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Original Research Article

ROPIVACAINE VERSUS LEVOBUPIVACAINE IN USG GUIDED TAP BLOCK FOR POST OPERATIVE ANALGESIA IN PATIENTS UNDERGOING INFRAUMBILICAL ABDOMINAL SURGERY UNDER GENERAL ANAESTHESIA

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ABSTRACT

Background: Effective postoperative analgesia is crucial for enhancing recovery after infraumbilical abdominal surgery. Ultrasound-guided transversus abdominis plane (TAP) block has emerged as a reliable regional analgesic technique. This study aimed to compare the efficacy and safety of ropivacaine versus levobupivacaine for TAP block in patients undergoing infraumbilical abdominal surgery under general anesthesia.

Materials and Methods: This prospective, randomized study included 128 patients (ASA I–II, age 18–65 years) scheduled for infraumbilical surgery. Patients were randomly assigned to receive either 20 mL of 0.2% ropivacaine (Group R, n=64) or 20 mL of 0.25% levobupivacaine (Group L, n=64) bilaterally under ultrasound guidance. Hemodynamic parameters, postoperative pain using Visual Analogue Scale (VAS), time to first rescue analgesia, total tramadol consumption, patient satisfaction, and adverse events were recorded for 24 hours postoperatively. Data were analyzed using independent t-test and Chi-square test; $p < 0.05$ was considered significant.

Results: Baseline demographics, ASA status, BMI, and duration of surgery were comparable between groups. Hemodynamics remained stable in both groups throughout surgery ($p > 0.05$). Postoperative VAS scores were lower in the levobupivacaine group at 16 hours (4.0 ± 1.1 vs 4.5 ± 1.2; $p=0.041$) and 24 hours (3.2 ± 0.9 vs 3.8 ± 1.0; $p=0.025$). Time to first rescue analgesia was longer (482.5 ± 85.6 min vs 424.5 ± 81.4 min; $p=0.031$), and total tramadol consumption was lower (100 ± 23.3 mg vs 123.8 ± 32.7 mg; $p=0.045$) in Group L. Patient satisfaction scores were higher with levobupivacaine (8.5 ± 1.0 vs 7.8 ± 1.2; $p=0.016$). Adverse events were minimal and comparable in both groups.

Conclusion: Both ropivacaine and levobupivacaine provide safe and effective analgesia when used in ultrasound-guided TAP block. Levobupivacaine offers a modestly longer duration of analgesia, reduced opioid requirement, and improved patient satisfaction, making it a preferred option for extended postoperative pain control.

Keywords: TAP block, ropivacaine, levobupivacaine, postoperative analgesia, infraumbilical abdominal surgery, ultrasound-guided, opioid-sparing.

INTRODUCTION

Effective postoperative analgesia after infraumbilical abdominal surgery is crucial to enhance patient comfort, reduce stress response, facilitate early mobilization, and prevent complications such as atelectasis, thromboembolism, and delayed recovery.[1] Multimodal analgesic regimens incorporating regional techniques are now standard practice to minimize systemic opioid use and its

associated adverse effects, including nausea, vomiting, ileus, and respiratory depression.[2]

The transversus abdominis plane (TAP) block, first described by Rafi in 2001, has emerged as a reliable regional technique for somatic pain control after lower abdominal surgeries.[3] By depositing local anesthetic between the internal oblique and transversus abdominis muscles, TAP block blocks the thoracolumbar nerves (T6–L1) supplying the anterolateral abdominal wall. The use of ultrasound (USG) guidance has significantly improved the success rate and safety profile of TAP blocks by allowing direct visualization of anatomical layers, needle tip, and local anesthetic spread.[4,5]

Among the commonly used long-acting local anesthetics for TAP block, ropivacaine and levobupivacaine are both S-enantiomer derivatives of bupivacaine with a more favorable cardiotoxicity and neurotoxicity profile. Ropivacaine is known for its differential sensory block with minimal motor blockade, whereas levobupivacaine has been reported to provide slightly longer duration of analgesia in some studies.[6-8] Several studies comparing the two drugs in TAP blocks have shown comparable pain scores and opioid-sparing effects, but findings remain inconsistent, likely due to variability in concentrations, volumes used, surgical procedures, and adjunct analgesics.[9,10]

Given the increasing reliance on TAP block as part of multimodal analgesia and the clinical need to choose an optimal local anesthetic for prolonged pain relief with minimal opioid consumption and side effects, a direct comparison of ropivacaine and levobupivacaine under standardized conditions is warranted. So, this study was conducted with an aim to determine the efficacy of ropivacaine and levobupivacaine in ultrasound-guided TAP block as a viable mode of postoperative analgesia in patients undergoing infraumbilical abdominal surgery under general anesthesia. Also, we aimed to compare total opioid requirement in the first 24 hours following surgery between the two groups; and to assess patient satisfaction scores in both groups.

