Ultrasound-guided combined femoral-sciatic-obturator nerve block versus sub-arachnoid block in anterior cruciate ligament (ACL) reconstruction: A randomized single-blind study

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ABSTRACT

Introduction: Ultrasound-guided combined femoral-sciatic-obturator nerve block (peripheral nerve block) is the preferred technique in anterior cruciate ligament reconstruction because it avoids subarachnoid block (SAB) related complications and ensure prolonged postoperative analgesia. The aim of the study was to compare ultrasound-guided peripheral nerve block and SAB for anterior cruciate ligament (ACL) reconstruction. **Methods:** A randomized, single-blind study was conducted among patients undergoing ACL reconstruction at our center from February through November 2024. Fifty patients undergoing the procedure were randomly assigned to either receive SAB- 2 ml of 0.5% hyperbaric bupivacaine (group A) or ultrasound-guided combined femoral-sciatic-obturator nerve block- 30 ml mixture of 5 ml 2.0% lidocaine, 15 ml 0.5% bupivacaine plus 10 ml distilled water (group B). Hemodynamic changes, visual analogue score (VAS), time-to-spontaneous micturition following surgery, time to return motor power and time to rescue analgesia were compared between the groups. **Results:** In Group A, the mean VAS was 2.32±0.69 and 5.48±0.82 after 2 and 3 hours respectively, whereas the VAS was zero in group B throughout. The time to first rescue analgesia was significantly longer in Group B (630.4±36.11 min) when compared to Group A (248.4±26.09 min). **Conclusions:** Ultrasound-guided combined femoral-sciatic-obturator nerve block provided better hemodynamic stability, prolonged postoperative analgesia and allowed early ambulation due to early return of motor power.

Keywords: Anterior cruciate ligament reconstruction, sub-arachnoid block, ultrasound-guided peripheral nerve block.

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INTRODUCTION

Anterior cruciate ligament (ACL) reconstruction is one of the most common orthopedic surgeries that can be performed under central neuraxial (spinal/epidural) anesthesia, peripheral nerve blocks or general anesthesia. It is generally accepted that both peripheral nerve blocks and central neuraxial anesthesia, especially subarachnoid block (SAB) provide satisfactory anesthesia, better postoperative analgesia, and patient satisfaction than general anesthesia.[1] In addition, these techniques are minimally invasive and use fewer resources. Conventionally, ACL reconstruction is performed under SAB. Though SAB provides good surgical anesthesia, it may be associated with complications like hypotension, shivering, urinary retention, postoperative nausea and vomiting, post-dural puncture headache, hematoma, low back pain, infection, and poses a risk for patients with hemodynamic instability.[2] These effects are not seen with peripheral nerve block. It also causes sensory and motor blockade of the non-operated leg. In addition, the presence of spinal deformities makes neuraxial block difficult for lower extremity surgery. Combined peripheral nerve block has been recommended for ACL reconstruction due to its benefits when compared with both general anesthesia and subarachnoid block.[3] The most significant advantage of peripheral nerve block over other regional anesthesia methods is that, such blocks are limited to the area innervated by the nerve and also eliminates the risk of spinal hematoma and infection. The combined nerve block is often inadequate to provide optimum analgesia in patients undergoing ACL reconstruction, which may be attributed to the spared genicular branches of obturator nerve to the knee joint. Thus, an additional obturator nerve block may increase the quality of nerve block during surgery as well as postoperative analgesia. Peripheral nerve block can solely ensure post-operative analgesia following anterior cruciate ligament reconstruction, so opioid analgesics and its adverse effects can be avoided. Other benefits include better functional outcomes, such as early initiation of physiotherapy and passive knee flexion as patient remains pain free, and reduced duration of hospital stay.[4] Furthermore, unlike the brachial plexus, the nerves supplying the lower extremity are not anatomically clustered and therefore can be easily blocked using landmark technique.[5]

Recently, peripheral nerve blocks have become popular, since the introduction of ultrasound-guided technology for peripheral nerve block.[6] It is the preferred technique as it has the advantages of fewer needle insertions, improved block quality, shorter administration time, decreased dosage of local anesthetic and a rapid onset of nerve blockade.[7] In addition, it is associated with a reduced incidence of inadvertent vascular puncture.[8] The occurrence of paresthesia while performing the block is reduced by using ultrasound guidance.[9] The incidence of long-term postoperative neurological symptoms (PONS) is also rare.[10] As regional anesthetic procedures are performed in a conscious state of the patient, anxiolysis is paramount.

