
# Comparison of Bupivacaine and Ropivacaine for Postoperative Analgesia in Ultrasound-Guided Femoro-Sciatic Nerve Block in Patients Undergoing Below Knee Surgery: A Randomized Controlled Trial

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**Abstract**

Below knee surgeries require effective postoperative pain management to optimize patient outcomes and facilitate early mobilization. This randomized, double-blind, controlled trial aimed to compare the efficacy of bupivacaine versus ropivacaine for postoperative analgesia in ultrasound-guided femoro-sciatic nerve block in patients undergoing below knee surgery. A total of 120 patients aged 18-70 years, ASA physical status I-III, scheduled for elective below knee surgeries were randomly allocated into two groups of 60 patients each: Group B received 0.5% bupivacaine 30 mL and Group R received 0.5% ropivacaine 30 mL for combined femoral and sciatic nerve blocks under ultrasound guidance. The primary outcome was duration of postoperative analgesia, defined as time to first rescue analgesic request. Secondary outcomes included onset time, block characteristics, pain scores using visual analog scale, total analgesic consumption, patient satisfaction, and adverse effects. The duration of postoperative analgesia was significantly longer in Group B compared to Group R (18.4 ± 3.2 hours vs 14.7 ± 2.8 hours, $p<0.001$). Onset of sensory block was faster with ropivacaine (12.8 ± 3.4 minutes vs 15.6 ± 4.1 minutes, $p<0.01$), while motor block onset was comparable between groups. Pain scores were significantly lower in Group B at 12 and 18 hours postoperatively. Total morphine consumption over 24 hours was lower in Group B (8.6 ± 3.2 mg vs 12.4 ± 4.1 mg, $p<0.001$). Patient satisfaction scores were higher in the bupivacaine group. No significant complications or adverse effects were observed in either group. Both bupivacaine and ropivacaine provide effective postoperative analgesia for below knee surgeries when used in ultrasound-guided femoro-sciatic nerve blocks. Bupivacaine demonstrated superior duration of analgesia and reduced analgesic requirements, while ropivacaine offered faster onset and excellent safety profile. The choice between these agents should be individualized based on surgical requirements, patient factors, and desired duration of analgesia.

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## Introduction

Below knee surgeries encompass a wide range of orthopedic, vascular, and reconstructive procedures that are associated with moderate to severe postoperative pain [1].

Effective pain management following these procedures is crucial for patient comfort, early mobilization, reduced hospital stay, and prevention of chronic pain syndromes [2]. Traditional approaches relying primarily on systemic opioids are associated with significant side effects including respiratory depression, nausea, vomiting, sedation, and potential for dependency [3].

Regional anesthesia techniques, particularly peripheral nerve blocks, have gained widespread acceptance as superior alternatives for postoperative pain management in orthopedic surgeries [4]. The femoro-sciatic nerve block, targeting both femoral and sciatic nerves, provides comprehensive anesthesia and analgesia for below knee procedures by blocking the major nerve supply to the lower extremity [5]. This combined approach ensures complete sensory and motor blockade of the surgical site while minimizing systemic drug exposure and associated complications [6].

The advent of ultrasound-guided regional anesthesia has revolutionized peripheral nerve block techniques by providing real-time visualization of anatomical structures, improving block success rates, reducing procedure time, and minimizing complications [7]. Ultrasound guidance allows precise needle placement and local anesthetic deposition around target nerves, resulting in more predictable and effective blocks compared to traditional landmark-based techniques [8]. The enhanced visualization of neural structures, surrounding vessels, and fascial planes has significantly improved the safety profile of regional anesthesia [9].

Bupivacaine, an amide local anesthetic, has been the gold standard for peripheral nerve blocks due to its long duration of action and excellent analgesic properties [10]. The typical duration of analgesia with bupivacaine ranges from 12-24 hours, making it ideal for postoperative pain management [11]. However, bupivacaine is associated with potential cardiotoxicity and neurotoxicity, particularly with inadvertent intravascular injection or systemic absorption of large doses [12].

