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Original Research Article

Comparison Study of Adductor Canal Block with 0. 25% and 0.5% Bupivacaine for Postoperative Analgesia in Outpatient Arthroscopic ACL Repair

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Abstract:

Introduction: Effective postoperative pain management is critical for enhancing recovery and patient satisfaction after anterior cruciate ligament (ACL) reconstruction surgery. Traditional femoral nerve blocks, while effective, can cause quadriceps weakness, delaying mobility. Adductor canal block (ACB) has emerged as an alternative, providing adequate analgesia while preserving quadriceps strength. This study aimed to compare the analgesic efficacy and safety of 0.25% versus 0.5% bupivacaine administered via ACB in outpatient arthroscopic ACL repair.

Materials and Methods: This prospective study, conducted at Mamata Medical College, included 60 patients (ASA I or II, aged 18–50) undergoing outpatient arthroscopic ACL repair. Patients were randomized into two groups: Group A (0.25% bupivacaine) and Group B (0.5% bupivacaine), each receiving 20 mL via ultrasound-guided ACB. Postoperative pain was assessed using the Visual Analog Scale (VAS) at multiple intervals up to 24 hours. Secondary outcomes included time to first analgesic request, total analgesic consumption, motor recovery, and complications. Statistical analysis was performed using SPSS v25, with $p < 0.05$ considered significant.

Results: Group B showed significantly longer analgesia duration (11.1 ± 4.2 vs. 8.4 ± 2.6 hours, $p = 0.024$) and lower total analgesic use (7.5 ± 3.1 mg vs. 12.3 ± 4.6 mg, $p = 0.001$). VAS scores were consistently lower in Group B across all time points, with significant differences observed from 6 to 24 hours. Motor recovery was similar in both groups, and complications were mild and comparable.

Conclusion: The use of 0.5% bupivacaine provides superior analgesia with prolonged pain relief and reduced opioid consumption compared to 0.25% bupivacaine in outpatient ACL repair, without compromising safety.

Keywords: Adductor Canal Block, Bupivacaine Concentration, Postoperative Analgesia.

Introduction

Proper pain management after ACL reconstruction surgery is crucial for enhancing surgical results and ensuring patient satisfaction. [1,2] Arthroscopic ACL repair, while minimally invasive, can cause substantial postoperative pain, hindering mobility and prolonging hospital stays. [3] Consequently, choosing the most suitable pain relief approach is crucial. [4]

In the past, femoral nerve blocks, also known as femoral nerve blocks (FNB), have been widely employed to alleviate postoperative pain following ACL reconstruction, as they have consistently demonstrated their effectiveness. [5,6] However, FNB is linked to temporary weakness in the quadriceps muscles, which can lead to delayed walking and an increased risk of falls. The adductor canal block (ACB) offers effective pain relief while preserving quadriceps strength, addressing the limitations of traditional nerve blocks. [7,8]

The ACB primarily targets the saphenous nerve and anterior articular branches of the femoral nerve, providing sensory blockades with minimal motor impairment. [9,10] This allows patients to mobilise earlier, enhancing recovery and reducing

hospital stays. Additionally, ultrasound-guided ACB ensures precise drug delivery, increasing patient comfort and minimizing potential complications. [11,12]

While various concentrations of local anaesthetics have been used in ACB, bupivacaine remains a common choice due to its long-acting analgesic properties. [13] However, the optimal concentration for balancing efficacy and safety remains unclear. Higher concentrations may offer prolonged analgesia but could increase the risk of toxicity. [14]

Given the growing use of ACB in ACL reconstruction and the need for evidence-based concentration guidelines, this study aims to compare the analgesic efficacy of 0.25% versus 0.5% bupivacaine administered via ACB. The primary objective is to evaluate postoperative pain relief using the VAS score, while the secondary outcomes include adverse effects. This research seeks to optimise postoperative pain management protocols by identifying the most effective bupivacaine concentration, supporting faster recovery and improved patient outcomes in outpatient arthroscopic ACL repair.

