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RESEARCH ARTICLE

Ultrasound-Guided Sciatic Nerve Block in Below Knee Amputation Surgery: Sub Gluteal Versus Popliteal Approach

Rania Maher Hussien*, Dalia Ahmed Ibrahim and Islam Gamal Hamed Abdelnaby

Department of Anaesthesia and ICU, Ain Shams University, Cairo, Egypt

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Abstract:

Background:

Ultrasound guided sciatic nerve block has been proved to be effective in pain control for lower limb surgeries, fortunately, it can be performed at different levels *via* different approaches.

Aims:

To compare the effectiveness of the sub-gluteal and the popliteal approaches of blocking the sciatic nerve as well as their success rate.

Settings and Design:

After approval of the ethical committee and obtaining a written informed consent from 56 ASA II, III patients aged 45–75 year, this prospective, randomized, interventional double blinded study was done to patients undergoing elective below knee amputation.

Methods:

Patients were randomly assigned to receive either sciatic nerve block using a popliteal approach (group P, n 28) or a sub gluteal approach (group G, n 28). femoral nerve block done for sensory block of the medial side of the leg. Time to complete sensory and motor block, time taken to perform the block, block-related complications, block duration, time for asking for rescue analgesia in the first 24 h and both patients′ and surgeons′ level of satisfaction were recorded. Success of the block was considered when the block is solid and doesn't require shifting to GA.

Result:

Patients in the P group had a 100% success rate, shorter time to perform the block, less overall complications, required no postoperative rescue analgesia. Yet, more surgeons preferred the sub-gluteal approach.

Conclusion:

Popliteal approach is as effective as the sub-gluteal approach block providing adequate analgesia with a 100% success rate

Keywords: Below knee amputation, Femoral nerve block, Popliteal nerve block, Sciatic nerve block, Sub-gluteal, Ultrasound guided.

1. INTRODUCTION

Patients who undergo below-knee amputation usually presents with a poor general condition and multiple co-morbidities as diabetes, hypertension and ischemia which makes General Anaesthesia (GA) a risky option, moreover,

* Address correspondence to this author at Department of Anaesthesia and ICU, Ain Shams University, 4 Eladeeb Mohamed Elsbaee, Elnozha, Cairo, Egypt, Tel: 01000544520; E-mail: raniamhm@yahoo.com

postoperative pain control may need large doses of analgesics as opioids and this makes these patients liable to analgesics side effects [1].

Nowadays, ultrasound guided regional nerve blocks became popular and frequently used for anaesthesia and postoperative pain control of such cases, having the advantages of providing a good intraoperative anaesthesia as well as a prolonged postoperative analgesia that may last for up to 20 hours [1, 2].

Sciatic nerve is formed from the anterior rami of L4–S3 spinal nerves. Due to its long course, it can be blocked at different levels using different approaches for anaesthesia as well as analgesia during lower limb surgery, out of these approaches the sub-gluteal and the popliteal approaches were successfully done by previous studies [1, 3]. Saphenous nerve should also be blocked, either directly or through a femoral nerve block, to assure complete anaesthesia of the leg below the knee [3].

In patients undergoing surgery in the lower limbs, the sciatic nerve block at the sub-gluteal level provides anaesthesia and a wider range of pain control than its block at the popliteal level in addition to better motor blockade. However, being the biggest peripheral nerve, the resultant blockade at the sub-gluteal level is much more affected by the pattern of spread of the local anaesthetic greater than the other location of sciatic nerve blockade, including blockade at the popliteal level. Moreover, because of its deep location, visualization of the nerve is less ideal and needs a low-frequency, curved transducer "5-8 MHz" which requires high operator′s technical skills to achieve a good spread of the Local Anaesthesia (LA) around the nerve thus increasing the performance time and the incidence of traumatic injury as well as increasing the incidence of intraneural injections [4].

Popliteal approach of the sciatic nerve has the advantage of being easy to perform and the feasibility of using linear probe [4].

