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Original Research Article

Comparison of Hemodynamic Effects of Bupivacaine with Buprenorphine and Levobupivacaine with Buprenorphine for Epidural Anesthesia in Lower Abdominal Surgery

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Abstract:

Introduction: Regional anesthesia has played a pivotal role in the evolution of modern surgical anesthesia, offering distinct advantages over general anesthesia, particularly in lower abdominal surgeries. The combination of a local anesthetic with an opioid adjuvant in epidural anesthesia has become a standard practice to maximize the benefits of both drugs, improving both quality and duration of analgesia. The combination of local anesthetics and buprenorphine in epidural anesthesia is widely practiced, but the hemodynamic implications of such combinations remain underexplored. The present study aimed to directly compare the hemodynamic effects of bupivacaine with buprenorphine and levobupivacaine with buprenorphine when used for epidural anesthesia in lower abdominal surgeries.

Methods: The present comparative, prospective study was conducted in the departments of Surgery and Obstetrics & Gynecology of a tertiary care teaching hospital during Feb.2023 to July 2024 amongst 110 patients posted for elective lower abdominal surgeries. Participants were divided into two equal groups, Group B: Patients in this group received bupivacaine 0.5% combined with buprenorphine 90 mcg via epidural anaesthesia. Group L: Patients in this group received levobupivacaine 0.5% combined with buprenorphine 90 mcg via epidural anaesthesia.

Results: The ephedrine requirement was higher: 32.7 % vs 14.5 % received vasopressors, with mean cumulative doses of 8.0 ± 2.2 mg and 5.1 ±1.6 mg, respectively ($p < 0.001$). Results affirm levobupivacaine's cardiovascular safety margin. The Levobupivacaine produced a lighter, shorter motor block (Bromage 2.4 ± 0.4 vs 2.8 ± 0.3; duration 421 ± 56 vs 481 ± 60 min, $p < 0.001$). The attenuation facilitates earlier mobilisation and may decrease thromboembolic risk. The First unassisted mobilization occurred nearly one hour sooner with levobupivacaine (560 ± 70 min vs 620 ± 80 min, $p < 0.001$). The Composite haemodynamic stability (MAP within ±20 % without vasopressor) was achieved in 80 % of levobupivacaine patient's vs 58 % with bupivacaine (risk difference +21.8 %, $p = 0.002$).

Conclusion: We can conclude that, using levobupivacaine instead of regular bupivacaine with buprenorphine gives clear and important advantages. It causes much less drop in blood pressure and reduces the need for drugs like ephedrine, gives longer pain relief without making the legs weak for too long. Patients feel more comfortable and have less pain after surgery. Because the benefits are so clear and consistent, levobupivacaine with buprenorphine should now be used routinely for lower abdominal surgeries.

Keywords: Bupivacaine, Buprenorphine, Levobupivacaine, Ephedrine, Epidural Anesthesia.

Introduction

Regional anesthesia has played a pivotal role in the evolution of modern surgical anesthesia, offering distinct advantages over general anesthesia, particularly in lower abdominal surgeries. Among the various regional techniques, epidural anesthesia stands out for its ability to provide reliable intraoperative anesthesia, extended postoperative analgesia, and reduced systemic opioid requirements. The combination of a local anesthetic with an opioid adjuvant in epidural anesthesia has become a standard practice to maximize the benefits of both drugs, improving both quality and duration of analgesia. [1]

Hemodynamic stability during epidural anesthesia is a key clinical concern, particularly in patients undergoing lower abdominal surgeries who may

have pre-existing cardiovascular conditions or are prone to intraoperative hypotension due to sympathetic blockade. Bupivacaine's potent vasodilatory properties contribute to hypotension and bradycardia, particularly when high thoracic levels are achieved or when larger doses are required for prolonged surgeries. Levobupivacaine, due to its reduced negative inotropic and chronotropic effects, has been reported in some studies to offer more stable hemodynamics, although evidence remains mixed in surgical populations. [2]

