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Ultrasound Guided Sciatic Nerve Blockage in the Popliteal Fossa Using a Lateral Approach: Onset Time Comparing Separate Tibial and Common Peroneal Nerve Injections vs. Single Injection Proximal to the Bifurcation

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Ultrasound Guided Sciatic Nerve Blockade in the Popliteal Fossa Using a Lateral Approach: Onset Time Comparing Separate Tibial and Common Peroneal Nerve Injections vs. Single Injection Proximal to the Bifurcation.

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Abstract:

The popliteal nerve block can be performed either proximal to the bifurcation of the sciatic nerve, or distal to the bifurcation, thus blocking both the common peroneal and tibial nerves. Studies have shown equal success rates when comparing the two methods. The purpose of this investigation is to determine if blocking the tibial and common peroneal nerves individually in the popliteal fossa under ultrasound guidance will result in a faster onset time to surgical anesthesia when compared to blocking the sciatic nerve proximal to the bifurcation under ultrasound guidance. A total of 56 patients who underwent foot surgery were randomized to either pre-bifurcation or post bifurcation. The block was then evaluated by a blinded investigator, for pinprick sensitivity and motor blockade beginning at 10 minutes from the injection of the anesthetic, and every three minutes thereafter until the block had completely set. Mean times for sensory and motor score end points were calculated for each group and compared using the Mann-Whitney test. The mean time for complete sensory loss in the tibial distribution for the proximal group was 25.7 minutes, while the mean time for the distal group was 15.9 minutes (difference = 9.8, $p < 0.002$). The mean times for motor loss on the tibial group was 27.9 and 16.4 minutes respectively (difference = 11.5, $p < 0.001$). The mean times for complete sensory loss in the peroneal distribution were 16.6 minutes for the proximal block and 13.1 for the distal block (difference = 3.5, $p = 0.03$). The mean times for peroneal motor loss were 15.8 and 12.3 minutes respectively (difference = 3.5, $p = 0.05$). The authors conclude that injecting anesthetic distal to the bifurcation of the sciatic nerve will result in faster onset to surgical anesthesia when compared to a proximal injection.

Introduction:

The sciatic nerve block in the popliteal fossa is a commonly used peripheral nerve block to provide primary surgical anesthesia and/or post-operative pain control for surgeries below the knee. The time of onset of the block to surgical anesthesia is typically longer for the popliteal nerve block than for other peripheral nerve blocks and ranges from approximately 15-30 minutes.[i] The long onset time of the block can lead to delays in surgery start times or necessitate induction of general anesthesia for the procedure rather than using the nerve block as the primary anesthetic. Using general anesthesia instead of a peripheral nerve block as the primary method of anesthesia increases the risk of having side effects such as post-operative nausea and vomiting, aspiration pneumonitis, and a longer recovery time.

Previous research evaluating popliteal nerve block onset times has been done using nerve stimulation. Paqueron *et al* compared the success rate of the popliteal block using nerve stimulation to locate either both components of the sciatic nerve simultaneously, or each component individually in a randomized study.[ii] A similar investigation performed by March *et al,* also used nerve stimulation to locate either each component of the sciatic nerve individually or both components of the nerve simultaneously, but with a different anesthetic.[iii] Research completed by Vloka *et al,* studied the location of the division of the sciatic nerve, and found variable results, revealing the anatomic inconsistencies among patients.[iv] Thus, one of the weaknesses the former two studies share is that, since the stimulating technique is a blind technique, there is no way of knowing if the tibial and common peroneal nerves are being stimulated proximal or distal to the bifurcation of the sciatic nerve in the popliteal fossa and therefore not useful in determining if onset times differ between the two locations.

In recent years, ultrasonography has shown utility in the placement of local anesthetic around peripheral nerves under direct visualization rather than by blind stimulation. Numerous studies have validated the usefulness and safety of using ultrasound to guide peripheral nerve blockade and such use is standard at the University of New Mexico Hospital.[v,vi]

The intent of this study is to evaluate whether the time to onset of surgical anesthesia can be shortened by directing local anesthetic individually to both the tibial and common peroneal nerves in the popliteal fossa, distal to the sciatic nerve bifurcation under ultrasound guidance, rather than blocking the sciatic nerve proximal to the bifurcation under ultrasound guidance. To the authors' knowledge, this will be the first study that uses ultrasound guidance to compare the onset of the popliteal block, with anesthetic placement either proximal or distal to the bifurcation of the sciatic nerve. If this method reduces the onset time, then delays to OR start may be reduced, and more patients will be able to enjoy the benefits of avoiding a general anesthetic which would result decrease intraoperative risk, and result in fewer post-operative side-effects, and a quicker recovery time.