This study was done to compare between sub-gluteal and popliteal approaches of sciatic nerve block regarding their efficacy.

2. PATIENTS AND METHODS

This study was done after approval of the local ethics committee and obtaining written informed consent from the enrolled patients. It included 56 ASA physical status II and III patients, weighing 70-85 kg aged 45-75 years, undergoing elective below knee amputation.

Exclusion criteria included patients who refused to participate in the study, those having allergy to local anaesthetics, or having contraindications to regional anaesthesia (having neurologic or neuromuscular disease, on anticoagulation therapy, or having skin infection at the site of needle insertion).

In pre-induction room, a wide bore IV cannula G18 was inserted and monitors were attached "pulse oximetry, electrocardiogram and non-invasive arterial blood pressure", during performing the block and throughout the surgical procedure. All patients were pre-medicated by giving 1-2 mg IV midazolam (Midazolam Hameln 5mg/1ml, manufactured by Sunny Pharmaceutical-Egypt under license of Hameln pharmaceuticals- Germany for Sunny Medical Group). Patients were randomly assigned using computer-generated number lists and sealed opaque envelopes to receive either sciatic nerve block using a popliteal approach (group **P**, *n* 28) or a sub gluteal approach (group **G**, n=28).

A standard regional anaesthesia tray was prepared, containing Sterile towels and gauze packs, a syringe containing 0.5% bupivacaine (Sunnypivacaine, 20 ml vial contains Bupivacaine HCL Monohydrate 105.5 mg eq. to 100 mg Bupivacaine HCL, Sunny Pharmaceutical, Badr city- Cairo- Egypt), 5-mL syringe plus 25-gauge needle with 1% lidocaine (Lidocaine Hydrochloride- Pharco B international 50mg/5ml) for skin infiltration, sterile gloves, spinal needle G22, marking pen and emergency drugs (epinephrine, atropine, ephedrine) are prepared.

Patients in the popliteal group (Group P) were placed in the lateral position, the skin was disinfected, and transducer (linear transducer with frequency of 8-12 MHz) placed in the transverse position at the popliteal crease. Popliteal artery was identified, and then common peroneal and tibial nerves were identified. Probe was then advanced proximally till sciatic nerve was seen at separation of Tibial (TN) and Common Peroneal Nerves (CPN). Once sciatic nerve was seen, lidocaine 1% was infiltrated subcutaneously, the needle (blunt spinal needle G22) was inserted in plane 2 to 3 cm lateral to the transducer and advanced toward the sciatic nerve. Once the needle tip was adjacent to the sciatic nerve in the epi-neural sheath of the sciatic nerve between the TN and the CPN, the syringe was gently aspirated and 25 ml of bupivacaine 0.5% was injected circumferentially around the sciatic nerve, causing separation of the TN and the CPN.

Patients in sub-gluteal group (Group G) were placed in the lateral decubitus position tilted slightly forward. The foot on the side to be blocked was positioned over the dependent leg so that elicited motor response of the foot or toes can be easily observed. Ultrasound device (S-Nerve ultrasound system, Fujifilm Sonosite Inc., Bothell, WA) was used with frequency of 5-8 MHz. Curved transducer was put transversely at or just below the gluteal crease. After skin disinfection, lidocaine 1% was infiltrated subcutaneously. Once sciatic nerve was distinguished, the needle (blunt spinal needle G22) was inserted in plane lateral to the probe and a 25 ml of bupivacaine 0.5% was injected around the sciatic nerve.

Patients in both groups received ultrasound-guided femoral nerve block to ensure sensory block of the medial side of the leg. Patient was put in the supine position, the skin over the femoral crease was disinfected and the transducer (linear transducer with frequency of 8-12 MHz) was positioned to identify the femoral artery, femoral nerve is lateral to the artery in the femoral sheath. Once visualized, lidocaine 1% was infiltrated subcutaneously 1 cm away from the lateral edge of the transducer. The needle (blunt spinal needle G22) was inserted in-plane in a lateral-to-medial orientation and advanced through the fascia iliaca toward the femoral nerve, after negative aspiration, 10 ml of bupivacaine 0.5% was injected around the femoral nerve.