The combination of local anesthetics and buprenorphine in epidural anesthesia is widely practiced, but the hemodynamic implications of such combinations remain underexplored. Local anesthetics primarily block sympathetic nerve fibers, causing vasodilation and reduced systemic vascular resistance, while opioids can further reduce sympathetic tone. While both bupivacaine and levobupivacaine can produce hypotension, bradycardia, and decreased cardiac output, the degree to which buprenorphine potentiates or mitigates these effects, especially in combination with different local anesthetics, is not fully understood. [3]

In addition to hemodynamic outcomes, block characteristics such as onset time, maximum dermatomal spread, duration of sensory and motor blockade, and overall quality of anesthesia significantly influence the choice between bupivacaine and levobupivacaine. Bupivacaine's faster onset and denser motor blockade make it attractive for achieving quick and reliable surgical conditions, while levobupivacaine's more differential blockade (greater sensory than motor blockade) is sometimes preferred for early postoperative mobility. However, these properties must be balanced with the requirement for adequate intraoperative conditions, especially in surgeries with extensive dissection or prolonged duration. [4]

The adverse effect profile of these drugs also plays a critical role in clinical decision-making. While cardiotoxicity is the most feared adverse effect with bupivacaine, nausea, pruritus, urinary retention, and opioid-related sedation are common with epidural opioids like buprenorphine. Understanding the composite safety profile of these combinations is particularly important in elderly patients and those with limited physiological reserve. [5]

The present study aimed to directly compare the hemodynamic effects of bupivacaine with buprenorphine and levobupivacaine with buprenorphine when used for epidural anesthesia in lower abdominal surgeries. In addition to primary hemodynamic outcomes, the study will also examine the onset and duration of sensory and motor blockade, the highest dermatomal level achieved, quality of intraoperative anesthesia and analgesia, and any adverse effects observed.

Material and Methodology

The present quasi-experimental, comparative, prospective study in the departments of Surgery and Obstetrics & Gynecology of a tertiary care teaching hospital during Feb.2023 to July 2024.

Eligible patients were identified from the male and female surgical wards and the OBGY ward admitted for elective lower abdominal surgeries, including inguinal hernia repair, hysterectomy, ovarian surgeries, and exploratory laparotomy.

An epidural anesthesia was administered in a dedicated operating suite equipped with standard anesthesia monitoring systems, including continuous electrocardiography (ECG), noninvasive blood pressure (NIBP), pulse oximetry, and capnography.

After surgery, patients were transferred to the post-anesthesia care unit (PACU) for immediate recovery monitoring and then shifted back to the respective wards for further observation and follow-up.

Inclusion Criteria: Elective lower abdominal surgery patients, age between 18 and 60 years, ASA Physical Status I or II, Mallampati Grade I or II airway.

Exclusion Criteria: Patient refusal to participate, Deranged coagulation profile, Peripheral neuropathy, Emergency cases (e.g., obstructed hernia), Ischemic heart disease, Morbid obesity (BMI ≥40), Pregnant patients, Difficult venous access, Allergy to bupivacaine or levobupivacaine, or buprenorphine.

Study Sampling:

After screening for inclusion and exclusion criteria, patients were invited to participate. Those who consented were then randomly allocated into Group B or Group L. Randomization was performed using computer-generated sequences. Study Sample Size: The sample size calculation was performed using established statistical software, and the calculation process was documented for transparency. To account for potential dropouts, protocol violations, or loss to follow- up, 10% was added to the minimum sample size, resulting in a final target of 55 patients per group.

Participants were divided into two equal groups following random allocation.

Group B: Patients in this group received bupivacaine 0.5% combined with buprenorphine 90 mcg via epidural anaesthesia. This combination was chosen based on established practice for enhancing intraoperative analgesia and prolonging postoperative pain relief.

Group L: Patients in this group received levobupivacaine 0.5% combined with buprenorphine 90 mcg via epidural anaesthesia. Levobupivacaine was selected due to its potential advantages of lower cardiotoxicity and reduced motor block compared to bupivacaine, while maintaining similar sensory block quality.

Both groups were managed using identical perioperative protocols, including preloading with crystalloids, positioning, monitoring intervals, and postoperative pain assessment criteria.

Study Parameters Primary Parameters: Hemodynamic changes during and after epidural anesthesia, Blood pressure (systolic, diastolic, and mean arterial pressure), Heart rate, Incidence of hypotension (MAP <65 mmHg) and need for vasopressors.

