Ultrasound Guided Procedures: An Introduction

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Rounds Agenda
- Why Ultrasound?
- Comparison of Blind vs US Guided Injections with available evidence
- Case presentations
- Discussion

Traditional Injection Technique
- Know Surface Anatomy
- Cerebral 3-D reconstruction
- Years of Practice
- Taught by Supervisor so it must be the "right" way
- Comfort with many procedures and few complications

US vs Blind Injections: What is the Evidence?
- Very few direct comparison studies
- Most studies now use US!
- MTrP: no comparative studies found
- Intra-articular injections...
N=148 randomized to palpation guided vs US guided

Results

1. Non-responder is <50% reduction in VAS
2. PalpGuid improves pain
3. USGuid improves pain more (with statistical significance)
Group 1 = PalpGuided
Group 2 = USGuided
US guided provided better pain relief and improved SFA.
The ASRA Evidence-Based Medicine Assessment of Ultrasound-Guided Regional Anesthesia and Pain Medicine

**Executive Summary**

- US superior to or equal - none found US to be dangerous or inferior
- Most serious of complications (permanent nerve injury and LAST) too rare
- Statistical advantage – not necessarily clinical advantage
- No evidence US eliminates complications – limited data suggests complication rates similar
- Poor technique, failure to image needle or novice behavior may increase risk
- No literature on US in specific patient populations (Pediatrics, DM, chemotherapy neuropathy)
- US significant advance but does not lessen responsibility for using time proven strategies

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Why do we use ultrasound?

- Real-time imaging
  - Vision is the most highly evolved of 5 senses
  - Other nerve localization techniques are “blind”
- Benign (non-ionizing energy)
- Available
- Education
- New approaches

- Advantages (compared to conventional nerve localization in regional anesthesia?)
  - Shorter procedure time
  - Faster onset
  - Lower anesthetic volume
  - Higher success rate
  - Improved safety
  - Higher patient satisfaction

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Ultrasound Guided Procedures

The Learning Triad

Familiarity with ultrasound equipment and scientific principles of ultrasonography

- Acquisition and interpretation of anatomic structures (nerves, muscles, tendons, artifacts, etc)
- Proficiency with scanning and needle/probe manipulation

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Why US for Imaging?
Ten Basic Skills

1) Visualize key landmark structures such as vascular, muscular, bony structures
2) Identify target structures on short-axis imaging as well as long axis if appropriate
3) Survey the target area in general checking for anatomic variations prior to needle intervention
4) Plan for a safe needling approach
5) Maintain an aseptic technique
6) Follow needle advancement under real-time visualization
7) Consider a secondary confirmation technique, such as nerve stimulation for regional anesthesia or fluoroscopy for pain interventions
8) Inject a small local anesthetic volume as a test solution to rule out unintentional/intravascular injection
9) Make necessary needle adjustments to ensure proper spread of local anesthetic and other injected agents
10) Maintain traditional safety guidelines.

US Guided Injection Proficiency Requirements

- US Scanning technique (manual skill)
- Image interpretation (cognitive skill)
- Needle handling and tracking (manual skill)
- Assessment of injectate spread to intended target (cognitive skill)

Ultrasound of TrP

US of Normal Muscle

Shah, Arch PMR. 2009

Chan, et al. 2010

US Scanning technique (manul skill)
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Shah, Arch PMR 2009

**Multiple TrPs??**

Could explain poor results from injection
US should improve this!

Shah, Arch PMR 2009

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**Selected US Guided Blocks**

- Greater Occipital Nerve
- Suprascapular Nerve
- Intercostal Nerve
- Ilioinguinal/Iliohypogastric/TAP block
- Lateral Femoral Cutaneous

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**Greater Occipital Nerve**

- The GON is the posterior ramus of C2
- Emerges below the posterior arch of atlas
- Wraps around Oblique Capitis Inferior Muscle (OCIM)
  - Nerve runs lateral to medial at level of C1
- The nerve pierces
  - Semispinalis Capitis
  - Splenius Capitis
  - Trapezius/Fascia
- Areas of entrapment
  - Emerges between the C1-2
  - OCIM and SSC
  - Pierce the SSC
  - Exit from tendinous aponeurosis of Trapezius
Indication:
- Occipital Neuralgia
- Differentiate headaches of cervical origin
- Site of Neuromodulation
  - Chronic Daily Headache, Migraine and even Cluster Headaches

