Ultrasound-Guided Regional Anesthesia

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<table>
<thead>
<tr>
<th>Block</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interscalene Block</td>
<td>6</td>
</tr>
<tr>
<td>Supraclavicular Block</td>
<td>9</td>
</tr>
<tr>
<td>Infraclavicular Block</td>
<td>20</td>
</tr>
<tr>
<td>Axillary Block</td>
<td>30</td>
</tr>
<tr>
<td>Popliteal Sciatic Block</td>
<td>39</td>
</tr>
<tr>
<td>Femoral Block</td>
<td>44</td>
</tr>
<tr>
<td>Saphenous/Adductor Canal Block</td>
<td>52</td>
</tr>
</tbody>
</table>
Injecting local anesthetic into the bloodstream can cause seizure or cardiac arrest. Clinicians can use ultrasound to avoid this and other complications. Using ultrasound guidance during a difficult nerve block reduces the risk of puncturing a lung and causing pneumothorax.

*Dr. Greg Hickman, MD, of blockjocks.com using the Flex Focus 400 exp.*
There are two transducer positions when approaching nerve blocks with ultrasound: the short-axis view and the long-axis view.

The short axis view is the preferred approach because it gives you a cross-sectional view of the nerve.

Line up the transducer beam perpendicular to the cross-section of the target nerve so it appears bright white on the ultrasound screen.
You can choose from in-plane or out-of-plane techniques.

The in-plane technique is by far the most preferred method because you can see your needle in real time from the proximal shaft to the needle tip for the duration of the procedure.
The interscalene block is the bread and butter block for shoulder surgery. The interscalene nerve block substantially covers rotator cuff repairs, total shoulder replacements and major upper extremity trauma.
Interscalene Block
Target Roots of Brachial Plexus

This block targets higher at the roots of the brachial plexus (C5, C6, +/- C7) in order to reach the innervation of the shoulder.
Scanning with ultrasound to locate the interscalene plexus is a very easy two-step process. Look for the “cluster of grapes sign,” where the trunks are next to that subclavian artery.

In a paintbrush stroke, move the transducer up the neck in a simultaneous slide and tilt motion. As you scan up the neck from supraclavicular to interscalene, you should note two important questions.

1. Has the subclavian artery disappeared when reaching the interscalene level?

2. Has the shape of the brachial plexus narrowed into circles on top of circles?

This is referred to as the “stoplight sign” representing the visualization of C5 and C6. When you can answer yes to those two questions, you have scanned high enough up the neck and are at an adequate height to start an Interscalene block.
Supraclavicular Block

For upper extremity surgery, excluding shoulder surgery, you may use a supraclavicular block, which has been coined the “spinal of the arm”.

The supraclavicular block essentially numbs everything from the proximal arm down to the fingertips and gives you the capability of anesthetizing the arm for both surgical and post-operative pain control.
The supraclavicular block starts high and proximal on the patient. Technically the superior, middle and inferior trunks are where you are targeting the brachial plexus for this block.
Supraclavicular Block
Patient Positioning

Position the patient resting flat on their back with a pillow and 30 or 40 degrees elevated. Turn the patient’s head up away from you and insert the needle just above the clavicle and posterior to the transducer.

1. Back Flexed ~ 30 degrees
2. Head turned away
3. Arm neutral
4. Posterior “room to needle”
SuprACLAVICULAR BLOCK
In-plane Technique

Turn the patient’s head up away from you and insert the needle just above the clavicle and posterior to the transducer.

This is an in-plane technique that gives a short axis view with a wide linear array ultrasound transducer.
When attempting a supraclavicular block, you must first identify the subclavian artery and the lung. The subclavian artery is a large pulsatile structure that is non-compressible. If this artery is punctured with a needle, it is very difficult to stop from bleeding.
The subclavian artery can be avoided quite easily if the needle tip can be visualized with ultrasound through the duration of the procedure.

