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# Comparison of Ultrasound-Guided Femoral Nerve Block and Adductor Canal Block for Postoperative Pain Control and Early Mobilization Following Knee Surgery

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## Abstract

**Background:** Effective control of postoperative pain is essential after knee surgeries to promote early movement, minimize postoperative complications, and improve overall patient outcomes. Femoral nerve block (FNB) is widely used and provides dependable pain relief, but it often weakens the quadriceps muscle, which can delay early mobilization. The adductor canal block (ACB), which largely preserves motor power, has emerged as an alternative technique that may allow earlier ambulation without compromising analgesia.

**Methods:** This prospective, randomized observational study enrolled 100 adults aged 18–60 years with ASA physical status I–II scheduled for elective knee surgery under neuraxial anesthesia. Participants were randomly assigned to Group F (FNB, n = 50) or Group A (ACB, n = 50). Both groups received 20 mL of 0.25% bupivacaine combined with 8 mg dexamethasone under ultrasound guidance. Pain was assessed using the Visual Analog Scale (VAS) at 0, 2, 4, 6, 8, 12, 18, and 24 hours postoperatively. Quadriceps strength was evaluated through the straight-leg-raise test. Intravenous tramadol 100 mg was administered when the VAS exceeded 4. Patient satisfaction at 24 hours was also recorded.

**Results:** Both techniques yielded similar analgesic profiles throughout the postoperative period, with slightly lower VAS values in the FNB group at select time points. Quadriceps power was significantly better maintained in the ACB group, allowing patients to ambulate earlier. Rescue analgesia requirements were comparable (FNB: 30%; ACB: 36%), and mean tramadol use differed only slightly (FNB: 90 ± 30 mg vs. ACB: 100 ± 25 mg). High satisfaction levels were noted in both groups, with 50% in the FNB group and 56% in the ACB group reporting high satisfaction.

**Conclusion:** Ultrasound-guided ACB offers pain relief comparable to FNB while preserving quadriceps muscle strength and enabling earlier ambulation. With consistently high patient satisfaction and better motor function, ACB serves as an effective and motor-sparing option for postoperative pain management following knee surgeries.

**Keywords:** Adductor canal block, femoral nerve block, postoperative analgesia, quadriceps preservation, knee surgery, early mobilization.

## Introduction

Postoperative pain is one of the most common challenges following surgery and is often aggravated by soft-tissue handling, inflammation, and reflex muscle spasm [1]. Although intraoperative anesthesia provides adequate analgesia, many patients report significant pain once its effects subside, particularly after orthopedic procedures [2]. Knee surgeries—such as arthroscopic interventions and reconstructive operations - are known to produce considerable postoperative discomfort, which can interfere with sleep, appetite, and active participation in physiotherapy sessions [3].

Effective control of postoperative pain is therefore essential, as inadequate analgesia may delay mobilization, hinder rehabilitation, extend hospital stay, and adversely affect patient satisfaction [4]. Multimodal analgesic regimens—using combinations of opioids, acetaminophen, nonsteroidal anti-inflammatory drugs, alpha-2 agonists, NMDA antagonists, gabapentinoids, and dexamethasone—have been shown to enhance pain relief and promote smoother recovery [5]. However, opioids can lead to complications such as respiratory depression, nausea, vomiting, and opioid-induced hyperalgesia, while NSAIDs alone often fail to adequately relieve moderate-to-severe postoperative pain [5]. Epidural analgesia, although effective, is limited by technical constraints, side effects, and potential risks, prompting increased interest in safer alternatives [6].

Peripheral nerve blocks (PNBs) have emerged as an important component of postoperative analgesia in orthopedic surgery due to their targeted effect and opioid-sparing benefits [6]. Ultrasound guidance further improves the precision of PNBs by enhancing visualization, reducing procedural attempts, shortening onset time, and lowering complication rates [6]. The adductor canal block (ACB) selectively anesthetizes the saphenous nerve within the mid-thigh region, providing sensory blockade to the medial and anterior knee while largely maintaining quadriceps motor strength—an advantage that supports early mobilization [1,3]. Conversely, the femoral nerve block (FNB) offers strong analgesia but frequently compromises quadriceps function, increasing the risk of weakness and falls during initial ambulation [2,4].Although ACB is often promoted as a motor-sparing alternative, clinical findings remain mixed. While several studies demonstrate comparable analgesia with better preservation of quadriceps strength and faster functional recovery using ACB, other reports show minimal differences between the two techniques in terms of pain scores or mobility outcomes [3–5]. Such variability may be influenced by differences in local anesthetic volume, injection technique, surgical characteristics, and individual patient factors.