Materials and Methods

This prospective clinical research was conducted from July 2023 to July 2024 at Mamata Medical College in Khammam, Telangana, India. Sixty patients, aged 18 to 50, undergoing outpatient arthroscopic anterior cruciate ligament (ACL) repair were recruited and divided into 2 groups (n = 30 each). Group A received an adductor canal block with 20 ml of 0.25% bupivacaine, while Group B received 20 ml of 0.5% bupivacaine.

The inclusion criteria included patients who were classified as American Society of Anaesthesiologists (ASA) I or II, without a history of previous knee surgery, and without any contraindications to regional anaesthesia. Individuals with coagulopathy, infections, or allergies to local anaesthetics were not included in the study. The blocks were carried out using a nerve stimulator and ultrasound guidance to guarantee accurate needle placement within the adductor canal. After confirming that the aspiration was negative, the prepared solution was given to the patient at a slow pace. All patients were given the same type of general anaesthesia and pain relief after the surgery. The intensity of postoperative pain was analysed using the visual analog scale (VAS), (0 = no pain and 10 = most excruciating pain) with measurements at 2, 6, 12, 18, and 24 hours after the surgery. The study evaluated the time it took for the first pain relief medication to be requested, the total amount of pain medication consumed, and the restoration of motor function. Furthermore, complications like nausea, vomiting, and any issues with sensory or motor functions were recorded.

Statistical analysis was conducted using SPSS Statistics version 25. Continuous variables were presented as mean ± SD and analyzed with the independent t-test. Categorical variables were expressed as percentages and examined using the chi-square test. A p-value below 0.05 was considered statistically significant.

Results

The study included 60 patients, and there were no significant demographic differences between the groups (see Table 1). The mean age was 34.2 years (± 5.8) for Group A and 35.6 years (± 6.1) for Group B (p = 0.451). Other baseline characteristics, such as BMI and ASA physical status, were similar in both groups.

Table 1: Demographic characteristics

Variable	Group A	Group B	p-value
Mean Age	34.2 ± 5.8	35.6 ± 6.1	0.451
Gender			
Male	18 (60%)	20 (66.7%)	0.592
Female	12 (40%)	10 (33.3%)	
BMI	24.8 ± 2.5	24.6 ± 2.7	0.722
ASA			
I	25 (83.3%)	26 (86.7%)	0.717
II	5 (16.7%)	4 (13.3%)	

Group B (0.5% bupivacaine) demonstrated a significantly longer time to first analgesic request (11.1 ± 4.2 hours vs. 8.4 ± 2.6 hours, p = 0.024) and required less total analgesic use (7.5 ± 3.1 mg vs. 12.3 ± 4.6 mg, p = 0.001) compared to Group A.

Pain scores, measured using the VAS, consistently favoured Group B across all time points. Although VAS at 2 hours showed a non-significant trend (p = 0.055), significant differences emerged at 6, 12, 18, and 24 hours, with Group B exhibiting lower pain scores (e.g., VAS at 18 hours: 2.1 ± 1.0 vs. 3.5 ± 1.2, p = 0.001). These findings suggest that 0.5% bupivacaine provides superior postoperative

analgesia with prolonged pain relief and reduced opioid consumption.

Table 2: Post-operative outcomes

Parameter	Group A	Group B	p-value
Time to first analgesic (hours)	8.4 ± 2.6	11.1 ± 4.2	0.024
Analgesic use (mg)	12.3 ± 4.6	7.5 ± 3.1	0.001
VAS at 2 hours	4.5 ± 1.1	3.8 ± 1.0	0.055
VAS at 6 hours	4.2 ± 1.0	3.2 ± 0.9	0.031
VAS at 12 hours	3.8 ± 1.2	2.6 ± 1.1	0.028
VAS at 18 hours	3.5 ± 1.2	2.1 ± 1.0	0.001
VAS at 24 hours	2.8 ± 1.1	1.9 ± 0.8	0.034

Recovery of motor function, evaluated by the ability to extend the knee, was comparable between groups, with 90% of patients in both groups regaining full quadriceps strength by 24 hours. Complications were mild and evenly distributed, with nausea occurring in 10% and 13% in Group A and B respectively. No significant sensory or motor deficits were observed in either group.