Data recorded were Sensory and motor functions on the operated limb that was examined every 10 minutes after LA injection.

Time to complete sensory block: it is time from completing the block (complete injection of LA) till patient loses sensation. Sensation was examined by pin pricking on the distribution of sciatic nerve (plantar and dorsal aspect of the foot, supplied by tibial and superficial peroneal nerves branches of the sciatic nerve and the posterolateral aspect of the leg that is supplied by the sural nerve).

Time to complete motor block: It is the time from the end of injecting LA till patient is totally unable to do dorsiflexion or plantar flexion of the foot and toes.

Time taken to perform the block: It is time from the insertion of the block needle to the end of local anaesthetic injection and needle withdrawal.

Success was considered when the block provided solid analgesia with no need to shift to GA (we calculated success rate from percent of successful blocks to total blocks) so failed blocks were not excluded from the study

We also recorded any block-related complications *e.g.* any signs or symptoms of Local Anaesthesia Systemic Toxicity (LAST), failed block and switching to GA, paraesthesia and postoperative motor weakness 24 hours after the surgery.

Duration of the block: time from completing LA injection till complete recovery of sensory function, *i.e.*, patient feels pinprick.

Number of patients asking for rescue analgesia, in the form of Nalbuphine 5 mg-10 mg, in the first 24 h were also recorded.

After the procedure, the participants were asked to determine their degree of satisfaction and tolerance to the procedure either satisfied or unsatisfied or indifferent. Finally, surgeons were asked about their degree of satisfaction either satisfied or unsatisfied or indifferent to the technique.

The surgery was allowed after confirming a complete sensory and motor block, 50 -100 μg fentanyl were given as supplemental analgesia as required.

One experienced anaesthiologist was allocated to perform either block (sub- gluteal or popliteal) and has nothing to do with assessing or recording, and the technique was selected through a computer- generated numbers and sealed envelopes. All data were recorded by another anaesthesiologist who was blinded to the technique used. Also, the surgeon was blinded to the technique used.

The primary outcome was to compare between the two techniques as regards the success rate. Secondary outcomes were time taken to perform the block, time to complete sensory block, time to complete motor block, duration of the block, patient′s and surgeon′s satisfaction.

3. STATISTICAL ANALYSIS

Group sample sizes of 28 in each group achieve 82% power to detect a difference between the group proportions of

20% in success of block. The test statistic used is the two-sided Z test with pooled variance. The significance level of the test was targeted at 0.05.

Data were analyzed using the Statistical Package for Social Sciences v18 SPSS 18.0 for Windows (SPSS, Chicago, IL, USA). Normally distributed numerical data are presented as mean ± SD and differences between groups were compared using the independent Student's *t*-test, data not normally distributed were compared using Mann-Whitney test and are presented as median (IQR) and categorical variables were analyzed using the χ^2 test or Fisher′s exact test as appropriate and are presented as number (%). All P values are two-sided. $P < 0.05$ is considered statistically significant.

4. RESULTS

Our study included 56 patients scheduled for below knee amputation surgery done under regional anaesthesia by sciatic nerve block either through sub gluteal or popliteal approaches together with femoral nerve block. Baseline patient characteristics and duration of the operation were similar in both study groups (Table **1**).

Table 1. Patients′ characteristics and duration of surgery.

Variable	Group P (n=28)	Group G (n=28)	P-Value
Age (years)	61.07±8.14	60.43±6.75	0.75
Gender (M/F)	20/8	22/6	0.54
Weight (kg)	79±6.7	78.5±8.6	0.056
ASA (II/ III)	13/15	13/15	1
Duration of surgery (min)	82. 3± 20.43	86.79±68.7	0.363

Data are presented as mean (SD) or as numbers.

Table 2. Time taken to perform block, time to complete sensory and motor block and block duration.

