The ankle block: Anatomical review and anesthetic technique

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The ankle block is a safe and effective means of providing sensory anesthesia to the foot. The nerve supply to the foot at the level of the ankle is relatively superficial and consists of five nerve branches. The posterior tibial, which supplies the plantar aspect of the foot; the saphenous, supplying the medial portion of the foot; the deep peroneal, supplying an area between the great and second toes; the superficial peroneal, two branches supplying the majority of the dorsum of the foot; and the sural nerve, which supplies the lateral aspect of the foot. Using a small amount of local anesthesia, these nerves can be effectively anesthetized to prepare areas of the foot for surgical intervention.

Introduction
The primary goal of the anesthetist is to provide the patient with the safest and most effective means of anesthesia. Providing an effective anesthetic is not enough. If the choice of anesthetic technique carries unnecessary risk, then the patient is ill-served. Surgical procedures on the foot are accomplished daily under a variety of anesthetic techniques. General, spinal, epidural and a combination of major and minor nerve blocks are used for procedures involving the foot. When evaluating the safety of all of these anesthetic techniques for foot surgery, blocking the nerves at the ankle is one of the safest techniques. As well as being safe, the ankle block is a very effective technique.

The purpose of this paper is to review the sensory nerve distribution to the foot, the anesthetic techniques for blocking these nerves and the indications, contraindications and benefits of choosing the technique. Each nerve involved in the ankle block will be described in detail.

Sensory nerves to the ankle
It should be kept in mind that at the level of the ankle, there is no motor nerve supply to the foot other than the intrinsic muscles which do not contribute significantly to the patient's ability to ambulate. Movement of the foot during ambulation is primarily accomplished through muscle and tendon movement of the leg which extend downward to the foot. The intrinsic muscles of the foot, when anesthetized by the ankle block at the posterior tibial nerve, does reduce stabilization of the foot but does not prevent ambulation. Anesthesia at the ankle can provide effective sensory and vasomotor anesthesia without affecting the musculoskeletal activity of the foot. This benefit can readily be appreciated in ambulatory patients.

Posterior tibial nerve. Located deep and posterior to the posterior tibial artery, at the level of the medial malleolus, the posterior tibial nerve runs anatomically with three tendons, two veins and an artery through the tarsal tunnel. (See Figure 1.) When this nerve is blocked at the ankle level, the entire plantar aspect of the foot is anesthetized (Fig-
Once the needle reaches the proper location, a parasthesia is felt by the patient that extends to the toes and is described as an “electrical sensation.” At this point, 3-5 cc of local anesthetic is administered.

When blocking the posterior tibial nerve, it is often helpful to have the patient inform the anesthetist when parasthesia is elicited. Telling the patient that he or she might have an electrical sensation when the nerve is stimulated might prevent a surprised patient from jerking his foot away when parasthesia occurs. It should also be noted that the caudal direction of needle insertion will prevent improper advancement of the needle if the patient should “jerk” his or her foot. This similar type of parasthesia is usually not elicited in the other nerves.

**Saphenous nerve.** Located deep and posterior to the great saphenous vein, the saphenous nerve can be located by following the great saphenous vein to the medial portion of the leg to the ankle (Figure 3). This nerve is a cutaneous nerve. When the saphenous nerve is anesthetized at the ankle level, the medial portion of the foot will become numb to the area of the first metatarsal (Figure 4).

The needle is inserted just posterior and deep to the vein where .5-1 cc of local anesthetic is deposited. If the vein cannot be isolated, the nerve can be anesthetized by depositing the anesthetic agent at the anterior aspect of medial malleolus. It is important to note that at the level of the ankle, this superficial nerve is located at the depth of the vein.

The posterior plantar aspect of the heel to the tips of the toes just distal to the nail bed is affected except for a minor area of the first interspace (between the great and second toes).

