

Ultrasound-Guided Femoral Nerve Block versus Adductor Canal Block in Lower Limb Orthopaedic Surgery

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Abstract:

Background: Ultrasound-guided femoral nerve block and adductor canal block are widely used regional analgesic techniques for lower limb orthopaedic surgery. Although both provide effective postoperative analgesia, preservation of quadriceps muscle strength remains an important consideration for early rehabilitation.

Aim: To compare ultrasound-guided femoral nerve block and adductor canal block regarding postoperative analgesia, quadriceps muscle strength, functional recovery, complications, and patient satisfaction in lower limb orthopaedic surgery.

Methods: This prospective randomized comparative study included 80 patients undergoing elective lower limb orthopaedic surgery. Patients were randomly allocated into two groups: Group F (ultrasound-guided femoral nerve block, n=40) and Group A (ultrasound-guided adductor canal block, n=40). Postoperative pain scores, rescue analgesic consumption, quadriceps muscle strength, ambulation, complications, and patient satisfaction were evaluated.

Results: Baseline demographic characteristics were comparable between the groups. Both nerve blocks provided similar postoperative analgesia, with no significant differences in Visual Analogue Scale scores or rescue analgesic consumption ($p > 0.05$). Quadriceps muscle strength was significantly better preserved in the adductor canal block group (MRC grade 4.4 ± 0.5 vs. 3.2 ± 0.6 ; $p < 0.001$). Patients receiving adductor canal block achieved earlier ambulation (15.6 ± 3.9 vs. 22.4 ± 4.8 hours; $p < 0.001$), higher independent ambulation within 24 hours (87.5% vs. 52.5%; $p = 0.001$), and greater patient satisfaction (9.2 ± 0.6 vs. 8.4 ± 0.8 ; $p < 0.001$). Quadriceps weakness occurred significantly more frequently in the femoral nerve block group (35.0% vs. 7.5%; $p = 0.003$), while other complications were similar between the groups.

Conclusion: Ultrasound-guided adductor canal block provides postoperative analgesia comparable to femoral nerve block while significantly preserving quadriceps muscle strength, promoting earlier ambulation, and improving patient satisfaction. It represents a safe and effective regional analgesic technique for lower limb orthopaedic surgery, particularly within enhanced recovery protocols.

Keywords: Adductor Canal Block; Femoral Nerve Block; Ultrasound-Guided Regional Anaesthesia; Orthopaedic Surgery; Postoperative Analgesia; Quadriceps Strength; Early Ambulation.

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Introduction

Lower limb orthopaedic surgeries, including fracture fixation, total knee arthroplasty, ligament reconstruction, and other reconstructive procedures, are frequently associated with significant postoperative pain. Inadequate pain control may delay mobilization, prolong hospital stay, increase opioid consumption, and negatively affect functional recovery. Therefore, effective multimodal analgesia has become an essential component of perioperative care in orthopaedic surgery. [1,2] Peripheral nerve blocks have gained

widespread acceptance as an important component of multimodal analgesia because they provide excellent postoperative pain relief while reducing opioid-related adverse effects. Ultrasound guidance has significantly improved the accuracy, success rate, and safety of peripheral nerve blocks by enabling direct visualization of neural structures, surrounding anatomy, and local anaesthetic spread. Consequently, ultrasound-guided regional anaesthesia has become the standard of care for many lower limb orthopaedic procedures. [2-4] The

femoral nerve block (FNB) has traditionally been regarded as the gold standard for postoperative analgesia following knee and other anterior thigh surgeries because it provides effective blockade of the femoral nerve supplying the anterior knee joint and surrounding soft tissues. Numerous studies have demonstrated that femoral nerve block significantly reduces postoperative pain scores, opioid requirements, and patient discomfort. However, blockade of the motor fibers of the femoral nerve frequently results in quadriceps muscle weakness, delayed ambulation, impaired rehabilitation, and an increased risk of falls during the postoperative period. [3-5]

The adductor canal block (ACB) has recently emerged as an attractive alternative to femoral nerve block. The adductor canal contains predominantly sensory nerves, including the saphenous nerve and nerve to the vastus medialis, while largely sparing the motor branches supplying the quadriceps muscle. Consequently, adductor canal block provides effective postoperative analgesia with better preservation of quadriceps strength, allowing earlier mobilization and functional recovery after lower limb orthopaedic surgery. [5]

Several randomized controlled trials have compared femoral nerve block and adductor canal block with respect to analgesic efficacy, motor function, opioid consumption, and rehabilitation outcomes. Although both techniques provide satisfactory postoperative analgesia, growing evidence suggests that adductor canal block offers comparable pain relief while minimizing motor weakness and facilitating early ambulation, an important goal of enhanced recovery after surgery (ERAS) protocols. [6]

Continuous regional analgesia and ultrasound-guided adductor canal block have further demonstrated advantages in maintaining postoperative analgesia without significantly compromising muscle strength.

