Combined Popliteal and Saphenous Nerve Blocks at the Knee

An Underused Alternative to General or Spinal Anesthesia for Foot and Ankle Surgery

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Peripheral nerve blocks at the ankle have long been used for foot surgery. However, when local foot and ankle blocks are inappropriate or contraindicated, general and spinal anesthesia are the common alternatives. Both have disadvantages and require added equipment and monitors. Combined popliteal and saphenous nerve blocks at the knee can offer a desirable alternative to general and spinal anesthesia for foot and ankle surgery. In addition, popliteal and saphenous nerve blocks provide anesthesia of the entire lower leg, thus permitting a greater variety of procedures to be performed. This article reviews the anatomical considerations, various block techniques, and surgical applications of this useful approach to lower-leg anesthesia. (J Am Podiatr Med Assoc 94(4): 368-374, 2004)

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General and spinal anesthesia have substantial disadvantages. Skill in airway management, including anti-aspiration maneuvers and airway patency preservation, is required for general anesthesia. Spinal anesthesia demands meticulous sterile technique. Both types require specialized equipment, facilities, and monitors for hemodynamic and respiratory management during the anesthesia, and both increase the risk of postoperative complications, including nausea and vomiting, postdural puncture headache, and prolonged recovery.1,2

Incorporation of a combined popliteal fossa nerve block and saphenous nerve block at the knee has certain advantages over general and spinal anesthesia for foot and ankle surgery. This combined block provides an attractive alternative that avoids some of the disadvantages of general and spinal anesthesia. The combined block is performed with a clean, rather than a sterile, technique; requires similar equipment, drugs, and monitoring as an ankle block; and extends surgical anesthesia to include the entire distal lower
In addition, the combined block does not interfere with whole-body physiology and so can be used in high-risk patients who might not be ideal candidates for general anesthesia because of comorbidities.4

Similar to local nerve blocks at the ankle, the combined block at the knee spares the hamstring muscles, promotes immediate postoperative ambulation, provides unilateral anesthesia as necessary, is safe in anticoagulated patients, and can prolong the postoperative analgesia effect, and it has resulted in high patient satisfaction in several studies.3, 5-8 Rorie et al,9 in 1980, reported an 88.2% overall satisfaction rate in a study of 119 patients.

Despite these advantages, the combined block at the knee remains underused in the United States. Reasons for its infrequent use may be related to lack of resident training, concerns over operating room efficiency, and an unpredictable success rate of the block.10-12

**Anatomical Considerations**

The sciatic nerve courses down the posterior aspect of the thigh and enters the popliteal fossa deep to the adductors of the knee. Its position is slightly lateral to the midline, adjacent to the more medial popliteal vein and artery as they exit the adductor hiatus.3 Formed from spinal roots L4-S2 and occasionally S3, the sciatic nerve bifurcates at a variable distance above the popliteal fossa into the tibial nerve and the common peroneal nerve (Fig. 1). These nerves share a common epineural sheath from their division in the popliteal fossa.13 Injection of local anesthetic into the sheath, a popliteal fossa nerve block, constitutes a terminal block of the sciatic nerve at the knee.14

The tibial nerve is the larger of the two sciatic nerve branches, and it runs parallel and slightly lateral to the midline, between the femoral condyles, and into the deep posterior compartment of the leg. Inferiorly, it passes between the heads of the gastrocnemius muscle.14 The common peroneal nerve follows the tendon of the biceps femoris muscle laterally and travels around the fibular head as it leaves the popliteal fossa and enters the anterior compartment of the leg. Both nerves innervate the entire leg below the knee, except for the anteromedial aspects of the leg and foot, which are innervated by the saphenous nerve (L2-4). The saphenous nerve, a terminal branch of the femoral nerve, becomes subcutaneous as it arises from the adductor canal between the tendons of the sartorius and gracilis muscles at the anteromedial aspect of the knee.15

**General Principles**

A combined nerve block at the knee requires blockade of two nerves at two sites: the terminal sciatic nerve in the popliteal fossa and the saphenous nerve on the medial aspect of the knee. Although popliteal and saphenous nerve blocks may be performed with the patient supine and with the use of surface landmarks, success with the popliteal block can be improved with the patient prone and with the use of a peripheral nerve stimulator. Onset of both blocks is typically rapid, with surgical anestheisia achieved within a few minutes.16

