Infragluteal-Parabiceps Sciatic Nerve Block: An Evaluation of a Novel Approach Using a Single-Injection Technique

Radha Sukhani, MD, Kenneth D. Candido, MD, Robert Doty, Jr., MD, Edward Yaghmour, MD, and Robert J. McCarthy, PharmD

Department of Anesthesiology, Northwestern University, Feinberg School of Medicine, Chicago, Illinois

Clinical use of the sciatic nerve block (SNB) has been limited by technical difficulties in performing the block using standard approaches, substantial patient discomfort during the procedure, or the need for two injections to block the tibial and peroneal nerves. In this report, we describe a single-injection method for SNB using an infragluteal-parabiceps approach, where the nerve is located along the lateral border of the biceps femoris muscle. SNB was performed in the prone or lateral decubitus position. The needle was positioned (average depth, 56 ± 15 mm) to the point where plantar flexion (53%) or inversion (45%) of the ipsilateral foot was obtained at ≤0.4 mA. Levobupivacaine 0.625% with epinephrine (1:200:000) was administered at a dose of 0.4 mL/kg. The procedure was completed in 6 ± 3 min. Discomfort during block placement was treated with fentanyl 50–100 μg in 24% of patients. Complete sensory loss and motor paralysis occurred in 92% of subjects at a median time of 10 (range, 5–25) min after injection. Compared with plantar flexion, foot inversion was associated with a more frequent incidence (86% versus 100%), and shorter latency for both sensory loss and motor paralysis of the peroneal, tibial, and sural nerves. There were no immediate or delayed complications. We conclude that the infragluteal-parabiceps approach to SNB is reliable, efficient, safe, and well tolerated by patients.

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To be widely accepted in clinical anesthesia practice, a peripheral nerve blocking technique must be technically simple, use easily identifiable landmarks, produce minimal patient discomfort, and provide prompt onset of surgical anesthesia. Although several approaches to sciatic nerve block (SNB) have been described, limitations of these techniques preclude greater use in clinical anesthesia practice (1–6). SNB has been perceived as being technically demanding, painful for the patient, and providing unreliable anesthesia for several reasons: difficulty in identifying bony landmarks (particularly in overweight patients), substantial patient discomfort because most approaches require needle passage through dense gluteal or thigh musculature, or the need for two injections to achieve surgical anesthesia of both the tibial nerve and common peroneal nerve (7,8).

In an effort to delineate the surface anatomy and anatomic relationship of the sciatic nerve in the posterior thigh distal to the gluteus maximus muscle, 10 cadaver dissections were performed. In the infragluteal location, the sciatic nerve lies over the adductor magnus and is crossed obliquely in a mediolateral direction by the long head of the biceps femoris. The sciatic nerve, therefore, lies at first lateral to and subsequently deep to the long head of the biceps femoris muscle. For a short distance (3–4 cm), where the nerve lies lateral to the long head of the biceps femoris, there is no overlying musculature and the nerve is covered only by skin and subcutaneous tissue (Fig 1). The approach to the nerve in this area can be determined by using two easily identifiable landmarks: the lateral border of the biceps femoris muscle and the lower border of the gluteus maximus (gluteal crease or natal fold) (Fig. 2). Additionally, at this point, the tibial and common peroneal nerves lie in close approximation and are covered by a common connective tissue sheath, such that a single injection of local anesthetic may produce a complete block of both components of the sciatic nerve (Fig. 1, inset).

Our purpose was to evaluate the time required to perform, and the efficacy and complications of a single-injection SNB using the infragluteal-parabiceps approach. Because the prompt onset of surgical anesthesia in both components of the sciatic nerve is an important consideration in a clinical setting, we also examined the impact of evoked motor response on the

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Address correspondence to Radha Sukhani, MD, Department of Anesthesiology, 251 E. Huron, Olson 7-428, Chicago, IL 60611. Address e-mail to radhasukhani@yahoo.com.