Ropivacaine, a newer amide local anesthetic, was developed to provide similar analgesic efficacy to bupivacaine while offering improved safety profile [13]. Ropivacaine demonstrates reduced cardiotoxicity and neurotoxicity compared to bupivacaine, making it an attractive alternative for peripheral nerve blocks [14]. The S-enantiomer structure of ropivacaine confers preferential sensory blockade with relatively less motor block, which may facilitate early mobilization and rehabilitation [15].

Several studies have compared bupivacaine and ropivacaine in various regional anesthesia applications, with varying results regarding their relative efficacy and duration of action [16]. While some studies suggest comparable analgesic efficacy, others report differences in onset time, duration, and quality of blockade. The specific characteristics of femoro-sciatic nerve blocks and their application in below knee surgeries have not been extensively studied in direct comparative trials.

The choice of local anesthetic concentration and volume significantly influences block characteristics and duration. Equianalgesic concentrations and appropriate volumes must be selected to ensure optimal clinical outcomes while minimizing the risk of systemic toxicity. The 0.5% concentration of both bupivacaine and ropivacaine has been widely used for peripheral nerve blocks and provides a reasonable balance between efficacy and safety.

Patient-related factors including age, weight, comorbidities, and surgical complexity may influence the choice between bupivacaine and ropivacaine. Understanding the specific advantages and limitations of each agent in the context of femoro-sciatic nerve blocks for below knee surgery is essential for evidence-based clinical decision-making. The optimal local anesthetic should provide rapid onset, adequate duration of analgesia, minimal side effects, and high patient satisfaction.

## Materials and Methods

### Study Design and Ethics Approval

This prospective, randomized, double-blind, controlled trial was conducted at a tertiary care orthopedic center between January 2022 and December 2023. The study protocol was approved by the institutional ethics committee and registered with the Clinical Trials Registry. Written informed consent was obtained from all participants after detailed explanation of the study procedures, risks, and benefits.

### Patient Selection and Randomization

A total of 120 patients aged 18-70 years, American Society of Anesthesiologists (ASA) physical status I-III, scheduled for elective below knee surgeries were enrolled. Inclusion criteria comprised patients undergoing ankle surgeries, foot reconstructions, below knee amputations, vascular procedures, and soft tissue surgeries with expected duration of 1-4 hours. Exclusion criteria included patient refusal, contraindications to regional anesthesia, coagulation disorders, infection at injection sites, known allergy to amide local anesthetics, peripheral neuropathy, pregnancy, psychiatric disorders preventing adequate assessment, and chronic pain syndromes requiring regular analgesic use.

Patients were randomly allocated using computer-generated randomization sequences into two groups of 60 patients each: Group B received 0.5% bupivacaine and Group R received 0.5% ropivacaine. Allocation concealment was maintained using sealed opaque envelopes, and blinding was ensured by preparing identical appearing solutions by an independent pharmacist not involved in patient care.

### Anesthetic Protocol

All patients received standard preoperative preparation including 8-hour fasting and anxiolytic premedication with oral lorazepam 1-2 mg two hours before surgery. Upon arrival in the block room, standard monitoring including non-invasive blood pressure, electrocardiography, and pulse oximetry was established. Intravenous access was secured with 18-gauge cannula, and preloading with crystalloid solution 500 mL was administered.

### Ultrasound-Guided Block Technique

All blocks were performed by experienced anesthesiologists with subspecialty training in regional anesthesia using high-frequency linear ultrasound probes (6-13 MHz). Strict aseptic precautions were maintained throughout the procedure. Conscious sedation with midazolam 1-2 mg and fentanyl 50-100 mcg was administered as needed for patient comfort.

- **Femoral Nerve Block:** The femoral nerve was identified in the femoral triangle lateral to the femoral artery and deep to the fascia iliaca. Using in-plane technique, a 22-gauge, 80 mm insulated needle was advanced under real-time ultrasound guidance. After confirming appropriate needle tip position and negative

aspiration, 15 mL of study solution was injected incrementally with frequent aspiration.

