Popliteal and Saphenous Nerve Blocks

This is an alternative to general or spinal anesthesia for surgery of the leg, ankle and foot.

Local anesthesia has long been used for lower extremity surgery with immense success. Common types of local anesthetic blocks performed by foot and ankle surgeons include local infiltration, digital blocks, ray blocks and ankle blocks. Consideration can be given to regional anesthesia at a level proximal to the ankle as an alternative to general or spinal anesthesia. Use of a saphenous nerve block (SNB) at the proximal leg segment combined with the terminal sciatic

Objectives

1) Explain the details of the popliteal and saphenous nerve blocks, including techniques, indications and potential complications.

2) Explain the value of this type of regional anesthetic block, when general, spinal anesthesia and ankle block anesthesia is contraindicated.

3) Show the wide range of surgical procedures that can be done using these techniques.

4) Demonstrate the possibilities of incorporating these techniques into residency training programs where lower-extremity surgery is done.

5) Show the value of these blocks as an adjunct to post-operative analgesia.

6) Suggest the potential value of these techniques in developing regions around the world where general and spinal anesthesia are not readily available.

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Following this article, an answer sheet and full set of instructions are provided (p. 190).—Editor
nerve block or popliteal fossa nerve block (PFNB) results in complete anesthesia below the knee for soft tissue and osseous procedures. Advocacy for more frequent use of this method of anesthesia, as well as anatomical considerations, alternative techniques and surgical applications are reviewed.

Incorporation of a terminal sciatic or popliteal fossa nerve block (PFNB) and a saphenous nerve block (SNB) has certain advantages over general and spinal anesthesia for surgery of the leg, ankle and foot. When compared to general anesthesia, they carry fewer inherent risks, especially for the compromised or chronically ill patient. Many patients who require surgical intervention are diabetic, hypertensive and have cardiac disease. A significant number of these patients are not good candidates for general anesthesia. In addition, compared with general anesthesia, the neuroendocrine response with regional anesthesia is significantly inhibited due to the blockade of spinothalamic tract afferent impulses and their stimulation of hypothalamic-pituitary-adrenal pathways. Intra-operative and post-operative hemodynamic disturbances are minimized as a result of this blockade. The value of inhibiting the neuroendocrine response can be especially appreciated in the diabetic patient, where the secretion of cortisol and other steroids is minimized. Both general and spinal anesthesia increase the risk of post-operative complications, including nausea and vomiting and prolonged recovery.

When compared to spinal anesthesia, this procedure yields no risk of postdural puncture headache, and unlike spinal anesthesia, the anesthetic effect is unilateral. Compared to more proximal approaches to the sciatic nerve block, the popliteal block spares the hamstring muscles and promotes immediate post-operative ambulation. In addition, a popliteal block can provide prolonged post-operative analgesia and can be performed in patients being treated with anticoagulant therapy. Many authors have advocated this procedure in the past with good results; however, it is still not routinely used in the United States and other countries, both developed and developing. In fact, in 1980, Rorie, et al. reported an 88.2% overall satisfaction rate in a study of 119 patients. Infrequent use of this block method may be related to lack of resident training, concerns over operating room efficiency and an unpredictable success rate of the block.

Anatomical Considerations
Formed from spinal roots L4-S2 and occasionally S3, the sciatic nerve consists of two distinct divisions, the tibial nerve (TN) and common peroneal nerve (CPN) (Figure 1). They share a common epineural sheath from their origin to the popliteal fossa. In the popliteal fossa, the sciatic nerve is termed the popliteal nerve. At a variable distance above the popliteal fossa crease, the popliteal nerve divides into two separate nerves, the TN and CPN. Therefore, a popliteal nerve block is essentially the terminal block of the sciatic nerve at the level of the knee.

The TN is the larger of the two branches and runs parallel and slightly lateral to the midline. Inferiorly, it passes between the heads of the gastrocnemius muscle. The CPN follows the tendon of the biceps femoris muscle laterally and travels around the fibular head as it leaves the popliteal fossa. 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-L4).

General Principles
Suggested anatomic landmarks for determining needle insertion

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points for the tibial and common peroneal blocks have been categorized into two approaches: the classical and intertendinous methods. Both of these approaches can be performed with or without a peripheral nerve stimulator (Figure 2). The value of a peripheral nerve stimulator is that it takes advantage of the clinical motor activity of the tibial and common peroneal nerves in locating an appropriate injection point for the local anesthesia. This technique removes some of the guesswork from positioning the needle, because when the peripheral nerve stimulator is not used, the only clinical symptom assisting the clinician is the elicitation of paresthesias. Precise placement of the needle during the popliteal block is important because of a potential differential blockade of the tibial and common peroneal nerves. Vloka, et al. found that this may be due to a common epineural sheath. Additionally, the peripheral nerve stimulator is a valuable tool in the obese patient or where there is acute or chronic deformity of the popliteal region.

