

Comparison between Ultrasonographic Visibility during Sciatic Nerve Block by Medial Approach and Popliteal Approach

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peripheral nerve disease, and patients with other major complications were excluded from this study.

Background

When combined with femoral nerve block (FNB), sciatic nerve block (SNB) provides an effective auxiliary means of analgesia for pain after total knee arthroplasty (TKA) [1]. However, several difficulties are encountered when SNB is performed before FNB, because the sciatic nerve (SN) is located on the posterior side while the femoral nerve (FN) is located on the anterior side. For example, when SNB is performed by anterior approach, the procedure can be performed in the supine position, the same as FNB, but a convex type transducer is usually needed because the deep location of SN (about 8 cm, although its depth varies with patients' physique) often makes it difficult to visualize [2-6]. Since a linear transducer is used for ultrasound guidance when blocking FN, which is located closer to the surface, if SNB by the anterior approach is immediately followed by FNB, the transducer needs to be changed. The course of SN in the popliteal region is close to the surface, making SNB in this region easy to perform with a linear transducer. However, since posterior approach is used, the patient's position needs to be changed to the lateral decubitus position, to the prone position, or to the supine position with the knees raised [7-9]. The author devised medial approach for SNB that can be performed in the supine position with a linear transducer [10], thus enabling both nerve blocks without requiring any change in the patient's position or the probe. However, because SN is about 5 cm below the surface when approached from the medial side [11], clear ultrasound images are not always easy to obtain, and the procedure may take a long time.

The objective of this study was to compare visibility of ultrasonographic sciatic nerve (SN) images, time taken to achieve SNB, duration of SNB, and postoperative analgesic effect when SNB is performed with a linear transducer by the medial approach and the popliteal approach.

Methods

The study was approved in advance by the Tokyo Metropolitan Ohtsuka Hospital Ethics Committee (Approval No. 2012-2), and the subjects were 40 patients (ASA-PS1-2) scheduled to undergo total knee arthroplasty. After written consent was obtained from each patient, a table of random numbers (prepared with a computer in advance) was used to randomly assign them to SNB by the medial approach group (M Group, n=20) or by the popliteal approach group (P Group, n=20). Patients scheduled to undergo bilateral surgery, patients with central or

No premedication was administered. In the operation room, electrocardiography, non-invasive blood pressure and peripheral oxygen saturation were recorded at baseline and then every 5 min thereafter. After induction of anesthesia with propofol (1.5-2 mg/kg) and fentanyl (100 mcg), a laryngeal mask (LMA ProSeal™) was inserted to maintain inhalation anesthesia with oxygen (concentration 40%-50%) and sevoflurane (1%-2%). SNB and FNB were used in combination. Intraoperatively, fentanyl and/or remifentanyl were administered as per the discretion of the attending anesthesiologist, guided by intraoperative hemodynamics.

The nerve blocks were performed under general anesthesia. SNB and FNB were performed by using an S-Nerve ultrasonic diagnosis device with an HFL50x/15-6 linear ultrasound transducer (FUJIFILM SonoSite Inc., Tokyo, Japan), and a Stimuplex HNS12 nerve stimulator (B. Braun Aesculap, Tokyo, Japan).

SNB by the medial approach (M Group)

In the supine position, the patient's hip joint was rotated externally, and the knee joint was flexed. The area cleaned with povidone and was draped. The transducer with sterile cover was applied at the point about 10 cm distal to the pubic tubercle to visualize the femur and adductor muscles (Figure 1).



Figure 1: Position of the patient for sciatic nerve block by the medial approach. The hip joint is rotated externally, and knee joint is flexed. The same position as for femoral nerve block was adopted.

The SN is visualized as a hyperechoic structure on the dorsal side of the adductor muscles at the point about 1 cm posterior to the femur [10]. An 8-cm Stimuplex® (B Braun Aesculap, Tokyo, Japan) was

inserted by an out of plane manner, and after a response at 0.5 mA was recorded, 0.5% ropivacaine (25 mL) was injected.

SNB by the popliteal approach (P Group)

In the supine position, the patient's hip and knee joints were flexed, and the knees were kept raised. The area cleaned with povidone. The probe without sterile cover was applied to the popliteal groove, and after identifying the tibial nerve, it was advanced about 5 cm cranial (Figure 2). SN was visualized before bifurcation of the tibial nerve and common peroneal nerve. The 8-cm Stimuplex® (B Braun Aesculap, Tokyo, Japan) was inserted by an in plane manner, and after a response at 0.5 mA was recorded, 0.5% ropivacaine (25 mL) was injected.



Figure 2: Position of the patient for sciatic nerve block by the popliteal approach. The hip and knee joints are flexed, with the knees kept raised. When the sciatic nerve block procedure had been completed, the patient's position was changed to start the femoral nerve block.