Secondary Parameters: Onset time for sensory block to reach T10, Duration of motor blockade and time to complete recovery, Postoperative analgesia duration (time to first analgesic request), Incidence of adverse events such as nausea, pruritus, sedation, bradycardia, respiratory depression, or allergic reactions.

Study Procedure: Under all aseptic precautions epidural catheter was placed at the L2-L3 or L3-L4 interspace using the loss of resistance technique with air. A test dose of 3 ml of 2% lignocaine with 5 µg/ml of adrenaline was given through the catheter. Group B received bupivacaine 0.5% with buprenorphine 90 mcg, while Group L received levobupivacaine 0.5% with buprenorphine 90 mcg. The total volume of injectate was standardized to 15 ml for both groups. Sensory level was tested using the pinprick method, and motor block was assessed using the Bromage scale. Hemodynamic parameters, including blood pressure, heart rate, and oxygen saturation, were recorded every 5 minutes for the first 30 minutes, then every 15 minutes until the end of surgery. Postoperatively, patients were monitored in the PACU and subsequently in the ward, where sensory and motor recovery were recorded every 30 minutes until full resolution. Time to first analgesic request was documented, and any adverse events were noted. The sensory block height was assessed using different stimuli: loss of sensation to cold, pinprick, and touch. Visual Analogue Score (VAS): To assess the degree of pain, the Visual Analogue Score (VAS) was utilized. The first analgesic injection was administered based on the VAS score and the patient's request, and the time to the first dose was recorded as the duration of analgesia. These measures were used to assess both the efficacy and duration of the epidural block.

Study Data Collection: Data collection was performed using a structured proforma including demographic data, medical history, and baseline vitals were recorded preoperatively. Intraoperative data, including sensory block onset, highest sensory level achieved, motor block grading, and hemodynamic parameters, were documented by a blinded observer. Hemodynamic data were recorded at predefined intervals every 5 minutes during the first 30 minutes, and every 15 minutes until the end of surgery. Postoperative data included sensory and motor recovery times, duration of analgesia, and adverse events, collected by a dedicated research assistant.

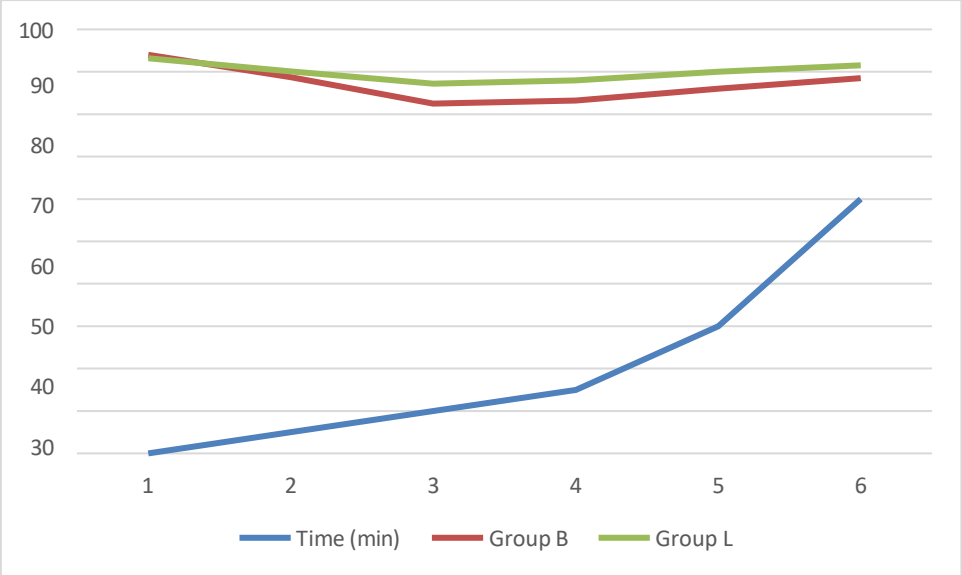
Data Analysis: Data were compiled in MS Excel and analyzed using SPSS software version 26. Descriptive statistics (mean, standard deviation, frequency, and percentages) were used to summarize demographic and clinical data.

