Ultrasound Guided Regional Anesthesia
UGRA

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Aric C Bunch

• Primarily work at Crozer hospital
• Perform common blocks for shoulder, knee, and hand surgeries
• Most experience is with a vascular access ultrasound machine
• Have found that ultrasound guidance has increased speed and efficacy of blocks
• Formal training at .....
Crozer Chester Medical Center

- Level II trauma center
- 424 bed facility
- Nathan Speare Regional Burn Treatment Center
- Open heart, OB, joint replacement, bariatric, and pediatrics
Goals

• Intended to address the fundamentals of ultrasonography
• Review the basic anatomy of common blocks
• Give an overview of ultrasound guided regional anesthesia UGRA
• Discuss the advantages and disadvantages of UGRA
The Department of Health and Human Services recently acknowledged reimbursement benefits for the CRNA delivery of acute and chronic pain services describing it as an “evolving field”

This rule further reiterated the longstanding pay rates being the same between physicians and CRNAs

The placement of Swann-Ganz catheters was referenced in this rule as an example of CRNA benefits already established
Thanks AVANA Staff

• Thanks to the many dedicated staff that made today possible
• To the tireless efforts of Diane Boettger for her assistance and hard work
Ultrasound Basics

• Use of ultrasound in medicine began in the 1940’s
• Ultrasound has many diagnostic and procedural uses
• Reports of placing regional blocks with ultrasound assistance started to appear in earnest around 1995
• The use of ultrasound for vascular access predates UGRA
Ultrasound Basics

• Piezoelectric crystals are arranged to provide acoustic energy
• Ultrasound machines typically emit a range between 1-18 MHz
• The human ear typically can detect a range of 20Hz-20kHz
Ultrasound Basics

• The transducer emits an ultrasound wave
• When the wave returns to the transducer a picture is processed
• Objects with a great difference in impedance will create a white (hyperechoic) picture
• Objects with a slight difference in impedance will create a gray (hypoechoic) picture
• Areas with no return will be black (anechoic)
Ultrasound Basics

• Any objects with a difference in impedance will appear white
• The difference between muscle and fat are smaller and will have a gray appearance or boundary
• Injected fluids often appear very dark
• This is much different than imaging that relies on the penetration of a tissue
Ultrasound Basics

Controls

• **Gain** - raises the level of signal returning to the probe. Too much will cause white out & too little will cause black out

• **Time Gain Compensation** - allows gain to be altered at different depths

• **Frequency** - higher frequency settings result in better resolution but at a cost of lower penetration
Ultrasound Basics

Controls

- **Focal Zone** - is the narrowest part of the ultrasound beam. This is the area with the best resolution
- **Depth** - how deep the beam will reach
- Anatomy of interest in the brachial plexus tends to be at a 2-3cm depth
Ultrasound Basics

Probes

• Various probes are available
• There are linear or curved array probes with various footprints
• Most regional anesthesia utilizes a linear probe
Not this probe
Ultrasound Basics
Movements of the probe

• The angle of incidence is the angle at which the sound hits the object
• Optimal angle of incidence is 90°
• The ultrasound picture may be optimized by Sliding, Angling, Rotating, Tilting, or applying Pressure
• These techniques are utilized to deal with the anisotropy of an object
Ultrasound Basics

Movements of the probe

- Sliding
- Angling
- Rotating
- Tilting
- Pressure

Source: Mayo Clinic
Ultrasound Basics

Approach

• The approach refers to whether or not the needle is inserted parallel (in-plane) or perpendicular (out-of-plane) to the probe

• Both techniques have their advantages and risks

• In-plane approaches allow the needle to be best visualized but may not always be practical due to anatomical constraints

• The out-of-plane approach offers better visualization of the needle
Ultrasound Basics
Approach

Ultrasound-Guided Supraclavicular Brachial Plexus Block

Source: NYSORA
Ultrasound Basics
Approach
Ultrasound Basics
Approach
Ultrasound Basics
Approach

Source: Mayo Clinic
Ultrasound Basics

Artifacts

• **Reverberation** - occurs when the sound pulse is reflected back into the patient and again returns to the probe.

