreement between the US/X-ray identified interspaces was seen in 71% of cases
- Agreement between the surface palpation of landmarks/ X-ray identified interspaces was seen in 30% of cases
- The discrepancy between US/X-ray identified interspaces was never more than 1 level, but between clinically identified/X-ray identified interspaces was more than 1

Epidural and intrathecal spaces identification by ultrasonography

- 2 groups of residents /60 obstetric epidurals under supervision
- Control group (CG)- loss of resistance technique
- Ultrasound group (UG) - supported by prepuncture ultrasound imaging of spine
- Success was defined as adequate epidural anesthesia requiring a maximum of three attempts



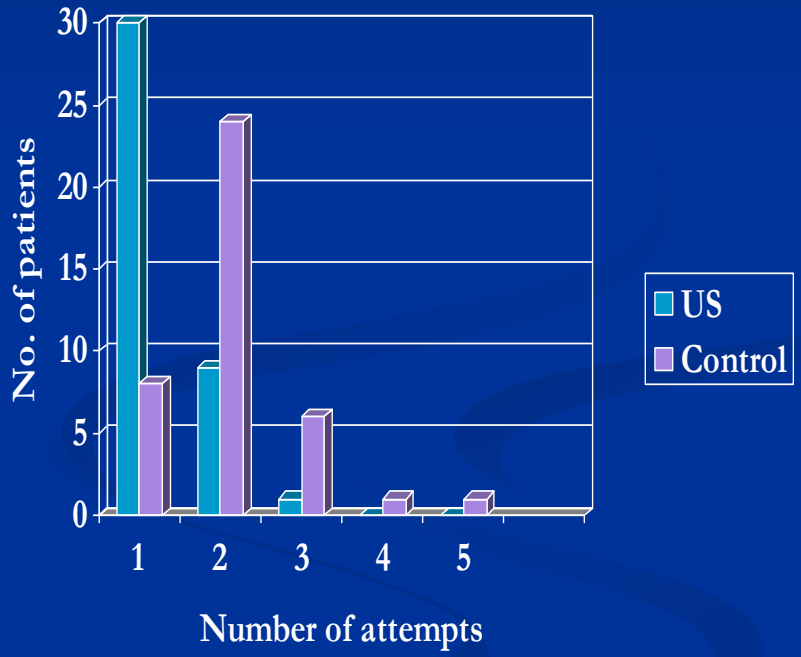
($p < 0.001$). SD =standard deviation; CG = control group; UG = ultrasonography group

Grau T et al. Can J Anesth 2003

Number of puncture attempts ultrasound *vs.* control group (1)

