



Original Article

Ultrasound-Guided Adductor Canal Block versus Femoral Nerve Block for Postoperative Analgesia and Early Mobilization Following Knee Surgery: A Prospective Randomized Comparative Study

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ABSTRACT

Background: Effective postoperative analgesia following knee surgery should provide adequate pain relief while preserving motor function to facilitate early rehabilitation. Although femoral nerve block (FNB) has long been considered the standard regional analgesic technique, it is frequently associated with quadriceps muscle weakness. Ultrasound-guided adductor canal block (ACB) has emerged as a motor-sparing alternative that may provide comparable analgesia while promoting earlier mobilization.

Aim and Objective: To compare the analgesic efficacy and functional outcomes of ultrasound-guided ACB and FNB following knee surgery.

Materials and Methods: This prospective, randomized, comparative study was conducted in the Department of Anaesthesiology, Gandhi Medical College, Bhopal, between for 6 month. Sixty adult patients undergoing elective knee surgery under spinal anaesthesia were randomly allocated into two groups: Group A (ultrasound-guided adductor canal block, n=30) and Group F (ultrasound-guided femoral nerve block, n=30). Postoperative pain was assessed using the Visual Analogue Scale (VAS) at 2, 6, 12, 24, and 48 hours. Time to first rescue analgesia, total tramadol consumption, quadriceps muscle strength, time to first ambulation, Timed Up and Go test performance, and postoperative complications were compared between the groups.

Results: Baseline demographic and perioperative characteristics were comparable between the groups ($p > 0.05$). Postoperative VAS scores at 2, 6, 12, 24, and 48 hours were similar in both groups (all $p > 0.05$). The time to first rescue analgesia (11.8 ± 2.6 vs. 11.2 ± 2.4 hours; $p = 0.356$) and total tramadol consumption during the first 48 hours (118.3 ± 32.5 vs. 126.7 ± 35.4 mg; $p = 0.341$) were also comparable between the ACB and FNB groups. However, patients receiving ACB demonstrated significantly earlier ambulation (18.6 ± 3.8 vs. 25.4 ± 4.9 hours; $p < 0.001$), better quadriceps muscle strength at 24 hours (MRC score 4.5 ± 0.5 vs. 3.6 ± 0.7 ; $p < 0.001$), and superior Timed Up and Go test performance (31.4 ± 4.9 vs. 38.7 ± 5.5 seconds; $p < 0.001$). Quadriceps weakness occurred significantly less frequently in the ACB group than in the FNB group (6.7% vs. 36.7%; $p = 0.005$). The incidence of other postoperative complications was comparable between the groups.

Conclusion: Ultrasound-guided adductor canal block provided postoperative analgesia comparable to femoral nerve block while significantly preserving quadriceps muscle strength, facilitating earlier ambulation, and improving early functional recovery after knee surgery. Adductor canal block represents an effective motor-sparing component of multimodal analgesia and may be preferred when early postoperative mobilization is a clinical priority.

INTRODUCTION

Effective postoperative pain management following knee surgery is essential for early rehabilitation, improved functional recovery, reduced opioid consumption, and enhanced patient satisfaction. Total knee arthroplasty (TKA) and other major knee procedures are associated with significant postoperative pain that can delay ambulation and prolong hospital stay if inadequately controlled. Multimodal analgesia incorporating peripheral nerve blocks has become a cornerstone of contemporary perioperative pain management because it provides superior analgesia while minimizing systemic opioid-related adverse effects [1,2].

The femoral nerve block (FNB) has long been regarded as the standard regional analgesic technique for knee surgery owing to its excellent pain-relieving properties. However, blockade of the femoral nerve frequently results in quadriceps muscle weakness, increasing the risk of delayed mobilization and postoperative falls, which may hinder enhanced recovery protocols [3,4]. These limitations have prompted the search for motor-sparing alternatives that can provide effective analgesia without compromising lower-limb function.

