**Highlights**

Ultrasound-guided nerve blocks offer an alternative to systemic narcotics and procedural sedation (wound exploration, laceration repair, fracture reduction, etc.).

Proper patient positioning and indications are essential.

Clinicians should be aware of nervous distribution in order to select the correct block.

Complete pre-block motor and sensory documentation is required.

**Indications**

Acute pain is a common emergency department (ED) complaint with emergency physicians at the forefront of pain management. Intravenous analgesia is often the only method employed to reduce pain, leading to either under-dosing (oligoanalgesia) or high rates of unwanted systemic effects (respiratory depression, hypotension, altered sensorium, etc.). Ultrasound-guided nerve blocks offer an alternative and/or adjunctive method to achieve pain control in the acutely injured ED patient.\(^1\)^\(^2\)

Along with pain reduction, ultrasound-guided nerve blocks can be a useful alternative to procedural sedation, which requires additional staff and can increase length of stay (LOS) in an often busy ED.\(^3\)

Ultrasound-guided regional anesthesia has rapidly become an accepted technique for anesthesiologists.\(^4\)^\(^5\) A Cochrane Review in 2009 demonstrated ultrasound-guided regional anesthesia to be quicker with a faster onset time.\(^6\) Adoption of principles from anesthesia has allowed emergency medicine (EM) physicians to employ single-injection ultrasound-guided nerve blocks as an adjunctive therapy for pain reduction and an alternative for procedural sedation. Ultrasound allows visualization of not only nerves, but other vital structures (arteries, veins, and even tendons) as well, allowing the EM clinician to integrate ultrasound-guided nerve blocks into EM practice safely after a moderate level of training.

Theses recent advances can be safely integrated into EM practice. Ultrasound-guided real-time anesthetic injections are quick, easy, and infinitely safer for your patient, as you can directly visualize all the involved structures – blood vessels, nerves, and the needle tip in real...
time, making it safe for the user. This real-time visualization eliminates the risk of dangerous side effects from procedural sedation and decreases ED LOS.\textsuperscript{5,7,10}

Forearm nerve blocks target the radial, median, and ulnar nerves. They are indicated for analgesia for acute injuries (burns, fractures, etc.) and before painful procedures (e.g., laceration repair, fracture reduction, foreign body removal). They do not provide anesthesia to the forearm or wrist.\textsuperscript{7}

Distal sciatic nerve blocks in the popliteal fossa are indicated for pain control in ankle and foot injuries (distal tibia or fibula fractures, achilles tendon rupture, dislocation) or as a procedural pain control tool.\textsuperscript{11-15}

This chapter will cover forearm nerve blocks of the radial, ulnar, and median nerves, as well as the lower extremity nerve block of the distal popliteal sciatic nerve.

**CONTRAINDICATIONS**

Contraindications to look for include the following:\textsuperscript{13}

1) Patients with an infection at the site of injection due to risk of introducing infection.

2) Allergy to anesthetic.

3) Risk for compartment syndrome.

4) Uncooperative, intoxicated, or altered patient due to need for an adequate pre- and post-anesthesia exam.

5) Acute neurologic deficit due to inability of physician to assess post anesthesia neurologic status.
**Highlights**

Basics of peripheral nerve blocks:
- Place patient on cardiac monitor.
- Position patient and yourself comfortably.
- Use sterile technique.
- ALWAYS visualize the needle on ultrasound.
- Aspirate before injecting.
- Stop injecting if anechoic fluid is not seen on the ultrasound or if the needle tip is lost.

**General Tips**

All patients who are to undergo a nerve block should be placed on the cardiac monitor. A motor and sensory exam of the involved limb should be performed before the procedure. The ultrasound system should be in the operator’s line of sight (Image 6.1).

**Image 6.1 - Sciatic Block Position**

Appropriate supplies should be available: a sterile dressing cover for the ultrasound probe, chlorhexidine to prep the skin prior to injection, 3.5-in 20-22 gauge spinal needle attached to a 20cc syringe, and 1% lidocaine with epinephrine. A survey scan of the affected...
area is recommended, with local skin wheal placed at the location of proposed needle entry. The clinician should always visualize the needle tip as it enters the skin and traverses under the probe. The provider should aspirate the syringe prior to injecting anesthetic to reduce rates of intravascular injection. If blood is not withdrawn, small aliquots of anesthetic can be injected, making sure that anechoic fluid is visualized on the ultrasound screen (Movie 6.1).

MOVIE 6.1 - Radial Nerve Block

If the operator loses visualization of the needle tip or cannot clearly see the anesthetic spread on the ultrasound screen, the procedure should be halted. After completing the anesthetic deposition, the skin should be marked with an indelible marker, indicating time and operator’s initials. We also recommend documentation in the clinical chart. For admitted patients, the inpatient consulting team should be involved in post-anesthesia follow up care and evaluation.