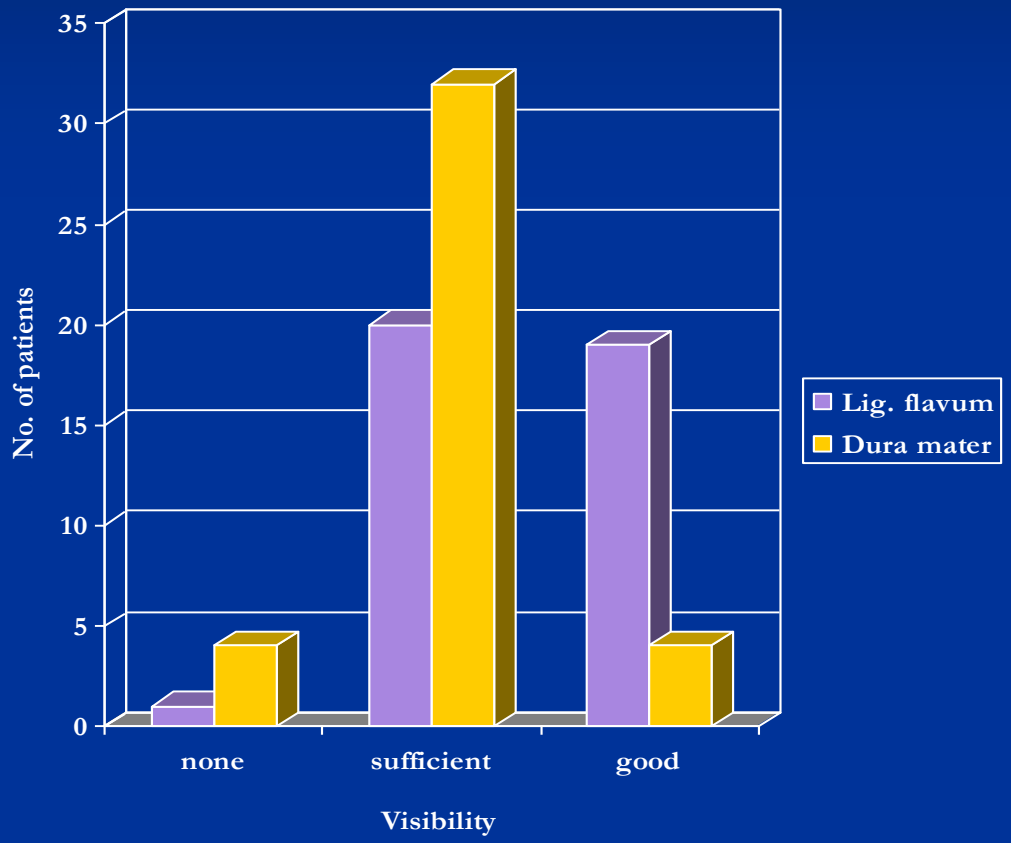
2 groups sheduled for cesarean delivery underwent combined spinal/epidural analgesia:

- 40 pts- after prepuncture ultrasound imaging of spine (US)
- 40 pts- without ultrasound imaging (Control)



Grau T et al. Reg Anesthesia and Pain Medicine 2001

Visibility of ligamentum flavum and dura mater on 5 mHz ultrasound images (2)

