The addition of a sciatic nerve block to a femoral nerve block after total knee arthroplasty (TKA) may provide superior analgesia by reducing posterior knee pain, although some investigators have shown no benefit.1–3 The sciatic nerve block may, however, cause an inability to dorsiflex the foot due to blockade of the common peroneal nerve (CPN), and some surgeons request no preoperative sciatic nerve block to avoid complete peroneal motor block.

We hypothesized that blocking only the tibial nerve component of the sciatic nerve would preserve peroneal nerve function and still provide adequate pain control when combined with femoral nerve block in TKA patients. This prospective, randomized, patient and observer-blinded study evaluated whether selective tibial nerve block in the popliteal fossa would reduce the incidence of postoperative complete peroneal motor block as the primary outcome. Secondary outcome measures included pain scores and opioid consumption in the postanesthesia period.
Methods

This study was approved by the IRB of St. Francis Hospital and Medical Center, and written informed consent was obtained from all subjects. Eighty patients scheduled for primary TKA under general anesthesia with a multimodal analgesic regimen including peripheral nerve block for postoperative analgesia were studied at St. Francis Hospital and Medical Center from March 2009 to December 2010. Patients with preexisting valgus deformity, flexion contracture, neuropathy, diabetes, or allergy to any medication used in the study were excluded. Patients were randomized using random number tables in blocks of 10, and group assignments were placed in serially numbered, opaque-sealed envelopes to receive either a sciatic nerve block (SN group) or selective tibial nerve block (TN group). Blocks were performed by anesthesiologists experienced in ultrasound-guided popliteal sciatic block. All patients were premedicated with oral celecoxib 200 mg and pregabalin 50 mg. Before block placement, standard monitors were applied and oxygen 2 L/min via nasal cannula was administered. Patients were sedated with no more than midazolam 2 mg and fentanyl 150 μg IV and verbal contact was maintained with the patient throughout the block procedure. An ultrasound-guided femoral nerve catheter was inserted using a Tuohy needle, stimulating catheter assembly (StimuCath™ Arrow Intl, Teleflex Medical, Research Triangle Park, NC). After the femoral nerve catheter was placed, the patients were positioned in the lateral decubitus position with the operative leg nondependent. Using sterile prep and sheath, a 13 to 6 MHz linear transducer (HFL38, Sonosite™, Bothell, WA) was placed at the popliteal crease to visualize the popliteal vessels in short axis, and the tibial nerve was visualized as a hyperechoic oval structure posterior to the popliteal vessels. Following the tibial nerve cephalad, the convergence of the CPN and tibial nerve was identified.

Patients randomized to the SN group received a sciatic nerve block just proximal to the bifurcation of the sciatic nerve, whereas patients in the TN group received a tibial nerve block just proximal to the popliteal crease where the nerve could be clearly defined. The block needle was advanced in a medial to anterolateral direction toward the target nerve using an in-plane approach. Nerve stimulation was used only to confirm the target nerve and not for needle positioning, which was accomplished using ultrasound and injection of sufficient ropivacaine 0.5% to encircle the target nerve, up to 20 mL. The block needle position was adjusted, if necessary, to achieve circumneural spread of the local anesthetic (Fig. 1). The distance from popliteal crease to needle insertion site and the volume of local anesthetic used for the block were recorded. Subsequently, the femoral nerve catheter was injected incrementally with 15 mL of ropivacaine 0.5%.

