Ultrasound Guided Epidural Placement

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Abstract

Student registered nurse anesthetists often have a lack of knowledge and familiarity with the use of ultrasound to assist with epidural placement. The aim of this project was to educate those SRNAs with a PowerPoint presentation and demonstration to increase their knowledge and interest in using ultrasound in the future to assist with placing epidurals.

After informed consent was obtained, a convenience sample of 26 SRNAs at Adventist University of Health Sciences participated in filling out a 10 question assessment of their baseline knowledge. A PowerPoint presentation was then given to the participants as well as a live demonstration of how to find the epidural space with ultrasound. At the conclusion of the presentation, the participants were given the same 10-question test. The tests were graded and statistical analysis was completed using a paired-t test in order to determine significant outcomes.

Average test scores increased from 4.9615 to 7.3846 between pretest and posttest assessments using a 10 question test. The standard deviation of the pretest was 1.53573 and the posttest was 1.23538. The obtained t score was -6.572 with an associated p value of $< .05$ which is considered statistically significant.

It can be concluded that the lecture significantly increased the students' test performance as indicated by the increase in average scores. The participants may now have a better understanding of the beneficial uses of ultrasound for epidural placement. This increase in knowledge and understanding has the potential to increase satisfaction and safety for patients in the future.

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Problem

The problem that this capstone project sought to address is the lack of assessment information that anesthesia providers are equipped with to accurately and safely locate the epidural space. The major problem in epidural anesthesia according to Grau, Bartusseck, Conradi, Martin, and Motsch (2003) is that there is no diagnostic information on the optimal puncture point and direction of needle, of expected angle, and depth. Without the use of ultrasound, palpation of bony landmarks is the only method to identify the lumbar interspinous spaces. Therefore, in the obese population, placement of epidural catheters can be challenging due to an excess of adipose tissue which can make palpation of bony prominences sometimes unachievable and optimal puncture point unknown. Singh et al. (2013) further identified that in the obese population, there is an increased likelihood for false positivity to the loss of resistance technique when locating the epidural space. In addition to the obese population, other patients in which ultrasound guidance can be useful according to Kwok and Karmakar (2010) include those with edema of the back, scoliosis, post laminectomy surgery, or previous spinal instrumentation.

This method of blind loss of resistance at unknown interspace levels can lead to repeated attempts at placement for patients, increased risk of epidural failure, and decreased patient satisfaction with epidural anesthesia. Furthermore, unknown catheter insertion depth can lead to an increased risk of accidental dural puncture resulting in a post-dural puncture headache caused by leakage of cerebrospinal fluid. Sachs and Smiley (2014) estimate that greater than 20,000 post-partum women in the United States will have experienced a headache from an accidental entry into the subarachnoid space during epidural placement in 2014. Additionally, the creation

of an accidental dural puncture is stressful for anesthesia providers and increases medical costs with further needed procedures such as epidural blood patches.

The pre-puncture use of ultrasound can assist with placement of lumbar epidural catheters by helping to identify lumbar interspaces, depth of insertion, and angle of insertion. There is a lack of knowledge amongst SRNAs about the use of ultrasound guidance in the placement of epidural catheters, since it is not being utilized in many clinical settings. This project intended to educate SRNAs about the beneficial uses of ultrasound in the placement of lumbar epidurals.

Review of Literature

Performing an epidural catheter placement relies primarily on the palpation of anatomical landmarks, which can be obscured in the context of obesity or anatomical variation according to Darrieutort-Laffite, Bart, Planche, Glemarec, Maugars, and Le Goff (2015). Multiple needle insertions and redirections due to difficulty with insertion are known to increase pain and discomfort for patients. Furthermore, accidental dural puncture can occur and lead to a post-dural puncture headache (PDPH). Kessler and Grau (2013) identified further risks for complications from multiple punctures such as hematoma, infection, nerve damage, and injuries of the adjacent structures. In order to lessen these complications, ultrasound has demonstrated its ability to produce a reliable and accurate depiction of the lumbar spine anatomy.

In their study, Grau, Leipold, Horter, Conradi, Martin, and Motsch (2001) found that pregnancy-associated weight gain and tissue changes was found to significantly change the spinal anatomy. Not only do parturients frequently have conditions such as scoliosis, hyperlordosis or kyphosis of the lumbar spine, severe obesity or local edema, but hormones can cause changes in tissue consistency, and the interspinous ligament becomes softer and inhomogeneous. This often causes a false loss of resistance and misplacement of the epidural

catheter. They found that the optimal puncture area on the skin for epidural space cannulation was smaller and the soft-tissue channel between the spinal processes was narrower by the end of pregnancy. The distance from the skin to the epidural space was longer and the epidural space was narrower. Therefore, the safety zone between transfixation of the ligamentum flavum and inadvertent dural puncture was smaller. Even though the ultrasound quality was found to be reduced by pregnancy, Grau et al. (2001) stated that "ultrasonography can be a valuable guide to epidural space puncture in parturients" (p. 803).

Most studies recommend using ultrasound to perform a pre-puncture scan prior to placement of a lumbar epidural catheter rather than a simultaneous scan and placement as there is limited data to support this technique. Kwok and Karmakar (2010) have determined that a pre-puncture scan, or scout scan, allows the operator to identify the midline and accurately determine the interspace for needle insertion, which are useful in patients in whom anatomic landmarks are difficult to palpate. It also allows the operator to preview the neuraxial anatomy, predict the depth to the epidural space, and determine the optimal site and trajectory for needle insertion. Such a scan can be useful for patients with presumed difficult epidural access, such as in those with a history of difficult epidural access, obesity, or scoliosis of the lumbar spine.

