Practical Neurologic Examination and Performance of Diagnostic Nerve Blocks

Include these tools in your treatment armamentarium.

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A complete lower extremity-focused neurologic examination can be straightforward and quickly performed by the clinician. A focused examination versus an exhaustive one can lead to an accurate diagnosis and ultimately a successful treatment plan even in the most complex cases. An integral part of a successful examination of complex pathology is peripheral nerve blocks.

This article also presents a simplification of the neurologic examination that can facilitate clinical implementation as well as understanding. This focused neurologic examination can be broken into essentially three parts: 1) status of sensation, 2) status of isolated motor strength, and 3) determination of neural injury and entrapment.

Sensation

Normal cutaneous sensation is accomplished by transmission of different types of stimuli by the A-beta fiber, which is the first fiber affected by hypoxia in focal peripheral nerve compression. Receptors such as the Merkel cell and Meissner's corpuscles cause transmission in the terminal afferents, giving the person a sensibility of touch. Accurate assessment of sensation is critical to accurate diagnosis-making in peripheral nerve pathology and in the assessment of efficacy of diagnostic blocks.

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Motor Strength

Motor innervation is accomplished by the largest-diameter A-alpha fiber, which is a more robust peripheral nerve fiber in some respects, and, unlike the A-beta fiber, can withstand more focal hypoxia, but not pressure. It should be noted that when a patient demonstrates motor weakness, there is significant nerve damage, and if there is a complete palsy, this is a relative surgical emergency if there is an isolated entrapment.

Determination of Neural Injury and Entrapment

Because electrodiagnostic testing is often falsely negative in lower extremity peripheral nerve pathology and conditions, the clinician is often forced to rely solely on clinical testing. Two important clinical tests can assist the clinician in determining areas of nerve injury and entrapment: the Hoffmann-Tinel sign, and the provocation sign. The Hoffmann-Tinel sign has been a mainstay in clinical evaluation of peripheral nerve conditions and injury since Phalen's popularization of it in the 1950s to evaluate carpal tunnel syndrome.[1] There has been much controversy on the sensitivity and specificity of the Hoffmann-Tinel sign, ranging from 23% sensitivity to 60%, and from 64% specificity to 87%.[2,3] Some of this variability has been attributed to poor inter-tester technique correlation and methods. Lee and Dellon reported much higher

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sensitivity and specificities in their clinical study of tarsal tunnel patients, ranging from 88% to 95% sensitivities and specificities ranging from 50% to 95%.[4]

More importantly, they reported a predictive positive value range of 88% to 93% in patients on whom they performed nerve decompression surgery.[4] The Hoffmann-Tinel sign may not be positive in patients with advanced nerve compression as well as those with early nerve compression. However, in advanced cases of moderate to severe compression, there will usually be clinical muscle atrophy. The Hoffmann-Tinel sign indicates nerve injury and/or compression, and following nerve repair, there should be a distally migrating demonstration of this clinical test.

There has been clinical confusion in the past regarding electro-diagnostic studies and their utility in assessment of tarsal tunnel syndrome. The reader may ask how important is electrodiagnostic testing? The answer in practicality is not very much with good clinical workup and neurosensory testing. Nerve conduction velocity testing in carpal tunnel syndrome does not have a significantly better record. Jablecki et al., in a literature review, report sensitivities ranging from 49% to 84% and specificities ranging from 95% to 99%.[5]

In the upper extremity, surgical efficacy for carpal tunnel surgery has been documented with reliance on clinical examination instead of electrodiagnostic testing.[6] In the author's experience, electrodiagnostic testing is falsely negative in more than 50% of clinically diagnosed tarsal tunnel syndromes. Electrodiagnostic studies can prove invaluable in the assessment of the patient with radiculopathy and a double crush situation.

Peripheral Nerve Blocks

The following specific case vignette illustrates the power of diagnostic peripheral nerve blockade and how imperative it is to implement these strategies from a bunion surgery. The osseous correction is fine; there is no pain with range of motion of the metatarsophalangeal joint, and the only pain generator is the scar. Most practitioners will attempt a local infiltration into the scar area, which is fine to determine if the scar is indeed the pain generator. However, this type of local infiltration does not give the practitioner any valid information into what nerve branch the nociception is being transferred. Essentially, four different nerves can be involved in the transmission of the scar pain, either in an isolated situation or in some combination of all these branches. There could be involvement of the distal aspect of the saphenous nerve, branches from the superficial peroneal nerve, branches from the deep peroneal nerve, and possibly branches from a variant medial plantar nerve.