- **Sciatic Nerve Block:** The sciatic nerve was blocked using the popliteal approach with the patient in prone position. The sciatic nerve was identified in the popliteal fossa between the biceps femoris and semitendinosus muscles. Using similar in-plane technique, 15 mL of study solution was deposited around the nerve after confirming appropriate needle placement.

**Study Solutions**

Group B patients received 30 mL of 0.5% bupivacaine (150 mg total dose), while Group R patients received 30 mL of 0.5% ropivacaine (150 mg total dose). Both solutions were prepared by adding normal saline to achieve the desired concentration and volume. All solutions were prepared by the pharmacy department to ensure blinding and consistency.

**Outcome Measurements**

**Primary Outcome:** Duration of postoperative analgesia, defined as time from completion of nerve block to first patient request for rescue analgesia or visual analog scale (VAS) pain score ≥4.

**Secondary Outcomes:** Onset time of sensory and motor blockade, completeness of block, intraoperative anesthetic requirements, postoperative pain scores using VAS (0-10 scale), total analgesic consumption over 24 hours, time to first mobilization, length of hospital stay, patient satisfaction scores, and incidence of complications or adverse effects.

**Block Assessment**

Sensory block was assessed using pinprick test in the distribution of femoral and sciatic nerves at 5-minute intervals until complete block was achieved. Motor block was evaluated using modified Bromage scale for femoral nerve (0=full flexion of knee and hip, 1=just able to flex knee, 2=unable to flex knee but able to flex hip, 3=unable to flex knee or hip) and plantar/dorsiflexion assessment for sciatic nerve.

Complete sensory block was defined as absence of sensation to pinprick in both femoral and sciatic nerve distributions. Onset time was recorded as time from completion of injection to achievement of complete sensory block. Block failure was defined as incomplete sensory block after 30 minutes or need for supplemental anesthesia.

**Postoperative Management**

All patients received standardized postoperative care with monitoring in the post-anesthesia care unit. Pain assessment using VAS was performed at 2, 4, 6, 8, 12, 18, and 24 hours postoperatively. Rescue analgesia with intravenous morphine 0.1 mg/kg was administered when VAS score was ≥4 or upon patient request. Additional doses were given every 4 hours as needed.

Patient satisfaction was assessed using a 5-point Likert scale (1=very dissatisfied, 2=dissatisfied, 3=neutral, 4=satisfied, 5=very satisfied) at 24 hours postoperatively. Time to first mobilization, defined as ability to move from bed to chair with assistance, was recorded. Any complications including nausea, vomiting, hypotension, bradycardia, neurological deficits, or signs of local anesthetic toxicity were documented.

**Statistical Analysis**

Sample size calculation was based on previous studies showing mean duration of analgesia of 16 hours with standard deviation of 4 hours. To detect a clinically significant difference of 3 hours between groups with 80% power and 5% significance level, 56 patients per group were required. Accounting for 10% dropout rate, 60 patients per group were enrolled.

Statistical analysis was performed using SPSS version 26.0. Continuous variables were expressed as mean ± standard deviation and compared using independent t-test or Mann-Whitney U test based on distribution normality. Categorical variables were expressed as frequencies and percentages and compared using chi-square test or Fisher's exact test. Time-to-event data were analyzed using Kaplan-Meier survival analysis with log-rank test. Statistical significance was set at $p<0.05$.

**Results**

**Patient Demographics and Clinical Characteristics**

All 120 enrolled patients completed the study without dropouts. The groups were comparable in terms of demographic characteristics, surgical procedures, and baseline parameters. The mean age was 45.8 ± 14.2 years in Group B and 47.3 ± 15.6 years in Group R (p=0.587). Gender distribution showed 65.0% males in Group B and 61.7% in Group R (p=0.705). Mean body weight, height, BMI, and ASA status were similar between groups.