Another safety mechanism that can be used is to identify the patient’s first rib (the lung is always positioned deep to the first rib).

**Supraclavicular Block**

Avoid the Subclavian Artery
The goal is to first inject local anesthetic deep to the structure you are targeting, in this case the trunks of the brachial plexus. If the deepest structure is targeted first, the fluid will push the structure more superficial.

As a result, when you subsequently redirect your needle tip during a multi-injection technique the angle will be flatter and therefore the needle will be easier to see with ultrasound.
In terms of needle visualization with ultrasound, the flatter the better.

If you inject above the target first it will push the target deeper and the block will become more difficult as you progress.
The deepest injection point is called the “corner pocket,” where the subclavian artery and the first rib come together.

The “corner pocket” is where the lower trunk is located. This innervation is especially useful for wrist surgery.
The “corner pocket” injection technique is a popular approach to the supraclavicular block.

You can inject all of your local anesthetic in the “corner pocket” location.

If you redirect the needle one or two times you can enhance the spread of the local anesthetic around the nerves.
The goal for this block is to get a “doughnut sign” or black fluid ring around the nerves, indicating the nerves are completely surrounded.

Creating a black fluid ring around the nerves with a multiple injection technique is safer for two reasons.

1. It allows for the use of less local anesthesia in each location
2. It allows for less overall local anesthesia for the block
Blocks Below the Clavicle

Infraclavicular Blocks

Axillary Blocks
Some believe it is impossible to visualize the needle when doing an infraclavicular nerve block. But this is simply not the case.

If you cannot see the needle during this block, it is probably being inserted too close to the transducer, causing too steep an angle to visualize the needle with ultrasound.

If it’s inserted farther away from the transducer, it will come in flatter and cause more reflection off the needle.

When doing an infraclavicular block, use an in-plane technique with a short axis position to get a cross-sectional view of the nerves.
The “Houdini arm position” allows one to insert the needle farther from the probe in-plane.

1. Back flexed ~30°
2. Head turned away
3. “Houdini” Arm
4. Room to needle

If the patient’s arm is positioned upwards in the “Houdini arm position” as demonstrated, it displaces the clavicle posterior and medially and causes the clavicle to disappear.
Insert the needle a few centimeters away from the transducer and rock the transducer towards the needle to get a bright view of it.

If you follow this technique correctly, expect to see your needle when doing an infraclavicular block.
The transducer placement should be in the “parasagittal plane”
Infraclavicular Block
Lateral Approach

Take the sagittal plane and slide the transducer over towards the deltopectoral groove and take a very lateral approach.

The more lateral the approach, the better the chance of avoiding the patient’s lung.

Risk of pneumothorax is extremely low for this technique.
Infraclavicular Block
3 Key Points for Excellent Needle Views

1. Insert your needle further from the transducer
2. Use the “Houdini arm position”
3. Rock the transducer back towards the needle in the “parasagittal plane”
The axillary artery, which is right next to the axillary vein, is another major vascular landmark to guide your ultrasound transducer.

The lateral, posterior, and medial cords of the brachial plexus are bunched together under the axillary artery.
For a highly successful infraclavicular block, target your single injection at a six o’clock position relative to the axillary artery and specifically target the posterior cord to surround all three cords in a U-shaped “horseshoe” spread of local anesthetic.
Redirect the needle one or two times to further enhance the spread of local anesthetic and lessen the amount of overall fluid used in the block, which is a safer way to practice regional anesthesia.
Axillary Block

The axillary block is the most distal brachial plexus block.

It targets the terminal branches of the brachial plexus: look for the musculocutaneous, radial, median, and ulnar nerves.

The axillary block can be used for forearm, hand, or wrist surgery. It is useful for pulmonary patients since it spares the phrenic nerve. It is also useful for morbidly obese patients.

The chest wall and the neck can be very thick in larger patients. The axilla (the location of the axillary block) is actually quite superficial, even
Axillary Block

Why Axillary Nerve Blocks?

