Ultrasound Guidance for the Placement of Peripheral Nerve Stimulation Devices

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Placement of implantable devices in the spine has become an integral part of the pain care algorithm for those suffering with neuropathic pain. In some settings, the use of a device in the spine is not the initial choice for neuromodulation. Using a spinal cord stimulation device to treat specific peripheral nerve–related conditions raises two issues: (1) Some regions of the body, such as the occipital nerve and the intercostal nerve, are very difficult to stimulate with a central target. (2) The risks of central neuraxis injury should be considered in the analysis of benefits versus adverse events. These two issues have led many implanters to prefer placing the lead in the direct vicinity of the nerve involved in the pain pattern distribution. This technique can be achieved using landmarks, nerve stimulation, or ultrasound-guided placement. This chapter will focus on ultrasound guidance of peripheral lead placement.

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29.1 History

Peripheral nerve stimulation (PNS) began as a very invasive method. The implanter would make an incision, dissect to the nerve, harvest a piece of fascia, and wrap the nerve in fascia prior to placing the lead just above the nerve (Fig. 29.1a). This invasive technique led to tissue trauma, and in many cases scar tissue formed and led to increased sensitivity or high impedance and lack of paresthesia (Fig 29.1b). Over time, the placement of PNS devices evolved to placement based on landmarks. Ultrasound-guided PNS grew out of the use of this technology to place nerve blocks in the operating room. The logical progression was to bring this pinpoint method to placing catheters for chronic pain and eventually placing PNS leads. Ultrasound guidance thus is important because it makes it possible to reduce the invasiveness of the procedure.

