

Effect of intrathecal hyperbaric 0.5% levobupivacaine and 0.75% ropivacaine in patients undergoing lower abdominal surgeries- a comparative study.

Submitted: 05 Sep 2026

Revised: 14 Sep 2026

Accepted: 20 Sep 2026

Published: 30 Sep 2026

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How to cite this article: Mili Jacob, Maya Menon. M, Jaleel K. B, Shamshad Beegum. T. S. Effect of intrathecal hyperbaric 0.5% levobupivacaine and 0.75% ropivacaine in patients undergoing lower abdominal surgeries- a comparative study. TAISAK 2026; 2(2): 53-65

ABSTRACT

Introduction: Sub Arachnoid Block is the commonly used anaesthesia technique for lower abdominal surgeries due to its simplicity, rapid onset and effective sensory and motor block. Bupivacaine, the most widely used intrathecal drug, has been showing several cardiovascular and CNS side effects. Levobupivacaine and Ropivacaine are long acting amide local anaesthetics with favourable profiles having fewer side effects on the central nervous system and the cardiovascular system. This review compares the efficacy, safety, and outcomes of these drugs in the context of lower abdominal surgeries.

Aims & Objectives: The study is aimed to compare the onset and duration of sensory and motor blockade along with a comparison of hemodynamic changes produced by the intrathecal administration of hyperbaric 0.5 % levobupivacaine and 0.75 % ropivacaine.

Methods: Patients are randomly divided into two groups. (n= 65 each), to receive either a spinal block of 3-ml 0.5% hyperbaric levobupivacaine (group L) or 3-ml 0.75% hyperbaric ropivacaine (group R). Spinal anaesthesia characteristics like sensory analgesia and motor blockade were observed. Hemodynamic parameters at particular intervals were noted. Data obtained was

compiled and statistically analysed with appropriate tests. A value of $P < 0.05$ was considered to be significant.

Results: The time to achieve sensory and motor blocks was significantly shorter in the Levobupivacaine group as compared with Ropivacaine group. Specifically, the mean time to attain sensory block was 1.5 minutes for Levobupivacaine and 2.2 minutes for Ropivacaine, with corresponding motor block times of 1.6 minutes for Levobupivacaine and 2.3 minutes for Ropivacaine. Levobupivacaine provided a mean duration of sensory block of 316.2 minutes, whereas Ropivacaine had a shorter mean duration of 205.8 minutes. Similarly, the mean duration of motor block was 278.0 minutes for Levobupivacaine and 167.9 minutes for Ropivacaine. No significant differences were statistically found in heart rate and systolic blood pressure between the Levobupivacaine and Ropivacaine groups post administration of sub arachnoid block.

Conclusion: Levobupivacaine exhibited a shorter time to achieve sensory and motor blocks, longer durations of sensory and motor blocks, and delayed onset of postoperative pain compared to Ropivacaine. This suggests that Levobupivacaine may offer superior intraoperative and postoperative analgesia, potentially reducing the need for early rescue analgesia compared to Ropivacaine. In clinical practice, to choose between Levobupivacaine and Ropivacaine, one should consider patient-specific factors, surgical requirements, and anaesthesia goals to optimize perioperative outcomes and patient satisfaction. These results contribute to the ongoing discourse on anaesthesia techniques for lower abdominal surgeries, aiming to enhance patient care and surgical outcomes.

Keywords: Levobupivacaine, Ropivacaine, intrathecal, lower abdominal surgeries, sub arachnoid block, sensory and motor block, hemodynamic parameters

Introduction

Spinal anaesthesia is widely used for lower abdominal surgery because of its rapid onset, effective sensory and motor blockade, and avoidance of complications associated with general anaesthesia[1]. The choice of intrathecal local anaesthetic is particularly important in short-duration procedures, where rapid onset, predictable block duration, early recovery, and haemodynamic stability are desirable[2]. Although bupivacaine remains widely used, its prolonged sensory and motor blockade and potential cardiotoxicity have led to the use of its S (-) - enantiomers, levobupivacaine and

ropivacaine [3,4]. Levobupivacaine has a favourable safety profile, while ropivacaine is associated with relatively less motor blockade [3,2].

