● Imaging Article

Ultrasound Imaging for Popliteal Sciatic Nerve Block

Avinash Sinha, M.B.Ch.B., F.R.C.A. and Vincent W. S. Chan, M.D., F.R.C.P.C.

Background and Objectives: Ultrasound is a novel method of nerve localization but its use for lower extremity blocks appears limited with only reports for femoral 3-in-1 blocks. We report a case series of popliteal sciatic nerve blocks using ultrasound guidance to illustrate the clinical usefulness of this technology.

Case Report: The sciatic nerve was localized in the popliteal fossa by ultrasound imaging in 10 patients using a 4- to 7-MHz probe and the Philips ATL HDI 5000 unit. Ultrasound imaging showed the sciatic nerve anatomy, the point at which it divides, and the spatial relationship between the peroneal and tibial nerves distally. Needle contact with the nerve(s) was further confirmed with nerve stimulation. Circumferential local anesthetic spread within the fascial sheath after injection appears to correlate with rapid onset and completeness of sciatic nerve block.

Conclusions: Our preliminary experience suggests that ultrasound localization of the sciatic nerve in the popliteal fossa is a simple and reliable procedure. It helps guide block needle placement and assess local anesthetic spread pattern at the time of injection. *Reg Anesth Pain Med 2004;29:130-134.*

Key Words: Popliteal, Catheter, Ultrasound, Anatomy, Local anesthesia.

Ultrasound imaging is a new method of peripheral nerve localization and can possibly improve block success and safety.[1,2] To date, most reports of ultrasound guidance for regional anesthesia have been limited to brachial plexus blocks in the interscalene,[3,4] supraclavicular,[5,6] infraclavicular,[7-9] and axillary[3,10] regions and paravertebral nerve blocks.[11,12] Its application for lower extremity blocks appears underutilized with only 2 studies on femoral 3-in-1 blocks.[13,14] We herein report a case series of 10 patients in whom popliteal sciatic nerve blocks were performed under ultrasound guidance and describe the ultrasound characteristics of the sciatic nerve in this region and the needle technique of nerve localization.

From the Department of Anesthesia, University of Toronto, Toronto, Ontario, Canada.

Accepted for publication January 4, 2004.

Correspondence: Vincent Chan, M.D., F.R.C.P.C., Department of Anesthesia and Pain Management, Toronto Western Hospital, University Health Network, 399 Bathurst St., Toronto, Ontario, Canada M5T 2S8. E-mail: vincent.chan@uhn.on.ca

1098-7339/04/2902-0012$30.00/0
doi:10.1016/j.rapm.2004.01.001

Case Report

We performed popliteal blocks under ultrasound imaging guidance in 10 American Society of Anesthesiologists physical status I patients (23 to 66 years old, 168 to 183 cm, 58 to 89 kg) scheduled to have foot and ankle surgery. The patients were positioned prone, and the surface landmarks of the popliteal triangle (the tendons of semitendinosus and semimembranosus muscles medially, the tendon of the biceps femoris muscle laterally, and the popliteal crease inferiorly) were identified and marked. We used the Philips ATL HDI 5000 ultrasound unit (ATL Ultrasound, Bothell, WA) with color flow Doppler, compound imaging and image video recording features. After betadine skin preparation, a linear 5-cm, 4- to 7-MHz probe inside a sterile cover was applied onto the posterior thigh approximately 8 cm proximal to the popliteal crease of the operative leg.

The probe positioned horizontally at this level captured a transverse view of the sciatic nerve (ie, the ultrasound beam 90° to the nerve) and showed the sciatic nerve as a single oval, well-circumscribed, hyperechoic structure (Fig 1) in all 10 patients. The nerve was consistently superficial and within 1 to 2 cm lateral to the pulsatile hypoechoic

