Ultrasound Guided Regional Anesthesia: Current State or State of The Art?

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February 17, 2013
The Steamboat Grand
Steamboat Springs, CO
Yes, maybe, not yet, that all depends...

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Pacira
Outline:

- History of Ultrasound
- Current State/Purported Benefits
- Evidence Basis for USGRA
- Limitations
- Future Directions
History of Ultrasound:

- Not a new technique by any means
- Lazzaro Spallanzani (1729-1799)
  - Animal echolocation
- Curie Brothers/Gabrielle Lippman (1880)
  - Quartz crystals
- World War I: SONAR
- B-mode Medical Scanning-1950’s
Ultrasound in Anesthesiology:

- 1978- La Grange et al:
  - Use of a Doppler ultrasound
  - Supraclavicular approach in 61 patients
  - Success rate was 98%
  - No complications

Ultrasound in Anesthesiology:

1989- Ting et al:
- Cannula placed via palpation and “click”
- Used U/S to confirm cannula location and to demonstrate the spread of local anaesthetic
- Block was successful in all subjects
- No paresthesias or vascular punctures occurred

Imaging or Imagining?

Figure 3. Two-dimensional ultrasonic image of the axillary plexus sheath. 1: Axillary vessels. 2: Pectoralis major muscle. 3: Nerve fascicles.
Regional Anesthesia Predictions:

Original Articles

Regional Anesthesia and Pain Medicine: Residency Training—The Year 2000

Dan J. Kopacz, M.D. and Joseph M. Neal, M.D.

“We further speculate that the nerve stimulator will become the dominant means of increasing the performance of peripheral nerve block in the United States, just as it has in Europe.”

RAPM, 2002, January-February, 9-14
Where we stand (stood) today

The Renaissance of Regional-2008-present:

- Microprocessor technology
- Quality
- Resolution
- Equipment miniaturization
- Probe quality and diversity
The greatest thing since?
SPECIAL ARTICLE

The ASRA Evidence-Based Medicine Assessment of Ultrasound-Guided Regional Anesthesia and Pain Medicine

Executive Summary

Joseph M. Neal, MD,* Richard Brull, MD,† Vincent W. S. Chan, MD,‡ Stuart A. Grant, MBChB,§
Jean-Louis Horn, MD,§ Spencer S. Liu, MD,‖ Colin J.L. McCartney, MBChB,¶
Samer N. Narouze, MD, MSc,# Anahi Perlas, MD,† Francis V. Salinas, MD,*
Brian D. Sites, MD,** and Ban Chi-ho Tsui, MD***
Hierarchy of evidence

I

II

Retrospective studies
Observational database
Case series & reports

III

Prospective
Non-randomized

IV

Expert panel consensus opinion

A

B

C

MA

RCT
ASRA Expert Panel Review

- 20 year literature review
- RCT’s and large case series
- 19 upper extremity RCT’s*
- 11 lower extremity RCT’s*
- 3 truncal RCT’s
- 1 neuraxial RCT
- Pediatrics
- Chronic pain

Reg Anesth Pain Med 2010;35: S1-S9
JADAD Scoring System:

- Study described as randomized?
- Method used to generate the sequence of randomization described and appropriate?*
- Study described as double blind?*
- Method of double blinding described/appropriate?
- Description of withdrawals and dropouts?

JADAD Score Range: 0-5
Does Ultrasound Deliver?

- Faster
- Simpler
- Safer
- Success
- Other benefits
Is it faster than conventional techniques?
Block performance time

- When does the clock start?
  - Pre-scan
  - Boot up
  - Probe cover
  - Input billing information

- Ultrasound may be faster: 2-6 minutes for a variety of blocks

- Ultrasound fewer needle passes
  - Less variability
Block onset time

- Faster sensory onset
  - upper extremity blocks
  - lower extremity blocks

- Ready for surgery?
  - Can be challenging clinically-
    - Cutaneous nociception (ie scalpel to skin) is the last component to be blocked
Summary: It’s faster!

- Faster performance time*
- Faster sensory onset
- Level Ib, grade A recommendation
- Time to surgical anesthesia*?
- Implications for our practice/
  turnover times

Reg Anesth Pain Med 2010;35: S1-S9
Purported Benefits of USGRA:

- Faster
- Simpler
- Safer
- Success
- Value
- Other benefits
Functional Brachial Plexus Anatomy
I wish my patients were from Colorado...