To anesthetize the posterior tibial nerve, the posterior tibial artery is palpated and the needle is inserted at a 30-45 degree angle in a cephalad direction running just posterior to the artery (Figure 1).
Deep peroneal nerve. At the level of the ankle, the deep peroneal nerve is located on the tibial crest deep into the tendons of the first and second digits (Figure 5). This is the only nerve which innervates muscle on the dorsal aspect of the foot. When this nerve is blocked, the first interspace or medial aspect of the second digit and the lateral aspect of the first digit are anesthetized (Figure 6).

The patient should dorsiflex his or her foot against resistance so the tendons in the foot will be easily visible. Then the needle is inserted at a 90-degree angle and advanced until the tibia is met, or until paraesthesia is felt between the great and second toes where 1-2 cc of local anesthetic is administered.

Superficial peroneal nerve (the medial and intermediate branches). Both the medial and intermediate branches of the superficial peroneal nerve are located at the level of the ankle on the dorsal lateral aspect of the foot. Both of these nerves can usually be visualized by having the patient plantarflex his foot (Figure 7). The intermediate dorsal cutaneous nerve divides the foot into a “Washington monument” shape which innervates distally to the medial aspect of the fifth digit and the lateral aspect of the third digit (Figure 8). The medial dorsal cutaneous innervates the medial aspect of the third digit and lateral aspect of the second digit. It also innervates the medial aspect of the great toe (Figure 9).

To anesthetize the superficial peroneal, the anesthetic agent is administered directly around the nerves, which are located superficially above the facia plane. If, in the obese patient, visual identification is not possible, then a wheal of anesthesia is raised above the superficial fascia just under the skin in a line from the lateral malleolus medial to midankle. It should be emphasized that these nerves are very superficial, and injecting the anesthetic below the facia plane will prevent distribution to the nerve.
Sural nerve. This nerve is located posterior to the lateral malleolus and resides in the superficial fascia plane. The sural nerve corresponds with the short saphenous vein, then travels to the lateral aspect of the fifth digit. (See Figure 10.) Occasionally, it extends dorsally all the way to the third digit. When the sural nerve is anesthetized, the lateral border of the foot to the fifth digit is anesthetized (Figure 11).

The sural nerve can be easily anesthetized by raising an anesthetic wheal in the superficial fascia plane from the lateral malleolus to the Achilles tendon. (Figure 11).
Patient preparation

As with any regional anesthesia, there will be patients who can tolerate the administration of the local anesthetic without sedation and those that require sedation to alleviate anxiety and the sensation of the administration of the local anesthetic. In all cases, it is prudent to provide venous access initially. Versed® (midazolam), administered intravenously, is a very effective sedative for the administration of the ankle block. With the profound amnesic effect of Versed®, patients often do not remember the administration of the ankle block. If possible, the patient should be in the supine position, and the sites of injection should be prepped in the same manner as any invasive procedure.

Anesthetic drugs

Any anesthetic agent that is acceptable for use in regional nerve blocks may be used to block the ankle. Patient status (such as patient history of allergic reaction) may contraindicate the use of a particular drug or class of drugs. Since there is no significant motor block when administering an ankle block, it is often desirable to administer the longest acting anesthetic agent. Prolonged postoperative pain relief is therefore a benefit for the patient. An 8-24 hour block can be accomplished with rapid onset by mixing 1% lidocaine and .5% bupivacaine in equal proportions.10

It is not necessary to use large volumes of anesthetic agents to block the nerves at the ankle. Volumes listed in the procedure areas of this paper are more than adequate in our experience when deposited in the locations described. Larger volumes can be used, but as volume increases, the potential for tissue damage and systemic toxicity is greater.

Hints on techniques

Equipment should include the following:
- Prep solution
- A 5 or 10 cc syringe
- A 27gX1 1/4-inch needle
- Anesthetic solution
- Resuscitative equipment
- IV access
- Standard monitoring

Even though five nerves represent in the innervation to the foot, the block can be accomplished with only three needle penetrations.

The posterior tibial and sural nerves will require separate injections as previously described, but the other three nerves can be anesthetized with one puncture (Figure 12).