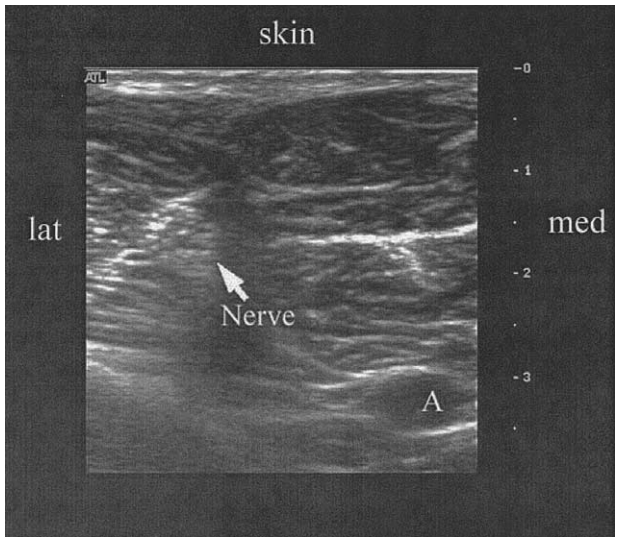

Fig 1. Transverse sonogram in the popliteal region showing the sciatic nerve as a hyperechoic nodule (arrow) lateral to the popliteal artery (A). Abbreviations: med, medial; lat, lateral.

popliteal artery, which was commonly 3 to 4 cm deep to the skin (Fig 1). In some cases, the vein was seen but easily compressed by the probe. Also seen were the biceps femoris muscle laterally and semitendinosus and semimembranosus muscles medially. The femur appeared as a dense hyperechoic line found deep to the neurovascular structures.

After local anesthetic skin infiltration, a 3.5-inch, 17-gauge insulated Tuohy block needle (Arrow, Reading, PA) was inserted below the midpoint of the probe perpendicular to the ultrasound beam (Fig 2). In this orientation, the needle was seen in cross section on ultrasound as a hyperechoic "dot" without full image of the needle shaft. Only needle and thigh tissue movement was observed in real time. Once the needle was deemed in contact with the nerve on ultrasound, foot dorsi-flexion or plantar flexion was sought using a nerve stimulator (Stimuplex; Braun Medical, Bethlehem, PA) until optimal stimulation was obtained at less than 0.5 mA. A 20-gauge stimulating catheter (Stimucath; Arrow) was then advanced 4 to 5 cm beyond the needle tip. After catheter stimulation with 0.5 to 1 mA, 15 mL of 1.5% lidocaine with epinephrine 1:200,000 and 15 mL of 0.5% bupivacaine were injected incrementally over 2 to 3 minutes.

In the transverse view, local anesthetic spread was examined after injection of 5 mL, 10 mL, 20 mL, and 30 mL to examine local anesthetic spread. Circumferential spread (Fig 3A, video [see video clip in this article at www.rapm.org]) was noted in 8 patients resulting in rapid onset (within 10 minutes) and complete anesthesia in the foot within 20 minutes. In contrast, spread seen only to one side of the nerve, not encompassing the whole nerve, was associated with a partial block (Fig 3B). We could also capture a longitudinal view of the sciatic nerve and the overlying stimulating needle by rotating the probe vertically from the horizontal position and scanning the nerve along its long axis (Fig 4).

Discussion

The use of popliteal nerve block to relieve pain after foot and ankle surgery is gaining popularity and can speed hospital discharge in outpatients.[15] The provision of a perineural catheter and local anesthetic infusion can further extend the period of pain control well beyond that following the single injection technique. Reduced opioid consumption, reduced opioid-related side effects, and improved patient satisfaction are benefits recently reported.[16] Unfortunately, the failure rate of single-shot popliteal blocks may be as high as 21% with many requiring supplementation.[17] It is conceivable that ultrasound imaging may improve the accuracy of nerve localization and needle placement. Direct visualization of nerve location and local anesthetic spread may also reduce block failure rate and shorten onset time.[13,14,18] Furthermore, imaging can help prevent accidental puncture to vessels and other neighboring structures.

Achieving consistent, interpretable ultrasound images of nerves and the block needle requires some degree of technical skill and correct ultrasound probe orientation. Using the classical popli-