Early ambulation is critical after knee surgery to prevent immobility-related complications such as joint stiffness, venous thromboembolism, and extended hospitalization. Therefore, a direct comparison of ultrasound-guided FNB and ACB is clinically relevant. This study aims to assess their impact on postoperative pain relief, quadriceps strength, opioid requirement, and early mobilization. The results will provide evidence to guide optimal analgesic strategies for enhancing recovery and improving patient safety and satisfaction following knee surgery [1–6].

## Materials and Methods

### Study Design

This prospective, randomized, comparative observational study was conducted to compare the efficacy of ultrasound-guided femoral nerve block and adductor canal block in providing postoperative analgesia and facilitating early mobilization among patients undergoing elective knee surgery.

### Study Setting and Duration

The study was carried out in the Department of Anaesthesiology at Shyam Shah Medical College and its affiliated hospitals, Rewa, Madhya Pradesh, over a period of one year from April 2024 to March 2025.

### Study Population

The study population comprised adult patients scheduled to undergo elective knee surgery under spinal (neuraxial) anesthesia. Eligible participants were enrolled after satisfying the predefined inclusion and exclusion criteria and were randomly allocated into study groups using the sealed envelope technique.

**Sample Size**

A total of **100 patients** were included in the study. The sample size was determined based on feasibility and previous studies evaluating postoperative analgesia following peripheral nerve blocks. Patients were randomly assigned into two equal groups of 50 participants each.

**Inclusion Criteria**

Patients aged between 18 and 60 years belonging to the American Society of Anesthesiologists (ASA) physical status I or II, scheduled for elective knee surgery under spinal anesthesia, and willing to provide written informed consent were included in the study.

**Exclusion Criteria**

Patients who refused participation, had hypersensitivity to local anesthetics or dexamethasone, cognitive impairment, chronic opioid use, pre-existing neurological deficits involving the lower limbs, coagulopathy, infection at the injection site, significant hepatic, renal, cardiac, or respiratory disease, or any contraindication to spinal anesthesia or peripheral nerve block were excluded.

**Data Collection Tool**

Following written informed consent, all participants underwent a detailed pre-anesthetic evaluation that included demographic characteristics, medical and surgical history, airway assessment, physical examination, and baseline investigations including complete blood count, liver and renal function tests, coagulation profile, electrocardiography, heart rate, blood pressure, and peripheral oxygen saturation. The Visual Analog Scale (VAS) for pain assessment and the patient satisfaction scoring system were explained before surgery. Under standard aseptic precautions, spinal anesthesia was administered at the L3–L4 intervertebral space using a 25-gauge Quincke spinal needle with 2.5 mL of 0.5% hyperbaric bupivacaine. Following successful spinal anesthesia, patients allocated to **Group F** received an ultrasound-guided femoral nerve block using 20 mL of 0.25% bupivacaine combined with 8 mg dexamethasone. The block was performed using an in-plane lateral-to-medial approach with deposition of the drug adjacent to the femoral nerve. Patients in **Group A** received an ultrasound-guided adductor canal block using the same volume and concentration of local anesthetic with dexamethasone, administered beneath the sartorius muscle adjacent to the femoral artery at the mid-thigh level. Postoperatively, all patients received intravenous diclofenac 75 mg and paracetamol 1 g as standard multimodal analgesia. Pain intensity was evaluated using the 10-cm Visual Analog Scale at 0, 2, 4, 6, 8, 12, 18, and 24 hours after surgery. Rescue analgesia with intravenous tramadol 100 mg was administered whenever the VAS score exceeded 4. Quadriceps muscle strength was assessed at 6, 12, 18, and 24 hours using the straight leg raise test and graded as normal power (Grade 0), mild weakness (Grade 1), or complete inability to raise the leg (Grade 2). Patient satisfaction regarding postoperative pain management was evaluated at 24 hours using a five-point Likert satisfaction scale ranging from highly satisfied to highly dissatisfied. All perioperative observations, analgesic requirements, motor function assessments, and satisfaction scores were systematically recorded in a structured case record proforma.

**Ethical Considerations**

The study protocol was approved by the Institutional Ethics Committee of Shyam Shah Medical College, Rewa, prior to commencement of the study. Written informed consent was obtained from all participants after explaining the objectives, procedures, benefits, and potential risks of the study in their local language. Confidentiality of patient information was maintained by assigning unique identification numbers, and all data were used exclusively for research purposes in accordance with the Declaration of Helsinki and ICMR ethical guidelines.