Despite their established use in regional anaesthesia, evidence comparing hyperbaric intrathecal levobupivacaine and ropivacaine remains limited. Therefore, this study aimed to compare 3 mL of 0.5% hyperbaric levobupivacaine with 3 mL of 0.75% hyperbaric ropivacaine for spinal anaesthesia in ASA physical status I and II patients undergoing elective lower abdominal surgery, with respect to the onset and duration of sensory and motor blockade, postoperative analgesia & haemodynamic change.

Study Design And Setting

This hospital-based observational study was conducted at MES Medical College, Perinthalmanna, over a period of one year following approval by the Institutional Ethics Committee. The study included 130 patients undergoing elective lower abdominal surgery under spinal anaesthesia.

Inclusion criterion:

Patients aged 18–65 years, belonging to American Society of Anesthesiologists (ASA) physical status I or II, with a body mass index (BMI) of 18.5–24.9 kg/m², and scheduled for elective lower abdominal surgery under spinal anaesthesia were included.

Exclusion criteria:

Patients were excluded if they had any contraindication to spinal anaesthesia, including bleeding or coagulation disorders, raised intracranial pressure, spinal deformities such as spina bifida or meningocele, pregnancy or lactation, known allergy to local anaesthetics, current anticoagulant therapy, or infection at the intended site of spinal needle insertion.

Sampling:

The sample size was calculated based on a previous study by Priyank Samar et al. (2020) [5] with an alpha error of 10%, a beta error of 10%, and 90% power. The required sample size was 65 patients per group, yielding a total sample of 130 patients. Participants were allocated by convenient sampling into two equal groups: Group L (n = 65), which received intrathecal hyperbaric 0.5% levobupivacaine, and Group R (n = 65), which received intrathecal hyperbaric 0.75% ropivacaine.

Methods:

Written informed consent was obtained from all patients. After securing an 18-gauge intravenous

cannula, patients were preloaded with weight-based Ringer's lactate and transferred to the operating theatre, where standard monitors were attached and baseline vital parameters were recorded.

Under strict aseptic precautions, spinal anaesthesia was performed in the lateral decubitus position using a 25-gauge Quincke–Babcock needle through a midline approach at the L2–L3 or L3–L4 intervertebral space. Following confirmation of free-flowing clear cerebrospinal fluid, 3 mL of the study drug was administered intrathecally by a consultant anaesthesiologist. Patients receiving 3 mL of 0.5% hyperbaric levobupivacaine were assigned to Group L, while those receiving 3 mL of 0.75% hyperbaric ropivacaine were assigned to Group R. Study drugs were prepared by an independent assistant to maintain blinding. Patients were subsequently placed supine.

Sensory blockade was assessed by loss of pinprick sensation along the midline, progressing cephalad from below, every 2 minutes until the block level stabilized. A sensory level of T6 was considered adequate for surgery. Motor blockade was assessed using the modified Bromage scale every 2 minutes for 10 minutes. The onset of motor block was defined as attainment of a Bromage score of 1, and the maximum motor block and time to achieve it were recorded. Surgery was commenced after achieving adequate sensory and motor blockade.

Heart rate, systolic and diastolic blood pressure, and SpO₂ were recorded at baseline and every 3 minutes for the first 15 minutes, followed by 5-minute intervals until completion of surgery or for a maximum of 2 hours. Sensory and motor block regression was assessed at 15-minute intervals postoperatively. The duration of effective analgesia was defined as the time from intrathecal drug administration to a VAS pain score >3. The time to a

VAS score >3, at which rescue analgesia was administered according to departmental protocol, was considered the endpoint.

Hypotension was defined as a reduction in systolic blood pressure >30% from baseline or a systolic blood pressure <90 mmHg and was treated with intravenous mephentermine 6 mg in incremental doses and fluids as required. Bradycardia (heart rate <50 beats/min) was treated with intravenous atropine 0.6 mg. Additional analgesia was administered according to departmental protocol when clinically indicated.

