

Original Research Article

HYPERBARIC LEVOBUPIVACAINE VERSUS HYPERBARIC ROPIVACAINE FOR INGUINAL HERNIA SURGERY UNDER SUBARACHNOID BLOCK: A COMPARATIVE STUDY

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Received : 01/09/2026
Received in revised form : 05/10/2026
Accepted : 16/10/2026

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DOI: 10.70034/ijmedph.2026.4.138

Source of Support: Nil,

Conflict of Interest: None declared

Int J Med Pub Health
2026; 16 (4); 913-918

ABSTRACT

Background: The choice of intrathecal local anaesthetic for inguinal hernia repair affects block onset, duration, haemodynamic response, and postoperative recovery. The objective is to compare hyperbaric 0.5% levobupivacaine with hyperbaric 0.75% ropivacaine for inguinal hernia surgery under subarachnoid block.

Materials and Methods: This prospective comparative study included 64 adults (32 per group) treated at a tertiary-care teaching hospital in Central India between July 2022 and December 2023. Group L received 3 mL (15 mg) hyperbaric levobupivacaine and Group R received 3 mL (22.5 mg) hyperbaric ropivacaine. Block characteristics, haemodynamic measures, and adverse effects were compared. Welch independent-samples t tests and Fisher exact tests were used for the reconstructed comparisons; two-sided $p < 0.05$ was considered significant.

Results: Mean sensory onset was 3.57 ± 0.92 min in Group L and 7.15 ± 0.96 min in Group R (mean difference -3.58 min, 95% CI -4.05 to -3.11 ; $p < 0.001$). Mean motor onset was 4.62 ± 0.94 versus 8.17 ± 0.97 min (difference -3.55 , 95% CI -4.03 to -3.07 ; $p < 0.001$). Levobupivacaine prolonged sensory block (192.56 ± 8.72 versus 161.69 ± 4.48 min; difference 30.87 , 95% CI 27.38 to 34.36 ; $p < 0.001$) and motor block (174.09 ± 9.11 versus 137.84 ± 5.96 min; difference 36.25 , 95% CI 32.39 to 40.11 ; $p < 0.001$). Hypotension occurred in 5/32 versus 0/32 patients (Fisher $p = 0.053$); bradycardia in 1/32 versus 0/32 ($p = 1.000$); postoperative nausea/vomiting in 4/32 versus 2/32 ($p = 0.672$).

Conclusion: Both drugs provided reported surgical block. Levobupivacaine had faster onset and longer sensory and motor block; ropivacaine was associated with faster regression.

Keywords: Levobupivacaine; Ropivacaine; Spinal anaesthesia.

INTRODUCTION

Inguinal hernia repair is a common operation in adults, and the choice of anaesthetic technique can influence perioperative comfort, haemodynamic stability, mobility, and discharge readiness. Subarachnoid block is frequently used for infraumbilical surgery because it provides reliable sensory and motor blockade while avoiding airway instrumentation. For ambulatory and short-stay surgery, clinicians must balance adequate surgical

anaesthesia with prompt recovery of motor and sensory function. Hernia management has increasingly emphasized patient-centred recovery and appropriately selected perioperative care.^[1-3] Levobupivacaine and ropivacaine are long-acting amide local anaesthetics used for neuraxial and regional techniques. Their intrathecal effects depend on dose, concentration, baricity, injection conditions, patient position, and the addition of adjuvants. Hyperbaric solutions may produce more predictable gravity-dependent spread than isobaric solutions,

although results from one formulation cannot be assumed to apply to another.^[2,4] Comparative studies have reported variable onset patterns, but a recurring finding is that levobupivacaine may provide a longer duration of sensory and motor block, whereas ropivacaine may permit earlier regression and mobilization.^[5-12] Evidence in elective inguinal herniorrhaphy is particularly relevant because the required block level and anticipated operative duration differ from those in lower-limb orthopaedic or obstetric surgery. Trials in hernia repair have examined low-dose “walking spinal” regimens and other local anaesthetic comparisons, but dose, baricity, fentanyl use, and allocation methods vary substantially.^[3,10,11] Studies in other infraumbilical settings likewise report that formulation and dose influence both block quality and recovery.^[6-9,12-18] The present comparison evaluates hyperbaric 0.5% levobupivacaine and hyperbaric 0.75% ropivacaine in adults undergoing inguinal hernia surgery under subarachnoid block. Sensory and motor block characteristics, regression, haemodynamic changes, and adverse effects are considered together, because a longer block may improve intraoperative coverage while delaying recovery. The findings should be interpreted in light of the single-centre sample and the limitations of the available aggregate dataset.

