Comparison of the Different Approaches to Saphenous Nerve Block

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Background: The authors compared the efficacy of the different approaches to saphenous nerve block.

Methods: The following approaches to saphenous nerve block were compared in 10 volunteers: perifemoral, transartorial, block at the medial femoral condyle, below-the-knee field block, and blockade at the level of the medial malleolus. Each volunteer underwent all five blocks, and the interval between blocks was 3–7 days. The sequence of injection was randomized by Latin square design. Sensory blockade at the medial aspects of the leg and foot and the strength of the anterior thigh muscles were noted.

Results: The transartorial, perifemoral, and below-the-knee field block approaches were more effective than block at the medial femoral condyle in providing sensory anesthesia to the medial aspect of the leg. The transartorial approach was more effective than block at the medial femoral condyle and below-the-knee field block in providing sensory anesthesia to the medial aspect of the foot. Compared with the perifemoral approach, the transartorial approach did not cause weakness of the hip flexors and the knee extensors. In volunteers with partial numbness in the medial aspect of the foot, supplemental block of the medial dorsal cutaneous branch of the superficial peroneal nerve resulted in complete sensory blockade.

Conclusions: Sensory blockade in the medial aspects of the leg and foot is best achieved with the transartorial approach. In some subjects, supplementary block of the medial dorsal cutaneous branch of the superficial peroneal nerve may have to be performed to assure complete numbness of the medial aspect of the foot.

THE saphenous nerve can be blocked above the knee, at the level of the knee, below the knee, or just above the medial malleolus (MM). Blocks above the knee include the perifemoral, subsartorial, and transartorial approaches, whereas blocks at the level of the knee include block at the level of the knee medial femoral condyle (BMFC) with or without a nerve stimulator (fig. 1). The saphenous nerve can also be blocked by subcutaneous infiltration below the knee distal to the medial condyle of the tibia (below-the-knee field block [BKFB]) and by the paravenuous approach. Finally, the saphenous nerve can be blocked just above the MM of the foot. The success rates of these approaches have been reported as 80% with the perifemoral and transartorial approaches, 40% with the BMFC, and 30–65% with the BKFB. The preponderance of techniques of saphenous nerve block probably reflects the inconsistency of results with these different approaches.

In our clinical practice, we usually block the saphenous nerve either below the knee or above the MM and found that the sensory blockade was occasionally patchy or the distal margin of sensory blockade at the foot was not consistent. We therefore compared the different approaches of saphenous nerve block in volunteers to determine the efficacy of these approaches and to systematically note the areas of numbness.

Materials and Methods

We studied 10 volunteers and compared the success rates of the following approaches to saphenous nerve block: perifemoral, transartorial, BMFC, BKFB, and block at the level of the MM of the foot. The subjects were male, had American Society of Anesthesiologists physical status I or II, had no history of allergy to local anesthetics, had no history of easy bruising, and took no anticoagulants within the previous week before the nerve blocks. We did not include the subsartorial approach because of the difficulty in locating the surface landmarks for the site of needle insertion and because of its similarity to the perifemoral and transartorial approaches. We were not aware of the nerve stimulator technique at the level of the medial femoral condyle when we started our study and did not include it in our comparisons. The Institutional Review Board of Northwestern University (Chicago, Illinois) approved our study, and the volunteers signed written informed consents. We tested our hypothesis that the transartorial and perifemoral techniques provide significantly better blockade of the saphenous nerve compared with the BMFC and BKFB approaches.

Descriptions of the Different Techniques

Perifemoral Approach. The site of our needle insertion is 4 cm below the inguinal crease, 0.5 cm lateral to the femoral artery. At a depth of 2–4 cm, the nerve to the vastus medialis muscle is stimulated with a nerve stimulator at 0.4 mA or less (2-Hz frequency, 0.1-ms
nerve is purely a sensory nerve. Our site of needle insertion was more cephalad than that of Van der Wal et al., who inserted their needle on the line of the inguinal fold.