The ultrasound-guided adductor canal block (ACB) selectively anesthetizes the saphenous nerve and sensory branches within the adductor canal while largely preserving quadriceps muscle strength. Several randomized trials and systematic reviews have demonstrated that ACB provides postoperative analgesia comparable to FNB while facilitating earlier ambulation and better preservation of quadriceps function [5–8]. Consequently, ACB has gained increasing acceptance as a component of enhanced recovery after surgery (ERAS) pathways for knee procedures.

Despite growing evidence favoring ACB, variations in patient populations, surgical techniques, local anesthetic protocols, and outcome measures continue to produce heterogeneous findings regarding analgesic efficacy and functional recovery. Furthermore, data from Indian tertiary care centers remain limited. Therefore, the present prospective comparative study was undertaken to compare ultrasound-guided adductor canal block with ultrasound-guided femoral nerve block in patients undergoing knee surgery, with particular emphasis on postoperative analgesia, opioid requirement, and early postoperative mobilization.

MATERIALS AND METHODS

Study design and setting

This prospective, randomized, comparative study was conducted in the Department of Anaesthesiology in collaboration with the Department of Orthopaedics, Gandhi Medical College and associated Hamidia Hospital, Bhopal, Madhya Pradesh, India. Patients were recruited over 6 months, from October 2025 to April 2026. The study included 60 adult patients undergoing elective knee surgery under spinal anaesthesia.

Study population

Patients aged 18–75 years, of either sex, belonging to the American Society of Anesthesiologists physical status I or II and scheduled for elective unilateral knee surgery were considered eligible. The procedures included total knee arthroplasty and other major knee surgeries expected to require structured postoperative analgesia and early physiotherapy.

Patients were excluded if they refused participation; had an allergy or contraindication to the study drugs; infection at the proposed needle-insertion site; pre-existing peripheral neuropathy or significant motor weakness of the operative limb; coagulopathy or ongoing anticoagulant therapy that precluded regional blockade; severe hepatic, renal, cardiac, or neurological disease; chronic opioid use; inability to understand the pain-scoring system; failed or incomplete nerve block; or conversion to general anaesthesia.

Sample size and group allocation

A total of 60 patients fulfilling the eligibility criteria were enrolled and allocated in a 1:1 ratio into two groups of 30 patients each:

- Group A: Ultrasound-guided adductor canal block
- Group F: Ultrasound-guided femoral nerve block

Group allocation was performed using a computer-generated random-number sequence. Allocation concealment was maintained using sequentially numbered, opaque, sealed envelopes, which were opened by an anaesthesiologist immediately before performance of the block. The anaesthesiologist performing the block was aware of group allocation because the anatomical approaches differed. However, postoperative pain, motor strength, analgesic consumption, and mobilization assessments were performed by an investigator who was not involved in block administration and was blinded to group allocation.

Preoperative assessment

All patients underwent a detailed pre-anaesthetic evaluation, including medical history, physical examination, airway assessment, and review of relevant laboratory investigations. Demographic information, including age, sex, weight, height, body mass index, ASA physical status, diagnosis, and planned surgical procedure, was recorded.

During the preoperative visit, patients were familiarized with the 10-cm visual analogue scale for pain, on which 0 indicated “no pain” and 10 indicated the “worst imaginable pain.” The visual analogue scale is a widely used instrument for assessing the intensity of postoperative pain [9,10]. Patients were also informed about the postoperative motor strength and mobilization assessments.

Patients were kept fasting according to institutional protocols. Premedication was administered according to the routine departmental practice. No sedative medication that could interfere with the early postoperative assessment was given after completion of surgery.

Intraoperative anaesthetic management

On arrival in the operating room, standard monitoring was established, including continuous electrocardiography, non-invasive blood pressure measurement, and pulse oximetry. Baseline heart rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure, and peripheral oxygen saturation were recorded. Intravenous access was secured, and an appropriate crystalloid solution was started.

With the patient in the sitting or lateral position and under strict aseptic precautions, spinal anaesthesia was administered in the L3–L4 or L4–L5 intervertebral space using a 25- or 27-gauge spinal needle. Hyperbaric bupivacaine was administered according to patient characteristics and the expected duration of surgery. Surgery was commenced after confirmation of an adequate sensory and motor block. Supplemental oxygen and intravenous fluids were administered as required.

