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Research Article

A comparative study of local anaesthetic agent levobupivacaine and ropivacaine in ultrasound guided erector spinae plane block in patients undergoing laparoscopic cholecystectomy

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ABSTRACT

Introduction: Laparoscopic cholecystectomy is frequently associated with moderate to severe postoperative pain, necessitating effective multimodal analgesia. The erector spinae plane block (ESPB) has emerged as an effective regional technique, but the optimal local anesthetic agent for this block remains underexplored. This study aimed to compare the analgesic efficacy and safety of equipotent doses of 0.5% levobupivacaine and 0.5% ropivacaine in ultrasound-guided ESPB for patients undergoing laparoscopic cholecystectomy.

Material and Methods: In a prospective comparative study, 60 ASA I–II patients scheduled for elective laparoscopic cholecystectomy were randomly assigned to two groups: Group L (levobupivacaine 0.5%, 10 mL bilateral) and Group R (ropivacaine 0.5%, 10 mL bilateral). The ESPB was performed at the T7 level under ultrasound guidance before extubation. Postoperative pain was assessed using the Visual Analog Scale (VAS) at intervals up to 24 hours. Time to first analgesic request, rescue analgesic consumption, hemodynamic parameters, and incidence of postoperative nausea and vomiting (PONV) were recorded.

Results: Both groups were comparable in demographic and intraoperative characteristics. VAS scores, time to first rescue analgesia (levobupivacaine: 17.17 ± 4.20 hours, ropivacaine: 16.83 ± 4.20 hours;

p = 0.760), and rescue analgesic requirements were similar at all time points (*p* > 0.05). Hemodynamic parameters (heart rate, systolic and diastolic blood pressure) remained stable and comparable between groups. The incidence of PONV was also similar (levobupivacaine: 20%, ropivacaine: 16.7%; *p* = 0.739).

Conclusion: Ultrasound-guided ESPB with 0.5% levobupivacaine and 0.5% ropivacaine provides equivalent postoperative analgesia, opioid-sparing effects, and hemodynamic stability in patients undergoing laparoscopic cholecystectomy. Both agents are safe and effective, with no significant difference in analgesic efficacy or side-effect profile.

Keywords: Cholecystectomy, Erector spinae plane block, Ultrasonography, Bupivacaine; Ropivacaine & Postoperative Pain Management

Introduction

Laparoscopic cholecystectomy (LC) has become the gold standard for symptomatic gallbladder disease due to advantages including reduced surgical trauma, shorter hospital stays, and faster recovery compared to open surgery [1]. Despite being minimally invasive, patients frequently experience moderate to severe postoperative pain during the first 24–72 hours following surgery [2]. This pain arises from a combination of somatic pain from trocar insertion sites, visceral pain from gallbladder dissection, and referred shoulder pain due to diaphragmatic irritation from pneumoperitoneum [3]. Poorly controlled postoperative pain can delay mobilization, prolong hospital stay, increase opioid consumption, and negatively impact patient satisfaction and recovery outcomes [4]. Effective perioperative pain management is therefore a critical component of anaesthetic care in LC. Multimodal analgesia, which combines analgesics acting through different mechanisms, is widely recommended to enhance analgesic efficacy while minimizing opioid-related adverse effects such as nausea, vomiting, respiratory depression, ileus, and sedation [5]. This approach typically includes non-steroidal anti-inflammatory drugs (NSAIDs), paracetamol, opioids, and regional anaesthesia techniques [6]. Among regional techniques, ultrasound-guided fascial plane blocks have emerged as effective and technically simpler alternatives to neuraxial and paravertebral techniques, offering significant opioid-sparing benefits [7].

The Erector Spinae Plane Block (ESPB), first described by Forero et al. in 2016, is a relatively novel ultrasound-guided