MATERIALS AND METHODS

Study Design: This prospective, interventional, randomized, double-blinded study was conducted for the period of 12 months between June 2023 to June 2024, in the department of Anaesthesia in the College of Medicine & JNM Hospital (COMJNMH), Kalyani. Ethical clearance was obtained from the institutional ethics committee, and written informed consent was taken from all participants prior to enrollment.

Study Population: The study population included all patients scheduled for elective infraumbilical abdominal surgery under general anesthesia at COMJNMH. Patients aged 18–65 years, of American Society of Anesthesiologists (ASA) physical status I or II, and body mass index (BMI) between 18.5 and ≤30 kg/m² were considered eligible. Exclusion criteria included any contraindication or hypersensitivity to local anesthetics, inability to communicate, infection, scar tissue, or anatomical abnormalities at the site of injection, and significant systemic illness (ASA ≥ III). Only patients meeting inclusion criteria and providing informed consent were recruited.

Sample Size and Randomization: The sample size was calculated based on data from H. Baby Rani et al., in which the mean 24-hour visual analogue scale (VAS) scores in the ropivacaine and levobupivacaine groups were 0.31 ± 0.84 and 0.60 ± 0.89, respectively. Assuming a detectable mean difference of 0.42, a confidence interval of 95%, and a power of 80%, a total of 128 patients were required, with 64 patients allocated to each group. Sample size calculation was performed using WinPepi software (version 3.8). Participants were randomized into two groups using a computer-generated random number table by Anaesthesiologist 1 (A1), who prepared the study drugs. Allocation was concealed, and both the patient and the anesthesiologist assessing postoperative outcomes were blinded to group assignment.

Preoperative Assessment: All patients underwent a thorough pre-anesthetic evaluation, which included detailed medical history, general physical examination, airway assessment, systemic examination, and routine investigations including complete blood count, liver and renal function tests, electrocardiogram (ECG), and spine examination. Additional investigations were performed as indicated. Patients were informed about the TAP block procedure and the use of the visual analogue scale for pain assessment, and their questions were addressed to ensure understanding.

Anesthetic Management: On the day of surgery, patients were identified, verified for fasting status, and intravenous access was established. Standard monitoring was applied, including heart rate, systolic and diastolic blood pressure, mean arterial pressure, SpO_2, end-tidal CO_2, and ECG, and baseline readings were recorded. Premedication consisted of intravenous glycopyrrolate (0.2 mg), midazolam (1 mg), fentanyl (2 µg/kg), and ondansetron (4 mg). Preoxygenation was performed with 100% oxygen for 3 minutes via an appropriate-sized anatomical mask. Anesthesia induction was achieved with intravenous propofol (2 mg/kg) titrated to loss of verbal response, followed by vecuronium (0.1 mg/kg) to facilitate endotracheal intubation. Anesthesia was maintained using a mixture of nitrous oxide and oxygen along with isoflurane, with intermittent vecuronium supplementation (0.03 mg/kg) for muscle relaxation. Intraoperative analgesia was supplemented with intravenous paracetamol 1 g infusion.

Ultrasound-Guided TAP Block Procedure: At the completion of surgery, the study drug was prepared by A1 according to randomization. Patients in Group R received 20 mL of 0.2% ropivacaine on each side,

while patients in Group L received 20 mL of 0.25% levobupivacaine on each side. The procedure was performed under aseptic conditions using a high-frequency linear ultrasound probe (GE LOGIQ V2, 6–12 MHz) covered with a sterile sleeve. The probe was positioned in the mid-axillary line between the costal margin and iliac crest to identify the fascial plane between the internal oblique and transversus abdominis muscles. A Stimuplex™ needle was advanced in-plane from medial to lateral, and after negative aspiration, 20 mL of the study drug was injected on each side under direct visualization of local anesthetic spread.