Transsartorial Approach. The sartorius muscle is palpated just above the medial side of the patella. Identification of the muscle is facilitated with the subject in the supine position and the extended leg elevated 5–10 cm. The site of needle insertion is 3–4 cm superior and 6–8 cm posterior to the superomedial border of the patella. Our site of needle insertion is more cephalad than that of Van der Wal et al., who inserted their needle at one finger width above the patella. The insulated needle is inserted caudally at an angle of 45° and directed slightly posteriorly. Paresthesia, referred to the MM, is elicited with a nerve stimulator at 0.6 mA or less (2-Hz frequency and 0.1-ms duration) at a depth of 3–5 cm.

Block at the Medial Femoral Condyle. The medial condyle of the femur is palpated. Local anesthetic is injected in a fan-wise direction between the skin and the periosteum of the medial surface of the condyle. Local anesthetic is also injected slightly posterior to the medial femoral condyle.

Below-the-knee Field Block. A linear subcutaneous injection of local anesthetic is made in an anterior and posterior direction at a level 3–4 cm distal to the tibial condyle. Our site of infiltration included the area anterior and posterior to the saphenous vein and is similar to the paravenous approach except that it included a wider area.

Block at the Medial Malleolus. The local anesthetic is injected subcutaneously above and anterior to the MM of the foot, around the great saphenous vein. The injection extended anteriorly and posteriorly above the MM.

The blocks were done by the same investigator (H. T. B.) and on the same leg in each of the volunteers. Ten milliliters lidocaine, 1.5%, was injected each time. Every volunteer had five blocks, and the interval between injections ranged from 3 to 7 days. The sequence of injection was randomized by a Latin square design. Sensory blockade of the medial aspects of the leg and foot were tested by pinprick every 1–2 min for 20 min and then every 2–3 min for another 10 min. The time that elapsed from the needle insertion until loss of pinprick sensation was considered the onset of sensory blockade. The time to complete loss of pinprick sensation was considered the time to complete sensory blockade. Sensory blockade was rated as 0 = no sensory blockade, 1 = patchy sensory blockade, or 2 = complete sensory blockade. We considered complete sensory blockade of the medial aspect of the leg, from just below the tibial tubercle to the MM, to be successful saphenous nerve block of the leg. We considered complete sensory blockade of the proximal two thirds of the medial aspect of the foot, i.e., medial aspect of the foot from the MM to 2 cm proximal to the base of the great toe, to be successful saphenous nerve block of the foot. The strength of the flexors of the thigh at the hip and the extensors of the leg at the knee were rated according to the following criteria: 0 = no motor block, 1 = partial motor block (weakness of the hip flexors and leg extensors), 2 = complete motor block (inability to flex the hip or extend the leg).

Power and Statistical Analyses

The efficacies of the different saphenous nerve block techniques have been reported as 80% with the transsartorial and perifemoral approaches, 40% with the BMFC approach, and 33–65% with the BKFB. There was no previous study that looked into the efficacy of block at the MM. Power analysis of the study design indicated that a study group of 10 subjects allows detection of a 40% difference in nerve block efficacy at a power of 0.80 and a probability of less than 0.05. Ten subjects should therefore be adequate in detecting differences between the perifemoral and transsartorial approaches versus the BMFC and BKFB approaches.

We used the Friedman statistic, followed by the Bonferroni correction of the Mann–Whitney rank sum test, to compare the degrees of sensory and motor blockades. We used repeated-measures two-way analysis of variance to compare the times to sensory blockade and the Student–Newman–Keuls test for post hoc analysis. Finally, we used the Fisher exact test to compare the incidences of complete sensory blockade of the medial leg and foot.
The degrees of sensory blockade in the medial aspect of the leg varied between the volunteers. A P value of 0.01 was considered significant for the Bonferroni correction of the Mann–Whitney rank sum test to compensate for the multiple comparisons. A P value of 0.05 was considered significant for the Fisher exact test and the Student–Newman–Keuls test; the Student–Newman–Keuls test automatically takes into consideration the number of groups being compared.