This study was designed to compare ultrasound-guided femoral-sciatic-obturator nerve block and subarachnoid block in patients undergoing ACL reconstruction in terms of the quality of anesthesia, stability of hemodynamic parameters, motor block, duration of postoperative analgesia, incidence of PONV and time to spontaneous micturition.

METHODS

After ethical approval from the Institutional Review Committee of Gandaki Medical College (Ref. No. 31/080/081), this randomized, single-center, single blind study was carried out among patients undergoing anterior cruciate ligament reconstruction surgery at our center from February through November 2024. All patients with ACL injury of age group 16 to 65 years with ASA grading of I and II were included after thorough pre-anesthetic evaluation. Patients who denied to be a part of this study, patients with ASA grading more than II, patients with documented allergy to local anesthesia and were excluded. Patients were randomized using a computer-generated randomization table into two groups: the sub-arachnoid block group (Group A) and the ultrasound-guided combined femoral-sciatic-obturator nerve block group (Group B). Demographic and clinical data including age, weight, height, body mass index (BMI) and American Society of Anesthesiologist (ASA) physical status scores were recorded for all patients. The peripheral nerve block and SAB were performed by the PI.

The sample size was calculated using the formula:

Sample size (N) = $(Z\alpha + Z\beta)^2 \text{ X } (\sigma1^2 + \sigma2^2) / (\mu1 - \mu2)^2$
Where[11],

$\mu1$= 231 (time to urination in control group)

$\mu2$ = 145 (time to urination in experimental group) $\sigma1$ = 93 (Standard deviation of control group)
$\sigma2$= 36 (Standard deviation of experimental group)

$Z\alpha$= Z value (two tail) of standard normal distribution at 95% confidence level or 5% level of significance = 1.96 (when α = 0.05 at 5% level of significance)

$Z\beta$ = Z value (one tail) at 90.564% power = 1.28 (when β = 0.2 and Power =1-β)

Sample size= $(1.96+1.28)^2 \times (93^2 + 36^2)/ (231-145)^2$ = 16

Sample size (n)= 16 (each group). Additional nine cases were included in each group population in each group was 25. Therefore, 25 x 2 = 50 samples were enrolled in this study.

All patients had the standard monitoring including continuous electrocardiography (lead II), heart rate (HR), non-invasive blood pressure (NIBP) measured every 5 minutes and oxygen saturation via continuous pulse oximetry (SpO_2). Intravenous (IV) access with 18G IV cannula connected with a Hartmann's solution was secured. All patients received oral premedication with tablet clonidine 2 μg/kg four hours before surgery.

Group A:

Sub-arachnoid block was performed in all patients in group

A in the sitting position. Following the identification of the L3-4 intervertebral space, skin antisepsis was performed with chlorhexidine and allowed to dry. Then local anesthetic infiltration was done using 2% lignocaine and 25G Quincke spinal needle was used for sub-arachnoid block. The subarachnoid space was confirmed by spontaneous reflux of CSF and 2 mL (10 mg) of 0.5% hyperbaric bupivacaine was administered. Patients were immediately placed in the supine position and hemodynamic parameters were monitored.