Potential Complications:
- Hemorrhage
- Seizure
- Stroke
Cho et al. 2010
- CSA GON (2mm), OCI
- Greher et al. 2010
  - Compared two US techniques injected with .1 ml dye
    - 16/20 vs. 20/20
Shim et al. 2011
- Blind vs. US guided significant difference in VAS at 4 weeks

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US Guided GON Block, 4 week FU

![Graph showing VAS scores for US guided GON block after 4 weeks]

Shim et al., KJ Anesthesiol, 2011 July 66(1) p50

GON Block nonUS

<table>
<thead>
<tr>
<th>Study design</th>
<th>n</th>
<th>Intervention</th>
<th>Results</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prospective, non-controlled</td>
<td>152</td>
<td>Repeated injections to the vicinity of occipital nerves using lidocaine and bupivacaine</td>
<td>65% experienced headache relief lasting at least one week; 98% reported relief for more than one week</td>
<td>Sandhill et al.20</td>
</tr>
<tr>
<td>Case series</td>
<td>101</td>
<td>GON injection using lidocaine and mepivacaine</td>
<td>87% had complete response (pain-free) and 47.5% had partial response</td>
<td>Afridi et al.20</td>
</tr>
<tr>
<td>Prospective, randomised controlled</td>
<td>37</td>
<td>GON block and TPs using lidocaine, hydrocortisone, - either side or contralateral</td>
<td>Headache severity decreased significantly in 20 minutes in both groups, with no significant difference</td>
<td>Ashkenazi et al.20</td>
</tr>
<tr>
<td>Open label</td>
<td>15</td>
<td>GON block using phenol and diethyleneurea</td>
<td>No change in headache severity in 75% of subjects, worsening of headache in 25%</td>
<td>Liaindi-Dahla et al.20</td>
</tr>
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Ashkenazi et al., Headache, 2009; p943-952
Suprascapular Nerve Block

- Upper trunk (C5-6) –
- Suprascapular notch under ligament
  - Medial branch to SS and articular branch
  - Supraspinous fossa
  - Around lateral border of the spine (spinoglenoid notch) to infraspinatus fossa
- Sensory – post/sup capsule, AC joint, subacromial bursa and coracoclavicular and acromial ligaments

Indication:
- Various types of shoulder pain
  - Rheumatologic disorders, cancer, trauma, postoperative pain
  - Pulsed RF

Reported Complications:
- Arterial puncture
- Direct nerve injury
- Bruising
- Parasthesias

Position:
- Sitting or Prone

Probe:
- Linear high frequency

Scan:
- Probe perpendicular to line connecting coracoid process and acromion

Approach:
- In plane
  - Medial to Lateral

Narouze et al. 2010; Chan and Peng 2011

CHAN AND PENG 2011

FIGURE 3. Suprascapular nerve and its branches. Superior articular branch. Br. SS supplies the coracohumeral ligament, subacromial bursa, and posterior aspect of the acromioclavicular joint capsule; interior articular branch. Br. AC supplies the suprascapular notch; Br. SS branch to the infraspinatus muscle. Reproduced with permission from CMA (www.cma.ca).
Suprascapular Nerve Block

Traditional
- Posterior, superior, lateral, anterior
- Blind, nerve stimulator, electromyography, fluoro and CT
- Risk of Pneumothorax, intravascular or nerve injury
- Amount of injectate –
  - 10 ml – can spread to plexus
  - Blind injectate in SS or above

Dangoisse MJ et al., Acta Anaesthes Belg, 1994
Harmon 2007 –
- Trapezius, Supraspinatus and transverse ligament
- <5 cm deep, Doppler will reveal artery
- Medial to lateral approach, 5 ml total

Peng et al. 2010 –
- Supraspinous fossa

Taskaynatan et al 2011
- US accuracy measured with NS
  - 5/27 successful, 19/27 semi, 3/27 unsuccessful

Intercostal Nerve Block
- Ventral rami of thoracic nerves
  - Mixed
  - Branches
    - Lateral cutaneous branch (mid-axillary line)
    - Anterior cutaneous branch
  - Exceptions:
    - 1st – no anterior and usually no lateral (join C8)
    - Fibers from 2nd and 3rd – intercostobrachial nerve
    - Axilla, medial aspect of upper arm
    - 12th – call subcostal nerve