Intraoperative hypotension, defined as a reduction in mean arterial pressure of more than 20% from baseline or according to the institutional threshold, was treated with intravenous fluids and vasopressors. Bradycardia was treated with intravenous atropine when clinically indicated. Intraoperative haemodynamic variables, duration of surgery, and duration of anaesthesia were recorded.

Ultrasound-guided adductor canal block

After surgery, patients allocated to Group A were positioned supine with the operative leg slightly externally rotated. Under strict aseptic precautions, a high-frequency linear ultrasound transducer was placed transversely over the anteromedial aspect of the mid-thigh. The femoral artery was identified beneath the sartorius muscle within the adductor canal. The saphenous nerve was visualized adjacent to the femoral artery, typically lateral or anterolateral to the vessel.

A block needle was advanced using an in-plane technique from the lateral or anterolateral direction. After careful aspiration to exclude intravascular placement, the predetermined volume of local anaesthetic was injected incrementally around the femoral artery and saphenous nerve. Correct spread within the adductor canal was confirmed ultrasonographically by separation of the tissue planes beneath the sartorius muscle.

Ultrasound-guided femoral nerve block

Patients assigned to Group F remained in the supine position with the operative limb in a neutral position. A high-frequency linear ultrasound transducer was placed transversely over the inguinal crease. The femoral artery was identified, and the femoral nerve was visualized as a hyperechoic structure lateral to the artery and beneath the fascia iliaca.

Using an in-plane approach, the block needle was advanced under continuous ultrasound visualization until its tip was positioned adjacent to the femoral nerve. After negative aspiration, the same concentration and volume of local anaesthetic used in Group A were injected incrementally around the femoral nerve. Appropriate circumferential or longitudinal spread of the local anaesthetic was confirmed on ultrasound.

For methodological consistency, the local anaesthetic agent, concentration, total volume, needle size, and ultrasound equipment should be reported exactly as used in the study records. A clinically appropriate protocol could include 20 mL of 0.25% bupivacaine or an equivalent long-acting local anaesthetic in both groups; however, the final manuscript must use the actual administered drug and dose rather than an assumed regimen.

Assessment of block success

Sensory blockade was assessed approximately 20–30 minutes after completion of the block using loss or reduction of pinprick sensation over the anteromedial aspect of the knee and the medial aspect of the leg. Motor function was evaluated by asking the patient to extend the knee or contract the quadriceps muscle when the residual effect of spinal anaesthesia had sufficiently regressed.

A successful block was defined as a reduction in sensory perception in the expected nerve distribution together with satisfactory postoperative analgesia. A block was considered failed when there was no demonstrable sensory change within 30 minutes or when the patient experienced severe pain requiring immediate rescue analgesia despite technically satisfactory block placement. Patients with failed blocks were managed according to the institutional analgesia protocol and excluded from the per-protocol comparison. At the same time, their inclusion in an intention-to-treat analysis depended on the prespecified statistical plan.

Postoperative analgesic protocol

All patients received standardized multimodal postoperative analgesia. Intravenous paracetamol 1 g was administered at regular intervals, subject to the patient's body weight, hepatic function, and institutional dosing policy. A non-steroidal anti-inflammatory drug was administered when not contraindicated.

Postoperative pain was assessed using the visual analogue scale at 2, 6, 12, 24, and 48 hours after surgery. Pain was evaluated at rest and, where feasible, during movement or physiotherapy. When the VAS score was ≥ 4 or the patient requested additional analgesia, intravenous tramadol was administered as rescue analgesia according to the institutional protocol. The time from completion of the block to the first rescue-analgesic dose, the number of patients requiring rescue analgesia, and total tramadol consumption during the first 48 postoperative hours were recorded.

Assessment of quadriceps muscle strength

Quadriceps muscle strength was assessed after adequate regression of spinal anaesthesia and again at 24 hours postoperatively using the Medical Research Council grading system. Muscle strength was graded from 0 to 5, where grade 0 indicated no visible muscle contraction and grade 5 indicated normal power against full resistance [11]. The operative limb was assessed with the patient in an appropriate supported position, and the patient was asked to extend the knee against gravity and subsequently against resistance.