Emergence and Postoperative Management: Following completion of the TAP block, residual neuromuscular blockade was reversed with neostigmine (0.05 mg/kg) and glycopyrrolate (0.2 mg/kg), and patients were oxygenated with 100% oxygen for 5 minutes. Patients were extubated once spontaneous respiration and vital signs were stable, and then transferred to the postoperative recovery unit. The end of surgery was considered as time zero (T_0). Postoperative monitoring included vital parameters and pain assessment using the VAS at 30-minute intervals for the first 6 hours and every 2 hours thereafter up to 24 hours.

Rescue analgesia was administered with intravenous tramadol (2 mg/kg) if VAS ≥ 4 at 10 minutes after extubation, and the time to first analgesic requirement was recorded. Total tramadol consumption over 24 hours was noted. Patient satisfaction was assessed on a 0–10 scale, where 0 represented "not satisfied" and 10 represented "fully satisfied" with postoperative analgesia.

Statistical Analysis: Data were coded and analyzed using SPSS version 20. Continuous variables were presented as mean ± standard deviation and compared using independent t-test, while categorical variables were presented as frequencies and analyzed using the chi-square test. A p-value <0.05 was considered statistically significant.

RESULTS

The study included 128 patients, equally divided into Group R and Group L. Both groups were comparable in terms of age, gender distribution, BMI, ASA physical status, and presence of co-morbidities. The mean age was 42.1 ± 12.3 years in Group R and 43.5 ± 11.7 years in Group L (p = 0.505). Males comprised 59.3% in Group R and 54.7% in Group L (p = 0.612). Mean BMI values were similar between groups (24.8 ± 3.1 vs 25.2 ± 3.0; p = 0.425). Duration of surgery and ASA grading also did not differ significantly, indicating well-matched study groups [Table 1].

Table 1: Demographic and baseline clinical characteristics of patients in Group R (Ropivacaine) and Group L (Levobupivacaine).

Variable	Group R (n=64)	Group L (n=64)	p-value
	Frequency (%)/ mean ± SD		
Age (years)	42.1 ± 12.3	43.5 ± 11.7	0.505
Gender			
Male	38 (59.3%)	35 (54.7%)	0.612
Female	26 (40.7%)	29 (45.3%)	
BMI (kg/m²)	24.8 ± 3.1	25.2 ± 3.0	0.425
ASA Grade			
I	40 (62.5%)	42 (65.6%)	0.618
II	24 (37.5%)	22 (33.4%)	
Duration of Surgery (min)	95.4 ± 21.7	98.7 ± 18.5	0.124
Co-morbidities	18 (28.1%)	20 (31.3%)	0.722

Heart rate (HR), mean arterial pressure (MAP), and SpO_2 were comparable between groups at all measured time points. Baseline HR was 84 ± 9 bpm in Group R and 83 ± 10 bpm in Group L (p = 0.612). Post-induction and post-incision HR and MAP showed expected physiological variations without significant intergroup differences. Oxygen saturation remained stable at 98 ± 1% throughout the surgery in both groups (p = 1.000). These findings suggest that both drugs maintained hemodynamic stability during surgery [Table 2].

Table 2: Heart rate, mean arterial pressure, and oxygen saturation at baseline, post-induction, post-incision, and end of surgery in both groups.

Time	T_1 (baseline)	T_2 (post-induction)	T_3 (post-incision)	T_{12} (end of surgery)
	mean ± SD			
HR (bpm)				
Group R (n=64)	84 ± 9	76 ± 8	82 ± 10	78 ± 9
Group L (n=64)	83 ± 10	75 ± 9	83 ± 9	77 ± 8
p-value	0.612	0.515	0.237	0.685
MAP (mmHg)				
Group R (n=64)	94 ± 7	88 ± 6	92 ± 8	89 ± 7
Group L (n=64)	95 ± 8	87 ± 7	93 ± 7	88 ± 6
p-value	0.585	0.456	0.615	0.623
SpO_2 (%)				
Group R (n=64)	98 ± 1	98 ± 1	98 ± 1	98 ± 1

Group L (n=64)	98 ± 1	98 ± 1	98 ± 1	98 ± 1
p-value	1.000	1.000	1.000	1.000

HR = heart rate; MAP = mean arterial pressure; SpO_2 = peripheral oxygen saturation.