Kwok and Karmakar (2010) also concluded that ultrasound examination performed before the epidural puncture improves the success rate of epidural access on the first attempt, reduces the number of puncture attempts, or the need to puncture multiple levels, and also improves patient comfort during the procedure. Furthermore, when used for obstetric epidural anesthesia, ultrasound guidance was reported to improve the quality of analgesia, reduce side effects, and improve patient satisfaction. A scout scan may also improve the learning curve of students for epidural blocks in parturients.

As mentioned earlier, risk of accidental dural puncture from unknown interval to the dural space, can result in a PDPH. This is often treated with an epidural blood patch (EBP). Sachs and Smiley (2014) found that while the complications associated with EBP are similar to epidural placement, there is an increased risk of lower limb paresthesia, epidural infection, and backache (secondary to nerve root and perhaps muscular irritation from the blood), which can last up to five days. In addition, if blood is accidentally injected intrathecally, instead of epidurally, it can cause arachnoiditis, meningitis, cauda equine syndrome, and permanent nerve damage. Therefore, although PDPH is treatable, the treatment adds risks to the patient which would be better off prevented. Sachs and Smiley (2014) also found that young pregnant women with a low body mass index (BMI) seem to constitute the highest risk group for the development of PDPH. Therefore, a scout scan for estimation of depth of insertion can be beneficial in not only the obese population but with those with low BMI as well.

The incidence of difficult epidural catheter placement and early failure is significantly more likely among the morbidly obese population (Singh et al., 2013). Morbidly obese parturients have a higher incidence of initial epidural failure rate, with reports as high as 42%, versus 6% in the general population. Among the general population, the incidence of accidental dural puncture without the use of ultrasound has been reported as ranging from 1% to 5%. Balki, Lee, Halpern, and Carvalho (2009) had no dural punctures in a series of 46 obese patients when they used ultrasound to estimate epidural depth, whereas with Singh et al. (2013) the incidence of a dural puncture was 0.6% with ultrasound. Therefore, even with visualization difficulties associated with the increased adipose tissue of morbidly obese parturients, epidural placement outcomes were better when ultrasound guidance was used.

Neuraxial ultrasound was first introduced in the beginning of the 1980s, as a tool to localize and measure the depth of the epidural space. However, even though there was great success in identifying and determining the depth of the epidural space, the technological impossibility of filtrating artifacts in the images of the neuroaxis kept ultrasound assistance from gaining popularity according to Helayel, da Conceição, Meurer, Swarovsky, and de Oliveira Filho (2010). Nevertheless, there has been great progress in the last 10 years in the generation and resolution of ultrasound images, allowing better visualization of the dura mater. Today, there is ultrasound technology available that specifically facilitates image guidance of spinal anesthesia. This technology uses software that automates spinal bone landmark detection and provides automatic epidural location and depth measurements to the anesthetist which is described by Rivanna Medical (n.d.).

The traditional ultrasound technique used to locate the midline and interspinous space as described by Nomura, Shenbagamurthi, O'Connor, and Humphrey (2007) uses ultrasound landmarks with a 5- to 10-MHz linear probe. In their study, with obese patients, a 2- to 4-MHz curved array probe was needed in order to achieve deeper tissue penetration. The height of the landmark site was determined using the traditional method of using Tuffier's line, which is the horizontal line that connects the superior iliac crests. To determine the midline, the probe was used in a transverse plane to identify spinous process. Once the midline was identified, the probe was rotated to a sagittal plane to identify the midline dorsal spinous process of the superior and inferior vertebrae. The dorsal spinous process was identified by its characteristic crescent-shaped hyperechoic appearance with shadowing posteriorly. The midpoint between the dorsal spinous processes was then marked as the landmark for the interspinous space.

Kwok and Karmakar (2010) also describe how to perform an ultrasound scout scan for

neuraxial anesthesia. First, a transverse scan is executed. On a transverse sonogram, the spinous process and the lamina on either side are seen as a hyperechoic reflection anterior to which there is a dark acoustic shadow that hides the underlying spinal canal and neuraxial structures. Therefore, this view is only useful for finding the midline when the spinous processes cannot be palpated and not for identifying epidural space.

Then, according to Kowk and Karmakar (2010), the anesthetist should perform a sagittal scan by placing the transducer on the lower back 1 to 2 cm lateral to the spinous process with its orientation marker directed cranially. They should tilt the transducer slightly medially during the scan. The sacrum can be used as a landmark. It appears as a flat hyperechoic structure with a large acoustic shadow anteriorly. The transducer should then be moved in a cephalad direction to locate the L5-S1 interlaminar space between the sacrum and the L5 lamina. The lamina appears hyperechoic and are the first osseous structure visualized. The anesthetist can continue to move cephalad counting lamina until arriving at the desired interlaminar space.

The interlaminar space, as described by Kwok and Karmakar (2010), is the gap between the adjoining lamina through which the neuraxial structures are visualized within the spinal canal. The ligamentum flavum appears as a hyperechoic band across adjacent lamina. The posterior dura is the next hyperechoic structure anterior to the ligamentum flavum, and the epidural space is the hypoechoic area between the ligamentum flavum and the posterior dura which is a few millimeters wide. These landmarks can be used as a preview of spinal anatomy or to guide the toughy needle in real time during lumbar epidural placement.

