*Original Research Article*

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# Comparative Evaluation of Nerve Stimulation and Ultrasound Guidance for Popliteal Block: A Randomized Double Blinded Study

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**Abstract**

*Introduction*: Popliteal block is one of the rarely performed regional anaesthetic techniques because it requires great expertise in anatomical land marks and is often very technically challenging. Recent introduction of ultrasound technique for nerve blocks has gained popularity when comparing to the standard nerve stimulation technique. In this study, we have compared the success rate, duration of block procedureand complications between nerve stimulation and ultra sound guidance of popliteal block. *Methods*: 120 patients undergoing foot and ankle surgery were randomized to receive the block using either the nerve stimulation (n = 60) or the ultra sound technique (n = 60). Ropivacaine 0.25% (30 mL)was injected for both the groups. *Results*: Duration of the block procedure and block failure rate were significantly higher in nerve stimulation technique than the ultra sound technique (P value < 0.05). There were no differences in onset and duration of block between two techniques. The nerve stimulation guidance was associated with significant incidence of vascular puncture (13.3%) but ultrasound technique was safer with nil incidence of vascular puncture. *Conclusions*: Ultrasound guidance technique was better in lesser block procedure time and a good success rate (P value < 0.05) and was safer, with no incidence of vascular puncture.

**Keywords:** Nerve Stimulation; Popliteal Block; Ropivacaine; Ultra Sound.

## Introduction

Sciatic nerve block in the popliteal fossa (Popliteal block) is one of the regional anesthetic techniques used for ankle and foot surgeries. Compared to spinal anesthesia it is safe because it is devoid of adverse effects such as hemodynamic changes, post dural puncture headache and also provides good postoperative analgesia. Despite these advantages, popliteal block is not often performed because of inadequate technical experience and a highly unpredictable success rate of the block. The most routinely used guidance for popliteal block is the nerve stimulation which can cause significant discomfort to the patient due to the electric stimulation of the nerves. The introduction of ultrasound guidance for nerve blocks has made a new mile stone in regional anaesthesia which is less discomfort to the patient. In this study we are comparing the two approaches in respect to duration of block procedure, success rate, onset and duration of block and complications.

## Material and Methods

This study was performed between january 2016 to march 2017 in a 1500 bedded super-specialty teaching hospital. A total of 120 patients were involved in this single-center, double-blinded,

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parallel-group randomized clinical trial. Patients posted for elective surgery in foot or ankle, planned for regional anaesthesia were enrolled in this study. Criteria for inclusion were, American Society of Anesthesiologists status I and II, age more 18 and less than 65 years. The exclusion criteria include: patient refusal, allergy to local anesthetics, pregnancy, emergency surgery, injection site deformities, infection at the injection site, peripheral neuropathy, coagulopathies and other contraindications to peripheral nerve blockade. During the pre-anaesthetic checkup, patients were explained about the procedure and written informed consent was obtained. The anesthesiologist performing the procedure was blinded to the patient allocation until he or she was ready to commence with the block. At that point, a lot system was used to select the technique by categorizing them into either of the two groups namely N for nerve stimulation and U for ultrasound techniques and the anesthesiologist performed the block accordingly. Another anaesthesiologist who was blinded to the group allocation assessed the block progress and monitored the patient till the end of surgery. The anaesthesiologist who took care of the patient in the post-operative care unit was also blinded of this study.

Popliteal blocks were performed by qualified anesthesiologists who were trained in peripheral nerve blockade using nerve stimulation as well as ultrasound techniques. After shifting into the operating room, intravenous line was started using a 20 G cannula and the patients were put on prone position and monitors like pulse-oximeter, noninvasive blood pressure, and electro-cardiogram were connected. The injection site was prepared with povidone iodine 5% solution and draped with sterile linen. A local anesthetic solution (3mL of lidocaine, 1%) was infiltrated subcutaneously at the site of planned needle insertion. Patients were sedated with 10 - 30 microgram/kg midazolam to relieve anxiety while maintaining verbal interaction. According to group allotment, patients received their popliteal nerve blocks under one of the following two techniques.