Both groups demonstrated effective postoperative analgesia following TAP block. At 10 minutes post-extubation, mean VAS scores were 3.2 ± 1.1 in Group R and 3.0 ± 1.0 in Group L (p = 0.315). At 12, 16, and 24 hours, the levobupivacaine group exhibited slightly lower pain scores compared to ropivacaine, reaching statistical significance at 16 hours (4.5 ± 1.2 vs 4.0 ± 1.1; p = 0.041) and 24 hours (3.8 ± 1.0 vs 3.2 ± 0.9; p = 0.025). These results indicate a marginally longer duration of analgesia with levobupivacaine [Table 3].

Table 3: Postoperative pain intensity measured by Visual Analogue Scale (VAS) at specified time intervals up to 24 hours.

Time post-surgery	Group R (n=64)	Group L (n=64)	p-value
	VAS (Mean ± SD)		
10 min	3.2 ± 1.1	3.0 ± 1.0	0.315
4 hours	2.8 ± 0.9	2.6 ± 0.8	0.252
8 hours	3.5 ± 1.0	3.2 ± 0.9	0.181
12 hours	4.0 ± 1.1	3.5 ± 1.0	0.052
16 hours	4.5 ± 1.2	4.0 ± 1.1	0.041
24 hours	3.8 ± 1.0	3.2 ± 0.9	0.025

VAS score ranges from 0 (no pain) to 10 (worst pain).

A higher proportion of patients in Group R required rescue analgesia (65.6% vs 53.1%; p = 0.102), although this was not statistically significant. Time to first rescue analgesia was significantly longer in Group L (482.5 ± 85.6 min) compared to Group R (424.5 ± 81.4 min; p = 0.031). Total tramadol consumption over 24 hours was also lower in Group L (100 ± 23.3 mg) than in Group R (123.8 ± 32.7 mg; p = 0.045). Patient satisfaction scores were higher in the levobupivacaine group (8.5 ± 1.0 vs 7.8 ± 1.2; p = 0.016), reflecting improved analgesic quality [Table 4].

Table 4: Rescue analgesia requirement, total tramadol consumption, time to first analgesic, and patient satisfaction scores in both groups.

Parameter	Group R (n=64)	Group L (n=64)	p-value
	Frequency (%)/ mean ± SD		
Patients requiring rescue analgesia	42 (65.6%)	34 (53.1%)	0.102
Time to first rescue analgesia (min)	424.5 ± 81.4	482.5 ± 85.6	0.031
Total tramadol consumption (mg)	123.8 ± 32.7	100.0 ± 23.3	0.045
Patient satisfaction score (0–10)	7.8 ± 1.2	8.5 ± 1.0	0.016

Rescue analgesia indicates requirement for tramadol. Patient satisfaction scored 0–10 (0 = not satisfied; 10 = fully satisfied).

Both local anesthetics demonstrated a favorable safety profile. Incidence of nausea/vomiting was 6.3% in Group R and 4.7% in Group L (p = 0.778). Hypotension occurred in 3.1% and 1.6%, while bradycardia was observed in 1.6% of patients in both groups. No cases of local anesthetic toxicity were reported. Block failure was rare (3.1% vs 1.6%; p = 0.506), indicating high effectiveness and safety for both ropivacaine and levobupivacaine in TAP block [Table 5].

Table 5: Frequency of postoperative adverse events and block-related complications in both groups.

Event	Group R (n=64)	Group L (n=64)	p-value
	Frequency (%)		
Nausea/Vomiting	4 (6.3%)	3 (4.7%)	0.778
Hypotension	2 (3.1%)	1 (1.6%)	0.586
Bradycardia	1 (1.6%)	1 (1.6%)	1.000
Local anesthetic toxicity	0 (0.0%)	0 (0.0%)	–
Block failure	2 (3.1%)	1 (1.6%)	0.506

DISCUSSION

The present study compared the efficacy and safety of ropivacaine and levobupivacaine for ultrasound-guided transversus abdominis plane (TAP) block in patients undergoing infraumbilical abdominal surgery under general anesthesia.