Table 3: Adverse Drug Reactions

Adverse Reaction	Group A	Group B	p-value
Nausea (%)	3 (10%)	4 (13.3%)	0.687
Vomiting (%)	1 (3.3%)	2 (6.7%)	0.553
Sensory deficit (%)	0%	0%	-
Motor deficit (%)	0%	0%	-

Discussion

The present study reported a mean age of 34.2 ± 5.8 years in Group A (0.25% Bupivacaine) and 35.6 ± 6.1 years in Group B (0.5% Bupivacaine), with no significant difference (p=0.451). Similar findings were noted by Hossain MB et al. [15] (p=0.68), while Guven Kose S et al. [16] reported slightly higher age averages across their study groups. Gender distribution showed male predominance: 60% males in Group A and 66.7% in Group B (p=0.592). Hossain MB et al. [15] and Guven Kose S et al. [16] also reported a male majority, suggesting potential gender-related selection. BMI averages were 24.8 ± 2.5 kg/m² in Group A and 24.6 ± 2.7 kg/m² in Group B (p=0.722), aligning with Guven Kose S et al. [16], though Hossain MB et al. [15] reported higher BMI values.

Most participants were ASA I: 83.3% in Group A and 86.7% in Group B (p=0.717), consistent with Hossain MB et al. [15] However, Guven Kose S et al. [16] observed more ASA II classifications in certain groups. Despite minor differences in demographic distributions, all studies demonstrated consistent patterns in age, gender, BMI, and ASA classification, contributing to a robust comparative analysis. These similarities support the generalizability of findings across diverse clinical contexts.

The present study demonstrated superior post-operative analgesic outcomes in Group B (0.5% Bupivacaine) compared to Group A (0.25% Bupivacaine). Group B showed a significantly longer time to first analgesic (p=0.024) and reduced total analgesic consumption (p=0.001). Whereas VAS scores were consistently lower in Group B at all time points, achieving statistical significance at 6 hours, 12 hours, 18 hours, and 24 hours. In comparison, Hossain MB et al. [15] found no significant differences between their groups for time to first analgesic requirement (16.75 ± 2.45 vs. 17.35 ± 2.70 hours, p=0.73) or total analgesic consumption (39.6 ± 6.7 mg vs. 36.8 ± 5.4 mg, p=0.81). VAS scores remained comparable at most time points (p>0.05), suggesting more homogeneous analgesic effects in their study. Overall, the present study highlights a more pronounced analgesic advantage with higher bupivacaine concentrations, consistent with better pain management outcomes.

The present study reported minimal adverse events in both groups. Nausea occurred in 10% of Group A and 13.3% of Group B (p=0.687), while vomiting was reported in 3.3% of Group A and 6.7% of Group B (p=0.553). No sensory or motor deficits were observed in either group. Similarly, Hossain MB et al. [15] reported low incidences of nausea (p=0.149), vomiting (8% vs. 12%, p=0.167), and dizziness (8% vs. 4%). No significant differences were noted between the groups in either study. Both studies demonstrated a favorable safety profile and low adverse event rates for both bupivacaine concentrations. The present study found that 0.5% bupivacaine offered better post-operative analgesia (longer pain relief, lower analgesic need, lower VAS scores) than 0.25% bupivacaine, with minimal and comparable adverse events in both groups. In contrast, Hossain MB et al. [15] reported no significant differences in

analgesic outcomes, though adverse events were similarly low.

Conclusion

The use of 0.5% bupivacaine has demonstrated superior postoperative analgesic efficacy compared to 0.25% bupivacaine in the context of outpatient arthroscopic anterior cruciate ligament (ACL) repair. Specifically, 0.5% bupivacaine provided prolonged pain relief, decreased the consumption of analgesics, and resulted in lower Visual Analog Scale (VAS) scores. Both concentrations exhibited favorable safety profiles, characterized by minimal adverse events. These findings advocate for the adoption of 0.5% bupivacaine as a more effective option for postoperative pain management within clinical practice.

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