Ultrasound Guided Procedures: An Introduction

McMaster University Health Sciences
St. Joseph's Healthcare Hamilton
Dinesh Kumbhare, MD, MSc, FRCPC
Physical Medecine and Rehabilitation
Associate Clin. Prof, Dept. of Surgery, McMaster University

Rounds Agenda

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

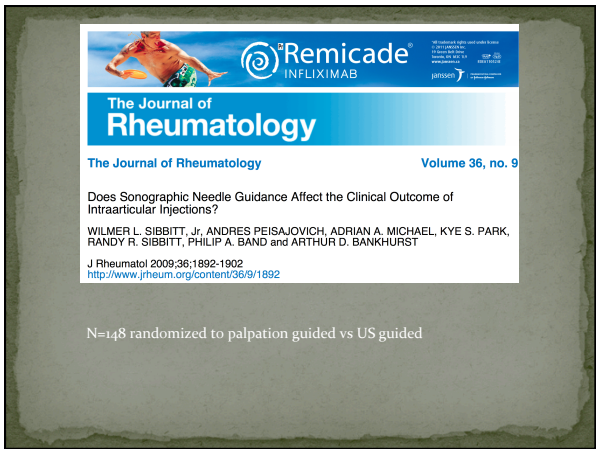
Traditional Injection Technique

- 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?

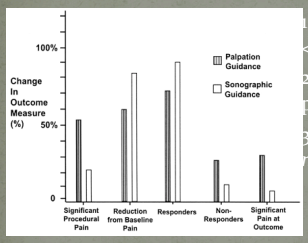
- Very few direct comparison studies
- Most studies now use US !

- MTrP: no comparative studies found
- Intra-articular injections....

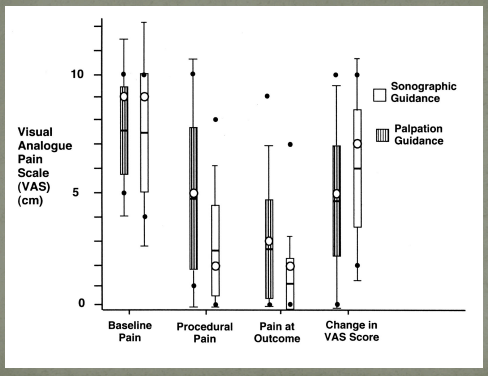


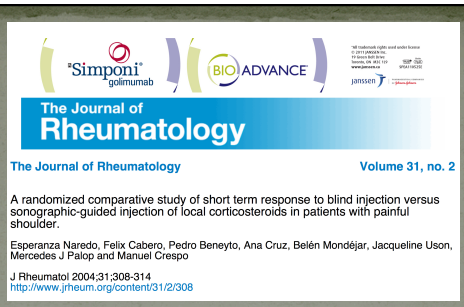
N=148 randomized to palpation guided vs US guided

Results



1. Non-responder is <50% reduction in VAS
2. PalpGuid improves pain
3. USGuid improves pain *more* (with statistical significance)





N=41, randomized to blind or US Guided SASD bursa using lateral approach

Outcomes: VAS, ROM, SFA (shoulder function assessment)

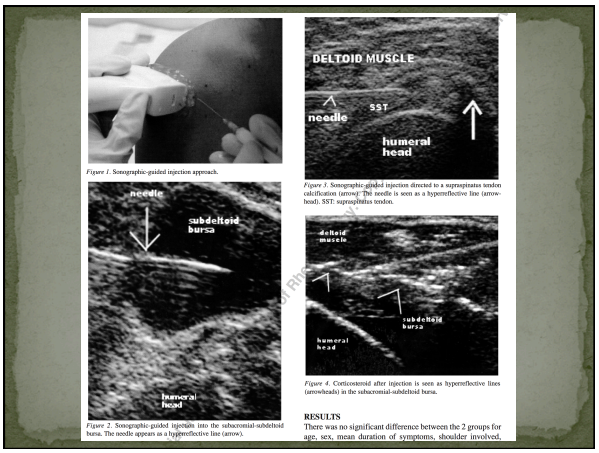


Figure 1. Sonographic-guided injection approach.