regional anaesthesia technique [8]. The block involves deposition of local anaesthetic deep to the erector spinae muscle at the level of the transverse process. The injectate spreads cranially and caudally within the fascial plane, providing multilevel analgesia by acting on the dorsal rami, ventral rami, and rami communicantes of spinal nerves, enabling both somatic and visceral analgesia [9]. Compared to other regional techniques such as paravertebral block and quadratus lumborum block, ESPB is technically easier to perform, has a more superficial needle path, and carries a lower risk of complications such as pneumothorax, hypotension, or inadvertent neuraxial spread [10]. These advantages make ESPB an attractive component of multimodal analgesia within Enhanced Recovery After Surgery (ERAS) pathways[11]. Local anaesthetics commonly used for ESPB include bupivacaine, ropivacaine, and levobupivacaine. Ropivacaine and levobupivacaine are both long-acting amide local anaesthetics with improved safety profiles compared to racemic bupivacaine [12]. Ropivacaine is associated with less cardiotoxicity and motor blockade, while levobupivacaine, the S-enantiomer of bupivacaine, offers prolonged sensory blockade with reduced central nervous system and cardiovascular toxicity [13]. Although multiple studies have evaluated ESPB using either ropivacaine or levobupivacaine individually, direct comparative studies assessing their relative efficacy, onset, and duration of analgesia in ESPB for LC are limited. Existing literature suggests that levobupivacaine may provide a longer duration of analgesia compared to ropivacaine; however, evidence remains insufficient and inconclusive [14].

Given the increasing adoption of ESPB as part of multimodal analgesia for LC, identifying the most effective local anaesthetic agent is essential to optimize postoperative pain control and minimize opioid requirements. While both ropivacaine and levobupivacaine are widely used due to their favorable safety profiles, there is a paucity of high-quality comparative data evaluating their analgesic efficacy when used in equipotent concentrations for ESPB. The present study is therefore designed to compare 0.5% ropivacaine and 0.5% levobupivacaine in ultrasound-guided ESPB in patients undergoing LC. The findings may contribute valuable evidence to guide anaesthesiologists in selecting the optimal local anaesthetic agent for ESPB, thereby improving postoperative analgesia, reducing

opioid consumption, and enhancing overall patient recovery.

Aims and Objectives

1. To compare the efficacy of ropivacaine and levobupivacaine in ESPB by assessing postoperative pain scores using the Visual Analogue Scale (VAS) over 24 hours.
2. To compare the total requirement of rescue analgesia and the time to first analgesic request within the first 24 hours postoperatively.

Material and Methods

Study Design and Setting: This prospective, comparative study was conducted in the Department of Anaesthesiology at Santosh Medical College and Hospital after obtaining Institutional Ethical Committee approval (IEC No: SU/2022/MC/127). Written informed consent was obtained from all participants.

Participants: Sixty adult patients (ASA physical status I-II), aged 18-60 years, scheduled for elective LC under general anaesthesia were enrolled. Exclusion criteria included ASA status III-IV, emergency surgery, acute cholecystitis, coagulopathy, morbid obesity (BMI >35 kg/m^2), known allergy to local anaesthetics, and inability to comprehend the pain scale.

Sample size calculation was done in open epi software version 3.0 taking the Study by Manazir Athar et al reported that mean time to achieve sensory block was 13.5±4.94 minute and mean time of onset of motor block to bromage 3 was 12.17±4.09 minute in levobupivacaine group while mean time to achieve sensory block was 7.33±2.54 minute and mean time of onset of motor block to bromage 3 was 7.83±2.84 minute in ropivacaine group. At 95% confidence level and 90% power, expecting this difference as statistically significant, sample size was calculated as 16 per group, considering 20% non-response rate and rounded up to 60 study participants were selected (30 in each group).

Randomization and Blinding: Patients were randomly allocated to one of two groups (n=30 each) using a computer-generated random number sequence concealed in serially numbered opaque sealed envelopes (SNOSE). The anaesthesiologist performing the block was not blinded due to the nature of the intervention, but the post-anaesthesia care unit (PACU) nursing staff and the investigator responsible for postoperative data collection were blinded to the group allocation.

Study Groups:

- **Group L (Levobupivacaine):** Received bilateral ESPB with 10 mL of 0.5% levobupivacaine on each side (total 20 mL).

- **Group R (Ropivacaine):** Received bilateral ESPB with 10 mL of 0.5% ropivacaine on each side (total 20 mL).

Anaesthetic and Surgical Technique: Standard general anaesthesia protocol was followed for all patients. After completion of surgery and before extubation, the patient was placed in the lateral decubitus position. Under aseptic conditions, a high-frequency linear ultrasound probe was used to identify the T7 transverse process and the overlying erector spinae muscle. Using an in-plane technique, a 22-gauge Tuohy needle was advanced to the fascial plane between the transverse process and the erector spinae muscle. After negative aspiration, the study drug was injected, observing hydrodissection of the fascial plane. The block was repeated on the contralateral side.