Motor blockade was assessed according to modified Bromage scale

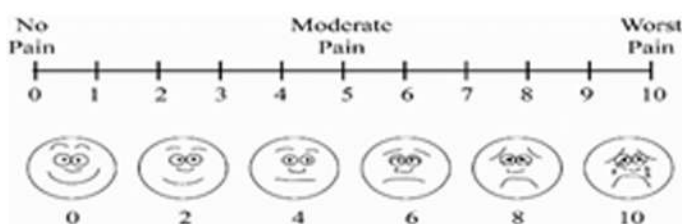
0 = no paralysis, able to flex hips/knees/ankles

1 = able to move knees, unable to raise extended legs

2 = able to flex ankles, unable to flex knees

3 = unable to move any part of the lower limb

Visual analogue scale- pain score is recorded between 0 and 10 (0= no pain 10 =worst pain)



STATISTICAL DATA ANALYSIS AND RESULTS

Statistical analysis was performed using IBM SPSS Statistics for Windows, Version 27.0 (IBM Corp., Armonk, NY, USA). Continuous variables were assessed for normality using the Shapiro–Wilk and Kolmogorov–Smirnov tests and were expressed as mean $\pm$ standard deviation (SD) when normally distributed or as median with interquartile range (IQR) when non-normally distributed. Comparisons of continuous variables between the levobupivacaine and ropivacaine groups were performed using the independent-samples Student's t-test or Mann–Whitney U test, as appropriate. Categorical variables were summarized as frequencies and percentages and compared using the Chi-square test or Fisher's exact test, as applicable. All statistical tests were two-tailed, and a p-value <0.05 was considered statistically significant.

Among the 130 patients, 65 received Levobupivacaine and 65 received Ropivacaine. The age, gender, weight, height, body mass index and ASA grades were comparable between the groups. Levobupivacaine demonstrated a significantly faster onset of both sensory and motor block compared with Ropivacaine. The mean time to sensory block was 1.5 ± 0.7 minutes with Levobupivacaine versus 2.2 ± 0.9 minutes with Ropivacaine ($p < 0.001$). Similarly, motor block was achieved earlier with Levobupivacaine (1.6 ± 1.0 minutes) than with Ropivacaine (2.3 ± 1.2 minutes; $p < 0.001$).

TABLE 1: COMPARISON OF STUDY GROUPS, BY TIME TO ATTAIN BLOCK (IN MINUTES)

Time to attain block (in minutes)	Levobupivacaine N = 65	Ropivacaine N = 65	Total N = 130	P value
	Mean (SD)	Mean (SD)	Mean (SD)	
Sensory	1.5 (0.7)	2.2 (0.9)	1.8 (0.9)	<0.001*
Motor	1.6 (1.0)	2.3 (1.2)	2.0 (1.2)	<0.001*

*Statistically significant at $p < 0.05$

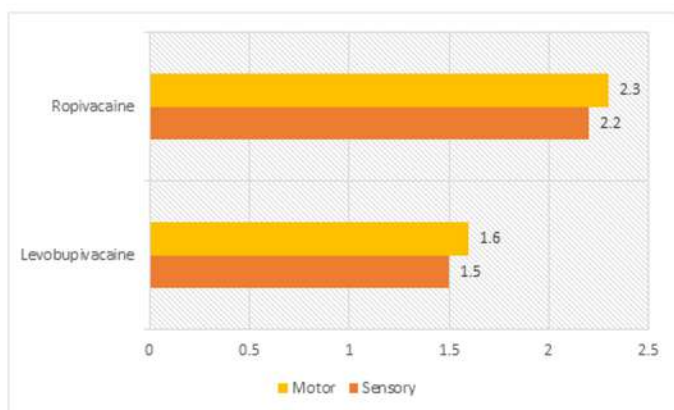


FIG 1: COMPARISON OF STUDY GROUPS, BY TIME TO ATTAIN BLOCK (IN MINUTES)

The duration of both sensory and motor block was significantly longer in the Levobupivacaine group than in the Ropivacaine group. The mean duration of sensory block was 316.2 ± 90.9 minutes with Levobupivacaine compared with 205.8 ± 56.4

minutes with Ropivacaine ($p < 0.001$). Similarly, the mean duration of motor block was 278.0 ± 102.3 minutes and 167.9 ± 53.8 minutes in the Levobupivacaine and Ropivacaine groups, respectively ($p < 0.001$).