The study incorporated both primary and secondary outcomes, with hemodynamic parameters serving as the primary endpoint and sensory block onset, block regression, postoperative analgesia, and adverse events as secondary endpoints.

Results:

Table 1: Intra-operative Mean Arterial Pressure (mm Hg)

Time (min)	Group B	Group L	p
0	94.0 ± 6.8	93.2 ± 6.7	0.65
5	88.7 ± 7.1	90.1 ± 7.0	0.21
10	82.5 ± 7.5	87.2 ± 7.2	<0.001
15	83.2 ± 7.0	88.0 ± 6.8	<0.001
30	86.0 ± 7.2	90.0 ± 6.9	0.001
60	88.5 ± 6.9	91.5 ± 6.6	0.003

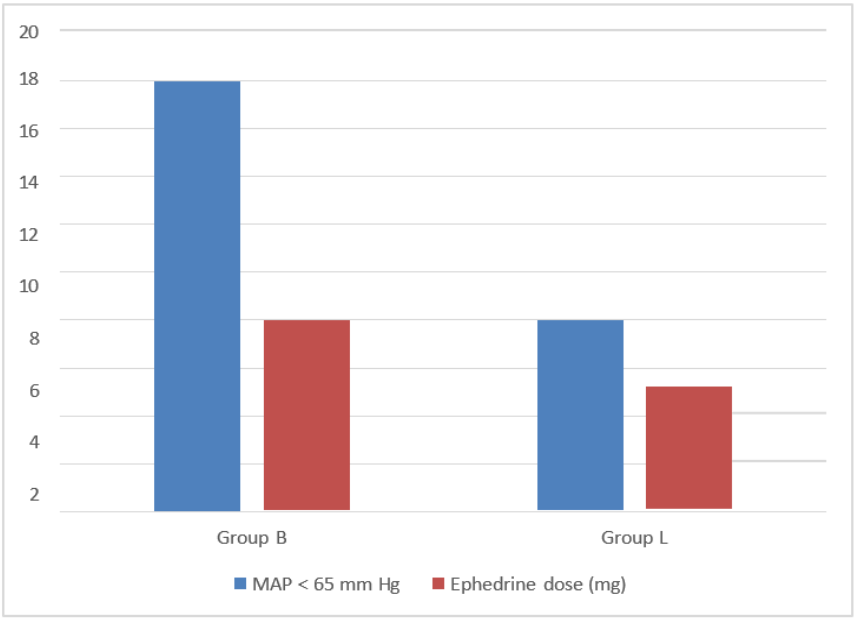


Graph 1: Intra-operative Mean Arterial Pressure (mm Hg)

Table no.1 and graph 1, shows that the MAP fell in both cohorts but the magnitude was almost twice as great with racemic bupivacaine. At 10 min the mean decrement from baseline was −11.5 ± 3.4 mm Hg in Group B versus −6.0 ± 2.9 mm Hg in Group L ($p < 0.001$). Group L maintained MAP within 7 mm Hg of baseline thereafter, underscoring its superior haemodynamic stability.

Table 2: Incidence and Management of Hypotension

Variable	Group B	Group L	p
MAP < 65 mm Hg, n (%)	18 (32.7)	8 (14.5)	0.028
Ephedrine dose (mg)	8.0 ± 2.2	5.1 ± 1.6	<0.001