Figure 2. Sonographic-guided injection into the subacromial-subdeltoid bursa. The needle appears as a hyperreflective line (arrow).

Figure 3. Sonographic-guided injection directed to a supraspinatus tendon calcification (arrow). The needle is seen as a hyperreflective line (arrowhead). SST: supraspinatus tendon.

Figure 4. Corticosteroid after injection is seen as hyperreflective lines (arrowheads) in the subacromial-subdeltoid bursa.

RESULTS

There was no significant difference between the 2 groups for age, sex, mean duration of symptoms, shoulder involved,

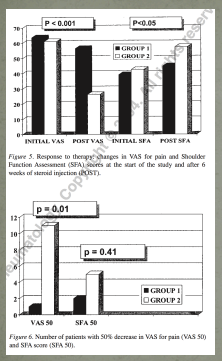


Figure 5. Response to therapy: changes in VAS for pain and Shoulder Function Assessment (SFA) scores at the start of the study and after 6 weeks of steroid injection (POST).

Figure 6. Number of patients with 50% decrease in VAS for pain (VAS 50) and SFA score (SFA 50).

- Group 1= PalpGuided
- Group 2=USGuided
- US guided provided better pain relief and improved SFA.

RHEUMATOLOGY

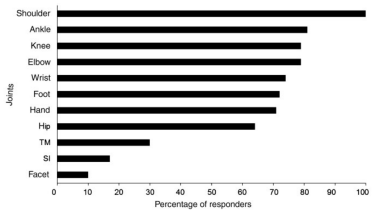
Rheumatology 2012;51:184–190
doi:10.1093/rheumatology/ker331
Advance Access publication 24 November 2011

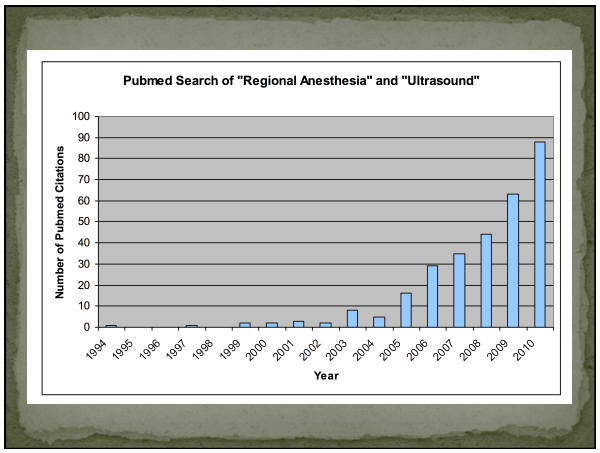
Original article

Practice of ultrasound-guided arthrocentesis and joint injection, including training and implementation, in Europe: results of a survey of experts and scientific societies

Peter Mandl[1,2], Esperanza Naredo[3], Philip G. Conaghan[4], Maria-Antonietta D'Agostino[5], Richard J. Wakefield[6], Artur Bachta[6], Marina Backhaus[7], Hilde B. Hammer[8], George A. W. Bruyn[9], Nemanja Damjanov[10], Emilio Filippucci[11], Walter Grassi[11], Annamaria Iagnocco[12], Sandrine Jousse-Joulin[13], David Kane[14], Juhani M. Koski[15], Ingrid Möller[16], Eugenio De Miguel[17], Wolfgang A. Schmidt[18], Wijnand A. A. Swen[19], Marcin Szkudlarek[20], Lene Terslev[21], Hans-Rudolf Ziswiler[22], Mikkel Østergaard[21] and Peter V. Balint[1]

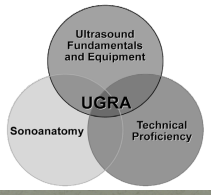
FIG. 2 Commonly targeted joints for UGAJ by percentage of responders. Each represented joint also includes UGAJ performed on related bursae, ligaments and tendons. TM, temporomandibular joint; SI, sacroiliac joint; facet, zygapophysial joint.





