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Ultrasound Guided Interventions in Pain Management

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Traditionally interventional procedures in Pain Medicine are performed under fluoroscopy or CT guidance. Only minor intervention are done blindly relying on superficial anatomical landmarks.

CT is reserved mainly for major interventions such as spinal cord stimulation , celiac plexus block or known difficult selective spinal nerve root blocks. It involves huge amount of radiation forcing operator to move in-out the room. Understandably access to CT scanner is not always easily available even in the most modern hospitals.

Fluoroscopy is a standard aid in visualizing invasive procedures at the pain clinics across the world. Even interlaminar epidurals are routinely performed under X-ray control when contrast injection confirm position and spread of solution . Author's audit in 2004 showed that more than 60% of epidural are performed under fluoroscopy guidance, numbers being likely more than 90% at present (1) In difficult spine cases fluoroscopy is of great help , contrast deficits inform about anatomical obstacle and legal aspects are not to be forgotten. However , the soft tissue cannot be visualized and also expose patient and the provider to the risk of radiation. It also requires more manpower as radiographer assistance is usually mandatory.

Ultrasound brings a new dimension to intervention in pain management. Since the article of Kapral et al (2) in 1994 describing ultrasound guided supraclavicular brachial plexus block the number of publications in the field of regional anaesthesia exceed 1000 . Between 1982- and 2002 there have been only 3 publications related to ultrasound guided techniques in chronic pain management. Again Kapral and colleagues from Vienna group in 1995 described Ultrasound Imaging for Stellate Ganglion Block: Direct Visualisation of Puncture Site and Local Anaesthetic (3). However it has been much slower uptake perhaps due to technical limitations of ultrasound, lack of experience , formal training and simply lack of any evidence and publications. There have been 42 publications since 2003 and numbers are growing rapidly.(2) US systems are more available and affordable nowadays. Portable devices provide high resolution and quality pictures. Ultrasound imaging allows real-time visualisation of needle and surrounding structures especially while operating in so called " tiger area" eg. Stellate

ganglion. All peripheral neural structures and soft tissue can be easily showed in 2D dimension.(4, 5)

Merging experience from various specialities seems to be a way forward. Musculoskeletal US experts (radiologists, rheumatologists) may help to develop skills in joint injections . Trigger point injections (including Botulinum Toxin A) are not longer to be blind but specific group of muscle can be targeted and potential complications (pneumothorax , intraperotineal , intravascalur injection) avoided.

Anaesthetists with experience with peripheral nerve blocks under ultrasound guidance naturally progress to blocks in field of chronic pain.

What are the limitations ?

Deeper in the forest are more trees. High frequency probe providing high resolution pictures will not penetrate deep tissue. Low frequency probe penetrates deeper but quality of picture is degraded . Structures like bones are not easily penetrated by ultrasound wave producing scattering and other artefacts.

For Pain Clinician deeply localized targets like facet joints/ medial branches , epidural , caudal , sacroiliac joints are of interest. In general they can be accessed under ultrasound guidance but in very degenerative spine , in high BMI patient a combination with fluoroscopy is recommended. Level of intervention especially for cervical spine can be quickly confirmed and verified with fluoroscopy and actual procedure performed under direct vision. In some interventions like suprascapular nerve block/ pulsed radiofrequency fluoroscopy can be completely abandoned. For procedures like stellate ganglion ultrasound becomes mandatory .

Potential advantages of Ultrasound are :

1. Visualisation of nerves and surrounding structures: vessels, muscles , bone and viscera- pleura, lung, peritoneum , bowel
2. Diagnostic - Recognizing anatomical variabilities and pathology
3. Real time visualisation of needle trajectory , needle – nerve contact and injectate spread.

Potentially and in practice it should lead to

1. Reduce complication- nerve injury, vessels puncture, pneumothorax etc.
2. Higher success rate
3. Quicker onset
4. Reduce performance time
5. Reduce volume of local anaesthetic.
6. New techniques" and approaches as nerve or other structure may be localized along its anatomical route
7. "Old techniques" revived eg infra/ supraclavicular or modified (suprascapular)

Basic knowledge of ultrasound principles and familiarity with equipment is mandatory.