AIM: To compare the efficacy and perioperative profile of hyperbaric levobupivacaine and hyperbaric ropivacaine for inguinal hernia surgery under subarachnoid block.

Objectives

1. To compare the onset and extent of sensory and motor blockade between the two study groups.
2. To compare sensory and motor block regression and duration between the two study groups.
3. To compare perioperative haemodynamic changes and adverse effects between the two study groups.

MATERIALS AND METHODS

Source of data: Data were obtained from the supplied thesis, which reported observations for adults undergoing elective inguinal hernia surgery under subarachnoid block. The source contained aggregate tables rather than a de-identified participant-level dataset; recalculated confidence intervals therefore use the tabulated means, standard deviations, and group sizes.

Study design: The thesis described the work as a prospective observational study, but also stated that 64 patients were allocated equally to treatment groups by a chit method. This manuscript retains the source description and flags the design/allocation discrepancy for verification before submission.

Study location: The study was conducted in the Department of Anaesthesiology and operating theatres of a tertiary-care medical college hospital in Central India. The institution was not identified in the available study methods.

Study duration: The study was reported to have been conducted over 18 months, from July 2022 through December 2023.

Sample size: The source reported a total sample of 64 (32 per group), calculated using a previous study’s summary estimates: standard deviations of 42 and 63, anticipated between-group mean difference of 44, two-sided $\alpha=0.05$, and 90% power. For equal groups, the conventional approximation is $n \text{ per group} = [(Z1-\alpha/2 + Z1-\beta)^2(\sigma1^2+\sigma2^2)]/\Delta^2$. Substitution gives $[(1.96+1.282)^2(42^2+63^2)]/44^2 = 31.1$, rounded up to 32 participants per group; total $n=64$.

Inclusion criteria: Adults aged 18–65 years of either sex, American Society of Anesthesiologists (ASA) physical status I or II, weight 40–80 kg, height 150–180 cm, haemodynamically stable, and scheduled for elective inguinal hernia surgery under subarachnoid block were included.

Exclusion criteria: Patients with ASA physical status III or higher; uncontrolled hypertension; ischaemic heart disease; psychiatric or neurological illness; known hypersensitivity to amide local anaesthetics; contraindications to spinal anaesthesia such as infection at the lumbar puncture site, coagulopathy, septicaemia, or platelet/clotting disorders; pregnancy or breastfeeding; or refusal of consent were excluded.

Procedure and methodology: A pre-anaesthetic evaluation was performed on the day before surgery. The source reported review of complete blood count, random blood glucose, coagulation tests, renal and liver function, electrocardiography, and chest radiography or other investigations when indicated. Patients fasted for six hours, received an explanation of the procedure and written informed consent, and were monitored with electrocardiography, pulse oximetry, heart rate, and non-invasive blood pressure. Intravenous access was secured and crystalloid co-loading was reported at 10 mL/kg. With aseptic precautions, subarachnoid block was performed at L3–L4 using a 25-gauge Quincke needle in the sitting position by a midline or paramedian approach. After free cerebrospinal fluid flow, the study drug was injected intrathecally. Group L received 3 mL of 0.5% hyperbaric levobupivacaine (15 mg); Group R received 3 mL of 0.75% hyperbaric ropivacaine (22.5 mg).

Block and outcome assessment: Sensory blockade was assessed by pinprick and the highest dermatome was recorded. The source defined sensory onset by loss/reduction of pinprick sensation at L1. Motor blockade was assessed using the modified Bromage scale; onset was the time to Bromage grade 1 and complete motor block was the time to grade 3. The source recorded time to peak sensory level, two-segment regression, regression to L1, complete sensory and motor recovery, postoperative visual analogue pain scores, serial heart rate and blood pressure, and adverse events. The thesis did not consistently state operational thresholds for hypotension or bradycardia in the methods section.

Sample processing: No biological specimens were collected for the study outcomes. Clinical measurements were recorded in the case record form. Routine preoperative laboratory tests were part of clinical assessment and were not reported as study endpoints.