Intercostal Nerve Block
- Three layers of intercostal muscles
  - External, internal and innermost
  - Neurovascular bundle between internal and innermost muscles in costal groove
  - Hardy 1998 – up to 73% of cadavers NV bundle lay between the ribs rather than costal groove
**Indication:**
- Pain - acute or chronic pain
  - Thorax and upper abdomen

**Complication:**
- Pneumothorax reported in up to 8.7% (0.9 – 8.7%)
- Abrahams et al. 2010
  - Grade C – one small case series

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**US Intercostal Nerve Block**

- Curatolo et al. 2007
- High frequency probe
  - Prone, angle of rib (approx 7 cm) from spinous process
  - Short axis of rib, in-plane approach preferred
  - Enter upper margin one level below
  - Hydrodissection
- Post procedure scan for pneumothorax
  - Highly sensitive and specific (100%/96.5%)
  - (Wu et al 1995)
Confusing/opposite landmark techniques
Low success rates
Indication:
- Post hernia or appendectomy pain
- Groin/penis/labia/medial thigh pain
Complication:
- Femoral nerve palsy, bowel perforation or pelvic hematoma.

Ilioinguinal nerve
- Anterior rami of L1
  - Lateral psoas and pierce TA above the iliac crest
  - Superomedial area of thigh and skin over root of penis and scrotum

Iliohypogastric nerve
- Anterior rami of L1
  - Pierces internal oblique above above the ASIS
  - Travels between EO and IO
  - Lower abdomins rectus

High Frequency probe
- Perpendicular to line connecting of ASIS and pubic tubercle
- Lateral end of probe just above or posterior to ASIS
- Between TA and IO
- 5ml injectate
US IL/IH nerve block

- Eichenberger 2006 – Cadaver study
  - 95% accuracy
- Abrahams et al. 2010-
  - Grade A
    - Two RCTs/1 dose-finding study
    - Less analgesic post op
    - 50% with US scanning vs. blind
    - Higher volume of LA?
  - Higher probability of block success with a lower volume compared to blind techniques
Lateral Femoral Cutaneous Block

- Purely Sensory
- Dorsal branch of 2nd and 3rd lumbar nerves
  - Lateral border of psoas
  - Across the iliacus between 2 layers of iliac fascia
  - Beneath the inguinal ligament
  - Medial to ASIS over the sartorius
  - Varying distance from ASIS
    - 4.6 to 7.3 cm

Indication:
- Meralgia Parasthetica
- LFCN compression/entrapment
  - Obesity and Pregnancy

Complication:
- Coincidental block of other nerves
- Direct nerve trauma or damage to local vascular structures

Position:
- Supine

Probe:
- High frequency linear (if possible)

Scanning:
- Lateral probe on ASIS at inguinal ligament
- Distal
- Sartorius inverted triangle – nerve superficial
- Variable location and appearance

Approach:
- In line
- Lateral to medial
High variability as it passes into thigh

- Ng et al 2008 – very poor correlation in cadaver and volunteers using blind technique
- Shannon et al. 1995 –
  - Blind technique 40% success
  - Femoral nerve spread 35%
  - With stimulator 85% success
- Bodner et al. 2009
  - 15/16 successful blocks with .3 ml of LA
US LFCN Block

  - Distal localization
  - Triangular shape laterally over sartorius
  - Proximal localization more difficult
  - 70% success rate
  - Inguinal level, lateral probe on ASIS
  - Hyperechoic dot between fascia lata and iliac 2-3 cm from ASIS
- Tagliafico et al. 2011 –
  - Complete resolution in 20 patients at 2 mos.
- Kim et al 2011
  - Case report—success in 94 kg patient
- Mulvaney 2011
  - Case report—US guided percutaneous nucleoplasty

Conclusions....

- Emerging evidence suggesting US is superior to the cerebral 3-D recon method
  - May improve localization
  - Reduce amount of injectate
  - Reduce complication rates (?)
- Please consider adding US to your injection procedures

Thank You Very Much

Any Questions??

Safety Data

- Vascular Puncture and Intravascular Injection
- Neural Puncture and Intraneural Injection
- Other:
  - Esophageal puncture
  - Phrenic nerve paresis