Methods

Patients were met preoperatively in the pre-anesthesia holding area as is typical for most orthopedic procedures, where an attending anesthesiologist evaluated the patient and their planned surgical procedure, and then determined that the best anesthetic plan included a popliteal nerve block. The anesthesiologist then insured the patient provided informed consent for their anesthetic plan; if the patient consented, they were enrolled in the study.

Approximately 90 subjects will be enrolled by the termination of the study to reach a power of 0.8 and an alpha of 0.05, however, at the time of this paper, 56 patients have been enrolled. Exclusion criteria included: patients who were pregnant, had an ASA status of III or greater, peripheral vascular disease, diabetes, a casted foot or other impediment to evaluating the motor and sensory divisions in the foot, and patients under the age of 18. The patient's surgical site was verified by standard time-out procedure and standard monitoring including pulse oximetry, EKG, and non-invasive blood pressure cuff was placed as well as a nasal canula. The patient was given midazolam IV, up to 0.05 mg/kg as needed for anxiolysis. The nerve block was performed by either the attending anesthesiologist or a resident physician directly supervised by the attending anesthesiologist using the lateral approach to the popliteal fossa and ultrasound guidance. The person placing the nerve block was informed of the type of approach that the patient is randomized to (either blocking proximal to the bifurcation of the sciatic nerve or distal to the bifurcation targeting the tibial and common peroneal nerves). The patient and the investigator assessing the block after placement were blinded to the approach used.

The physician performing the block used standard aseptic technique and local anesthetic infiltration of the skin. Then, using ultrasound guidance and a 22g Touhy needle, a popliteal nerve blocked was placed using either 30cc of a mixture of 1.5% Mepivicaine, 100 mcg preservative free clonidine and epinepherine 1:200,000 circumferentially around the sciatic nerve proximal to the bifurcation in the popliteal fossa, or 15cc's each of the above mixture around both the tibial and common peroneal nerves distal to the bifurcation of the sciatic nerve in the popliteal fossa.[vii,viii] Of note, placing local anesthetic around the individual tibial and common peroneal nerves does not require more than one needle insertion through the skin.

The time of insertion of the touhy needle was recorded as well as the time of completion of injection of anesthetic, which is referred to in this paper as the procedure time. Starting at 10 minutes after injection, a separate investigator (blinded to the technique employed) assesed the level of motor block for both plantar and dorsiflexion of the foot and the tibial and common peroneal sensory dermatomes on the foot using pinprick with a 16g blunt needle, and then reassessed every 3 minutes until motor and sensory blocks were complete.

As has been used in prior studies, motor scores of 0, 1, and 2 were used for no motor blockade (0), partial motor blockade (1), and complete motor blockade (2). Similarly, sensory scores would reflect no change in pinprick sensitivity (0), diminished pinprick sensitivity (1), and complete loss of sensitivity to pinprick (2).[ix] Ready for surgical anesthesia will be defined as scores of 2 and 2 for motor and sensory. Any patient not achieving a score of 2 on the sensory scale by 46 minutes will be considered a failed block. Once in the OR, data was collected on whether or not the patient experienced pain on incision, required supplemental pain medicine or sedation, or if the patient required general anesthesia and the reason for needing general anesthesia (e.g. patient discomfort, surgeon request, etc). Post-operatively, a motor and sensory exam were again performed on the patients for whom the nerve block did not achieve scores of 2 and 2 prior to undergoing surgery and on the patients who required general anesthesia. Additional data regarding the patient age, weight, type of surgery, and sex were recorded. No patient identifiers were recorded.

Data Analysis: Summary statistics and 95% confidence intervals were calculated for patient demographic variables. Mean times for sensory and motor score end points were calculated for each group and compared using the Mann-Whitney test. Two dimensional tables were analyzed using the Chi square distribution or Fisher's exact test as appropriate. All calculations were performed on an Intel Pentium-based microcomputer with a clock speed of 1.8 GHz. Statistical calculations were made with Statgraphics Centurion XV version 15.2.06 (StatPoint, Inc. , Herndon, VA). Data management was carried out using Microsoft Excel 2002 (Microsoft Corporation, Redmond, WA). Two tailed tests and a Type I error rate of 0.05 were employed throughout.

