Disclaimer

- The views expressed in this article are those of the author and do not reflect official policy or position of the Department of the Navy, the Department of Defense, the Uniformed Services University of the Health Sciences, or the United States Government.

Disclosure

- Nothing else to disclose
Objectives

- Review ultrasound basics
- Describe the use of pre-procedural ultrasound (U/S) assessment of sonoanatomy of the spine
- Discuss research findings on the use of pre-procedural ultrasonography in parturients
- Provide some practical tips for incorporating U/S into practice

Clinical Vignette

- A fellow CRNA calls for assistance
- G1P0 morbidly obese parturient requested an epidural at 4 cm dilation (6'5” & 365 lbs.)
- PMH: CHTN, OSA, morbid obesity
- OB: severe preeclampsia, platelets = 120K
- Airway: MP 4, 3 FB, limited ROM
- FHT: occasional late decelerations
- Exam: unable to palpate spinous processes
- Procedure: multiple attempts unsuccessful
  - U/S performed
  - Success on 1st attempt

Clinical Vignette

- 30 y/o G2P1 @38 w presents for repeat LTCS for twins
  - PMH: -, Prenatal: uncomplicated
  - Exam: exaggerated lumbar lordosis (66” & 80 kg)
  - Airway: MP 2, 3 FB, FROM Labs: WNL
  - History of difficult epidural
  - SRNA- multiple attempts by SRNA & CRNA unsuccessful
  - Nurse gets the ultrasound machine
  - U/S scanning identifies ideal insertion point @ L3-4 and depth to ligamentum flavum (LF) = 6 cm
  - Original insertion points off midline by ~ 2 cm
  - Spinal placed through ideal insertion point on first attempt without redirection
Clinical Vignette

- An SRNA first day on OB (never placed labor epidural; CLE)
- A G1P0 parturient requests a epidural at 4 cm dilation (65" and 165 lbs)
- The student and staff palpate the back
- Staff performs U/S
- Marks ideal insertion point and estimates the depth to LF = 4 cm
- With coaching, SRNA achieves loss or resistance (LOR) at 4.3 cm
- Places epidural on the first attempt
- SRNA describes how she was able to focus on the feeling of LOR
- CRNA's anxiety level was less because he was confident in the insertion point and depth estimation

What is Pre-Procedural U/S?

- Use of a curvilinear probe to identify lumbar spine sonoanatomy to facilitate placement of spinals and epidurals
- Not real-time
- U/S scan +/- palpate
- Scan two acoustic windows
  - Longitudinal paramedian
  - Transverse
- Estimate depth
- Mark the location

Ultrasound Physics

Seeing with Sound

Basic Principles:

Ultrasound is form of mechanical sound energy that travels through a conducting medium (e.g., tissue) and then gets reflected back to form an image
U/S Theory & Terminology

- Ultrasound waves are created by piezoelectric crystals in transducer
- U/S waves penetrate tissue to different depths based on probe frequency
- High frequency probes (5-13 MHz)
  - Great resolution, shallow depth
- Low frequency probes (2-5 MHz)
  - Poor resolution, deep depth (up to 30 cm)
U/S Theory & Terminology

- **Echogenicity**
  - U/S image depends on tissue density and ability of machine to reflect U/S waves back to transducer
- **Hyperechoic**
  - Structures with greater propensity to reflect U/S wave
  - Bones, nerves, vascular walls, connective tissue
  - Images appear brighter on screen
- **Hypoechoic**
  - Structures with less propensity to reflect U/S waves
  - Blood vessels, lung, fluid filled structures, etc
  - Images appear darker
- **Acoustic impedance**
  - Reduction in U/S wave energy as it passes through structures
  - Accounts for the depth limits of U/S

Benefits of U/S in OB Anesthesia

- Identify best interspace
- Identify ideal insertion point
- Estimate depth to the epidural space
- Reduce attempts, trauma and complications
- Improve learning curve for trainees
- May assist with placement of epidural/spinal in the “difficult back”
  - Scoliosis
  - Back surgery
  - Obesity

Probe

- Low frequency (2–5 MHz) curvilinear probe

Acoustic Windows

- Longitudinal paramedian
  - Sacrum
  - Articular process
  - Ligamentum flavum and posterior dura mater
  - Anterior dura mater, post. long. lig., & vertebral body

- Transverse
  - Spinous process
  - Articular process
  - Ligamentum flavum & posterior dura mater
  - Anterior dura mater, post. long. lig., & vertebral body
Depth Estimation

- Freeze screen
- Place caliper at skin & inner side of LF
- Depth = 4.5 cm
- U/S underestimates LOR depth
Marking the Skin

Figure 3. Skin Markings for Longitudinal and Transverse Scanning Plans

Figure 9. Sonogramy of the Lumbar Spine of an Obese Patient. Note that the tip of the spinal process is 4.28 cm from the skin and 7.22 cm from the ligamentum flavum-posterior dura mater. If significant compression of the subcutaneous tissue is applied during the ultrasonic assessment, a significant underestimation of the distance will occur.