Postoperative Analgesia Protocol: In the PACU, pain was assessed using a 10 cm Visual Analogue Scale (VAS; 0=no pain, 10=worst imaginable pain) at 0, 1, 2, 4, 8, 10, 12, 16, and 24 hours postoperatively. Rescue analgesia with intravenous tramadol 100 mg was administered when the VAS score was ≥4. The time to the first request for rescue analgesia was recorded. The total number of tramadol doses required in the first and second 12-hour periods was noted.

Data Collection: Demographic data (age, gender, weight, height, BMI, ASA status), duration of surgery, intraoperative and postoperative haemodynamic parameters (heart rate, systolic and diastolic blood pressure), VAS scores, time to first rescue analgesia, total rescue analgesic consumption, and incidence of PONV were recorded.

Statistical Analysis: Data were analysed using SPSS version 16.0. Normality of continuous data was assessed using the Kolmogorov-Smirnov test. Normally distributed data (age, haemodynamic parameters) were presented as mean ± standard deviation and compared using the independent samples t-test. Non-normally distributed data (VAS scores) were presented as median (interquartile range) and compared using the Mann-Whitney U test. Categorical data (gender, ASA, PONV, rescue analgesic requirement) were presented as numbers (percentages) and compared using the Chi-square or Fisher's exact test. A p-value <0.05 was considered statistically significant.

Results

Table 1: Baseline and Intraoperative Characteristics of the Study Groups

Characteristic	Group L (n=30)	Group R (n=30)	p-value
Age (years), mean ± SD	37.63 ± 10.18	38.90 ± 12.10	0.663
Gender (Female), n (%)	18 (60.0)	16 (53.3)	0.602
ASA I / II, n	Nov-19	Dec-18	0.791
Weight (kg), mean ± SD	67.77 ± 9.09	68.97 ± 9.31	0.356
BMI (kg/m²), mean ± SD	24.50 ± 2.10	24.55 ± 2.51	0.938
Surgery Duration (min), mean ± SD	79.47 ± 6.75	82.00 ± 6.89	0.156

The mean age among the Levobupivacaine group was 37.63 ± 10.18 years and that of the Ropivacaine Group was 38.90 ± 12.10 years. Both the group was found to be similar with respect to age (P value 0.663). Among 30 patients in Levobupivacaine group 12 (40.0%) were Males and 18 (60.0%) were females. In 30 cases in Ropivacaine Group 14 (46.7%) were Males and 16 (53.3%) were females. Gender was equally distributed in both the groups with the p value shows 0.602. Among the Levobupivacaine group, 11 (36.7%) patients were classified as ASA PS 1 and 19 (63.3%) patients as ASA PS 2. Among the Ropivacaine Group, 12 (40.0%) patients were ASA PS 1 and 18 (60.0%) were ASA PS 2. The distribution with respect to ASA PS status was found to be similar in both the groups. The mean weight of study participants among the Levobupivacaine group was 67.77 ± 9.09 Kgs and that of the Ropivacaine Group was 68.97 ± 9.31Kgs. Both the group has statistically similar mean weight with a p value of 0.356. The mean height of study participants among the Levobupivacaine group was 165.97 ± 5.86 cms and that of the Ropivacaine Group was 167.33 ± 5.49 cms. Both the group has statistically similar mean height with a p value of 0.615. The mean BMI of study participants among the Levobupivacaine group was 24.50 ± 2.10 Kg/m2 and that of the Ropivacaine Group was 24.55 ± 2.51 Kg/m2. Both the group has statistically similar mean BMI with a p value of 0.938. The mean duration of surgery distribution among the

Levobupivacaine group was 79.47 ± 6.75 minutes and that of the Ropivacaine Group was 82.00 ± 6.89 minutes. Both the group has statistically similar mean duration of surgery with a p value of 0.156.