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

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?

Why US for Imaging?

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

Executive Summary

(Reg Anesth Pain Med 201:35: S1-9)

- 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

Ten Basic Skills

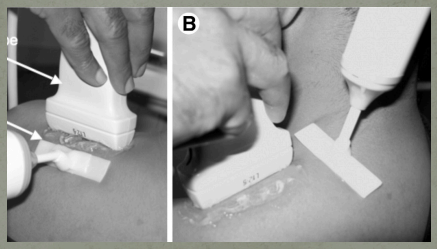
1) Visualize key landmark structures such as vascular, muscular, bony structures
2) Identify target structures on short-axis imaging as well as long axis if appropriate
3) Survey the target area in general checking for anatomic variations prior to needle intervention
4) Plan for a safe needling approach
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.

Chan, V et al 2010

US Guided Injection Proficiency Requirements

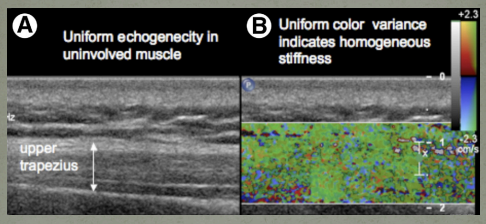
- US Scanning technique (manual skill)
- Image interpretation (cognitive skill)
- Needle handling and tracking (manual skill)
- Assessment of injectate spread to intended target (cognitive skill)

Ultrasound of TrP

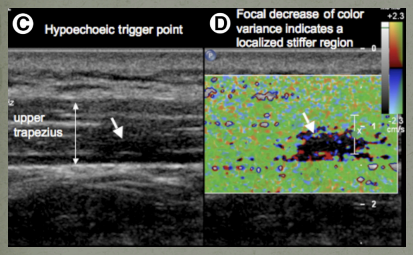


Shah, Arch PMR 2009

US of Normal Muscle



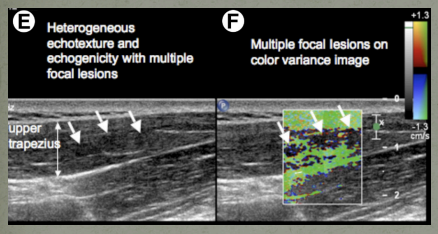
Shah, Arch PMR 2009



US guidance for better localization!

Shah, Arch PMR 2009

Multiple TrPs??



Could explain poor results from injection→ US should improve this!

Shah, Arch PMR 2009

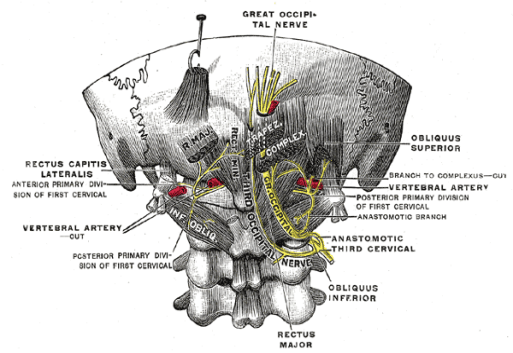
Selected US Guided Blocks

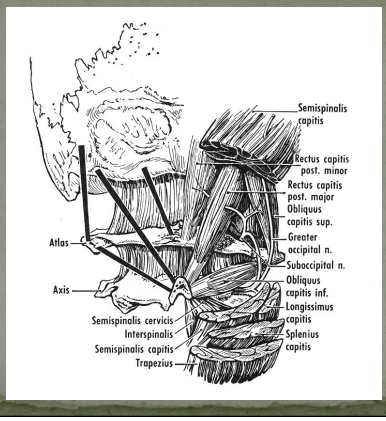
- Greater Occipital Nerve
- Suprascapular Nerve
- Intercostal Nerve
- Ilioinguinal/Iliohypogastric/TAP block
- Lateral Femoral Cutaneous