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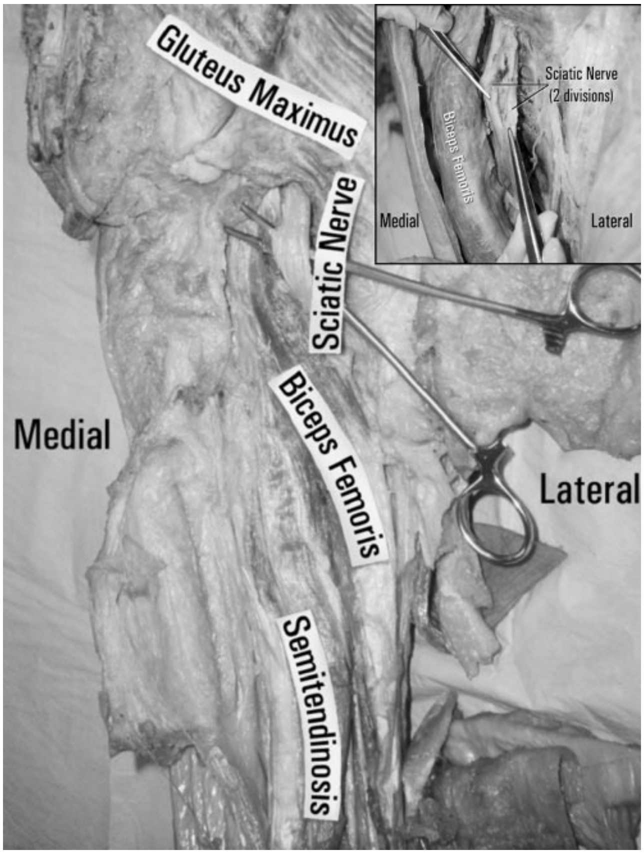

Figure 1. Dissection of the gluteal region and upper thigh demonstrating the relationship of the sciatic nerve to the gluteus maximus and biceps femoris muscles. At the distal border of the gluteus maximus, the sciatic nerve lies alongside the lateral border to the biceps femoris muscle. At this point, the nerve is superficial and, for a short distance (1–3 cm), is covered only by skin and subcutaneous tissues. Inset, Dissection of the nerve sheath showing two distinct divisions of the sciatic nerve. The larger posterior tibial nerve lies medially and the smaller peroneal nerve laterally.

latency and extent of sensory and motor block in the distribution of the tibial and common peroneal nerves.

Methods

After IRB approval, written informed consent for study participation was obtained from 100 patients (>18 yr of age) scheduled to receive an SNB as a component of their anesthesia management for elective reconstructive ankle surgery. Excluded were patients who had hemostatic abnormalities, chronic pain syndromes, or preexisting neuropathy or neuromuscular disease that could interfere with data collection. Patients were also excluded if they were receiving chronic opioid analgesia therapy, or reported a history of allergy to amide local anesthetic drugs.

The SNB was performed a minimum of 45 min before the start of surgery. Ninety-nine of the blocks were initiated by resident trainees under the supervision of one of the authors, who each have experience