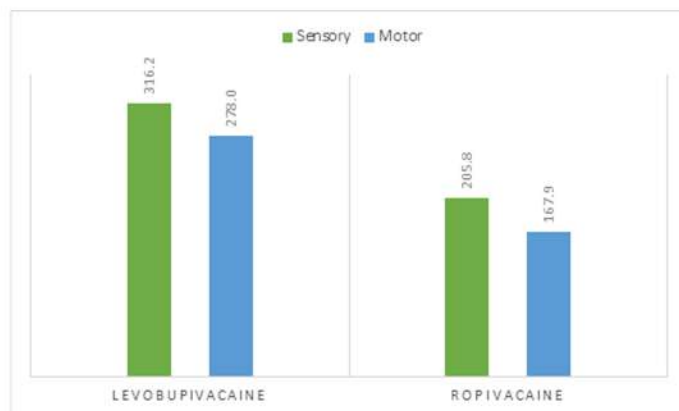


FIG 2: COMPARISON OF STUDY GROUPS, BY TOTAL DURATION OF BLOCK (IN MINUTES)

TABLE 2: COMPARISON OF STUDY GROUPS, BY TOTAL DURATION OF BLOCK (IN MINUTES)

Duration of block (in minutes)	Levobupivacaine N = 65	Ropivacaine N = 65	Total N = 130	P value
	Mean (SD)	Mean (SD)	Mean (SD)	
Sensory	316.2 (90.9)	205.8 (56.4)	260.9 (93.5)	<0.001*
Motor	278.0 (102.3)	167.9 (53.8)	222.9 (98.4)	<0.001*
*Statistically significant at $p < 0.05$				

The mean time to rescue analgesia was significantly longer in the Levobupivacaine group than in the Ropivacaine group (341.4 ± 93.8 vs. 254.4 ± 69.9 minutes, respectively; $p < 0.001$), indicating a significantly prolonged analgesic effect with Levobupivacaine.

FIG 3: COMPARISON OF STUDY GROUPS, BY TIME TO RESCUE ANALGESIA (N MINUTES)