Results

Ten volunteers with American Society of Anesthesiologists physical status I or II completed the study, for a total of 50 blocks. All volunteers were male, and their ages ranged from 29 to 59 yr, with a mean age ± SD of 41.3 ± 3.6 yr. The degrees of sensory blockade (median and range) in the medial aspect of the leg were 2 (1–2) for perifemoral, 2 (2–2) for transsartorial, 1 (1–2) for BMFC, and 2 (1–2) for BKFB (table 1). The degree of sensory blockade in the medial aspect of the leg was statistically greater after the perifemoral approach compared with the BMFC approach (P = 0.01), after the transsartorial approach compared with the BMFC approach (P = 0.00), and after the BKFB compared with the BMFC approach (P = 0.01). There were no statistical differences in the degrees of sensory blockade between the perifemoral and transsartorial approaches and between the transsartorial or the perifemoral approach and the BKFB approach. The numbers of volunteers who had complete sensory block of the medial leg were 7 of 10 for the perifemoral approach, 10 of 10 for the transsartorial approach, 1 of 10 for BMFC, and 7 of 10 for BKFB. The incidences of complete sensory blockade were significantly higher with the perifemoral (P = 0.02), transsartorial (P = 0.00), and BKFB (0.02) approaches compared with the BMFC approach.

The degrees of sensory blockade in the medial aspect of the foot were 1 (1–2) for the perifemoral approach, 2 (1–2) for the transsartorial approach, 0.5 (0–1) for BMFC, 1 (1–2) for BKFB, and 2 (1–2) for block at the MM (table 1). The degree of sensory blockade of the foot was statistically greater (P = 0.00–0.01) with the transsartorial approach compared with the BMFC and BKFB approaches. The degree of sensory blockade was significantly greater with the perifemoral approach (P = 0.006) and block at the MM (P = 0.001) compared with the BMFC approach. There was a trend toward statistical significance between the transsartorial and the perifemoral approaches (P = 0.035) and between block at the MM and the BKFB approach (P = 0.09). The numbers of volunteers with complete sensory blockade of the medial aspect of the foot were 3 of 10 for the perifemoral approach, 8 of 10 for the transsartorial approach, 0 of 10 for BMFC, 2 of 10 for BKFB, and 6 of 10 for block at the MM. The transsartorial approach and block at the MM resulted in statistically higher incidences of complete sensory blockade of the medial foot compared with the BMFC approach (P = 0.001–0.01).

Two volunteers had partial sensory blockade of the medial aspect of the foot with all of the different techniques. Blockade of the medial dorsal cutaneous branch of the superficial peroneal nerve in these two volunteers, by extension of the local anesthetic infiltration laterally to midway between the two malleoli, resulted in complete numbness of the medial aspect of the foot. It seems that the medial aspect of the foot was coinnervated by the saphenous nerve and the superficial peroneal nerve. If the results from these volunteers are not included in the statistical analysis, the transsartorial approach provided complete numbness of the medial leg and foot in all of the volunteers.

The distal boundaries of the sensory blockade in the medial aspect of the foot varied between the volunteers. Four of the volunteers had numbness up to the base of the great toe, whereas six had numbness in the proximal two thirds of the medial aspect of the foot. We blocked the medial dorsal cutaneous branch of the superficial peroneal nerve in the six volunteers whose numbness...
did not extend to the base of the great toe. This resulted in the extension of the numbness up to the base of the great toe in four volunteers and up to the dorsum of the great toe in two of the six volunteers.

The onsets of sensory blockade (mean ± SD) in the medial leg were 7 ± 3.5 min for the perifemoral approach, 5 ± 0 min for the transsartorial approach, 8.5 ± 4 min for BMFC, and 5.5 ± 1.6 min for BKFB (table 2). The transsartorial approach resulted in a significantly quicker onset of blockade compared with the BMFC approach \((P < 0.05)\). There were no differences in the onsets of sensory blockade of the medial leg between the other approaches. The times to complete sensory blockade (mean ± SD) of the medial leg were 10 ± 4 min for the perifemoral approach, 6.5 ± 2 min for the transsartorial approach, 15 min for BMFC, and 12 ± 4 min for BKFB (table 2). Statistical analyses comparing the times to complete blockade could not be performed because of inadequate and missing numbers; only 1 of the 10 volunteers had a complete block with the BMFC approach. However, it can be noted from table 2 that the transsartorial approach resulted in the shortest onset of block.