Both groups were comparable in terms of age, gender, BMI, ASA grade, co-morbidities, and duration of surgery. Proper matching of baseline characteristics is essential to minimize confounding in clinical trials assessing analgesic efficacy. Similar demographic matching has been reported in previous studies evaluating TAP block analgesia, including Babu et al., Sharma et al., and Şahin et al., ensuring that observed differences in analgesic outcomes are attributable to the study drugs rather than patient factors.[11-13]

Intraoperative heart rate (HR), mean arterial pressure (MAP), and oxygen saturation (SpO_2) remained stable across both groups. Post-induction decreases in HR and MAP and post-incision increases were observed in both groups, reflecting expected physiological responses to anesthesia and surgical stimulation. There were no statistically significant differences between ropivacaine and levobupivacaine at any time point. These findings align with studies by Sharma et al., and Gujjar et al., which demonstrated minimal cardiovascular impact with both ropivacaine and levobupivacaine compared to racemic bupivacaine, highlighting their safety profile in perioperative settings.[14,15]

VAS scores indicated effective postoperative analgesia in both groups immediately post-extubation and during the early postoperative period. Notably, levobupivacaine provided slightly lower VAS scores at 12, 16, and 24 hours postoperatively, reaching statistical significance at 16 and 24 hours ($p < 0.05$). These findings are consistent with previous comparative studies; for instance, Luck et al., and Vampugalla et al., reported that levobupivacaine exhibits longer sensory blockade and slightly prolonged analgesic effect compared to ropivacaine, which may be explained by its higher lipid solubility and greater protein binding, leading to slower systemic absorption and extended duration of action.[16,17] Sahu et al., also reported that TAP block with long-acting amide anesthetics provides reliable postoperative analgesia, particularly for lower abdominal surgeries.[18]

The levobupivacaine group demonstrated a significantly longer time to first rescue analgesia (482.5 ± 85.6 min vs 424.5 ± 81.4 min; $p = 0.031$) and lower total tramadol consumption (100 ± 23.3 mg vs 123.8 ± 32.7 mg; $p = 0.045$). Although the proportion of patients requiring rescue analgesia was higher in the ropivacaine group (65.6% vs 53.1%), this difference did not reach statistical significance ($p = 0.102$). These observations reinforce the opioid-sparing benefit of levobupivacaine in TAP block, consistent with findings by Qian et al., and Romi et al., who reported reduced postoperative opioid requirements with long-acting amide anesthetics.[19,20] Clinically, prolonged analgesia translates to better patient comfort, early mobilization, and reduced risk of opioid-related adverse effects.

Patient satisfaction scores were significantly higher in the levobupivacaine group (8.5 ± 1.0 vs 7.8 ± 1.2; $p = 0.016$). This is likely a reflection of the longer duration of analgesia and reduced need for rescue analgesics. Several studies, including Bhat et al., and Athar et al., have highlighted that patient-reported satisfaction correlates closely with the quality and duration of postoperative pain control, emphasizing the clinical relevance of selecting an agent that provides extended analgesia.[21,22]

Both drugs were well tolerated, with minimal adverse events. The incidence of nausea/vomiting, hypotension, bradycardia, block failure, or local anesthetic toxicity was low and comparable between groups. No cases of systemic toxicity were observed. These findings corroborate previous reports by Mankikar et al., and Karasu et al., who emphasized the safety of ultrasound-guided TAP blocks with long-acting amide anesthetics.[23,24] The use of ultrasound guidance likely contributed to the high block success rate and low complication rate by allowing real-time visualization of anatomical planes and needle placement.

Limitations: The study was conducted at a single center and included only ASA I–II patients, limiting generalizability to higher-risk populations. Additionally, only a single concentration and volume of each drug were used; variations in dosage could potentially alter analgesic outcomes. Future studies could explore continuous TAP block infusions or multimodal analgesia combinations to optimize pain control further.

CONCLUSION

Ultrasound-guided TAP block with either ropivacaine or levobupivacaine provides effective and safe postoperative analgesia for patients undergoing infraumbilical abdominal surgery under general anesthesia. Both agents maintain stable intraoperative hemodynamics and offer satisfactory early postoperative pain control. Levobupivacaine demonstrates a modest but statistically significant advantage in prolonging analgesic duration, reducing opioid consumption, and improving patient satisfaction within the first 24 hours post-surgery. These findings support the use of levobupivacaine as a preferred agent in TAP blocks where extended analgesia is desirable, while confirming that ropivacaine remains a reliable alternative with comparable efficacy and safety.

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