All patients received general anesthesia with a laryngeal mask airway for surgery. Anesthesia was induced with propofol and the anesthetic was maintained with sevoflurane, air, and oxygen. Fentanyl and hydromorphone were the only opioids allowed without any specific limitation. After emergence from anesthesia, in the PACU, tibial and peroneal sensorimotor function was recorded by PACU nurses blinded to study group. PACU nurses were trained for sciatic assessment prestudy, and testing was performed when patients were sufficiently awake to respond appropriately. Tibial motor function (plantar flexion of the foot) was tested with a 3-point scale (0 = normal, 1 = weak, 2 = absent), and sensation to cold was tested on the plantar aspect of the foot using a 3-point scale (0 = normal, 1 = absent cold perception but touch sensation intact, and 2 = absence of touch sensation). Cold sensation was tested using an alcohol swab compared to the nonoperative foot. Common peroneal motor function (dorsiflexion of the foot) was tested with a 3-point scale (0 = normal, 1 = weak, and 2 = absent dorsiﬂexion), and sensation to cold was tested on the dorsum of the foot using a 3-point scale (0 = normal, 1 = absent cold perception but touch sensation intact, and 2 = absence of touch sensation). Complete motor block of the peroneal nerve was defined as a peroneal motor score of 2. A verbal numeric pain rating score (NRS) (0–10) was recorded on admission and discharge from the PACU. If patients complained of pain, its location was ascertained; for anterior knee pain the femoral nerve catheter...
was initially bolused with 10 mL ropivacaine 0.2% and if the pain continued after the bolus, IV hydromorphone was titrated. For patients complaining of pain in a location other than the anterior knee or poorly localized knee pain, IV hydromorphone was initially administered; if pain persisted after 0.5 mg of hydromorphone, their femoral nerve catheter was also bolused with 10 mL of ropivacaine 0.2%. Patients continued to receive a regimen of oxycodoin 10 mg, celecoxib 200 mg, and pregabalin 50 mg every 12 hours, and acetaminophen 975 mg every 6 hours postoperatively. For breakthrough pain, oxycodone tablets or IV hydromorphone was administered. On the orthopedic floor, pain scores were recorded every 6 hours for 24 hours after PACU discharge. All pain scores were recorded by nurses blinded to study groups. Opioid consumption during surgery, in the PACU, and 24 hours after PACU discharge was recorded. Patients were followed postoperatively by surgeons and physical therapists although there was no formal assessment tool for complications.

Sample size was calculated based on the assumption that complete peroneal motor block would be at minimum 60% in the SN group and no greater than 20% in the TN group. A sample size of 40 per group (assuming a 90% block success rate) would support the ability to detect this difference with a power of 95% (β error = 0.05) and 2-tailed α = 0.05 with unequal variances. Normality assumption of distribution was assessed using the Kolmogorov-Smirnov test with Lilliefor’s correction. Variables that followed a normally distributed. A Bonferroni α correction was used to account for the 6 evaluations of pain scores. We used an α level of 0.05/6 = 0.008 to assess statistical significance. Data analyses were conducted using SPSS version 18.0 (SPSS, Chicago, IL). P values <0.05 were considered statistically significant.

**RESULTS**

There were no differences in the demographic variables between groups (Table 1). No patient in the TN group developed complete peroneal motor block compared to 82.5% of patients in the SN group (P < 0.001). In the TN group, 22.5% of patients developed partial peroneal motor block, compared to 12.5% of patients in the SN group (not statistically significant) (Fig. 2). Similarly, 72.5% of patients in the SN group had absence of sensation (sensory score of 2) in the peroneal distribution compared to 2.5% of patients in the TN group (P < 0.001). Both groups had a similar number of patients with a sensory score of 1 in the peroneal distribution (25% in SN versus 32.5% in TN). There were no differences in the sensory and motor block characteristics between the groups in the tibial nerve distribution (Fig. 3).

<table>
<thead>
<tr>
<th>Table 1. Patient Demographics</th>
<th>Tibial nerve group</th>
<th>Sciatic nerve group</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patients</td>
<td>40</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>66.6 ± 8.0</td>
<td>64.5 ± 10.5</td>
<td>0.329</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>89.2 ± 18.5</td>
<td>87.2 ± 22.7</td>
<td>0.671</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>171.1 ± 11.4</td>
<td>167.0 ± 12.0</td>
<td>0.126</td>
</tr>
<tr>
<td>Gender (F/M)</td>
<td>18/22</td>
<td>24/16</td>
<td>0.179</td>
</tr>
</tbody>
</table>

Values are expressed as mean ± standard deviation. P values were derived from 2-sided 2-sample tests assuming unequal variances.

Figure 2. Percentage of patients with complete, partial, and no motor and sensory block in the peroneal nerve distribution, comparing the tibial nerve (TN) and the sciatic nerve (SN) groups. The SN group had more patients with complete peroneal motor and sensory block than the TN group. *P < 0.001.

Figure 3. Percentage of patients with complete, partial, and no motor and sensory blocks in the tibial nerve distribution, comparing the tibial nerve (TN) and sciatic nerve (SN) groups. (No statistically significant differences between groups.).
Intraoperatively, there was no significant difference in the amount of fentanyl and hydromorphone administered, or in NRS pain score on admission to the PACU with 25% of patients in the TN group and 15% of patients in the SN group requiring hydromorphone \((P = 0.264)\) (Table 2). In addition, 30% of TN patients and 17.5% of SN patients needed rebolusing of their femoral nerve catheter \((P = 0.189)\). The time course of pain assessments throughout the study is illustrated in Figure 4. There were no significant differences at all points and in the average cumulative pain scores for the 24-hour pain scores on the orthopedic floor scores postoperatively \((P = 0.714)\). Opioid consumption on the orthopedic floor was similar between groups (Table 2).