In a randomized study by Grau, Leipold, Conradi, and Martin (2001), 72 parturients with presumed difficult epidural puncture were compared using a traditional blind loss of resistance and ultrasound examination technique. To be considered as difficult epidural puncture, the

parturients had either a history of difficult epidural anesthesia, or substantial alterations of the lumbar spine such as scoliosis, kyphosis or hyperlordosis. Thirty-eight percent had a Body Mass Index greater than 33. The control group consisted of 36 parturients and the remaining 36 parturients had an ultrasound examination of the appropriate spinal region prior to epidural puncture. The groups were similar regarding age, weight, body height and ASA risk factors.

In the control group, 1.4-2.6 puncture attempts were made as compared to 0.9-1.5 attempts in the US group (*P* 0.001). In the control group, 0.7-1.5 intervertebral spaces had to be punctured before the epidural space was successfully reached and in the US group 0.5-1.3 (*P* 0.05). An average of 0.6-1.3 catheter advancement attempts were made in the control group and 0.4-1.1 in the US group (*P* 0.003). Asymmetrical spread of sensory blockade was found in 14.7% of the control group and in 5.5% of the US group. The researchers found higher satisfaction in the ultrasound group. They found no disadvantages related to ultrasound scanning. When a difficult puncture of the epidural space is expected Grau, Leipold, Conradi, and Martin (2001) recommended to use ultrasound to facilitate the procedure.

Project Description

The focus of this project was to clearly define the challenging scenarios and patient populations that can make the placement of lumbar epidural catheters using a blind loss of resistance technique difficult. It further intended to openly discuss the advantages of using ultrasound guidance to assist with the placement of epidurals. After a thorough review of the literature was presented, this project intended to convey the beneficial outcomes of using ultrasound guidance to reduce the number of unwanted events in epidural placement. It further intended to increase SRNA interest in ultrasound guided epidural placement and awareness in beneficial circumstances to advocate for ultrasound guided placement if the opportunity arises.

In order to address the problem of lack of knowledge among SRNAs of the benefits of using ultrasound guidance for the placement of lumbar epidural catheters, an oral presentation was given to the first year SRNA class along with an accompanying power point and demonstration. Teaching goals were evaluated using a 10 question pre-test to assess baseline knowledge and a post-test to access knowledge gained from the presentation. The pre and post tests were identical and numerically coded to assess individual knowledge.

Evaluation

The ultimate goal of this project was for first year SRNAs to be exposed to the beneficial uses of ultrasound when placing lumbar epidural catheters. Even though it is not current common practice at clinical settings to use ultrasound in the placement of epidurals, the opportunity to use ultrasound guidance for placement may arise in their future practice at diverse settings worldwide. Therefore, it was considered to be in the best interest of the SRNAs to have knowledge in the advantageous uses. A presentation was given to the 2018 cohort of SRNAs at Adventist University of Health Sciences before they had exposure to obstetric specialty rotations and therefore baseline knowledge in the actual skill of placing epidural catheters was minimal.

Before the presentation was given, full written informed consent was administered to all SRNAs requiring their signature of full understanding. An anonymous, numerically coded, identical, pre-test and post-test was distributed to all SRNAs in individual envelopes. After completing and returning the written pre-test, commencement of the presentation proceeded. After completion of the power point presentation and demonstration, the SRNAs were asked to fill out the post-test and return it in the envelope provided. The presenter was then able to evaluate the outcome of teaching goals by assessing students' baseline knowledge as well as

knowledge that was gained from the presentation by comparing the scores of the pre-test and post-test to determine gain scores using a paired-t test.

Results and Conclusions

Two identical tests were administered to 26 SRNAs both before and after a power point presentation was given. The test can be referenced in Appendix B. The average test score increased from 4.9615 to 7.3846 between pretest and posttest assessments. Statistical analysis was completed using a paired-t test in order to determine significant outcomes. The results of this test is presented in Appendix D. The obtained t score was -6.572 with an associated p value of $< .05$ which is statistically significant. It can be concluded that the lecture significantly increased the SRNAs' test performance as indicated by the increase in average scores.

The anticipated outcome of this project was an increase in knowledge among first year SRNA students about the use of ultrasound for epidural placement. Based on the results of the paired-t test it can be concluded that knowledge increased among the SRNAs, as their test scores indicated improved performance. Limitations to this project included the ability for the SRNAs to open envelopes containing the posttest prior to the conclusion of the presentation. Although attempt was made to keep the posttest concealed until the presentation was given in entirety by placing them inside envelopes, it was noted that several SRNAs removed their posttest from the envelope prior to the completion of the presentation and began answering questions. This may have increased test scores in favor of some of the SRNAs without an accurate assessment of their knowledge gained.

An interesting finding of this project included the observed increase in interest by the SRNAs in the presentation with the inclusion of a live demonstration. The demonstration used the Accuro ultrasound device to locate the epidural space of a volunteer from the audience. This

increase in interest displayed the value of active participation in a presentation intended to hold the interest of an audience. Implications of this project include recognition that the overall increase in knowledge and interest in the beneficial uses of ultrasound in the placement of epidurals may lead to increased use of ultrasound in the future by the participants. This has the potential to increase satisfaction and safety for patients.