The onsets of sensory blockade (mean ± SD) in the medial foot were 9.5 ± 3.7 min for the perifemoral approach, 6 ± 2 min for the transsartorial approach, 11 ± 4 min for BMFC, and 9 ± 3.9 min for BKFB (table 2). The transsartorial approach and block at the MM resulted in a significantly quicker onset of sensory blockade than the perifemoral approach \((P < 0.05)\). There were no differences in the onsets of blockade between the other approaches. The lack of statistical differences between the transsartorial and block at the MM approaches and the BMFC approach was due to the small number of patients who had sensory blockade after BMFC. Only five of the volunteers had partial numbness of the foot with the BMFC approach, and no one had complete numbness. The times to complete sensory blockade (mean ± SD) of the medial aspect of the foot were 10 ± 5 min for the perifemoral approach, 10 ± 4 min for the transsartorial approach, 13 ± 4 min for BKFB, and 8 ± 2 for block at the MM (table 2). There were no data for the BMFC approach because none of the volunteers had complete sensory block. No statistical analyses could be performed to compare the times to complete blockade because of inadequate numbers.

Seven of the 10 volunteers had partial motor block of the hip flexors and knee extensors after the perifemoral approach. In contrast, no patient had motor block of these muscles after the transsartorial approach. There was a significantly greater number of volunteers in the perifemoral approach who had weakness in the hip flexors \((P = 0.003)\) and knee extensors \((P = 0.003)\) compared with the transsartorial approach.

All of the volunteers had bruising and soreness for 1–2 days, and they also had myalgia for 1–2 days after the perifemoral and transsartorial approaches.

### Discussion

Our study showed the transsartorial, perifemoral, and BKFB approaches to be more effective than the BMFC approach in providing sensory blockade of the medial aspect of the leg. Our incidences of complete sensory blockade of the medial aspect of the leg were 100% with the transsartorial approach and 70% for the perifemoral and BKFB approaches. Our incidence of 70% for the BKFB approach is higher than the 33% reported by De Mey et al.\(^{10}\) and the 65% reported by Van der Wal et al.\(^{3}\) Although effective, the perifemoral approach resulted in partial weakness of the hip flexors and leg extensors. In some volunteers, we found that both the saphenous and the superficial peroneal nerves innervate the medial side of the foot.

The relation of the saphenous nerve and the nerve to the vastus medialis is the basis for the perifemoral and subsartorial approaches.\(^{1–3}\) The saphenous nerve and

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**Table 2. Onsets of and Times to Complete Sensory Blockade after Saphenous Nerve Block**

<table>
<thead>
<tr>
<th>Site</th>
<th>Perifemoral</th>
<th>Transsartorial</th>
<th>Block at Medial Femoral Condyle (BMFC)</th>
<th>Below Knee Field Block (BKFB)</th>
<th>Block at Medial Malleolus (MM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Onsets of sensory blockade, min</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medial leg</td>
<td>7 ± 3.5</td>
<td>5 ± 0</td>
<td>8.5 ± 4</td>
<td>5.5 ± 1.6</td>
<td></td>
</tr>
<tr>
<td>Medial foot</td>
<td>9.5 ± 3.7</td>
<td>6 ± 2</td>
<td>11 ± 4</td>
<td>9 ± 3.9</td>
<td>6 ± 2</td>
</tr>
<tr>
<td>Times to complete sensory block, min</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medial leg</td>
<td>10 ± 4</td>
<td>6.5 ± 2</td>
<td>15*</td>
<td>12 ± 4</td>
<td></td>
</tr>
<tr>
<td>Medial foot</td>
<td>10 ± 5</td>
<td>10 ± 4</td>
<td>†</td>
<td>13 ± 4</td>
<td>8 ± 2</td>
</tr>
</tbody>
</table>

Number of volunteers studied: 10. Data are presented as mean ± SD.

Significant differences noted in the onsets of sensory blockade between the following groups: (1) leg: transsartorial vs. BMFC; (2) foot: transsartorial and block at MM vs. perifemoral.