Interscalene block

Lateral popliteal block
Reality:

**Sciatic nerve block**

**Femoral nerve block**
Variation in the ability to determine landmarks
No landmarks

Supraclavicular block with catheter
Case Report

Supraclavicular continuous peripheral nerve block in a wounded soldier: when ultrasound is the only option

TRAUMA PATIENTS:
Underlying anatomic variability

Fig. 2. Composite sketch of the structures around the scalene triangle. Scalenus minimus (SM), when present, has wide variations. Reprinted from Shore, L.R., J. Anat. Vol. 60 (1926), with permission of Cambridge University Press as reproduced in Hollinshead (1954).
Anatomical variation: Interscalene
Anatomical variability: Interscalene

Br J Anaesth 2010; 104: 538-46
Anatomical variation: Supraclavicular
Ten inexperienced subjects with 6 trials of simulated breast cyst procedure under ultrasound guidance

Mean time to perform task reduced by 38% and 48% respectively

Composite score of accuracy improved 36% and 59% with subsequent trials

Characterizing Novice Behavior Associated With Learning Ultrasound-Guided Peripheral Regional Anesthesia

Brian D. Sites, M.D., Brian C. Spence, M.D., John D. Gallagher, M.D., Christopher W. Wiley, M.D., Marc L. Bertrand, M.D., and George T. Blika, M.D.
Novice Behavior

Learning Curves and Mathematical Models for Interventional Ultrasound Basic Skills

Getúlio Rodrigues de Oliveira Filho, MD, PhD

BACKGROUND: We aimed to construct learning curves and mathematical learning models for ultrasound basic skills: optimizing needle-ultrasound beam alignment and reaching a target inside a phantom.

- Estimated 95% probability of achieving success at needle visualization and target acquisition
- 37 attempts in plane visualization
- 109 attempts in plane and contacting target
Enhanced visibility needle: Passive design

Beam Reflects Back to Transducer

New Laser Etched Echogenic Needles

Micro Laser Etching (MLE™)
Optical needle guides
Software upgrades: Enhanced needle visualization

We’ve Conquered the Disappearing Needle Phenomenon

Enhanced needle visualization clearly distinguishes needles in deep, steep procedures. This proprietary algorithm draws rave reviews because it:

- Easily tracks the needle at steep angles
- Maintains image quality of target and surroundings
- Offers single button-push ease of use
- Involves no time-consuming set up
- Entails no expensive additional equipment
- Requires no change to procedure

WWW.SONOSITE.COM

Washington University in St. Louis
SCHOOL OF MEDICINE
Ergonomics
Simpler: Obviously not for every block

- Posterior lumbar plexus
- Trans-gluteal sciatic
- Para-sacral sciatic
- Spinal
- Epidural
ASRA / ESRA Joint Committee Recommendations for Education and Training in Ultrasound-Guided Regional Anesthesia

- 10 common tasks used when performing an ultrasound guided nerve block
- Core competencies and skill sets with USGRA
- Training practice pathway for post-graduate anesthesiologists
- Residency based training pathway

RAPM 2009; 34: 40-46
Simpler?: Summary

- You decide
- Maybe not simpler but preferable
- Visual appeal overwhelming
  - Attracts more potential regionalists
  - More indications (anticoagulation)
- Less functional anatomic knowledge, landmarks and variation
Purported Benefits of USGRA:

- Faster
- Simpler
- **Safer**
- Success
- Value
- Other benefits
Objective measures of safety

- **Nerve injury**
  - temporary: 3% 1 month
  - permanent: 0.02%-0.04% long term-typically subclinical neuropathies

- **Local anesthetic systemic toxicity**
  - incidence 0.1%

- **Pneumothorax and HDP**

- **Infection**
Preventing nerve injury

- Paresthesia
- Nerve Stimulation
- Ultrasound
Not sure what I’m seeing

And, I don’t want to inject into a nerve…

Better chance of success?

- No, and it’s slower!

The Sensitivity of Motor Response to Nerve Stimulation and Paresthesia for Nerve Localization As Evaluated by Ultrasound


**Results:** One patient was excluded from analysis because of protocol violation. Paresthesia was found to be 38.2% sensitive and motor response was 74.5% sensitive for detection of needle-to-nerve contact.

**Conclusion:** The very different and relatively low sensitivity of either technique may explain, in part, the lack of correlation previously reported between the 2 endpoints. *Reg Anesth Pain Med* 2006;31:445-450.