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Appendix A

ADU NAP CAPSTONE PROJECT – INFORMED CONSENT

My name is Candice Cassano, and I am a MSNA student in the Nurse Anesthesia Program (NAP) at Adventist University of Health Sciences (ADU). I am doing a Capstone Project called *Ultrasound Guided Epidural Placement*. This project is being supervised by Manuel Tolosa, DNAP, CRNA. I would like to invite you to participate in this project. The main purpose of this form is to provide information about the project so you can make a decision about whether you want to participate.

WHAT IS THE PROJECT ABOUT?

The purpose of this project is to provide you with knowledge of the patients at high risk for difficult lumbar epidural placement and the advantages to using ultrasound guidance before epidural placement to reduce associated risks.

WHAT DOES PARTICIPATION IN THIS PROJECT INVOLVE?

If you decide to participate in this project, you will be asked to complete an anonymous pre-assessment, attend a classroom presentation, and then complete an anonymous post-assessment. The assessment will address your baseline knowledge and knowledge gained from the presentation about ultrasound guided epidural placement. Your participation by attendance at the presentation and completion of the survey is anticipated to take approximately 60 minutes.

WHY ARE YOU BEING ASKED TO PARTICIPATE?

You have been invited to participate as part of a convenience sample of students currently enrolled in the ADU NAP. Participation in this project is voluntary. If you choose not to participate or to withdraw from the project, you may do so at any time.

WHAT ARE THE RISKS INVOLVED IN THIS PROJECT?

Although no project is completely risk-free, I don't anticipate that you will be harmed or distressed by participating in this project.

ARE THERE ANY BENEFITS TO PARTICIPATION?

I don't expect any direct benefits to you from participation in this project. The possible indirect benefit of participation in the project is the opportunity to gain additional knowledge about ultrasound guided epidural placement.

HOW WILL THE INVESTIGATORS PROTECT PARTICIPANTS' CONFIDENTIALITY?

The results of the project will be published, but your name or identity will not be revealed. To maintain confidentiality of assessments, the investigator will conduct this project in such a way to ensure that information is submitted without participants' identification. This will be conducted my administering an anonymous pre-test and post-test provided in separate envelopes. Thus, the investigator will not have access to any participants' identities.

WILL IT COST ANYTHING OR WILL I GET PAID TO PARTICIPATE IN THE PROJECT?

Your participation will cost approximately 60 minutes of your time, but will require no monetary cost on your part. You will not be paid to participate.

VOLUNTARY CONSENT

By signing this form, you are saying that you have read this form, you understand the risks and benefits of this project, and you know what you are being asked to do. The investigator will be happy to answer any questions you have about the project. If you have any questions, please feel free to contact Candice Cassano at Candice.Cassano@my.adu.edu If you have concerns about the project process or the investigator, please contact the Nurse Anesthesia Program at (407) 303-9331.

_____ _____

Participant Signature **Date**

_____

Participant Name (PRINTED LEGIBLY)

Appendix B

Ultrasound Guided Epidural Placement Survey Questions

Pre- and Post-Test

1) **Before placing a lumbar epidural in an obese patient, difficulty palpating landmarks may occur:**
   A) 5 % of the time
   B) 33% of the time
   C) 68% of the time
   D) >90% of the time

2) **True/False: In the obese population, there is an increased likelihood for false positivity to the loss of resistance technique when locating the epidural space.**
   A) True
   B) False

3) **Patients in which ultrasound guidance for epidural placement can be useful include: (select all that apply)**
   A) edema of the back
   B) scoliosis
   C) post laminectomy surgery
   D) patients requesting unmedicated childbirth
   E) obese patients
   F) coagulopathic patients

4) **The pre-puncture use of ultrasound can assist with placement of lumbar epidural catheters by helping to:**
   A) identify thoracic interspaces
   B) identify depth of insertion
   C) identify angle of insertion
   D) A and C are correct
   E) B and C are correct
   F) All are correct

5) **The highest risk group for the development of a post dural puncture headache is:**
   A) young pregnant women with a low BMI
   B) young pregnant women with a high BMI
   C) advanced maternal aged pregnant women with normal BMI

6) True/False: The distance from the skin to the epidural space is shorter with pregnancy.
A) True
B) False

7) Multiple needle insertions and redirections due to difficulty with epidural insertion are known to:
A) Increase the likelihood of success
B) Cause a hematoma
C) Herniate a lumbar disc
D) Predict the likelihood of needing general anesthesia

8) True/False: The interspinous ligament becomes softer with pregnancy.
A) True
B) False

9) Which type of scan with the ultrasound is best to determine if you are midline?
A) Transverse
B) Paramedian
C) Sagittal

10) The space between the ligamentum flavum and the dura mater is _____ in the parturient.
A) Wider
B) Narrower
C) Unchanged

Appendix C

Ultrasound Guided Epidural Placement

Candice Cassano, SRNA

The Problem

There is a lack of assessment information that anesthesia providers are equipped with to accurately and safely locate the epidural space.

The Problem

- Without the use of ultrasound, palpation of bony landmarks is the only method to identify the lumbar interspinous spaces.
- There is no diagnostic information on the optimal puncture point and direction of needle, of expected angle, and depth.

