Original Article

Comparison of genicular nerve block with adductor canal block for postoperative pain management in patients undergoing arthroscopic knee ligament reconstruction: A randomised controlled trial

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ABSTRACT

Background and Aims: Genicular nerve block **(**GNB) is beneficial in early ambulation and faster patient discharge since it selectively blocks articular branches and is motor-sparing. This study aimed to compare the analgesic efficacy of ultrasound (US)-guided GNB with adductor canal block (ACB) in patients undergoing arthroscopic anterior cruciate ligament reconstruction (ACLR). **Methods:** This randomised, double-blind study was conducted on 38 adults undergoing arthroscopic ACLR. Patients in Group GNB (n = 19) received US-guided GNB with 3 ml of 0.25% bupivacaine and 2 mg dexamethasone. Patients in Group ACB (n = 19) received US-guided ACB with 20 ml of 0.25% bupivacaine with 6 mg dexamethasone. Postoperative rescue analgesia was provided by intravenous Patient Controlled Analgesia (PCA) with morphine. The primary outcome was Numerical Rating Scale (NRS) pain scores over 24 h. The secondary outcome was the duration of analgesia and 24-h morphine consumption. The Chi-square test was used to test the statistical significance between categorical variables. Independent t-test or Mann–Whitney U test was used to compare continuous variables. **Results:** NRS scores at rest and physical activity at 24 h were similar in both the groups (P = 0.429 and P = 0.101, respectively). The mean time to rescue analgesia was comparable in both groups (Group GNB: 820.79 [483.65] min [95% confidence interval {CI}: 603.31–1038.27] and Group ACB: 858.95 [460.06] min [95% CI: 652.08, 1065.82], P = 0.805), and the mean 24-h morphine consumption was also comparable in both groups (P = 1.000). **Conclusion:** US-guided GNB has an analgesic efficacy similar to US-guided ACB for patients undergoing arthroscopic ACLR.

Keywords: Adductor canal block, analgesia, anterior cruciate ligament reconstruction, bupivacaine, genicular nerve block, nerve block, postoperative pain

INTRODUCTION

Arthroscopic anterior cruciate ligament reconstruction (ACLR) is an ambulatory procedure. An effective postoperative analgesic regimen helps fast-track patients by providing early mobilisation and enhanced patient satisfaction, as well as reducing costs to the healthcare system. Guidelines recommend multimodal analgesia, including non-steroidal anti-inflammatory drugs, opioid analgesics and peripheral nerve blocks.

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Common regional techniques for ACLR surgeries are femoral nerve block, adductor canal block (ACB) and local instillation.[1-6] Ultrasound (US)-guided genicular nerve block (GNB) and radiofrequency ablation have been successfully used for managing chronic knee pain.[7,8] Genicular nerves (GNs) are the main innervating articular nerves for the knee joint and consist of superior lateral (SL), middle, superior medial (SM), inferior lateral, inferior medial (IM) and recurrent peroneal GN. GNB might be helpful in early ambulation and faster discharge of patients since it selectively blocks articular branches and is motor sparing.

Many studies assess the analgesic efficacy of ACB for ACLR, but limited case reports indicate the analgesic efficacy of GNB for ACLR.[9,10] We hypothesised that the analgesic efficacy of GNB is similar to ACB. Hence, in this study, we aimed to compare the postoperative analgesic efficacy of US-guided GNB with ACB in patients undergoing ACLR. The primary objective was to compare the postoperative pain scores between the two groups using a Numerical Rating Scale (NRS) over 24 h. The secondary objective was a comparison of the duration of analgesia of the two blocks and morphine consumption postoperatively over 24 h.

METHODS

This study was conducted from 01 March 2021 to 30 June 2022 after obtaining approval from the Institutional Ethics Committee (IEC/VMMC/SJH/Thesis/2020-11/CC-47, dated 10 December 2020). The study was registered in the Clinical Trials Registry-India (CTRI/2021/03/031626, accessible at www.ctri.nic.in/). Written informed consent was obtained regarding participation in the study and the use of data for educational and research purposes. The study was carried out in accordance with the principles of the Declaration of Helsinki, 2013 and good clinical practice.

