Anatomic Basis to the Ultrasound-Guided Approach for Saphenous Nerve Blockade

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Background and Objectives: Successful blockade of the saphenous nerve using surface landmarks can be challenging. We evaluated the anatomic basis of performing a saphenous nerve block with ultrasound (US) using its relationship to the saphenous branch of descending genicular artery, sartorius muscle, and the adductor hiatus as defined by cadaveric measurements.

Methods: Using a total of 9 cadaveric knee dissections, the saphenous nerve and its relationship to the saphenous branch of the descending genicular artery (SBDGA) were examined. The distances from the patella to the distal end of the adductor canal and the bifurcation of the saphenous nerve were recorded. US images of an above-the-knee, subsartorial saphenous nerve block were reviewed.

Results: The saphenous nerve coursed with the SBDGA. It exited the adductor canal at a median of 10.25 cm (range, 7.0–11.5 cm) cephalad to the proximal patellar border and traveled closely with the SBDGA. At its bifurcation into the infrapatellar branch and sartorial branch, the saphenous nerve was at its closest approximation to the SBDGA. This point was found to be at a median of 2.7 cm (range, 2.1–3.4 cm) cephalad and a median of 6.6 cm (range, 5.0–9.0 cm) posterior to the proximal and posterior patellar border, respectively.

Conclusions: The US-guided approach for saphenous nerve blockade using its close anatomic relationship to the SBDGA is a feasible alternative to previously described surface landmark–based or US-guided paravenous approaches.

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Sciatic nerve blockade in the popliteal fossa with an associated saphenous nerve block is a well-established regional anesthesia technique for surgeries distal to the knee.[1] Several techniques have been described to block the saphenous nerve. Traditionally, a subcutaneous wheal of local anesthetic is injected from the medial aspect of the tibial tuberosity to the anterior border of the medial head of the gastrocnemius muscle[2]; however, this has been associated with a high failure rate.[3] Improved success has been reported with surface landmark approaches such as the transsartorial,[4] the paravenous,[5] and peripheral nerve stimulation[6] techniques. Gray and Collins[7] published a letter to the editor in 2003 describing the use of ultrasound (US) to identify the saphenous vein below the knee and injected local anesthetic in the same fascial plane. In a comparison study, Benzon et al[8] demonstrated only 10% success with an injection at the femoral condyle, 70% success with a peripheral nerve stimulation perifemoral injection, 70% success with a below-the-knee field block, and 100% success with a peripheral nerve stimulation paresthesia–elicited transsartorial approach. Consistent with our own experience, these studies confirm a low success rate with a landmark-only technique and suggest that using a specific method to find the nerve, that is, transsartorial approach, nerve stimulation, or US, is likely to be more effective.[8] Despite the success of Benzon et al[8] with the transsartorial approach, landmarks without the aid of US can prove difficult to identify, especially in obese patients.

Several authors have demonstrated an improved outcome using US guidance.[9,10] Although most nerves from the brachial, lumbar, and sacral plexuses have been successfully blocked with US guidance, little data are available for the saphenous nerve. Lundblad et al[11] reported a US method to identify the saphenous nerve and its infrapatellar branch. Krombach and Gray[12] published a letter describing the use of US to block the saphenous nerve at the vastoadductor membrane more proximally, providing insight for our technique.

ANATOMY

The saphenous nerve, a terminal branch of the posterior division of the femoral nerve, provides sensory innervation to the medial, anteromedial, and posteromedial aspects of the lower extremity from the distal thigh to the medial malleolus. The saphenous nerve separates from the femoral nerve in the proximal third of the thigh, courses through the adductor canal with the femoral artery, and emerges from the canal with the saphenous branch of the descending genicular artery (SBDGA)[13] (Fig. 1). After the saphenous nerve leaves the adductor canal, it divides into the infrapatellar branch, which provides a sensory branch to the peripatellar plexus of the knee, and the sartorial branch, which perforates the superficial fascia between the gracilis and sartorius muscles and emerges to lie in the subcutaneous tissue below the knee fold. It then descends along the medial tibial border with the long saphenous vein, giving multiple cutaneous branches to the medial aspect of the leg, ankle, and forefoot. The anatomic relationship of the saphenous nerve with its surrounding muscles and tendons has been well described by a combined cadaver–magnetic resonance imaging study showing that the saphenous nerve lies between the sartorius and gracilis muscles at the level of the knee joint.[14] Although the course of the saphenous nerve is clearly defined in relation to the gracilis and sartorius muscles, we studied cadaveric knees to characterize the relationship of the saphenous nerve to the SBDGA, proximal to the joint line, which has not been described yet.