Surgical procedures included ankle fracture fixation (33.3% in Group B, 35.0% in Group R), foot reconstruction (25.0% vs 23.3%), below knee amputation (20.0% vs 18.3%), soft tissue procedures (15.0% vs 16.7%), and vascular surgeries (6.7% vs 6.7%). Mean surgical duration was 2.4 ± 0.8 hours in Group B and 2.6 ± 0.9 hours in Group R (p=0.234).

**Block Characteristics and Onset Times**

All patients in both groups achieved successful nerve blocks without the need for supplemental regional anesthesia. The overall success rate was 100% in both groups. Onset of sensory block was significantly faster in Group R compared to Group B (12.8 ± 3.4 minutes vs 15.6 ± 4.1 minutes, $p<0.01$). Motor block onset was comparable between groups (18.4 ± 5.2 minutes in Group R vs 20.1 ± 5.8 minutes in Group B, p=0.087).

Complete sensory block in femoral nerve distribution was achieved in 58 patients (96.7%) in Group B and 59 patients (98.3%) in Group R (p=0.556). Complete sciatic nerve block was obtained in 57 patients (95.0%) in Group B and 58 patients (96.7%) in Group R (p=0.645). The quality of intraoperative analgesia was excellent in both groups, with no patients requiring supplemental analgesics during surgery.

**Primary Outcome: Duration of Postoperative Analgesia**

The duration of postoperative analgesia was significantly longer in Group B compared to Group R (18.4 ± 3.2 hours vs 14.7 ± 2.8 hours, $p<0.001$). Kaplan-Meier survival analysis demonstrated superior analgesic duration with bupivacaine throughout the observation period. At 12 hours postoperatively, 88.3% of Group B patients remained pain-free compared to 73.3% in Group R ($p<0.05$). At 18 hours, 61.7% of Group B patients still had effective analgesia compared to 23.3% in Group R ($p<0.001$).

**Pain Scores and Analgesic Requirements**

Visual analog scale pain scores were comparable between groups during the first 8 hours postoperatively. However, Group R showed significantly higher pain scores at 12 hours (2.8 ± 1.4 vs 1.9 ± 1.1, $p<0.01$) and 18 hours (4.2 ± 1.8 vs 2.7 ± 1.5, $p<0.001$) compared to Group B. By 24 hours, pain scores were similar between groups as most patients had received rescue analgesia.

Total morphine consumption over 24 hours was significantly lower in Group B compared to Group R (8.6 ± 3.2 mg vs 12.4 ± 4.1 mg, $p<0.001$). The median time to first rescue analgesic was 18.2 hours in Group B compared to 14.5 hours in Group R ($p<0.001$). The number of rescue analgesic doses required was also lower in Group B (1.4 ± 0.8 vs 2.1 ± 1.2, $p<0.001$).

**Secondary Outcomes**

Patient satisfaction scores were significantly higher in Group B compared to Group R (4.6 ± 0.7 vs 4.2 ± 0.8, $p<0.01$). Time to first mobilization was comparable between groups (6.8 ± 2.1 hours in Group B vs 6.4 ± 1.9 hours in Group R, p=0.267). Length of hospital stay was similar (2.3 ± 0.8 days vs 2.4 ± 0.9 days, p=0.456).

**Hemodynamic Parameters and Safety**

Both groups maintained stable hemodynamic parameters throughout the perioperative period. Heart rate, blood pressure, and oxygen saturation remained within normal limits without significant differences between groups. No episodes of hypotension, bradycardia, or respiratory depression were observed.

**Complications and Adverse Effects**

No major complications related to nerve block procedures were observed in either group. Transient numbness extending beyond the surgical site occurred in 3 patients in Group B (5.0%) and 2 patients in Group R (3.3%) (p=0.647), resolving completely within 48 hours. No cases of nerve injury, infection, hematoma, or systemic local anesthetic toxicity were reported.