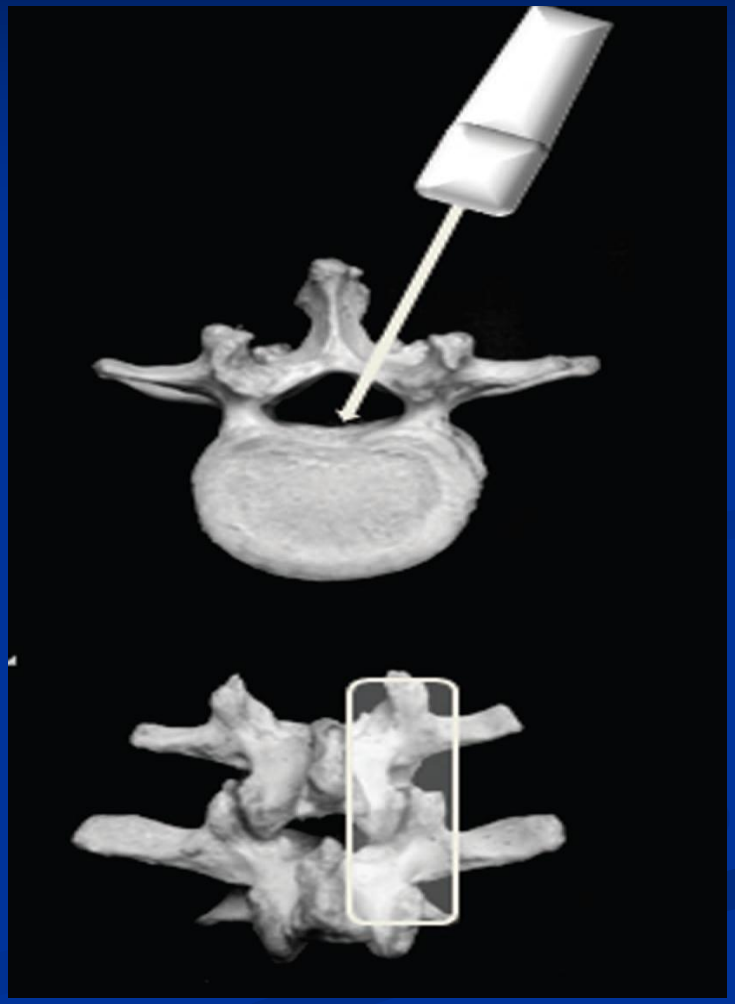


Both guiding structures (ligamentum flavum and dura mater) could be identified in 88% of cases

Grau T et al. Reg Anesthesia and Pain Medicine 2001

Optium window for US imaging

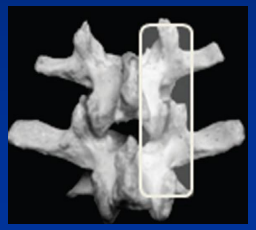
- 100 patients
- The paramedian sagittal oblique view is better than the transverse view for identifying the ligamentum flavum, especially at L4–L5/L5–S1 interspaces.



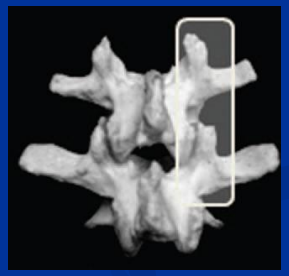
Borges BC et al. Reg Anesth Pain Med 2009

Optium window for US imaging

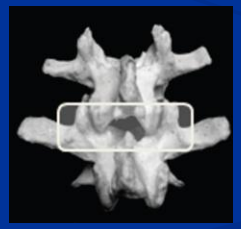
- 60 subjects
- A single operator performed an US scan of the lumbar spine in all subjects
- The acoustic window was larger in the paramedian sagittal oblique view than in the sagittal view
- Structures were better visualized in the paramedian sagittal oblique view than in the transverse view



paramedian sagittal oblique !



paramedian sagittal



transverse view

Grau T et al. J Clin Anesth 2001

Skin-to-epidural space or skin-to-intrathecal space distances

- The correlation between ultrasound-measured depth (UD) and actual needle insertion depth (ND) has been evaluated in multiple studies:
- Correlation was excellent in all studies (Pearson correlation coefficients, 0.80–0.99), whether measurements were made in the paramedian sagittal, paramedian sagittal oblique, or transverse views:

1. There was good correlation between UD and ND (r = 0.79). Grau T et al. Anaesthesist 2001
2. There was good correlation between UD and ND (r = 0.99). Bonazzi M et al. Minerva Anestesiol 1995
3. There was good correlation between UD to the lamina and ND (r =0.96). Currie JM. Br J Anaesth 1984

