Combined Ultrasound-Guided Femoral and Sciatic Nerve Block Efficacy in Arthroscopic Knee Surgeries Anesthesia and Post-Operative Analgesia

The Department of Anesthesiology, Intensive Care and Pain Management, Faculty of Medicine, Cairo University

Abstract

Background: Most orthopedic surgeries is performed on extremities (arms and legs), the innervations of which is derived centrally from the spinal nerves. These nerves coalesce into plexuses, and finally divide into terminal nerves supplying the bones and muscles and innervating the skin of the arm and leg. At certain points along their path these nerves can easily be identified and blocked with local anesthetic, achieving analgesia and anesthesia.

Objective: Sciatic nerve block guided ultrasound in combination with femoral nerve block has been suggested to be useful in relieving pain during and after knee arthroscopic surgery. We discuss multiple approaches of sciatic nerve block guided ultrasound to evaluate their efficacy in combination with femoral nerve block as analgesia in knee arthroscopic surgery.

Methods: For two years, between 2013-2015 in Kasr Al-Ainy University Hospital (264) patients, ASA I, II or III of both gender and age between 20 and 50 years, undergoing unilateral knee arthroscopic surgeries under general anesthesia, using femoral nerve block plus sciatic nerve block guided ultrasound as analgesia, were enrolled in a prospective, randomized, double blind study.

Patients were divided into three equal groups, (88) patients each. All the patients received femoral nerve block guided ultrasound in addition to sciatic nerve block guided ultrasound either posterior sub-gluteal approach (posterior group), anterior approach (anterior group), or medial mid-thigh approach (medial group).

Patients were assessed as regards the onset, duration and intensity of the sensory and motor blocks; post-operative knee pain assessment for 12 hour and also the patient satisfaction were investigated.

Result: It was found that the only 7 patients of the posterior subgluteal approach, 8 patients of the anterior group and 12 patients of medial mid-thigh group reported as failure due to delayed loss of sensory loss in all dermatomes after 30 minutes, the onset of sensory loss in all dermatomes of the lower limb showed no significant differences between all groups. Regarding the intensity of sensory loss showed significant difference in posterior group, it showed 16 patients with no pain after 30 minute and only 7 patients suffered from severe pain but there were no significant differences in both anterior and mid-thigh groups, and there were no significant difference between all groups in the duration of sensory block.

Concerning motor assessment there were no significant difference between all groups regarding onset and duration of the block, but in the motor intensity of block the posterior group showed statistically different result as 16 patients couldn't flex their knee and ankle, in comparison to 8 patients in anterior group and only 7 patients in mid-thigh group.

As postoperative analgesia recording just after the finishing of the operation there were significant difference between the three groups on visual analogue score, in the posterior group 12 patients gave 0 score, the anterior group 8 patients gave 0 and only 7 patients in mid-thigh group gave 0 score, but when observed 6 and 12 hours after the operation there were no statistical difference between groups.

Observing patients satisfaction resulted in significant differences between the three groups as 19 patients in anterior group reported excellent satisfaction, 14 patients in posterior group but only 7 patients in mid-thigh group.

Conclusion: All approaches is considered as effective analgesia in combination with general anesthesia during arthroscopic knee surgeries, these blocks provided good or excellent postoperative analgesia for all patients in the different groups. The posterior subgluteal approach is easier with higher success rate and it gave tense sensory and motor block and great post-operative analgesia. The anterior approach is difficult and need high experience especially in obese patients. The medial mid-thigh approach was the least performed technique. However, it is useful in patients in supine position, and easy to be done in thin patients, but this technique showed difficulty in obese patients due to limitation of rotation the leg. Patients were satisfied using anterior approach.

Key Words: Sciatic nerve block – Arthroscopic – Knee surgeries – Anesthesia.
**Introduction**

**SCIATIC** Nerve Block (SNB) has become increasingly popular for anesthesia or analgesia during lower limb procedures. There are several techniques or approaches for SNB. Most techniques described to date rely on surface anatomical landmarks [1].