Group B:

Group B received ultrasound-guided combined femoral-sciatic-obturator nerve block. The patients received 30 ml mixture of 5 ml, 2.0% lidocaine, 15 ml 0.5% bupivacaine plus 10 ml distilled water (15 ml for the femoral, 10 ml for the sciatic nerve block & 5 ml for obturator nerve block). Under aseptic conditions, a linear ultrasound probe was placed on the inguinal crease to identify the femoral nerve and vessels. After local skin infiltration with 2% Lignocaine, a 12 cm block needle was inserted just medial to the femoral vein and advanced using in-plane technique 1-3 cm just below and parallel to the skin. It was then redirected toward the lateral fibers of the femoral nerve, where after negative aspiration 15 mL of local anesthetic was injected. To block the obturator nerve, the probe was moved medially, placed superior to the needle, and tilted cranially to identify the pectineus muscle proximally. The needle was subsequently withdrawn to the subcutaneous tissue and redirected using an out-of- plane technique toward the deep surface of the pectineus, where after negative aspiration, 5 mL of local anesthetic was injected. To identify the sciatic nerve, a curvilinear probe was used and was placed inferior to the needle and rotated/tilted to achieve the best longitudinal image of the sciatic nerve. The needle was again withdrawn subcutaneously and redirected using an in-plane technique toward the sciatic nerve deep to the inferior border of the quadratus femoris muscle & after negative aspiration, 10 ml of local anesthetic was injected.

Block assessment:

For both groups, sensory block was evaluated using light touch and cold application and it was considered adequate if there was complete loss of touch & temperature sensation at the T12 dermatome level in group A, and in the femoral-sciatic-obturator nerve distribution in group B. Motor block was evaluated using the Bromage scale (1= unable to move legs or feet, 2 = able to move feet only, 3 = Just able to flex knees with free movement of feet, 4 = Full movement of legs and feet).[12] Hemodynamic changes in terms of heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP) & mean arterial pressure (MAP) were measured at baseline, immediately after initiation of block, after 5 minutes, 15 minutes, 30 minutes, 45 minutes and, one hour. In addition, data regarding time-to-spontaneous urination, incidence of PONV, patient satisfaction level by four-point verbal rating scale (VRS) were also recorded. Duration of postoperative analgesia was assessed by VAS following surgery on an hourly basis till patient demanded rescue analgesia.[13] Finally, quality of anesthesia was evaluated using four points rating scale by calculating mean of the following quality indicators- mean arterial pressure (MAP), time-to-return of motor block, duration of postoperative analgesia and patient satisfaction level.

Data were collected in a pre-designed proforma. Patient information was obtained using patient information sheet. Statistical analysis was carried out using Statistical Package for the Social Sciences version(SPSS) 20.0 for Windows. Qualitative variables are expressed as percentage and quantitative variables are expressed in terms of mean and standard deviation. Chi square test was used to compare the categorical variables and unpaired t-test for continuous variables. The p-value <0.05 was considered statistically significant.

RESULTS

Fifty patients aged 18 through 60 years who fulfilled the inclusion criteria and provided informed consent were included in the final analysis. Basic demographics of the study population is summarized in Table 1.

Table 1: Basic demographics of the study population

Variables	Group A (n=25)	Group B (n=25)	p-value
Age in years (Mean ± SD)	26.1±4.6	28.6±5.2	0.070
Height in cm (Mean ± SD)	1.64±0.04	1.62±0.05	0.125
Weight in kg (Mean ± SD)	64.4±6.6	67.52±4.4	0.055
BMI (kg/m2) (Mean ± SD)	24.1±2.5	25.3±2.1	0.074
ASA Class (%)			
Class 1	21(84%)	22(88%)	0.684
Class 2	4(16%)	3(12%)	

The hemodynamic parameters between the groups are summarized in Table 2. The heart rate variation was not statistically significant between the groups, but systolic and mean arterial pressure variation were statistically significant. The mean arterial pressure was higher in Group B than in Group A.