Classical or Anatomical Approach

Landmarks for the classical approach are formed in the posterior aspect of the knee (popliteal fossa), with the borders forming a triangle. Medial and lateral borders are formed by the semimembranosus and biceps femoris tendons and muscle bellies, respectively. Identification of the popliteal cease is marked and a bisection of the triangle is drawn (Figure 3). In the classical approach, the needle is inserted 5-6 cm. proximal to the popliteal crease and 1 cm lateral to the bisection.

Intertendinous Approach

In 2002, Hadzic, et al. suggested needle placement should be directly between the semimembranosus and biceps femoris tendons. In 1997, Vloka, et al. demonstrated that the classical approach is significantly less effective than the intertendinous approach. Confirmed by MRI, they found an accuracy of 75% compared to 25% with the classical approach. Hadzic, et al. found that the muscle boundaries of the popliteal triangle are often difficult to appreciate with any reproducible accuracy. Subsequently, placement of the needle is often made too far lateral for contact with the sciatic nerve using the classical approach. 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 (Figure 4). In addition, needles inserted using the classical approach are more prone to transect the body of the biceps femoris muscle, which can result in increased pain during the procedure. Landmarks for the intertendinous approach utilize the semimembranosus and biceps femoris tendons only, without the additional variables of the semimembranosus and biceps femoris muscles as landmarks (Figure 3). The needle is inserted at a midpoint between the semimembranosus and biceps femoris tendons 5-6 cm. proximal to the popliteal crease. In 1988, Hadzic et al compared a lateral approach to the classical posterior approach, and found no significant differences in anesthesia results.

As with any anesthesia procedure, these approaches do carry potential complications.

The need to position the patient in the prone position is the main disadvantage of either of the posterior approach techniques to the sciatic nerve block in the popliteal fossa, and may prohibit its use in certain circumstances. Conditions such as advanced pregnancy, morbid obesity, spine and hemodynamic instability, and mechanical ventilation are examples that may prevent the use of the prone position. However, the lateral approach to the sciatic nerve can result in reliable anesthesia, comparable to that of the posterior approach. Execution of the block using the lateral approach is relatively straightforward when the described technique is followed, although it may take more attempts at nerve localization. In addition to utilizing the lateral approach in patients who cannot assume the prone position, this technique provides the option of performing supplementary blocks (i.e., saphenous or femoral nerve blocks) and surgery without the need for patient repositioning.

Block Technique

Techniques described here are the intertendinous popliteal approach with and without a peripheral nerve stimulator, a lateral popliteal approach with and without a peripheral nerve stimulator and the saphenous nerve block, which is used in conjunction with either technique.

Intertendinous Popliteal Technique (Figures 3, 5, 6 and 7)

1. The block is performed with the patient in the prone position.
2. Landmarks are identified and marked as previously described.
3. Proper needle placement is marked by extending a 5-6 cm. vertical line cephalad from the midpoint of the popliteal crease line between the semi-membranosus and biceps femoris tendons intersection with that line.
4. A needle is introduced at an angle of approximately 45-60 degrees cephalad.
5. Insert the needle to 3-5 cm. depth.
6. Paresthesias will be

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elicited when the needle is in the proximity of nerves.
7. If a peripheral nerve stimulator is used, the needle with stimulator should be inserted in the same manner as described above and the nerve stimulator set at 1.5 mA.
8. A motor response will be noted when the tibial nerve is stimulated with resultant plantarflexion of the foot clinically observable.
9. Continue to lower the amperes to 0.5 mA; if motor response is still visible, acceptable proximity to the nerve has been achieved.
10. When paresthesias or a motor response are elicited, (depending on the technique) inject 1 cc of 1.0% lidocaine and the paresthesias or motor response should cease.
11. When the paresthesias or motor response ceases, infiltrate 9 cc of 1.0% lidocaine plain or 0.5% bupivacaine, or a mixture of both to anesthetize the tibial nerve.
12. The needle with or without a nerve stimulator is then redirected slightly laterally.