The Obese Population

- Excess of adipose tissue
- Palpation of bony prominences sometimes unachievable
- Optimal puncture point unknown
- Increased likelihood for **false positivity** to the loss of resistance technique

The Obese Population

Stiffler, Jwayyed, Wilber, and Robinson (2006) reported difficulty in palpating landmarks in:

- 5% of patients with normal BMI
- 33% in those who were overweight
- **68% of obese patients**

Patient Populations that can Benefit

Ultrasound guidance can be useful for patients with:

- Edema of the back
- Scoliosis
- Post laminectomy surgery
- Previous spinal instrumentation
- Obesity

Blind Loss of Resistance Complications

Blind loss of resistance at unknown interspaces can lead to:

- Repeated attempts at placement for patients
- Increased risk of epidural failure
- Decreased patient satisfaction
- Accidental dural puncture resulting in a post-dural puncture headache (PDPH) caused by leakage of cerebrospinal fluid (CSF)

Post Dural Puncture Headache

- Sachs and Smiley (2014) estimated that more than 20,000 post-partum women in the United States experienced a PDPH in 2014.
- The creation of an accidental dural puncture:
  - Is stressful for patients who are trying to take care of a newborn
  - Increases medical costs with further needed procedures such as epidural blood patches

Post Dural Puncture Headache

- Young pregnant women with a **low body mass index** (BMI) make up the **highest risk** group for the development of PDPH.
- The very thin, small patient can be just as stressful to place an epidural. Is the depth 2.5 cm or 6 cm from the skin? The ultrasound could answer that question ahead of placement and make placement less risky for a PDPH and less stressful for the provider.
- Therefore, a scout scan for estimation of depth of insertion can be beneficial in not only the obese population but with those with low BMI as well.

Other Complications

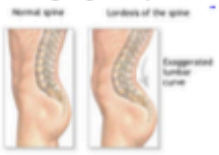
Multiple needle insertions and redirections due to difficulty with insertion are known to:

- Increase pain and discomfort for patients
- Cause a **hematoma**
- Increase risk of infection
- Cause nerve damage
- Cause injuries of the adjacent structures

Changes with Pregnancy

Pregnancy-associated weight gain and tissue changes significantly changes spinal anatomy:

- Scoliosis
- Hyperlordosis of the lumbar spine
- Severe obesity or local edema
- Hormonal changes in tissue consistency



Changes from Pregnancy Hormones

- Interspinous ligament becomes **softer**. This often causes a false loss of resistance and misplacement of the epidural catheter.
- The optimal puncture area on the skin for epidural space cannulation is smaller and the soft-tissue channel between the spinal processes is narrower by the end of pregnancy.
- The distance from the skin to the epidural space is **longer** and the epidural space is narrower.
- The safety zone between the ligamentum flavum and inadvertent dural puncture is **smaller**.

A Solution to the Problem

- The pre-puncture use of ultrasound can assist with placement of lumbar epidural catheters by helping to identify:
  - lumbar interspaces
  - depth of insertion
  - angle of insertion

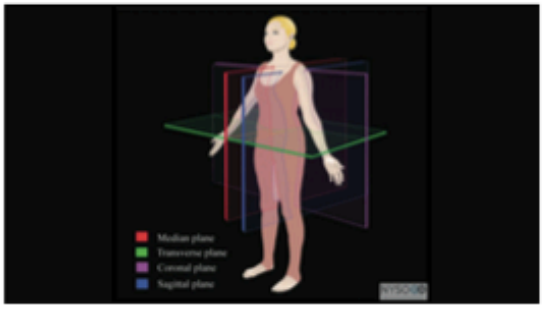
Grau, T., Leipold, R. W., Conradi, R., & Martin, E. (2001). Ultrasound control for presumed difficult epidural puncture. Acta Anaesthesiologica Scandinavica, 45(6), 766–771. http://dx.doi.org/10.1034/j.1399-6576.2001.045006766.x

- Randomized study
- 72 parturients with presumed difficult epidural puncture.
- The control group = 36 parturients using standard method, Ultrasound exam before epidural puncture group =36 parturients.
- Number of puncture attempts: CG 1.6-2.6 attempts, US[illegible] 0.9-1.5 attempts (P 0.001)
- Number of intervertebral spaces punctured: CG 0.7-1.5, and US[illegible] 0.5-1.3 (P 0.05)
- Catheter advancement attempts: CG 0.4-1.3, and US[illegible] 0.4-1.1 (P 0.001)
- Asymmetrical spread of sensory blockade was found in the CG 14.7% and in the US[illegible] 5.5% of the time.
- Conclusion: higher satisfaction in the ultrasound group. They found no disadvantages related to ultrasound scanning.

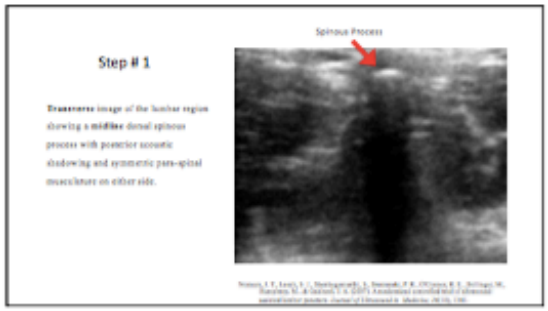
Chin, K. J., Perlas, A., Chan, V., Brown-Shreves, D., Koshkin, A., & Vaishnav, V. (2011). Ultrasound Imaging Facilitates Spinal Anesthesia in Adults with Difficult Surface Anatomic Landmarks. Anesthesiology, 115(1), 94–101. http://dx.doi.org/10.1097/aln.0b013e31821a844f