With careful understanding of the neuro-anatomy, the practitioner can easily determine which branch or branches are conducting the impulse. The reader may ask, "Why is this important?" It depends on the planned treatment. This is a good question if only localized scar treatment is planned, but proximal nerve denervation surgery may be indicated and more effective for the patient. With judicious peripheral nerve blocks, the surgeon can isolate the involved nerve, and effective surgical treatment can be planned. Dellon states that a reduction of pain on a standard visual analog scale of 5 or greater, after a peripheral nerve diagnostic block, gives the patient a 90% chance for excellent pain relief after a denervation.[7]

Before delineation of each specific nerve block technique, it is important to understand that there are several universal principles that must be followed to fully gain every advantage of the techniques (Table 1). First, precise location of the neuro-anatomy must be appreciated proximally in the lower extremity where there is no possibility for neural overlap. For example, on the dorsum of the foot, there can be no assurance that pain generation is coming from the deep peroneal or superficial peroneal nerves, as they literally lay over one another, and with individual neuroanatomical differences, no assurance can be made that it is either one of them or even both that are acting as conductors of the nociceptive receptors.

In this case, the peripheral nerve blocks must be made with infiltrations proximal to the ankle joint where there is distinct anatomical geography that assures the nerve block

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TABLE 1:
Principles of Peripheral Nerve Blocks

1st Must have knowledge of precise neuro-anatomy.

2nd Use least amount of local anesthetic agent possible, 0.5–1 cc.

3rd Assess function with standing, walking, and foot gear.

4th Verify nerve block.

5th Determine purpose of the block: decompression or denervation.

6th Use conformational serial blocks and compare results.

7th Use sterile saline in "psychogenic" cases.

8th Relief usually means no central nervous system centralization.

Electrodiagnostic studies can prove invaluable in the assessment of the patient with radiculopathy and a double crush situation.

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is specific. Additionally, if in this same example, the surgeon were to infiltrate around the common peroneal nerve at the level of the fibular neck, there could be no differentiation between deep and superficial peroneal nerve transmission, as both of these large branches would be blocked.

Use Least Amount of Anesthetic

The second principle of nerve blocks is to use the least amount of local anesthesia possible to assure specificity of the block. Usually, only 0.5 to 1 cc of local anesthetic agent is needed. If larger amounts are used, the surgeon cannot be sure how much of the agent has dispersed into neighboring tissue, confounding the results of the blocks. Third, allow for about 10 minutes to pass after the infiltration before making a clinical assessment of the block. It is usually best to have the patient stand, put on his or her shoes, and walk around to ascertain the amount of relief from the block.

In addition to subjectively, asking patients to try to quantify the amount of relief (usually a reduction of pain percentage-wise), the clinician should make some assessment of amount of pain with palpation compared with before the block, skin color changes, and patient mobility and gait changes. Fourth, the practitioner must verify that the block has truly worked on the correct nerve. This can be easily done with testing via a harmless, but noxious, stimulus, such as a pair of forceps with teeth. In the case of a deep peroneal block, the patient can be tested in the dorsal first web space skin, and, if anesthetic, the proximal block can be verified.

Fifth, what is the purpose of nerve blocks clinically? Is it to determine whether a nerve is to be sacrificed or simply decompressed? In both cases, this diagnostic tool is incredibly valuable. In nerve decompression, for example, consider Morton's entrapment. Patients often have multiple interspace involvement with entrapment in both the second and third interspaces. However, they often have difficulty locating their pain. With a small amount of lidocaine, the clinician can infiltrate it into the most symptomatic interspace, and then make an assessment of both interspaces. It is not unusual to have an elimination of pain in both interspaces, and then the surgeon knows that only the blocked interspace needs decompression.

This leads to the sixth principle: in situations with an equivocal response, additional blocks need to be performed at another time as confirmation. The seventh principle is that the clinician can determine whether patients are demonstrating psychogenic manifestations by infiltrating sterile saline only, and then assessing their reduction of pain. This is a very valuable tool when the practitioner has a "gut" feeling that something is not clinically correct with the patient.

Finally, the eighth principle is that if the peripheral nerve block relieves pain, then central nervous system centralization likely has not occurred. However, there is some controversy about this. The author has experienced situations where there is no doubt that central nervous system centralization and plasticity have occurred, yet there has been great pain relief from a peripheral nerve block.

Figure 1: The common peroneal (fibularis) nerve is located just inferior to the fibular head as delineated by the "U"-shaped dotted outline. The vertical solid line indicates the usual level of entrapment by the deep fascia of the peroneus (fibularis) longus muscle, and the straight dotted line is the usual course of the nerve.

Figure 2: As in Figure 1, the orientation of the nerve to the needle and approximate depth are shown. The practitioner should take extra caution not to cause a paresthesia and remain superficial to the nerve, remembering that it curves away proximally from the initial needle orientation.

Use the least amount of local anesthesia possible to assure specificity of the block.