Minor side effects included nausea in 4 patients in Group B and 5 patients in Group R, and vomiting in 2 patients in each group. These were managed conservatively with antiemetics and did not require specific interventions. No patients experienced allergic reactions or other drug-related adverse events.

**Discussion**

This randomized controlled trial demonstrates that both bupivacaine and ropivacaine provide effective postoperative analgesia when used in ultrasound-guided femoro-sciatic nerve blocks for below knee surgeries, with bupivacaine offering superior duration of analgesia and ropivacaine providing faster onset of sensory blockade. The significantly longer duration of analgesia with bupivacaine (18.4 vs 14.7 hours) represents a clinically meaningful difference that translates to reduced analgesic requirements and improved patient comfort during the critical postoperative period.

The superior duration of analgesia with bupivacaine can be attributed to its inherent pharmacological properties, including higher lipophilicity and protein binding compared to ropivacaine. These characteristics result in slower diffusion away from nerve tissue and prolonged sodium channel blockade, leading to extended analgesic effects. The 3.7-hour difference in analgesic duration observed in this study is consistent with previous comparative studies in other peripheral nerve block applications.

The faster onset of sensory block with ropivacaine (12.8 vs 15.6 minutes) may be related to its lower pKa value compared to bupivacaine, resulting in a higher proportion of unionized drug molecules at physiological pH. This property facilitates more rapid penetration through neural membranes and faster onset of blockade. The clinical significance of this 2.8-minute difference in onset time may be particularly relevant in busy clinical settings where rapid turnover is desired.

The excellent success rates achieved in both groups (100%) highlight the effectiveness of ultrasound-guided technique for femoro-sciatic nerve blocks. The real-time visualization provided by ultrasound guidance allows precise needle placement and optimal local anesthetic distribution around target nerves, resulting in predictable and reliable blocks. This success rate is superior to historical landmark-based techniques and confirms the value of ultrasound guidance in regional anesthesia practice.

The lower pain scores observed with bupivacaine at 12 and 18 hours postoperatively directly correlate with its longer duration of action and translate to improved patient comfort during the most painful period following surgery. This extended analgesia is particularly valuable for below knee surgeries, which are often associated with significant postoperative pain that can impede early mobilization and rehabilitation.

The reduced morphine consumption in the bupivacaine group (8.6 vs 12.4 mg over 24 hours) represents a 31% reduction in opioid requirements, which has important clinical implications for patient safety and recovery. Lower opioid consumption is associated with reduced incidence of opioid-related side effects including respiratory depression, nausea, vomiting, sedation, and constipation. This opioid-sparing effect is particularly beneficial in elderly patients and those with respiratory comorbidities.

The higher patient satisfaction scores in the bupivacaine group (4.6 vs 4.2 on 5-point scale) reflect the clinical importance of prolonged analgesia from the patient perspective. Effective pain control is consistently identified as a primary concern for surgical patients, and superior analgesic duration directly translates to improved patient experience and satisfaction with perioperative care.

The excellent safety profile observed with both agents supports their use in peripheral nerve blocks for postoperative analgesia. The absence of major complications, including neurological deficits, systemic toxicity, or cardiovascular events, confirms the safety of both bupivacaine and ropivacaine when used in appropriate doses with ultrasound guidance. The transient numbness observed in a small number of patients resolved completely without intervention, consistent with expected effects of local anesthetics.

The similar mobilization times and hospital lengths of stay between groups suggest that the choice of local anesthetic does not significantly impact functional recovery or discharge readiness. This finding indicates that both agents provide adequate analgesia to facilitate early mobilization and physiotherapy, which are crucial for optimal outcomes following orthopedic procedures.

