



Original Article

Corresponding Author:
Dr. Darshan Hasmukhlal Vegada

MD (Anaesthesiology),
Department of Anaesthesiology,
D. Y. Patil Medical College,
Hospital and Research Institute,
D. Y. Patil Education Society
(Deemed to be University),
Kolhapur, Maharashtra, India

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Ropivacaine 0.2% Versus Bupivacaine 0.25% for Bilateral External Oblique Intercostal Block After Upper Abdominal Surgery: A Randomized, Double-Blind Trial

Dr. Darshan Hasmukhlal Vegada^{1*}, Dr. Sandeep Kadam², Dr. Chiragkumar G. Adroja³, Dr. Yogeshwari⁴

¹MD (Anaesthesiology), Department of Anaesthesiology, D. Y. Patil Medical College, Hospital and Research Institute, D. Y. Patil Education Society (Deemed to be University), Kolhapur, Maharashtra, India

²MD (Anaesthesiology), Professor and Head, Department of Anaesthesiology, D. Y. Patil Medical College, Hospital and Research Institute, D. Y. Patil Education Society (Deemed to be University), Kolhapur, Maharashtra, India

³MD (Medicine), Assistant Professor, Department of General Medicine, GMERS Medical College, Morbi, Gujarat, India

⁴MD (Anaesthesiology), Department of Anaesthesiology, D. Y. Patil Medical College, Hospital and Research Institute, D. Y. Patil Education Society (Deemed to be University), Kolhapur, Maharashtra, India.

ABSTRACT

Background and Aims: The external oblique intercostal (EOI) block is increasingly used after upper abdominal surgery, but the best local anaesthetic for it is unknown. We compared ropivacaine 0.2% with bupivacaine 0.25% for bilateral EOI block.

Methods: In this prospective, randomised, double-blind trial, 39 adults of ASA physical status I-II scheduled for elective upper abdominal surgery under general anaesthesia received a bilateral ultrasound-guided EOI block at the end of surgery. Each side was given 20 mL of either ropivacaine 0.2% (Group R, n = 19) or bupivacaine 0.25% (Group B, n = 20). The primary outcome was the duration of postoperative analgesia. Secondary outcomes included time to first rescue analgesia, visual analogue scale (VAS) scores, tramadol use and adverse effects.

Results: Median (interquartile range) duration of analgesia was 480 (370–540) min with ropivacaine and 300 (195–345) min with bupivacaine ($P < 0.001$). First rescue request came later, at 520 (465–660) vs 315 (215–352.5) min ($P < 0.001$). The difference held after adjustment for age, sex and ASA status (β 214.8 min; 95% confidence interval 128.2 to 301.4). The 24-h VAS area under the curve was lower with ropivacaine (51.7 vs 62.7; $P = 0.001$), and a single tramadol dose was enough for more patients (14/19 vs 4/20; $P = 0.001$). Nausea occurred in 10.5% vs 40.0% ($P = 0.065$), and there were no block-related complications.

Conclusion: Ropivacaine 0.2% gave longer analgesia and reduced rescue opioid needs compared with bupivacaine 0.25% in bilateral EOI block. This finding was unexpected and needs to be confirmed in larger trials.

Keywords: Abdominal muscles; analgesia; bupivacaine; nerve block; pain, postoperative; ropivacaine.

INTRODUCTION

Pain after upper abdominal surgery is often severe, and it gets worse every time the patient breathes deeply or coughs.[1] Relying mainly on opioids brings its own problems, including nausea, sedation and ileus, which is why current guidance favours multimodal analgesia with a regional component wherever possible.[2–4] Adequate pain relief also matters for lung function and for getting patients out of bed early after these operations.[5] Thoracic epidural analgesia does the job well, but hypotension, concerns about coagulation and the small risk of serious neuraxial complications limit its use.[6,7] Fascial plane blocks such as the transversus abdominis plane, erector spinae plane and quadratus lumborum blocks have filled much of this gap.[8–10]

The EOI block was described by Elsharkawy and colleagues. Local anaesthetic is placed beneath the external oblique muscle, over the ribs and intercostal muscles at the level of the sixth to eighth ribs.[11] The block covers the lateral and anterior cutaneous branches of T6–T10, it is done with the patient supine, and the needle stays well away from the pleura.[11,12] Several randomised trials and meta-analyses have now shown lower pain scores and less opioid use with this block after laparoscopic cholecystectomy, open hepatectomy and other upper abdominal procedures.[13–18]

What these studies do not tell us is which drug to use. Trials have used either bupivacaine or ropivacaine, in concentrations anywhere from 0.2% to 0.5%, and the two have not been compared directly in this block.[13–18] The choice matters because fascial plane blocks need large volumes, so the margin of safety of the drug becomes important. Ropivacaine is less cardiotoxic than bupivacaine, but it is also less potent.[19–25] We therefore set out to test whether the duration of postoperative analgesia after bilateral EOI block differs between ropivacaine 0.2% and bupivacaine 0.25% in adults undergoing upper abdominal surgery.

METHODS

We carried out this prospective, randomised, double-blind, parallel-group trial in the Department of Anaesthesiology of a tertiary teaching hospital in western India over a period of 18 months. The Institutional Ethics Committee approved the study (approval details are given on the title page), and the trial was registered with the Clinical Trials Registry–India (CTRI/2025/02/080575). All patients gave written informed consent. The study followed the Declaration of Helsinki (2013), and we report it in line with the CONSORT 2010 statement.[26]

Adults aged 18–60 years, of ASA physical status I or II, who were scheduled for elective upper abdominal surgery under general anaesthesia were eligible. We excluded patients undergoing emergency surgery and those with infection at the puncture site, allergy to amide local anaesthetics, pregnancy or lactation, or coagulopathy or anticoagulant therapy.