All adult patients with American Society of Anesthesiologists physical status I or II (18–65 years) scheduled for elective ACLR under spinal anaesthesia were recruited for this study. Patients with contraindications to nerve blocks (having coagulopathy or taking anticoagulants and having local infection at the site of needle insertion), history of allergy to drugs used in the study, pre-existing neurological deficits, or patients suffering from cardiac, renal, hepatic and respiratory insufficiency were excluded from the study.

Patients were randomly allocated into two groups using a computer-generated random number table. Sequentially numbered, opaque, sealed envelopes (for allocation concealment) containing computer-generated random sequence numbers were opened on the day of surgery, just before administration of the block. A regional anaesthesia fellowship-trained anaesthesiologist administered either US-guided GNB (Group GNB) or US-guided ACB (Group ACB) as per the envelope. The resident anaesthesiologist recording the results in the postoperative period was blinded to the group allocation.

All patients underwent preanaesthetic check-ups and were given a patient information sheet, and participant informed consent form. Subjects were explained about the block technique and grading of pain using NRS, with 0 corresponding to no pain and 10 being the worst unbearable pain. They were also educated regarding using the PCA pump (B Braun Melsungun AG-2011) in the postoperative period. They were advised to press the PCA button whenever NRS ≥4.

Monitors were attached to the patient in the operating room, and baseline parameters (heart rate [HR], systolic blood pressure [SBP], diastolic blood pressure [DBP] and oxygen saturation [SpO_2]) were noted. Ringer lactate was given at 5 ml/kg/h intravenously (IV). In both groups, spinal anaesthesia was administered. Under all aseptic precautions, with the patient in the sitting position, skin was infiltrated with 1–2 ml of 1% lidocaine; subarachnoid block was given at L3–L4 intervertebral space using a 25-gauge spinal needle with 10–15 mg (2.0–3.0 ml) of hyperbaric bupivacaine (0.5%) and 10 μg fentanyl, injected intrathecally at a rate of 0.2 ml/s after confirming clear and free flow of cerebrospinal fluid. The patient was then positioned supine, and oxygen was administered using a venturi mask (4 l/min). After administering the spinal block, nerve blocks were administered as per the group allocation.

Group GNB: US-guided GNB was performed at the sites of SL, SM and IM GN with the help of the Mindray M7 US system (Mumbai, Maharashtra, India, 2018). Colour Doppler was used to identify the genicular arteries, which serve as landmarks for the corresponding nerves. The site of drug injection is depicted in Figure 1. A 5-cm, 21G, insulated block needle (Stimuplex Ultra, B Braun ©2008; B Braun Medical Inc., Bethlehem, PA, USA) was inserted and aligned with the US scanning plane [Figure 1]. Once

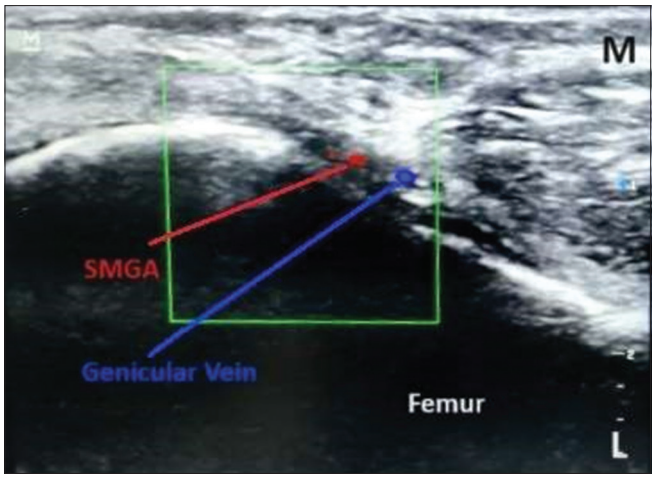

Figure 1: Site of drug injection in superior medial genicular nerve block. L = lateral, M = medial, SMGA = superior medial genicular artery

the satisfactory position of the needle was confirmed, 3 ml of 0.25% bupivacaine with 2 mg dexamethasone was slowly injected in proximity to each of the three GNs. The spread of local anaesthetic was observed to be adjacent to the target nerves.