FNB

In M Group, FNB was performed following SNB in the same position without additional sterile technique. In P Group, after the patient's leg was turned to straight, the area cleaned with povidone and the transducer was covered. The response of the quadriceps femoris muscle to 0.5 mA stimulation was confirmed with a 5 cm Contiplex® (B. Braun Aesculap, Tokyo, Japan), and after injecting 0.5% ropivacaine (15 mL), a catheter was inserted, and 0.5% ropivacaine (5 mL) was infused through the catheter. Postoperatively, 0.133% ropivacaine was continuously infused via the catheter for 60 hours at a rate of 4 mL/h.

Outcomes

The primary outcome was ultrasonographic visibility of SN. Ultrasound images were evaluated separately by 2 examiners (Y.O. and the assistant), and visibility was rated on a five-grade scale: Grade A (easily seen by both examiners), Grade B (easily seen by one of the examiners), Grade C (seen by one of the examiners, but not easily), Grade D (poorly seen by both examiners, but the block succeeded), and Grade E (poorly seen by both examiners, and required a change of approach). To standardize the procedure, all blocks were performed by the author, and a physician trained in nerve blocks (specialist in anesthesiology or higher expertise level) served as the assistant. A block was judged to be successful if the Raj sign was positive.

Secondary outcomes were time taken to achieve SNB, duration of ankle motion block, and postanesthetic analgesic effect evaluated at 0,

3, 6, 12, 24, and 48 hours postoperatively (Numeric Rating Scale: NRS, 0-5: no pain=0, maximum possible pain=5). The time taken to achieve SNB was measured from the start of positioning for the block to the completion of the drug infusion.

The visibility and NRS data were tested for significant differences between the groups by the Mann-Whitney U-test, and the data for the other parameters were subjected to the t-test. P values <0.05 were regarded as statistically significant.

Results

There were no significant differences in background variables between the two groups (Table 1). SNB was successful in all subjects, and no changes in approach because of difficult visualization were necessary. Ultrasound images are shown in Figure 3.

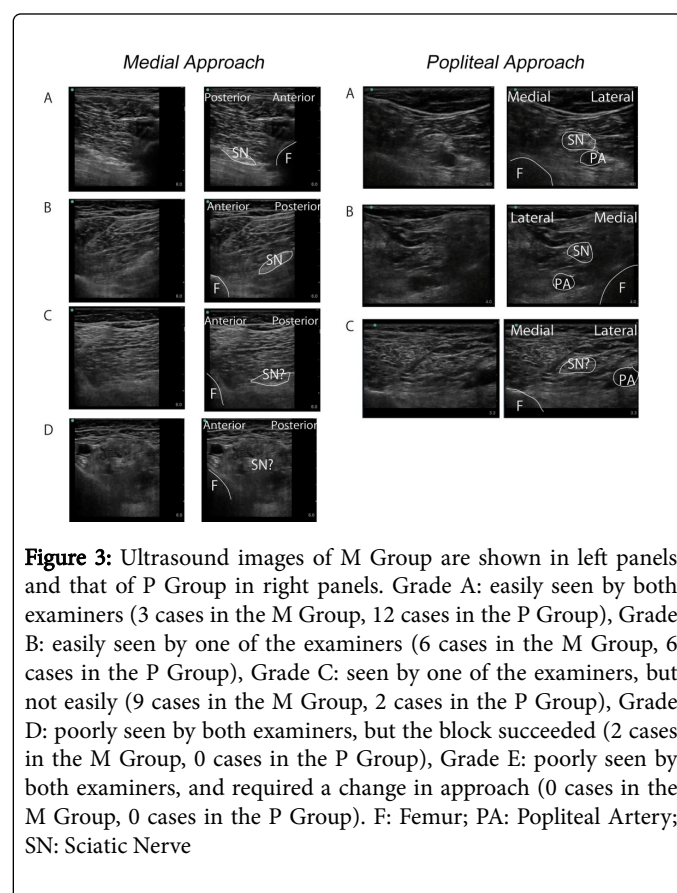


Figure 3: Ultrasound images of M Group are shown in left panels and that of P Group in right panels. Grade A: easily seen by both examiners (3 cases in the M Group, 12 cases in the P Group), Grade B: easily seen by one of the examiners (6 cases in the M Group, 6 cases in the P Group), Grade C: seen by one of the examiners, but not easily (9 cases in the M Group, 2 cases in the P Group), Grade D: poorly seen by both examiners, but the block succeeded (2 cases in the M Group, 0 cases in the P Group), Grade E: poorly seen by both examiners, and required a change in approach (0 cases in the M Group, 0 cases in the P Group). F: Femur; PA: Popliteal Artery; SN: Sciatic Nerve

Ultrasonographic visibility was significantly better in the P Group ($p < 0.05$), and it was rated Grade A in 3 cases in the M Group and 12 cases in the P Group, Grade B in 6 cases in the M Group and 6 cases in the P Group, Grade C in 9 cases in the M Group and 2 cases in the P Group, Grade D in 2 cases in the M Group and 0 cases in the P Group, and Grade E in 0 cases in the M Group and 0 cases in the P Group.