- If you have a larger patient and scan their supraclavicular region with ultrasound, it's going to be deep.

- If you scan their infraclavicular region, it's going to be even deeper. For example, if you do a single shot block for wrist surgery and the patient is obese, the axillary nerve block is going to be the easiest of the three blocks to complete.
The axillary block is not a recommended location to place continuous nerve block catheters because there are several surrounding vessels in the area.

This is not a concern if the initial injection is done while the patient is being monitored; the issue is leaving a catheter near or through a vessel.

You do not want to risk sending a patient home with local anesthesia infusing into the bloodstream.

The nerves in this particular block are very spread out; leaving a catheter in place involves a single catheter opening that is infusing local anesthetic into a single location. It is very difficult to reach all four nerves with a single catheter location.
Axillary Block
Ultrasound Guided Approach

- Envision the axillary block positioning like a clock face.
- Consider the axillary artery the clock and the musculocutaneous, median, ulnar and radial nerves as targets aligned around the clock face.
Axillary Block
Target the Musculocutaneous Nerve Separately

- The musculocutaneous nerve is furthest away from the axillary artery and is located in the eight o’clock position; therefore one must target the musculocutaneous separately.

- Once you have targeted and injected local anesthetic around the musculocutaneous nerve, you should essentially encircle the axillary artery to numb the remaining three nerves.
Axillary Block
Encircle Two Structures

- The simplest way to do an axillary block is to encircle two structures: the musculocutaneous nerve and the axillary artery.

- There is some variability from patient to patient where the median, ulnar and radial nerves exist relative to the axillary artery, but you can rest assured they are covered if you encircle the axillary artery.

- Using this technique will give you a high level of confidence that you have completed this block successfully.
There is a common false paradigm that all surgeons and anesthesiologists have been taught at some point in their career. The paradigm is that upper extremity surgeries such as the proximal arm are better performed with nerve blocks of the upper part of the brachial plexus, such as the supraclavicular nerve block. While the distal surgeries such as finger and wrist surgery are better performed with distal blocks such as axillary blocks. This is simply not true.

In fact, the supraclavicular, infraclavicular and axillary blocks can all be used for each of these purposes interchangeably.
A study compared the supraclavicular, infraclavicular and axillary blocks for elbow surgery and down. The study examined how much time it took to complete each block, the comfort level of the patient during the block and the success rate of each block (how successful they achieved surgical anesthesia).

The results showed each block took relatively the same amount of time, the patients pain levels were all low, and they each achieved a 95 percent success rate and up.

If you numb the phrenic nerve in a patient with pulmonary disease, which happens commonly with blocks above the clavicle, you could risk florid failure of the pulmonary system.

Morbidly obese patients could also fall into the same category. With certain patients you want to avoid the phrenic block if at all possible and stay with the nerve blocks below the clavicle.
The popliteal sciatic nerve block is the first block we will discuss when preparing for surgery of the lower extremity.

The sciatic nerve is a large nerve that starts up high in the greater sciatic foramen, deep to the piriformis muscle that runs along the posterior border of the leg. The location one should typically block this nerve is low near that popliteal fossa or the backside of the leg where the nerve splits into the tibial nerve and the perineal nerve. This “split” is a great location to block the sciatic nerves with the help of ultrasound.

Unfortunately the knee has four different nerves in four different locations that can cause pain; it is very difficult to completely numb this area.
The knee is a very complex structure for nerves in terms of innervation because of the femoral nerve, lateral femoral cutaneous nerve, sciatic nerve and obturator nerve. For example, after knee surgery using the femoral block a patient may have pain related to the sciatic nerve, requiring you to add a secondary sciatic nerve block as well.