METHODS

Cadaver Study

Our institutional review board approved the research on cadavers procured in this study. Nine knees from embalmed whole cadavers were dissected. All the specimens were supine and in full extension. The skin and subcutaneous tissues of the anterior and medial thigh from the level of the femoral triangle to the level of the medial tibial condyle were carefully removed to reveal the relationship of the sartorius muscle to the vastus medialis muscle. The sartorius muscle was reflected anteriorly, to reveal the adductor canal and subsartorial compartment at

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the distal end of the adductor canal. The course of the saphenous nerve was followed from within the adductor canal to the point where it emerged from the distal end of the adductor canal and then further distally to its bifurcation into the infrapatellar and sartorial branches (Fig. 2).

Careful measurements were taken from reproducible landmarks by 2 independent examiners. The surface landmark of the proximal and medial patella was used because it is easily palpable in most patients. The longitudinal distance from the proximal border of the patella and the anteroposterior distance from the medial border of the patella to the bifurcation of the saphenous nerve into the infrapatellar and sartorial branches were recorded. Also, the distance from the distal aspect of the adductor canal to the proximal border of the patella was measured. Measurements were rounded to the nearest millimeter and recorded as median with ranges.

US Imaging

Our institutional review board was contacted for this case report and waived their requirement for a formal approval as it

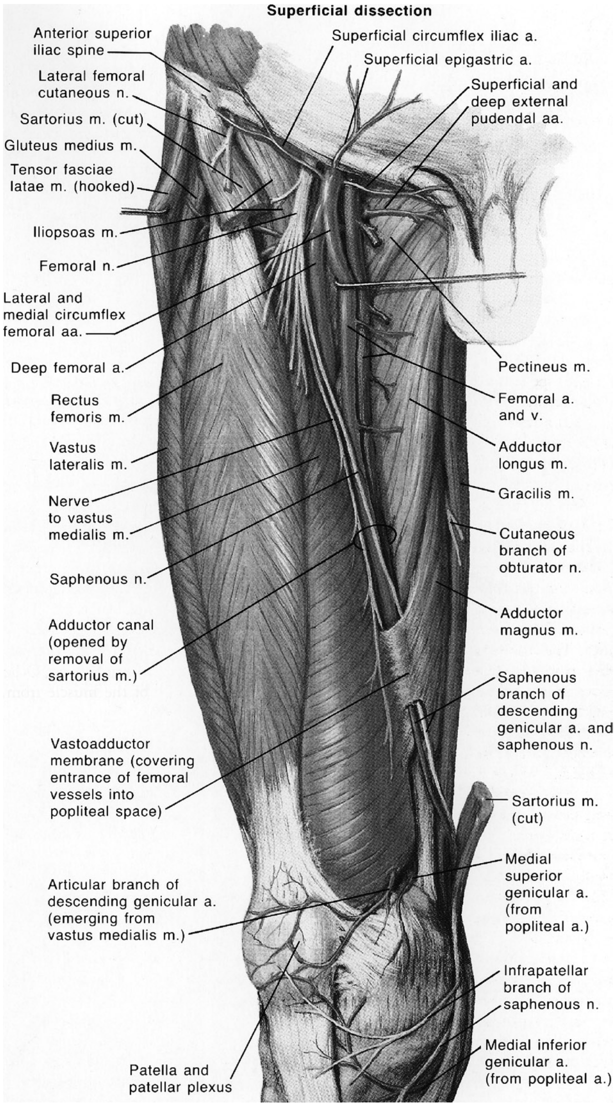

FIGURE 1. Anatomic drawing. Used with permission from Netter; Atlas of Human Anatomy, 2006, © Elsevier.

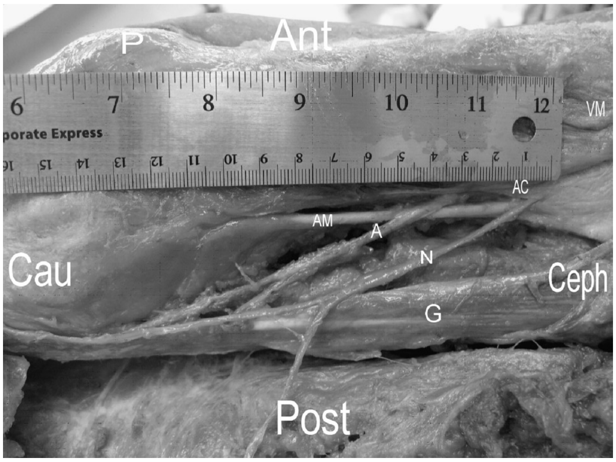

FIGURE 2. Medial view of a dissected knee. The sartorius muscle is reflected to expose the anatomic structures. Cau indicates caudate; Ceph cephalad; Ant, anterior; Post, posterior; A, artery of the descending genicular; N, saphenous nerve; G, gracilis muscle and tendon; AC, adductor canal; P, patella; VM, vastus medialis; AM, tendon of the adductor magnus.