**DISCUSSION**

This study demonstrates that selectively blocking the tibial nerve in the popliteal fossa as described with 0.5% ropivacaine did not result in complete motor block of the peroneal nerve in patients having TKA. Some degree of blockade of the peroneal nerve occurred in the TN group, with 22.5% of those patients showing partial motor block and 32.5% showing partial sensory block. Although partial peroneal motor block might be undesirable in patients and prompt surgeons to request no block, weak dorsiflexion may still allow for serial monitoring in the postoperative period to detect progression of peroneal dysfunction and intervention, or recovery. Schinski et al.\(^5\) in their series of patients with nerve injury after TKA reported that all patients had sensory deficits and peroneal paralysis as their initial presentation in the immediate postoperative period. Cephalad spread of local anesthetic solution from the site of tibial nerve block leading to partial block of the CPN was likely responsible for the weakness of dorsiflexion and decreased sensation on the dorsal aspect of the foot seen in some of our patients, although we did not evaluate the spread of local anesthetic with ultrasound after injection. In addition, the variability of the level of bifurcation of the sciatic nerve may have made patients with more distal divergence more vulnerable to partial blockade of the CPN when selective tibial nerve block was performed. Further reduction in volume or concentration of local anesthetic solution at the selective TN site may reduce the degree of common peroneal block, but may also negatively impact the success and duration of the desired analgesia; this was not tested in this study.

In our study, 65% of patients in the SN group developed complete sensorimotor block in both the tibial and common peroneal distribution. This is comparable to a published report of complete sensorimotor block in 68% of patients with 20 mL of ropivacaine 0.75%.\(^8\) In the TN group, 55% of patients had complete sensorimotor block in the tibial nerve distribution which is lower than the success rate reported by Prasad et al.\(^9\) where the tibial nerve and CPN were blocked separately and all patients developed a complete block in 50 minutes in both tibial and common peroneal distributions. However, larger volumes of a more highly concentrated local anesthetic (30 mL of 2% lidocaine/0.5% bupivacaine with 1:200,000 epinephrine) were used and may explain the more complete nerve block. The block success for the selective TN group in our study is challenging to compare to other studies using different local anesthetics, definition of success, or time to assessment. In this study, the rate of complete tibial sensory block was high (72.5% in TN group and 75% SN group), which provided adequate analgesia postoperatively (Fig. 3).

The analgesic benefit from blockade of only the tibial nerve was similar to that of the more proximal sciatic nerve

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**Table 2. Perioperative Opioid Consumption**

<table>
<thead>
<tr>
<th></th>
<th>Tibial nerve group</th>
<th>Sciatic nerve group</th>
<th>99% CI of median differences</th>
<th>(P)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Intraop fentanyl ((\mu)g)</strong></td>
<td>50 (50, 0–200)</td>
<td>50 (100, 0–200)</td>
<td>0–50</td>
<td>0.670</td>
</tr>
<tr>
<td><strong>Intraop hydromorphone (mg)</strong></td>
<td>0.6 (1.0, 0.0–2.0)</td>
<td>0.4 (1.0, 0.0–4.0)</td>
<td>0–1</td>
<td>0.888</td>
</tr>
<tr>
<td>Patients needing narcotics in PACU (%)</td>
<td>25</td>
<td>15</td>
<td></td>
<td>0.264</td>
</tr>
<tr>
<td>Patients needing Ropi 0.2% 10 ml bolus in PACU (%)</td>
<td>30</td>
<td>17.5</td>
<td></td>
<td>0.189</td>
</tr>
<tr>
<td>PACU hydromorphone (mg)</td>
<td>0 (1.0, 0.0–2.0)</td>
<td>0 (0.0, 0.0–2.0)</td>
<td>0–0</td>
<td>0.575</td>
</tr>
<tr>
<td>Floor 24-h oxycodone (mg)</td>
<td>10 (20, 0–40)</td>
<td>10 (15, 0–30)</td>
<td>0–10</td>
<td>0.165</td>
</tr>
<tr>
<td>Floor 24-h hydromorphone (mg)</td>
<td>0 (0, 0.0–1.0)</td>
<td>0 (0, 0.0–4.0)</td>
<td>0–0</td>
<td>0.365</td>
</tr>
</tbody>
</table>