1. Ultrasound imaging is based on sound waves that are transmitted from , and received by an US utilizing frequencies of 2- 15MHz.
2. The sound waves travel into the body and hit a boundary between tissues (e.g. between fluid and soft tissue, soft tissue and bone).

3. Some of the sound waves reflect back to the probe, while some travel on further until they reach another boundary and then reflect back to the probe .

The reflected waves are detected by the probe (Transducer) and relayed to the machine. Transducer is a piezo-electric crystal. Converts electric signals to mechanical & vice versa .Transmits pulses of sound into tissue and listens for echos **Most** of the time is spent listening for echoes

High frequencies offers high resolution images , however the higher the frequency , the smaller the penetration depth

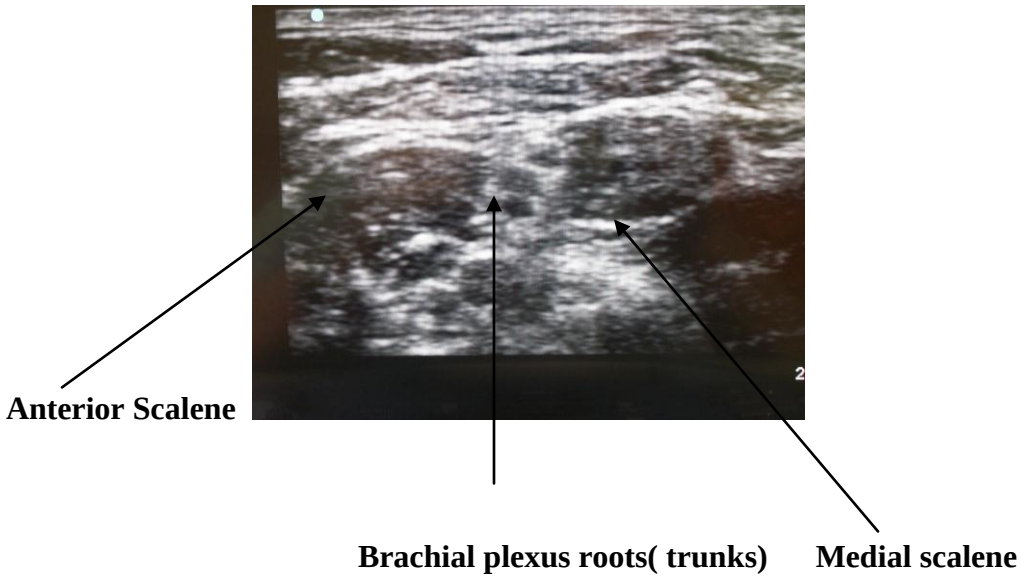
For majority of nerve structures (1-5 cm depth) you will need medium frequency

probe 5- 12 MHz

For deeper structures : celiac plexus, lumbar plexus, lumbar spine low frequency 2-5 MHz , curved probe is more appropriate.

You will need to switch to 2D dimension and find the orientation on the screen . Bear your anatomical knowledge in mind .

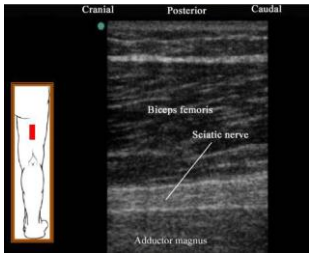
Most of the blocks we perform on transverse scan where the nerves appear as multiple round or oval hypoechoic areas encircled by a relatively hyperechoic horizon.



Hypoechoic – dark structures

Hyperechoic - bright structures

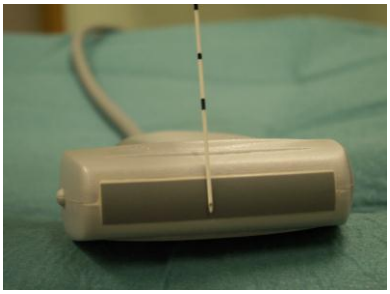
Longitudinal section might be visualised as well



Anisotropy - the image is highly dependent on the angle to ultrasound beam. Some nerves are more anisotropic than others. 90 degrees gives the best picture
Air- ultrasound beam will not pass through air . Be generous with gel to provide air-free contact with skin.
Acoustic shadowing - highly reflective surfaces (bone) reflect almost all of the sound beam , throwing a shadow over all deeper structure
Post cystic enhancement : increased brightness behind fluid filled structure
Arteries- anechoic , pulsatile
Veins - anechoic , compressible