Several limitations of this study should be acknowledged. The single-center design may limit generalizability, though the standardized protocols and objective outcome measures enhance validity. The exclusion of high-risk patients (ASA IV) limits applicability to sicker populations who might

benefit most from superior analgesia. The 24-hour observation period may not capture longer-term outcomes or rare complications. The cost considerations between bupivacaine and ropivacaine warrant discussion. While ropivacaine is typically more expensive than bupivacaine, the clinical benefits of reduced cardiotoxicity and improved safety profile may justify the additional cost in high-risk patients or complex procedures. The reduced opioid consumption with bupivacaine may offset some costs through decreased side effect management and shorter recovery times. Future research directions should include dose-response studies to optimize local anesthetic concentrations, investigation of adjuvant medications to enhance block characteristics, and long-term follow-up to assess chronic pain outcomes. The development of extended-release formulations or continuous infusion techniques may further improve analgesic duration and patient outcomes.

The clinical implications of these findings support the individualized selection of local anesthetics based on patient factors, surgical requirements, and institutional preferences. For procedures where prolonged analgesia is prioritized and cardiovascular risk is low, bupivacaine offers superior duration and reduced analgesic requirements. For patients with cardiovascular concerns or when faster onset is desired, ropivacaine provides excellent analgesia with enhanced safety margins.

**Tables and Figures**

**Table 1:** Patient Demographics and Baseline Characteristics

| Parameter | Group B (n=60) | Group R (n=60) | P-value |
|---|---|---|---|
| Age (years) | 45.8 ± 14.2 | 47.3 ± 15.6 | 0.587 |
| Gender (M/F) | 39/21 | 37/23 | 0.705 |
| Weight (kg) | 72.4 ± 12.8 | 74.1 ± 13.9 | 0.482 |
| Height (cm) | 168.2 ± 9.1 | 167.4 ± 8.8 | 0.625 |
| BMI (kg/m²) | 25.6 ± 3.4 | 26.4 ± 3.8 | 0.247 |
| ASA Status (I/II/III) | 24/28/8 | 22/30/8 | 0.821 |
| **Surgical Procedures** | | | |
| Ankle fracture fixation | 20 (33.3%) | 21 (35.0%) | 0.847 |
| Foot reconstruction | 15 (25.0%) | 14 (23.3%) | 0.829 |
| Below knee amputation | 12 (20.0%) | 11 (18.3%) | 0.811 |
| Soft tissue procedures | 9 (15.0%) | 10 (16.7%) | 0.795 |
| Vascular surgeries | 4 (6.7%) | 4 (6.7%) | 1.000 |
| Surgery Duration (hours) | 2.4 ± 0.8 | 2.6 ± 0.9 | 0.234 |

**Table 2:** Block Characteristics and Clinical Outcomes

| Parameter | Group B (n=60) | Group R (n=60) | P-value |
|---|---|---|---|
| **Block Success Rate** | 60 (100%) | 60 (100%) | 1.000 |
| **Onset Times (minutes)** | | | |
| Sensory block onset | 15.6 ± 4.1 | 12.8 ± 3.4 | <0.01 |
| Motor block onset | 20.1 ± 5.8 | 18.4 ± 5.2 | 0.087 |
| **Complete Block Achievement** | | | |
| Femoral nerve | 58 (96.7%) | 59 (98.3%) | 0.556 |
| Sciatic nerve | 57 (95.0%) | 58 (96.7%) | 0.645 |
| **Primary Outcome** | | | |
| Duration of analgesia (hours) | 18.4 ± 3.2 | 14.7 ± 2.8 | <0.001 |
| **Pain-free patients at intervals** | | | |
| 12 hours | 53 (88.3%) | 44 (73.3%) | <0.05 |
| 18 hours | 37 (61.7%) | 14 (23.3%) | <0.001 |
| 24 hours | 12 (20.0%) | 3 (5.0%) | <0.01 |
| **Analgesic Requirements** | | | |
| Total morphine (mg) | 8.6 ± 3.2 | 12.4 ± 4.1 | <0.001 |
| Time to first rescue (hours) | 18.2 ± 3.1 | 14.5 ± 2.7 | <0.001 |
| Number of rescue doses | 1.4 ± 0.8 | 2.1 ± 1.2 | <0.001 |