Values are expressed as medians with interquartile range, minimum and maximum in parentheses or as percentages. Intraop = intraoperative; Ropi = Ropivacaine; PACU = postanesthesia care unit.
block with equivalent NRS pain scores and opioid consumption. Although articular branches to the knee joint arise from both the tibial nerve and CPN, the results of this study suggest that the sensory contribution from the CPN may be clinically less important than from the tibial nerve.

This study has a number of limitations. Patients were excluded for ethical reasons if they were at increased risk of peroneal dysfunction, because the ability to avoid peroneal paralysis with the selective tibial nerve block could not be assured before study. It remains to be determined if these higher risk patients can be managed with selective tibial nerve block and monitored and treated appropriately, but the results provide an ethical basis to now study this question. The anesthesiologist performing the block could not be blinded to study group, and unconscious bias may have been introduced in the performance of the blocks, but the consistency of the results for tibial sensory and motor blocks in the two groups suggest the block technique was comparable. A different volume of local anesthetic was used in the 2 groups, because it is common to use only enough local anesthetic to surround a target nerve when limited spread or minimal dosage of local anesthetic is the goal. If an equal volume had been used in both groups, and, hence, a larger volume than necessary to surround the tibial nerve selectively in the TN group, more spread to the peroneal component might have occurred. In addition, a higher concentration of ropivacaine was used than many anesthesiologists use for postoperative analgesia, but this choice increased the potential for complete motor block of the peroneal nerve and improved the ability to discriminate an effect due specifically to the site of injection. In addition, the study may have been underpowered to prove equivalence of analgesia as a secondary endpoint. The aggressive pre- and postoperative multimodal analgesic regimen routinely used in these patients is likely to have contributed to the low pain scores.

In conclusion, this study demonstrated that selective tibial nerve block performed below the bifurcation of the sciatic nerve in the popliteal fossa, instead of sciatic nerve block above the bifurcation, avoided complete motor block of the peroneal nerve and provided comparable pain relief after TKA in patients who were not at increased risk of peroneal injury. It remains to be determined if selective tibial nerve block will similarly allow for monitoring and intervention in patients at high risk for peroneal nerve injury.

**DISCLOSURES**

Name: Sanjay K. Sinha, MB, BS.

Contribution: This author helped design the study, conduct the study, analyze the data, and write the manuscript.

Attestation: Sanjay K. Sinha has seen the original study data, reviewed the analysis of the data, approved the final manuscript, and is the author responsible for archiving the study files.

Conflicts of Interest: The author has no conflicts of interest to declare.

Name: Jonathan H. Abrams, MD.

Contribution: This author helped design the study, conduct the study, analyze the data, and write the manuscript.

Attestation: Jonathan H. Abrams has seen the original study data, reviewed the analysis of the data, and approved the final manuscript.

Conflicts of Interest: The author has no conflicts of interest to declare.

Name: Sivasenthil Arumugam, MB, BS.

Contribution: This author helped design the study and conduct the study.

Attestation: Sivasenthil Arumugam approved the final manuscript.

Conflicts of Interest: The author has no conflicts of interest to declare.

Name: John D’Alessio, MD.

Contribution: This author helped design the study and conduct the study.

Attestation: John D’Alessio approved the final manuscript.

Conflicts of Interest: The author has no conflicts of interest to declare.

Name: David G. Freitas, MD.

Contribution: This author helped conduct the study.

Attestation: David Freitas approved the final manuscript.

Conflicts of Interest: The author has no conflicts of interest to declare.

Name: John T. Barnett, MD.

Contribution: This author helped conduct the study.

Attestation: John Barnett approved the final manuscript.

Conflicts of Interest: The author has no conflicts of interest to declare.

Name: Robert S. Weller, MD.

Contribution: This author helped design the study, analyze the data, and write the manuscript.

Attestation: Robert S. Weller reviewed the analysis of the data and approved the final manuscript.

Conflicts of Interest: Robert S. Weller reported receiving research support from I-Flow Corporation and honoraria from Sonosite Corporation.

This manuscript was handled by: Terese T. Horlocker, MD.

**REFERENCES**