Results

The mean age of the study participants was 48 years old. The mean weight of the study participants was 81.0kg, the mean height was 170.0cm, and the mean BMI was 27.6. The mean procedure time for all participants was 3.0 minutes. See table 1.

Table 1

Variable	N	Mean	95% CI
Age	56	48.0 years	41.92 to 49.72
Weight	55	81.0 kg	79.12 to 89.08
Height	52	170.0 cm	167.1 to 172.2
BMI	52	29.15 units	27.6 to 30.8
Procedure Time	56	3 minutes	2.8 to 3.7

The two study groups were similar to each other with respect to age, weight, height, and BMI's. (See table 2)

Table 2

Variable	Mean Proximal	Mean Distal	Difference	95% CI	P value
Age	48.4	43.6	4.8	-12.56 to 3.00	0.22
Weight	82.6	85.5	2.9	-7.12 to 12.97	0.56
Height	170.0	168.5	2.4	-7.61 to 2.76	0.35
BMI	28.2	30.0	1.8	-1.46 to 5.04	0.27

The proportion of patients randomized to each procedure was not significantly different when analyzed by gender (p = 0.3). See table 3.

Table 3

	Male	Female	Total
Proximal	14	12	26
Distal	12	18	30
Total	26	30	

Chi-Squared = 1.074. p = 0.30

The mean procedure time was 3.0 minutes for both the proximal procedure and the distal procedure (difference = 0, 95% CI, -0.705 to 1.000, p = 0.73). The mean time for onset of a tibial sensory score of 2 for the proximal procedure was 25.7 minutes and 15.9 minutes for the distal procedure (difference = 9.8 minutes, p = 0.002). The mean time to onset of a tibial motor score of 2 for the proximal procedure was 25.7 and for the distal procedure was 16.4 (difference = 11.5, p = <0.001). The mean time for onset of a peroneal sensory score of 2 for the proximal procedure was 16.6, and 13.1 for the distal procedure (difference = 3.5, p = 0.03). The mean time to onset of a peroneal motor score of 2 for the proximal procedure was 15.8, and for the distal procedure was 12.3 (difference = 3.5, p = 0.05). See table 4.

See Table 4

Variable	Mean Proximal	Mean Distal	Difference	P- value
Procedure Time	3.0	3.0	0.2	0.73
Tibial Sensory	25.7	15.9	9.8	0.002
Tibial Motor	27.9	16.4	11.5	<0.001
Peroneal Sensory	16.6	13.1	3.5	0.03
Peroneal Motor	15.8	12.3	3.5	0.05

There were no reports of pain on incision in either group. There were no failures in the distal group and one single failure (3.9%) in the proximal group (p = 0.46).

Discussion

In recent years, ultrasonography has been shown to enhance the quality of the popiteal block by facilitating the placement of local anesthetic around peripheral nerves under direct visualization. Perlas *et al* showed that ultrasound guidance indicated no increase in procedure time or complications, yet resulted in faster progression of the sensorimotor block, faster onset to surgical anesthesia, and higher success rates when compared to using the nerve stimulating technique.[v,x] Several other studies have demonstrated the value of using ultrasound guidance while performing peripheral nerve blocks.[xi] However, previous research examining the onset time for popliteal nerve block has been performed using only nerve stimulation, which shows variable results.

Paqueron *et al* completed a randomized study comparing the success rate of the sciatic nerve blockade in the popliteal fossa when using nerve stimulation to locate either both components of the nerve simultaneously or each component individually. One group received a single 20 ml injection of a mixture of 2% Lidocaine and 0.5% Bupivicaine after eliciting a response from both the common peroneal and tibial nerves, while the other group received a 10 ml injection of the same anesthetic after stimulation of each component of the sciatic nerve separately. They concluded no difference in onset time for complete sensorimotor blockade between the two groups. However, they also found a higher success rate in the double stimulation group.[ii]

March *et al* performed a similar study of 60 participants, using nerve stimulation to locate and inject 25 ml of 1% mepivicaine either as a single injection after coincident stimulation of both components of the sciatic nerve or two injections (12.5ml each) after separate stimulation. They did find a difference in the onset of sensory blockade in the peroneal nerve component, with single injection mean time at 18.4 minutes and double injection at 11.3 minutes. However, they concluded that there was no difference between the two groups in onset time to complete sensory block (21.9 min vs 22.1 min). They also found equal success rates between the two groups and more paresthesias after the double stimulation technique was employed.[iii]