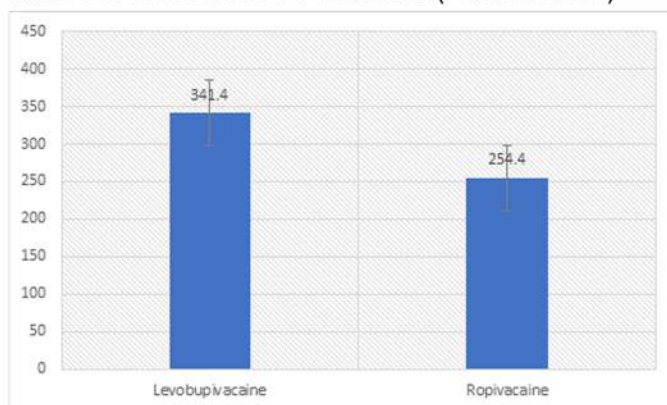


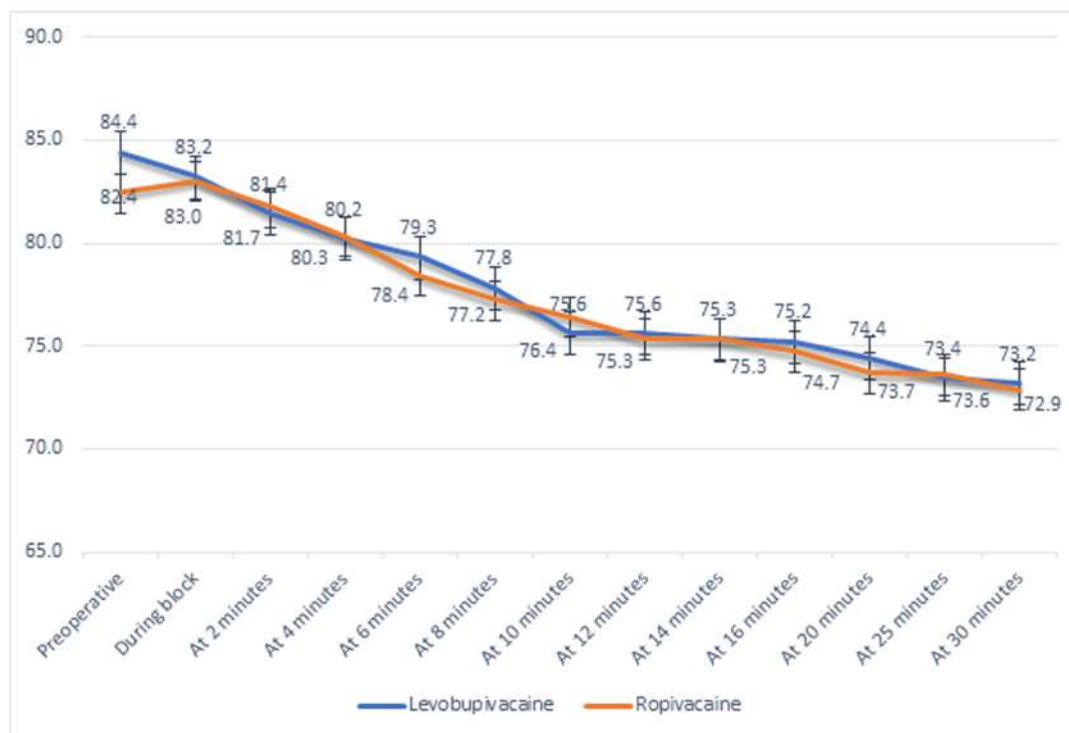
TABLE 3: COMPARISON OF STUDY GROUPS, BY TIME TO RESCUE ANALGESIA (IN MINUTES)

	Levobupivacaine N = 65	Ropivacaine N = 65	Total N = 130	P value
	Mean (SD)	Mean (SD)	Mean (SD)	
Time to rescue analgesia (in minutes)	341.4 (93.8)	254.4 (69.9)	297.9 (93.2)	<0.001*
*Statistically significant at p<0.05				

Heart rate remained comparable between the Levobupivacaine and Ropivacaine groups throughout the study period. Although a gradual decline in mean heart rate was observed from the preoperative period to 30 minutes after the block in both groups, there were no statistically significant intergroup differences at any time point (all $p>0.05$).

Mean heart rate decreased from 84.4 ± 12.8 to 73.2 ± 9.7 beats/min in the Levobupivacaine group and from 82.4 ± 13.7 to 72.9 ± 11.3 beats/min in the Ropivacaine group. These findings indicate that both anesthetic groups had comparable effects on perioperative heart rate.

FIG 4: COMPARISON OF STUDY GROUPS, BY HEART RATE (PER MINUTE) AT VARIOUS TIME POINTS



Systolic blood pressure showed a progressive decline from baseline in both groups following the block. No statistically significant intergroup differences were observed from the preoperative period through 16 minutes ($p > 0.05$), although values approached significance at 12 and 14 minutes ($p = 0.050$ & 0.053 , respectively). From 20 minutes onward

systolic blood pressure was significantly lower in the Levobupivacaine group compared with the Ropivacaine group (113.5 ± 12.2 vs. 119.6 ± 12.0 mmHg at 20 minutes, $p = 0.005$; 113.4 ± 12.4 vs. 119.0 ± 11.4 mmHg at 25 minutes, $p = 0.008$; and 112.9 ± 11.2 vs. 119.9 ± 12.1 mmHg at 30 minutes, $p = 0.001$).