These characteristics have made adductor canal block increasingly popular among anaesthesiologists and orthopaedic surgeons, particularly for patients in whom early physiotherapy and rapid functional recovery are desired. [7] Despite increasing clinical adoption of adductor canal block, femoral nerve block continues to be widely used in many institutions. Comparative evaluation of these two ultrasound-guided techniques remains important to determine the optimal balance between postoperative analgesia and preservation of motor function.

Therefore, the present study was undertaken to compare ultrasound-guided femoral nerve block and ultrasound-guided adductor canal block in patients undergoing lower limb orthopaedic surgery

with respect to postoperative pain relief, opioid consumption, quadriceps muscle strength, early ambulation, duration of analgesia, complications, and patient satisfaction.

Materials and Methodology

Study Design: This was a prospective, randomized, comparative clinical study.

Study Setting: The study was conducted in the Department of Anaesthesiology in collaboration with the Department of Orthopaedics at a tertiary care teaching hospital.

Study Duration: The study was carried out over 18 months after obtaining approval from the Institutional Ethics Committee.

Sample Size: A total of 80 patients were enrolled in the study and randomly allocated into two equal groups:

- **Group F (n = 40):** Ultrasound-guided Femoral Nerve Block
- **Group A (n = 40):** Ultrasound-guided Adductor Canal Block

The sample size was calculated with a 95% confidence level, 80% statistical power, and an anticipated clinically significant difference in postoperative pain scores between the two techniques.

Study Population: Adult patients undergoing elective lower limb orthopaedic surgery under spinal or general anaesthesia with postoperative peripheral nerve block for analgesia.

Inclusion Criteria

- Age 18–70 years.
- Either sex.
- ASA physical status I or II.
- Elective lower limb orthopaedic procedures involving the knee, femur, tibia, or patella.
- Ability to understand the Visual Analogue Scale (VAS).
- Written informed consent.

Exclusion Criteria

- Patient refusal.
- Allergy to amide local anaesthetics.
- Coagulopathy or anticoagulant therapy.
- Local infection at the injection site.
- Pre-existing peripheral neuropathy.
- Severe hepatic or renal dysfunction.
- ASA physical status III or IV.
- Cognitive impairment preventing pain assessment.

Randomization: Patients were randomized using a computer-generated randomization sequence into Group F or Group A. Allocation concealment was achieved using sequentially numbered, sealed opaque envelopes.

Anaesthetic Technique: All patients received standard anaesthetic management according to institutional protocol.

Standard ASA monitoring, including electrocardiography, non-invasive blood pressure, pulse oximetry, and heart rate monitoring, was instituted. Peripheral nerve blocks were performed under strict aseptic precautions using a high-frequency linear ultrasound probe.

Group F (Femoral Nerve Block): The femoral nerve was identified below the inguinal ligament lateral to the femoral artery. Using an in-plane ultrasound-guided technique, 20 mL of 0.25% bupivacaine was injected around the femoral nerve after negative aspiration.

Group A (Adductor Canal Block): The adductor canal was identified at the mid-thigh level beneath the sartorius muscle. Using an ultrasound-guided in-plane approach, 20 mL of 0.25% bupivacaine was deposited around the saphenous nerve within the adductor canal after negative aspiration.

Outcome Measures

Primary Outcome

- Postoperative pain intensity measured using the Visual Analogue Scale (VAS) at 2, 6, 12, and 24 hours after surgery.

Secondary Outcomes

- Time to first rescue analgesia.
- Total opioid/analgesic consumption during the first 24 hours.
- Duration of sensory block.
- Quadriceps muscle strength assessed using the Medical Research Council (MRC) muscle grading scale.
- Time to first ambulation.

- Incidence of postoperative nausea and vomiting.
- Block-related complications (vascular puncture, hematoma, infection, nerve injury).
- Patient satisfaction score.

Rescue Analgesia: Patients with a VAS score ≥ 4 received intravenous paracetamol 1 g as first-line rescue analgesia. If pain persisted, intravenous tramadol 50 mg was administered according to institutional pain management protocols.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using SPSS version 25.0. Continuous variables were expressed as mean $\pm$ standard deviation (SD) and compared using the independent Student's t-test. Categorical variables were expressed as frequencies and percentages and analyzed using the Chi-square test or Fisher's exact test. Repeated measures ANOVA was used to compare VAS scores over time. A p-value < 0.05 was considered statistically significant.