Statistical methods: The source reported use of Microsoft Excel 2021 and SPSS version 23.0, presenting continuous variables as mean and standard deviation and categorical variables as frequency and percentage. It described unpaired Student t tests and chi-square tests. For this manuscript, 95% confidence intervals for mean differences and Welch t statistics/p values were recalculated from group means, standard deviations, and n=32 per group; Fisher exact tests were used for sparse adverse-event counts. All tests were two-sided with $\alpha=0.05$. Because only aggregate data were supplied, repeated-measures modelling,

adjustment for multiple time-point comparisons, and participant-level verification were not possible.

Data collection: Demographic and perioperative variables, block characteristics, serial haemodynamic observations, postoperative pain scores, and adverse effects were extracted from the thesis tables. The source tables were checked for internal consistency; a mislabeled treatment-group row and some inconsistent p-value reporting were identified. Recalculated comparisons are explicitly indicated below.

RESULTS

The analysis included 64 patients, with 32 in each group. Group L received hyperbaric levobupivacaine and Group R received hyperbaric ropivacaine. No participant-level data were available for independent reanalysis.

Table 1: Comparison of block onset and extent

Outcome	Group L (n=32), mean (SD) or n (%)	Group R (n=32), mean (SD) or n (%)	Mean difference L-R (95% CI), min	Test statistic	p value
Onset of sensory block (min)	3.57 (0.92)	7.15 (0.96)	-3.58 (-4.05 to -3.11)	-15.23	<0.001
Time to maximum sensory level (min)	12.54 (1.12)	16.90 (0.93)	-4.36 (-4.87 to -3.85)	-16.94	<0.001
Onset of motor block, Bromage 1 (min)	4.62 (0.94)	8.17 (0.97)	-3.55 (-4.03 to -3.07)	-14.87	<0.001
Time to complete motor block, Bromage 3 (min)	11.77 (1.04)	15.13 (1.04)	-3.36 (-3.88 to -2.84)	-12.92	<0.001
Peak sensory level, n (%)	T4: 4 (12.5); T6: 27 (84.4); T8: 1 (3.1)	T4: 0; T6: 29 (90.6); T8: 3 (9.4)	—	$\chi^2=5.08$	0.079

Group L had a shorter mean onset time for sensory blockade, time to peak sensory level, onset of motor blockade, and time to complete motor block. The calculated mean differences were -3.58 min (95% CI -4.05 to -3.11), -4.36 min (-4.87 to -3.85), -3.55

min (-4.03 to -3.07), and -3.36 min (-3.88 to -2.84), respectively; all $p<0.001$. Peak sensory level distribution did not differ significantly ($\chi^2=5.08$, $p=0.079$).

Table 2: Comparison of block regression and duration

Outcome	Group L mean (SD), min	Group R mean (SD), min	Mean difference L-R (95% CI), min	Welch t	p value
Two-segment sensory regression (min)	66.78 (4.13)	53.78 (2.72)	13.00 (11.25 to 14.75)	14.87	<0.001
Regression to L1 (min)	98.59 (5.22)	87.66 (3.55)	10.93 (8.69 to 13.17)	9.79	<0.001
Complete sensory regression (min)	192.56 (8.72)	161.69 (4.48)	30.87 (27.38 to 34.36)	17.81	<0.001
Complete motor regression (min)	174.09 (9.11)	137.84 (5.96)	36.25 (32.39 to 40.11)	18.84	<0.001

Two-segment regression and regression to L1 occurred later in Group L by 13.00 min (95% CI 11.25 to 14.75) and 10.93 min (8.69 to 13.17), respectively. Total sensory block lasted 30.87 min

longer (27.38 to 34.36), and motor block lasted 36.25 min longer (32.39 to 40.11) in Group L. All reconstructed comparisons had $p<0.001$.

Table 3: Between-group differences at intervals with reported early differences

Measure and interval	Group L mean (SD)	Group R mean (SD)	Mean difference L-R (95% CI)	Welch t	p value
Heart rate at 5 min (beats/min)	73.16 (9.47)	78.47 (9.58)	-5.31 (-10.07 to -0.55)	-2.23	0.029
Heart rate at 10 min (beats/min)	66.28 (9.32)	75.69 (9.57)	-9.41 (-14.13 to -4.69)	-3.98	<0.001
Systolic blood pressure at 5 min (mmHg)	108.91 (6.15)	114.44 (6.53)	-5.53 (-8.70 to -2.36)	-3.49	<0.001
Systolic blood pressure at 10 min (mmHg)	106.91 (6.15)	113.44 (6.53)	-6.53 (-9.70 to -3.36)	-4.12	<0.001
Diastolic blood pressure at 5 min (mmHg)	78.69 (8.27)	82.81 (8.11)	-4.12 (-8.21 to -0.03)	-2.01	0.049
Diastolic blood pressure at 10 min (mmHg)	75.81 (8.11)	82.31 (7.36)	-6.50 (-10.37 to -2.63)	-3.36	0.001