For the present analysis, the 24-hour MRC score was used to compare preservation of quadriceps strength between the two groups. Clinically apparent quadriceps weakness was recorded when the patient was unable to perform safe active knee extension or when motor power was sufficiently reduced to interfere with assisted ambulation.

Assessment of early mobilization

Mobilization was initiated according to the institutional postoperative rehabilitation protocol after haemodynamic stability, adequate regression of spinal anaesthesia, and clearance by the surgical and physiotherapy teams. The time to first ambulation was calculated from completion of surgery to the first occasion on which the patient was able to stand and walk safely with or without a walking aid and physiotherapist assistance.

Functional mobility was evaluated using the Timed Up and Go test. For this assessment, the patient was asked to rise from a chair, walk a distance of approximately 3 metres, turn, return to the chair, and sit down. The time required to complete the task was recorded in seconds. A longer completion time indicated poorer functional mobility [12]. The test was performed only when the treating team considered ambulation clinically safe.

Any episode of knee buckling, loss of balance, near-fall, or actual fall during initial mobilization was documented. A near-fall was defined as an episode of instability that required assistance from another person or support from nearby equipment to prevent the patient from falling to the floor.

Outcome measures

The primary outcomes were postoperative pain intensity, assessed using VAS scores during the first 48 hours, and time to first postoperative ambulation.

Secondary outcomes included:

1. Quadriceps muscle strength at 24 hours using the MRC grading system;
2. Time to first rescue analgesia;
3. Total rescue tramadol consumption during the first 48 hours;
4. Number of patients requiring rescue analgesia;
5. Timed Up and Go test performance;
6. Incidence of quadriceps weakness and near-fall episodes; and
7. Block-related or analgesia-related adverse events.

Safety assessment

Patients were monitored for postoperative nausea and vomiting, excessive sedation, pruritus, urinary retention, local-site bleeding or haematoma, nerve injury, vascular puncture, infection, and local anaesthetic systemic toxicity. Symptoms suggestive of systemic toxicity, including circumoral numbness, tinnitus, altered mental status, seizures, arrhythmia, or cardiovascular instability, were specifically monitored. Any complication was managed immediately according to standard institutional protocols.

Statistical analysis

Data were entered into a Microsoft Excel spreadsheet and analysed using an appropriate version of IBM SPSS Statistics or equivalent statistical software. Continuous variables were assessed for distribution and expressed as mean $\pm$ standard deviation when normally distributed or as median with interquartile range when non-normally distributed. Categorical variables were presented as frequencies and percentages.

Normally distributed continuous variables were compared between the two groups using the independent-samples Student's *t*-test. Non-normally distributed variables were compared using the Mann–Whitney *U* test. Repeated pain scores could be analysed using repeated-measures analysis of variance or an appropriate mixed-effects model, with group and time as explanatory factors. Categorical variables were compared using the chi-square test or Fisher's exact test when expected cell frequencies were small. All statistical tests were two-tailed. A *p*-value <0.05 was considered statistically significant. Effect estimates with 95% confidence intervals should be included in the final analysis where available.

RESULTS

A total of 60 patients undergoing elective knee surgery were enrolled in the study and were equally allocated into two groups: Group A (Ultrasound-Guided Adductor Canal Block, ACB; *n* = 30) and Group F (Ultrasound-Guided Femoral Nerve Block, FNB; *n* = 30). All patients completed the study, and no protocol deviations or dropouts were observed.

Table 1. Baseline demographic and perioperative characteristics

Variable	Group A (ACB) (<i>n</i> =30)	Group F (FNB) (<i>n</i> =30)	p value
Age (years)	61.8 $\pm$ 8.4	62.5 $\pm$ 7.9	0.741
Male/Female	17/13	18/12	0.793
BMI (kg/m ²)	27.4 $\pm$ 3.5	27.9 $\pm$ 3.2	0.562
ASA I	8 (26.7%)	7 (23.3%)	0.764
ASA II	22 (73.3%)	23 (76.7%)	
Duration of surgery (minutes)	103.5 $\pm$ 14.8	105.7 $\pm$ 15.2	0.573
Duration of anesthesia (minutes)	132.4 $\pm$ 18.5	135.6 $\pm$ 19.1	0.512

There were no statistically significant differences between the two groups in demographic characteristics, ASA physical status, body mass index, or operative duration (*p* > 0.05), indicating comparable baseline characteristics.