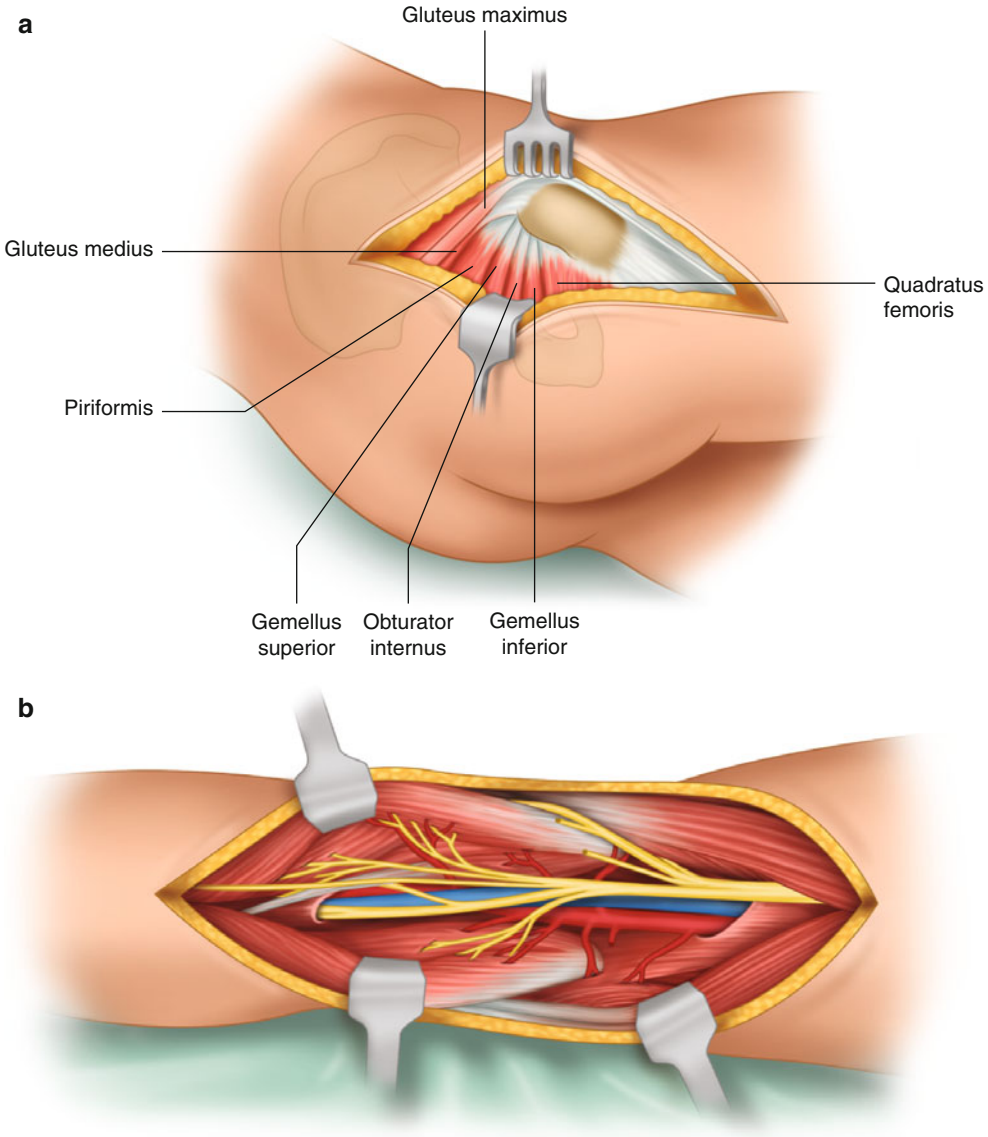


Fig. 29.1 (**a**) Dissection of muscles in the buttock. (**b**) Dissection to the popliteal nerve for open technique nerve placement

29.2 Technical Overview

Ultrasound guidance technology can be used for many peripheral nerve targets, including the occipital nerve, ilioinguinal nerve, intercostal nerve, axillary nerve, median nerve, ulnar nerve, sciatic nerve, posterior tibial nerve, common peroneal nerve, and saphenous nerve. The basic principal is the same: First, the nerve location is identified under ultrasound guidance and then a peripheral electrode is placed in closed proximity. It has most often been observed that best stimulation is achieved by placing the electrode perpendicular to the course of the nerve. Initially, a three and one half–inch 22G spinal needle is used to visualize the path, and then a 14G needle should be placed in the same direction under ultrasound guidance. The 22G needle is used as a safety precaution in the event of invasion of the nerve or a blood vessel.

29.3 Technique Examples

Ultrasound guidance is especially helpful for initial placement of the PNS lead, as illustrated by the following examples.

29.3.1 Occipital Nerve Stimulation

The patient is placed in the prone position. The ultrasound probe is placed just lateral to the occipital protuberance bilaterally. The probe is gradually moved laterally to visualize the pulsation of the greater and lesser occipital artery. The nerve is in close proximity to artery pulsation and on the medial aspect in most patients. In the plane approach, the lead is placed perpendicular to the course of the occipital nerve (Fig. 29.2).

29.3.2 Ilioinguinal Nerve Stimulation

The patient is placed in the supine position. The ultrasound probe is placed 2 cm medial and 2 cm inferior to the anterior superior iliac spine. Under ultrasound guidance, the plane between the internal oblique muscle and the transverse abdominis muscle is visualized and its depth is gauged and marked. At the same depth, the lead is passed under ultrasound guidance in the same plane and perpendicular to the inguinal ligament (Fig. 29.3).

29.3.3 Common Peroneal and Posterior tibial Nerves

The patient is placed in the prone position. The ultrasound probe is placed about 5 cm proximal to the popliteal crease. The popliteal artery pulsation is visualized and its depth is gauged. Both the common peroneal nerve and posterior tibial nerves are superficial to the artery. The lead is placed more medial for individual stimulation of the posterior tibial nerve, and more lateral for the common peroneal nerve. If the ultrasound probe is moved more proximally, the common peroneal nerve can be visualized joining the posterior tibial nerve and forming the sciatic nerve (Fig. 29.4).