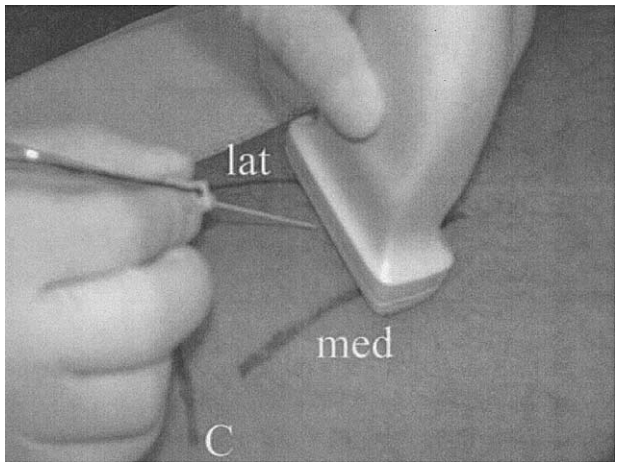

Fig 2. An example of ultrasound-guided needle technique showing one hand holding the probe and one hand holding the insulated needle in the popliteal fossa. The needle is advanced below the midpoint of the ultrasound probe perpendicular to the ultrasound beam. Abbreviations: C, popliteal crease; med, medial border formed by the semitendinosus and semimembranosus muscle tendons; lat, lateral border formed by the biceps femoris muscle tendon.

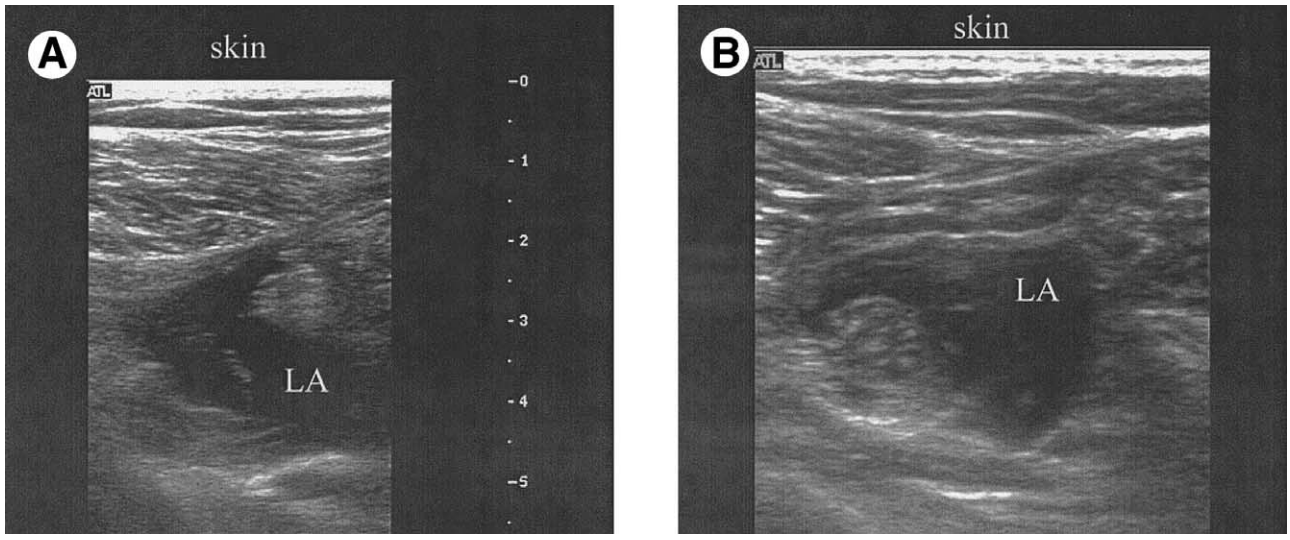

Fig 3. (A) Transverse sonogram showing circumferential local anesthetic spread around the sciatic nerve after a 30-mL injection. (B) Transverse sonogram showing incomplete local anesthetic spread. Abbreviation: LA, local anesthetic.

teal block approach,[19] we advance the needle in the posterior thigh while the ultrasound probe is positioned horizontally. In this orientation, we can only infer needle position through associated movement, as the needle moves perpendicular to the ultrasound beam. If visualization of the needle shaft is desired, the ultrasound probe must have a longitudinal orientation to the nerve (probe now vertical) so that the beam is aligned with the long axis of both the needle and the sciatic nerve (Fig 4).

