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A COMPARATIVE STUDY ON THE EFFECTS OF 0.5% EPIDURAL LEVOBUPIVACAINE AND 0.75% ROPIVACAINE IN LOWER LIMB SURGERY: A CROSS-SECTIONAL STUDY

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ABSTRACT

Background

Levobupivacaine and ropivacaine are widely used local anesthetics in lower limb surgeries. Both agents offer favorable safety profiles, but their comparative effects on anesthesia quality and duration remain a subject of interest. This study compared the clinical efficacy, onset, duration, and safety of 0.5% levobupivacaine and 0.75% ropivacaine in lower limb surgeries.

Methods

Eighty patients were randomly randomized into two groups: Group R (ropivacaine 0.75%, 20 ml) and Group L (levobupivacaine 0.5%, 20 ml). Onset times, duration of sensory and motor block, anesthetic quality, and hemodynamic parameters were recorded and analyzed using SPSS version 20.0.

Results

The mean age of participants was comparable between groups (Group R: 42.5 ± 12.1 years; Group L: 41.8 ± 11.6 years; $p = 0.76$). Levobupivacaine had a faster onset of sensory block (8.3 ± 1.5 minutes vs. 10.2 ± 1.7 minutes; $p < 0.001$) and motor block (12.5 ± 1.8 minutes vs. 14.7 ± 2.0 minutes; $p < 0.001$). Sensory block duration was longer in Group L (240.5 ± 20.3 minutes) compared to Group R (215.7 ± 18.6 minutes; $p < 0.001$). Motor block duration was also longer in Group L (205.4 ± 17.2 minutes vs. 185.9 ± 16.5 minutes; $p < 0.001$). Both groups had similar safety profiles, with no significant differences in hemodynamic stability or adverse effects.

Conclusion

Levobupivacaine demonstrated faster onset, longer duration, and better anesthesia quality than ropivacaine, making it more suitable for longer surgeries. Both agents were well tolerated, with comparable safety profiles.

Recommendations

Further research is recommended to explore the long-term outcomes and cost-effectiveness of these anesthetic agents in different surgical settings.

Keywords: *Levobupivacaine, Ropivacaine, Lower limb surgery, Epidural anesthesia, Onset time, Block duration.*
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INTRODUCTION

Levobupivacaine and ropivacaine are widely used local anesthetics for lower limb surgeries, with both drugs offering favorable profiles compared to bupivacaine due to lower cardiotoxicity and neurotoxicity. Levobupivacaine, the S-enantiomer of bupivacaine, has been shown to provide a longer duration of both sensory and motor block compared to ropivacaine, making it ideal for longer surgeries [1]. However, ropivacaine has been found to offer quicker motor recovery, which may benefit procedures requiring rapid postoperative mobilization.

Recent studies confirm that both agents provide stable hemodynamic parameters and excellent safety profiles in epidural anesthesia for lower limb surgeries. Levobupivacaine's longer duration of action makes it advantageous for more extended procedures, while ropivacaine's faster recovery of motor function may be preferred in cases where quicker patient mobilization is required. Comparative studies have consistently demonstrated that levobupivacaine offers faster onset and longer-lasting effects in epidural anesthesia [2].

In a study, the use of epidural levobupivacaine 0.5% was compared to ropivacaine 0.75% for lower limb surgeries. The study confirmed levobupivacaine's more prolonged sensory block and better quality of motor block, making it a suitable option for longer-duration surgeries where extended anesthesia is required [3]. These findings align with other recent studies that have highlighted levobupivacaine's effectiveness and safety for orthopedic procedures. Nonetheless, ropivacaine's shorter recovery

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time is advantageous in surgeries where early mobilization is critical [4].
This study aims to compare the clinical efficacy, onset, duration, and safety of 0.5% levobupivacaine and 0.75% ropivacaine in lower limb surgeries.

METHODOLOGY

Study Design
A cross-sectional study.

Study Setting
The study took place at Patna Medical College and Hospital, Patna, over 180 days.

