LOCAL ANESTHETIC TECHNIQUES IN LOWER EXTREMITY SURGERY

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ANATOMY

The proper and effective delivery of local anesthesia begins with a thorough knowledge of the sensory innervation of the lower extremity. Knowledge of the location and distribution of the nerves of the lower extremity is one of the most important tools the surgeon carries in his armamentarium. Without this tool, the amount, potency, onset of action, and the duration of the agent being employed for anesthesia are useless.

The realm of anatomy concerning the podiatric surgeon is innervated by nerves originating from either the lumbar or sacral plexus, L3 through S2. From these two plexuses come the sciatic nerve, which eventually divides into the tibial and common peroneal nerves just proximal to the knee, and the femoral nerve, which eventually gives off the saphenous nerve. These three nerves, the tibial, common peroneal, and saphenous, are responsible for all of the sensory and motor innervation of the lower extremity distal to the knee. The other major sensory nerve of the lower extremity, the sural nerve, is formed from branches of the tibial and common peroneal nerves.

The tibial nerve courses along the posterior aspect of the lower leg, passing under the medial malleolus on its way through the tarsal tunnel. Along its course, the tibial nerve gives off the medial calcaneal nerve, which supplies cutaneous innervation to the medial aspect of the heel. The tibial nerve, which divides into the medial and lateral plantar nerves, supplies cutaneous innervation to the plantar aspect of all the digits.

The common peroneal nerve courses just distal to and around the fibular head and divides into the superficial and deep peroneal nerves. The superficial peroneal divides into the medial and intermediate dorsal cutaneous nerves which supply cutaneous innervation to the dorsum of the foot. The medial dorsal cutaneous nerve serves the dorso-medial aspect of the hallux and the adjacent dorsal aspects of the second and third digits. The intermediate dorsal cutaneous nerve serves the adjacent dorsal aspects of the third, fourth, and fifth digits, while the deep peroneal nerve supplies the dorso-lateral aspect of the hallux and medial second toe.

The dorso-medial aspect of the foot is supplied by the saphenous nerve which is cutaneous along its course down the medial lower leg, crossing the ankle anterior to the medial malleolus. The dorso-lateral aspect of the foot and fifth digit are supplied by the sural nerve and its branch, the lateral dorsal cutaneous nerve, respectively.

AGENTS

The most commonly used agents for local anesthesia in podiatric surgery are lidocaine (Xylo-

caine), which is available in a 1% or 2% solution, and bupivacaine (Marcaine), which is available in a 0.25 or 0.5% solution. Both agents are available with or without epinephrine.

Both of these agents have well-known toxic levels, however a recent study by Mineo and Sharrock using lidocaine and bupivacaine in mid-tarsal blocks, showed that negligible levels of these two agents were found in the blood stream following local nerve blocks near the maximum recommended doses.

The major differences between lidocaine and bupivacaine are the onset and duration of action. Lidocaine, with a duration of 1.5 - 2 hours, is the shorter acting of the two. Its onset of action usually occurs within minutes. Bupivacaine is reported to have a duration of 6 - 8 hours, but longer time periods have been seen, especially in the presence of epinephrine. Bupivacaine has a reported onset of 5 - 10 minutes. Another agent used for local anesthesia is mepivacaine (Carbocaine). Mepivacaine, like lidocaine, also has a rapid onset of action but it is more commonly used in dental procedures.

Epinephrine, a catecholamine neurotransmitter which acts on nerve synapses, is also a potent vasoconstrictor. It is commonly mixed with local anesthetics in a 1:100,000 or 1:200,000 dilution. Epinephrine's vasoconstrictive action aids in prolonging the duration of action of local anesthetics by inhibiting their evacuation from the injection site. The use of epinephrine in end organs, such as the digits, has historically been contraindicated, but its use has not proven to be a problem.

INSTRUMENTATION

Lidocaine and bupivacaine are weak acids and therefore produce a burning sensation when injected. In order to minimize this discomfort, the surgeon may use a smaller barrel syringe and a smaller gauge needle. The smaller syringe, usually a 3 cc syringe, allows a slower infiltration of the local anesthetic agent into the tissue. The smaller needle size, preferably 27 gauge, allows for slower infiltration as well, and is not as uncomfortable as a larger needle when penetrating the skin.

Fluoro-Ethyl and Ethyl Chloride are skin refrigerants that, when sprayed on the injection site, block the sensation of the needle passing through the skin. Dermaject, a product intended to minimize the pain associated with local anesthetic administration, works by injecting a small amount of lidocaine just under the dermis, thus desensitizing the skin to the penetration of the needle.