involves retrospective data review of a routine anesthetic technique. The block was performed in prone position on a 43-year-old man, 173-cm, 77-kg, American Society of Anesthesiologists physical status I, scheduled for ankle surgery. Conscious sedation was provided with fentanyl and midazolam. Ultrasound imaging for the saphenous nerve blockade was accomplished with an L12-3 probe connected to an HD11XE (Philips Ultrasound, Bothell, Wash). A mark was made approximately 2.7 cm cephalad to the proximal patellar border to aid in preliminary scanning (middle lateral line). The probe was then covered with a sterile transparent dressing (Tegaderm; 3M Health Care, Borken, Germany), and sterile ultrasonic gel (Aquasonic 100, Fairfield, NJ) was used. The leg was prepared in sterile fashion using chlorhexidine/alcohol (Chloraprep with tint; Enturia Inc, Leawood, Kan) (Fig. 3).

The saphenous nerve was blocked after a US-guided popliteal approach for the sciatic nerve blockade. The US probe was repositioned on the medial surface of the knee, with the probe placed in transverse orientation relative to the sartorius muscle (Fig. 3A). The goal was to obtain short-axis views of the muscles, saphenous nerve, and SBDGA. The vastus medialis was identified anteriorly, and the sartorius muscle was located superficially (medial) and posterior to the vastus medialis. The gracilis muscle was located directly posterior to the sartorius muscle (Fig. 3B), and the saphenous nerve and SBDGA lay deep to the sartorius muscle within a subsartorial fascial plane. The saphenous nerve appeared as a hyperechoic, round to oval structure, which is often surrounded by a rim of hypoechoic perineural fat (so-called subsartorial fat-pad). The SBDGA typically appears as a small pulsatile anechoic circular structure directly adjacent to the saphenous nerve. Color flow Doppler was used to identify the artery that is often too small to visualize without Doppler. The color flow Doppler was set at 3.8 MHz, 65% gain with a scale ranging from −5 to + 5 cm/sec. After the transducer was positioned to identify the SBDGA, a short-bevel, 22-gauge, 50-mm needle (Stimuplex; B. Braun Medical Inc, Bethlehem, Pa) was advanced vertically from posterior to anterior using an in-plane technique (to the US beam)[15] for needle advancement toward either the saphenous nerve (when visible) or the SBDGA from the posterior insertion point in this

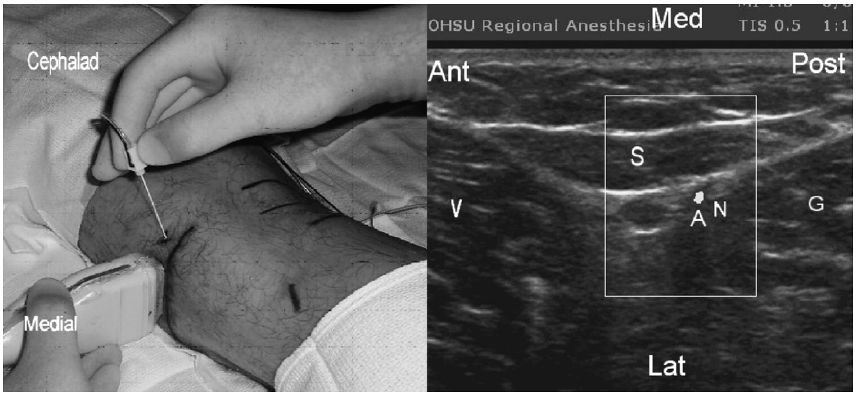

FIGURE 3. A, Block performance. The posterior aspect of the knee is prepared for the sciatic nerve block and saphenous nerve block, with the patient in prone position. The probe is positioned on the medial aspect of the knee. The middle lateral line marks the proximal border of the patella. The needle was advanced in-plane with the probe under direct US visualization. B, Ultrasound image. Color Doppler displays the SBDGA, deep to the sartorius muscle. Med, medial; Lat, lateral; Post, posterior; Ant, anterior; A, saphenous branch of the descending branch of the genicular artery; N, saphenous nerve; G, gracilis muscle; V, vastus medialis; S, sartorius muscle.

case. Once the needle tip was located in close proximity to the target structures, gentle aspiration was performed followed by incremental injection of 8 mL of ropivacaine 0.5% (Naropin, Novaplus; AstraZeneca, Wilmington, Del) within the subsartorial compartment around the SBDGA. The block was assessed with cold spray in the sartorial and infrapatellar branch distributions first and then with pinprick before surgical incision in the sartorial branch distribution.