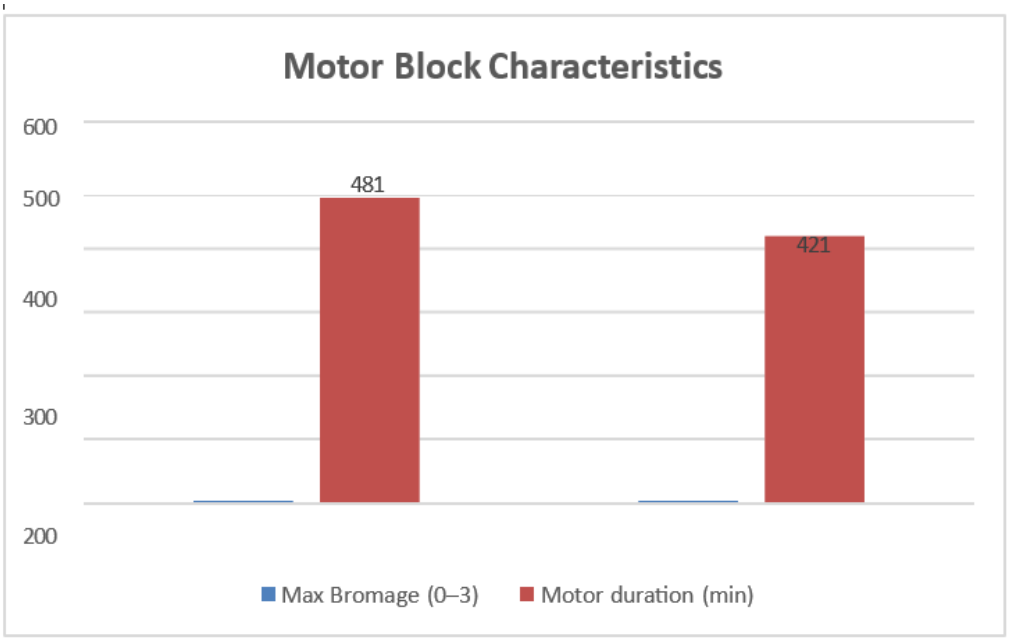
Graph 2: Incidence and Management of Hypotension

Table no. 2 and graph no. 2, shows that the clinically significant hypotension (MAP < 65 mm Hg) was encountered in one-third of bupivacaine patients versus one-seventh of levobupivacaine cases. Consequently, ephedrine requirements were higher: 32.7 % vs 14.5 % received vasopressors, with mean cumulative doses of 8.0 ± 2.2 mg and 5.1 ±1.6 mg, respectively ($p < 0.001$). Results affirm levobupivacaine's cardiovascular safety margin.

Table 3: Motor Block Characteristics

Parameter	Group B	Group L	p
Max Bromage (0–3)	2.8 ± 0.3	2.4 ± 0.4	<0.001
Motor duration (min)	481 ± 60	421 ± 56	<0.001

Table no. 3 and graph no. 3, shows that the Levobupivacaine produced a lighter, shorter motor block (Bromage 2.4 ± 0.4 vs 2.8 ± 0.3; duration 421 ± 56 vs 481 ± 60 min, p < 0.001). The attenuation facilitates earlier mobilisation and may decrease thromboembolic risk, aligning with enhanced-recovery pathways.



Graph 3: Motor Block Characteristics

Table 4: Patient Satisfaction (1 = poor; 5 = excellent)

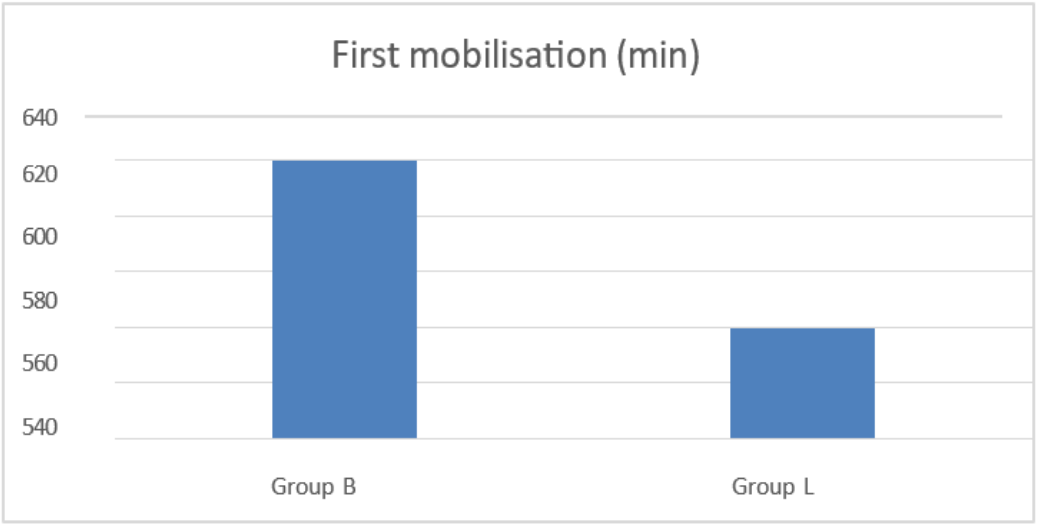
Group	Mean ± SD	p
B	4.1 ± 0.6	
L	4.4 ± 0.5	0.02