Group ACB: After identifying the adductor canal, the probe was placed at the mid-thigh, half the distance between the inguinal crease and the patella. The superficial femoral artery was visualised dorsal to the boat-shaped sartorius muscle. At this level, the hyperechoic view of the saphenous nerve was visualised lateral and anterior to the artery in the subsartorial region. Twenty millilitres of 0.25% bupivacaine with 6 mg of dexamethasone was injected here using an in-plane technique.

Intraoperatively, vitals (HR, SBP, DBP, mean arterial pressure and SpO_2) were monitored every 5 min throughout the surgery. IV paracetamol (15 mg/kg) was administered. At the end of the surgery, patients were shifted to Post Anaesthesia Care Unit (PACU) and monitored. If any patient complained of pain intraoperatively (NRS >7), the patient was administered general anaesthesia. The patient was given care as per the standard of practice and excluded from the analysis.

In the postoperative period, IV PCA pump was used for analgesia. The pump settings were morphine 1 mg/ml, bolus dose 1 ml, lockout interval 10 min and maximum dose 5 mg/h. The pain was assessed using NRS from 0 (pain-free) to 10 (worst imaginable pain) during rest and physical activity (cough or deep breathing) at 2, 4, 8, 12 and 24 h after block administration. The total amount of morphine consumed was recorded at different time intervals (2, 4, 8, 12 and 24 h).

The time from block administration to patient's first pressing of the PCA button was recorded as the time to rescue analgesia. Any side effects, including nausea and vomiting, were documented. The resident recording the results, such as postoperative NRS scores, morphine consumption and time to rescue analgesia, was blinded to the group allocation. All patients were administered 1 g of paracetamol IV eight hourly for the first day, followed by a 650 mg tablet of paracetamol orally for the next two days.

The sample size was calculated by taking a mean difference of 2.2 and pooling a standard deviation (SD) of 1.867 for the NRS pain score at rest between periarticular injection (PAI) and ACB groups, as per the study by Kim *et al*.[11] The other parameters considered for sample size calculation were 95% study power and 5% two-sided alpha error. The ratio of the two groups (PAI: ACB group) was 1:1. Statistical Package for the Social Sciences statistics software version 21.0 (IBM Corp, Armonk, NY, USA) was used for statistical analysis. Categorical variables such as gender were presented as frequency and proportion using a Chi-squared test. Continuous variables such as age, height, weight, body mass index, NRS scores, time to first rescue analgesia and morphine consumption were presented as mean (SD) or median (interquartile range). The Chi-squared test was used to test the statistical significance of cross-tabulation between categorical variables. An independent *t*-test or Mann–Whitney U test was used to compare continuous variables between the two groups. P value < 0.05 was considered statistically significant.

RESULTS

Sixty-two patients were screened, of whom 22 were excluded. This study was conducted on 38 patients [Figure 2]. Both groups' demographic data and baseline characteristics were comparable ($P > 0.05$) [Table 1]. There was no significant difference in NRS scores at any time point during rest and physical activity in the two groups ($P > 0.05$) [Table 2]. Mean time to rescue analgesia was also similar in both the groups. In the ACB group, the mean (SD) time to first rescue analgesia was 858.95 (460.06) min [95% confidence interval (CI): 652.08, 1065.82], whereas it