The times taken to achieve the block in the M Group (16.0 ± 7.4 min) and P Group (13.9 ± 8.8 min) did not differ significantly. The duration of the ankle motion block was 14 ± 8 hours in the M Group and 19 ± 3 hours in the P Group ($p < 0.05$, Table 2). There were no differences between the groups in postoperative analgesic effect.

	M Group (n=20)	P Group (n=20)	P value
Sex (Male/Female)	5/15	2/18	
(Male percentage%)	-25%	-10%	
Age	73 ± 7	75 ± 10	0.5
Height (cm)	155 ± 9	153 ± 7	0.56
Weight (kg)	59 ± 9	59 ± 11	0.9
Operation time (minutes)	125 ± 28	117 ± 33	0.47
Anesthesia time (minutes)	207 ± 34	194 ± 39	0.27
Results presented as in number/percentage for gender and in rest parameters mean ± SD.			

Table 1: Patients Backgrounds.

	M Group (n=20)	P Group (n=20)	P value	
Postoperative pain (NRS0-5)				
	Postanesthesia 0 h	0.3 ± 0.9	0.1 ± 0.2	0.3
	Postanesthesia 3 h	0.4 ± 1.2	0.2 ± 0.7	0.41
	Postanesthesia 6 h	0.3 ± 0.6	0.2 ± 0.5	0.53
	Postanesthesia 12 h	1.0 ± 1.4	0.7 ± 1.1	0.35
	Postanesthesia 24 h	1.9 ± 1.5	1.3 ± 1.3	0.26
	Postanesthesia 48 h	1.9 ± 1.3	2.7 ± 1.4	0.07
Procedure time (minutes)	16.0 ± 7.4	13.9 ± 8.8	0.42	
duration of ankle motion block (hours)	14 ± 8	19 ± 3	0.009*	
Results presented as mean ± SD.				

Table 2: Pain scores.

Discussion

This study compared the ultrasonographic visibility of SN and the effects of SNB by medial approach (M Group) and popliteal approach (P Group) in the supine position. The visibility of ultrasonographic SN images was better in P Group than M Group. The duration of ankle motion block was longer in P Group. There were no significant differences between the times taken to achieve the block or postoperative analgesic effect.

Since it is not always easy to perform position changes and probe changes in clinical settings, the approach used in the M Group in this study seems to be superior because it enables SNB to be performed with the patient in the same position and with the same linear transducer as for FNB. However, because SN is located about 5 cm below the surface, ultrasonographic visibility with the linear transducer in the M Group was not always good [10]. Although no intraoperative changes in approach were necessary in this study, visibility was rated as Grade C or Grade D in many cases in the M Group, suggesting that visualization of SN by this approach will be difficult, particularly in obese patients.

With the popliteal approach (P Group), SNB is also possible with a linear transducer in the supine position, the same as FNB [7-9], but the position used for SNB is not exactly the same as used for FNB; for example, SNB by the popliteal approach requires that the knees be kept raised. However, the popliteal approach often yields clear ultrasound images, because SN is visualized at a depth of 1-2 cm. Clear visualization of nerves by ultrasonography affects the success rate and the time taken for the procedure [3,7,12], but there were no differences between the P Group and M Group in success rate or time taken for the procedure in this study. We cannot rule out the possibility that the need for a change in position affects the time taken for the procedure, even when the change required is a minor one.

The time until resumption of toe motion was confirmed was significantly longer in the P Group and the difference seems to have been attributable to the fact that because visibility was better in the P Group, it was possible to infuse the drug solution into the perineural area in the P Group. Because of the anatomical features of SN, whose medial aspect lies adjacent to the tibial nerve and whose lateral aspect lies adjacent to the common peroneal nerve, the tibial nerve area tended to be mainly blocked in the M Group (medial approach) [2-6,10,11].

In the evaluation of postoperative analgesic effects, no difference was found in the pain score between the P Group and M Group. That was probably because the femoral nerve area is mainly involved in transmitting the postoperative pain after TKA, and SNB has only a small effect on the postoperative pain [1].

Limitations

Evaluation of whether an image is easy to read depends on the subjective assessment of individual examiners, and we cannot rule out lack of objectivity in the assessments in this study. In the future, it will be necessary to evaluate images more objectively, for example, by calculating the percent consistency between evaluated images and ideal images, i.e., images rated as Grade A, increasing the number of image examiners, etc.

Conclusions

This is the first study to evaluate the visualization of SNB by a medial approach. Medial approach has the advantage of enabling the block to be performed with the patient in the same position and with the same transducer as for FNB.

Conflicts of Interest

None

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