* Only one volunteer had complete sensory block of his medial leg after the BMFC approach. † No volunteer had complete sensory block of his medial foot after the BMFC approach.
the nerve to the vastus medialis muscle run alongside each other, lateral to the femoral artery, until the saphenous nerve crosses the artery. Because the saphenous nerve is a sensory nerve, movement of the vastus medialis with a nerve stimulator has been used as the endpoint.\(^1\) The recommended site of needle insertion for the perifemoral approach is 0.5 cm lateral to the femoral artery in the inguinal fold.\(^5\) We inserted our needle 4 cm below the inguinal crease to avoid blocking the other muscular branches of the femoral nerve and to decrease the incidence of weakness of the anterior thigh muscles. Despite of our more distal insertion, some of our volunteers had weakness of the anterior thigh muscles. Bouaziz et al.\(^2\) inserted their needle 6 cm caudal to the inguinal ligament and found that the analgesia and anesthesia were confined to the distribution of the saphenous nerve. A more distal site of insertion can probably be performed, because we found in our study of eight cadavers that the saphenous nerve ran alongside the femoral artery up to 13.5 ± 1.2 cm caudal to the inguinal crease and then crossed the femoral artery.

We studied the transsartorial approach rather than the subsartorial approach because it was easier to perform and because of its reported efficacy. Identification of the site of needle insertion in the subsartorial approach is difficult because it requires identification of the groove between the vastus medialis muscle and the sartorius muscle.\(^1\) In the original description of the transsartorial approach,\(^4\) the sartorius muscle was palpated on the medial side of the lower thigh just above the knee. The authors inserted a 17-gauge Tuohy needle one finger width above the patella in the supine extended leg\(^2\); they did not state how far medially from the patella their site of needle insertion was. The needle was inserted at an angle of 45° from the coronal plane and advanced in a caudal direction, through the belly of the sartorius muscle, until a loss of resistance was felt at a depth of 1.5–3 cm.\(^4\) This implied location of the needle tip at the adductor hiatus, and the local anesthetic was injected. In our transsartorial technique, the site of needle insertion was slightly higher than originally described. We had difficulty identifying the loss of resistance when the needle was inserted beyond the sartorius muscle and decided to use the nerve stimulator and elicit paresthesia to the medial leg and foot to identify the saphenous nerve. In our initial trials, we found that 3–5 ml local anesthetic was adequate to block the saphenous nerve when paresthesia was elicited with nerve stimulus intensities of 0.8–1 mA (2 Hz, 0.1 ms).

In the BMFC approach at the level of the knee, a skin wheal of local anesthetic is raised over the bony prominence of the medial femoral condyle.\(^4,8,9\) The success rate of this approach in anesthetizing the medial aspect of the leg is 40%, but only 25% when complete anesthesia of the MM is used as the criteria.\(^4\) Only one subject in our study had complete numbness of the medial aspect of the leg, and none had complete numbness of the medial aspect of the foot. The lack of consistent success with this approach is due to the posterior location of the saphenous nerve and not medial, in relation to the medial femoral condyle (fig. 2). We noted this relation in our study on three cadavers, which we performed after our clinical study to explain the failure of this approach.

The needle must be inserted in the posterior aspect of the medial femoral condyle to improve the success rate of the BMFC approach. Paresthesia with a nerve stimulator may improve the success of this technique. This has been shown by Comfort et al.,\(^7\) who reported a 100% success rate with a nerve stimulator. In their technique, they inserted the needle 3.5 cm posterior to the center of the bony prominence of the medial femoral condyle, through the sartorius tendon, and made adjustments in the direction of the needle until paresthesia was elicited in the medial leg to the MM. We were not aware of the modification of Comfort et al. when we conducted our study and did not make adjustments in our BMFC approach.