Although the anterior approach and medial mid-thigh to the sciatic nerve block have rarely been performed due to lack of reliable surface anatomical landmarks and technical difficulty compared with posterior subgluteal approach, ultrasound guidance may make performance of these approaches easier [2].

The aim of the present study was to evaluate the efficacy of the posterior subgluteal, anterior and medial mid-thigh approaches for sciatic nerve block guided by ultrasound together with ultrasound guided femoral nerve block in knee arthroscopic surgeries anesthesia and post-operative analgesia [3].

**Patients and Methods**

*Patients:* The current study was carried out on 264 patients ASA I, II and III, of both genders, age range between 20 and 50 years, scheduled for knee arthroscopic surgeries. After approval of the Local Ethics Committee, the patients were enrolled in a prospective, randomized and double blind study. Full explanation of the procedure, possible side effects and complications were discussed before informed written consents were obtained from the candidates. Patients refusing the procedure, uncooperative, have allergy to any of the drugs used in the study, with diabetic peripheral neuropathy or have a history of stroke with lesion affecting the side of surgery were excluded from the study. Patients with bleeding disorders or receiving an anticoagulant and those with infection at the site of injection were also excluded.

*The patients were divided into three equal groups:* (88 patients each).

*Posterior group:* 88 patients had ultrasound guided sciatic nerve block posterior subgluteal approach and ultrasound guided femoral nerve block for anesthesia in arthroscopic knee surgery.

*Anterior group:* 88 patients had ultrasound guided sciatic nerve block anterior approach and ultrasound guided femoral nerve block for anesthesia in arthroscopic knee surgery.

*Medial group:* 88 patients had ultrasound guided sciatic nerve block medial mid-thigh approach and ultrasound guided femoral nerve block for anesthesia in arthroscopic knee surgery.

*Techniques:* The operating theater with all equipment and drugs for resuscitation had been made ready. Heart rate, (ECG), and peripheral oxygen saturation (SO₂) was monitored continuously. Blood Pressure (BP), non-invasively, was also monitored. IV cannula, 18-G inserted and 8ml/kg of crystalloid ringer lactate solution infused as a preload by rate 15ml/min and continuous infusion by rate 2.5 ml/min. Sedation was achieved with IV midazolam (0.03-0.05mg/kg) and Fentanyl (50-100mcg).

Approaches to sciatic nerve block performed using a hand-held ultrasound device with a low-frequency, 5 to 2MHz, curved array transducer.

*Posterior group:* Following Karmakar et al., [4] the patients were placed in lateral position, with the side to be anesthetized uppermost and with the hip and knees flexed Fig. (1). The lateral prominence of the greater trochanter and the ischial tuberosity were then identified, and a line was drawn between these two landmarks using a skin marking pen Fig. (1). The sciatic nerve was scanned at this location using a low-frequency, 5-2MHz, curved array probe. Liberal amount of ultrasound gel was applied to the skin over the area to be scanned for acoustic coupling and the ultrasound probe was positioned parallel to the line previously drawn with its orientation marker directed laterally (i.e. directed towards the greater trochanter, so as to provide a transverse scan of the subgluteal space and the sciatic nerve).

A 'scout-scan' (pre-intervention scan) was performed to identify the sciatic nerve in the subgluteal space and to optimize the ultrasound image before the intervention. The ultrasound image was optimized by making the following adjustments on the ultrasound unit:

1- Selecting a scanning preset.
2- Setting an appropriate scanning depth.
3- Selecting the ‘General’ (mid-range) frequency range as the ultrasound probe used was a broadband probe.
4- Finally, the ‘gain’ was adjusted manually to obtain the best possible image Fig. (2).

On a sonogram, the ‘subgluteal space’ was seen as a hyperechoic area between the hypoechoic perimysium of the gluteus maximus and the quadratus femoris muscles Fig. (2). It extended from...
the greater trochanter laterally to the ischial tuberosity medially. The medial limit of the subgluteal space was difficult to see. At this level, the sciatic nerve was seen as an oval hyperechoic nodule approximately 1.5-2cm in diameter within the subgluteal space Fig. (2).