Common Peroneal (Fibularis) Nerve Block

To locate the common peroneal nerve (CPN), palpate the head of the fibula and mark an area just distal and medial to that spot. Apply the block at the neck of the fibula, posterior to that aspect. Compression of the CPN occurs where it passes under the peroneous longus muscle near the fibular head, just below the popliteal fossa. When evaluating the results of the block, be sure to ask about any reduction in low back pain, if the patient has it, to ascertain a double crush with radiculopathy (Figures 1 and 2).

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Superficial Peroneal (Fibularis) Nerve Block

The block of the superficial peroneal nerve (SPN) is applied at the common site of entrapment, where the nerve courses from the deep compartments, usually the lateral compartment through the foramen in the fascia, where it becomes superficial (Figures 3 and 4). To determine that anatomical location, mark the lateral malleolus and come 10 to 12 cm proximal to it. Palpate the tibial crest and then follow the fibula proximally. Divide the distance between these two markers. The nerve is just lateral to the midpoint about 0.5 cm. If the patient has a positive provocation sign along the superficial peroneal nerve, then correlate the block to that point of most provocation. This point will often correspond to the anatomical delineation above.

The saphenous nerve is not generally decompressed, because there is no natural entrapment site. However, this nerve can be entrapped as a result of contusion-type injuries.

Figure 3: The topographical markings illustrate the approximate location where the superficial (fibularis) nerve exits from the deep compartment into the subcutaneous space. This should be approximately 10 cm proximal to the lateral malleolus, at a two-thirds position lateral to the tibial crest between the tibial crest and fibula. The deep peroneal (fibularis) nerve can be blocked by entering at about the same area, usually just lateral to the tendon of the extensor halluces longus (see Fig.5), making sure to go deep to the fascia before any infiltration of the anesthetic in the subcutaneous space, which would confound the interpretation of the block by potentially affecting the superficial peroneal (fibularis) nerve. The deep peroneal block can be ascertained by numbness in the dorsal first web space.

Deep Peroneal (Fibularis) Nerve Block

The block of the deep peroneal nerve (DPN) is usually applied proximal to the ankle, NOT distally at the common site of entrapment or compression. This is because of the multiple mixed innervation distally, where a block at this level would not give the practitioner any substantive information about which nerve is actually the pain generator.

The block is applied proximal to the ankle joint. The nerve is deep, usually in the anterior compartment, just lateral to the tendon of the extensor hallucis longus (Figure 5).

The block must be applied completely through the deep fascia, near the interosseous membrane. Once you can feel the resistance of the tibia or the interosseous membrane, then back up approximately 1 mm. Do not place any of the anesthetic agent subcutaneously because this would potentially block a branch of the superficial peroneal nerve, which could confound the outcome of the diagnostic block. The fluid must be completely contained in the deep compartment space.

Figure 4: A close-up view of the usual location of the superficial peroneal (fibularis) nerve at the foraminal exit.

Figure 5: Palpation of the extensor hallucis longus tendon in order to place the deep peroneal (fibularis) nerve block.

Saphenous Nerve Block

The saphenous nerve is not generally decompressed, because there is no natural entrapment site. However, this nerve can be entrapped as a result of contusion-type injuries. Radiofrequency ablation (RFA) should be considered in case of injury to this nerve because the distribution is limited. When performing RFA on this nerve, be cautious of skin burn because the nerve is very superficial. A tenting technique must be used to prevent burn.

To locate the nerve, palpate the tibial crest. Where the tibia ends, move just medially. The nerve is

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Figure 6: Block of the saphenous nerve is easily attained, as the saphenous nerve courses over the flat anterior surface of the tibia. Infiltration of the anesthetic agent in the area of the oval accomplishes this block.

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going to be in this area and very superficial. The block is applied just under the skin (Figure 6).

Sural Nerve Block

Similar to the saphenous nerve, the sural nerve is not generally decompressed, because there is no natural anatomical entrapment site. However, this nerve can be entrapped as a result of injury. RFA should be considered in case of injury to this nerve because the distribution is limited. The block is applied posterior to the lateral malleolus and anterior to the Achilles tendon (Figure 7).

Medial Calcaneal Nerve(s) Block

Blocks of the medial calcaneal nerve (MCN) are generally used to determine the presence of multiple etiology heel pain syndrome. This should be done only after a positive provocation sign is found.

In cases of a painful scar, usually from prior heel surgery, this block can help determine if the MCN is one of the pain generators. The MCN may become entrapped between the tight fascia at the origin of the abductor hallucis muscle and the calcaneus. The block is applied directly over the nerve, from proximal to distal, about 1 cm (Figure 8).

Sinus Tarsi Blocks

Blocks of the sinus tarsi can be used to determine if the sinus tarsi innervation is contributing to a painful subtalar joint or painful lateral ankle. This is a non-specific nerve block because it is known that the sinus tarsi can be innervated by the sural nerve in approximately 20% of cases in addition to the most common innervation by a branch of the deep peroneal nerve. It can also have innervation contribution from the tibial nerve.[8] This block is useful if there is to be an ablation of the sinus tarsi itself—but NOT useful if there is to be a proximal denervation surgery.