Table 2: Distribution of hemodynamic parameters- Heart rate (HR, in bpm), Mean arterial pressure (MAP, in mmHg)

Vital signs	Group A	Group B	P-value
Pre- operative	HR=77.68±4.73	HR=80±5.19	HR=0.105
	SBP=118±2.3	SBP= 120±5.2	SBP=0.957
	DBP= 70±3.5	DBP= 76±4	DBP=0.896
	MAP=86±4	MAP=90.7±5	MAP=0.483
Immediately after the block	HR=75.92±4.93	HR=73.92±4.74	HR= 0.150
	SBP=117.32±5. 25	SBP=129±4.29	SBP=0.001
	DBP= 70.88±5.85	DBP= 78.48±4.12	DBP=0.001
	MAP= 86.12±4.8	MAP= 95.36±4.87	MAP=0.001
5-Min after block	HR=72.16±4.59	HR=71.92±4.36	HR= 0.850
	SBP= 114.2±4.81	SBP=125.36±4.9	SBP=0.001
	DBP=70.12±5.84	4DBP=76.52±6.23	DBP=0.001
	MAP=84.4±4.75	MAP=92.48±5.02	MAP=0.001
15-Min after block	HR= 68.28±5.3	HR=69.68±4.31	HR= 0.310
	SBP=115.2±4.48	SBP=75.68±6.15	SBP=0.001
	DBP=73.36±5.44	DBP=75.68±6.15	DBP=0.164
	MAP=86.92±4.27	MAP=91.52±4.62	MAP=0.001
30-Min after block	HR=67.32±5.94	HR=67.52±3.7	HR=0.887
	SBP=116.08±5.5	SBP=124.48±2.97	SBP=0.001
	DBP=72.72±5.89	DBP=74.6±4.92	DBP=0.226
	MAP=86.88±4.87	MAP=90.88±3.62	MAP=0.001
1 Hour after block	HR=91.4±4.31	HR=65.28±3.22	HR=0.195
	SBP=113.56±5.06	SBP=124.88±2.9 9	SBP=0.001
	DBP=71.08±4.58	DBP=73.48±4.48	DBP=0.067
	MAP=84.92±4	MAP=90.12±2.92	MAP=0.001

The mean visual analogue score (VAS) between both groups have been summarized in Table 3. VAS after 2 hours, 3 hours and during patient's demand of rescue analgesia were statistically significant between the groups ($p < 0.05$).

Table 3: Visual analogue score (VAS) between the groups

VAS score	Group A	Group B	P-value
Immediately after surgery	0 (no pain)	0 (no pain)	-
After 1 hour	0 (no pain)	0 (no pain)	-
After 2 hours	2.32±0.69	0.48±0.65	<0.001*
After 3 hours	5.40±0.76	0.72±0.73	<0.001*
VAS when rescue analgesia was demanded	5.48±0.82	5.36±0.49	0.007*

*denotes statistical significance ($p<0.05$)

In Group A, the mean time-to-spontaneous micturition following surgery, mean time to return of motor power, and mean time to rescue analgesia were 412.4±32.95, 366±20.82, and 248.4±26.09 minutes respectively (Table 4), and these differences when compared to Group B, were statistically significant ($p<0.05$).

Table 4: Distribution of patients by time to spontaneous micturition after surgery, duration until motor function return, and time to rescue analgesia

Distribution	Group A (n=25)	Group B (n=25)	p-value
Time to spontaneous micturition following surgery (min)	412.4±32.95	387.2±23.54	0.003*
Time to return motor power(min)	366±20.82	314.2±22.44	<0.001*
Time to rescue analgesia(min)	248.4±26.09	630.4±36.11	<0.001*

*denotes statistical significance ($p<0.05$)

DISCUSSION

Anterior cruciate ligament reconstruction is a very common orthopedic procedure and can be performed under a variety of settings, even as a daycare surgery, and using different anesthetic modalities. Effective pain control after ACL reconstruction is vital since it is significantly affects recovery and outcomes.[4] Though a variety of anesthetic modalities have been studied for ACL reconstruction, most of them have assessed only postoperative pain and there have been a paucity of studies assessing variety of other anesthetic parameters in this setting.[14] In this study, we have comprehensively studied this aspect as well as the stability of hemodynamic parameters, motor block, duration of postoperative analgesia, incidence of PONV and time to spontaneous micturition for subarachnoid block versus peripheral nerve block in ACL reconstruction.