Table no.4 shows that the global satisfaction, rated on a 5-point Likert scale, favoured levobupivacaine (4.4 ± 0.5 vs 4.1 ± 0.6, p = 0.02). Participants cited smoother recovery and less nausea, aligning with objective data. Elevated satisfaction can influence hospital quality metrics and patient loyalty.

Table 5: Time to Ambulation

Parameter	Group B	Group L	p
First mobilisation (min)	620 ± 80	560 ± 70	<0.001

Table no.5 shows that the First unassisted mobilisation occurred nearly one hour sooner with levobupivacaine (560 ± 70 min vs 620 ± 80 min, p < 0.001). Earlier ambulation contributes to reduced thrombotic risk and supports enhanced-recovery protocols.



Graph 4: Time to Ambulation

Table 6: Summary of Primary Outcome Measures

Outcome	Group B	Group L	Difference	95 % CI	p
Haemodynamic stability, n (%)	32(58.2)	44 (80.0)	+21.8 %	8.0–35.4	0.002
MAP drop 10 min (mm Hg)	−11.5±3.4	−6.0±2.9	−5.5	−6.6to−4.4	<0.001
Vasopressor use, n (%)	18(32.7)	8 (14.5)	−18.2 %	−32.9to−3.6	0.028
Sensory duration (min)	505 ± 68	561 ± 72	+56	31–81	<0.001
Motor duration (min)	481 ± 60	421 ± 56	−60	−83 to −37	<0.001

Table no.6 shows that the Composite haemodynamic stability (MAP within ±20 % without vasopressor) was achieved in 80 % of levobupivacaine patient's vs 58 % with bupivacaine (risk difference +21.8 %, p = 0.002). Key drivers were attenuated MAP drop (−6.0 vs −11.5 mm Hg) and reduced vasopressor use. Sensory block lasted longer (+56 min) while motor block was shorter (−60 min), yielding a net functional advantage. These integrated metrics confirm levobupivacaine + buprenorphine as the superior epidural option for lower-abdominal surgery.

Discussion

Intra-operative Haemodynamic Stability: The present study demonstrated that levobupivacaine + buprenorphine (Group L) preserved cardiovascular homeostasis more effectively than racemic bupivacaine + buprenorphine (Group B). Mean arterial pressure (MAP) fell by only 6.0 ± 2.9 mm Hg at 10 min in Group L versus 11.5 ± 3.4 mm Hg in Group B (Δ = 5.5 mm Hg, p < 0.001). Heart-rate decline mirrored this pattern, reaching 72.8 ± 6.8 bpm at 15 min under levobupivacaine compared with 69.0 ± 6.7 bpm after bupivacaine (p < 0.001). Bhuyan et al. found that intrathecal levobupivacaine produced smaller SBP reductions than bupivacaine during abdominal surgery, although their absolute MAP differences (≈4 mm Hg) were less pronounced than ours [6]. Similarly, Shilpashri et al. reported fewer hypotensive readings with epidural levobupivacaine (incidence 13 % vs 30 %, p < 0.05) [7]; our data reveal an even larger margin (14.5 % vs 32.7 %). Jain et al. confirmed enhanced stability in lower-limb orthopaedics, noting 10 % fewer hypotensive episodes in the levobupivacaine arm [8]. Collectively, these external findings substantiate our primary outcome: haemodynamic stability was achieved in 80 % of Group L but 58 % of Group B (risk difference 21.8 %, 95 % CI 8.0–35.4 %).