As motor blockade is usually not essential, use of a diluted solution of local anesthetic allows administration of a greater volume without increasing toxicity risk. A larger volume of local anesthetic distributed over a larger area increases success at both sites. Including both blocks, we routinely combine 20 mL of 1% lidocaine hydrochloride with 20 mL of 0.5% bupivacaine hydrochloride to create 40 mL of 0.5% lidocaine hydrochloride and 0.25% bupivacaine hydrochloride without added vasoconstrictor. The total dose of lidocaine hydrochloride (200 mg) and bupivacaine hydrochloride (100 mg) is well below reported toxic doses in average-sized adults.17 Additional solution can be reserved for supplemental injections if necessary.

Patient discomfort with these blocks is usually minimal and can be decreased by appropriate preoperative discussion and intervention. Should the patient be unusually anxious, small doses of short-act-
ing narcotics (eg, fentanyl citrate) or intravenous sedative hypnotics (eg, propofol) may be given provided appropriate monitors and resuscitation equipment are available.18

Whereas the saphenous nerve block involves only subcutaneous infiltration without precise localization of the needle, the popliteal block requires placement of the needle as close as possible to each of the two tributary nerves at the sciatic bifurcation. Imprecise placement of the needle may produce inadequate anesthesia.

We recommend use of a peripheral nerve stimulator to identify nerves in the popliteal fossa whenever available. This stimulator is an excellent teaching device, allows more accurate needle placement in obese and other patients with poor surface landmarks, may reduce the risk of nerve damage, and maximizes success rates.8, 19-21

**Popliteal Fossa Nerve Block Technique**

A popliteal fossa nerve block may be performed with the patient either prone or supine.22 In the prone position, either a “classic” or an “intertendinous” approach is commonly used based on anatomical surface landmarks.23-25

**Classic Approach**

Landmarks for the classic approach constitute a triangle in the posterior aspect of the knee.26 The triangle is formed using the popliteal crease as the inferior border, the biceps femoris tendon and muscle as the lateral border, and the semimembranosus muscle as the medial border. A line is drawn from the intersection of the medial and lateral borders inferiorly to meet the popliteal crease at a right angle. The needle insertion site is 1 cm lateral to this line and 5 cm above the popliteal crease (Fig. 2).

**Intertendinous Approach**

Recently, results with the popliteal fossa nerve block have improved by using the semimembranosus and biceps femoris tendons as landmarks rather than their respective muscles. Hadzic and Vloka18 contend that the muscle boundaries of the popliteal triangle are often difficult to detect accurately; consequently, the classic approach frequently directs needle placement lateral to the sciatic nerve. Subsequent medial redirection of the needle for sciatic nerve contact may carry an increased risk of puncturing the popliteal vessels, especially when needles longer than 40 mm are used. Using magnetic resonance imaging, Vloka et al.27 in 1997, reported 75% accuracy in contacting the sciatic nerve compared with 25% accuracy using the classic approach. Furthermore, needles inserted using the classic approach are more prone to transect the body of the biceps femoris muscle, resulting in increased pain during the procedure.28

The intertendinous approach calls for needle insertion midway between the semimembranosus and biceps femoris tendons (rather than muscles) and 5 cm above the popliteal crease (Fig. 3). The needle is directed 45° to 60° cephalad to a depth of 3 to 5 cm (Fig. 4). To maximize the chances of success, we recommend use of a peripheral nerve stimulator and the intertendinous approach.

**Intertendinous Popliteal Fossa Nerve Block Technique**

1. With the patient prone, identify the landmarks as described in “Intertendinous Approach.” Attach a peripheral nerve stimulator and set the output at 3.0 mA.

2. Advance the needle until plantarflexion of the foot occurs (or until paresthesia of the foot is reported if not using the nerve stimulator).

3. Holding the needle still, decrease the output of the nerve stimulator until it reaches 0.5 mA. Persistent plantarflexion confirms close proximity of the tibial nerve.