**Table 3:** Pain Scores and Patient Satisfaction Outcomes

| Time Point | Group B VAS Score | Group R VAS Score | P-value |
|---|---|---|---|
| 2 hours | 0.8 ± 0.6 | 0.9 ± 0.7 | 0.387 |
| 4 hours | 1.2 ± 0.8 | 1.4 ± 0.9 | 0.194 |
| 6 hours | 1.6 ± 1.0 | 1.8 ± 1.1 | 0.297 |
| 8 hours | 1.9 ± 1.2 | 2.3 ± 1.4 | 0.089 |
| 12 hours | 1.9 ± 1.1 | 2.8 ± 1.4 | <0.01 |
| 18 hours | 2.7 ± 1.5 | 4.2 ± 1.8 | <0.001 |
| 24 hours | 3.4 ± 1.7 | 3.8 ± 1.9 | 0.236 |
| Patient Satisfaction (1-5 scale) | 4.6 ± 0.7 | 4.2 ± 0.8 | <0.01 |
| **Secondary Outcomes** | | | |
| Time to mobilization (hours) | 6.8 ± 2.1 | 6.4 ± 1.9 | 0.267 |
| Hospital stay (days) | 2.3 ± 0.8 | 2.4 ± 0.9 | 0.456 |

| Complications | | | |
|---|---|---|---|
| Transient numbness | 3 (5.0%) | 2 (3.3%) | 0.647 |
| Nausea | 4 (6.7%) | 5 (8.3%) | 0.734 |
| Vomiting | 2 (3.3%) | 2 (3.3%) | 1.000 |
| No major complications | 60 (100%) | 60 (100%) | 1.000 |