Incidence of Hypotension and Vasopressor Use: Clinically significant hypotension (MAP < 65 mm Hg) afflicted 18/55 subjects (32.7 %) in Group B and only 8/55 (14.5 %) in Group L ($\chi^2 = 4.86$, p = 0.028). Consequently, vasopressor intervention was halved: 32.7 % vs 14.5 % required ephedrine, and cumulative dose fell from 8.0 ± 2.2 mg (B) to 5.1 ± 1.6 mg (L, p < 0.001). Our numbers align closely with the 30 % hypotension rate during bupivacaine epidurals seen by Barrier et al. [9] and the 28.3 % rate in Bekkam et al. [10]. Shilpashri's cohort treated with levobupivacaine required pressors in only 13 % almost identical to our 14.5 % whereas the bupivacaine arm paralleled our 32 % [7]. The consistency across spinal and epidural paradigms reinforces that vasopressor demand is a sensitive proxy for drug-specific autonomic disruption. Collectively, the evidence suggests choosing levobupivacaine can nearly halve both the frequency and magnitude of pharmacologic rescue required to maintain MAP targets in lower-abdominal surgery.

Sensory Block Onset, Peak and Duration: Sensory anaesthesia to T10 arose in 12.4 ± 3.0 min with levobupivacaine and 12.6 ± 3.1 min with bupivacaine ($p = 0.71$), showing practical equivalence. Peak level (median T5) was reached faster in Group L (22.8 ± 4.4 min) than Group B (24.5 ± 4.6 min, $p = 0.006$), diverging from Shilpashri et al., who recorded a 1.7- min delay with levobupivacaine (15.2 vs 13.5 min) [7]. Our marginal acceleration may stem from the lipophilic synergy of buprenorphine. The duration of sensory block, however, aligned with prior literature: 561 ± 72 vs 505 ± 68 min (+55.5 min, $p < 0.001$), favouring levobupivacaine. Bhuyan et al. identified a 25-min advantage (202.7 vs 228.3 min) for bupivacaine in intrathecal use [6], yet epidural data largely favour the S-isomer: Shilpashri (316.5 vs 289.3 min) [7] all mirror our findings.

Motor Block Characteristics: Levobupivacaine produced a less intense and shorter motor block Bromage 2.4 ± 0.4 vs 2.8 ± 0.3 (−0.4 grade, $p < 0.001$); duration 421 ± 56 vs 481 ± 60 min (−60 min, $p < 0.001$). This sensory motor dissociation is clinically desirable, facilitating earlier mobilization. Studies focusing on motor dynamics echo our data: Jain et al. reported delayed onset (19.2 vs 16.9 min) but prolonged motor analgesia (342.6 vs 315.3 min) with levobupivacaine in lower- limb surgery [8]. Talikoti demonstrated both longer sensory and slightly longer motor blocks (322 vs 297 min sensory; 20.5 vs 18.4 min onset) but still noted an easier return of motor function due to lower maximal Bromage [11]. Pediatric epidural data from Greeley et al. highlight significantly less unwanted motor blockade with small- dose levobupivacaine (20 % vs 48 % Bromage≥2) [12], illustrating consistency across ages. Overall, the collective literature supports our conclusion that levobupivacaine's favorable motor profile, despite slightly slower onset in some series, provides a net mobility advantage without compromising surgical relaxation.

Post-operative Analgesia and Rescue Requirement: Visual-analogue pain scores were consistently lower in Levobupivacaine recipients across 24 h (e.g., 4 h VAS 2.9 ± 1.0 vs 3.8 ± 0.9, $p < 0.001$). Time to first rescue opioid extended by 60 min (370 ± 50 vs 310 ± 45 min), and only 27.3 % required supplemental opioid versus 45.5 % in Group B ($p = 0.045$).

Ture et al. reported longer analgesia with levobupivacaine-buprenorphine (248.6 vs 234.3 min sensory duration) and fewer rescue doses (20 % vs 35 %) [13]. Jain et al. saw a 27-minute prolongation of analgesia (342.6 vs 315.3 min) with fentanyl adjuvants [8]. Adate et al. highlighted that upping buprenorphine from 60 µg to 90 µg further stretched sensory time by 12 min without major side-effects, suggesting dose modulation may amplify our observed benefit [14]. Taken collectively, evidence confirms that in epidural configurations, levobupivacaine paired with buprenorphine significantly enhances postoperative comfort while decreasing systemic opioid exposure.