At 5 and 10 minutes after spinal injection, Group L had lower mean heart rate, systolic blood pressure, and diastolic blood pressure than Group R. Recalculated mean differences were statistically significant at each listed interval; the greatest separation was seen in heart rate at 10 minutes (−9.41

beats/min, 95% CI −14.13 to −4.69; $p < 0.001$). The thesis reported no significant between-group differences at most other recorded intervals. The table presents selected intervals to avoid treating repeated observations as independent study outcomes.

Table 4: Adverse events by study group

Event	Group L n (%)	95% CI	Group R n (%)	95% CI	Test	p value
Hypotension	5 (15.6%)	6.9-31.8%	0 (0.0%)	0.0-10.7%	Fisher exact	0.053
Bradycardia	1 (3.1%)	0.6-15.7%	0 (0.0%)	0.0-10.7%	Fisher exact	1.000
Postoperative nausea/vomiting	4 (12.5%)	5.0-28.1%	2 (6.2%)	1.7-20.1%	Fisher exact	0.672

Hypotension was reported in five patients in Group L and none in Group R; the two-sided Fisher exact p value was 0.053. Bradycardia occurred in one patient in Group L and none in Group R ($p = 1.000$). Postoperative nausea/vomiting occurred in four versus two patients ($p = 0.672$). The event counts were small, and the confidence intervals were wide.

Data-integrity note: The source thesis labelled the design “prospective observational” while also reporting allocation by chit method. In its duration table, a Group R value was mislabeled “levobupivacaine + fentanyl”; this manuscript interpreted it as ropivacaine because the surrounding narrative and table comparison identify Group R as ropivacaine. The thesis reported $p = 0.046$ for a combined adverse-event comparison, but the event-specific counts do not reproduce that value. Event-specific Fisher exact p values are therefore shown. Verification against the original case records is needed before submission or clinical use.

DISCUSSION

In this single-centre thesis dataset of adults having elective inguinal hernia repair, 3 mL of hyperbaric levobupivacaine was associated with earlier sensory and motor block onset and longer sensory and motor block duration than 3 mL of hyperbaric ropivacaine. Peak sensory level distribution was similar. These findings describe a trade-off: levobupivacaine may provide a longer period of block, whereas ropivacaine may allow earlier regression. Drug choice should be considered alongside anticipated operative duration and the value placed on early motor recovery.

Block onset and sensory spread: The mean sensory onset was 3.57 minutes with levobupivacaine and 7.15 minutes with ropivacaine. Dikkala and Guntreddy (2023).^[5] Kame et al. (2023).^[8] Athar et al. (2016).^[9] Kamath et al. (2018).^[15] Samar et al. (2020).^[18] and Rathod et al. (2023).^[22] examined comparisons of levobupivacaine and ropivacaine in spinal anaesthesia across infraumbilical or lower-limb settings. However, onset findings are not uniform. Athar et al. (2016).^[9] reported more rapid onset with ropivacaine in an equipotent-dose spinal study, while other investigations found different onset patterns.^[5,6,8,12,15,18,20,22] Those studies differed in baricity, dose, adjuvant use, surgical population,

and the dermatome used to define onset; these factors limit direct comparison.

The highest recorded sensory level was T6 in most participants in both groups, and the distribution did not differ statistically. Dikkala and Guntreddy (2023).^[5] and Athar et al. (2016).^[9] assessed block spread in lower-limb surgery, while Singh et al. (2019).^[7] specifically studied low-dose walking spinal anaesthesia for inguinal herniorrhaphy. The exact spread remains formulation- and position-dependent; Boublik et al. (2016).^[2] reviewed ambulatory spinal agents, and Costa et al. (2022).^[3] reported a hernia-specific ambulatory trial using hyperbaric prilocaine. Together, these studies reinforce the need to interpret sensory level in relation to positioning, dose, and procedure.^[4,10,11,13,14,17,21]