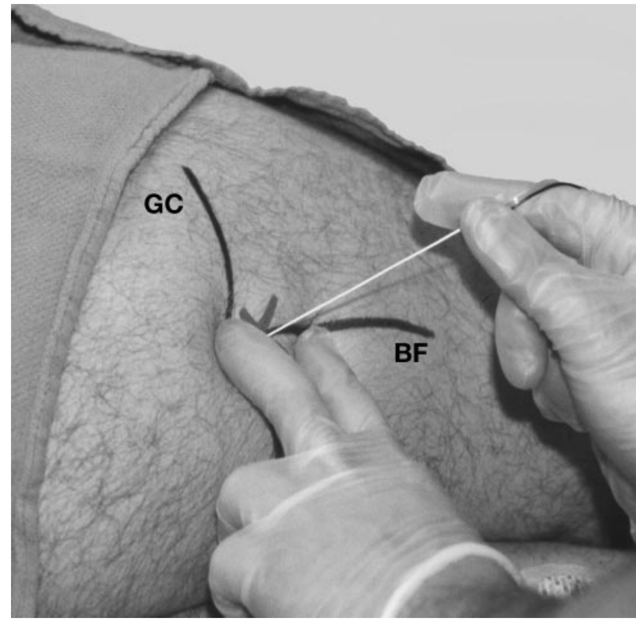

Figure 2. Anatomical landmarks for the infragluteal-parabiceps approach to the sciatic nerve: GC = gluteal crease, BF = lateral border of biceps femoris muscle, X = needle entry site (1 cm distal to the gluteal crease alongside the biceps femoris. The needle is advanced in a slightly cephalad direction at a 70°–80° to the skin-gurney plane with a cephalad and anterior orientation within the parasagittal plane.

in regional block techniques including the infragluteal-parabiceps approach. After placement of standard American Society of Anesthesiologists (ASA) monitors, a peripheral IV access was established and baseline vital signs were recorded. All patients received midazolam 2–5 mg IV before the procedure. The procedures were preferentially performed with the patient in the prone position. The lateral decubitus position, with the extremity to be blocked up, rolled forward, and the knee flexed to 90° was used when patients could not be positioned prone. The leg was supported to permit unrestricted movement of the foot in response to nerve stimulation.

The surface landmarks for the infragluteal-parabiceps approach were the gluteal crease and the lateral border of the biceps femoris muscle. When more than one gluteal crease was encountered, the proximal crease was accepted as the landmark. The point of needle entry was marked at 1 cm distal to the gluteal crease along the lateral border of the biceps femoris muscle (Fig. 2). The skin at the needle entry site was infiltrated with 2 mL of lidocaine 1% using a 25-gauge, 38-mm hypodermic needle. To locate the nerve and for the nerve block, a 50-mm 22-gauge insulated needle (B-Braun/McGaw Medical, Bethlehem, PA) was used for patients weighing ≤60 kg, and a 100-mm needle was used for patients >60 kg. The needle was connected to the negative lead of a constant voltage nerve stimulator (Stimuplex DIG;

B-Braun/McGaw Medical) and inserted through the skin at an angle of 70°–80° to the skin-gurney plane with a cephalad and anterior orientation within the parasagittal plane (Fig. 2). The stimulation frequency was set at 2 Hz, pulse width at 100 μs, and the intensity of the stimulating current was set to deliver 1.0–1.2 mA.

The needle position was considered optimal only if the evoked motor response obtained was a brisk plantar flexion, an inversion, or a dorsiflexion of the foot at ≤0.4 mA. If an eversion of the foot was noted, the needle was withdrawn and redirected 2–3 mm medially. If the needle contacted bone (femur), it was retracted to the superficial tissue plane, the skin was retracted medially in 2- to 3-mm increments and the needle reintroduced. If a biceps femoris contraction was produced upon needle advancement, the needle was withdrawn to the superficial tissue plane, the skin retracted laterally in 2- to 3-mm increments, and the needle reintroduced. Levobupivacaine 0.625% with epinephrine 1:200,000 (Chirocaine®; Purdue Pharma, Stamford, CT) was then injected in 5-mL aliquots with aspiration between aliquots to a total volume of 0.4 mL/kg (minimum, 25 mL; maximum, 35 mL). Fentanyl, 50–100 μg IV, was administered to patients who reported discomfort (Verbal Rating Score for Pain [VRSP] >4) during the block procedure. As indicated by the surgical procedure, patients received either supplemental femoral nerve block or saphenous nerve blocks above the medial malleolus.

Assessments for the onset of sensory and motor block were performed every 2 min for 10 min and then at 5-min intervals up to 30 min by 2 observers working simultaneously. Sensory block assessments were performed in the distribution of the superficial peroneal nerve, common peroneal nerve, posterior tibial nerve, and sural nerve. A 3-level scale was used to grade the intensity of sensory block using pinprick stimulation: 0 = normal sensation (pin prick felt as sharp), 1 = analgesia (pin prick felt, but not sharp), and 2 = anesthesia (pin prick not felt at all). Motor block intensity was also graded on a 3-level scale: 0 = normal strength (no discernible weakness), 1 = paresis (diminished movement), and 2 = paralysis (no movement at all). Motor block assessments performed were plantar flexion (representing tibial nerve component) and dorsiflexion of the foot at the ankle (representing peroneal nerve component), and toe movements (representing both tibial and peroneal components). A complete block was defined as one associated with Grade II sensory anesthesia and Grade II motor block in the distribution of both the tibial as well as peroneal nerves. Patients who did not have complete anesthesia at the surgical site by the end of a 30-min period were given the option of supplemental popliteal SNB or general anesthesia.