Greater Occipital Nerve

- The GON is the posterior ramus of C2
- Emerges below the posterior arch of atlas
- Wraps around Obliquus 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
  - Pierces the SSC
  - Exit from tendinous aponeurosis of Trapezius

Cho et al. 2010





Greater Occipital Nerve

- Indication:
  - Occipital Neuralgia
  - Differentiate headaches of cervical origin
  - Site of Neuromodulation
    - Chronic Daily Headache, Migraine and even Cluster Headaches
- Potential Complications:
  - Hemorrhage
  - Seizure
  - Stroke

Greater Occipital Nerve

- Position:
  - Prone (with flexion) or Lateral
- Probe:
  - Linear high frequency
- Scan:
  - Begin midline over the occiput – scan caudally
  - First bifid spinous process is C2
  - Lateral with lateral end of probe aimed at the transverse process of C1 (mastoid)
- Approach:
  - In plane
  - Lateral to medial

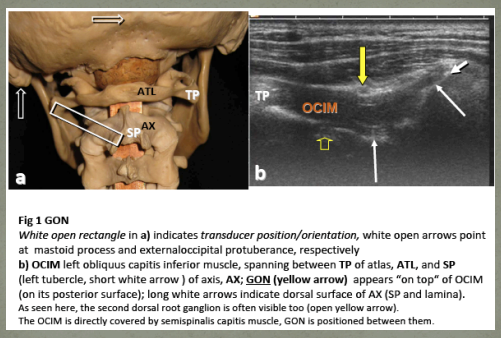
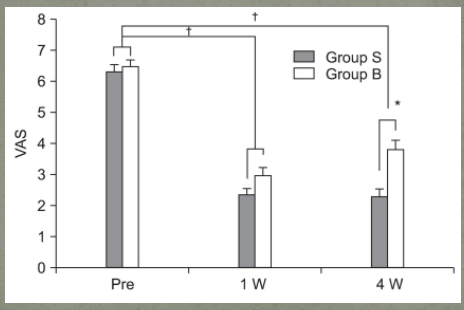


Fig 1 GON
White open rectangle in **a)** indicates *transducer position/orientation,* white open arrows point at mastoid process and externalоccipital protuberance, respectively
b) OCIM left obliquus capitis inferior muscle, spanning between **TP** of atlas, **ATL**, and **SP** (left tubercle, short white arrow) of axis, **AX; GON (yellow arrow)** appears "on top" of OCIM (on its posterior surface); long white arrows indicate dorsal surface of **AX** (SP and lamina).
As seen here, the second dorsal root ganglion is often visible too (open yellow arrow).
The OCIM is directly covered by semispinalis capitis muscle, GON is positioned between them.

Greater Occipital Nerve

- 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

US Guided GON Block, 4 week FU



Shim et al., K J Anesthesiol, 2011 July 61(1) p50

GON Block nonUS

Study design	n	Intervention	Results	Reference
Prospective, non-controlled	112	Repeated injections to the vicinity of occipital nerves using lidocaine and betamethasone	65% experienced headache relief lasting at least one week; 56% experienced relief for more than 4 weeks	Saadah and Taylor[12]
Case series	101	GON injection using lidocaine and methylprednisolone	22% had complete response (pain free) and 31% had partial response	Afridi et al[11]
Prospective, randomized controlled	37	GON block and TPIs using lidocaine, bupivacaine + either saline or triamcinolone	Headache severity decreased significantly at 20 minutes in both groups, with no significant between-group difference	Ashkenazi et al[13]
Open label	15	GON block using prilocaine and dexamethasone	No change in headache severity in 73% of subjects; worsening of headache in 20%	Leinisch-Dahlke et al[15]

Ashkenazi et al., Headache, 2010 50; 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