Participants
The study involved 80 participants. All participants were classified under the American Society of Anesthesiologists (ASA) physical status Grade I and II and were scheduled for lower limb surgery. They were randomly assigned to one of two groups: Group R, which received 20 ml of 0.75% ropivacaine, and Group L, which received 20 ml of 0.5% levobupivacaine.

Inclusion Criteria
- Adults aged 18 to 65 years.
- ASA Grade I or II.
- Patients scheduled for lower limb surgeries.

Exclusion Criteria
- Uncontrolled or labile hypertension.
- Heart block or dysrhythmia.
- Current use of cardiac medications, including adrenergic receptor antagonists, calcium channel blockers, or angiotensin-converting enzyme inhibitors.
- History of narcotic addiction.
- Indication for lower segment cesarean section.
- Any contraindication to epidural anesthesia.

Bias
Random allocation of participants to each group helped mitigate selection bias. Equal volumes of the anesthetic were administered in both groups to standardize the intervention. The blinding of participants or staff was not specifically mentioned.

Variables
The variables examined were the onset and duration of sensory and motor block and the quality of anesthesia. Secondary variables included monitoring intraoperative hemodynamic parameters such as pulse oximetry (SpO2), noninvasive blood pressure, and electrocardiogram readings.

Data Collection
Data were gathered by clinical observation and patient monitoring throughout the procedure. The sensory block was assessed using a short hypodermic needle in the mid-clavicular line, while the motor block was evaluated using the modified Bromage scale. These assessments were performed at specified intervals, with changes recorded over time.

Procedure
Before the administration of the epidural anesthesia, all participants received a preload of 15 ml/kg of Ringer's lactate solution. In the operating room, continuous monitoring of pulse oximetry, noninvasive blood pressure, and electrocardiogram was conducted. Epidural catheter insertion was performed in a seated position at the L2-L3 or L3-L4 space using Tuohy's needle and the loss of resistance technique under sterile conditions. Depending on the group, either 20 ml of 0.75% ropivacaine (Group R) or 20 ml of 0.5% levobupivacaine (Group L) was administered. Sensory and motor block onset, duration, and quality of anesthesia were assessed after drug administration.

Statistical Analysis
Data analysis was done using SPSS software (version 20.0). Results were given as mean ± standard deviation. The unpaired t-test was utilized for comparing numerical data, whereas Fisher's exact test was used for frequency data. A p-value of less than 0.05 was declared statistically significant, while values below 0.001 were considered extremely significant.

Ethical considerations
The study protocol was approved by the Ethics Committee and written informed consent was received from all the participants.

RESULTS
Eighty patients in all, forty in each of the two groups (Group R and Group L), were enrolled in the study. Age, gender, and body mass index (BMI) were similar for both groups. Regarding the groups' demographic features, there were no statistically significant differences ($p > 0.05$).

Table 1a: Participant Demographics

Demographic Variable	Group R	Group L	p-value
Mena Age (years)	42.5 ± 12.1	41.8 ± 11.6	0.76
Gender (Male/Female)	24/16	22/18	0.68
Mean BMI (kg/m²)	25.1 ± 3.6	24.9 ± 3.4	0.82

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Table 1b: ASA grade

ASA Grade	Group R	Group L	p-value
I	22	23	0.87
II	18	17	

Compared to Group R (ropivacaine), Group L (levobupivacaine) experienced the onset of sensory block more quickly. In Group R, the mean time for the start of sensory block was 10.2 ± 1.7 minutes, whereas in Group L it was 8.3 ± 1.5 minutes. There was a statistically significant difference ($p < 0.001$).

In a similar vein, Group L experienced the onset of motor block earlier than Group R, with a mean time of 12.5 ± 1.8 minutes versus 14.7 ± 2.0 minutes ($p < 0.001$).

Table 2: Onset of Sensory and Motor Block

Parameter	Group R	Group L	Mean Difference	95% CI	p-value
Onset of Sensory Block (min)	10.2 ± 1.7	8.3 ± 1.5	1.9	1.1 to 2.7	< 0.001
Onset of Motor Block (min)	14.7 ± 2.0	12.5 ± 1.8	2.2	1.3 to 3.1	< 0.001

When comparing Group L to Group R, the length of the sensory and motor block was noticeably longer in Group L. In Group R, the mean sensory block duration was 215.7 ± 18.6 minutes ($p < 0.001$), but in Group L it was 240.5 ± 20.3 minutes. Group L experienced a longer motor block duration (205.4 ± 17.2 minutes) than Group R (185.9 ± 16.5 minutes), with a statistically significant difference ($p < 0.001$).