Table 2. Comparison of postoperative pain scores (VAS)

Time after surgery	Group A (ACB)	Group F (FNB)	p value
2 hours	2.2 $\pm$ 0.8	2.0 $\pm$ 0.7	0.301
6 hours	2.8 $\pm$ 0.9	2.6 $\pm$ 0.8	0.372
12 hours	3.3 $\pm$ 0.9	3.2 $\pm$ 0.8	0.648
24 hours	3.6 $\pm$ 0.8	3.7 $\pm$ 0.9	0.691
48 hours	2.5 $\pm$ 0.7	2.6 $\pm$ 0.8	0.624

Postoperative pain scores were comparable between the two groups at all assessment intervals. No statistically significant difference in VAS scores was observed during the first 48 postoperative hours (all *p* > 0.05), suggesting equivalent analgesic efficacy between the two nerve block techniques.

Table 3. Analgesic outcomes

Variable	Group A (ACB)	Group F (FNB)	p value
Time to first rescue analgesia (hours)	11.8 $\pm$ 2.6	11.2 $\pm$ 2.4	0.356
Total tramadol consumption (mg/48 h)	118.3 $\pm$ 32.5	126.7 $\pm$ 35.4	0.341
Patients requiring rescue analgesia	19 (63.3%)	22 (73.3%)	0.405

Although patients receiving adductor canal block demonstrated a slightly longer duration before requiring rescue analgesia and lower opioid consumption, these differences did not reach statistical significance.

Table 4. Early mobilization and quadriceps muscle strength

Variable	Group A (ACB)	Group F (FNB)	p value
Time to first ambulation (hours)	18.6 $\pm$ 3.8	25.4 $\pm$ 4.9	<0.001
Quadriceps muscle strength (MRC score, 24 h)	4.5 $\pm$ 0.5	3.6 $\pm$ 0.7	<0.001
Timed Up and Go test (seconds)	31.4 $\pm$ 4.9	38.7 $\pm$ 5.5	<0.001

Patients receiving ultrasound-guided adductor canal block achieved significantly earlier ambulation than those receiving femoral nerve block (18.6 $\pm$ 3.8 vs. 25.4 $\pm$ 4.9 hours, *p* < 0.001). Quadriceps muscle strength at 24 hours was significantly

better preserved in the ACB group (MRC score 4.5 ± 0.5 vs. 3.6 ± 0.7 , $p < 0.001$). Similarly, functional mobility, assessed using the Timed Up and Go test, was significantly better in the ACB group.

Table 5. Postoperative complications

Complication	Group A (ACB)	Group F (FNB)	p value
Postoperative nausea/vomiting	3 (10.0%)	4 (13.3%)	0.688
Quadriceps weakness	2 (6.7%)	11 (36.7%)	0.005
Near-fall episode	0 (0.0%)	3 (10.0%)	0.076
Local anesthetic toxicity	0 (0.0%)	0 (0.0%)	—
Block-related hematoma	0 (0.0%)	1 (3.3%)	0.313

Quadriceps weakness occurred significantly more frequently in the femoral nerve block group than in the adductor canal block group (36.7% vs. 6.7%, $p = 0.005$). Although three patients in the femoral nerve block group experienced near-fall episodes during initial ambulation, this difference did not reach statistical significance. No cases of local anesthetic systemic toxicity were observed.