Narouze et al 2010; Chan and Peng 2011

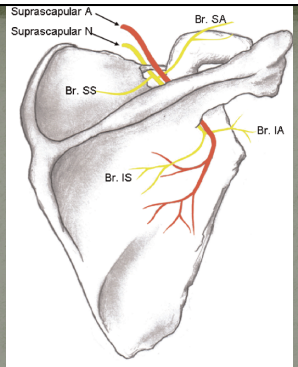


FIGURE 3. Suprascapular nerve and its branches. Superior articular branch (Br. SA) supplies the coracohumeral ligament, subacromial bursa, and posterior aspect of the acromioclavicular joint capsule; inferior articular branch (Br. IA) supplies the posterior joint capsule; Br. SS indicates branch to the supraspinatus muscle; Br. IS, branch to the infraspinatus muscle. Reproduced with permission from USRA (www.usra.ca).

Suprascapular Nerve Block

- Indication:
  - Various types of shoulder pain
    - Rheumatologic disorders, cancer, trauma, postoperative pain
  - Pulsed RF
- Reported Complications:
  - Arterial puncture
  - Direct nerve injury
  - Bruising
  - Parasthesias

CHAN AND PENG 2011

Suprascapular Nerve Block

- Position:
  - Sitting or Prone
- Probe:
  - Linear high frequency
- Scan:
  - Probe perpendicular to line connecting coracoid process and acromion
- Approach:
  - In plane
  - Medial to Lateral

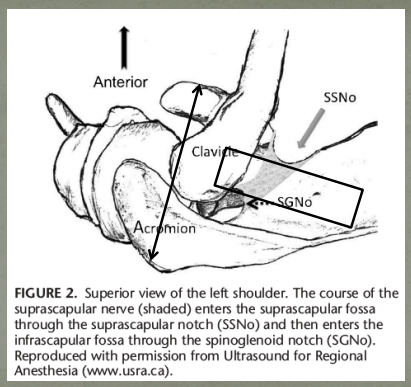
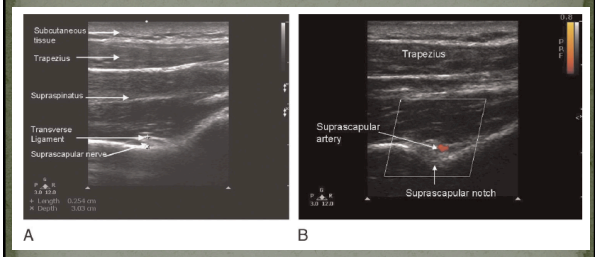
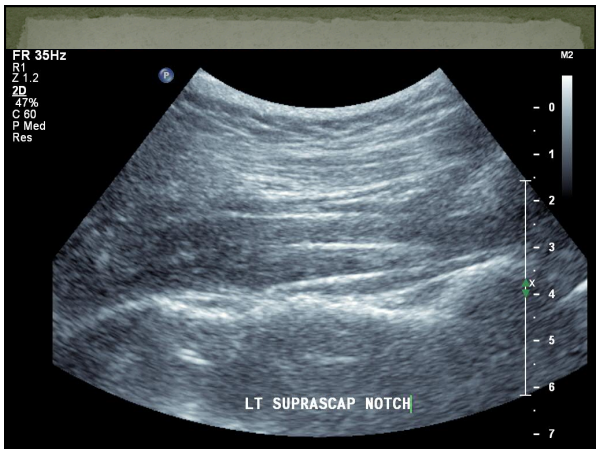


FIGURE 2. Superior view of the left shoulder. The course of the suprascapular nerve (shaded) enters the suprascapular fossa through the suprascapular notch (SSNo) and then enters the infrascapular fossa through the spinoglenoid notch (SGNo). Reproduced with permission from Ultrasound for Regional Anesthesia (www.usra.ca).