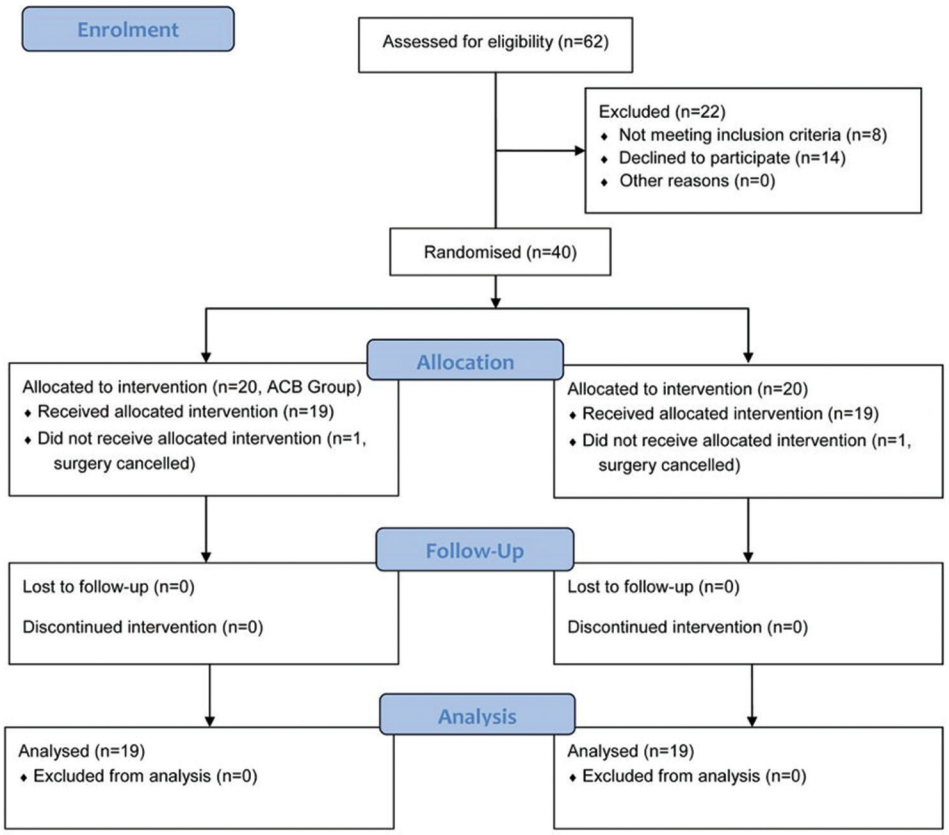

Figure 2: Consolidated Standards of Reporting Trials (CONSORT) flow diagram. ACB = Adductor canal block, GNB = Genicular nerve block, *n* = Number of patients

Table 1: Demographic variables

Variable	Group ACB (*n*=19)	Group GNB (*n*=19)
Age (years)	26.32 (6.39)	26.47 (7.59)
Gender (male:female)	16:3	15:4
Height (cm)	167.95 (9.62)	166.05 (6.35)
Weight (kg)	67.05 (8.94)	62.84 (6.87)
Body mass index (kg/m^2)	23.77 (2.66)	22.76 (1.76)

Data expressed as mean (standard deviation) or numbers. ACB=Adductor canal block, GNB=Genicular nerve block, *n*=number of patients

was 820.79 (483.65) min [95% CI: 603.31, 1038.27] in the GNB group, with mean difference 38.16 [95% CI: −272.42, 348.74] and $P = 0.805$. There was no significant difference in the mean (SD) morphine consumption at different time points between the two groups [Table 3].

DISCUSSION

This study highlights that ACB and GNB provide comparable postoperative analgesia in patients undergoing ACLR. The NRS scores and postoperative opioid requirements were similar in patients receiving ACB and GNB. Although the mean time to first rescue analgesia was lower in the GNB group compared to the ACB group, it was statistically non-significant.

Although ACB is a relatively familiar technique, it provides incomplete analgesia to the knee joint. ACB provides analgesia primarily to the anterior structures of the knee joint, sparing the posterior capsule of the knee joint. GNB is theoretically superior as it blocks all nerves blocking the knee joint, primarily the distal intra-articular branches. This makes GNB a unique block as there is no sparing of any area of the knee joint capsule.[12-14]

The nerve supply to the knee joint involves a complex interplay between various branches of the obturator, femoral and sciatic nerves. The saphenous nerve supplies the anterior knee joint capsule and the articular branches of the vastus (medialis, intermedius and lateral). Anterior synovial tissues and fat pads are highly sensitive to mechanical stimulation.[14] This study highlights the importance of blocking all nerves to the anterior knee joint to achieve adequate analgesia for the knee joint. ACB does not cover all these nerves and is insufficient as a sole analgesic technique for