Nerve stimulation technique:This technique was performed with patient in prone position with leg fully extended and ankle projecting slightly beyond the end of the table. The nerve stimulator was turned on, and a grounding lead was placed on the lateral aspect of the leg being blocked. The popliteal fossa was identified by the popliteal crease inferiorly, the semimembranosus and semitendinosus muscles medially and the biceps femoris muscle laterally. The needle insertion site was 7cm above the popliteal crease and 1cm lateral to the midline of the popliteal fossa triangle. After local anaesthetic infiltration 22-gauge, 90-mm insulated needle (Inmed) was inserted with the nerve stimulator (Inmed) set at 1.0mA (0.1 milliseconds) at 2Hz. The needle was inserted perpendicular to the skin and advanced from posterior to anterior until the sciatic nerve was identified by twitch response. If motor response at the ankle was elicited, the nerve stimulator intensity was reduced while maintaining this response at 0.4 mA or less. If the evoked response persists at 0.2mA, the needle was withdrawn until the response was maintained between 0.2 and 0.4 mA. If no motor response was achieved, the needle was withdrawn until the skin, redirected in 5° laterally and advanced. When the correct needle position was achieved, 30mL of 0.25% ropivacaine was injected slowly after negative aspiration for blood. The injection was stopped if there was a blood aspirate, pain or paresthesia reported during the injection and the needle was then repositioned to achieve a satisfactory response [1,2].

Ultrasonography technique: Ultrasound machine with linear transducer (8-12 MHz), sterile sleeve, and gel (in a very obese patient, a curved transducer might be needed). Patient was put in prone or oblique position with the legs slightly abducted. A small footrest may be used to relax the hamstring tendons, making transducer placement and manipulation easier. Ultrasound probe was placed in the popliteal fossa just above the popliteal crease and pulsation of the popliteal artery was identified. The tibial nerve would lie superficial and lateral to the artery. Changing the angle of the probe in different directions might help with getting the ideal view of the nerve. Once the tibial nerve was identified, the probe moved proximally with the same rotation and to identify the common peroneal nerve and the bifurcation of the sciatic nerve [3]. Once identified, a skin wheal was made immediately lateral or medial to the transducer. Once the needle tip was confirmed to be adjacent to the nerve, the syringe was gently aspirated and the local anesthetic was injected. Such injection should result in distribution of the local anesthetic within the epineural sheath, and often, separation of the tibial and common peroneal nerves. The injection was stopped if blood aspirated or if pain or paresthesia was reported; the needle was repositioned or the block abandoned.

Duration of the block procedure (from positioning of the patient till the end of the drug

injection) was noted. After the procedure, the tibial and common peroneal nerve distribution area was assessed for sensory loss every 5 minutes until complete sensory block was achieved. Block was assessed every 5 minutes; hence, the onset time was recorded in 5-minute intervals.

Sensory block was evaluated with cotton wool with spirit: full sensation (2); decreased sensation (1); and no sensation (0). Patients without complete sensory loss in both distributions within 30 minutes of the end of injection were considered failed blocks. Postoperatively, duration of block was assessed by onset of pain and recorded. The block duration was defined as the elapsed time between block completion and first demand of analgesics, as reported by the patient in the postoperative care ward [4]. Routine follow-up was performed in the post anesthesia care unit until 72 hours after the procedure.

The primary outcome was the failed block even after 30 minutes of the procedure. The following secondary outcomes were also measured:duration of block procedure, sensory block onset time, duration of analgesia and complications if any.

*Statistical Analysis*

Data are given as percentages for nominal data and means±SD for continuous variables. Differences in proportions of patients in nominal data among two groups (Sex) were tested using Fishers exact test or chi-square test. Differences in continuous variables (Age, weight, onset of block, duration of block) were tested using student t test. Differences were considered significant at 0.05 level.

## Results

A total of 120 patients were assessed for eligibility and offered enrollment in this study. There were no significant differences in ASA status, demographics (Age, weight, sex) and in onset and duration of anaesthesia between the groups. Block failure was significant in nerve stimulation technique than that of USG ($P<0.05$) (Table 1). For the comparison of block procedure time, onset and duration of the block, a sample size of 100 patients were selected, 50 in each group who had successful block was taken. In our study the block procedure time was significantly lesser in U group than in the N group but regarding the onset and duration of analgesia there were no statistically significant difference between the two groups (Table 2). In the N group was 10% (6) of patients had vascular puncture as a complication but the U group is free of complications as far as this study is concerned.