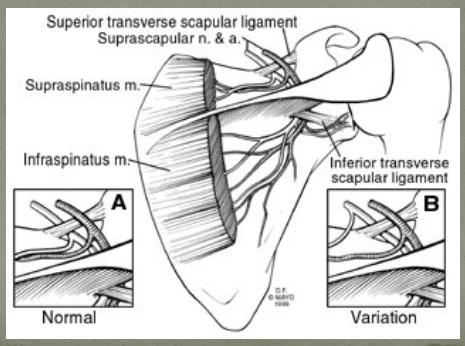


Suprascapular Nerve Block

Traditional

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

Dangoisse MJ et al., *Acta Anaesth Belg*, 1994



US Suprascapular Nerve Block

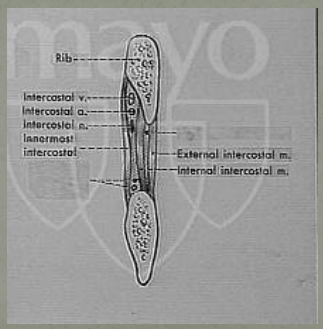
- Harmon 2007 –
  - Trapezius, Supraspinatus and transverse ligament
  - <5 cm deep, Doppler will reveal artery
  - Medial to lateral approach, 5 ml total
- Peng et al. 2010 –
  - Supraspinous fossa
- Taskaynatan et al 2011
  - US accuracy measured with NS
    - 5/27 succesful, 19/27 semi, 3/27 unsuccsful

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

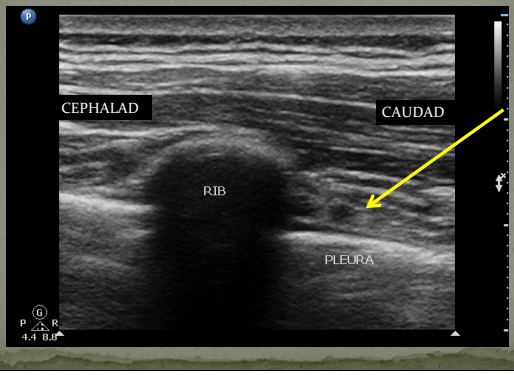


Intercostal Nerve Block

- 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

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)

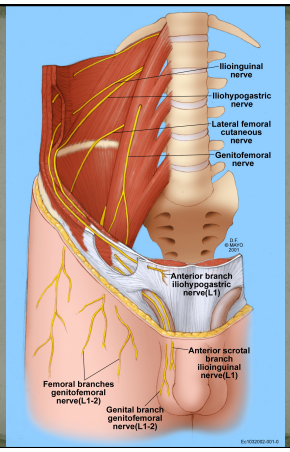


Ilioinguinal/Iliohypogastric Nerve Block

- 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.

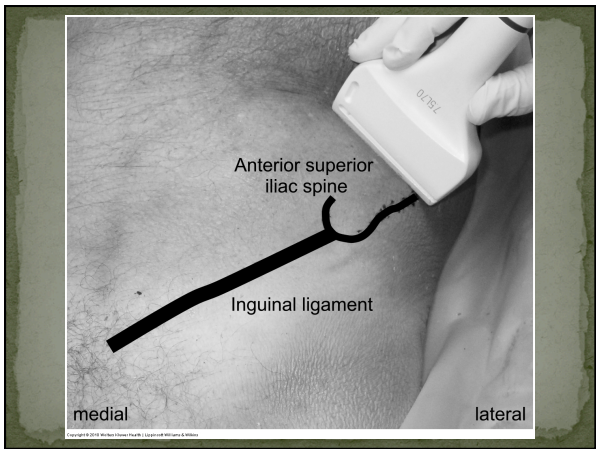
Ilioinguinal/Iliohypogastric Nerve Block