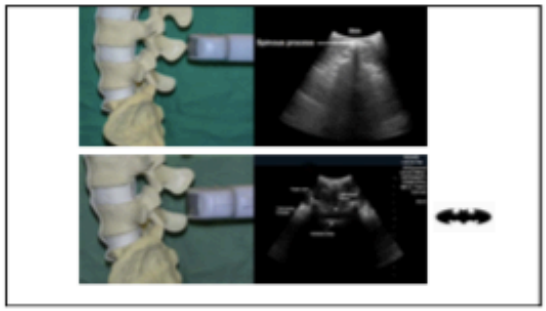
- Randomized study
- 120 orthopedic patients with one of the following: body mass index more than 30 kg/m2 and poorly palpable spinous processes; moderate to severe lumbar scoliosis; or previous lumbar spine surgery.
- Control Group (CG) to receive spinal anesthetic by traditional method, (USG) to receive pre-procedure ultrasound scan.
- The first-attempt success rate: CG 33% vs. USG 65% (P 0.001)
- Number of needle insertion attempts: CG avg. 2 [1–4] vs. USG avg. 1 [1–2] (P 0.001)
- Number of needle redirections CG avg. 10 [3–21] vs. USG avg. 4 [1–10] (P 0.001)
- Conclusion: Preprocedural ultrasound imaging facilitates the performance of spinal anesthesia in the nonobstetric patient population with difficult anatomic landmarks.

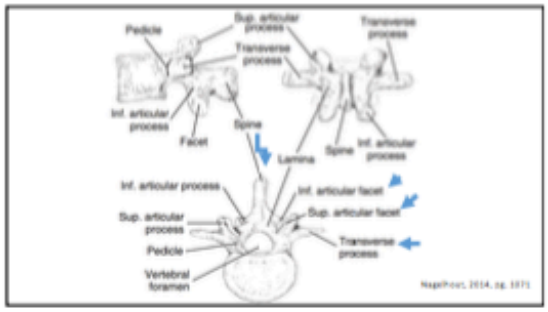
How do you use ultrasound to place an epidural?

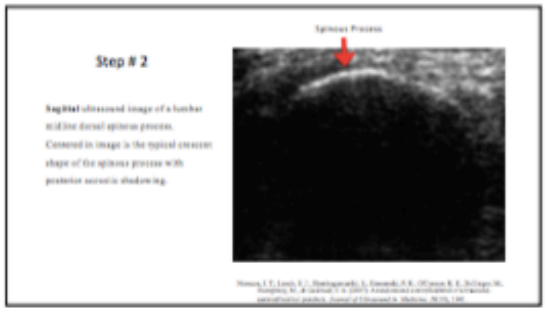


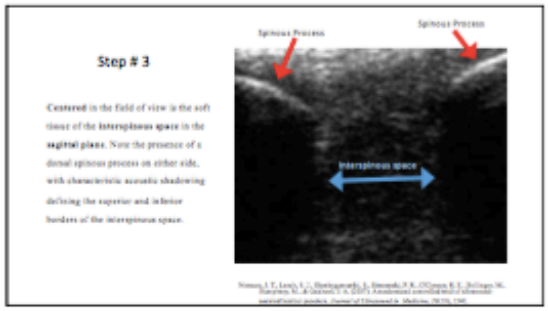
There Are Three Views We Will Use

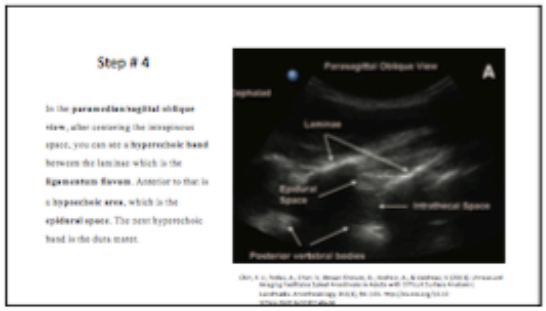

Step # 1
Spinous Process
Transverse image of the lumbar region showing a midline dorsal spinous process with posterior acoustic shadowing and symmetric para-spinal musculature on either side.

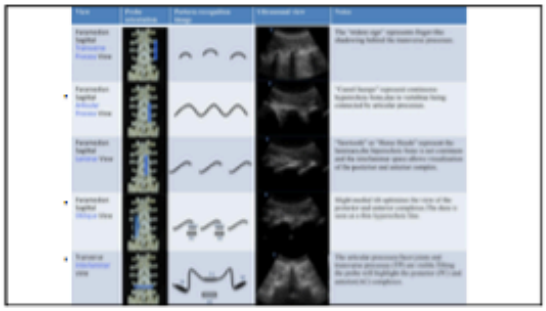



Pedicle
Sup. articular process
Transverse process
Transverse process
Inf. articular process
Facet
Spine
Lamina
Spine
Inf. articular process
Inf. articular process
Inf. articular facet
Sup. articular process
Sup. articular facet
Pedicle
Transverse process
Vertebral foramen
NagelPrint, 2014, pg. 1371

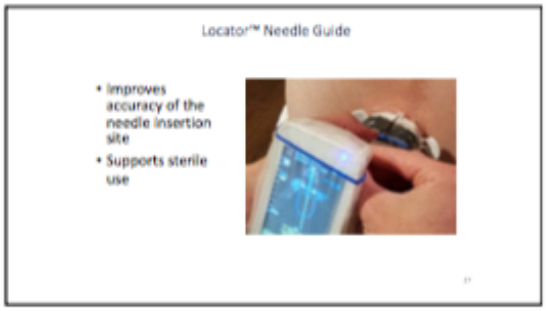

Spinous Process
Step # 2
Sagittal ultrasound image of a lumbar midline dorsal spinous process. Centered in image is the typical crescent shape of the spinous process with posterior acoustic shadowing.