### Statistical Analysis

Data were entered into Microsoft Excel and analyzed using the Statistical Package for the Social Sciences (SPSS) software version 26.0. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. The normality of continuous data was assessed using the Shapiro–Wilk test. Comparisons of continuous variables between the two groups were performed using the independent sample *t*-test for normally distributed data and the Mann–Whitney U test for non-normally distributed data. Repeated pain scores over different postoperative time intervals were compared using repeated-measures analysis of variance (ANOVA). Categorical variables, including quadriceps muscle strength grading, rescue analgesic requirement, and patient satisfaction scores, were compared using the Chi-square test or Fisher's exact test, as appropriate. A *p*-value of less than 0.05 was considered statistically significant.

## Results

**Table 1: Demographic Characteristics of Study Participants**

| Parameter | Group F (n=50) | Group A (n=50) | Total (n=100) |
|---|---|---|---|
| Age (years, mean ± SD) | 45 ± 10 | 44 ± 9 | 44.5 ± 9.5 |
| Gender (M/F) | 28 / 22 | 30 / 20 | 58 / 42 |
| ASA I / II | 30 / 20 | 32 / 18 | 62 / 38 |
| BMI (kg/m², mean ± SD) | 26 ± 3 | 25.5 ± 3 | 25.8 ± 3 |

The study population was comparable between the two groups in terms of age, gender distribution, ASA physical status, and BMI. The mean age was 44.5 ± 9.5 years, with a balanced male-to-female ratio (58:42). ASA I and II patients were similarly distributed across groups, and mean BMI values were also comparable (25.8 ± 3 kg/m²), indicating that both groups were well-matched for baseline characteristics, reducing potential confounding factors for postoperative outcomes.

**Table 2: Postoperative VAS Scores (Mean ± SD)**

| Time post-op (hrs) | Group F | Group A |
|---|---|---|
| 2 | 3.0 ± 1.0 | 3.2 ± 1.1 |
| 4 | 3.5 ± 1.2 | 3.6 ± 1.0 |
| 6 | 3.8 ± 1.0 | 3.7 ± 1.2 |
| 8 | 3.2 ± 0.9 | 3.5 ± 1.1 |
| 12 | 2.8 ± 0.8 | 3.1 ± 0.9 |
| 24 | 1.5 ± 0.6 | 1.8 ± 0.7 |

Postoperative pain, measured using the Visual Analog Scale (VAS), showed that both groups experienced moderate pain in the early hours following knee surgery, with Group F (Femoral Nerve Block) having slightly lower scores at most time points compared to Group A (Adductor Canal Block). At 2 and 4 hours, VAS scores were comparable (3.0 ± 1.0 vs 3.2 ± 1.1 at 2 hrs; 3.5 ± 1.2 vs 3.6 ± 1.0 at 4 hrs). By 6–8 hours, pain remained similar in both groups, while at 12 and 24 hours, Group F continued to demonstrate marginally lower pain levels (2.8 ± 0.8 vs 3.1 ± 0.9 at 12 hrs; 1.5 ± 0.6 vs 1.8 ± 0.7 at 24 hrs).

**Table 3: Quadriceps Muscle Strength Assessment (Straight Leg Raise Test)**

| Time post-op (hrs) | Group F (n=50) | Group A (n=50) |
|---|---|---|
| 6 | Grade 0: 20 Grade 1: 15 Grade 2: 15 | Grade 0: 40 Grade 1: 10 Grade 2: 0 |
| 12 | Grade 0: 30 Grade 1: 10 Grade 2: 10 | Grade 0: 45 Grade 1: 5 Grade 2: 0 |
| 24 | Grade 0: 40 Grade 1: 5 Grade 2: 5 | Grade 0: 50 Grade 1: 0 Grade 2: 0 |

Quadriceps strength assessment showed that Group A (Adductor Canal Block) better preserved motor function than Group F (Femoral Nerve Block). At 6 hours postoperatively, 40 patients in Group A had normal strength versus only 20 in Group F. By 12 hours, most Group A patients maintained full strength, while Group F still had some weakness or paralysis. After 24 hours, all Group A patients had recovered, whereas Group F had 10 patients with residual impairment.

**Table 4: Rescue Analgesic Requirement (Tramadol 100 mg IV)**

| Parameter | Group F (n=50) | Group A (n=50) |
|---|---|---|
| Patients requiring rescue | 15 (30%) | 18 (36%) |
| Total dose (mg, mean ± SD) | 90 ± 30 | 100 ± 25 |

Rescue analgesia was required in 30% of patients in Group F and 36% in Group A. The mean total dose of tramadol administered was slightly higher in Group A (100 ± 25 mg) compared to Group F (90 ± 30 mg), indicating comparable analgesic efficacy between the femoral nerve block and adductor canal block.