FIG 5 : COMPARISON OF STUDY GROUPS, BY SYSTOLIC BLOOD PRESSURE (IN mmHg) AT VARIOUS TIME POINTS

Diastolic blood pressure demonstrated a progressive decline from baseline in both groups following the block. No statistically significant differences were observed between the Levobupivacaine and Ropivacaine groups from the preoperative period through 16 minutes ($p > 0.05$). However, diastolic

blood pressure was significantly lower in the Levobupivacaine group at 20, 25, and 30 minutes compared with the Ropivacaine group (63.4 ± 10.1 vs. 68.8 ± 10.7 mmHg, $p = 0.004$; 66.4 ± 9.9 vs. 70.0 ± 11.0 mmHg, $p = 0.042$; and 66.2 ± 9.6 vs. 70.1 ± 10.7 mmHg, $p = 0.031$, respectively).



FIG 6 : COMPARISON OF STUDY GROUPS, BY DIASTOLIC BLOOD PRESSURE (IN MMHG) AT VARIOUS TIME POINTS

Peripheral oxygen saturation (SpO₂) remained stable and comparable between the Levobupivacaine and Ropivacaine groups throughout the study period. The mean preoperative SpO₂ was $98.3 \pm 0.9\%$ and $98.5 \pm 0.8\%$ in the Levobupivacaine and Ropivacaine groups, respec-

tively. There were no statistically significant differences between the groups at any time point, either during or after the block (all $p > 0.05$). SpO₂ remained within a narrow range of 98.3–98.6% in both groups, indicating comparable and stable oxygenation throughout the observation period.



FIG 7: COMPARISON OF STUDY GROUPS, BY SPO₂ AT VARIOUS TIME POINTS

Postoperative pain scores were comparable between the Levobupivacaine and Ropivacaine groups during the early postoperative period, with no significant differences observed up to 75 minutes ($p > 0.05$). However, VAS scores were significantly lower with Levobupivacaine at 90 minutes (0.4 ± 1.0 vs. 1.0 ± 1.4 ; $p = 0.008$), 105 minutes (0.6 ± 1.2 vs. 1.6 ± 1.7 ; $p < 0.001$), and 120 minutes (1.0 ± 1.2 vs. 1.9 ± 1.5 ; $p < 0.001$). These findings indicate better postoperative analgesia with Levobupivacaine, particularly from 90 minutes onward.

0 vs. 1.0 ± 1.4 ; $p = 0.008$), 105 minutes (0.6 ± 1.2 vs. 1.6 ± 1.7 ; $p < 0.001$), and 120 minutes (1.0 ± 1.2 vs. 1.9 ± 1.5 ; $p < 0.001$). These findings indicate better postoperative analgesia with Levobupivacaine, particularly from 90 minutes onward.

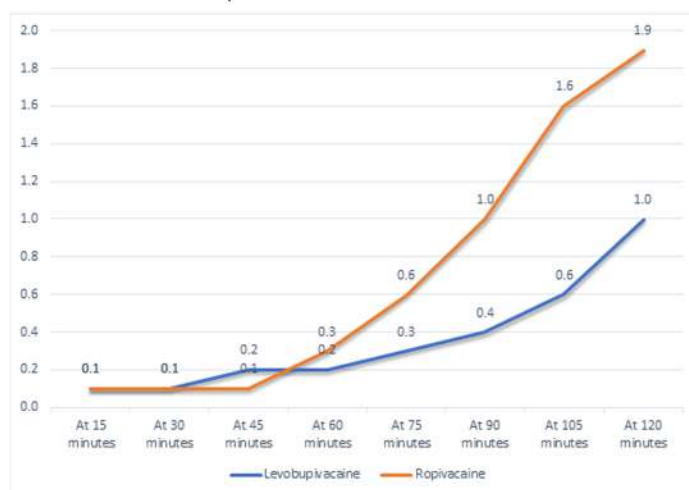


FIG 8: COMPARISON OF STUDY GROUPS, BY VISUAL ANALOGUE SCALE SCORES (VAS) AT VARIOUS TIMEPOINTS

Postoperative Bromage scale scores were significantly higher in the Levobupivacaine group than in the Ropivacaine group at all assessed time points from 15 to 120 minutes ($p \leq 0.002$). The difference progressively increased over time, with scores at

120 minutes of 2.0 ± 1.0 in the Levobupivacaine group compared with 1.1 ± 0.9 in the Ropivacaine group ($p < 0.001$). These findings indicate a more prolonged motor block with Levobupivacaine and earlier recovery of motor function with Ropivacaine.