BLOCKS

Various types of blocks are available to the surgeon, including field blocks, digital blocks, Mayo blocks, isolated nerve blocks, and Bier blocks. The type of block chosen depends on the surgical site and area of anesthesia desired by the surgeon.

Field Block

A field block is used when the surgeon wishes to anesthetize a generalized area. For example, a field block may be used for the excision of plantar lesions such as verruca. A plantar field block is performed by infiltrating local anesthetic subcutaneously just proximal to the surgical site. It is also advisable to infiltrate the anesthetic agent on either side of the site for more complete anesthesia to the area.

However, since plantar injections have proven to be quite painful, the surgeon may chose to do a posterior tibial nerve block. The posterior tibial nerve lies just anterior to the posterior tibial artery and, when blocked, will provide anesthesia to the entire plantar aspect of the foot with less discomfort to the patient.

Digital Block

A digital block is the method of choice for isolated digital procedures such as hammertoe correction and nail surgery. For nail procedures, a digital block is performed by infiltrating the local anesthetic subcutaneously along the medial and lateral aspects of the base of the digit in a dorsoplantar direction. Additional anesthetic can be infiltrated subcutaneously across the dorsum of the foot at the base of the digit for hammertoes or other digital procedures. If a local anesthetic with epinephrine is being used, the surgeon may wish to inject subcutaneously along the incision site for added hemostasis.

Mayo Block

A Mayo block is a nerve block that is performed circumferentially along the base of a metatarsal. The Mayo Block is used in various metatarsal

osteotomies and may be administered at any point along the metatarsal depending on the site of surgery. This block is performed by depositing a local anesthetic in a dorsoplantar direction on the medial and lateral side of the involved metatarsal. The local anesthetic may also be infiltrated across the dorsal and plantar aspect of the metatarsal.

Isolated Nerve Block

An isolated nerve block may be performed when the desired area of anesthesia is innervated by a certain nerve. For example, a posterior tibial nerve block may be used to block the plantar aspect of the foot. It is performed by locating the posterior tibial artery and injecting the local anesthetic just anterior or medial to the vessel. For a more accurate block, the posterior tibial nerve may be palpated before the deposition of the agent.

The saphenous nerve may be located by palpating the greater saphenous vein at the level of the ankle just medial to the medial malleolus. The saphenous nerve is included in this neurovascular bundle.

The medial and intermediate dorsal cutaneous nerves are palpable across the dorsum of the foot just distal to the ankle joint. These nerves are easily located by plantarflexing and adducting the foot. Due to their nonelastic nature, they can be bowstrung under the surgeon's finger.

The sural nerve is palpable on the lateral aspect of the foot as it passes posterior to the lateral malleolus and turns distally. Locating it may be facilitated by dorsiflexing and inverting the foot which helps to bowstring the nerve. Once located, the nerve can then be blocked by the infiltration of a local anesthetic.

Of the nerves that cross the ankle joint, the deep peroneal nerve is the most difficult one to palpate. However, it may be anesthetized by depositing local anesthetic between the tendons of extensor hallucis and extensor digitorum longus at the level of the ankle. The deep peroneal nerve lies in the same neurovascular bundle as the dorsalis pedis artery so care must be taken to avoid intravascular injection.

Bier Block

The Bier block, also known as intravenous regional anesthesia, was developed by August Bier, a German physician, in 1908. His concept of using a tourniquet and injecting local anesthetic intravenously into the surgical limb, is most commonly used in upper extremity procedures. However, it can also be used successfully in the lower extremity.

The method of performing a Bier block in the lower extremity begins with gaining access to a vein near the surgical site. Once IV access is obtained, two tourniquets are placed just distal to the fibular head, being careful not to compress the common peroneal nerve. The limb is elevated and exsanguinated and the proximal tourniquet is inflated to approximately 150 mm Hg above systolic pressure. At this time lidocaine, the preferred anesthetic for IV regional anesthesia, is injected through the cannula.

A dose of 3 mg/kg will minimize adverse affects while allowing for suitable anesthesia. As the proximal tourniquet becomes painful, it can be released after inflation of the distal tourniquet. It is important to keep the total tourniquet time between 20 and 30 minutes to minimize the chance of a toxic reaction upon release. This time will allow the local anesthetic to adequately diffuse through the vessel walls into the surrounding soft tissue.

CONCLUSION

Local anesthetic techniques, when performed properly, offer many advantages to the physician and the patient. It allows for painless surgery without the after-effects of general anesthesia. If done properly, the physician can anesthetize the surgical site with a minimal number of injections and local anesthetic.

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