After completing the injection for the deep peroneal nerve as described above, the needle should not be completely withdrawn. Just prior to the withdrawal of the needle, it should be redirected laterally to anesthetize the medial and intermediate superficial peroneal nerves (Figure 13). Then, having the patient dorsiflex his or her foot, the large tendon (anterior tibial) is identified, and the needle can be advanced under this tendon di-
rectly to the saphenous nerve under the saphenous vein (Figure 14). This will then complete the ankle block with the least amount of discomfort to the patient.

**Figure 13**  
Prior to withdrawal, the needle is redirected laterally to anesthetize the medial and intermediate superficial peroneal nerves.

**Figure 14**  
The needle is advanced under the anterior tibial tendon to the saphenous nerve.

**Tourniquet use**  
A disadvantage to the technique described is that it does not diminish the discomfort of the calf or thigh tourniquet. During a procedure of the foot, minimal discomfort from the tourniquet can be achieved by placing it just proximal to the medial and lateral malleolar heads of the ankle. A lubricating substance applied to the skin and a cotton wrap placed under the tourniquet is desirable. It is important to follow currently acceptable time and pressure limitations. When the tourniquet is pressurized, do not plantarflex the foot. The nerve is bound under the pressure of the tourniquet, and excessive plantarflexion may stretch the nerve in a “bow string” effect and possibly cause some postoperative discomfort.

**Indications and contraindications**  
The ankle block described is effective for any foot or lower ankle procedure. It is also acceptable for temporary nonsurgical pain relief. An indication for utilizing the ankle block is patient safety. Contraindications include systemic or localized infection at the site of injection, history of allergic reaction to the anesthetic drug or drug in the same class, or lack of patient acceptance.

**Clinical uses**  
The following is a partial list of procedures and appropriate nerves to block for each procedure. It is important to note that not all nerves need to be blocked in all cases.

*Heal spur excision or steroid injections:* Block the posterior tibial, saphenous and sural nerves.

*Bunionectomy:* Block the posterior tibial, superficial peroneal (medial and intermediate cutaneous), deep peroneal and the saphenous nerves. The last three nerves require only one puncture as previously described.

*Morton’s neuroma:* Block the posterior tibial and superficial peroneal nerves.

*Laceration or foreign body puncture wound:* When this occurs on the plantar aspect of the foot, it requires only a posterior tibial block. Local infiltration through the plantar aspect of the foot is unnecessary and painful to the patient. The posterior tibial block is much more effective for cleansing and suturing wounds than local infiltration.

**Conclusions**  
The use of the ankle block is a very safe and effective means of providing anesthesia for surgical procedures of the foot or lower ankle. The technique is simple to learn. It provides an adequate surgical field for a prolonged period of time, and it
has the obvious benefit of prolonged postoperative pain relief. The indications for the use of an ankle block are many, while the contraindications are few.

REFERENCES


AUTHORS

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ACKNOWLEDGEMENT

Special thanks to Sherry Speer, RN, BSN, for her illustrations.

Test Yourself Answers

(Questions appeared on page 118.)

1. Gases are identified by their mass to charge ratio. Gases entering the mass spectrometer are ionized and then passed through a magnetic field. The magnetic field causes the ions to follow a trajectory that is proportional to their mass to charge ratio.

2. The mass spectrometer has the ability to simultaneously measure the inspired and expired concentrations of the respiratory gases (nitrogen, oxygen, carbon dioxide) and the anesthetics (nitrous oxide, halothane, enflurane and isoflurane).

3. A gradual or sudden rise in the end tidal nitrogen concentration occurring alone or concomitantly with a decrease in end tidal carbon dioxide should alert the anesthetist to the possibility of air embolism.

4. Hypoxic gas mixtures can result from oxygen line failure, inaccurate or fractured oxygen flow meters, exhaustion of oxygen cylinders and personnel failure.

5. The most important function of carbon dioxide measurement during anesthesia is to assure the adequacy of ventilation.