The block is applied into the

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In cases of a painful bunion, one or more pain generators may be involved. These can include the deep, superficial, or saphenous nerve.

Figure 9: This patient presented with a chronically painful surgical scar from a peroneal tendon surgery. By mapping out the blocks and percentage of relief, the surgeon can determine which nerve to denervate.

Figure 7: The sural nerve is usually located at the malleolar level, 1 cm anterior to the anterior medial border of the Achilles tendon. Infiltration of 1 cc is usually all that is needed to perform an effective block.

Figure 8: The medial calcaneal block is started proximally in the thinner skin, which is a less painful injection, and then coursed just superficially as illustrated. The tibial nerve and its branches and the medial and lateral plantar nerves, are shown with the dotted lines. The infiltration is usually 0.5 cc, and care is taken to avoid infiltration of the medial or lateral plantar nerves. It must be verified that there is no loss of sensation in these branches of the tibial nerve to determine the effect on the medial calcaneal nerve.

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sinus tarsi, which angles from anterior distal lateral to proximal medial. The entrance to the sinus tarsi is located just anterior to the distal lateral malleolus and above the calcaneal tuberosity.

It has been shown that there is only a 2% incidence of drawing blood back into the syringe with a 30-gauge needle, but with a 27-gauge needle, there is an 87% aspiration if placement is into the vein.

TABLE 2:

Fundamental Techniques to Render Painless Injections

1) Know the neuro-anatomy.	Never inject the plantar surface of the foot, as this can be made anesthetic with a tibial nerve block at the level of the ankle.
2) Never intentionally try to elicit a paresthesia.	Nerve injection injuries are common, but knowledge of anatomy allows you to place the infiltrate around the nerve. If by chance you do elicit a paresthesia, back the needle up a couple of millimeters and then begin a very slow infiltration. If there is any pain on infiltration, stop and back out the needle more.
3) Use the smallest-gauge needle.	30-gauge needles are the least painful.
4) Pre-inject the area with bacteriostatic saline.	This technique can provide for a painless block in those patients who have a high sensitivity to lidocaine.
5) Inject slowly.	Slow infiltration is painless and avoids damage to tissues.
6) Distract and pre-sedate.	Telling patients to inform you if they have any discomfort gives them some feeling of control and allows you to slow down the infiltration if it causes pain. If there is real "needle anxiety," have the patient reschedule and take 5 to 10 mg of diazepam before the next office visit. They will need to be driven to the appointment.
7) Always orient the injection in an area of soft supple tissue that has minimal skin tension.	Giving blocks proximally will allow for less pain versus a block that is in a tight tension area, such as the medial aspect of the heel for the medial calcaneal nerve. As seen in Figure 8, the needle is introduced proximally and then, once through the skin, the anesthetic migrates slowly to the area of infiltration.

Example of Blocks Needed to Solve the Painful Bunion Scar Innervation Pattern

In cases of a painful bunion, one or more pain generators may be involved. These can include the deep, superficial, or saphenous nerve. Blocks applied distally are not diagnostically accurate because the nerve distribution runs very close and any block applied will likely involve all three nerves (cannot isolate). Therefore, blocks should be applied for each nerve at the aforementioned sites proximal to the ankle.

The saphenous nerve should be the first blocked. If this eliminates all pain, the pain generator has been successfully isolated. Surgery should be considered (RFA).

If the saphenous nerve block eliminates no pain or only a portion of the pain, blocks should be applied for the superficial and deep peroneal nerves, in the surgeon's preferred order. Allow 10 to 15 minutes between blocks for accurate results. Figure 9 illustrates the mapping process of diagnostic blocks for a painful surgical scar resulting from a peroneal tendon surgery.

Injection Technique

With the development of excellent injection techniques, patients will have a better experience, and the clinician will have the advantage of the assurance of effective nerve blocks, which are painless. Because local anesthetics can be administered in

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the lower extremity painlessly,[9] patients will not be reluctant to have additional or confirmatory peripheral nerve blocks.

There are some fundamental techniques that can render a painless a peripheral nerve block (see Table 2). The author recommends the use of lidocaine with small 30-gauge needles for peripheral nerve blocks, because there is less pain with a smaller gauge needle. Also, it has been shown that there is only a 2% incidence of drawing blood back into the syringe with a 30-gauge needle, but with a 27-gauge needle, there is an 87% aspiration if placement is into the vein. There is a 100% aspiration rate with a 25-gauge needle.[10] Since it is nearly impossible to aspirate with a 30-gauge needle, the use of lidocaine poses no cardiac risk to the patient, as would an unintended infiltration of bupivacaine. **PM**

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