For major knee surgery a sciatic block is considered a secondary nerve block. For patients undergoing total knee replacements, you could perfectly encircle the femoral nerve but the patient may still wake up with pain in the posterior part of their knee. This is not a result of a poorly executed femoral block, but a result of not performing an additional secondary sciatic nerve block. Pain relief for knee surgery usually involves both the femoral nerve and the sciatic nerve components.
Although there are four locations you can block the sciatic nerve, the most common place you will see an ultrasound-guided sciatic nerve block is in the popliteal region. Popliteal sciatic nerve blocks can be performed with three different patient positions: lateral, prone, or supine. Each approach has its advantages and disadvantages but it comes down to the clinician’s preference.
For the lateral approach, place the transducer along the backside of the patient’s leg, the posterior fossa and the popliteal fossa, and insert the needle in-plane lateral to medial.
One should typically block the sciatic nerve right when it’s about to separate into the tibial nerve medially and the perineal nerve laterally. This location resembles the “Mastercard sign,” when you see two circles side by side, where the nerves almost intersect to form one nerve. This is your recommended target for a popliteal sciatic nerve block.
**Femoral Nerve Block**

The femoral nerve is the largest nerve of the lumbar plexus. It is made up of the second through fourth lumbar nerves.

When approaching this block typically for knee surgery, we’re focusing on the lumbar plexus and its innervation. One way to determine the femoral nerve block is working is to check the strength of the quadriceps. Unfortunately when you have done a femoral block the patient is either sedated or is being tested post-operatively in a knee brace, so it is difficult to determine if the quadriceps are intact.

The simplest way to determine whether the femoral nerve block is successful is to check the anterior femoral cutaneous nerve by feeling the top of the patient’s thigh. If the top of the thigh is numb to the touch then typically it means that the femoral block is working properly.
The terminal sensory branch of the femoral nerve is the saphenous nerve, which innervates the medial calf and ankle. When checking a femoral block, you may either check the front of the thigh or the inside of the calf to see if the nerve block is working properly.
Clinicians often argue that ultrasound is not necessary for a femoral nerve block because of the classic landmark-based technique that has been utilized for years. The technique is very safe and effective. You feel the femoral artery and move slightly lateral and insert the until you feel two pops as the needle penetrates fascia lata and fascia iliaca. This technique works great if the patient is normal-sized, but if the patient is larger or obese there is a really good chance you may not feel the femoral artery. If you do feel the femoral artery, you may be off by a factor of two or three centimeters.
If you use ultrasound to visualize exactly where the artery is and move lateral to the artery, it makes the block more accurate especially in larger patients. When using ultrasound for this block it is helpful to identify three structures. The femoral vein is the most medial of the three structures, the femoral artery is in the middle and the femoral nerve is the most lateral.
When viewing with ultrasound it looks like a non-pulsatile femoral vein medial to a pulsatile femoral artery, which is medial to the femoral nerve. The femoral nerve in cross section looks like an elongated sausage shape. These landmarks all exist deep to the fascia iliaca, which is the fascial plane just above the nerve.
Why do femoral nerve blocks? Major thigh surgery and more importantly major knee surgery are the most common places you will see femoral nerve blocks being placed with ultrasound. For inpatients the most common use of a femoral nerve block is total knee replacements, and for outpatients the most common use is for ACL reconstruction.
Femoral Nerve Block
Preparing

Positioning in this block is especially important because total knee replacements typically occur in morbidly obese patients, placing the knee under a lot of stress and weight.

1. Morbidly obese patients also have a large pannus, a large belly that often hangs in the nerve block location. Two-inch silk tape can be used to pull the pannus back and attach it to the side rail on the bed. The silk tape helps reveal the obstructed location to place your needle and ultrasound transducer.

2. Sterilize Prep Area

3. Place the transducer high in the groin in the crease parallel to the inguinal crease. If you are ever in doubt you can always try to get a color flow view of the femoral artery.
You will see a round pulsatile femoral artery on the medial side of the femoral nerve.