Results

A total of 80 patients undergoing elective lower limb orthopaedic surgery were enrolled in the study. Patients were randomly allocated into two equal groups:

- Group F:** Ultrasound-Guided Femoral Nerve Block (n = 40)
- Group A:** Ultrasound-Guided Adductor Canal Block (n = 40)

Both groups were comparable with respect to demographic characteristics and surgical variables. Postoperative analgesia, quadriceps muscle strength, ambulation, analgesic consumption, and complications were evaluated.

Table 1: Baseline Demographic and Surgical Characteristics

Variable	Group F (n=40)	Group A (n=40)	p-value
Age (years)	48.2 $\pm$ 11.3	47.5 $\pm$ 10.9	0.781
Male, n (%)	24 (60.0)	23 (57.5)	0.821
Female, n (%)	16 (40.0)	17 (42.5)	
BMI (kg/m ²)	25.4 $\pm$ 3.1	25.1 $\pm$ 2.9	0.658
ASA I, n (%)	26 (65.0)	28 (70.0)	0.629
ASA II, n (%)	14 (35.0)	12 (30.0)	
Duration of Surgery (minutes)	106.5 $\pm$ 18.6	104.9 $\pm$ 19.2	0.703

Both groups were comparable with respect to age, gender, BMI, ASA physical status, and duration of surgery. No statistically significant differences were observed between the two groups (p>0.05).

Table 2: Postoperative Pain Scores and Analgesic Requirement

Variable	Group F	Group A	p-value
VAS Score (2 hours)	2.3 $\pm$ 0.7	2.5 $\pm$ 0.8	0.238
VAS Score (6 hours)	3.1 $\pm$ 0.9	3.3 $\pm$ 0.8	0.314
VAS Score (12 hours)	3.8 $\pm$ 0.9	4.0 $\pm$ 1.0	0.359
VAS Score (24 hours)	2.6 $\pm$ 0.8	2.8 $\pm$ 0.9	0.287
Time to First Rescue Analgesia (hours)	9.8 $\pm$ 2.1	9.3 $\pm$ 2.3	0.326
Total Rescue Analgesic Consumption (24 hours, mg tramadol equivalent)	118 $\pm$ 32	124 $\pm$ 35	0.421

Postoperative pain scores, duration of analgesia, and rescue analgesic requirements were comparable between the femoral nerve block and adductor canal block groups. No statistically significant differences were observed ($p>0.05$), indicating similar analgesic efficacy.

Table 3: Functional Recovery and Quadriceps Muscle Strength

Variable	Group F	Group A	p-value
Quadriceps Muscle Strength (MRC Grade at 6 hours)	3.2 $\pm$ 0.6	4.4 $\pm$ 0.5	<0.001
Time to First Ambulation (hours)	22.4 $\pm$ 4.8	15.6 $\pm$ 3.9	<0.001
Independent Ambulation within 24 hours, n (%)	21 (52.5)	35 (87.5)	0.001
Patient Satisfaction Score (0–10)	8.4 $\pm$ 0.8	9.2 $\pm$ 0.6	<0.001

Patients receiving adductor canal block demonstrated significantly better preservation of quadriceps muscle strength, earlier ambulation, higher rates of independent walking within 24 hours, and greater patient satisfaction compared with those receiving femoral nerve block ($p<0.001$).

Table 4: Postoperative Complications

Complication	Group F (n=40)	Group A (n=40)	p-value
Postoperative Nausea and Vomiting	5 (12.5%)	4 (10.0%)	0.723
Quadriceps Weakness	14 (35.0%)	3 (7.5%)	0.003
Fall/Near-Fall Episodes	3 (7.5%)	0 (0%)	0.078
Vascular Puncture	1 (2.5%)	0 (0%)	0.314
Local Hematoma	1 (2.5%)	1 (2.5%)	1.000
Nerve Injury/Infection	0	0	—

Quadriceps weakness occurred significantly more frequently in the femoral nerve block group (35.0%) than in the adductor canal block group (7.5%) ($p=0.003$). Other postoperative complications were infrequent and comparable between the two groups.

Discussion

The present prospective randomized comparative study evaluated the efficacy of ultrasound-guided femoral nerve block (FNB) and adductor canal block (ACB) for postoperative analgesia in patients undergoing lower limb orthopaedic surgery. The study demonstrated that both techniques provided comparable postoperative analgesia and similar rescue analgesic requirements. However, adductor canal block preserved quadriceps muscle strength significantly better, facilitated earlier ambulation, and resulted in higher patient satisfaction while maintaining an equivalent safety profile.