• **Shadowing** - seen when a strongly attenuating substance is proximal to the probe blocking the view

• **Enhancement** - a hyperechoic region appears beneath an object with low attenuation i.e. below a blood vessel
Ultrasound Basics
Artifacts
Ultrasound Basics

Artifacts
Ultrasound Basics
Artifacts
Phantom Targets

• Used for training
• Helpful for both learning how to scan and needle approximation to a target
• Can be self made or purchased from various companies
• Various authors advocate for and against the use of phantom target for training
Phantom Targets
Ultrasound Basics
Six Steps

1. Preparation
2. Visualization
3. Approximation
4. Interrogation
5. Deposition
6. Evaluation
Blocks of the Brachial Plexus

- Multiple approaches to the brachial plexus exist
- They include interscalene, supraclavicular, infraclavicular, and axillary techniques
- Nerve roots C-5 through T-1 are included
- Each block has its benefits and limitations so therefore proper block selection is required
Anatomy of the Brachial Plexus

• Consists of the anterior primary divisions (Ventral Rami) of C-5 through C-8 as well as T-1

• As the nerve roots leave the boney structures of the spine they form three trunks

• These trunks are formed in between the anterior and middle scalene muscles

• Superior (C-5 through C-6) Middle (C-7) and Inferior (C-8 through T-1)
Remember

• Real
• Texans
• Drink
• Cold
• Beer
Anatomy of the Brachial Plexus

• The trunks break into divisions
• These division then give rise to distinct cords
• The cords are:
  • **Lateral** with three branches being developed by C-4 thru C-7
  • **Posterior** having five branches and being developed by C-5 thru T-1
  • **Medial** having five branches and being developed by C-7 thru T-1
Supraclavicular Block

• Typically used for the arm distal to the shoulder including hand, forearm, and elbow
• Commonly encounters the brachial plexus at the level of the divisions
• There is significant risk of pneumothorax
• Insufficient evidence exists to advocate or discredit ultrasounds ability to improve safety
Supraclavicular Block

• From above the clavicle the brachial plexus lies posterior and slightly inferior
• The subclavian artery is just medial to the brachial plexus
• Classically the brachial plexus is approached 2.5cm lateral from the clavicular head of the sternocleidomastoid and 1cm superior
• Take care not to advance the needle past the depth of the clavicle (2.5-3cm)
Sternocleidomastoid
Sternocleidomastoid
Supraclavicular Block

Source: Mayo Clinic
Supraclavicular Block

- Place the ultrasound probe in the supraclavicular fossa
- Direct beam caudally towards the first rib
- Locate the subclavian artery
- Lateral to the artery are 4-6 or more hypoechoic circles
- A hyperechoic sheath may be evident
- The artery may be confirmed by color flow
Supraclavicular Block

- Typically the vein is located just medial to the artery with an evident valve visible
- The first rib and pleura may be visible as hyperechoic structures
- The hyperechoic pleura can be observed moving with respiration
- Approach the plexus in-plane anteromedially and slightly caudal
- Local is injected at lowest point of plexus near artery
- Several redirections may be made for adequate spread
Supraclavicular Block

First Rib

Pleura
Supraclavicular Block
Supraclavicular Block
Supraclavicular Block

• Perlas, *et al* conducted a 510 patient study
• 47 practitioners of various training levels participated
• 94.6% of patients had adequate block after single attempt
• No clinically symptomatic pneumothorax occurred
• 1% hemi diaphragmatic paresis 1% Horner and 0.4% vascular puncture occurred
Supraclavicular Block

• Studies demonstrate the utility of this block for shoulder surgery

• Conroy & Awad as well as Liu, Gorden, *et al* demonstrate the ability of this block to cover the shoulder

• Liu, Gorden, *et al* found a slight benefit of supraclavicular vs interscalene block in shoulder arthroscopy
Interscalene Block

• Frequently used for shoulder surgery
• At the interscalene approach the brachial plexus is typically in its trunks
• The three trunks of the brachial plexus include the superior (C-5 & C-6), middle (C-7), and inferior (C-8 and T-1)
• As these three trunks approach the first rib they disperse into their anterior and posterior divisions
Interscalene Block

• The trunks lie between the anterior and middle scalene muscles
• The phrenic nerve is typically located anterior and medial to the brachial plexus
• The subclavian artery lies caudad to the trunks
• The vertebral artery is parallel and medial to the trunks
Interscalene Block

Source: Mayo Clinic
Interscalene Block

• Using landmark technique the patient is placed supine with a towel under the head or in a slight Fowler’s position

• The lateral edge of the sternocleidomastoid muscle is identified

• The patient is asked to raise head to a sniffing position

• The interscalene groove is palpated by rolling your fingers off the neck posteriorly
Interscalene Block

• The interscalene groove is the space between the anterior and middle scalene muscle
• This is palpated at the C-6 level (Chassaignac’s tubercle)
• After local is placed the block needle is advanced at a 45° caudad angle to illicit a twitch
Interscalene Block

• As superficial as it is the brachial plexus may be difficult to see sonographically