29.3.4 Saphenous Nerve

The patient is placed in the prone position. The ultrasound probe is placed about 5 cm proximal to the popliteal crease on the medial aspect. The sartorius muscle is visualized. The lead is placed adjacent to the sartorius muscle, perpendicular to the course of the muscle (Fig. 29.5).

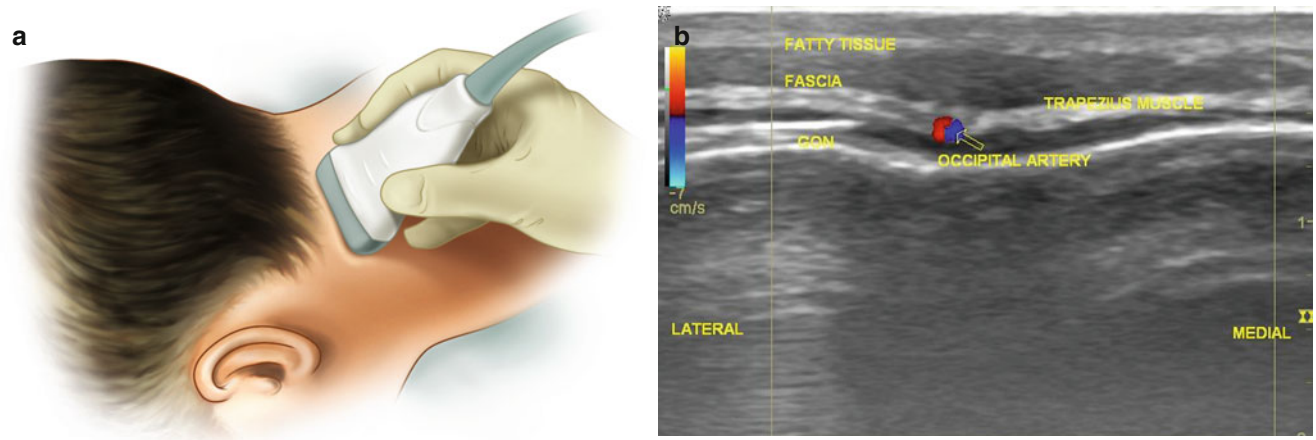


Fig. 29.2 (**a**) Out of plane position of transducer to locate the occipital nerve. (**b**) Highlighted US image of greater occipital nerve, and the surrounding anatomy