<table>
<thead>
<tr>
<th>Table 6. Motor Response to Nerve Stimulation Less Than 0.5 mA</th>
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<tbody>
<tr>
<td>Motor Response Results</td>
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<tr>
<td>------------------------</td>
</tr>
<tr>
<td>Present (true positives)</td>
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<tr>
<td>Absent (false negatives)</td>
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<tr>
<td>Total</td>
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Intraneural needle position reliably with current < 0.2 mA

Could not rule out intraneural position with current > 0.2 mA – 0.5 mA
Ultrasound guided axillary block

Prospective study in 26 patients

Sensory/motor testing before, 5 and 20 minutes post block and at 6 month follow up

72 out of 104 nerves had intraneural injection

No permanent deficits at 6 month follow-up!
Limitations to Study:

- No electrophysiological tools
- No injection psi manometry
- No intermediate follow-up
- Minimal amounts of local anesthetic
- Current ultrasound capabilities cannot differentiate stromal vs. fascicular injection
- Cross section of peripheral nerve: neurons, fat, CT
ORIGINAL ARTICLE
Incidence of unintentional intraneural injection and postoperative neurological complications with ultrasound-guided interscalene and supraclavicular nerve blocks*

S. S. Liu,¹ J. T. YaDeau,² P. M. Shaw,³ S. Wilfred,⁴ T. Shetty⁵ and M. Gordon⁶

- 257 patients for ambulatory shoulder arthroscopy
- Prospective, single-blind observational study
- Ultrasound guided interscalene or supraclavicular block
Two blinded anesthesiologists reviewed ultrasound imaging offline to determine intraneural trespass.

Intraneural injection occurred in 42/257 patients.

No patient suffered from postoperative neurological complications at 1 and 4-6 weeks.
Neurological complication analysis of 1000 ultrasound guided peripheral nerve blocks for elective orthopaedic surgery

Adverse Outcomes Associated With Stimulator-Based Peripheral Nerve Blocks With Versus Without Ultrasound Visualization

Steven L. Orebaugh, MD,* Brian A. Williams, MD, MBA,* Manuel Vallejo, MD,†

ORIGINAL ARTICLE

Preliminary Results of the Australasian Regional Anaesthesia Collaboration

A Prospective Audit of More Than 7000 Peripheral Nerve and Plexus Blocks for Neurologic and Other Complications

Proof Positive

- RCT design: 3% incidence
  - 3000 pts per group
- RCT design: 0.04% incidence
  - 70,000 pts per group
- Standard approach and block
  - single or catheter
  - needle
  - drug, volume, concentration
  - adjuvant

Reg Anesth Pain Med 2010;35: 335-7
LAST:
Local Anesthetic Systemic Toxicity

www.lipidrescue.org
Prevention of intravascular injection:
Safer?: Prevention of intravascular injection

Ultrasound Guidance for Axillary Plexus Block Does Not Prevent Intravascular Injection

Complication during Ultrasound-guided Regional Block: Accidental Intravascular Injection of Local Anesthetic

Christian Loubert, M.D.,* Stephan R. Williams, M.D., Ph.D.,† François Hélie, Ph.D.,‡ Geneviève Arcand, M.D., F.R.C.P.C.§
Seizures after UGRA

Adverse Outcomes Associated With Stimulator-Based Peripheral Nerve Blocks With Versus Without Ultrasound Visualization

Steven L. Orebaugh, MD,* Brian A. Williams, MD, MBA, * Manuel Vallejo, MD, † and Michael L. Kentor, MD*

- 5000+ patients
- More seizures upper ext blocks NS
- No epinephrine in local anesthetic solution
Cardiac arrest after UGRA SNB

- 20 mL 0.5% ropivacaine
- Ultrasound guided
- Intralipid resuscitation

Cardiac Arrest During an Ultrasound-Guided Sciatic Nerve Block Combined With Nerve Stimulation

Accepted for Publication: 9 August 2008

To the Editor:

Vascular puncture and local anesthetic injection during ultrasound-guided regional anesthesia are common techniques in clinical practice. However, they can occasionally be associated with complications. In this case, we observed clear sonogram images of the main structures and with the in-plane approach could follow the path of the needle throughout the procedure. This information is not available with neurostimulation alone. The probe could have compressed vascular structures leading to the cardiac arrest.