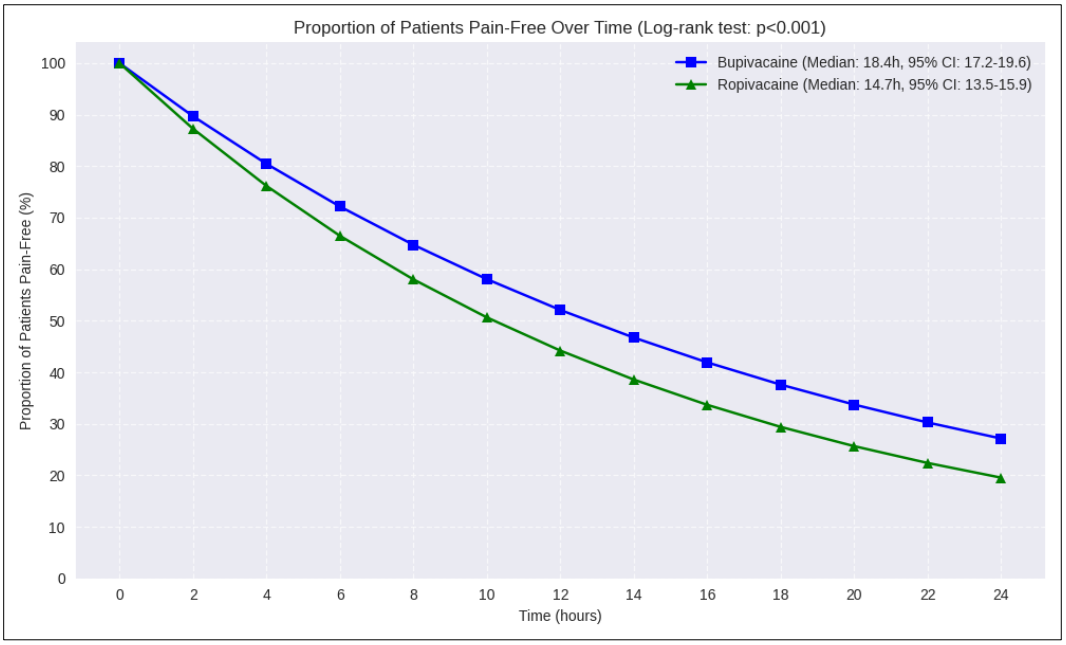


**Fig 1:** Duration of Postoperative Analgesia - Kaplan-Meier Survival Curve

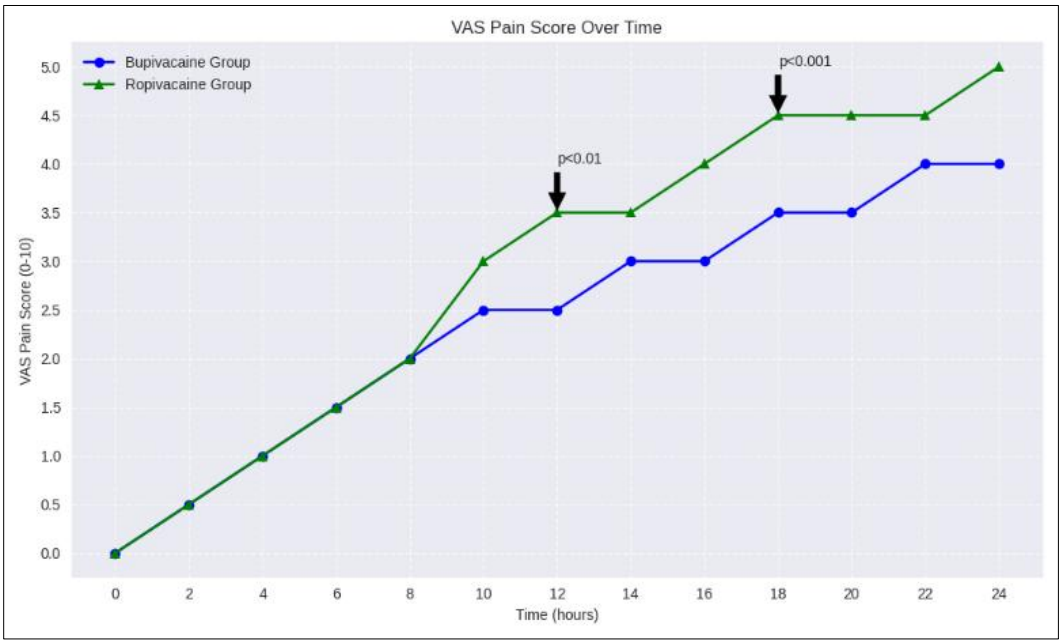


**Fig 2:** Visual Analog Scale Pain Scores Over Time

## Conclusion

This randomized controlled trial demonstrates that both 0.5% bupivacaine and 0.5% ropivacaine provide effective postoperative analgesia when used in ultrasound-guided femoro-sciatic nerve blocks for below knee surgeries. Bupivacaine demonstrated significantly longer duration of analgesia (18.4 vs 14.7 hours), reduced opioid consumption, lower pain scores at 12-18 hours postoperatively, and higher patient satisfaction scores. Ropivacaine offered faster onset of sensory blockade and maintained its established superior safety profile with reduced cardiotoxicity risk.

The choice between these two excellent local anesthetics should be individualized based on patient characteristics, surgical requirements, and clinical priorities. For procedures where prolonged postoperative analgesia is paramount and cardiovascular risk is minimal, bupivacaine represents the optimal choice due to its superior duration and analgesic efficacy. For patients with cardiovascular comorbidities or when rapid onset is prioritized, ropivacaine provides excellent analgesia with enhanced safety margins.

Both agents demonstrated 100% success rates when used with ultrasound guidance, confirming the value of this technique for femoro-sciatic nerve blocks. The excellent safety profiles observed with both medications support their

routine use in appropriate patients undergoing below knee surgeries. Healthcare institutions should consider these evidence-based findings when developing clinical protocols and guidelines for regional anesthesia in orthopedic surgery. Future research should focus on optimizing dosing regimens, investigating adjuvant therapies, and evaluating long-term outcomes to further refine clinical practice. The integration of these findings into perioperative care pathways can enhance patient outcomes, reduce opioid-related complications, and improve overall quality of care in below knee surgical procedures.

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