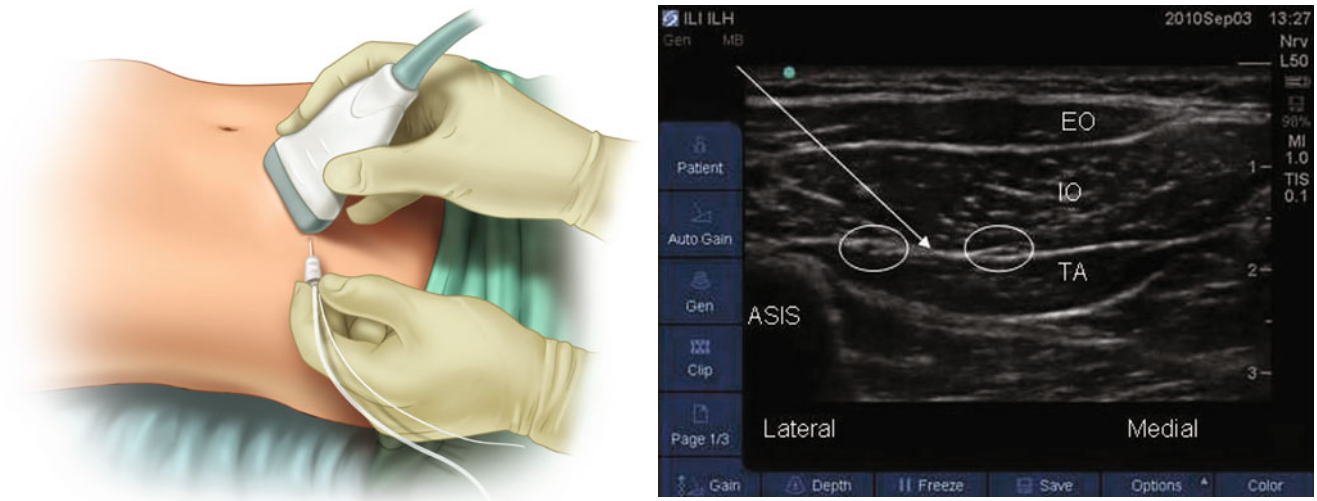


Fig. 29.3 Transducer approach and US image of ilioinguinal anatomy