Variable	Group P (n=28)	Group G (n=28)	P-Value
Time taken to perform block (min)	11±3.8	18.15±4.7	<0.001*
Time to complete sensory block (min)	12.3 ± 1.3	17.2 ± 1.61	<0.001*
Time to complete motor block(min)	23±1.5	26.63± 2.57	<0.001*
Block duration (hours)	11.185± 3.65	10.04± 1.39	0.13

Data are presented as mean (SD).

Patients in the group P had a shorter time to perform the block and to achieve sensory and motor block, longer block duration and less overall complications when compared to patients in group G, while none of the patients in both groups showed signs or symptoms of Local Anesthetic Systemic Toxicity (LAST). However, the block in group G was more preferred by the surgeons (Tables **2** and **3**).

Six patients in the sub-gluteal group and none with the popliteal group required supplemental fentanyl during surgery. Moreover, patients in group P required no rescue analgesia and had a 100% success rate compared to patients in group G (Table **3**). Patients were equally satisfied by the two approaches, whereas, surgeons where more satisfied by the sub gluteal approach (Table **4**).

Table 3. Complications and success rate.

Variable	Group P (n=28)	Group G (n=28)	P-Value
Complications (IO) - discomfort - need for intraoperative analgesia (fentanyl 50-100μg)	13 (46.4%)	25 (89.2%) 6(21.4%)	<0.001* <0.001*
Number of patients asking for rescue analgesia (Nalbuphine 5mg-10mg)	0	3(10.7%)	0.115
Failed block and shifting to GA	0	4(14.2%)	0.056
Success rate	28 (100%)	22 (78.6%)	0.026*

Data are presented as number (%).

5. DISCUSSION

In the current study, sciatic nerve block through sub-gluteal or popliteal approaches were compared. Both approaches were effective in providing intraoperative anesthesia as well as postoperative analgesia. Both approaches had a comparable block duration and patients were equally satisfied by them. However, patients in the (P group) had a 100% success rate, shorter time to perform the block, shorter time to achieve sensory and motor block, less overall complications, and required no postoperative rescue analgesia. Yet, more surgeons preferred the sub-gluteal approach.

Previous studies showed that single-shot nerve blocks are very effective for postoperative pain control, providing adequate pain relief for 10-20 h [1, 2]. According to these results we considered performing single shot sciatic nerve block for providing anaesthesia and postoperative analgesia in patients undergoing below knee amputation surgery and we found that it provided a solid sensory block and that only six patients in the sub-gluteal approach patients and none with the popliteal approach required supplemental fentanyl during surgery. The current study also revealed that the block duration provided by sciatic nerve block through the popliteal approach and the sub-gluteal approach was 11.185 ± 3.65, 10.04 ± 1.39 hours, respectively which was considered enough for postoperative pain control which was also evident when only 3 patients in the sub-gluteal approach required rescue analgesia while no patients in the popliteal approach required any rescue analgesia.

Table 4. Patients′ and surgeons′ satisfaction.

Variable	Group P(n=28)	Group G (n=28)	P-Value
Patients′ satisfaction	28 (100%)	28 (100%)	1
Surgeons′ satisfaction - Satisfied - Indifferent	20(71%) 8(28%)	28(100%)	0.001* 0.001*

Data are presented as number (%).

Time to complete sensory and motor blocks were shorter in the popliteal approach. This can be explained that at the popliteal approach both the tibial and the common peroneal nerves are two smaller branches that can be easily penetrated and directly blocked by the LA. while the sciatic nerve at the sub-gluteal region is a large thick nerve, requiring longer time for local anaesthetic to penetrate and perform its effect.

This finding was consistent to that reached by Buys *et al.* [5] who concluded that ultrasound-guided blockade of the tibial and common peroneal nerves individually after sciatic nerve bifurcation in the popliteal fossa had a significantly shorter time to complete sensory block than sciatic nerve blockade before its bifurcation. They compared the block just caudate to the bifurcation, where the nerve is thinner than at the sub-gluteal region.