Additional study variables that were recorded included patient age, weight, sex, ASA physical status, the block performance time (time from initiation of block procedure to completion of local anesthetic injection), depth of the needle at which the injection was made, duration of surgery, tourniquet time, and duration of analgesia (time from the completion of block to the first report of pain at the surgical site). Assessments for complications were made before hospital discharge and by telephone follow up at 1 wk and 1 mo after surgery. At these times, patients were specifically questioned in lay terms regarding the presence of paresthesias, dysesthesias, prolonged anesthesia, or unexpected motor deficits.

The sample size estimated for this study ($n = 108$) was determined to detect a difference in the frequency of a complete block among patients exhibiting plantar flexion-, dorsiflexion-, or inversion-evoked motor response at $\alpha = 0.05$, w = 0.3, and power = 0.80. The frequency of complete block, sex, and ASA physical status were compared among groups by using the Fisher's exact test or the χ^2 test. Tourniquet time, age, weight, duration of surgery, and current intensity at needle positioning was compared among groups by using an independent sample *t*-test. The Mann-Whitney *U*-test was used to compare block latencies to a sensory score of 2 or a motor score of 2 in the distributions of the component nerves among groups. A $P < 0.05$ was required to reject the null hypothesis.

Results

The demographic and clinical characteristics of the patients are listed in Table 1. The types of surgical procedures were: ankle arthroscopy for debridement or fusion (30%), tendon repair or transfers (30%), open repair of ankle fracture (25%), tarsal tunnel release, and miscellaneous (15%). Additional blocks, administered on the basis of the surgical procedure site, were saphenous nerve blocks in 66%, and femoral nerve blocks in 33% of the patients.

Eighty-five percent of the blocks were placed with the patient in the prone position, and 94% were completed by resident trainees. The time to complete the SNB, i.e., the time from local anesthetic infiltration at the needle entry site to sciatic nerve location with optimal motor response and completion of local anesthetic injection, was 6 ± 3 (range, 2–15) min. The average depth of the needle was 55 ± 15 (range, 30–90) mm at the point of evoked motor response. Paresthesias were encountered during nerve localization in 4% of patients, although no patient reported a paresthesia during local anesthetic injection. Discomfort during the procedure, necessitating fentanyl for analgesia, was encountered in 24% of patients.

Table 1. Demographic and Clinical Characteristics

	Overall	Evoked motor response: Plantar flexion	Evoked motor response: Inversion
No. of subjects	99	53	45
Age (yr)	43 ± 16	44 ± 16	43 ± 16
Weight (kg) (range)	84 ± 17 (52–158)	84 ± 17 (57–158)	85 ± 17 (52–140)
Sex: male/female (*n*)	61/38	33/20	27/18
Surgical duration (min)	84 ± 42	78 ± 39	88 ± 44
Tourniquet time (min)	55 ± 28	50 ± 23	59 ± 31
ASA I:II:III:IV (*n*)	51:41:5:2	30:20:2:1	21:20:3:1
Duration of analgesia (h)	19 ± 7	19 ± 6	19 ± 7

Data presented as mean ± SD unless specified.

Of the 100 patients enrolled, 98 completed the study and were included in the data analysis. Neither plantar flexion nor inversion could be evoked in the two patients who were not included in the data analysis. In one, dorsiflexion only was observed and in the other, the nerve block was abandoned because of difficulty in locating the nerve. The evoked motor response at needle placement was plantar flexion in 53 patients and inversion in 45 patients. The current at evoked response was similar in the plantar flexion (0.35 ± 0.03) and inversion (0.34 ± 0.04) groups.