Under aseptic precautions, 18-G Tuohy needle was inserted in the long axis (in plane) of the ultrasound beam Fig. (1) and advanced slowly towards the sciatic nerve under real-time ultrasound guidance. As the needle was advanced in the long axis of the ultrasound beam, it was possible to see the advancing needle in most cases. However, when the needle could not be seen, the position of the needle tip could only be inferred by jiggling the needle and looking for tissue movement on the ultrasound scan. Once the block needle was in contact with the sciatic nerve (identified by observing nerve movement) or in the subgluteal space close to the sciatic nerve.

The final position of the needle in the subgluteal space was confirmed in all patients by injecting 2-5ml of saline through the needle and observing a distention of the subgluteal space [i.e. separation of the perimysium of the gluteus maximus and quadratus femoris muscle on the ultrasound image.

After negative aspiration through the needle, a local anesthetic solution of 15mL of 0.25% plain Bupivacaine and 10ml of 1% Lidocaine then were injected incrementally over 2-3min while observing the distribution of the local anesthetic in real time on the ultrasound scan. Distention of the subgluteal space [seen in, Fig. (3)] and circumferential spread of the local anaesthetic around the sciatic nerve was noted.

**Anterior group:** Following Vloka J.D. et al., [5] patients in the anterior approach group were placed in supine position with the hip and knee on the operated side flexed and the leg externally rotated by approximately 45 degrees. The ultrasound transducer was first positioned perpendicular to the skin approximately 8cm distal to the inguinal crease Fig. (4).

After sterilizing the skin and scan with a low-frequency curvilinear 2-5-MHz ultrasound transducer covered by a sterile adhesive dressing. The transducer was placed transverse over the proximal thigh, approximately 8cm from the inguinal crease, to capture a cross-sectional view of the sciatic nerve Fig. (5). The femur was identified, a bony landmark that casts a curve hyperechoic outline and an underlying acoustic shadow. The muscular landmarks, the anterior compartment group of muscles (adductor muscles) medially, and the muscle in the posterior compartment of the thigh, Biceps Femoris Muscle (BFM) more (distally), and the Gluteus Maximus Muscle (GMM) more (proximally) was identified. The sciatic nerve that is posterior to the femur and also between the adductor muscle group and the posterior GMM (more proximally) or the BFM (more distally) was identified. Then skin infiltration with 2% lidocaine, tuohy needle 18-G inserted parallel and in line with the ultrasound transducer from antero-medial to postero-lateral of the thigh while the sciatic nerve was kept in the middle of the ultrasound screen. The needle advanced slowly under real-time ultrasound guidance until it was in close proximity to the nerve. A local anesthetic solution of 15mL of 0.25% plain Bupivacaine and 10ml of 1% Lidocaine then were injected incrementally. The needle-tip was repositioned so that a circumferential spread of the solution could be produced.

The location then scanned by sliding and tilting the transducer until a clear transverse image of the hyperechoic sciatic nerve located posterior and medial to the lesser trochanter obtained. After skin sterilization with an iodine-containing solution and skin infiltration with 2% lidocaine, tuohy needle 18-G inserted parallel and in line with the ultrasound transducer covered with a sterile plastic cover and gel from antero-medial to postero-lateral of the thigh while the sciatic nerve was kept in the middle of the ultrasound screen. The needle advanced slowly under real-time ultrasound guidance until it was in close proximity to the nerve. A local anesthetic solution of 15mL of 0.25% plain Bupivacaine and 10ml of 1% Lidocaine then were injected incrementally. The needle-tip was repositioned so that a circumferential spread of the solution could be produced.