Table 3: Duration of Sensory and Motor Block

Parameter	Group R	Group L	Mean Difference	95% CI	p-value
Duration of Sensory Block (min)	215.7 ± 18.6	240.5 ± 20.3	-24.8	-33.4 to -16.2	< 0.001
Duration of Motor Block (min)	185.9 ± 16.5	205.4 ± 17.2	-19.5	-27.4 to -11.6	< 0.001

The quality of anesthesia, assessed using the modified Bromage scale, was found to be higher in Group L. A higher proportion of patients in Group L achieved complete motor block (Bromage score 3) compared to Group R. The difference in the quality of anesthesia was statistically significant ($p = 0.015$).

Table 4: Quality of Anesthesia

Bromage Score	Group R (n = 40)	Group L (n = 40)	p-value
1 (Partial Block)	10 (25%)	5 (12.5%)	0.015
2 (Moderate Block)	18 (45%)	10 (25%)	
3 (Complete Block)	12 (30%)	25 (62.5%)	

Both groups showed stable hemodynamic profiles during surgery. There were no significant differences between the groups in terms of intraoperative pulse rate, blood pressure, or oxygen saturation levels ($p > 0.05$ for all comparisons).

Table 5: Hemodynamic Parameters

Hemodynamic Parameter	Group R	Group L	p-value
Mean Pulse Rate (beats/min)	78.6 ± 6.7	77.3 ± 6.2	0.32
Mean Arterial Pressure (mmHg)	92.5 ± 5.8	91.8 ± 5.6	0.54
Oxygen Saturation (SpO2, %)	98.7 ± 0.8	98.9 ± 0.6	0.24

Adverse effects occurred less frequently and were similar in both groups. Three patients in Group R and two in Group L experienced hypotension, and two in Group R and one in Group L felt nausea. The incidence of adverse effects did not differ in a statistically significant way ($p > 0.05$).

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Table 6: Adverse Effects

Adverse Effect	Group R (n = 40)	Group L (n = 40)	p-value
Hypotension	3 (7.5%)	2 (5%)	0.65
Nausea	2 (5%)	1 (2.5%)	0.56

Overall, the statistical analysis revealed that levobupivacaine (Group L) provided faster onset, longer duration, and better quality of sensory and motor blocks compared to ropivacaine (Group R), with statistically significant differences in all key parameters. Both agents showed similar safety profiles about hemodynamic stability and adverse effects.

DISCUSSION

The study included 80 patients, evenly distributed between two groups receiving either 0.75% ropivacaine (Group R) or 0.5% levobupivacaine (Group L) for lower limb surgery. The demographic variables, including age, gender, and BMI, were comparable between the two groups, ensuring no confounding factors influenced the outcomes. Both groups also had a similar distribution of ASA physical status classifications, making the comparison between the two anesthetic agents valid.

Compared to ropivacaine (Group R), levobupivacaine (Group L) showed a quicker onset of both motor and sensory block. With a highly significant p-value (< 0.001), Group L's mean time to sensory block start was significantly shorter (8.3 minutes) than Group R's (10.2 minutes). Likewise, Group L experienced a speedier start of motor block, with a mean time of 12.5 minutes, as opposed to Group R's 14.7 minutes, and a p-value of less than 0.001. These findings imply that levobupivacaine produces anesthesia more quickly, which might be useful for surgeries that have a tight timeline.

Apart from experiencing a quicker onset, Group L demonstrated a prolonged period of sensory and motor block. Group L experienced a sensory block that lasted almost twenty-five minutes longer than Group R, with a p-value of less than 0.001, which is highly significant. Similarly, Group L's motor block lasted almost twenty minutes longer. According to these findings, levobupivacaine produces anesthesia for longer periods, which may be advantageous for lengthier surgical procedures and lessen the need for subsequent anesthetic interventions.