Video Clip

- Ultrasound for Epidural Insertion
  [http://www.youtube.com/watch?v=M4hiP46YMuC](http://www.youtube.com/watch?v=M4hiP46YMuC)
- Accessed March 1, 2014
Review of Literature

- 16 studies on 1,373 patients
  - 1 systematic review
  - 5 randomized controlled trials
  - 1 cohort study
  - 1 case-control study
  - 8 descriptive correlational studies
- Majority published by 2 groups
  - Grau et al
  - Carvalho et al

Comparison of Ultrasound & Needle Depth

- Non-obese: 0 ± 0.35 cm
- Obese: 0.3 ± 0.5 cm
- \( r = 0.790 \) to 0.960
- LOR > 8 cm = 17%

May not need >10 cm epidural needle

Does U/S decrease number of attempts and improve success?

- Systematic review (Schnabel et al, 2010)
  - U/S decreases # insertion attempts by 1
  - U/S decreases # puncture sites by 0.2
  - 1st attempt success rate: 71%
  - 1st interspace success rate: 88%

- Limitation of studies
  - All epidurals and U/S scans by experienced providers

U/S 1st Attempt Success

<table>
<thead>
<tr>
<th></th>
<th>Nonobese</th>
<th>Obese</th>
</tr>
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<tbody>
<tr>
<td>No reinsertions</td>
<td>92%</td>
<td>76%</td>
</tr>
<tr>
<td>No reinsertions</td>
<td>76%</td>
<td>74%</td>
</tr>
<tr>
<td></td>
<td>67%</td>
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</tbody>
</table>

U/S Image Quality

- Good image quality 67-100%
- Obesity reduces image quality
- Paramedian best image quality
- Pts with abnormal sonoanatomy 8.2 times more likely to experience wet tap (95% CI: 3-22, P <0.0001)
- Clinical implication: choose interspace with best image quality
Does U/S reduce epidural failure rate?
- Vallejo et al (2010)
  - RCT N = 370 parturients
  - CLE placed by 1st yr residents supervised by staff
  - CLE failure rate =
    - pain >3/10 after 3 boluses
    - U/S < control
  - N = 300 “difficult backs”
  - Incomplete analgesia rate higher in control group (8% vs. 2%, P<0.05)

Does U/S decrease complications?
- Systematic Review (Schnabel et al, 2010)
  - PDPH 0.28 times lower (95% CI 0.14-0.57)
  - Incidence of back pain w/ placement similar
- Limitation
  - Definition of PDPH mixed
  - Publication & "dominating center" bias
  - Epidurals placed by experienced providers

Does U/S improve hasten trainee learning curve?
  - Randomized 10 residents to U/S or palpation alone
  - Single staff performed U/S
    - Insertion point & angle
    - Residents alone to place CLE
  - 600 epidurals placed
  - U/S improve proficiency in trainees
  - Demonstrates value of U/S in teaching and learning
What about staff learning curve?

- 18 anesthesiologists attended 1 day hands-on CME course
- 20 trials (2 min each) to practice identifying ideal interspace, insertion point & ultrasound depth
- F/U 1-2 weeks later
- Only 27% competent at identifying ideal interspace w/ U/S
- None competent to identify insertion point or ultrasound depth to LF
- Conclusion: Hard to teach old dog new tricks
  - To become competent need more experience

Discussion

- Preprocedural U/S improves efficiency of CLE placement
- May improve success in “difficult backs”
- May help improve trainee success
- Takes less <5 minutes
- Can improve 1st attempt success rate w/ spinal
- Problem: does require a fair bit of experience to become competent

Tip for Anesthetists

- Practice! Practice Practice!
- Practice scanning in controlled setting
- Look at a lot of ultrasound images
- Bring U/S machine in for “easy epidurals or spinals”
- Use preemptively in presumed “difficult backs”
- Use it to teach students
References

1. Desser M, Brocklesby J, Bamber J. Audit of the influence of body mass index on the performance of epidural analgesia in labour and the subsequent mode of delivery. BJOG. 2006;113(10):1178-1181.


References