The rate of complete block was 92%, and was more in patients demonstrating inversion (100%) compared with those demonstrating plantar flexion (86%) evoked motor response ($P = 0.014$, Fisher's exact test). Latencies to the onset of analgesia and anesthesia in the distributions of the posterior tibial, superficial peroneal, common peroneal, and sural nerve were not different within the plantar flexion or inversion response groups, but were shorter in all distributions in the inversion group (Fig. 3). Similarly, latencies to motor paresis and paralysis for three motor functions of the foot (plantar flexion: tibial nerve; dorsiflexion: common peroneal nerve; and toe movement: tibial and common peroneal nerves) were shorter in the inversion motor response group (Fig. 3). Of the seven patients who had partial block, five patients agreed to receive additional popliteal sciatic blocks, and two patients received general anesthesia to undergo the surgical procedure. The duration of analgesia was comparable between motor-evoked response groups (plantar flexion, 19 ± 6 h; inversion, 19 ± 7 h). There were no immediate or delayed complications related to SNB in the study group.

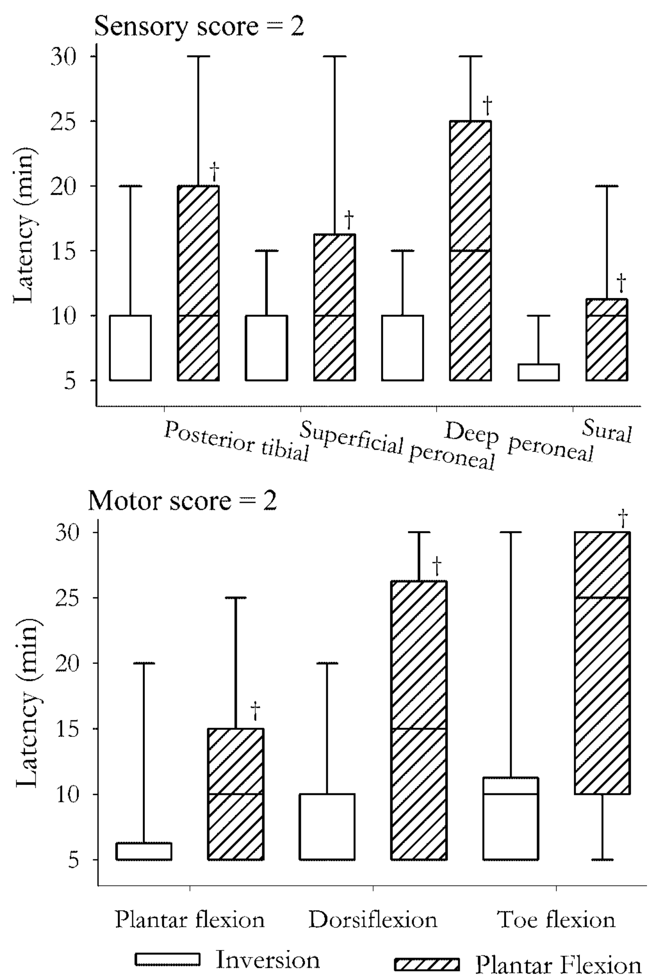

Figure 3. Box plots showing the effect of evoked motor response to nerve stimulation (<0.4 mA) before the injection of levobupivacaine 0.625% (0.4 mL/kg) on the latency of anesthesia (sensory score = 2) and motor paralysis (motor score = 2) in patients receiving infragluteal-parabiceps sciatic nerve blocks. Box represents 25th–75th percentiles, lower and upper whiskers 10th and 90th percentiles with solid horizontal line or top line of box equal to the median (†different from inversion, $P < 0.05$).

Discussion

Many published approaches to SNB are designed to block the nerve as it exits the pelvis where it lies in close proximity to the pelvic bones beneath the gluteal or thigh musculature. The advantage of blocking the sciatic nerve at this level is to achieve blockade of all the component nerves of the sciatic, including the posterior cutaneous nerve of the thigh. Because the posterior cutaneous nerve does not innervate structures below the knee, it does not need to be blocked for ankle surgery, and one may use a more distal approach to SNB that may be less uncomfortable to the patient.