Performing the block

Short –axis technique (transverse) – advantages/disadvantages
-typical entry point - needle only seen as a bright dot while within the beam
- shortest distant - poor vision of needle- nerve contact



Long- axis technique(longitudinal) advantages/ disadvantages

- needle visualized in entire length* - not common needle entry
- good vision of needle- nerve contact - longer distance skin- nerve
- tunnel for catheter placement - more painful

***The deeper the structure your needle will become less perpendicular and more parallel to the beam . At the angle < 60 you are likely to loose the needle image and then the benfits of " in plane technique"**

Apply **PART** to achieve optimal view.

Pressure
Alignment
Rotation
Tilt

Below a list of intervention potentially possible under US guidance and few US pictures.

Head &Neck

- Occipital nerve
- Extraforaminal cervical nerve roots
- Superficial cervical plexus
- Cervical medial branch/ facet
- Stellate ganglion
- Suprascapular nerve

Lumbar spine

- Facet joints
- Medial branch of posterior ramus
- Paraspinal muscle injection:
  - Erector spinae
  - Quadratus lumborum
  - Psoas
- Sacroiliac joint
- Piriformis muscle
- Pudendal nerve

Lower Limb

- Femoral nerve
- Lateral cutaneous of the thigh (LCT)
- Saphenous nerve
- Sciatic/ popliteal
- Hip joint
- Knee joint

Extraforaminal Cervical Root needle orientation

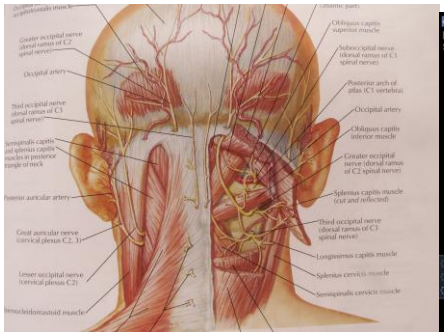
Cervical nerve root C6

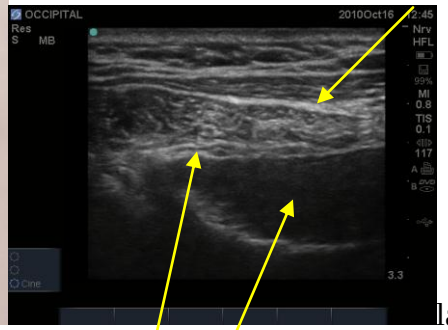
Cervical facet/medial branch- longitudal view. Out of plane technique- always keep medial to lateral needle orientation to avoid accidental vertebral artery puncture

Stellate ganglion block - here is the point of no return ! Once one can see what have been doing for years !! Finding the way to the target might be a real challenge

Occipital nerve block : GON neuralgia, Compartment Compression, cervicogenic headache- nerve block, P-RF – All at hand !!

Semispinalis Splenius

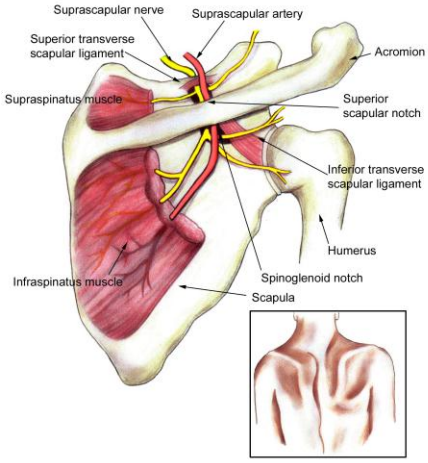


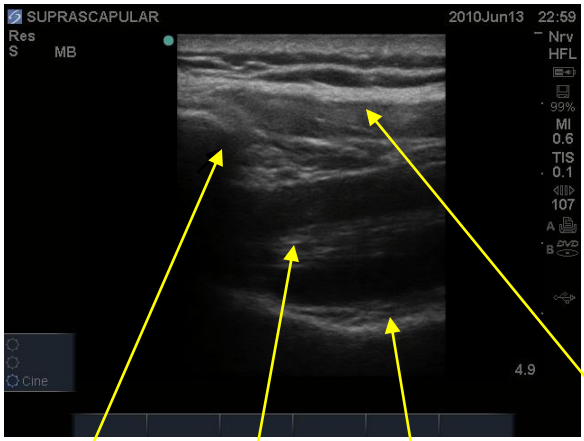


lateral

GON Inferior oblique

Suprascapular n- just modification of traditional technique. Is needle in the suprascapular notch or suprascapular fossa- That's another question.