**Medial group:** Following Yoshimune Osaka et al., [6] Patients in the medial mid-thigh approach were placed in a supine position, the hip and knee flexed and the leg externally rotated by approximately 45 Fig. (6A). The ultrasound transducer was positioned perpendicular to the skin at a location approximately 10cm distal to the inguinal crease (at the level of the upper middle thigh) and was directed between the Adductor Magnus Muscle (AMM) and the hamstrings Fig. (6B). A transverse image was obtained of the femur located laterally, with a hyperechoic bone Fig. (6C) outline and a hypoechoic bone shadow. The transducer was then moved 2-3cm posteriorly to visualize the sciatic nerve, which was visible as an oval hyperechoic nodule Fig. (6D).
After skin sterilization with an iodine-containing solution and skin infiltration with 2% lidocaine, tuohy needle 18-G was inserted parallel and in line with the ultrasound transducer covered with a sterile plastic cover and gel of the thigh while the sciatic nerve was kept in the middle of the ultrasound screen. The needle was advanced slowly under real-time ultrasound guidance until it was in close proximity to the nerve. A local anesthetic solution of 15mL of 0.25% plain Bupivacaine and 10ml of 1% Lidocaine then were injected incrementally. The needle-tip was repositioned so that a circumferential spread of the solution could be produced.

**Femoral nerve block:** It was done to all patients, in posterior group after sciatic nerve block, but in both anterior and medial group it was done before sciatic nerve block. Following Bogacz A & Jamison M [7].

The patient was placed supine with leg extended; the femoral artery was palpated to ensure accurate position before visualizing the nerve, the skin sterilized and ultrasound covered with protective sheath to prevent infection Fig. (7).

The ultrasound probe is placed over the femoral artery pulsation and moved medially or laterally to visualize and identify the femoral vessels by their individual characteristics. Blood vessels appeared as dark, circular areas in cross section on an ultrasound image. An artery was pulsatile and non-compressible on an ultrasound image, whereas a vein was nonpulsatile and compresses/collapses when the ultrasound probe was used to apply downward pressure to the skin overlying the vessel. The compartment containing the femoral nerve appeared as a speckled triangular structure lateral to the femoral artery [8] Fig. (8).

The needle often visualized on the ultrasound monitor, particularly with angles of insertion greater than 45 degrees Fig. (9). Advancement of the needle caused visible movement of the subcutaneous tissues on screen and correlated with the position of the tip of the needle. When the needle tip had crossed the fascia lata and fascia iliaca and into the femoral nerve compartment, aspiration attempted with the syringe to check for blood to ensure against accidental vascular puncture.

A 1ml 'test dose' of local anaesthetic slowly infiltrated and a corresponding small spread of local anaesthetic was seen on the monitor to further confirm correct needle position Fig. (10). Continued infiltration of local anaesthetic was preceded with visualized widening of the soft tissue space within the femoral nerve compartment and around the nerve as observed on the monitor Fig. (10).

**Induction of general anesthesia:** In all groups, general anesthesia induction and skin incision was performed at least 30min after the block the performance time of the sciatic and femoral nerve blocks carried out by all techniques was recorded and the procedure was considered a failure when the performance time exceeded 30 minutes. In all groups, the performance time was defined as: (Time from application of the probe till end of injection.

In all groups the induction of anesthesia was done by propofol 1% and inhalational maintenance by 1/2 MAC sevoflurane also using LMA as airway device, under complete monitor using pulse oximetry, non invasive blood pressure, ECG and ETCO$_2$ all the time during the procedure.

**Assessment:**

**Block assessment:**

**Sensory assessment:**

1- Onset of sensory loss by minutes (patient considered a part of sensory loss group when there were decrease in sensation in dermatomes covered by sciatic nerve compared with the other leg within 30 minutes of the starting of injection. The patients were assessed every 5 minutes, and if there were no change in sensation within 30 minutes the patient was considered as a failure and was reported as no sensory loss).

2- The intensity of sensory loss assessed after 30 minutes from starting of injection, Pinprick test was used and the results were reported by four points score:

- Score 0 = severe pain.
- Score 1 = moderate pain.
- Score 2 = mild pain.
- Score 3 = no pain.

3- Duration of sensory loss recorded every 4 hours for 24 hours, we considered the withdrawal of the block effect when no difference between 2 legs in sensation.

**Motor assessment:**

1- Onset of motor loss by minutes (patient considered a part of motor loss group when there were decrease in muscle power supplied by sciatic nerve which produce dorsiflection of foot compared with the other leg within 30 minutes of the starting of injection. The patients were assessed every 5 minutes, and if there were no
change in muscle power within 30 minutes the patient was considered as a failure and was reported as no motor loss).