Table 2: Comparison of NRS scores during rest between the groups

Time point (h)	Group ACB (*n*=19)	Group GNB (*n*=19)	Effect size, *r* (95% CI)	*P*
NRS scores at rest				
0 h	0 (0–0)	0 (0–0)	_	1.000
2 h	0 (0–0)	0 (0–0)	_	1.000
4 h	0 (0–0)	0 (0–0)	_	1.000
6 h	0 (0–0)	0 (0–0)	0.077 (0.005, 0.36)	0.673
8 h	2 (0–4)	2 (0–4)	0.02 (0.006, 0.38)	0.806
12 h	1 (0–3)	1 (0–2)	0.005 (0.005, 0.39)	0.964
24 h	2 (1–2)	1 (1–2)	0.226 (0.03, 0.54)	0.429
NRS scores during physical activity				
0 h	0 (0–0)	0 (0–0)	_	1.000
2 h	0 (0–0)	0 (0–0)	_	1.000
4 h	0 (0–0)	0 (0–0)	_	1.000
6 h	0 (0–0)	0 (0–0)	0.077 (0.005, 0.36)	0.637
8 h	2 (0–4)	2 (0–4)	0.02 (0.006, 0.38)	0.902
12 h	2 (0–3)	2 (1–2)	0.005 (0.005, 0.39)	0.976
24 h	2 (1–2)	1 (1–2)	0.226 (0.03, 0.54)	0.101

Data expressed as median (IQR). ACB=Adductor canal block, CI=Confidence interval, GNB=Genicular nerve block, IQR=Interquartile range, NRS=Numerical Rating Scale, *n*=number of patients, h=hours

Table 3: Comparison of morphine consumption between the groups

Time point (h)	Morphine consumption (mg)				Mean difference (95% CI)	*P*
	Group ACB (*n*=19)		Group GNB (*n*=19)			
	Mean (SD)	(95% CI)	Mean (SD)	(95% CI)		
0 h	0.00 (0.00)	-	0.00 (0.00)	-	-	1.000
2 h	0.00 (0.00)	-	0.00 (0.00)	-	-	1.000
4 h	0.00 (0.00)	-	0.00 (0.00)	-	-	1.000
6 h	0.16 (0.69)	(-0.15, 0.47)	0.11 (0.46)	(-0.1, 0.32)	0.05 (-0.33, 0.44)	0.780
8 h	0.68 (1.38)	(0.06, 2.14)	0.95 (1.31)	(0.36, 1.54)	-0.26 (-1.15, 0.62)	0.550
12 h	1.37 (1.71)	(0.6, 2.14)	1.26 (1.48)	(0.59, 1.93)	0.11 (-0.95, 1.16)	0.840
24 h	2.47 (1.93)	(1.6, 3.34)	2.47 (2.12)	(1.52, 3.42)	0.00 (-1.33, 1.33)	1.000

Data expressed as mean (SD). ACB=Adductor canal block, CI=Confidence interval, GNB=Genicular nerve block, SD=Standard deviation, *n*=Number of patients, h=hours

the knee joint. In contrast, GNB potentially blocks all intra-articular sensory GNs supplying the knee joint[15] and is relatively quick and easy to perform.

This study is important as most information on GNB is obtained from iatrogenic, radio-ablation and long-term denervation of GN for chronic knee pain.[16] Although GNBs are infrequently utilised for analgesia of the knee joint, their postoperative analgesic efficacy is comparable to ACB for patients undergoing ACL repair. However, more randomised controlled trials are warranted in this direction to determine the safety and efficacy of GNB after knee surgery. The study results indicate that neither ACB nor GNB can provide complete analgesia to knee joints.

The present study had several limitations. This was a single-centre study with a small sample size of 38 subjects. The duration of the sensory block was not assessed as it involved repeated sensory examinations. Also, SD was high in our study. More randomised controlled studies with a larger sample size are required in this direction.

CONCLUSIONS

Adductor canal block and genicular nerve block are comparable in terms of postoperative analgesia, time first to rescue analgesia and 24-h postoperative morphine requirement for patients undergoing arthroscopic anterior cruciate ligament reconstruction.

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Study data availability

De-identified data may be requested with reasonable justification from the authors (email to the corresponding author) and shall be shared after approval as per the authors' institution policy. We will surely provide that.

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Conflicts of interest
There are no conflicts of interest.

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