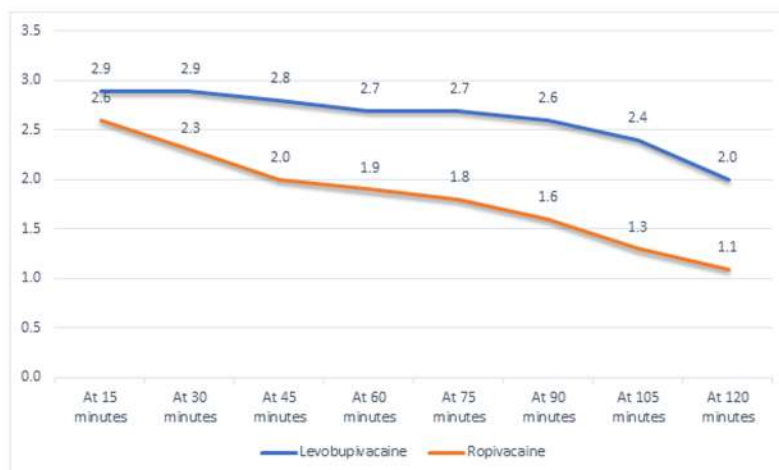


FIG 9 : COMPARISON OF STUDY GROUPS, BY BROMAGE SCALE SCORES AT VARIOUS TIME POINTS

DISCUSSION

The two groups were comparable with respect to demographic characteristics, comorbidities, and procedural variables, minimizing potential baseline confounding. Both intrathecal hyperbaric 0.5% Levobupivacaine and 0.75% Ropivacaine demonstrated overall comparable hemodynamic profiles during spinal anaesthesia for lower abdominal surgery.

Heart rate remained statistically comparable between groups throughout the observation period, consistent with previous studies reporting similar cardiovascular stability with both agents (Bajwa & Kaur, 2013; Olapour et al., 2020; Sharma et al., 2018).[6-8]

Although systolic and diastolic blood pressures were comparable at most time points, significantly lower values were observed in the Levobupivacaine group at 20, 25, & 30 min after intrathecal administration.

These findings are in agreement with previous reports demonstrating differences in blood pressure responses between Levobupivacaine and Ropivacaine (Erdil et al., 2009; Singh et al., 2018; Bardsley et al, 1998; Thalamati et al, 2021) [10–13]. Despite these differences, both groups generally maintained hemodynamic stability[9]. The observed reductions in blood pressure with Levobupivacaine may have clinical relevance, particularly in patients at risk of cardiovascular instability, and warrant appropriate perioperative monitoring. Individual patient characteristics and surgical factors should also be considered when interpreting these hemodynamic responses (Misirlioglu et al., 2013; Udelsmann et al., 2009).[14,15]

The present study demonstrated a significantly faster onset of both sensory and motor block with intrathecal hyperbaric 0.5% Levobupivacaine compared with 0.75% Ropivacaine. The mean time to achieve sensory block was 1.5 versus 2.2 minutes, while motor block was achieved in 1.6 versus 2.3

minutes, respectively. These findings are consistent with previous studies reporting a more rapid onset of spinal block with Levobupivacaine (Bhat et al., 2013; Kaur et al., 2015; Shaikh & Rohini, 2012).^{16–18} The faster onset associated with Levobupivacaine may facilitate earlier establishment of adequate surgical anaesthesia and potentially reduce the interval between intrathecal administration and commencement of surgery (Burlacu & Buggy, 2008) [19].