The findings of the present study are consistent with those reported by Andersen et al. [7], who compared continuous adductor canal block with continuous femoral nerve block following knee surgery. They observed that both techniques provided effective postoperative analgesia, while adductor canal block resulted in significantly better preservation of quadriceps muscle strength and earlier mobilization. Similar observations were made in the present study, where patients receiving adductor canal block demonstrated significantly higher muscle strength scores and earlier independent ambulation compared with those receiving femoral nerve block.

Comparable analgesic efficacy between the two nerve blocks has also been demonstrated by Kim et

al. [8], who reported no significant difference in postoperative pain scores or opioid consumption between adductor canal block and femoral nerve block after total knee arthroplasty. Their study concluded that adductor canal block offers equivalent analgesia while minimizing motor blockade. The present study similarly showed no statistically significant difference in postoperative VAS scores, duration of analgesia, or rescue analgesic consumption between the two groups.

A systematic review and meta-analysis conducted by Memtsoudis et al. [9] further supported these findings by demonstrating that adductor canal block provides analgesia comparable to femoral nerve block while preserving quadriceps muscle function. The authors emphasized that motor preservation contributes to safer postoperative mobilization and improved rehabilitation. In the present study, significantly fewer patients in the adductor canal block group experienced quadriceps weakness, which facilitated earlier postoperative mobilization and improved functional recovery.

The meta-analysis by Hussain et al. [10] also concluded that adductor canal block achieves postoperative analgesia comparable to femoral nerve block without compromising quadriceps muscle strength. Preservation of motor function is particularly important in orthopaedic patients because it reduces the risk of delayed rehabilitation and facilitates implementation of enhanced recovery protocols. The present findings corroborate these observations, with patients in the adductor canal block group achieving significantly earlier ambulation and higher satisfaction scores.

Similarly, Kuang et al. [11] analyzed multiple randomized controlled trials and reported that adductor canal block was associated with improved quadriceps strength and earlier functional recovery while maintaining equivalent pain relief following knee surgery. Their findings closely correspond with the present study, which demonstrated superior motor preservation and functional outcomes with adductor canal block despite similar analgesic efficacy between the two techniques.

One of the principal concerns following femoral nerve block is postoperative quadriceps weakness and the potential risk of falls. Elkassabany et al. [12] evaluated this complication and reported a significantly lower incidence of quadriceps weakness and fall risk among patients receiving adductor canal block compared with femoral nerve block. Although no actual postoperative falls occurred in the present study, quadriceps weakness was significantly more common in the femoral nerve block group, supporting the advantage of adductor canal block in preserving motor function.

The findings of the present study are further supported by Abdallah et al. [13], who demonstrated that adductor canal block provides non-inferior postoperative analgesia while preserving quadriceps muscle strength following lower limb reconstructive procedures. Better preservation of motor function resulted in improved patient mobility and rehabilitation without compromising pain control. Similar results were observed in the present study, where patients receiving adductor canal block exhibited higher patient satisfaction and earlier functional recovery. Finally, Kampitak et al. [14] reported that ultrasound-guided adductor canal block produced a significant motor-sparing effect while maintaining effective analgesia after knee surgery. Their randomized controlled trial concluded that adductor canal block should be preferred whenever early postoperative mobilization is a primary objective. The present study similarly demonstrated that adductor canal block preserved quadriceps strength, reduced motor impairment, and facilitated earlier ambulation while providing analgesia comparable to femoral nerve block.

Overall, the findings of the present study reinforce the growing body of evidence supporting ultrasound-guided adductor canal block as an effective alternative to femoral nerve block for lower limb orthopaedic surgery. By combining excellent postoperative analgesia with superior preservation of motor function, adductor canal block promotes enhanced recovery, earlier rehabilitation, and improved patient satisfaction.

Conclusion

Both ultrasound-guided femoral nerve block and adductor canal block provided effective

postoperative analgesia following lower limb orthopaedic surgery. There were no significant differences in postoperative pain scores, duration of analgesia, or rescue analgesic consumption between the two techniques. However, adductor canal block demonstrated significant advantages in preserving quadriceps muscle strength, facilitating earlier ambulation, improving functional recovery, and enhancing patient satisfaction while maintaining a similar safety profile. Therefore, ultrasound-guided adductor canal block appears to be the preferred regional analgesic technique for lower limb orthopaedic surgery, particularly when early postoperative mobilization and rehabilitation are desired.

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