Lateral Popliteal Technique
1. The block is performed with the patient in the supine position.
2. Identification of the biceps femoris tendon and the popliteal crease are marked.
3. A needle with or without a nerve stimulator is inserted 5 cm proximal to the popliteal crease and along the anterior border of the biceps femoris tendon in a slight cephalad direction.
4. Utilizing this approach, the needle will encounter the common peroneal nerve first, eliciting paresthesias or an eversion motor response.
5. Perform the same local anesthetic injection sequence as described previously for the common peroneal nerve injection with the intertendinous approach.

Saphenous Nerve Block Technique (Figure 8)16, 32
The final step in both techniques includes anesthetizing the saphenous nerve.

A peripheral nerve stimulator is unquestionably a reliable tool in a teaching environment.

1. Palpate the tuberosity of the tibia and from this point, draw a line distal and medial at a 45° angle to the intersection of the anterior and medial border of the gastrocnemius muscle.
2. Along this line, inject 10 cc of local anesthetic into the subcutaneous tissues.
3. The saphenous nerve lies approximately midway between these landmarks, passing beneath the midpoint of this line.

As with any anesthesia procedure, these approaches do carry potential complications. Besides the general risks of local anesthetic agents such as toxic and allergic reactions, one major complication would be puncture or rupture of the popliteal artery or vein.33 Another potential complication, however uncommon, would be the risk of puncturing and/or transecting the sciatic nerve, which could cause short or long-term paresthesias or permanent autonomic, sensory or motor deficits throughout the lower extremity.34, 35 Signs and symptoms of infection and hematoma must also be monitored.

Discussion
In addressing the historical lack of training in this technique, it is suggested that anesthesia departments institute clinical instruction for all appropriate staff, including anesthesia, podiatric, orthopedic, plastic, vascular and general surgery. Operating room efficiency can be facilitated with appropriate planning and staff training. Experience has demonstrated that this block can be integrated well into anesthesia operating room procedures.19 Use of this relatively safe and successful anesthetic technique with and without a peripheral nerve

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stimulator, can result in a high success rate for administering regional anesthesia at this level.

A peripheral nerve stimulator is unquestionably a reliable tool in a teaching environment. Additionally, the nerve stimulator can produce motor activity in patients who may have diminished or absent guidelines for “blind” unassisted nerve block administration.

The terminal sciatic and saphenous nerve blocks have many applications in lower extremity surgery distal to the knee (Figure 9). This technique, supplemented with intravenous monitored anesthesia care, has applications not only for incision and drainage and debridement, but also in reconstruction of the foot, ankle and leg threatened by trauma, infection, ischemia, arthritis, primary ulcerative disease, neoplasia, neuropathy and congenital and neuromuscular deformity. Forefoot, midfoot, rearfoot, ankle and below-knee amputations can be performed safely and efficiently using these blocks. 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, pins and staples. Injection of a local anesthetic agent at the foot and ankle level involved with cellulitis is usually avoided to prevent seeding of deeper tissues with infection. Saphenous and distal sciatic nerve blocks have significant value in cases such as this because the regional anesthesia can be administered at a level more proximal to that of the active infection.

Post-operative 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 post-operative patient in preventing complications is obvious, particularly in patients suffering from hypertension, diabetes and cardiac disease.

Ease of administering these anesthetic blocks suggests that there is significant value in encouraging its use 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, amputation or even death from sepsis. Where general and spinal anesthesia are not available, the combination of saphenous and popliteal blocks could be used routinely in modestly equipped medical facilities for incision and drainage, debridement and reconstruction of the distal lower extremity. With W.H.O. statistics predicting 300 million cases of Type II diabetes by the year 2012, the widespread use of these techniques could potentially translate into prevention of countless lower extremity amputations around the world annually. The role of telemedicine for both live and archived instruction in this technique can assist in widespread training on a global scale. Where telemedicine is not available, this technique could be disseminated by CD teaching material with still and video components.

In our experience, with over 40 of these blocks, over the past 2 years, no patient has had to progress to general anesthesia following this type of local anesthetic block. When considering the risks of spinal and general anesthesia, especially for the chronically ill, this procedure is a viable alternative. The authors advocate more frequent utilization of this block technique when anesthesia is needed distal to the knee.