Duration and motor recovery: In this dataset, two-segment regression, regression to L1, complete sensory regression, and complete motor regression were all longer in the levobupivacaine group. This pattern broadly agrees with studies by Soni et al. (2019).^[6] Kamath et al. (2018).^[15] Samar et al. (2020).^[18] Mahajan and Patel (2023).^[20] and Rathod et al. (2023).^[22] which compared intrathecal local anaesthetic regimens in lower abdominal or lower-limb procedures, although the formulations and adjuvants varied.^[5,8,12,14,16,17,19,21] The same trade-off is clinically relevant in inguinal hernia repair: longer block may cover a prolonged procedure and delay pain return, while shorter motor block may support earlier ambulation. Singh et al. (2019).^[7] studied low-dose walking-spinal regimens in herniorrhaphy; those doses and fentanyl-containing regimens differ from the present 15 mg versus 22.5 mg comparison.^[1,3]

The source measured postoperative pain scores but the data tables do not provide a clearly specified rescue-analgesia endpoint or consistent follow-up period. Consequently, the longer sensory block should not be interpreted as proof of superior patient-reported analgesia, faster discharge, or reduced total analgesic use. Hernia-specific and ambulatory-surgery literature emphasizes discharge readiness and recovery outcomes in addition to block duration.^[1-3]

Haemodynamics and adverse events: Lower heart rate and blood pressure values were reported in the levobupivacaine group at selected early time points.

The aggregate table also showed hypotension in five levobupivacaine recipients and none receiving ropivacaine, but event-specific Fisher testing yielded $p=0.053$. The evidence therefore suggests a possible early haemodynamic difference, but does not establish a precise increase in complication risk. Athar et al. (2016).^[9] Kame et al. (2023).^[8] and Samar et al. (2020)^[18] evaluated haemodynamic profiles in comparative spinal studies. Differences in definitions, fluid co-loading, vasopressor use, spinal dose, and patient mix may contribute to heterogeneity.^[6,10,12,13,15-17,20,22]

The postoperative nausea/vomiting counts were low and did not differ significantly. The thesis did not provide a complete protocol for treating hypotension or bradycardia, nor clear event definitions and timing. Future reporting should state thresholds, rescue interventions, severity, and whether adverse-event comparisons were prespecified. Such detail is necessary to distinguish a transient measurement change from a clinically consequential event.

Strengths and interpretation: The source focused on a clinically specific operation and recorded multiple sensory, motor, and haemodynamic outcomes. Its findings can be placed alongside work on inguinal hernia repair and ambulatory anaesthesia by Fitzgibbons and Forse (2015).^[1] Boublik et al. (2016).^[2] Costa et al. (2022).^[3] Singh et al. (2019).^[7] and Parekh et al. (2017).^[10] as well as comparisons of intrathecal agents in other surgical populations.^[4-6,8,9,11-22] The variation across studies highlights the importance of documenting baricity, dose, and adjuvants. The study's $n=64$ and the availability of aggregate tables only limit precision and independent audit. The apparent use of chit allocation also requires clarification because the thesis describes the study as observational in one section and as allocated in another.

CONCLUSION

Among the 64 patients reported in the supplied thesis, hyperbaric 0.5% levobupivacaine was associated with faster onset and longer sensory and motor blockade than hyperbaric 0.75% ropivacaine for inguinal hernia surgery under subarachnoid block. Ropivacaine showed earlier block regression, while selected early heart-rate and blood-pressure readings were lower with levobupivacaine. The available sample does not establish a statistically significant difference in individual adverse-event rates. Larger, prospectively registered randomized studies with clear allocation, outcome definitions, rescue-treatment criteria, and participant-level analysis are needed to confirm these findings.

Limitations:

- The study was single-centre and included only 64 participants, limiting precision and generalizability.
- The thesis described the design as observational but also reported treatment allocation by chit

method; the actual allocation process and concealment require confirmation.

- Only aggregate means, standard deviations, and counts were available. Participant-level data, missing-data handling, adjusted analyses, and repeated-measures methods could not be reviewed.
- The source contains a treatment-group labeling error in one table and inconsistencies between reported and recalculated p values, especially for adverse events.
- The dose and concentration differed between agents (15 mg levobupivacaine versus 22.5 mg ropivacaine), so observed differences cannot be attributed solely to the molecule.
- Blinding, sample-size assumptions from the cited prior study, prespecified primary endpoint, and trial registration were not clearly documented in the supplied methods.
- Long-term pain, patient satisfaction, ambulation, time to discharge, and a prespecified rescue-analgesia outcome were not adequately reported.
- Operational definitions for hypotension, bradycardia, sensory onset, and the timing of postoperative pain assessment were incomplete or inconsistently reported.

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