The point at which the sciatic nerve divides above the popliteal crease is highly variable (0-115 mm, mean of 61 mm ± 27 mm).[20] This can be a cause for difficult localization of both the peroneal and tibial nerves using the nerve stimulation technique. To prevent incomplete anesthesia, a double injection technique has been advocated to anesthetize individually both components of the sciatic nerve.[20] With ultrasound scanning, we were able to identify precisely the point at which the sciatic nerve divides in each of the 10 patients. Distally, we could also examine the spatial relationship between the common peroneal and tibial nerves. We found the 2 nerves situated side by side (Fig 5A) in 9 patients but, unexpectedly, atop one another (Fig 5B) in 1 patient. This later orientation would make it difficult, if not impossible, to individually localize both branches of the sciatic nerve with the conventional nerve stimulation technique. Ultrasound visualization of the sciatic nerve and its terminal branches at the time of nerve block shows the optimal site of needle placement. This is a significant advantage over conventional "blind" approaches.

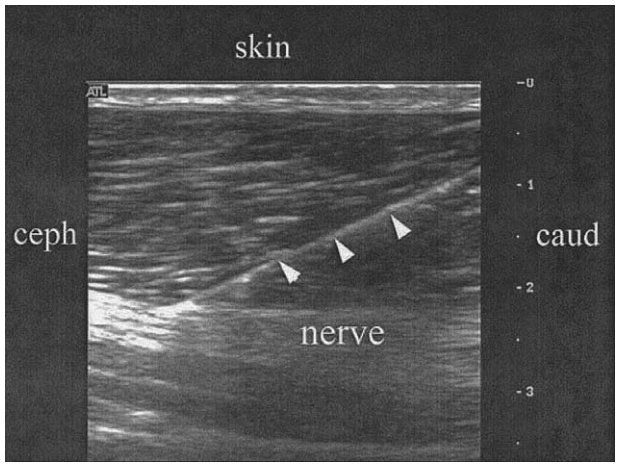

Fig 4. Longitudinal view of the sciatic nerve with the overlying stimulating needle (arrows). Abbreviations: ceph, cephalad; caud, caudad.

Anatomical studies show the presence of an adventitial sheath enveloping the sciatic nerve and its divisions and dye spread within this sheath in cadavers.[21] Our observation of local anesthetic spread around the nerves and extensive spread proximally along the nerves lends support to the adventitial sheath concept (Fig 6). We have observed both symmetrical circumferential (Fig 3A) and asymmetrical spread (Fig 3B) around the nerves. Our preliminary observation suggests that faster block onset and greater success happen with circumferential local anesthetic spread along the course of the nerve. To optimally assess local anesthetic spread, it is necessary to scan the nerve both distally and proximally and not at a single-nerve location. Extensive proximal local anesthetic spread after a 30-mL injection can also account for successful

block of both the peroneal and tibial divisions, despite injection at the site of stimulation of only one division. Conceivably, if ultrasound visualization during local anesthetic injection can identify the extent of circumferential and proximal spread, it is not necessary to block nerves individually, thus avoiding multiple attempts and, potentially, nerve injury.