Table 2: Visual analogue scale distribution compared between the groups

VAS score In various time period	Levobupivacaine group (n = 30)		Ropivacaine Group (n = 30)		p value
	Median	IQR	Median	IQR	
0 hours	0.00	0.00 - 0.00	0.00	0.00 - 0.00	1.000
1 hour	1.00	0.00 - 1.00	1.00	0.00 - 1.00	1.000
2 hours	1.00	1.00 - 1.00	1.00	1.00 - 1.00	0.619
4 hours	1.00	1.00 - 4.00	1.50	1.00 - 4.00	0.781
8 hours	2.00	2.00 - 2.00	2.00	2.00 - 2.00	1.000
10 hours	2.00	2.00 - 3.00	2.00	2.00 – 2.25	0.800
12 hours	3.00	2.00 - 3.00	3.00	2.00 - 3.00	1.000
16 hours	3.00	3.00 - 4.00	3.00	3.00 - 4.00	1.000
24 hours	3.00	2.75 - 4.00	3.00	2.75 - 4.00	0.863

Note p value based on Mann-Whitney U Test.

The median base line VAS score among the Levobupivacaine group was 0.00 (IQR = 0.00 - 0.00) and that of the Ropivacaine Group was 0.00 (IQR = 0.00 - 0.00). The mean 24 hours VAS score among the Levobupivacaine group was 3.00 (IQR = 2.75 - 4.00) and that of the Ropivacaine Group was 3.00 (IQR = 2.75 - 4.00). The median VAS score was equally distributed in both the groups over various time period with the p value shows more than 0.05 respectively.

Table 3: Rescue Analgesic Requirement compared between the groups

Parameter	Group L, n (%)	Group R, n (%)	p-value
Rescue Analgesic in First 12 hours	10 (33.3%)	11 (36.7%)	0.787
Rescue Analgesic in Second 12 hours	20 (66.7%)	19 (63.3%)	0.787
Total	30	30	

The mean time to first rescue analgesia was nearly identical (Group L: 17.17 ± 4.20 hours vs. Group R: 16.83 ± 4.20 hours; p=0.760). The requirement for rescue tramadol in the first 12 hours and second 12 hours was comparable between groups (Table 3).

Table 4: Post operative nausea and vomiting (PONV) distribution compared between the groups

PONV	Levobupivacaine group	Ropivacaine Group	Total	p value
Yes	6 (20.0%)	5 (16.7%)	11 (18.3%)	0.739
No	24 (80.0%)	25 (83.3%)	49 (81.7%)	
Total	30 (100.0%)	30 (100.0%)	60 (100.0%)	

Among 30 patients in Levobupivacaine group 12 6 (20.0%) were had reported PONV and 30 cases in Ropivacaine Group 5 (16.7%) were had PONV. PONV was equally reported in both the groups with the p value shows 0.739

Discussion

This prospective comparative study demonstrates that 0.5% levobupivacaine and 0.5% ropivacaine, when used in equal

volumes for bilateral ultrasound-guided ESPB, provide clinically equivalent postoperative analgesia in patients undergoing LC. The findings contribute to the evolving evidence on local anaesthetic selection for fascial plane blocks and have practical implications for perioperative pain management protocols. The comparable demographic profiles and intraoperative characteristics between the two groups, as detailed in Table 1, establish a robust foundation for unbiased comparison. The mean age in both cohorts aligns with the typical demographic for symptomatic gallstone disease [15], while the female predominance reflects well-established epidemiological patterns [16]. The similarity in BMI and surgical duration further minimizes confounding variables related to tissue pharmacokinetics and surgical stress, respectively [17].

The primary outcome of this study, the time to first rescue analgesic request, revealed no significant difference (17 hours for both groups). This finding is clinically significant as it suggests that the anticipated longer sensory blockade attributed to levobupivacaine's pharmacological profile—namely its higher lipid solubility and protein binding—may not translate into a practical advantage in the context of ESPB [13]. The mechanism of ESPB, which relies on fascial plane diffusion and multi-dermatomal spread rather than discrete perineural saturation, might attenuate the subtle potency differences observed in conventional nerve blocks [9, 18]. Our results are consistent with the meta-analysis by Li et al., which concluded that while levobupivacaine might show a trend toward longer duration in some peripheral nerve block settings, the overall clinical analgesic efficacy between the two agents is comparable [19]. However, they contrast with studies like that of Kulkarni et al. on supraclavicular block, which reported a longer analgesic duration with levobupivacaine [20]. This discrepancy highlights a key principle: the clinical behavior of a local anaesthetic is not solely a function of its pharmacology but is profoundly modulated by the anatomical environment and technique of administration [21].