Several other investigations that look at popliteal nerve block onset times using nerve stimulation demonstrate variable results with some showing a quicker onset when targeting stimulations of both tibial and common peroneal nerves while others showed no difference. [i, xii, xiii]

One of the disadvantages common to all of these studies is their use of nerve stimulation to locate the sciatic nerves. Nerve stimulation is a blind technique and thus, there is no way of ensuring whether the tibial and common peroneal nerves are being stimulated proximal or distal to the bifurcation. An investigation done by Vloka *et al*, evaluated the level of the division of the sciatic nerve in the popliteal fossa and the relationship of the epineural sheath of the sciatic nerve in 28 cadaveric leg specimens. They found that the division into the two components occurred at highly variable distances above the crease in the popliteal fossa, with a mean distance of 60.5 +/- 27.0 mm, thus concluding that the only way to ensure needle insertion proximal to the bifurcation is to place it 100 mm above the popliteal crease.[ix] Therefore, the previous studies are likely not useful in determining if onset times differ between block placement proximal or distal to the bifurcation.

To date, no investigation has been done using ultrasound guidance for the placement of local anesthetic deposition on the sciatic nerve either proximal to the point of bifurcation, or distal to both the tibial and common peroneal nerves separately, in order to compare time to onset and overall success rate. In this investigation, we found a difference in the time to onset of complete sensorimotor blockade between the two groups. For all four primary components that we evaluated (tibial motor and sensory block, and peroneal motor and sensory block) the mean time to onset in the group which received anesthetic distal to the bifurcation was significantly shorter. To obtain a complete sensorimotor block in the proximal group, the mean time was 27.9 minutes and 16.4 minutes for the distal group, with the limiting factor being the onset to tibial motor blockade on both cases. However, clinical relevance lies mainly in the time to complete sensory loss, as this is what indicates surgical anesthesia. The difference between the proximal and distal block was 9.8 minutes. Thus the limiting component to achieve surgical anesthesia lies in the onset of tibial sensory loss for both block locations. Since the tibial nerve is larger than the common peroneal nerve at the popliteal fossa, it is not suprising that surgical anesthesia occurs more rapidly in the common peroneal distribution.[xi]

Although not the primary purpose of the investigation, the success rates of the blocks were also evaluated. There was only one failed block in the proximal group and no failed blocks in the distal group, showing no statistical difference between the two groups. There were no patients who required general anesthesia due to pain on incision in the distribution of the tibial and common peroneal nerve.

The popliteal nerve block commonly has a long onset to surgical anesthesia when compared to other regional blocks. Longer onset times of blocks are associated with delays in surgery start times and can also lead to induction of a general anesthetic as the primary anesthetic rather than relying on the regional block. General anesthetics result in higher rates of side-effects which include a longer recovery time, post-operative nausea and vomitting, and aspiration pneumonitis. Since performing the block distal to the bifurcation of the sciatic nerve with the use of ultrasound has shown to have significantly faster onset, employing this method with may result in decresed delays to surgical start times and decreased necessity of a general anesthetic.

Potential limitations of this study include the subjective methods which were used to evaluate the onset of the nerve block. A sensory score of 2 was described as loss of sensation to pinprick using a 16 gauge blunt needle. The patient was pricked first on the unblocked foot in the common peroneal distribution and then again at the same location on the blocked foot. The patient was asked to report differences in pinprick sensation between the two, and to report when pinprick was no longer felt. This was repeated in the tibial distribution. Loss of motor skills was described as a patients inability to dorsiflex and plantar flex the blocked foot. Thus the primary outcomes of the study were based off patient report and cooperation, which may yield subjective report.

Furthermore, in both study groups, the time to achieve a motor and sensory score of 2 for both nerve distributions was highly variable. The results show a significant difference between the two groups to achieve surgical anesthesia, however, the difference is not absolute; blocking distal to the bifurcation may result in a long time to onset, just as placing the block proximal to the bifurcation may result in a short onset. The results suggest that it is more likely to attain a faster onset if placed distal to the bifurcation, but does not ensure this.

Supplementary investigation can be done to determine how to further decrease the time to onset to surgical anesthesia by using ultrasound to direct anesthetic distal to the bifurcation in the popliteal popliteal fossa and comparing different local anesthetics and their time to onset. Additional decreases in the time to onset can contribute to reducing delays in surgical start times and decreasing the need for a general anesthetic.

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