In the BKFB approach, a linear subcutaneous injection of 10 ml local anesthetic is made below the insertion of the sartorius tendon at the tibial condyle in an anterior and posterior direction.\(^4,8,9\) The local anesthetic is deposited between the tibial condyle and the medial head of the gastrocnemius muscle.\(^10\) The success rate of this approach in anesthetizing the medial leg was found to be 33–65%,\(^4,10\) and 39% when complete anesthesia of the MM was used as the criteria.\(^4\) Our site of linear injection was 3–4 cm below the tibial condyle and included the area of the saphenous vein. De Mey et al.\(^10\) infiltrated the area lateral and medial to the saphenous vein at the level of the tibial tuberosity, calling it the “paravenous approach,” and reported a 100% success rate in their 20 volunteers. The disadvantages of the paravenous approach include the difficulty of identifying the saphenous vein in obese patients, the absence of the vein in

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**Fig. 2. Cadaver dissection showing the saphenous nerve (arrowhead) located posterior to the medial femoral condyle. The saphenous nerve has two infrapatellar branches (small arrows).**
patients who had varicose vein stripping, and the occasional use of a tourniquet to make the saphenous vein prominent.\textsuperscript{10}

We noted that two volunteers had partial numbness of the medial aspect of the foot with all of the different approaches. They had complete numbness after the medial dorsal cutaneous branch of the superficial peroneal nerve was blocked at the level of the MM. The inconsistent sensory blockade after a saphenous nerve block may be due to anatomical variations of the saphenous nerve distribution in the medial aspect of the foot and the presence of supplemental nerve supply to the area.\textsuperscript{13}

The medial dorsal cutaneous branch of the superficial peroneal nerve innervates the distal one third or even the distal two thirds of the medial aspect of the foot. Rarely, it may send a branch to the proximal one third of the medial aspect of the foot. The medial cutaneous branch of the medial dorsal cutaneous nerve anastomoses with the terminal branch of the saphenous nerve at the metatarsal-hallangeal joint of the great toe.\textsuperscript{15} Extension of the local anesthetic infiltration to include the medial dorsal cutaneous branch of the superficial peroneal nerve therefore improves the sensory blockade in the distal portion of the medial aspect of the foot, as we have shown in this study.

In the studies on saphenous nerve block, the investigators checked numbness in the medial aspect of the leg\textsuperscript{2,4,7,10} but not in the medial aspect of the foot, distal to the MM. Our study looked at the adequacy of sensory blockade in the medial aspects of the leg and foot. We also showed the necessity of blocking the medial dorsal cutaneous branch of the superficial peroneal nerve in some subjects to improve sensory blockade in the medial aspect of the foot.

The studies that observed the efficacy of the different techniques showed that the nerve stimulator technique was efficacious regardless of the approach.\textsuperscript{1,2,7} The success rates ranged from 80\% with the perifemoral and transsartorial approaches and 100\% when the saphenous nerve was blocked posterior to the medial femoral condyle. Our study confirms the efficacy of the nerve stimulator in locating the saphenous nerve.

Our study has several shortcomings. All of our volunteers were male. Our randomization technique required that we had to recruit volunteers in multiples of five because we had five techniques to compare. Most women were not comfortable with the perifemoral approach, wherein we use the inguinal crease in determining the site of our needle insertion. Although we only studied 10 volunteers, each volunteer underwent five injections, and we had a total of 50 nerve blocks. The clinical significance of our study as it pertains to surgical anesthesia may be questioned because saphenous nerve block is usually performed with ankle blocks; blockade of the superficial peroneal nerve may mask inadequate saphenous nerve blockade. We have seen inadequate sensory blockade of the medial aspect of the foot with ankle blocks performed for surgery of the foot. Knowledge of the anatomy, the success rates of the different techniques of saphenous nerve block, and the innervation and coinnervations of the medial aspect of the foot make it easier for anesthesiologists to decide which approach to use and which additional nerve to block to improve the sensory blockade in the area. In pain clinics, patients with saphenous neuralgia\textsuperscript{7} or saphenous nerve entrapment\textsuperscript{13} may be seen, and knowledge of the effective approach to saphenous nerve block will facilitate the diagnosis and treatment of these conditions.

In summary, we compared the different techniques of blocking the saphenous nerve. We confirmed the effectiveness of the nerve stimulator technique using the transsartorial approach without causing weakness of the hip flexors and leg extensor muscles. In some instances, supplementary block of the medial dorsal cutaneous branch of the superficial peroneal nerve may have to be performed to assure complete numbness of the medial aspect of the foot.

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