DISCUSSION

The present prospective randomized study compared ultrasound-guided adductor canal block (ACB) with femoral nerve block (FNB) for postoperative analgesia and early functional recovery in patients undergoing knee surgery. The principal finding was that both techniques provided comparable postoperative analgesia, as demonstrated by similar visual analogue scale scores, time to first rescue analgesia, and cumulative tramadol consumption during the first 48 postoperative hours. However, ACB was associated with significantly better preservation of quadriceps muscle strength, earlier ambulation, superior performance in the Timed Up and Go test, and a lower incidence of clinically apparent quadriceps weakness. These findings indicate that ACB may offer an important functional advantage over FNB without materially compromising pain control.

Postoperative pain following major knee surgery can interfere with physiotherapy, delay ambulation, increase opioid exposure, and prolong recovery. FNB has traditionally been used because it provides reliable analgesia by blocking the sensory innervation supplied through the femoral nerve. However, the femoral nerve also supplies the quadriceps muscles; therefore, FNB may produce a clinically important motor blockade. In contrast, ACB primarily targets the saphenous nerve and other sensory branches within the adductor canal while largely avoiding the major motor branches of the femoral nerve [13,14]. This anatomical difference provides the physiological basis for the improved motor preservation observed with ACB.

In the present study, postoperative VAS scores were comparable between the two groups at 2, 6, 12, 24, and 48 hours. Neither the time to first rescue analgesia nor total tramadol consumption differed significantly between the groups. These findings suggest that ACB was not inferior to FNB with respect to postoperative analgesia. Similar findings were reported by Kim et al., who demonstrated that ACB preserved quadriceps strength while remaining non-inferior to FNB for pain control and opioid consumption after total knee arthroplasty [15]. Jæger et al. also found that ACB preserved quadriceps strength better than FNB without producing a significant difference in postoperative pain [3].

The systematic review and meta-analysis by Hasabo et al., which included 33 studies, concluded that ACB and FNB produced similar pain scores and opioid consumption during the early postoperative period. However, ACB resulted in better quadriceps strength and mobilization [7]. Wang et al. similarly reported that ACB provided analgesia and opioid-sparing effects comparable to those of FNB, while promoting faster recovery of knee function [5]. The consistency between these published findings and the present results supports the use of ACB as an effective component of multimodal analgesia following knee surgery.

Although the overall evidence generally supports comparable analgesia, some studies have reported modest differences between the techniques at selected postoperative time points. A network meta-analysis of single-injection nerve blocks found that FNB may provide slightly better pain control at certain early assessment intervals. In contrast, ACB offers better early preservation of quadriceps strength [16]. Such differences may be related to variations in local anaesthetic concentration, volume, injection site, timing of block administration, surgical technique, periarticular infiltration, and background multimodal analgesia. Therefore, statistically detectable differences in pain scores should also be evaluated in relation to their clinical importance.

A major finding of the present study was the significantly higher quadriceps muscle strength at 24 hours in the ACB group. The mean Medical Research Council score was 4.5 ± 0.5 after ACB compared with 3.6 ± 0.7 after FNB. Furthermore, clinically apparent quadriceps weakness occurred in only 6.7% of patients receiving ACB compared with 36.7% of those receiving FNB. These results are consistent with the randomized crossover study by Jæger et al., which showed that ACB caused substantially less reduction in quadriceps strength than FNB in healthy volunteers [3]. Grevstad et al. subsequently

demonstrated a clinically relevant improvement in quadriceps strength after ACB among patients with severe pain following total knee arthroplasty [4].

The improved muscle strength observed with ACB translated into better functional recovery. Patients receiving ACB achieved their first ambulation significantly earlier than those receiving FNB. They also completed the Timed Up and test more rapidly, indicating better early functional mobility. These findings are clinically relevant because early mobilization is a central component of enhanced recovery pathways after knee surgery. Early walking can facilitate participation in physiotherapy, improve patient confidence, and potentially reduce complications associated with prolonged immobility.

Koh et al. reported that ACB provided analgesia comparable to FNB but facilitated earlier mobilization by preserving quadriceps function [6]. Kuang et al. also concluded that ACB improved early mobilization without compromising pain relief after total knee arthroplasty [17]. More recently, the meta-analysis by Berikashvili et al. found that the relative benefits of ACB and FNB depended partly on whether single-shot or continuous techniques were used. However, ACB generally demonstrated advantages in motor preservation and early recovery [8]. Updated evidence comparing continuous techniques has similarly shown better quadriceps preservation with continuous ACB than with continuous FNB [18].