ANATOMY

It is important to know the specific motor function and sensory distribution for each nerve in order to correctly identify which nerve you want to block to achieve the desired effect (Movies 6.2-6.5). The following table provides a quick and basic review (Table 6.1).

**TABLE 6.1 – Neurological Exam by Nerve**

<table>
<thead>
<tr>
<th>NEUROLOGICAL EXAM</th>
<th>MOTOR</th>
<th>TEST</th>
<th>SENSORY</th>
<th>TEST</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RADIAL</strong></td>
<td>Wrist extensor</td>
<td>Extend wrist and fingers against resistance</td>
<td>Dorsum aspect of hand from thumb to radial half of ring finger</td>
<td>Sensation over dorsum thumb web space</td>
</tr>
<tr>
<td><strong>MEDIAN</strong></td>
<td>Wrist and finger flexion</td>
<td>Make a circle, or “OK” sign with thumb and index finger. Abduction of the thumb</td>
<td>Volar aspect of hand from thumb to radial half of ring finger</td>
<td>Sensation over volar aspect of hand thumb to radial half of ring finger</td>
</tr>
<tr>
<td><strong>ULNAR</strong></td>
<td>Intrinsic muscles of hand</td>
<td>Abduct 5th digit to touch thumb</td>
<td>Sensation to 5th digit, and ulnar half of ring finger</td>
<td>2 point sensory discrimination over tip of 5th digit</td>
</tr>
<tr>
<td><strong>SCIATIC</strong></td>
<td>Lower leg and foot</td>
<td>Dorsiflexion and plantarflexion of foot</td>
<td>L4-S3 dermatomes (lower leg and foot)</td>
<td>Sensation over dorsum and plantar foot and lower leg (except medially)</td>
</tr>
</tbody>
</table>
MOVIE 6.2 - Sciatic Nerve Test

MOVIE 6.3 - Ulnar Nerve Test

MOVIE 6.4 - Median Nerve Test

MOVIE 6.5 - Radial Nerve Test
HIGHLIGHTS

Patient positioning is very important, with the patient and practitioner in a comfortable position. The machine should be in a straight line of sight.

The radial nerve is “radial” to the radial artery.

The ulnar nerve is “ulnar” to the ulnar artery.

POSITIONING & PREPARATION

Place your patient in a supine position, with the targeted forearm extended and externally rotated 45 degrees at the shoulder, resting on a firm surface such as a procedure tray. Set up your ultrasound machine for optimal visualization in front of you and position yourself comfortably with easy access to the forearm (Image 6.2).

Nerve blocks require a high frequency linear probe (8-18MHz). Nerves on the ultrasound screen are often described as “honeycomb” in appearance. This reflects the hypoechoic bundles embedded within a more hyperechoic structure and homogenous regions of
the nerve. Placing the probe horizontally, start at the wrist and scan proximally until you clearly identify the targeted nerve at a safe distance adjacent to the corresponding vascular bundle (Movie 6.6).

**Radial Nerve**

The radial nerve is often best visualized in the mid forearm (Movie 6.7). Start to scan at the wrist and go proximal, following the pulsatile radial artery. At the level of the mid forearm, the radial nerve should be at a safe distance from the radial artery (Image 6.3).

**Movie 6.6 - Radial Nerve Block**

**Movie 6.7 - Radial Anatomy**

**Image 6.3 - Radial Nerve Block**
Ulnar Nerve

The ulnar nerve is often best visualized in the proximal forearm (Movie 6.8, Image 6.4). It appears as a small hyperechoic triangle on the ulnar side of the ulnar artery.

Movie 6.8 - Ulnar Nerve Block

Scan more proximal to optimize distance between the ulnar nerve and artery (Movie 6.9).

Movie 6.9 - Ulnar Nerve Block

Image 6.4 - Ulnar Nerve Block
**Median Nerve**

The median nerve is often best visualized in the middle of the mid forearm (Image 6.5). Start the scan at the wrist and go proximal until you see the flexor tendons. The median nerve will appear as a hyperechoic triangular structure (classic honeycomb) between the fascial planes (Movie 6.10).

Be careful not to confuse the median nerve with the flexor tendons, which appear more flat and will move with finger and wrist flexion (Movie 6.11).

**Injection Technique**

Once satisfied with your chosen entry location, you can prep the site with alcohol, chlorhexidine, or another cleansing agent. Numb the skin by creating a wheal of local anesthetic (i.e., 1% lidocaine).