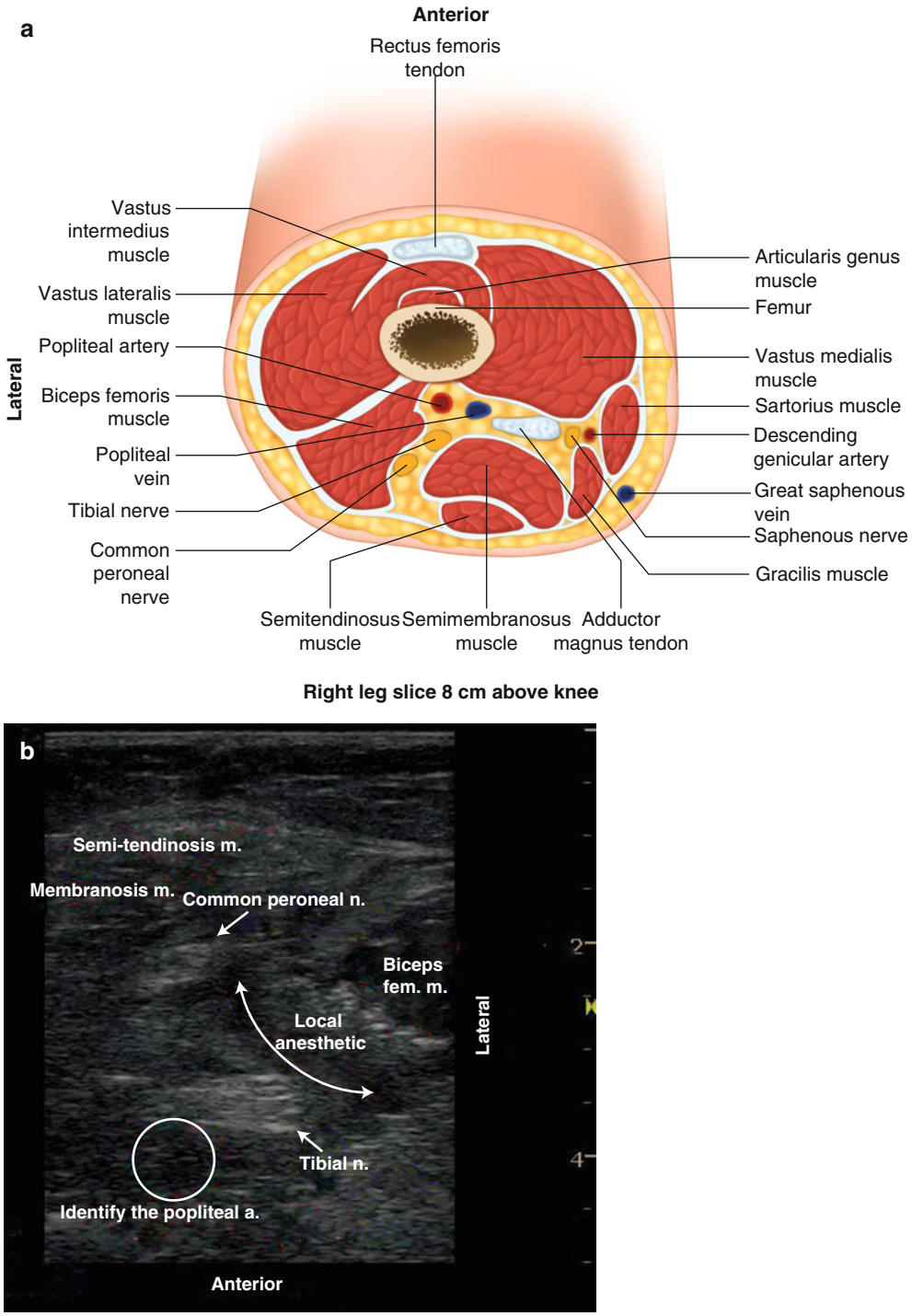
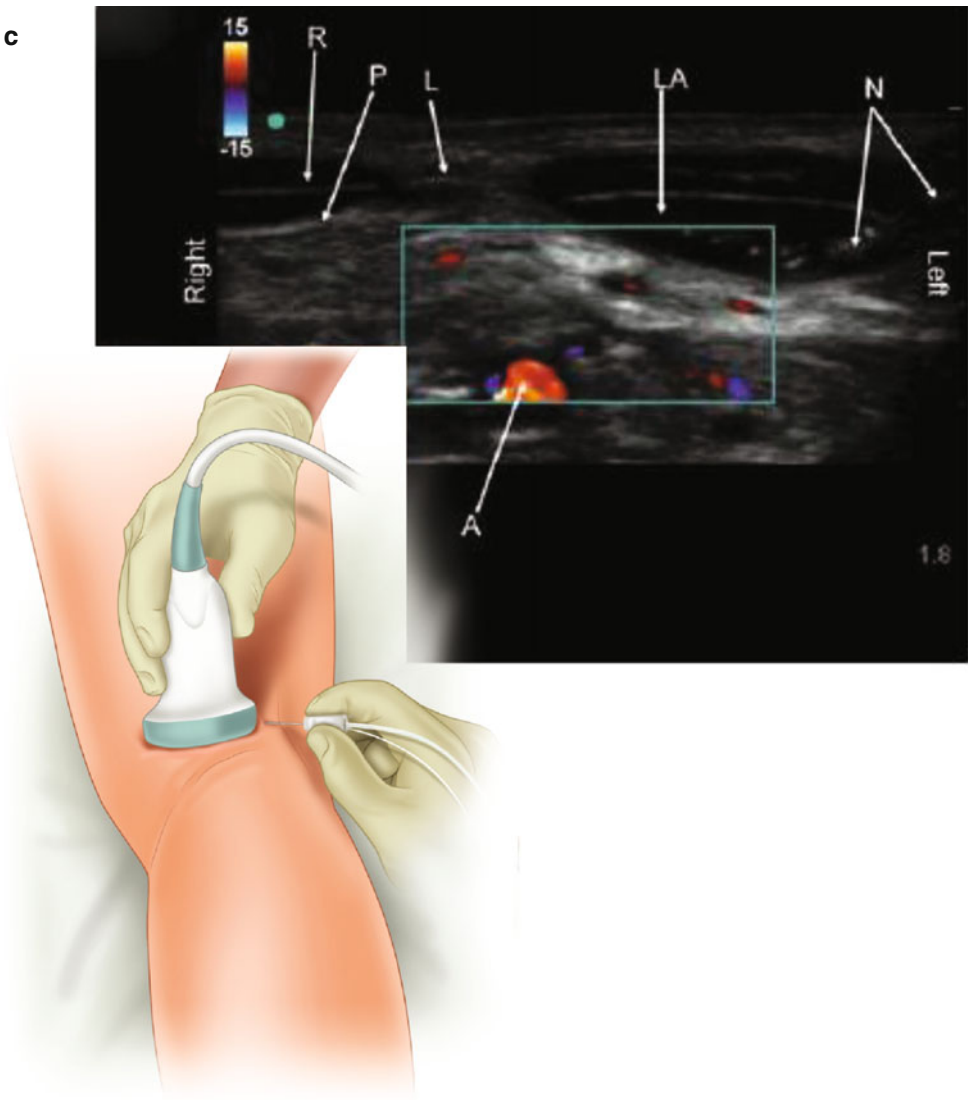