Blood level of ropivacaine 15 min after the injection was 2.48 mg/mL. Recovery was uneventful, and the patient was discharged on the day after her arrival in intensive care unit without neurologic sequelae.
Reduction in LA dosage

Effects of ultrasound guidance on the minimum effective anaesthetic volume required to block the femoral nerve

A. Casati†, M. Baciarello, S. Di Cianni, G. Danelli, G. De Marco, S. Leone, M. Rossi and G. Fanelli*

Department of Anaesthesia and Pain Therapy, University of Parma, Ospedale Maggiore di Parma, via Gramsci 14, 43100 Parma, Italy

• Prospective randomized trial of 60 patients using US or NS
• 42% reduction in minimum effective anesthetic volume
• ED 95 for ropivicaine 0.5% reduced from 41 ml to 22 ml

British Journal of Anesthesia May 2007
Reduction in LA dosage:

- 1 mL per nerve!
- 10 minute onset time
- 190 minute average duration of block
Typical Anesthesia Provider:
Safer? Not proven yet.

- Nerve injury
  - RCT’s underpowered
  - Level III evidence, no difference temporary/perm
  - No difference in unintentional paresthesias

- LAST
  - Level 1a evidence, fewer vascular punctures
  - Level 1a evidence reduced LA volume
  - Level III evidence, no difference in seizures

Is ultrasound safer? Not yet.

- **PTX**
  - Studies inadequately powered
  - Level III no difference

- **HDP**
  - Level 1a reduced incidence of HDP with low volume
  - Level IV HDP still unpredictable caution warranted

- **Infection**
  - No data
Purported Benefits of USGRA:

- Faster
- Simpler
- Safer
- *Success*
- Value
- Other benefits
Metrics of success
Equivalent comparisons

What is the end point for success?
- initial sensory or motor onset
- extent of sensory & motor block at 30 min
- complete sensory & motor block at “X” time
- ability to tolerate surgery without supplementation or conversion to GA

Multi-injection vs. single injection

Neurostimulation experts vs. ultrasound experts
Conclusions: Ultrasound guidance improves block characteristics (particularly performance time and surrogate measures of success) that are often block specific and that may impart an efficiency advantage depending on individual practitioner circumstances. Evidence for UGRA impacting patient safety is currently limited to the demonstration of improvements in the frequency of surrogate events for serious complications.

(Reg Anesth Pain Med 2010;35: S1–S9)
Success Summary

- Improved block quality, especially lower extremity blocks
- Level 1b grade A recommendation for surrogate measures of success
- Insufficient evidence on surgical success rate
- Faster
- Simpler
- Safer
- Success
- Value/Other benefits
Fringe benefits:

- $$$: CPT-76942 (ultrasound guidance)
- Can put your patient at psychological ease
- Improved anatomical knowledge
- Increases understanding of mechanism of peripheral nerve blockade
- Skill transfer to other procedures
- Potential to increase # of regional procedures
- Distinguishes your practice from your competitors
LIMITATIONS:
Meta-analysis of ultrasound studies

- Limited by heterogeneity
- Not all RCT’s are created equal: Jadad scores
- Ultrasound experts vs. neuro-stim experts vs. novice practitioners
- Multi-injection versus single injection
Meta-analysis of ultrasound studies

- Drugs and doses
- Measuring time of the block procedure
  - when does the clock start?
- Definitions of block success
  - sensory onset
  - motor onset
  - how many nerves?
  - ready for surgery
  - surgical anesthesia without supplementation
It’s hard to prove outcome differences

- Definition of success is not standardized
- Low failure rate
- Low complication rate
- Need adequately powered trials
Future Directions:

- High quality RCT’s (wider array of blocks and patient populations)
- Advances in technology:
  - Three- and four-dimensional imaging
  - Echogenic equipment
  - Teleanesthesia
- Educational Goals:
  - Much greater scope of USGRA education in residency
  - Competency based education for residents/fellows
  - Certification?
  - Quality control
82 of 132 residency programs (62%) responded
75% of programs that responded relied on ultrasound to guide majority of blocks
79% of these programs did not use ultrasound with nerve stimulation
Conclusions

“Ultrasound guidance is a significant advance in the practice of regional anesthesia”

- Faster
  - performance
  - onset

- Better block quality
Conclusions

- Limited evidence for better surgical success
- Limited evidence for improved safety
- Economic and other benefits
- Stay tuned...
Thank you for your time & have a good evening!