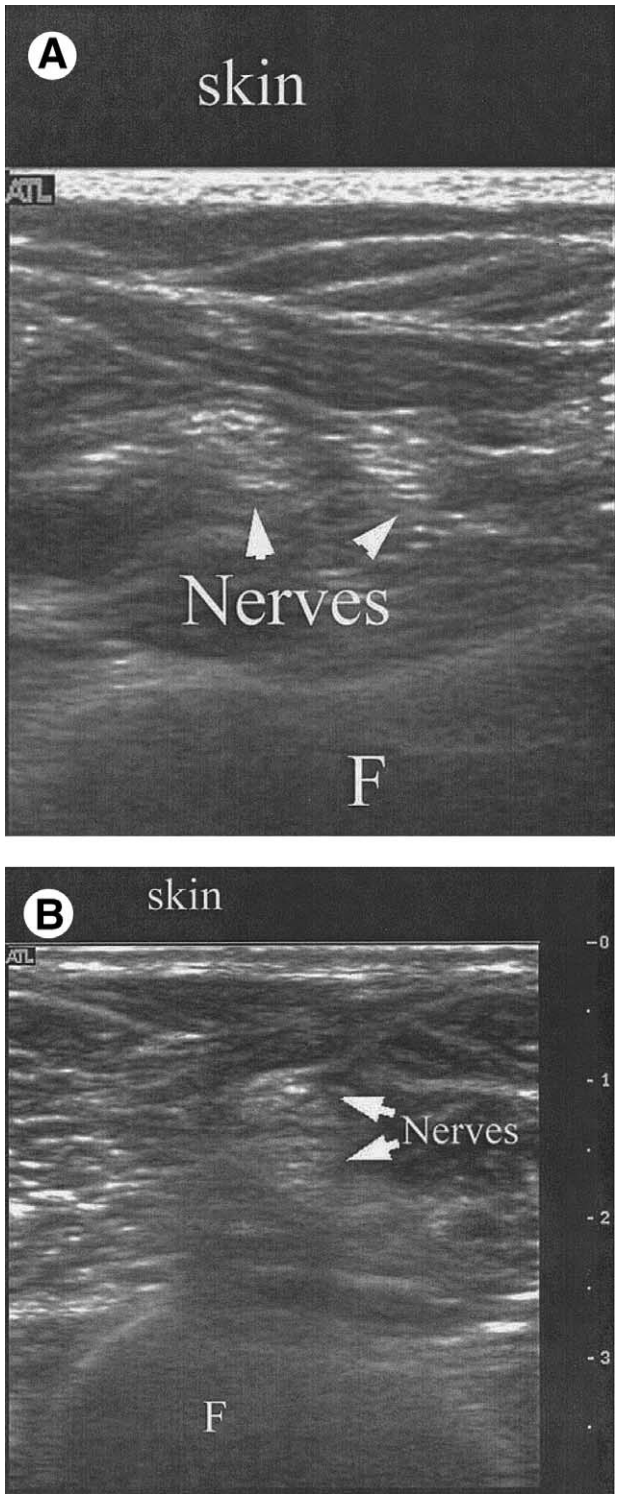

Fig 5. (A) Transverse sonogram showing peroneal and tibial divisions of the sciatic nerve lying side by side. (B) Transverse sonogram showing peroneal and tibial divisions atop of each other. Abbreviation: F, femur.

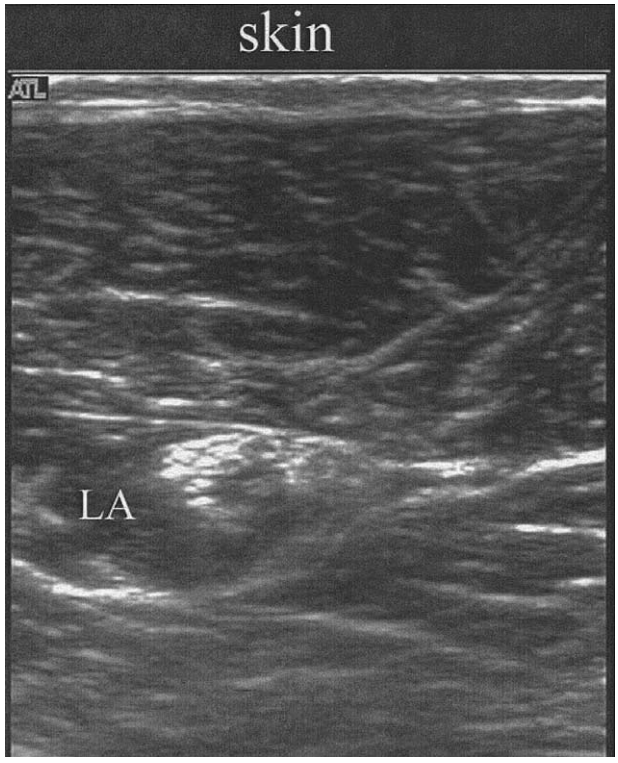

Fig 6. Transverse sonogram showing local anesthetic spread within the nerve sheath. Abbreviation: LA, local anesthetic.

Advanced ultrasound technology today yields high-quality anatomical images with distinct clarity. Our preliminary ultrasound experience of scanning the sciatic nerve and its branches in the popliteal fossa is encouraging. As for other peripheral nerves, we believe ultrasound imaging of the sciatic nerve will prove valuable for nerve localization clinically and can possibly predict block success and completeness. Whether ultrasound is useful for localizing the sciatic nerve in deeper locations of the lower extremity is not known at the present time and warrants future studies.

Acknowledgement

The ultrasound machine was on loan from Philips Medical Systems Canada.