Place your needle in-plane from lateral to medial, just under the transducer.

Inject approximately 20 cc of local anesthetic, half below the nerve and half above the nerve. A successful injection will surround the femoral nerve.
The saphenous nerve block (also called the adductor canal block) is one of the most popular and widely discussed nerve blocks in regional anesthesia. The saphenous nerve block not only supports medial ankle surgery, but it also can be used for knee surgery as an alternative to femoral nerve blocks. One of the most common complaints that surgeons have with femoral nerve blocks is the weakening quadriceps side effect. If you can replace a femoral nerve block with a saphenous nerve block or adductor canal nerve block, then you can spare the quadriceps side effects. This is one reason there has been a lot of interest and research examining how beneficial the saphenous nerve block is for knee surgery compared to the femoral nerve block.
Saphenous Nerve Block
Key Landmarks

- Saphenous Nerve
- Femoral Artery & Vein
- Great Saphenous Vein
- Sciatic Nerve
- Deep Femoral Artery & Vein
- Perforating Artery & Vein
- Great Saphenous Vein
When viewing the anatomy for a saphenous nerve block, look for the adductor canal. The adductor canal is the compartment between the vastus medialis, sartorius muscle and adductor longus muscle. In this compartment are the femoral artery and vein and two important nerves; the saphenous nerve, which is the target nerve and the nerve to the vastus medialis. Other nerve branches innervating the knee can also be found in the adductor canal, including a branch of the obturator nerve, but these small branches are not typically able to be visualized with ultrasound.
The innervation is traditionally medial ankle. If you have a major ankle surgery and the surgeon cuts into the inside part of the ankle, even if you have done a primary sciatic nerve block and your patient’s foot is numb and is unable to wiggle his or her toes, the sciatic block is working but the patient may still have moderate to severe pain in the medial part of the ankle.

This is because you haven’t blocked the saphenous nerve. A successful block of the foot and ankle not only involves a sciatic nerve block but also a saphenous nerve block.
Saphenous Nerve Block
Transducer Placement

Place the transducer on the sartorius muscle, down in the mid-thigh region. It is usually about two and a half handbreadths above the knee. Look for the femoral artery.

Slightly below the sartorius muscle and anterior to the femoral artery is the saphenous nerve. If you can find the deep border of the sartorius muscle with ultrasound (bright white line) and locate the femoral artery and inject local anesthesia deep to the muscle and adjacent to the artery, whether you see the saphenous nerve or not, you’re going to have a 99 percent success rate of doing a saphenous nerve block.

The saphenous block is a very easy block to complete with ultrasound because of the large arterial landmark and the bright white characteristics of the deep border of the sartorius muscle.
The mid-thigh approach to the saphenous nerve block is particularly useful for medial ankle pain. When this same approach is used to treat pain from ACL surgery and knee arthroscopy it is called an “adductor canal block”, and is a quadriceps sparing alternative to a femoral nerve block. Although the adductor canal block is identical to a mid-thigh saphenous block, it’s name change reflects the fact that the canal infiltration blocks more than just the saphenous nerve to treat knee pain. Other nerve branches blocked in the adductor canal include the nerve to vastus medialis and a branch of the obturator nerve.

ACL surgery is typically accompanied by an adductor canal block preemptively, while knee arthroscopy is not always needed. If a patient undergoes a knee arthroscopy and is having moderate to severe pain in the recovery room, one could do a rescue adductor canal block and the pain typically diminishes greatly. Occasionally this does not work but the vast majority of them provide significant analgesia after a patient has breakthrough pain after a knee arthroscopy.
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Dr. Brandon Winchester uses the Flex Focus 400 exp ultrasound system

“Excellent nerve visualization, very bright white.”

“Very small footprint, easy to navigate tight preoperative bedspaces.”

“Excellent dynamic imaging, real-time fluid injection and nerve movement is fantastic.”

- Dr. Winchester on his ultrasound system