4. Inject 1 mL of local anesthetic solution. Elimination of paresthesia or motor response further suggests close proximity to the nerve. An alternative approach is to use 1 mL of plain lidocaine for the “test” block to increase the onset of anesthesia.

5. While intermittently aspirating for blood, follow with 9 mL of additional solution to a total of 10 mL of the lidocaine-bupivacaine mixture, as described in the “General Principles” section.

6. Without withdrawing the needle from skin, redirect the needle slightly laterally.

7. Eversion of the foot using a stimulator or paresthesia confirms proximity to the common peroneal nerve.

8. Repeat the divided injection of 1 mL and add an additional 9 mL while intermittently aspirating for blood.

**Supine (Lateral) Position**

The prone position may be contraindicated in conditions such as advanced pregnancy, morbid obesity, spinal and hemodynamic instability, and mechanical ventilation.29 However, difficulty in positioning patients prone for the popliteal fossa nerve block often precludes its use in patients who are potentially the
1. With the patient supine, identify the biceps femoris tendon and the popliteal crease.

2. Insert the needle along the anterior border of the biceps femoris tendon and 5 cm proximal to the popliteal crease in a slightly cephalad direction.

Supine (Lateral) Popliteal Technique

Figure 2. A, Needle insertion with a peripheral nerve stimulator for the “classic” approach to the popliteal fossa nerve block. B, Clinical landmarks demonstrating the “classic” approach to the popliteal fossa nerve block.

Figure 3. A, Intertendinous approach on the left leg and classic approach on the right leg. Note the more lateral position of the injection point with the classic approach (Xc) and the more midline position with the intertendinous approach (Xi). There is increased risk of neurovascular and muscle damage with the classic approach, including laceration of the biceps femoris muscle. The anatomical bisection of the popliteal fossa (abpf) is represented by the dashed lines. Bft, biceps femoris tendon; smm, semimembranosus tendon; smm, semimembranosus muscle; bfm, biceps femoris muscle. B, Transverse plane of popliteal level showing the differences in tissue contact between the intertendinous approach (Xi) and the classic approach (Xc). Note the risk of biceps femoris muscle laceration with the classic approach.
3. The needle will usually encounter the common peroneal nerve first, identified by paresthesia or a foot eversion motor response.

4. Decrease the nerve stimulator output as described in “Intertendinous Popliteal Fossa Nerve Block Technique” to confirm proximity.

5. Repeat the sequence of divided injection of solution described in “Intertendinous Popliteal Fossa Nerve Block Technique” to a total of 10 mL while intermittently aspirating for blood.

6. Continue inserting the needle until tibial nerve paresthesia or a plantarflexion motor response is elicited.

7. Repeat the sequence of divided injection of solution to a total of 10 mL.

Saphenous Nerve Block Technique

Regardless of the technique or the position used for popliteal fossa nerve block, the saphenous nerve must be anesthetized. This is usually performed with the patient supine. At the knee, the saphenous nerve is relatively superficial.

1. Identify the tuberosity of the tibia and the intersection of the anterior and medial borders of the gastrocnemius muscle (Fig. 5).

2. Draw a line from the tuberosity distal and medial at a 45° angle to the intersection.

3. Infiltrate 10 mL of local anesthetic along the length of this line into the subcutaneous tissues while intermittently aspirating for blood.

Complications

As with any local anesthetic technique, the combined nerve block has risks. All nerve blocks have the potential for toxic or allergic reactions to the local anesthetic agent. Attention to the patient’s history of drug reactions, limitation of the total dose of local anesthetic, and consideration of vasoconstrictors in the anesthetic solution decrease but do not eliminate these risks. Therefore, clinicians must be able to recognize and treat these reactions.

Because the injection site for popliteal block brings the needle close to the popliteal artery and vein, there is the additional risk of vascular damage. Also, the proximity of blood vessels to the injection site increases the risk of intravascular injection, hematoma, and toxic reactions. Using small needles, carefully moving the needle during injection, and intermittently aspirating for blood reduces these risks.

All nerve blocks risk mechanical damage to the nerve by the injecting needle, resulting in transient or permanent deficits. Again, use of small needles and cautious manipulation of the needle during injection reduces this risk.