The present study demonstrated that the infragluteal-parabiceps approach offers distinct advantages over traditional proximal posterior and anterior approaches for SNB. The approach used non-bony landmarks—gluteal crease and lateral border the long head of the biceps femoris—which were identifiable even in obese patients. The block was well tolerated by most patients with only 24% of patients reporting some discomfort (VRSP >4). SNB placement was performed without technical difficulty; nerve localization was achieved in all but 1 subject and was generally obtained within 6 minutes of needle entry primarily by resident trainees.

The posterior subgluteus approach to SNB has been described and compared with the traditional Labat approach by Di Benedetto et al. (9). This method relied on bony landmarks (greater trochanter and ischial tuberosity) and the point of needle entry was 4 cm distal to the point used for the Labat approach. By magnetic resonance imaging, the point of needle entry was 3 cm above the lower limit of the gluteus maximus muscle. Forty-eight percent of the patients reported moderate-to-severe discomfort during the procedure and the authors attributed reduced patient discomfort during block placement to the shallower depth (compared with Labat's approach) at which the sciatic nerve was identified (45 ± 13 mm versus Labat 67 ± 12 mm).

In the present study, the needle entry site was at the lower limit of the gluteus maximus muscle (gluteal crease), distal to the site used by Di Benedetto et al. (9). The sciatic nerve was identified at a depth of 55 ± 15 mm and 24% of patients reported moderate discomfort (VRSP >4). In the current study, unlike the study of Di Benedetto et al., patients received a sedative dose of midazolam but all were alert and conversant with the investigators during the procedures. Taken together, the results of the present study and that by Di Benedetto et al., support the idea that the posterior approach to SNB performed at a more distal level than the traditional Labat approach produces less patient discomfort because the nerve at the distal location is at a shallow depth with less overlying muscle tissue.

The type of evoked motor response obtained was noted to impact both latency and success of complete block. Compared with patients with plantar flexion-evoked motor responses, patients exhibiting inversion of the foot had significantly faster complete sensory and motor onset times and a more frequent success (100%) of complete block. We chose to exclude eversion (representing stimulation of the superficial peroneal nerve) as the end point for needle location because it has been shown to be associated with more frequent incomplete block, i.e., delayed or no block of the tibial component of the sciatic nerve (10). Therefore, if the evoked motor response was eversion, the needle was withdrawn and redirected 2–3 mm medially until one of the desired responses (inversion, plantar flexion, or dorsiflexion) was obtained.

The intensity of the current at which peripheral nerve stimulation is achieved has also been proposed to be the primary factor determining the quality and extent of the block, rather than the type of evoked motor response obtained using high stimulating currents (11). Using a nerve stimulator to guide needle placement, a rate of 100% for complete block of the sciatic nerve in the popliteal fossa was reported when the motor response was accepted at a stimulating current of <0.4 mA (12). Complete block was defined as anesthesia at the surgical site, but the latency and degree of sensory and motor block in the distributions of the tibial and common peroneal nerves were not specifically assessed.

In the present study, the evoked motor responses that were accepted for needle placement (plantar flexion or inversion) were achieved at stimulating currents <0.4 (0.34–0.36) mA, and inversion was found to be associated with a more rapid onset and increased frequency of complete block than plantar flexion. A similar association between evoked motor response and success of popliteal SNB was reported by Benzon et al. (13), using higher stimulating currents. The results of the current study support the hypothesis proposed by Benzon et al., that inversion of the foot is caused by the action of both the tibialis posterior muscle, which is innervated by the tibial nerve, and the tibialis anterior muscle, which is innervated by the deep peroneal nerve. The increased frequency of complete nerve block with an elicited inversion, therefore, is attributed to the proximity of the needle to both branches of the sciatic nerve (13).