**Table 5: Patient Satisfaction at 24 Hours**

| Satisfaction Level | Group F (n=50) | Group A (n=50) |
|---|---|---|
| Highly satisfied | 25 (50%) | 28 (56%) |
| Satisfied | 18 (36%) | 15 (30%) |
| Neither satisfied/dissatisfied | 5 (10%) | 6 (12%) |
| Dissatisfied | 2 (4%) | 1 (2%) |
| Highly dissatisfied | 0 (0%) | 0 (0%) |

Patient satisfaction was generally high in both groups. In Group F, 50% of patients were highly satisfied and 36% satisfied, whereas in Group A, 56% were highly satisfied and 30% satisfied. A small proportion reported neutral or dissatisfied responses, and no patients were highly dissatisfied, indicating overall positive perception of analgesia in both the femoral nerve block and the adductor canal block groups.

## Discussion

The present study compared ultrasound-guided femoral nerve block and adductor canal block for postoperative pain relief and early mobility in patients undergoing knee surgery. Both techniques offered effective analgesia, with mean VAS scores at 2, 4, 6, 8, 12, and 24 hours remaining within acceptable ranges. Although the FNB group demonstrated slightly lower pain scores at 6 hours (3.8 ± 1.0) than the ACB group (3.7 ± 1.2), this minor difference did not translate into a meaningful clinical advantage. These findings are consistent with earlier reports by Marhofer et al. and Jaeger et al., who documented equivalent analgesic efficacy between femoral nerve block and adductor canal block, indicating that either technique can be used reliably for postoperative pain control following knee surgery. A notable benefit of ACB in the current study was its superior preservation of quadriceps muscle power. At the 6-hour assessment, 40 participants in the ACB group retained full strength, compared to only 20 individuals in the FNB group. Complete motor weakness was identified in 15 patients receiving FNB and was not observed in any patient who received ACB. Similar motor-sparing effects of ACB have been reported by Lund et al. and Siddiqui et al., who emphasized that preservation of quadriceps strength facilitates early ambulation, supports physiotherapy participation, and reduces the risk of postoperative falls.

In terms of supplemental analgesia, 30 percent of patients in the FNB group and 36 percent in the ACB group required rescue tramadol, with average consumption of 90 ± 30 mg and 100 ± 25 mg, respectively. These observations are in agreement with findings reported by Hussien et al., who noted that while ACB may produce a slightly less intense sensory block than FNB, this difference is clinically minimal and does not compromise overall analgesic effectiveness, particularly when balanced against the advantage of motor function preservation. Patient satisfaction scores were high in both groups, with 50 percent of individuals in the FNB group and 56 percent in the ACB group reporting a high level of satisfaction. The marginally higher satisfaction observed in the ACB group may be attributed to improved early mobilization and greater confidence related to preserved limb control. Similar trends have been described by Apfelbaum et al. and Kehlet and Dahl, who highlighted the importance of effective pain control combined with early functional recovery in improving overall patient satisfaction following surgery.

**Strengths**

This prospective randomized study employed ultrasound-guided peripheral nerve blocks with standardized anesthetic techniques and postoperative analgesic protocols, thereby improving procedural accuracy and minimizing performance bias. Serial assessment of pain, quadriceps muscle strength, rescue analgesic consumption, and patient satisfaction provided a comprehensive evaluation of postoperative analgesia and functional recovery.

**Limitations**

The study was conducted at a single tertiary care center with a relatively limited sample size, which may restrict the generalizability of the findings. In addition, follow-up was limited to the first 24 postoperative hours, and long-term functional recovery, rehabilitation outcomes, and chronic postoperative pain were not evaluated.

## Conclusion

In the present study, both ultrasound-guided femoral nerve block (FNB) and adductor canal block (ACB) offered effective postoperative analgesia for patients undergoing knee surgery. Although overall pain relief was comparable between the two techniques, ACB showed a clear benefit by better preserving quadriceps muscle strength, enabling earlier mobilization and supporting quicker functional recovery. The need for rescue analgesia and the level of patient satisfaction was similar in both groups, confirming that ACB maintains analgesic efficacy. Based on these findings, ACB can be considered a safe, efficient, and motor-sparing alternative to FNB, particularly advantageous in postoperative settings where early ambulation is a priority.

**Conflict of interest:** Nil

**Source Of Fund:** Nil

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