2- The intensity of motor loss assessed after 30 minutes from starting of injection, four-level bromage score method was used.
A- Score 0 = able to raise the leg (L2, 3), full flexion of knee and feet.
B- Score 1 = unable to raise leg, able to flex ankles (L5, S1).
C- Score 2 = unable to flex knee, able to flex ankles (S1, 2).
D- Score 3 = unable to flex ankles.

3- Duration of motor loss recorded every 4 hours for 24 hours, we considered the withdrawal of the block effect when no difference between 2 legs in muscle power.

Postoperative pain assessment:
Assessed according to visual analogue scale which is graded from 0 to 100 on linear scale:
• Score 0 = VAS 0-24 mean that there is no pain.
• Score 25 = VAS 25-49 mean that there is mild pain.
• Score 50 = VAS 50-74 mean that there is moderate pain.
• Score 100 = VAS 75-100 mean it is severe pain.

Post-operative pain assessment using VAS score was done every 6 hours post-operative for 24 hours and time 0 was considered immediately after the operation.

Patients’ satisfaction: Overall level of individual’s satisfaction about the technique was assessed using three-point scale:
• Poor.
• Good.
• Excellent.

Statistical analysis:
Mean and standard deviation (mean ± SD) were performed for numerical data.
Nominal non-parametric data were analyzed with the Chi-square test. Frequency and percentages were used for categorized data. p-values <0.05 were considered as statistically significant results. SPSS version 11.01 (SPSS Inc., Chicago, IL) was used in this analysis.
Fig. (4): Position of the patient and the ultrasound transducer during an ultrasound-guided SNB by anterior approach.

Fig. (5): (A) Anterior approach sonographic appearance. AMM adductor magnus muscles, ALM adductor longus muscle, GMM gluteus maximus muscle, LT lesser trochanter of femur, VLM ventral longitudinal muscle. The sciatic nerve is indicated by the arrow, (B) The sciatic nerve indicated by arrows surrounded by Local Anesthetics (LA).

Fig. (6): (A) Patient position, (B) Ultrasound transducer position, (C,D) Ultrasound images of the short axis (transverse view) of the (SN) Sciatic Nerve. (SN) Sciatic Nerve, (F) Femur, (AMM) Adductor Magnus Muscle, (STM) Semitendinosus Muscle, (SMM) Semimembranosus Muscle.
Fig. (7): Placement of ultrasound probe over the palpable femoral pulse.

Fig. (8): Ultrasound image of femoral artery (red), femoral vein (blue), femoral nerve compartment (yellow), fascia lata (green) and fascia iliaca (orange).

Fig. (9): Insertion of the injection needle under the mid-point of the ultrasound probe, which is overlying the femoral nerve.

Fig. (10): A small 1ml injection and small spread of local anaesthetic (left image) confirms the needle tip position within the nerve compartment. The widened spread of soft tissue with continued local anaesthetic infiltration (right image).


Results

Demographic data: Demographic data of the three groups of patients showed no statistically significant differences.

Table (1).

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Sensory assessment:

The onset of sensory loss and the duration of sensory block showed no statistically significant differences ($p>0.05$).

As regards the intensity of sensory block, there were statistically significant differences ($p<0.05$); significant values appeared with the posterior group as 10 patients suffered of severe pain and 50 patient with no pain.

Motor assessment:

The onset time and the duration of motor block in the three groups of patients, showed no statistically significant differences between them ($p>0.05$).
Intensity of motor block as scored according to bromage scale revealed a statistically significant intense block in the posterior group compared to the other groups, there is (48.4%) of patients in posterior group cant flex their knees or ankles compared to (24.2%) in anterior group and (21.2%) in mid-thigh group.