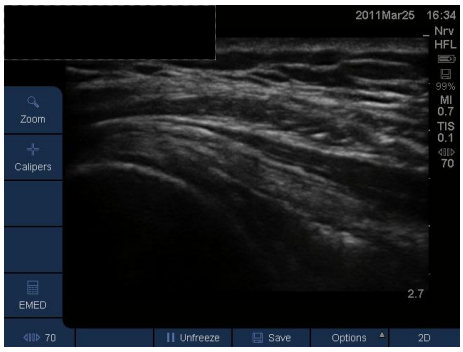




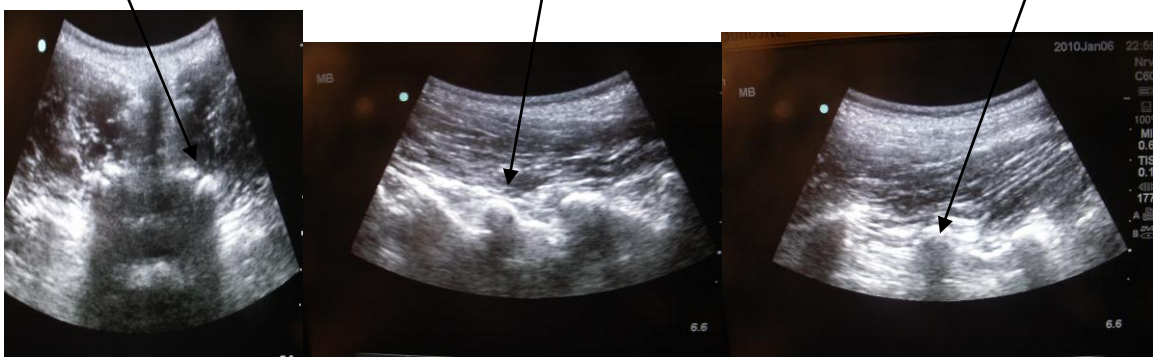
Coracoid supraspinatus

Suprascapular n. trapezius

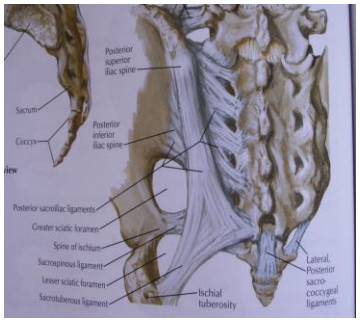
Shoulder joint and supraspinatus tendon – Keep asking our MSK specialists



Lumbar facets – transverse & longitudal view- to see is one thing to keep hand still and repeat it up to 6 times is another story. Old good fluoroscopy keeps well. TP & LP

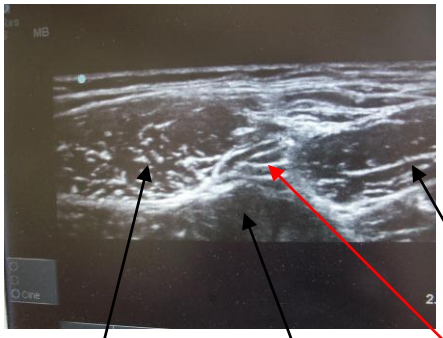


Sacroiliac joint- keep practicing and have fluoro handy. Has got a future.