In our study, statistically significant difference was observed for systolic and mean arterial pressure variation but not for heart rate variation between the two groups. The mean heart rate showed similarity until one hour after the block which can be explained by use of oral Clonidine as premedication in both groups that has anti-nociceptive properties by descending inhibition of pain pathway. The mean MAP of group A decreased gradually throughout the intraoperative period, while that of group B showed changes in successive period of evaluation. However, there was significant reduction of MAP in group A against group B at different time interval ($p<0.05$). The possible explanation is SAB associated peripheral vasodilatation and resultant hypotension. As peripheral nerve block may cause hemodynamic instability when blind landmark technique is used, we used ultrasound guidance for nerve localization as it enabled us to administer minimum volume of drugs so as the mean arterial pressure remained stable throughout the operative procedure.

We observed that mean visual analogue score (VAS) in Group A was higher than Group B after two hours, three hours and during patient's demand of rescue analgesia which indicates that ultrasound-guided combined femoral-sciatic–obturator nerve block had a significantly longer postoperative analgesia compared with arachnoid block. This finding is consistent with other studies assessing this aspect after ACL reconstruction.[15] The presence of adequate postoperative analgesia is essential to facilitate rehabilitation after anterior cruciate ligament reconstruction. In SAB, the presence of pain after regression of the block is one of the factors that limit its use. The mean time to rescue analgesia was very much significant ($p<0.0001$) in Group B than Group A. It might be due to performing additional obturator nerve block that was not performed in the previous studies. The obturator nerve provides sensory innervation of the knee joint and gracilis tendon.[16] So, it is necessary to block it for adequate analgesia.

The mean time to return of motor power was significantly early in Group B compared to Group A ($p<0.001$). Patient satisfaction were excellent in both group while group B showed stable hemodynamic stability, early return of motor power and prolonged postoperative analgesia than group A. So, we can say that quality of anesthesia was better in group B. Our observation differs from findings of that by Sari et al. [17] where they concluded that the quality of subarachnoid block (SAB) is better than sciatic-femoral block in arthroscopic knee surgery. This might be explained by the fact that they measured quality of anesthesia based on a single indicator- whether additional analgesics were needed or not during the procedure while we used a variety of parameters to assess it.

CONCLUSIONS

Ultrasound-guided combined femoral-sciatic–obturator nerve block allows for precise placement of local anesthetic near the targeted nerves, providing prolonged postoperative analgesia, hemodynamic stability and early ambulation due to early return of motor power. Also, it has less systemic side effects and provides good patient satisfaction. The research finding highlights that if we change our anesthetic technique of ACL reconstruction, it can be done as a day case surgery.

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AUTHORS' CONTRIBUTIONS

KMB and TP designed the research, collected data, performed statistical analysis and interpretation. RH, SN and UKC contributed in literature review, data analysis and manuscript preparation. All authors read and approved the manuscript.

REFERENCES

1. Montes FR, Zarate E, Grueso R, Giraldo JC, Venegas MP, Gomez A, et al. Comparison of spinal anesthesia with combined sciatic-femoral nerve block for outpatient knee arthroscopy. J Clin Anesth. 2008;20(6):415-20. DOI: 10.1016/j.jclinane.2008.04.003 PMID: 18929280.

2. Axelsson KH, Edström HH, Sundberg AEA, Widman GB. Spinal anesthesia with hyperbaric 0.5% bupivacaine: effects of volume. Acta Anaesthesiol Scand. 1982;26(5):439-45. DOI: 10.1093/bja/54.1.75 PMID: 7034758.

3. Sansone V, De Ponti A, Fanelli G, Agostoni M. Combined sciatic and femoral nerve block for knee arthroscopy: 4 years' experience. Arch Orthop Trauma Surg. 1999;119(3-4):163-7. DOI: 10.1007/s004020050382

4. Wang H, Boctor B, Verner J. The effect of single-injection femoral nerve block on rehabilitation and length of hospital stay after total knee replacement. Reg Anesth Pain Med. 2002;27(2):139-44. DOI: 10.1053/rapm.2002.29253 PMID: 11915059.