Fig. 29.4 (**a**) Axial slice of right LE 8 cm above the knee. (**b**, **c**) US-guided image and figure representation of ultrasound probe orientation

Fig. 29.4 (continued)



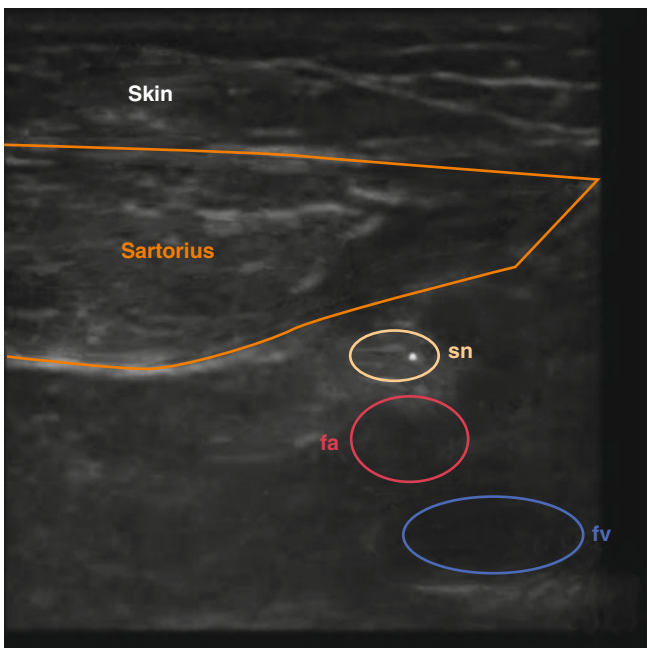


Fig. 29.5 US image of anatomy surrounding saphenous nerve

29.4 Electrode Positioning and Permanent Device Implantation

Once the lead is placed as described above for the applicable nerve, minor changes can be made in electrode position based on stimulation pattern. For permanent implantation, a small incision is made at the needle entry site and the fascia is exposed. The lead is anchored to the fascia using nonabsorbable suture. In most settings, an anchor is not used, because of the risk of tissue erosion. The internal programmable generator site varies, based on patient choice, the area of the body, and physician preference. Commonly used pocket sites for battery placement are the upper thoracic area and low back for occipital nerve stimulation, the anterior abdomen for the ilioinguinal nerve, and the posterior thigh or buttock for the sciatic and saphenous nerves.

29.5 Risk Assessment

Ultrasound-guided PNS is still new in the field of modern pain management. No major complications specific to the use of ultrasound guidance have yet been reported. The risk of complications for PNS is similar to that of other peripheral implants, but it is likely that the risk of nerve injury or bleeding is less with ultrasound guidance, particularly using Doppler technology to identify blood vessels. As with any implant, the risk of infection should be considered.

29.6 Risk Avoidance

Prior to implantation, the physician should evaluate the integrity of the skin in the local area and rule out infection or skin breakdown. As with other surgical techniques, intravenous antibiotics should be given within the hour prior to skin invasion. The clinician should have proper training and acceptable operating skill prior to placing the implant, and the physician should be especially familiar with the anatomy of the implant area. Vessel depth and nerve anatomy should be identified prior to lead placement. Seeker needles are helpful in reducing the risk of needle trauma prior to implantation. A conversant patient is helpful in improving safety in these cases, as injury to a peripheral nerve will cause a paresthesia.

Conclusion

The introduction of ultrasound enables individual peripheral nerves to be stimulated in a safe, effective, and minimally invasive way. With improving technology, ultrasound guidance will become a more common method of providing this important implantation technique.

Suggested Reading

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