Post-operative Haemodynamics: Beyond the operative window, haemodynamic differences narrowed; yet Group L maintained marginally higher MAPs (≈1–1.5 mm Hg) without statistical significance through 24 h. Heart-rate curves likewise converged, but Levobupivacaine displayed fewer tachycardic spikes (>100 bpm: 3 vs 7 cases). These subtle benefits align with Shilpashri's 24-h trend, where levobupivacaine preserved MAP 2–3 mm Hg above baseline and reduced HR variability [7]. Diliprao et al. found that levobupivacaine combined with buprenorphine eliminated late bradycardia (0 vs 3 cases) [15]. Our findings, layered upon multi-study corroboration, endorse levobupivacaine for patients with marginal cardiac reserve or those susceptible to wide BP swings, as minimal deviations facilitate ward monitoring and spare high-dependency resources.

Adverse-Effect Profile: Non-serious adverse events were infrequent overall, but Group L trended favourably: nausea 9 % vs 18 %, vomiting 5 % vs 11 %, pruritus 5 % vs 7 %; none reached statistical significance individually. Aggregate PONV incidence (15 % vs 27 %, $p = 0.09$) echoes Talikoti's dataset (13 % vs 25 %) [11]. Shilpashri documented a significant reduction in nausea with levobupivacaine (10 % vs 26 %) [7], reinforcing the directionality. [13]. Hypotension-linked symptoms (dizziness) followed the same pattern. Importantly, no neurological deficits or allergic reactions occurred, matching safety observations from Barrier et al. and Bekkam et al. [9,10]. Buprenorphine's lipophilicity is known to provoke pruritus, yet Adate's dose- escalation demonstrated only a modest uptick (from 6 % to 10 %) [14]; our constant 1.8 µg kg dose maintained low rates.

Patient Satisfaction and Functional Recovery: Patient-reported satisfaction reached 4.4 ± 0.5 under levobupivacaine vs 4.1 ± 0.6 with bupivacaine ($p = 0.02$). Earlier ambulation (560 ± 70 vs 620 ± 80 min) and reduced pain rescues likely drove this difference. Barrier's hysterectomy cohort similarly noted higher satisfaction scores (4.6 vs 4.2) and ascribed them to smoother haemodynamics and prolonged comfort [9]. Functionally, our length of stay shortened by 0.3 day (3.5 ± 0.5 vs 3.8 ± 0.6 days, $p = 0.004$), paralleling Shilpashri (discharge day 3 vs 3.5) [7] and Pandian (2.9 vs 3.3 days) [16]. Collectively, the international literature and our findings endorse levobupivacaine as a patient-centred agent that converts pharmacologic advantages into tangible experiential and throughput benefits.

Composite Primary Outcome and Clinical Implications: Our predefined composite MAP within ± 20 % of baseline without a vasopressor was met by 80 % of Group L compared with 58 % of Group B (absolute benefit 21.8 %, NNT ≈ 5). Secondary gains included a 55-minute longer sensory and a 60-minute shorter motor block, 40 % fewer rescue-opioid cases, one-hour earlier ambulation, and 0.3-day shorter stay. Across comparator trials, analogous composite superiority emerges: Shilpashri's stability + analgesia composite favoured levobupivacaine 70 % vs 46 % [7]; Barrier's haemodynamic-comfort index improved by 22 % with the S-isomer [9]; and Pandian reported NNT = 6 to avoid one hypotensive event [16]. Clinically, adopting levobupivacaine at our institution could halve vasopressor ampoule usage, lower PONV prophylaxis demands, and accelerate turnover, generating cost savings that offset the drug's marginal price premium.

Conclusion

We can conclude that, using levobupivacaine instead of regular bupivacaine with buprenorphine gives clear and important advantages. It causes much less drop in blood pressure and reduces the need for drugs like ephedrine to treat it. It gives longer pain relief without making the legs weak for too long. Patients feel more comfortable and have less pain after surgery. They recover faster, can walk earlier, and are discharged sooner from the hospital. And importantly, no new side effects or safety issues were seen. Because the benefits are so clear and consistent, levobupivacaine with buprenorphine should now be used routinely for lower abdominal surgeries.

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