**Table 1:** Demographic characteristic of the study groups (mean±SD) and success rate

| Variable | Group N (n=60) | Group U (n=60) | P |
|---|---|---|---|
| Asa I | 35 | 34 | |
| AsaII | 25 | 26 | 0.2490 |
| Age | 32±12.5 | 34±11.6 | 0.3655 |
| Sex Male | 41 | 40 | |
| Sex Female | 19 | 20 | 0.3412 |
| Successful Blocks | 50 (83.33%) | 57 (95%) | 0.0406 |

**Table 2:** Time for first demand analgesia (mean±SD) in the study groups

| Variable | Group N (n=50) | Group U (n=50) | P |
|---|---|---|---|
| Duration of block procedure (min) | 25±7 | 10±8 | 0.0001 |
| Onset of block (min) | 17±4 | 15±5 | 0.0295 |
| Duration of analgesia (min) | 365±45 | 376±50 | 0.2504 |

## Discussion

Peripheral nerve block in general is safer than general anesthesia as it has lesser incidence of complications such as nausea and vomiting or cardiovascular adverse reactions. Also, it is known to reduce several side effects caused by central neuraxial anesthesia like hypotension, bradycardia, shivering, postoperative urinary retention, and post dural puncture head ache which are commonly associated to spinal anesthesia [5]. In addition, surgery could be carried out in hemodynamically unstable patients and who were on anticoagulation therapy with less risk [6]. Even with the above advantages, peripheral nerve block done by traditional anatomical land mark and paresthesia technique has an unpredictable success rate and has

its own demerits which may often limit the usefulness of the procedure. The common side effects are: direct nerve damage, hematoma and consequent ischemic nerve damage, intravenous administration of local anesthetic and infection [7]. Hajek et al. reported superficial peroneal nerve and sural nerve damage in 3 patients (1.91%) out of 157 patients who were treated with continuous popliteal block. Possible causes were exposed nerve damage, neural toxicity of the local anesthetics, direct nerve damage and ischemia, and usage of tourniquet [8]. Usage of nerve stimulation guidance reduced most of the complications but still needle skin punctures for initial localization of the nerve often may cause problems like multiple needle prick and vascular puncture as we blindly approach the nerve. Moreover pain associated with the electrical stimulus may often be very troublesome to the patients [9].

We performed the classical posterior approach for both the groups than the newer lateral approach because posterior approach is technically easy to perform as the anatomical land marks are easily identifiable [10]. An advantage of ultrasound guidance is that peripheral nerves can be identified precisely and the median number of needle skin punctures can be reduced there by reducing the block procedure time [11]. In addition the spread of the local anaesthetic can be directly visualized and the needle direction may be altered to have an adequate spread of the drug in all directions ensuing a high success rate of the block [12]. Anahi Perlas et al. demonstrated that injection through a common paraneural sheath at the site of sciatic nerve bifurcation is simple and highly effective than injecting the individual nerves and it resulted in a faster onset of sensory and motor blockade than previously reported approaches without an increase in the incidence of intraneural injection [3]. Since ultrasound guidance is a real time procedure, the course and direction of the needle and the adjacent structures can be appreciated very well and complication such as vascular puncture could be avoided [13]. Various studies were performed for block procedure time with different techniques. Dufour et al. reported that combined ultrasound and nerve stimulation guidance does not reduce block time of posterior popliteal sciatic block versus nerve stimulation alone [14]. Perlas et al. demonstrated that block procedure time was similar between ultrasound and nerve stimulator-guided blocks [15]. In our study we observed that ultrasound guidance resulted in shorter procedure times and almost no incidence of vascular puncture than that of nerve stimulator-guidance. In future, this study gives the scope for further researches in this field such as continuous block technique and use of three dimensional ultrasound technologies for nerve blocks. Limitations of the present study include the fact that, like most procedure-related studies, it is not possible to blind the anaesthesiologist to group allocation. To minimize bias, 15 different anaesthesiologists, who were unrelated to the study performed the block procedures. In addition, assessment of sensory block and documentation of study outcomes were carried out by an independent investigator blinded to group allocation whenever feasible as described. Despite these measures, performance bias may not be completely ruled out.

## Conclusion

We conclude that ultrasound guidance technique was better in less block procedure time and a good success rate (P value < 0.05) and was safer, with no incidence of vascular puncture than the traditional nerve stimulation guidance for popliteal block.

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