European Journal of Anaesthesiology 2001, **18**, 706–712

Colour Doppler imaging of the interspinous and epidural space

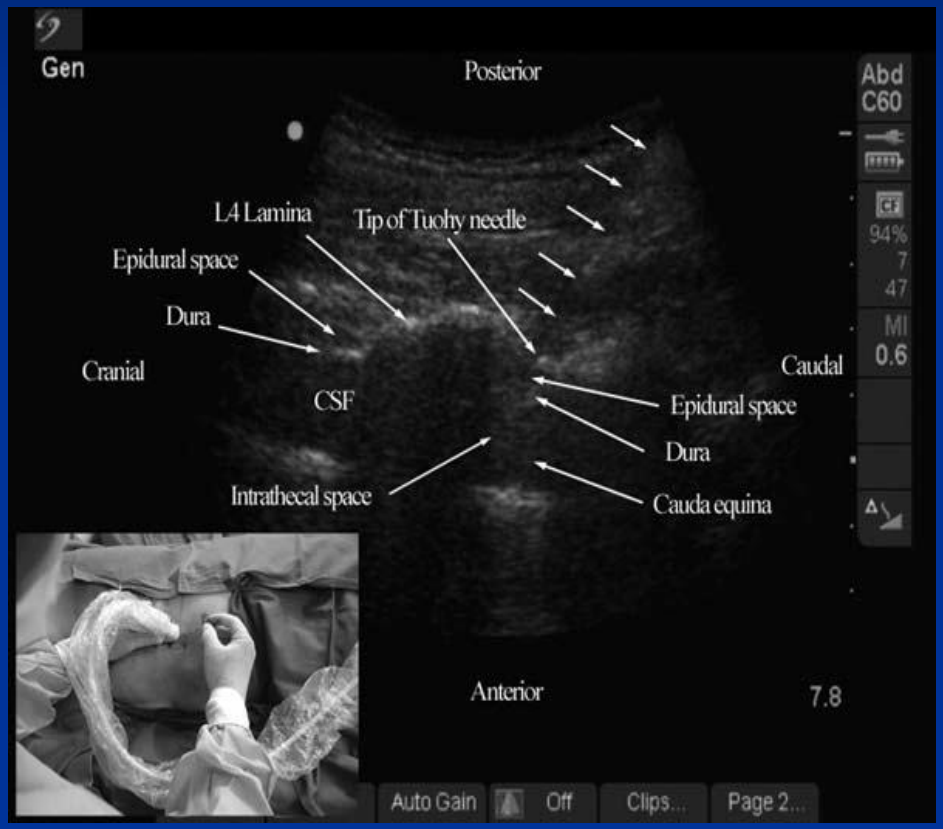
T. Grau, R. W. Leipold, J. Horter, E. Martin and J. Motsch
University of Heidelberg, Department of Anaesthesiology, Im Neuenheimer Feld 110, D-69120 Heidelberg, Germany

- 20 volunteers
- Ultrasonic examination of the L3/4 interspace
- Using a 4-MHz and a 7-MHz probe with B-mode and Colour Doppler imaging
- Four settings for the quality of vessel depiction in the puncture area

Results:

- Vessel detection was possible in 50% of the B-mode images and in all of the 4-MHz Doppler images
- Vessels were perceptible from a diameter of 0.5 mm
- Veins were the predominantly visible structures

Real-time ultrasound-guided neuraxial techniques



- 15 patients
- Received epidural or CSE for groin/lower limb surgery
- The epidural space was successfully entered in 14/15 patients
- Mean age of 66.3 (21.7) yr
- Weight 63 (6.3) kg and BMI 23.3 kg/m2
- Height 164 (5.2) cm

Karmakar MK et al. Br J Anaesth 2009

Real-time ultrasound-guided neuraxial techniques

- 19 obstetric patients received a combined spinal epidural inj.
- 18/19 successfull epidural space inj.
- Age 35 ± 5.3 yr, weight 80.3 ± 13.2 kg
- 160.0 ± 5.6 cm in height, and had a BMI of 31.5 ± 5.9 kg/m_2

Tran D et al. Can J Anaesth 2010

Conclusions

Ultrasound-assisted technique:

1. Location of a specific vertebral interspace
2. Epidural and intrathecal spaces may be identified by ultrasonography
3. Skin-to-epidural space or skin-to-intrathecal space distances may be accurately predicted
4. Preprocedure ultrasound is associated with a lower number of attempts
5. Angle of needle insertion could be visually noted
6. ½ “ blind”
7. Could be used for ESI if C-arm not available

Real-time ultrasound-guided technique:

1. Visible needle
2. More recent studies report the use of this modality, mostly in the pediatric population
3. Patients with normal anatomy
4. Difficult to perform/need three hands
5. Paucity of data exists in the nonobstetric adult population
6. There are only four published reports of lumbar central neuraxial blockade using continuous real-time ultrasound guidance
7. There is also a risk of introducing ultrasound gel into the epidural or intrathecal space (neurotoxisity)

Not recommended for routine use!