References

1. De Andres J, Sala-Blanch X. Ultrasound in the practice of brachial plexus anesthesia. *Reg Anesth Pain Med* 2002;27:77-89.
2. Peterson MK, Millar FA, Sheppard DG. Ultrasound-guided nerve blocks. *Br J Anaesth* 2002;88:621-624.

3. Perlas A, Chan VW, Simons M. Brachial plexus examination and localization using ultrasound and electrical stimulation: A volunteer study. *Anesthesiology* 2003;99:429-435.
4. Yang WT, Chui PT, Metreweli C. Anatomy of the normal brachial plexus revealed by sonography and the role of sonographic guidance in anesthesia of the brachial plexus. *AJR Am J Roentgenol* 1998;171:1631-1636.
5. Kapral S, Krafft P, Eibenberger K, Fitzgerald R, Gosch M, Weinstabl C. Ultrasound-guided supraclavicular approach for regional anesthesia of the brachial plexus. *Anesth Analg* 1994;78:507-513.
6. Chan VW, Perlas A, Rawson R, Odukoya O. Ultrasound-guided supraclavicular brachial plexus block. *Anesth Analg* 2003;97:1514-1517.
7. Nadig M, Ekatodramis G, Borgeat A. Ultrasound-guided infraclavicular brachial plexus block. *Br J Anaesth* 2003;90:107-108.
8. Sandhu NS, Capan LM. Ultrasound-guided infraclavicular brachial plexus block. *Br J Anaesth* 2002;89:254-259.
9. Greher M, Retzl G, Niel P, Kamolz L, Marhofer P, Kapral S. Ultrasonographic assessment of topographic anatomy in volunteers suggests a modification of the infraclavicular vertical brachial plexus block. *Br J Anaesth* 2002;88:632-636.
10. Ting PL, Sivagnanaratnam V. Ultrasonographic study of the spread of local anaesthetic during axillary brachial plexus block. *Br J Anaesth* 1989;63:326-329.
11. Kirchmair L, Entner T, Kapral S, Mitterschiffthaler G. Ultrasound guidance for the psoas compartment block: an imaging study. *Anesth Analg* 2002;94:706-710.
12. Kirchmair L, Entner T, Wissel J, Moriggl B, Kapral S, Mitterschiffthaler G. A study of the paravertebral anatomy for ultrasound-guided posterior lumbar plexus block. *Anesth Analg* 2001;93:477-481.
13. Marhofer P, Schrogendorfer K, Koinig H, Kapral S, Weinstabl C, Mayer N. Ultrasonographic guidance improves sensory block and onset time of three-in-one blocks. *Anesth Analg* 1997;85:854-857.
14. Marhofer P, Schrogendorfer K, Wallner T, Koinig H, Mayer N, Kapral S. Ultrasonographic guidance reduces the amount of local anesthetic for 3-in-1 blocks. *Reg Anesth Pain Med* 1998;23:584-588.
15. Rawal N, Hylander J, Nydahl PA, Olofsson I, Gupta A. Survey of postoperative analgesia following ambulatory surgery. *Acta Anaesthesiol Scand* 1997;41:1017-1022.
16. Ilfeld BM, Morey TE, Enneking FK. Continuous infraclavicular brachial plexus block for postoperative pain control at home: A randomized, double-blinded, placebo-controlled study. *Anesthesiology* 2002;96:1297-1304.
17. Provenzano DA, Viscusi ER, Adams SB Jr, Kerner MB, Torjman MC, Abidi NA. Safety and efficacy of the popliteal fossa nerve block when utilized for foot and ankle surgery. *Foot Ankle Int* 2002;23:394-399.
18. Chan VW. Nerve localization—Seek but not so easy to find? *Reg Anesth Pain Med* 2002;27:245-248.
19. Brown DL. *Popliteal block, Atlas of Regional Anesthesia.* Philadelphia, PA: W.B. Saunders Co; 2002:109-113.
20. Vloka JD, Hadzic A, April E, Thys DM. The division of the sciatic nerve in the popliteal fossa: Anatomical implications for popliteal nerve blockade. *Anesth Analg* 2001;92:215-217.
21. Vloka JD, Hadzic A, Lesser JB, Kitain E, Geatz H, April EW, Thys DM. A common epineural sheath for the nerves in the popliteal fossa and its possible implications for sciatic nerve block. *Anesth Analg* 1997;84:387-390.