RESULTS

Anatomic Findings From Dissections

The saphenous nerve runs with the SBDGA as it exits the adductor canal. The sartorius muscle is reflected to expose the subsartorial compartment. The median distance from the proximal patella to the distal end of the adductor canal is 10.25 cm, with a range of 7 to 11.5 cm. The bifurcation of the saphenous nerve was measured in 2 dimensions: anterior-posterior and caudad-cephalad with respect to the proximal and medial borders of the patella, respectively. The infrapatellar branch of the saphenous nerve is reflected downward. The median distance from the medial border of the patella to the bifurcation of the infrapatellar and sartorial branches of the saphenous nerve was 6.6 cm (range, 5.0–9.0 cm) in the anterior-posterior dimension. The median distance from the proximal border of the patella to the same point was 2.7 cm (range, 2.1–3.4 cm) in the caudad-cephalad dimension. Left-to-right variability on the cadaver specimens ranged from 0 to 0.9 cm (anterior-posterior) and 0 to 0.8 cm (caudad-cephalad). Interobserver variability was 0 to 0.2 cm. At its bifurcation into the infrapatellar branch and sartorial branch, we found that the saphenous nerve was at its closest approximation to the SBDGA artery (Fig. 2). A typical US image with color flow Doppler (Fig. 3B) of the subsartorial compartment was captured before injection of local anesthetic for the saphenous nerve block. The sartorial branch of the saphenous nerve was successfully anesthetized, and the patient underwent ankle surgery with light sedation (Fig. 2).

DISCUSSION

We describe the anatomic basis for a US-guided subsartorial saphenous nerve block that offers advantages over previously reported techniques. Using US to identify the SBDGA and its relationship to the saphenous nerve, we have shown an important vascular landmark to block the saphenous nerve.

Based on our cadaveric studies, the saphenous nerve reliably traverses the distal thigh with the SBDGA. We have found that at the point where the infrapatellar branch divides from the sartorial branch at approximately 2.7 cm proximal to the patellar border, the saphenous nerve is within its closest proximity to the artery. Because the saphenous nerve may be challenging to identify in some patients with only 2-dimensional US imaging, we take advantage of US imaging and the close anatomic relationship of the SBDGA via use of color flow Doppler to guide the injection.

Several approaches to block the saphenous nerve have been described with and without US guidance with variable success. Benzon et al[8] achieved the best success rate but used a nerve stimulator to elicit paresthesias with their transsartorial approach, which may be uncomfortable for the patient. Also, landmark-based approaches can become challenging in the obese population. Even with US, the sartorius muscle may be very thin and hard to identify in some populations. With technological advancements and improved economy, ultrasonographic guidance is increasingly used successfully to perform high-quality peripheral nerve blocks.

The identification of the saphenous nerve was greatly facilitated with color Doppler visualization of the SBDGA running with the nerve. The artery is usually easy to identify. More proximally, the sonographer can identify the femoral artery within the adductor canal, but caution should be used here because it is a tight compartment where nerve entrapment has been responsible for saphenous neuropathy.[16] We chose to block the nerve several centimeters after it exits the adductor canal when it is in close proximity to the SBDGA, approximately 2.7 cm above the proximal patellar border based on the cadaver study. More distally, the saphenous nerve divides into the infrapatellar and sartorial branches, and the anatomic relationships may be less predictable, yielding inconsistent or less dense blocks with more distal approaches.

While we described the saphenous nerve block performed in the prone position, it is also important to note that we have used the described US-guided landmark technique in the supine position when indicated. In the supine position, the approach is from anterior to posterior, with the needle tip directed toward the SBDGA within the subsartorial fat-pad.

Correlating our dissections with clinical anatomy from US imaging, we have found a reliable blockade of the saphenous nerve when using US by exploiting its intimate anatomic relationship with the SBDGA artery and sartorius muscle just proximal to the patella.

Disadvantages of the US-guided approach to the saphenous nerve block include the need for a high-quality US machine with a high-frequency probe (8–12 mHz) and color flow Doppler capability and proficiency in US-guided nerve block techniques. Knowledge of the pertinent anatomic structures is essential with any peripheral nerve block under US visualization. This study demonstrates the feasibility of the US-guided approach and was not designed to prove efficacy or safety, which will require a rigorous prospective clinical study.

In conclusion, the saphenous nerve can be precisely located, taking advantage of its close anatomic relationship to the SBDGA within the subsartorial compartment just proximal to the knee joint line and deep to the sartorius muscle using US guidance. This relationship can be used to facilitate a successful saphenous nerve blockade.

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