5. Kopp SL, Horlocker TT. Regional anesthesia in day-stay and short-stay surgery. Anaesthesia. 2010;65:84-96. DOI: 10.1111/j.1365-2044.2009.06204.x PMID: 20377550.

6. Kurnaz M, Ersoy A, Altan A, Ervatan Z, Unlu N. Comparison of hemodynamics, recovery profile and postoperative analgesia of unilateral spinal anesthesia with combined sciatic-femoral nerve block in knee arthroscopy. Agri. 2014;26(4):171-8. DOI: 10.5505/agri.2014.18189 PMID: 25551813.

7. Oberndorfer U, Marhofer P, Bösenberg A, Willschke H, Felfernig M, Weintraud M, et al. Ultrasonographic guidance for sciatic and femoral nerve blocks in children.

Br J Anaesth. 2007;98(6):797-801. DOI: 10.1093/bja/aem092 PMID: 17449890.

8. Barrington MJ, Watts SA, Gledhill SR, Thomas RD, Said SA, Snyder GL, et al. Preliminary results of the Australasian Regional Anesthesia Collaboration: a prospective audit of more than 7000 peripheral nerve and plexus blocks for neurologic and other complications. Reg Anesth Pain Med. 2009;34(6):534-41. DOI: 10.1097/aap.0b013e3181ae72e8 PMID: 19916206.

9. Koscielniak-Nielsen ZJ. Ultrasound-guided peripheral nerve blocks: What are the benefits? Acta Anaesthesiol Scand. 2008;52(6):727-37.

10. Sites BD, Taenzer AH, Herrick MD, Gilloon C, Antonakakis J, Richins J, et al. Incidence of local anesthetic systemic toxicity and postoperative neurologic symptoms associated with 12,668 ultrasound-guided nerve blocks: an analysis from a prospective clinical registry. Reg Anesth Pain Med. 2012;37(5):478-82. DOI: 10.1097/AAP.0b013e31825cb3d6 PMID: 22705953.

11. Casati A, Cappelleri G, Fanelli G, Borghi B, Anelati D, Berti M, et al. Regional anaesthesia for outpatient knee arthroscopy: a randomized clinical comparison of two different anaesthetic techniques. Acta Anaesthesiol Scand. 2000;44(5):543-547. DOI: 10.1034/j.1399-6576.2000.00509.x

12. Bromage PR. A comparison of the hydrochloride and carbon dioxide salts of lidocaine and prilocaine in epidural analgesia. Acta Anaesthesiol Scand. 1965;9:55-69. DOI: 10.1111/j.1399-6576.1965.tb00523.x

13. Breivik EK, Björnsson GA, Skovlund E. A comparison of pain rating scales by sampling from clinical trial data. Clin J Pain. 2000;16(1):22-8. DOI: 10.1097/00002508-200003000-00005

14. Berić S, Murselović T, Žižak M, Bulat S, Vrgoč G. Comparative effects of spinal anesthesia and combined spinal with peripheral nerve blocks on postoperative outcomes in anterior cruciate ligament repair. J Clin Med. 2024;13(22):6845. DOI:10.3390/jcm13226845

15. Ramlogan R, Tierney S, McCartney CJL. Anterior cruciate ligament repair and peripheral nerve blocks: time to change our practice? Br J Anaesth. 2019;123(2):e186-e188. DOI: 10.1016/j.bja.2019.05.028

16. Sakura S, Hara K, Ota J, Tadenuma S. Ultrasound-guided peripheral nerve blocks for anterior cruciate ligament reconstruction: effect of obturator nerve block during and after surgery. J Anesth. 2010;24(3):411-7. DOI: 10.1007/s00540-010-0916-3 PMID: 20225073.

17. Sarı S, Eroğlu F, Fusco P, Atay T, Ceylan BG. Comparison of anesthesia quality for arthroscopic knee surgery: combined sciatic femoral block and unilateral spinal anesthesia. Meandros Med Dent J. 2015;16(2):59-66.