• Although typically described as three trunks, more subdivisions may be seen

• Scanning technique

• The subclavian artery is visualized at the clavicle

• Just medial to the artery is the subclavian vein
Interscalene Block

• A valve is frequently seen within the subclavian vein

• The nerve bundle is followed cephalad to approximately C-6. A “stop light” or “snow man” bundle can be seen

• Anterior to the bundle is the anterior scalene muscle

• Posterior to the bundle lies the middle scalene muscle
Interscalene Block

- Further anterior scanning will show the internal jugular vein, and carotid artery
- The sternocleidomastoid muscle lies over top of the internal jugular and carotid artery
- Tracing the bundle cephalad will reveal the nerve trunks forming their bundles
Interscalene Block

• Nerve stimulation can be used to confirm position
• Ensure proper spread of local
• Inability to visualize spread may indicate malposition of the needle and place the patient at risk of local toxicity
• Aspiration should still be performed every 5 mL of local injected
Interscalene Block

• ASA closed claims findings show that 42% of block related claim between 1980-1999 were ISB related
• None of these claims involved an ultrasound guided technique
• Closed claims reports are limited in how the data is collected
Interscalene Block

- Kapral, *et al* found that surgical anesthesia was achieved in 99% of US guided blocks and 91% of nerve stimulator only blocks (n160)
- US onset time was found to be shorter as well
- No complications were noted in either cohort
- Direct needle tip visualization was attributed by the author to the US cohorts high success rate
Interscalene Block

• The American Society of Regional Anesthesia (ASRA) released a 2010 evidenced based medicine (EBM) executive study

• There was higher success rate and onset time with ultrasound

• This did not correlate into readiness for surgery time or a reduction in the need for block supplementation
Scanning Review

- This next sequence shows scanning of the supraclavicular area to the interscalene area.
- The neck is then scanned over to the internal jugular and back to the supraclavicular area.
Scanning Review

Subclavian Artery

Lateral → Medial
Infraclavicular Block

- Often utilized block for surgeries of the elbow and below
- Unlike the axillary block little arm movement is required
- A useful block for generating surgical conditions
- May require more sedation than other blocks
Infraclavicular Block

- Most frequent landmark technique
- Locate the coracoid process
- 2cm inferior and 2cm medial a 4” needle is placed directly posterior
- Depth of plexus ranges 2.5 cm to 8cm in an obese patient
- Medial redirects increase the risk of pneumothorax
- Lateral redirects may cause incomplete anesthesia
Infraclavicular Block

Source: Mayo Clinic
Infraclavicular Block

- Ultrasound technique may be easier
- The probe is placed just medial of the shoulder just below the clavicle
- The probe is oriented in a cephalad caudal orientation
- The axillary artery is seen
- Typically the axillary vein is just inferior to the artery
- Gentle probe pressure is a must to visualize the axillary vein
Infraclavicular Block

- It is ideal to block three cords
  - The medial, posterior, and lateral
  - The nerves should be hyperechoic and honeycomb-like
- The needle is inserted just inferior to the clavical
- Typically a 150mm needle is used as nerve location is widely variable
Infraclavicular Block

- Be aware that veins other than the axillary vein are frequently present in this area
- Respiratory complications are low and surgical onset can be fast
- This block can be unreliable due to the proximal exist of the musculocutaneous and axillary nerves
Infraclavicular Block

• Each cord may be injected upon
• If posterior spread is adequate a one injection technique may be sufficient
• Use of a nerve stimulator may be advisable
• Redirecting the needle medial or lateral is not advised
Infraclavicular Block

Infraclavicular and Axillary Blockade
Axillary Block

- Used for surgery of the arm at the elbow and below
- Anesthetizes the brachial plexus at three terminal branches: median, ulnar, radius
- Block may include the musculocutaneous nerve
- Relatively safe block
- Ultrasound has recently demonstrated significant patient variability in nerve location
- The radial nerve is posterior to the axillary artery
Axillary Block

- Catheter placement is possible with this technique
- A good block for teaching
- In-plane approach is most useful
- Many non-ultrasound guided techniques are described
- Reduces risk of Horner syndrome, phrenic nerve blockade, and pneumothorax
Axillary Block

- There are multiple classical techniques
- Nerve stimulation should always be considered
- The trans-arterial approach is also frequently utilized
- Scanning techniques
- Have the patient lie supine with head turned away from the block
Axillary Block

- Next abduct the arm and flex the elbow to about 90°
- The needle is inserted either just above or below the artery
- The terminal branches are then identified by twitch if a nerve stimulator is used
Axillary Block