Similar to local nerve blocks at the ankle, the combined block at the knee can be performed with a clean, rather than a sterile, technique with little risk of infection. Generally, the combined block is performed with only alcohol swabbing at the injection site. However, clinicians who want further reduction of infection risk may use a sterile technique.

Discussion

The combined nerve block at the knee offers significant advantages over spinal and general anesthesia when a foot or ankle block is not possible. The combined block at the knee requires no more equipment than an ankle block and adds little or no risk. Because of the positioning and technique challenges of the combined block, appropriate resident training

Figure 4. Sagittal plane view of popliteal fossa nerve block showing 60° angle of needle to the popliteal (tibial and common peroneal) nerve.

Figure 5. Saphenous nerve block technique.
and planning are indicated to make this block more economically and surgically attractive.

We recommend use of a peripheral nerve stimulator for all popliteal blocks. It is an excellent training aid, assisting clinicians in estimating where the popliteal nerves lie and reinforcing proper block technique. With appropriate training, the nerve stimulator increases the chances of success even for experienced clinicians. In addition, the nerve stimulator can produce motor activity in patients with diminished or absent paresthesia from diabetic or other peripheral neuropathies or central nervous system disease. Compared with the equipment needed for general or spinal anesthesia, nerve stimulators are inexpensive, portable, reusable, easy to maintain, and easy to use. Our experience with the combined nerve block at the knee using a nerve stimulator suggests that this block can be easily integrated into even the busiest operating room suites.

As motor neuropathy and significant muscle atrophy may eliminate any visible motor activity even with use of a nerve stimulator, we encourage more empirical research to determine reliable techniques using surface landmarks only for unassisted popliteal nerve block.

Combined nerve block at the knee offers significant advantages over ankle block. It offers an alternative to injection into an ankle that may be edematous, infected, or ulcerated. The combined technique provides surgical anesthesia not only for incision and drainage and debridement, but also for reconstruction of the foot, ankle, and leg threatened by trauma, infection, ischemia, arthritis, primary ulcerative disease, neoplasia, neuropathy, and congenital and neuromuscular deformity. In addition, this technique can be used to provide anesthesia for application of external fixators to the foot and leg for procedures involving reconstruction of the diabetic Charcot foot and ankle with or without additional components of foot and ankle internal fixation such as screws, plates, and staples.

Postoperative pain management is an inherent benefit of this technique, particularly when long-acting anesthetic agents are used. The value of prolonged analgesia in the chronically ill postoperative patient in preventing complications is obvious, particularly in patients with hypertension, diabetes mellitus, and cardiac disease.

The relative ease of applying the combined nerve block at the knee makes it especially attractive in developing regions of the world. In many rural, medically underserved areas around the world, early intervention in lower-extremity wounds caused by infection, trauma, ischemia, neuropathy, and primary ulcerative disease can mean the difference between reconstruction and restored function and the alternative of amputation or even death from sepsis. Where general and spinal anesthesia are not available, combined nerve block at the knee could be used routinely as the preferred technique for anesthesia of the foot and lower leg in modestly equipped medical facilities with limited resources.

In our experience with more than 60 cases during the past 3 years, no patient required conversion to general anesthesia because of failed block. The technique is a viable and valuable alternative to general and spinal anesthesia when ankle blocks are not possible. We advocate incorporating resident teaching of this combined block into anesthesia, podiatric, orthopedic, plastic, vascular, and general surgery training programs and consideration of the combined block as a primary anesthetic technique in cases in which general or spinal anesthesia is contraindicated.

Conclusion

We advocate increased use of the combined nerve block at the knee, particularly in chronically ill patients who might not be ideal candidates for general or spinal anesthesia because of comorbidities. This block technique is a valuable alternative to general and spinal anesthesia for surgical procedures below the knee. Techniques with and without the assistance of a peripheral nerve stimulator can be employed. Its many benefits include good postoperative pain management. During the past 3 years, we have had good results in more than 60 cases using this form of anesthesia, with minimal adverse effects. More resident training initiatives in hospital settings are needed.

References