The latency to onset of sensory and motor block with any peripheral nerve block is related to the type and dose (volume and concentration) of local anesthetic injected. The median time for complete blockade of the sciatic nerve has been reported to range between 10–25 minutes using ropivacaine 0.75%, but longer (20–30 minutes) with bupivacaine 0.5% (9,14–16). The median time to onset of complete blockade using levobupivacaine 0.625% in the present study was 10 (range, 5–30) minutes, comparable to that reported with ropivacaine. A limitation of this study is the use of supplemental popliteal SNBs in patients who did not have complete nerve block by 30 minutes, thereby truncating the upper limit of onset times at 30 minutes. An additional limitation to the current study is the lack of a control group preformed with a traditional approach, although the subgluteal approach has been previously compared with the traditional Labat method (9).

In summary, the infragluteal-parabiceps approach to SNB offers distinct advantages over traditional anterior or posterior approaches. The block can be performed by using easily identifiable soft-tissue landmarks without the need for palpation of bony structures, produces less patient discomfort than approaches that traverse more muscular tissue, and can be completed in a short period of time. The type of evoked motor response—plantar flexion versus inversion—impacts both latency and success rate of the block, with shorter latencies to analgesia and motor paralysis in patients with inversion during nerve localization. An additional advantage is the frequent success rate after a *single* injection of local anesthetic for ankle surgery, eliminating the need for additional blocks, and seemingly no procedure-related complications.

References

1. Labat G. Regional anesthesia: its technique and clinical applications. 2nd ed. Philadelphia: WB Saunders, 1922:45–55.
2. Winnie AP. Regional anesthesia. Surg Clin North Am 1975;55: 861–92.
3. Ichiyonagi K. Sciatic nerve block: lateral approach with patient supine. Anesthesiology 1995;20:601–4.
4. Beck GP. Anterior approach to sciatic nerve block. Anesthesiology 1963;24:222–4.
5. Raj PP, Parks RI, Watson TD, Jenkins MT. A new single position supine approach to sciatic-femoral nerve block. Anesth Analg 1975;54:489–93.
6. Chelly JE, Delaunnay L. A new anterior approach to the sciatic nerve block. Anesthesiology 1999;91:1655–60.
7. Bailey SL, Parkinson SK, Little WL, Simmerman SR. Sciatic nerve block: a comparison of single versus double injection technique. Reg Anesth 1994;19:9–13.
8. Fanelli G, Casati A, Garancini P, Torri G. Nerve stimulator and multiple injections technique for upper and lower limb block: failure rate, patient's acceptance, and neurologic complications. Anesth Analg 1999;88:847–52.
9. Di Benedetto P, Bertini L, Casati A, et al. A new posterior approach to the sciatic block: a prospective, randomized comparison with the classic posterior approach. Anesth Analg 2001; 93:1040–4.
10. Pawlowski J, Sukhani R, Frey K, et al. Infragluteal sciatic nerve block: latency versus evoked motor response. Reg Anesth 1999; 24:1.
11. Vloka JD, Hadzic A. The intensity of the current at which sciatic nerve stimulation is achieved is a more important factor in determining the quality of nerve block than the type of motor response obtained. Anesthesiology 1998;88:1408–9.
12. Hadzic A, Vloka JD. A comparison of the posterior versus lateral approaches to the block of sciatic nerve in the popliteal fossa. Anesthesiology 1998;88:1480–6.
13. Benzon HT, Kim C, Benzon HP, et al. Correlation between evoked motor response of the sciatic nerve and sensory blockade. Anesthesiology 1997;87:547–52.
14. Casati A, Fanelli G, Borghi B, Torri G. Ropivacaine or 2% mepivacaine for lower limb peripheral nerve blocks. Anesthesiology 1999;90:1047–52.
15. Casati A, Magistris L, Fanelli G, et al. Small-dose clonidine prolongs postoperative analgesia after sciatic-femoral nerve block with 0.75% ropivacaine for foot surgery. Anesth Analg 2000;91:388–92.
16. Coventry DM, Todd JG. Alkalinization of bupivacaine for sciatic nerve block. Anaesthesia 1989;44:467–70.