Source: Mayo Clinic
Axillary Block

- Sites, B.D. examined 56 patients receiving axillary block
- Patients received either an US or trans-arterial block
- Trans-arterial patients converted to general in 29% of cases
- No US blocks required conversion
- The Trans-arterial group took an average of 7.9 minutes to perform the block and the US group took 3.9 minutes
Axillary Block

• Limitations of this study
• This study had a low number of overall patients (n<56)
• The success of the trans-arterial axillary blockade seems low based on other studies (Tedore, *et al*; Cockings, *et al*; Koscielniak-Nielsen, *et al*) and anecdotal data
Axillary Block

- Key factor in using US for axillary guidance may be patient variability
- Remerand, *et al.*, found that 1 out of 5 patients have atypically placed musculocutaneous nerves
- Dr. Brain D. O’Donnell, citing multiple studies, demonstrated a significant reduction in the volume required for effective axillary blockade
Assessment of Brachial Plexus Block

• Mental status and meaningful contact with patient is the most important monitor or assessment

• Full patient monitoring, BP, Sao2, EKG, are also required

• The block may take some time to set up so results may not be evident right after administration
Assessment of Brachial Plexus Block

Patient will:

Push their forearm against light resistance (radial nerve)

Pull or flex their arm towards their nose with light resistance (musculocutaneous nerve)

Pinch the thumb (tests median nerve)

Pinch the pinky (tests ulnar nerve)
Femoral Nerve Block

• This block is frequently used for total knee replacements
• The femoral nerve arises from the ventral rami of L2-4 and sometimes L5
• It lies deep to the fascia lata and fascia iliaca
• The femoral nerve is classically located in the inguinal crease 1cm lateral from the pulse
Femoral Nerve Block

Source: NYSORA
Femoral Nerve Block

Source: Mayo Clinic
Femoral Nerve Block

- Classically the needle is inserted 1cm lateral to the artery in the femoral crease
- The needle may also be introduced 1 inch caudad with a 40-60° cephalad angle
- Two distinct pops can be appreciated with a blunt needle
- If the sartorius twitch is elicited, direct the needle posterior or lateral
Femoral Nerve Block

• Sonoanatomy includes locating the femoral artery and the two fascial planes
• For an in-plane approach consider a 4 inch needle
• The needle is guided just posterior to the femoral nerve
• The use of a nerve stimulator is advisable to confirm placement
Femoral Nerve Block

• In various studies Marhofer, *et al* demonstrated that US guidance in femoral nerve block had five major effects
  1. Increased quality of sensory block
  2. Reduced onset time
  3. Reduced risk of block
  4. Reduced volume required from 50mL down to 20mL per block
  5. Increased success from 70-80% up to 95%
Femoral Nerve Block

- Wilson and Horner demonstrated in a brief 10 patient study that merely injecting local within the femoral triangle was adequate
- Injection was performed if local was seen spreading towards nerve
- Close proximity to the nerve was avoided
- 90% success rate with no opiates in recovery was observed during knee arthroscopy
Femoral Nerve Block
Sonoanatomy
Transversus Abdominis Plane Block

- The TAP block is used for pain of the abdominal wall
- Landmarks include iliac crest, midaxillary line, costal margin and lumbar triangle of petit
- Much like femoral nerve block two “pops” are felt
- Under ultrasound two muscle planes are seen
- Single shot or catheter placement are possible
Novel use of EXPAREL®
Transversus Abdominis Plane Block

• Local is placed between the internal oblique and the transversus abdominis muscles
• Volume dependent block
• Possible locals include
  1. 20mL 0.375% bupivacaine
  2. 3mg/kg ropivacaine
  3. 40mL 1% lidocaine
Transversus Abdominis Plane Block

Source: NYSORA
Transversus Abdominis Plane Block
Transversus Abdominis Plane Block

• The TAP block has demonstrated a reduction in pain medication requirements and increase in patient satisfaction (McDonnell, *et al*; Heil, *et al*; O’Donnell; Tan, *et al*)

• Studies have demonstrated efficacy with both landmark based techniques and ultrasound guided techniques

• Of the above studies mentioned complications were not noted
UGRA

- Studies have yet to prove overwhelming improvements in safety or success
- The reasons for this may include the low incidence of untoward events with regional anesthesia
- It is difficult to believe that UGRA is not a useful tool for safe and effective blocks
- With experience UGRA may improve the timeliness of block performance
- Consensus among clinical instructors at NYSORA was that proficiency takes around two years to develop in UGRA basic blocks
Reference

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Reference

Reference