Step # 3
Spinous Process
Spinous Process
Centered in the field of view is the soft tissue of the interspinous space in the sagittal plane. Note the presence of s dorsal spinous process on either side, with characteristic acoustic shadowing defining the superior and inferior borders of the interspinous space.
Interspinous space

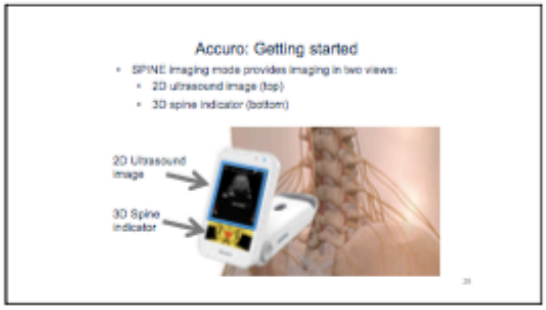

Step # 4
In the paramedian/sagittal oblique view, after centering the interspinous space, you can see a hyperechoic band between the laminae which is the ligamentum flavum. Anterior to that is a hypoechoic area, which is the epidural space. The next hyperechoic band is the dura mater.
Paramedian Oblique View
A
Laminae
Epidural Space
Intrathecal Space
Posterior vertebral bodies

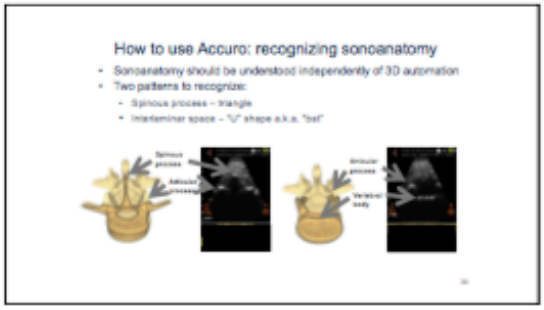


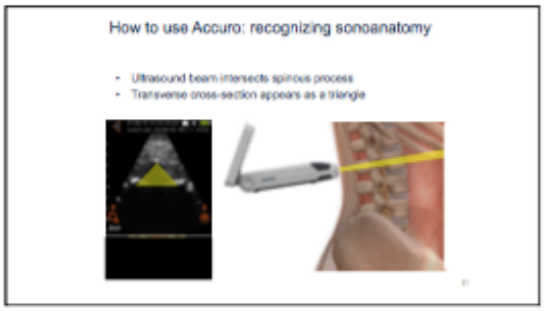

RIVANNA
Guiding Advancements in Ultrasound
Introducing Accuro…


Locator™ Needle Guide
• Improves accuracy of the needle insertion site
• Supports sterile use

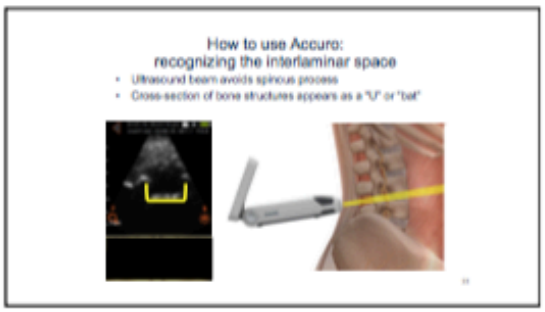

How to use Accuro: 6 easy steps
RIVANNA

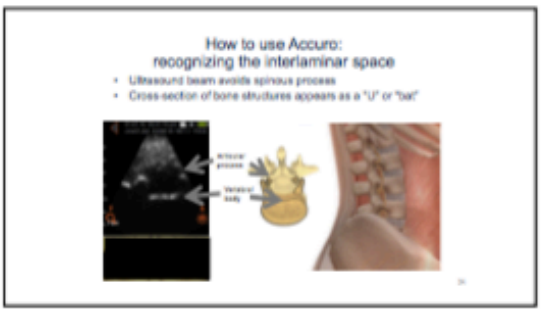

Accuro: Getting started
• SPINE imaging mode provides imaging in two views:
• 2D ultrasound image (top)
• 3D spine indicator (bottom)
2D Ultrasound image
3D Spine indicator

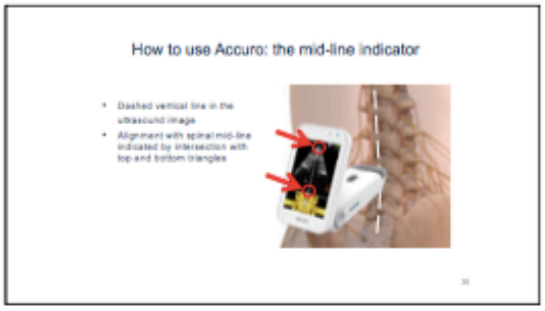

How to use Accuro: recognizing sonoanatomy
• Sonoanatomy should be understood independently of 3D automation
• Two patterns to recognize:
• Spinous process – triangle
• Interlaminar space – "U" shape a.k.a. "bat"

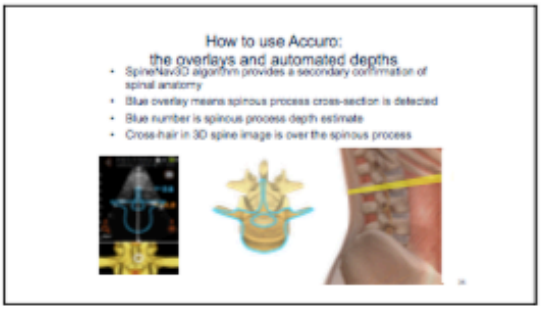

How to use Accuro: recognizing sonoanatomy
Ultrasound beam intersects spinous process
Transverse cross-section appears as a triangle