The levobupivacaine group had better anesthesia quality as measured by the modified Bromage scale. In comparison to Group R (30%), a greater proportion of patients in Group L (62.5%) attained total motor block, with a statistically significant difference (p = 0.015). This shows that levobupivacaine provides improved immobility during surgery by offering a more effective block.

Both anesthetic drugs are similarly safe in preserving cardiovascular stability, as evidenced by the stability and lack of significant variations in hemodynamic measures such as pulse rate, blood pressure, and oxygen saturation between the two groups. Additionally, there was no statistically significant difference in the frequency of hypotension or nausea between the groups, and the incidence of side effects was equivalent and mild.

Comparing levobupivacaine 0.5% to ropivacaine 0.75%, the former showed a quicker onset, longer duration, and higher quality of anaesthesia. Both agents had few side effects and were well tolerated. According to these results, levobupivacaine would be the better option for lower limb procedures requiring quick and deep anaesthesia.

In a randomized trial, individuals undergoing subarachnoid block for elective lower limb procedures were given 0.5% levobupivacaine versus 0.75% ropivacaine. While both anaesthetics were effective, levobupivacaine showed greater cardio stability, which may be advantageous for people with cardiovascular issues, according to the research. However, ropivacaine was better in situations where a quicker recovery from anaesthesia was required because of its shorter duration of sensory block [5].

In a similar vein, intrathecal administration of 0.5% isobaric levobupivacaine and 0.75% isobaric ropivacaine for lower limb procedures was examined in another study. It was discovered that as compared to ropivacaine, levobupivacaine caused sensory and motor blocks to occur more quickly and to last longer. Levobupivacaine also showed more stable haemodynamic parameters, indicating that it would be a preferable option with fewer adverse effects for individuals needing more prolonged anaesthesia [6].

Additional data demonstrated that, with similar haemodynamic stability between the two groups, 0.2% levobupivacaine with fentanyl produced noticeably longer post-operative analgesia than 0.2% ropivacaine with fentanyl [7].

According to a different study, ropivacaine was linked to a quicker onset and regression of both the motor and sensory block, whereas levobupivacaine had a delayed onset. Because of this, ropivacaine is a better option for shorter surgical operations when it's preferred to recover quickly [8].

Further research contrasting levobupivacaine with fentanyl as an adjuvant in lower limb surgeries revealed that the former produced a longer duration of sensory and motor block than the latter, with fewer side effects [9]. This further supports levobupivacaine's suitability for surgeries needing longer anaesthesia.

Generalizability

The findings of this study on the comparative efficacy of 0.5% levobupivacaine and 0.75% ropivacaine in lower limb surgeries are potentially generalizable to a broader patient population undergoing similar procedures, particularly those classified as ASA Grade I and II.

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However, generalizability may be limited by the study's inclusion criteria, which excluded patients with uncontrolled hypertension, significant cardiac conditions, or contraindications to epidural anesthesia. Future research in diverse clinical settings with a wider range of patient demographics could enhance the applicability of these results to various surgical contexts and populations.

CONCLUSION

Levobupivacaine demonstrated superior efficacy in terms of faster onset, longer duration, and better quality of anesthesia compared to ropivacaine in lower limb surgeries. Both agents exhibited similar safety profiles, with minimal adverse effects. Levobupivacaine may be the preferred option for procedures requiring prolonged anesthesia, while ropivacaine's faster motor recovery could benefit surgeries where early mobilization is crucial. Further research could explore its use in various clinical scenarios.

Limitations

The limitations of this study include a small sample population who were included in this study. Furthermore, the lack of a comparison group also poses a limitation for this study's findings.

Recommendation

Further research is recommended to explore the long-term outcomes and cost-effectiveness of these anesthetic agents in different surgical settings.

Acknowledgment

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List of abbreviations

ASA - American Society of Anesthesiologists
BMI - Body Mass Index
CI - Confidence Interval
SpO2 - Oxygen Saturation (Pulse Oximetry)
SD - Standard Deviation
L2-L3, L3-L4 - Lumbar vertebrae positions for epidural injection

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Conflict of interest

The authors have no conflicting interests to declare.

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