Summary

The purpose of this article is to advocate more universal clinical use of the terminal sciatic and saphenous nerve blocks, particularly in chronically ill patients. Applications of this block for surgical procedures below the knee as an alternative to general and spinal anesthesia are reviewed. Techniques with and without the assistance of a peripheral nerve stimulator are described. Ad-
References


1) The popliteal nerve is the name given to the distal aspect of:
   A) The sciatic nerve
   B) The saphenous nerve
   C) The sural nerve
   D) The superficial femoral nerve

2) The popliteal block consists of 2 components:
   A) Saphenous and sural nerve blocks.
   B) Tibial and common peroneal nerve blocks.
   C) Superficial femoral and tibial nerve blocks
   D) Pudendal and common peroneal nerve blocks

3) The following anesthetic procedure does not selectively block pain impulses to the spinothalamic tract:
   A) General
   B) Tibial nerve block
   C) Common peroneal nerve block
   D) Saphenous nerve block

4) The following is not a complication of a popliteal nerve block:
   A) Puncture of the femoral artery
   B) Puncture of popliteal artery
   C) Puncture of popliteal vein
   D) Laceration of the tibial nerve

5) A ________ is used to locate the tibial and common peroneal nerves prior to injection of local anesthesia in the popliteal fossa.
   A) Sensory action potential
   B) Electromyograph
   C) Nerve conduction velocity
   D) Peripheral nerve stimulator

6) One of the main reasons that the popliteal and saphenous nerve blocks are not routinely used for surgery of the leg, foot and ankle is:
   A) Historically, they have not been incorporated into residency training programs.
   B) There is a high incidence of block failure.
   C) They are difficult techniques to teach.
   D) There is limited post-operative analgesia with these techniques.

7) The__________ approach to the tibial and common peroneal nerve blocks has been shown to be as effective as the posterior, intertendinous approach.
   A) Medial
   B) Anterior
   C) Lateral
   D) Retrograde

8) Which technique reduces the risk of neurovascular damage during the popliteal block?
   A) Intertendinous approach
   B) Classical approach
   C) Scalene block
   D) Ankle block

9) One of the advantages of the popliteal and saphenous nerve blocks as well as all regional anesthetic blocks is:
   A) Elevation of the blood pressure in hypotensive patients.
   B) Increase of endogenous endorphins.
   C) Reduced neuroendocrine response in the chronically ill patient.
   D) Reduction of blood sugar levels in the diabetic surgical patient.

10) Which of the following might be considered a contraindication to a popliteal block?
    A) DVT
    B) Foot infection
    C) Charcot foot
    D) Ankle fracture

11) One of the side effects of spinal anesthesia not caused by popliteal and saphenous nerve blocks is:
    A) Postdural headache
    B) Spinothalamic tract blockade
    C) Complete anesthesia distal to the knee
    D) DVT

12) One of the many applications of the popliteal and saphenous nerve blocks that has been traditionally underutilized is:
    A) Use of these blocks in developing regions and countries.
    B) Abcesses of the knee.
    C) Hospitals without anesthesiologists.
    D) Distal bypass procedures.

13) The lateral approach to the popliteal nerve block, with the patient in the supine position, has the advantage of:
    A) Improved quality of block compared to that in the prone position.
    B) Less risk of neurovascular damage.
    C) Not having to turn and reposition the patient after the block before surgery.
    D) More proximal distribution of the block compared to that in the prone position.

14) The most valuable asset in using a peripheral nerve stimulator when administering a popliteal block is:
    A) Elicitation of motor activity of the common peroneal and tibial nerves.
    B) Elicitation of motor activity of the saphenous nerve.
    C) Elicitation of sensory action potentials of the tibial nerve.
    D) Elicitation of motor activity of the sural nerve.
15) The popliteal nerve is located___________ to the popliteal vessels.
   A) Medial  
   B) Lateral  
   C) Anterior 
   D) Posterior

16) The popliteal nerve is composed of:
   A) The sural and saphenous nerves.  
   B) The superficial femoral and tibial nerves.  
   C) The tibial and common peroneal nerves.  
   D) The sural and the superficial peroneal nerves.

17) When using the intertendionous or classical approach to the popliteal block, the needle should make an angle of ______degrees with the skin of the popliteal region.
   A) 10-20  
   B) 45-60  
   C) 80-90  
   D) 0-10

18) One of the complications of the classical approach to the popliteal block which is significantly reduced with the intertendinous approach is:
   A) DVT  
   B) Infection  
   C) Paresthesias  
   D) Risk of puncture of the popliteal vessels

19) One important benefit of a popliteal-saphenous nerve block compared to general anesthesia is:
   A) Accelerated wound healing  
   B) Less time for patient in the operating room  
   C) Post-operative analgesia  
   D) Better anesthesia

20) The sciatic nerve is formed from the spinal roots L4-S2 and occasionally S3 and consists of two distinct divisions:
   A) The tibial nerve and the common peroneal nerve.  
   B) The superficial femoral nerve and the saphenous nerve.  
   C) The common peroneal nerve and the sural nerve.  
   D) The sural nerve and the superficial femoral nerve.

See answer sheet on page 191.
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