Hold the transducer horizontally with your non-dominant hand. With your dominant hand, hold the syringe 0.5cm lateral to the probe: on the radial side for the radial nerve, ulnar side for ulnar nerve, and on either side for the median nerve. Insert the needle in plane with the probe, visualizing the needle tip at all times (Image 6.3, Image 6.4, Image 6.5). Once the needle tip is next to the nerve, inject the anesthetic in 1cc increments, encircling the nerve (Movie 6.6).
This section will cover one of the most common lower extremity nerve blocks, the distal popliteal sciatic nerve block.

**POSITIONING & PREPARATION**

The positioning of your patient can help in maximizing this nerve block technique. Ideally, place your patient prone (posterior approach) with the foot resting on a pillow for comfort (Image 6.6).

**IMAGE 6.6 - Distal Sciatic Nerve Block**

---

**HIGHLIGHTS**

The patient can be prone or supine.

Inject proximal to the bifurcation of the sciatic nerve into the common peroneal and tibial nerve.

Use 10-25 cc of anesthetic, attempting to surround the nerve.

Be familiar with and able to recognize and treat complications such as intravascular injection, nerve injury, and LAST.
The patient can be supine with a bent knee and several pillows underneath the foot, allowing enough space for the probe if unable to be placed prone (Image 6.7).

**IMAGE 6.7 - Sciatic Block Position**

Using the high frequency linear probe with the probe indicator pointing toward the patient’s right side, start scanning in transverse plane in the popliteal fossa to identify the popliteal vessels. The tibial nerve is superficial and lateral to the popliteal artery. Slide your probe proximally to follow the tibial nerve as it joins the common peroneal nerve to form the sciatic nerve (Movie 6.12). This junction of the nerves is where you will insert your needle from the lateral approach. You can measure the depth of the nerve on the screen and insert the needle in the skin at that distance from the probe. This will put the needle parallel to the probe and improve visualization as you advance. You should visualize the length of the needle on your screen as it approaches the sciatic nerve (Movie 6.13). Prep the skin widely with chlorhexidine and then inject 10-25cc (depending on patient size) of anesthetic circumferentially around the nerve.

**MOVIE 6.12 - Sciatic Nerve Anatomy**

**MOVIE 6.13 - Distal Sciatic Nerve Block**
INJECTION TECHNIQUE

Once the needle is under the probe in the longitudinal axis, you must visualize your needle tip on the screen. If you cannot see your needle, do not advance. You can try to fan your probe slowly to better locate your needle on the screen. Once you visualize your needle, advance the needle, directing it just distal to the nerve (Movie 6.13). You should never penetrate the nerve.

The next step is to draw back on your syringe prior to injecting to ensure you are not within a vascular structure. Then inject the anesthetic very slowly around the nerve in 3-5cc portions for a total of approximately 20cc. The goal is to slowly pour the anechoic anesthetic fluid so it surrounds the nerve bundle and creates a “donut” of anechoic or “black” fluid around the nerve bundle (Movie 6.14).

Redirect your needle all around the nerve bundle as needed to accomplish this. Once you have surrounded the anesthetic around the nerve, withdraw your needle.

Re-examine the patient’s nerve function to ensure proper nerve block. As the sciatic nerve is larger, it usually takes longer for the block to become evident than in the smaller nerves. After your nerve block and required procedure is done, communicate the care of the anesthetized limb to members of the inpatient consulting treatment team.

For more information, see the Ultrasound Podcast Sciatic Nerve Block episode.
**Pearls & Pitfalls**

Inadvertent vascular puncture is a feared complication. Clinicians should always visualize the needle tip, aspirate before anesthetic injections, and see anesthetic spread on the ultrasound screen, encircling the nerve. Even with a safe approach, cases of inadvertent vascular puncture have been reported. We recommend lidocaine (with or without epinephrine) to reduce the possibility of local anesthetic systemic toxicity (LAST). Anesthetic toxicity can be avoided by keeping the anesthetic dosing in consideration.

Another major concern is peripheral nerve injury (PNI) post ultrasound-guided nerve block. Keeping the needle tip at a safe distance from the nerve, as well as slow, low volume injections can theoretically reduce the risk of direct nerve trauma. The patient should always be awake during the procedure in order to inform the clinician of any pain or discomfort during injection.

Difficulty clearly identifying the nerve amongst the other structures is a common frustration. If you are ever uncertain that a particular structure is a nerve, just follow its course with the US probe to see if it changes shape; for example, tendons will become dense muscle bodies and can move with finger and hand flexion. Also, use Doppler and check for compressibility to distinguish it from vascular structures.

**Summary**

In summary, ultrasound guided nerve blocks are a great adjunct for pain control for patients with painful pathology or painful procedures being performed. Ultrasound guidance has greatly improved the safety and efficaciousness of nerve blocks and made it possible to perform at the bedside. There are certainly contraindications and issues to be aware of, but for the most part this is a skill that any physician can learn and apply to their practice.
REFERENCES