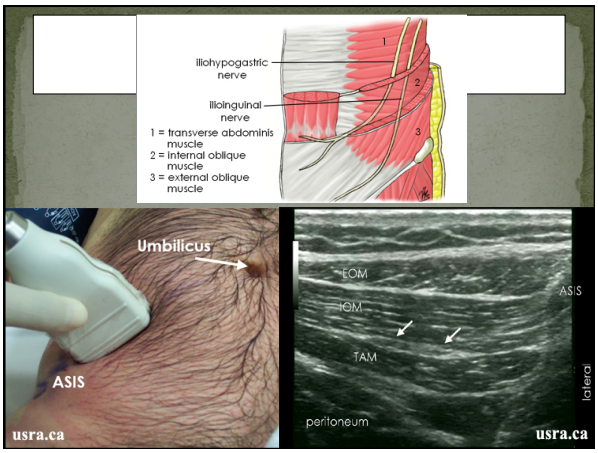
- Ilioinguinal Nerve
  - Anterior rami of L1
    - lateral psoas and pierce TA above the iliac crest
    - superomedial area of thigh and skin over root of penis and scrotum
- Iliohypogastric Nerve
  - Anterior rami of L1
    - Pierces internal oblique above above the ASIS
    - Travels between EO and IO
    - Lower abdomins rectus

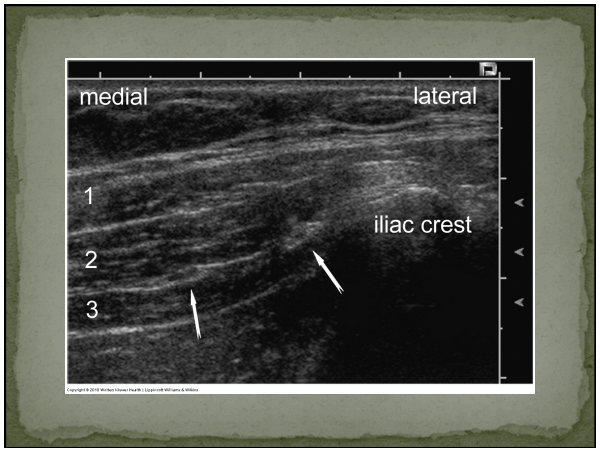


US IL/IH nerve block

- 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
    - 2 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

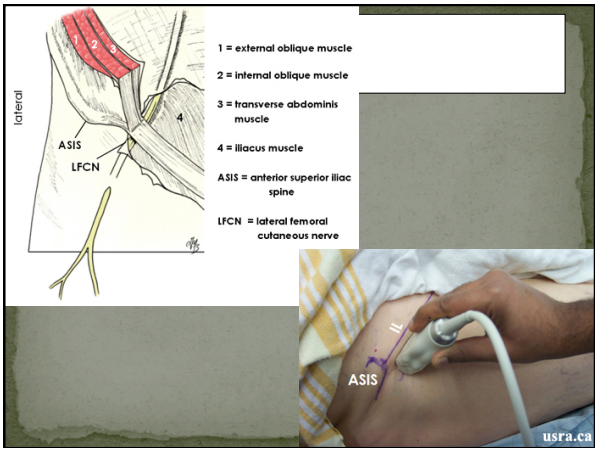
- Purely Sensory
- Dorsal branch of 2nd and 3rd lumbar nerves
  - Lateral border of psoas
  - Across the iliacius between 2 layers of iliac fascia
    - Beneath the inguinal ligament
    - Medial to ASIS over the sartorius
      - Varying distance from ASIS
        - 4.6 to 7.3 cm

Lateral Femoral Cutaneous Block

- Indication:
  - Meralgia Parasthetica
  - LFCN compression/entrapment
    - Obesity and Pregnancy
- Complication:
  - Coincidental block of other nerves
  - Direct nerve trauma or damage to local vascular structures