The duration of both sensory and motor block was significantly longer with intrathecal hyperbaric 0.5% Levobupivacaine than with 0.75% Ropivacaine [12, 20,21]. The mean duration of sensory block was 316.2 minutes with Levobupivacaine compared with 205.8 minutes with Ropivacaine, while the corresponding durations of motor block were 278.0 and 167.9 minutes, respectively. These findings are consistent with previous studies demonstrating a prolonged duration of spinal blockade with Levobupivacaine (Cline et al., 2004; Li et al., 2017; Thalamati et al., 2021) [12,20,21]. The longer duration may be related to differences in the pharmacokinetic and pharmacodynamic properties of the two local anaesthetics, including their interaction with spinal neural tissues (Maheshwari et al., 2016; Perotti et al., 2015) [22,23].

Bromage scale [24, 25] assessment further supported the findings on motor block onset and duration. Scores were consistently higher in the Levobupivacaine group than in the Ropivacaine group at all postoperative assessment points, indicating a more pronounced and prolonged motor blockade with Levobupivacaine (Athar et al., 2016).^{24–26} This observation is consistent with the longer duration of motor block demonstrated in the present study and previous reports (Gautier et al., 2003) [27]

From a clinical perspective, the faster onset and prolonged sensory and motor blockade observed with Levobupivacaine may facilitate more rapid

establishment of adequate surgical anaesthesia and provide prolonged postoperative analgesia compared with Ropivacaine (Kuthiala & Chaudhary, 2011) [28]. However, the prolonged motor blockade should be considered when early postoperative mobilization and recovery are priorities. The choice of intrathecal local anaesthetic should therefore be individualized according to the surgical requirements, desired duration of analgesia, hemodynamic profile, and anticipated recovery time.

The present study demonstrated superior postoperative analgesia with intrathecal hyperbaric 0.5% Levobupivacaine compared with 0.75% Ropivacaine. VAS scores [29] were low and comparable between the groups during the early postoperative period [30], with no significant differences at 15, 30, 45, 60, or 75 minutes. However, pain scores became significantly lower with Levobupivacaine from 90 minutes onward, with mean VAS scores of 0.4 versus 1.0 at 90 minutes ($p = 0.008$), 0.6 versus 1.6 at 105 minutes ($p < 0.001$), and 1.0 versus 1.9 at 120 minutes ($p < 0.001$) in the Levobupivacaine and Ropivacaine groups, respectively. These findings suggest that although both agents provide effective early postoperative analgesia, Levobupivacaine offers more sustained pain relief, consistent with previous reports (Bourne et al., 2014; Gupta et al.; Kataria et al., 2018) [31–33].

Levobupivacaine provided significantly longer postoperative analgesia than Ropivacaine, as demonstrated by the longer mean time to rescue analgesia (341.4 vs. 254.4 minutes; $p < 0.001$). This finding is consistent with the prolonged sensory and motor block observed with Levobupivacaine and indicates a more sustained analgesic effect [34]. The extended duration of analgesia may reduce the need for early supplemental analgesics & potentially decrease postoperative opioid requirements although this would require direct assessment in future studies.

Overall, these findings suggest a potential clinical advantage of Levobupivacaine when prolonged postoperative analgesia is desired.

CONCLUSION

In patients undergoing elective lower abdominal surgery under spinal anaesthesia, intrathecal hyperbaric 0.5% Levobupivacaine provided a faster onset and significantly longer duration of sensory and motor blockade than 0.75% Ropivacaine. Levobupivacaine also provided superior postoperative analgesia, with lower VAS scores from 90 minutes onward and a significantly longer time to rescue analgesia. Although both agents demonstrated overall hemodynamic stability, Levobupivacaine was associated with lower systolic and diastolic blood pressures at selected time points. Overall, Levobupivacaine may offer advantages when rapid onset, prolonged surgical anaesthesia, and extended postoperative analgesia are desired. The choice of intrathecal local anaesthetic should, however, be individualized according to surgical requirements, desired recovery profile, and patient-specific factors.

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