SI joint

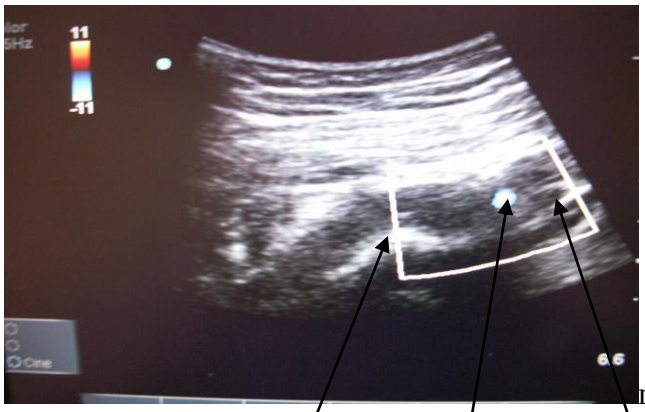
Lateral cutaneous of The Thigh Nerve



sartorius

Tensor fasciae latae rectus femoris (start to look here for LCT- Good Luck !!)

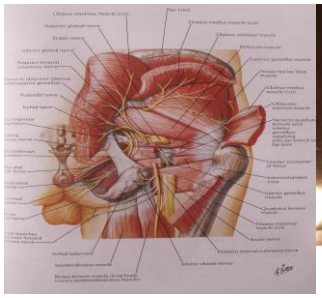
Pudendal nerve block- once you get to this point is easy

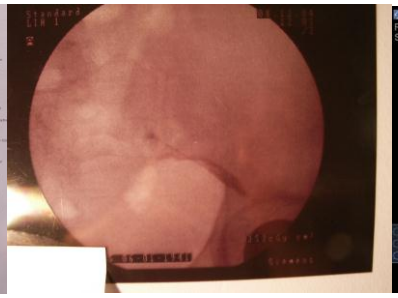


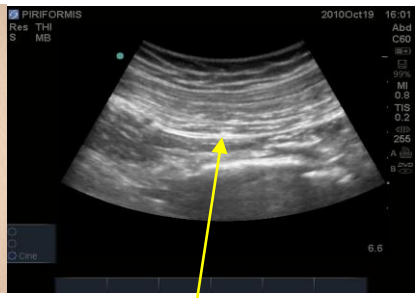
medial

Ischial spine pudendal artery & nerve

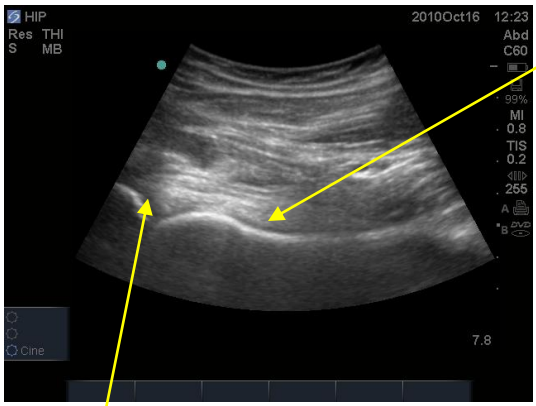
Piriformis muscle block- no vascular landmarks but still can be done







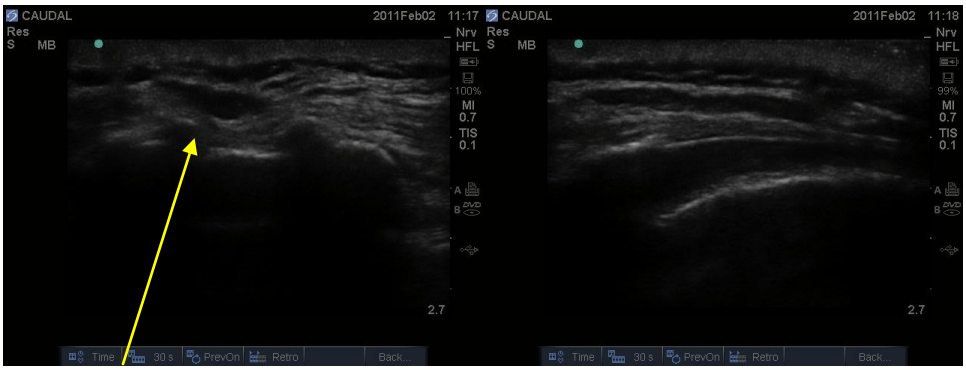
Piriformis muscle



hip joint block

acetabulum

Caudal Block transverse & longitudal view



Sacral cornua

Needle in epidural space

Useful websites:

www.**pain**centreatgstt.**blogspot**.com
www.painultrasound.com
www.lsora.co.uk
www.nysora.com
www.usra.ca
www.neuraxiom.com

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