A detailed analysis of VAS scores, presented in Table 2, shows an identical analgesic trajectory over 24 hours. Both groups experienced minimal pain (median VAS 0-1) in the immediate postoperative period (0-2 hours), with a gradual, parallel increase to moderate levels (median VAS 3) by 12-24 hours. This pattern underscores the effectiveness of ESPB in providing a

substantial pain-free window, aligning with the findings of Altıparmak et al., who demonstrated significantly reduced early postoperative pain scores with ESPB using bupivacaine [22]. The lack of statistical divergence at any time point strongly supports the equivalence of both agents in controlling dynamic and resting pain.

The rescue analgesic consumption data, detailed in Table 3, provides further evidence of equivalence. The similar proportion of patients requiring rescue medication in both the early (first 12 hours: 35%) and late (second 12 hours: 65%) phases indicates a consistent decay in block efficacy, irrespective of the local anaesthetic used. This pattern correlates with the rising VAS scores and suggests that the decision-point for supplemental analgesia was driven by a similar threshold of pain perception in both groups. This opioid-sparing effect is a well-documented benefit of ESPB, as evidenced by meta-analyses from Daghmouri et al. and Koo et al., which reported significant reductions in 24-hour opioid consumption following ESPB for LC [23, 24]. Our study confirms this benefit but finds it to be equally conferred by both local anaesthetics.

The haemodynamic stability observed throughout the study period is a noteworthy finding. Both groups maintained consistent heart rate and blood pressure within physiological ranges, with no episodes of clinically significant bradycardia or hypotension. This stability can be attributed to the fascial plane nature of the ESPB, which minimizes extensive sympathetic blockade compared to neuraxial techniques [10], and to the favourable cardiovascular safety profiles of both S-enantiomer local anaesthetics [12, 13]. Studies comparing ESPB to thoracic epidural or paravertebral blocks have consistently reported superior hemodynamic stability with ESPB, supporting its safety profile [25, 26].

The incidence of PONV, as shown in Table 4, was low (20% vs. 16.7%) and statistically comparable. This is a critical patient-centred outcome. The observed rates are substantially lower than those often reported in patients reliant on systemic opioids for analgesia [27]. This reduction can be directly attributed to the opioid-sparing effect of an effective regional block, reinforcing the role of ESPB within ERAS protocols aimed at minimizing opioid-related adverse effects [11, 28]. De Cassai et al., in a systematic qualitative review of ESPB, noted that a common finding across studies was a reduction in opioid-related side effects, including PONV, which aligns with our observations [29]. The clinical implications of

this study are immediately practical. In the context of ESPB for LC, anaesthesiologists can choose between levobupivacaine and ropivacaine based on institutional availability, cost considerations, and personal experience without compromising analgesic outcomes. This flexibility is valuable in resource-variable settings. Furthermore, the excellent safety and efficacy demonstrated support the routine integration of ESPB with either agent into standardized multimodal analgesia pathways for LC, as suggested by recent procedure-specific guidelines [30].

This study has several limitations. The single-centre design and sample size, though adequate for the primary comparison, limit the generalizability of the findings. The lack of blinding of the block performer is a potential source of bias, mitigated by blinding outcome assessors. We also did not evaluate long-term outcomes such as chronic post-surgical pain, patient satisfaction scores, or time to readiness for discharge, which are important metrics in contemporary perioperative care. Future research should address these gaps through multicentre trials with larger sample sizes. Investigations could explore dose-response relationships, the utility of adjuvants (e.g., dexamethasone, dexmedetomidine) to extend block duration, and direct comparisons with other local anaesthetics or different ESPB injection volumes [31]. Studies focusing on functional recovery metrics and cost-effectiveness analyses would also be highly valuable.

Conclusion

In conclusion, this prospective comparative study found no significant difference in the analgesic efficacy, duration, opioid-sparing effect, or safety profile between 0.5% levobupivacaine and 0.5% ropivacaine when used for ultrasound-guided bilateral ESPB in patients undergoing laparoscopic cholecystectomy. Both agents provided prolonged, effective postoperative analgesia with stable haemodynamics and a low incidence of side effects. Therefore, the choice between these two local anaesthetics for ESPB can be guided by factors such as cost, availability, and clinician preference, rather than an expectation of superior analgesic performance from one agent over the other.

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