Lateral Femoral Cutaneous Block

- 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



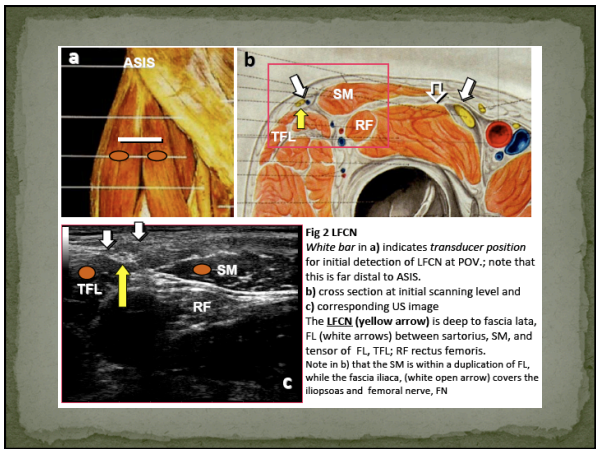
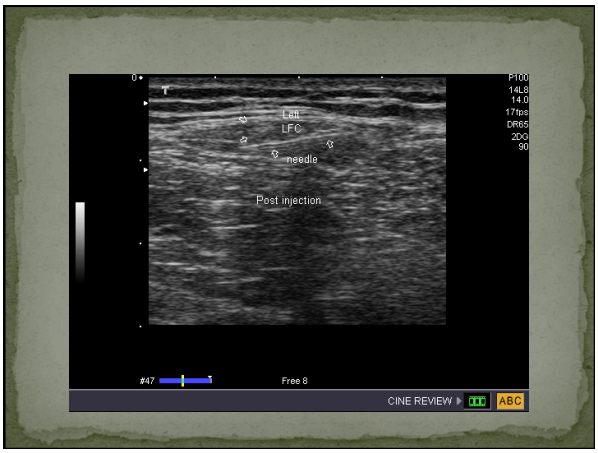
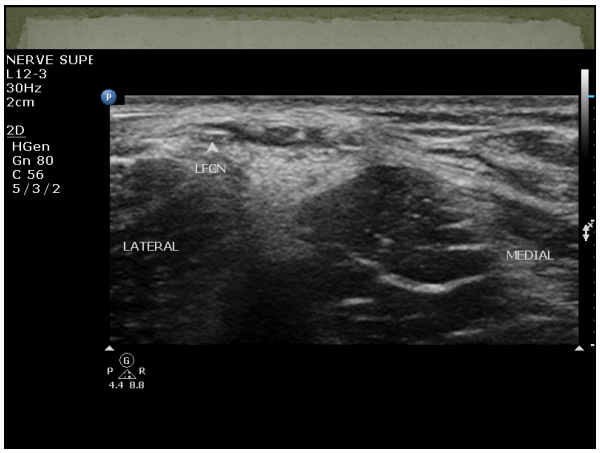


Fig 2 LFCN
White bar in **a)** indicates *transducer position* for initial detection of LFCN at POV.; note that this is far distal to ASIS.
b) cross section at initial scanning level and
c) corresponding US image
The **LFCN (yellow arrow)** is deep to fascia lata, FL (white arrows) between sartorius, SM, and tensor of FL, TFL; RF rectus femoris.
Note in b) that the SM is within a duplication of FL, while the fascia iliaca, (white open arrow) covers the iliopsoas and femoral nerve, FN





Lateral Femoral Cutaneous Block

- 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 succesful blocks with .3 ml of LA

US LFCN Block

- Tumber et al. 2008, Ng et al. 2008, Damarey et al. 2009 and Hurdle et al. 2007
  - 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 iliaca 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….

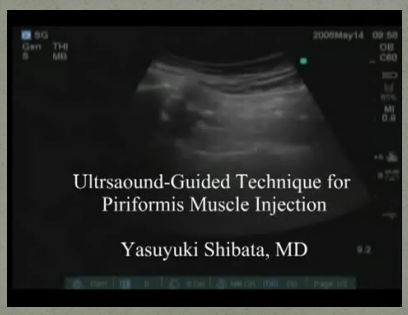
- Emerging evidence suggesting US is superior to the cerebral 3-D recon method
  - May improve localization
  - Reduce amount of injectate
  - Reduce complication rates (?)
- Please consider adding US to your injection procedures

Thank You Very Much

Any Questions??

Safety Data

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


Ultrsaound-Guided Technique for
Piriformis Muscle Injection
Yasuyuki Shibata, MD