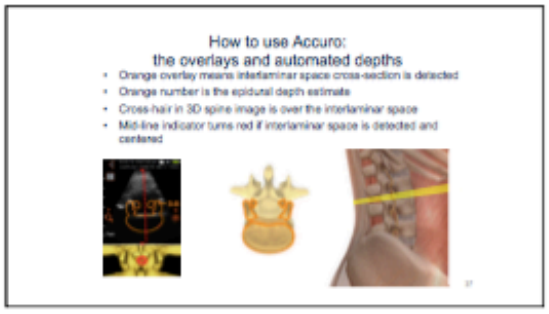

How to use Accuro: recognizing spinous process
Ultrasound beam intersects spinous process
Transverse cross-section appears as a triangle


How to use Accuro:
recognizing the interlaminar space
Ultrasound beam avoids spinous process
Cross-section of bone structures appears as a "U" or "bat"


How to use Accuro:
recognizing the interlaminar space
Ultrasound beam avoids spinous process
Cross-section of bone structures appears as a "U" or "bat"

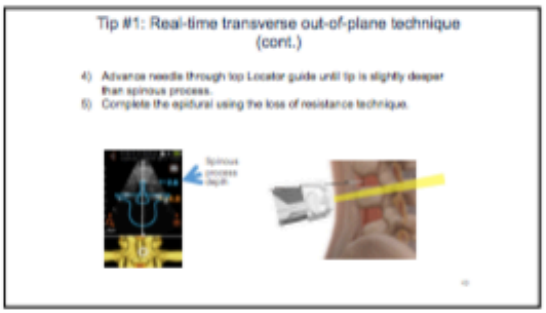

How to use Accuro: the mid-line indicator
Dashed vertical line in the ultrasound image
Alignment with spinal mid-line indicated by intersection with top and bottom triangles

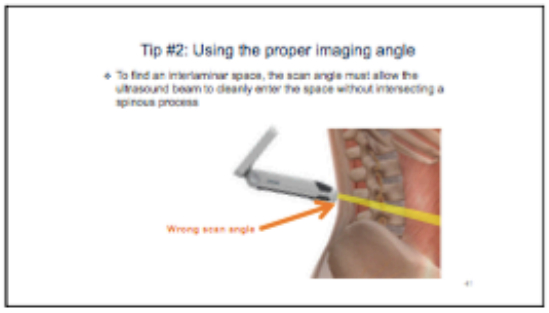

How to use Accuro:
the overlays and automated depths
SpineNav3D algorithm provides a secondary confirmation of spinal anatomy
Blue overlay means spinous process cross-section is detected
Blue number is spinous process depth estimate
Cross-hair in 3D spine image is over the spinous process

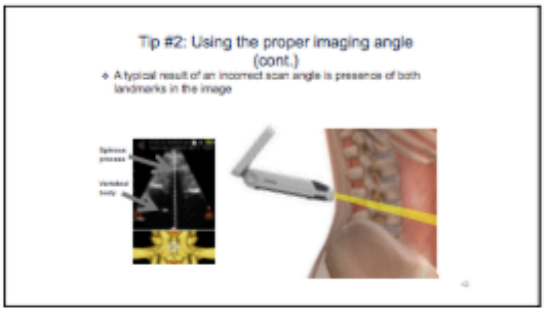

How to use Accuro:
the overlays and automated depths
Orange overlay means interlaminar space cross-section is detected
Orange number is the epidural depth estimate
Cross-hair in 3D spine image is over the interlaminar space
Mid-line indicator turns red if interlaminar space is detected and centered


Benefits of sterile scanning
Reduces risk of infection
Improves success
Less time between scan and needle insertion
Ability to re-scan as needed
Required for advanced real-time techniques


Tip #1: Real-time transverse out-of-plane technique
1) Repeat scouting technique to mark skin
2) Re-locate interlaminar space at marking site
3) Translate inferior to marking site until top Locator guide aligns with center of the four Locator marks.
Locator marks


Tip #1: Real-time transverse out-of-plane technique (cont.)
4) Advance needle through top Locator guide until tip is slightly deeper than spinous process.
5) Complete the epidural using the loss of resistance technique.


Tip #2: Using the proper imaging angle
To find an interlaminar space, the scan angle must allow the ultrasound beam to cleanly enter the space without intersecting a spinous process
Wrong scan angle


Tip #2: Using the proper imaging angle (cont.)
A typical result of an incorrect scan angle is presence of both landmarks in the image

Summary

- Without the use of ultrasound, there is no diagnostic information on the optimal puncture point and direction of needle, of expected angle, and depth when placing an epidural catheter.
- With obesity , palpation of bony prominences is sometimes impossible and the optimal puncture point is unknown , there is also an increased likelihood for false positivity to the loss of resistance technique when locating the epidural space.
- Young pregnant women with a low BMI are most likely to develop a PDPH.
- A scout scan for estimation of depth of insertion can be beneficial in not only the obese population but with those with low BMI as well.

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Appendix D

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PreTest	4.9615	26	1.53573	.30118
	PostTest	7.3846	26	1.23538	.24228

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	PreTest - PostTest	-2.42308	1.87985	.36867	-3.18237	-1.66379	-6.572	25	.000