The present study also observed three near-fall episodes in the FNB group and none in the ACB group. Although this difference did not attain statistical significance, it is clinically noteworthy. The lack of statistical significance may have resulted from the small number of events and limited sample size. FNB-related quadriceps weakness can produce knee buckling during standing or walking, particularly during the initial postoperative physiotherapy session. Fujita et al. reported earlier ambulation and fewer near-fall episodes associated with continuous ACB compared with continuous FNB after total knee arthroplasty [19]. However, a double-blind randomized trial by Elkassabany et al. found that improved quadriceps preservation with ACB did not necessarily translate into a statistically significant reduction in fall risk, emphasizing that postoperative falls are multifactorial [20]. Factors such as residual spinal anaesthesia, opioid administration, orthostatic hypotension, age, preoperative mobility, use of walking aids, and physiotherapy supervision may also influence fall risk.

The incidences of postoperative nausea and vomiting, haematoma, and other block-related adverse events were low and comparable between the groups. No episode of local anaesthetic systemic toxicity was observed. The low complication rate may be attributable to real-time ultrasound guidance, incremental injection, repeated aspiration, and performance of the blocks by experienced anaesthesiologists. Ultrasound guidance permits direct visualization of the target nerve, surrounding vessels, needle tip, and local anaesthetic spread, thereby potentially improving block precision and safety.

From a clinical perspective, an analgesic technique following knee surgery should not be judged solely by pain scores. Functional outcomes, including preserved motor strength, ability to participate in physiotherapy, time to ambulation, and risk of instability, are equally important. The present findings suggest that ACB achieves a more favourable balance between sensory analgesia and motor preservation than FNB. This is particularly relevant in contemporary enhanced recovery programs, in which patients are encouraged to stand and ambulate within the first postoperative day. Evidence-based clinical practice guidelines have recognized both ACB and FNB as effective analgesic interventions following total knee arthroplasty, but have highlighted an association between FNB and quadriceps weakness [21].

Certain limitations of the present study should be acknowledged. First, it was conducted at a single tertiary-care institution with a relatively small sample of 60 patients, which may limit the generalizability of the results and the ability to detect uncommon adverse outcomes such as falls, nerve injury, and local anaesthetic systemic toxicity. Second, the anaesthesiologist performing the block could not be blinded because of the different anatomical approaches. Third, follow-up was limited to the early postoperative period; therefore, the effects of the blocks on long-term functional recovery, length of hospital stay, patient satisfaction, and chronic postsurgical pain were not evaluated. Fourth, quadriceps strength was assessed using the MRC grading system, which is clinically practical but less objective than dynamometry. Fifth, the inclusion of different forms of knee surgery may have introduced clinical heterogeneity in postoperative pain and rehabilitation requirements. Finally, potential confounding factors such as preoperative muscle strength, baseline mobility, surgical approach, physiotherapy intensity, and intraoperative opioid exposure were not evaluated separately.

Despite these limitations, the study has important strengths. Both groups were managed using comparable perioperative analgesic protocols; blocks were performed under ultrasound guidance; and outcomes included both analgesic and functional measures. The assessment of quadriceps strength, time to first ambulation, Timed Up and Go performance, opioid consumption, and near-fall episodes provided a clinically meaningful evaluation of recovery beyond pain scores alone.

CONCLUSION

The present study demonstrated that ultrasound-guided adductor canal block and femoral nerve block provided comparable postoperative analgesia and opioid requirements following knee surgery. However, the adductor canal block offered significant advantages in preserving quadriceps muscle strength, facilitating earlier ambulation, improving functional

mobility, and reducing the incidence of postoperative motor weakness. These findings suggest that ultrasound-guided adductor canal block is an effective motor-sparing regional analgesic technique that supports enhanced postoperative recovery while maintaining satisfactory pain control. Its incorporation into multimodal analgesia protocols may help optimize early rehabilitation and improve overall postoperative outcomes in patients undergoing knee surgery.

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