Postoperative pain assessment:

Postoperative pain was statistically significant at 0 time \( (p<0.05) \) as 29 patients in the posterior group gave 0 pain score compared to 18 patients in anterior group and 17 patients in mid-thigh group. At times 6, 12, 18, 24 hours, there was no statistical significant difference between the three groups.
Patients’ satisfaction:

As regards patients satisfaction, there was statistically significant difference ($p<0.05$) between the three groups. More patients in the anterior group are satisfied than in the other groups, the result (60) patients in anterior group had excellent satisfaction compared to (31) patients in mid-thigh group.

Discussion

Combined sciatic and femoral nerve blocks can be an invaluable alternative to general anesthesia and epidural or spinal block for lower limb surgery in compromised patients, with higher degree of patient’s satisfaction, surgical outcome and rehabilitation together with lower incidence of side effects [9].

The present study included 99 patients of ASA I and II and the results showed no statistically significant differences ($p>0.05$) between the three groups as regards demographic distribution and those related to the duration of surgery. No hemodynamic instability was reported in any of the patients. Also, no statistically significant differences ($p>0.05$) were reported as regards the onset times of sensory and motor blocks and their duration times.

Assessment of sensory block using 4 point score of pain and motor assessment showed statistically significant ($p<0.05$) better results with the posterior approach than the anterior and the medial mid-thigh approaches.

The anterior group scored the best of the three groups as regards the patients satisfaction ($p<0.05$).

As regard the posterior subgluteal approach. The results of the current study are in agreement with that reported by Chelly JE and Delaunay L [10], regarding the onset times of sensory and motor blocks.
In the anterior approach, the results of the current study are in agreement with that reported by Pia Di Benedetto [11] except higher success rate in our study due to usage of ultrasound to make better identification of the position of sciatic nerve.

And in the medial mid-thigh approach, the current study is in agreement with that done by Yoshimune Osaka [12] in onset times and durations of sensory and motor blocks, only differed in the volume of local anesthetic needed which was attributed to the different concentrations.

Also in all groups it was found that tourniquet pain was inevitably tolerated by all patients due to the escape of the obturator nerve, the lateral femoral cutaneous nerve of the thigh which both originate from lumber plexus and supply the medial and lateral sensory sensation of the thigh and wasn't blocked using femoral nerve blockade which used in this study, also the escaping of posterior femoral cutaneous nerve of the thigh in anterior and medial mid-thigh approach for sciatic nerve block, led to remnant of sensory sensation in posterior slip of the thigh [13]. In posterior subgluteal approach, the high approach used didn’t miss the posterior cutaneous nerve of the thigh, which led to tense sensory block.

All approaches are effective in combination of general anesthesia (propofol and 50 microgram fentanyl analgesia with LMA insertion). The sciatic and femoral nerve blocks are time consuming and have delayed onset of action in comparison to neuroaxial block as spinal anesthesia.

Also the large volume of local anesthetic used in peripheral nerve blocks make the patients more susceptible to local anesthetic toxicity. The post-operative motor and sensory loss in peripheral nerve blocks continue till 18 hours after the operation, and that will be unacceptable in day case surgery.

At the end we can say that combined sciatic and femoral regional block can be considered the perfect choice in postoperative analgesia after arthroscopic knee surgeries, these blocks provided good or excellent postoperative analgesia for all patients in the different groups. The posterior subgluteal approach is easier with higher success rate and it gave tense sensory and motor block and great post-operative analgesia. The anterior approach is difficult and need high experience especially in obese patients. The medial mid-thigh approach was the least performed technique. However, it is useful in patients in supine position, and easy to be done in thin patients, but this technique showed difficulty in obese patients due to limitation of rotation the leg. Patients were satisfied using anterior approach.

**Conclusion:**
All approaches is considered as effective analgesia in combination with general anesthesia during arthroscopic knee surgeries, these blocks provided good or excellent postoperative analgesia for all patients in the different groups. The posterior subgluteal approach is easier with higher success rate and it gave tense sensory and motor block and great post-operative analgesia. The anterior approach is difficult and need high experience especially in obese patients. The medial mid-thigh approach was the least performed technique. However, it is useful in patients in supine position, and easy to be done in thin patients, but this technique showed difficulty in obese patients due to limitation of rotation the leg. Patients were satisfied using anterior approach.

**References**