Time taken to perform block was significantly less in the popliteal approach since blocking the sciatic nerve at the popliteal fossa is techniqually easy under ultrasound guidance as it is easier to identify the target nerves due to their superficial location with prominent landmarks near the nerve (popliteal artery and vein). Also, different densities and reflective characters of the tissues that surround the TN and CPN nerves and the landmarks make it easy to identify. Moreover, it requires less technical skills as there is no need to use nerve stimulator and the straight probe with high frequency is efficient.

On the other hand, the ultrasound-guided sciatic nerve block at the sub-gluteal region represents one of the most difficult blocks. As, in spite of being the large enough (ranging from 1 - 2 cm in thickness), yet, it remains, phantom-like in its ability to appear clearly in the ultrasound image. And multiple trails of needle insertion may be necessary to achieve successful block, moreover, a nerve stimulator may be needed to ensure the needle position [3].

These findings were opposite to that reported by Taboada *et al.* who found that patients receiving sciatic nerve block through the sub-gluteal approaches had shorter time to complete anaesthesia when compared to the lateral popliteal approach [6].

In another study, Taboada *et al.* also reported the same finding and attributed that to the anatomical differences at that two injection sites that may interfere with the diffusion of local anaesthetics. They assumed that the proximity of the two trunks of the sciatic nerve at the sub-gluteal region where they are separated by a very little amount of adipose tissue making it easier for the spread of the local anaesthetic. On the contrary, the distance that separates both the tibial and common peroneal nerves above the popliteal fossa crease is variable and it may be long enough rendering it difficult for the local anaesthetic to cover such distance. Moreover, the presence of multiple layers of connective tissue or fat within the popliteal space may explain the slower onset of nerve block in the lateral popliteal approach [6, 7].

The controversy between the results of the current study and that done by Taboada and others may be because in the current study, the sciatic nerve was blocked by a single injection around the sciatic nerve just as its two components separate, in other words, we plotted the tibial and common peroneal nerves at the popliteal fossa and followed them proximally and injected the sciatic nerve at the point of separation, thus the distance between the two nerves was negligible.

It is worth mentioning, that none of the patients in either groups complained of signs and symptoms of LA systemic toxicity. Complications faced in this study were in the form of patient discomfort and failed block and both were more in the sub-gluteal approach, where 4 patients in the sub-gluteal approach had failed block that general anaesthesia became necessary, achieving a success rate of 78.6%, while those who received sciatic nerve block through popliteal approach had no failed block with a 100% success rate which is considered a statistically and clinically significant difference.

We attributed patient discomfort during the sub-gluteal approach first due to the difficult technique which required many trails of needle direction and consequently longer duration to perform the block, moreover, the incidence of nonblocked areas was greater in the sub-gluteal approach.

However, at the end of the operation when patients were asked about their satisfaction, patients were equally satisfied and there was no significant difference between the two approaches. While more surgeons preferred the sub-gluteal approach because the motor block achieved by blocking the sciatic nerve at the sub-gluteal region affected flexion of the knee joint making the patients unable to move the blocked limb which made the operation easier in the sub-gluteal approach.

CONCLUSION

Lateral popliteal approach is as effective as the sub-gluteal sciatic nerve providing adequate intraoperative and postoperative analgesia with a higher success rate reaching 100%, shorter time to perform the block, shorter time to achieve sensory and motor blocks and a less overall complications.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This research is subject to ethical standards that promote and ensure respect for all patients and protect their health and rights. The research was carried out in accordance with the ethical standards of the committee responsible for human experimentation (institutional and national), and with the Helsinki Declaration of 1975, as revised in 2013 (http://ethics.iit.edu/ecodes/node/3931.

HUMAN AND ANIMAL RIGHTS

This research is subject to ethical standards that promote and ensure respect for all patients and protect their health and rights.

CONSENT FOR PUBLICATION

This study was done after approval of the local ethics committee and obtaining written informed consent from the enrolled patients.

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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Declared none.

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