Patients were allocated in a 1:1 ratio to Group R (ropivacaine 0.2%) or Group B (bupivacaine 0.25%) using a computer-generated random number table. An anaesthesiologist who took no other part in the study kept the allocation sequence and prepared identical, unlabelled 20-mL syringes. As a result, the anaesthesiologist who performed the block, the patient and the person assessing pain after surgery were all unaware of the group allocation.

All patients received standard monitoring. Premedication consisted of intravenous glycopyrrolate 0.004 mg/kg, midazolam 0.05 mg/kg, fentanyl 2 µg/kg and ondansetron 0.1 mg/kg. Anaesthesia was induced with propofol 2 mg/kg, and succinylcholine 2 mg/kg was given to facilitate intubation. Anaesthesia was maintained with sevoflurane at 0.8–1.0 minimum alveolar concentration in an oxygen–air mixture, with vecuronium for muscle relaxation. Patients were ventilated in volume-controlled mode with a tidal volume of 6–8 mL/kg, keeping end-tidal carbon dioxide between 35 and 40 mmHg. The blocks were given at the end of surgery, before extubation, under full aseptic precautions. We placed a 6–13 MHz linear probe in a parasagittal orientation between the midclavicular and anterior axillary lines at the level of the sixth to eighth ribs and identified the external oblique muscle, the ribs, the intercostal muscles and the pleura. The needle was advanced in-plane until its tip lay deep to the external oblique muscle and superficial to the rib. Correct placement was confirmed by hydrodissection with 1–2 mL of saline. After negative aspiration, 20 mL of the study drug was injected on each side, giving a total of 40 mL (80 mg of ropivacaine or 100 mg of bupivacaine).

Pain was measured on a 10-cm VAS,[27] where 0 means no pain and 10 the worst pain imaginable, at 10 and 30 min after extubation and then at 1, 4, 8, 12, 16, 20 and 24 h. Whenever the VAS score was above 3, the patient received intravenous tramadol 100 mg. Patients who did not need any rescue analgesia within 24 h were censored at 1440 min.

The primary outcome was the duration of postoperative analgesia, which we defined as the time from completion of the block to the first VAS score above 3. Secondary outcomes were the time from the end of the block to the patient's first request for rescue analgesia, VAS scores at each time point, the overall pain burden expressed as the VAS area under the

curve (AUC) over 24 h (trapezoidal method), the amount of tramadol used in 24 h, and adverse effects. The adverse effects we looked for were nausea, vomiting, hypotension, bradycardia, arrhythmia and signs of local anaesthetic systemic toxicity. The sample size was calculated with G*Power 3.1.9.4 for a difference between two independent means. Using an effect size (d) of 1.72 taken from preliminary literature, a one-tailed α of 0.01 and a power of 0.95, we needed 13 patients per group. To allow for exclusions, we planned to recruit 30 patients (15 per group). Recruitment was kept open for the full 18-month study period, and 39 patients were randomised in the end.

We checked the distribution of continuous data with the Shapiro–Wilk test. Continuous variables are reported as mean (standard deviation) or median (interquartile range [IQR]) and were compared with Welch's t-test or the Mann–Whitney U test, as appropriate. Categorical variables were compared with the chi-square test or Fisher's exact test. Changes in VAS within each group over time were tested with the Friedman test. We also analysed the repeated VAS scores with a linear mixed-effects model that included a random intercept for each patient, first without adjustment and then adjusted for age, sex and ASA status. Time to first rescue analgesia was also shown as Kaplan–Meier curves, with patients who never needed rescue censored at 24 h. To check whether the group effect on duration of analgesia was independent of other factors, we used multivariable linear regression adjusted for age, sex and ASA status. Two sensitivity models added diagnosis (acute or non-acute) and surgical approach (laparoscopic or open). A P value below 0.05 was taken as significant. The VAS comparisons at individual time points were not corrected for multiple testing and should be read as exploratory.

RESULTS

Table 1. Baseline characteristics. Values are mean (SD) or n (%).

Variable	Group R (n = 19)	Group B (n = 20)	P
Age, years	51.8 (12.6)	50.6 (9.6)	0.723
Male sex	7 (36.8)	13 (65.0)	0.113
ASA II	10 (52.6)	11 (55.0)	1.000
Systolic BP, mmHg	120.5 (9.1)	117.0 (10.3)	0.265
Diastolic BP, mmHg	79.5 (7.1)	74.8 (8.5)	0.066
Heart rate, beats/min	72.9 (10.1)	76.6 (12.0)	0.302
Diagnosis: cholelithiasis / acute calculous cholecystitis / choledocholithiasis / cholelithiasis with acute cholecystitis	7 / 5 / 4 / 3	7 / 4 / 6 / 3	0.922
Laparoscopic cholecystectomy	12 (63.2)	10 (50.0)	0.581*
Open cholecystectomy	5 (26.3)	5 (25.0)	
Open CBD exploration	1 (5.3)	1 (5.0)	
Open cholecystectomy with CBD exploration or splenectomy	1 (5.3)	4 (20.0)	

*P for overall distribution of procedures. ASA, American Society of Anesthesiologists physical status; BP, blood pressure; CBD, common bile duct.

We assessed 42 patients for eligibility, and three did not meet the inclusion criteria. The remaining 39 were randomised, 19 to Group R and 20 to Group B. Every patient completed the 24-h follow-up and was included in the analysis (Figure 1). The two groups were similar at baseline and in the type of surgery they underwent, although there were fewer men in Group R (Table 1).

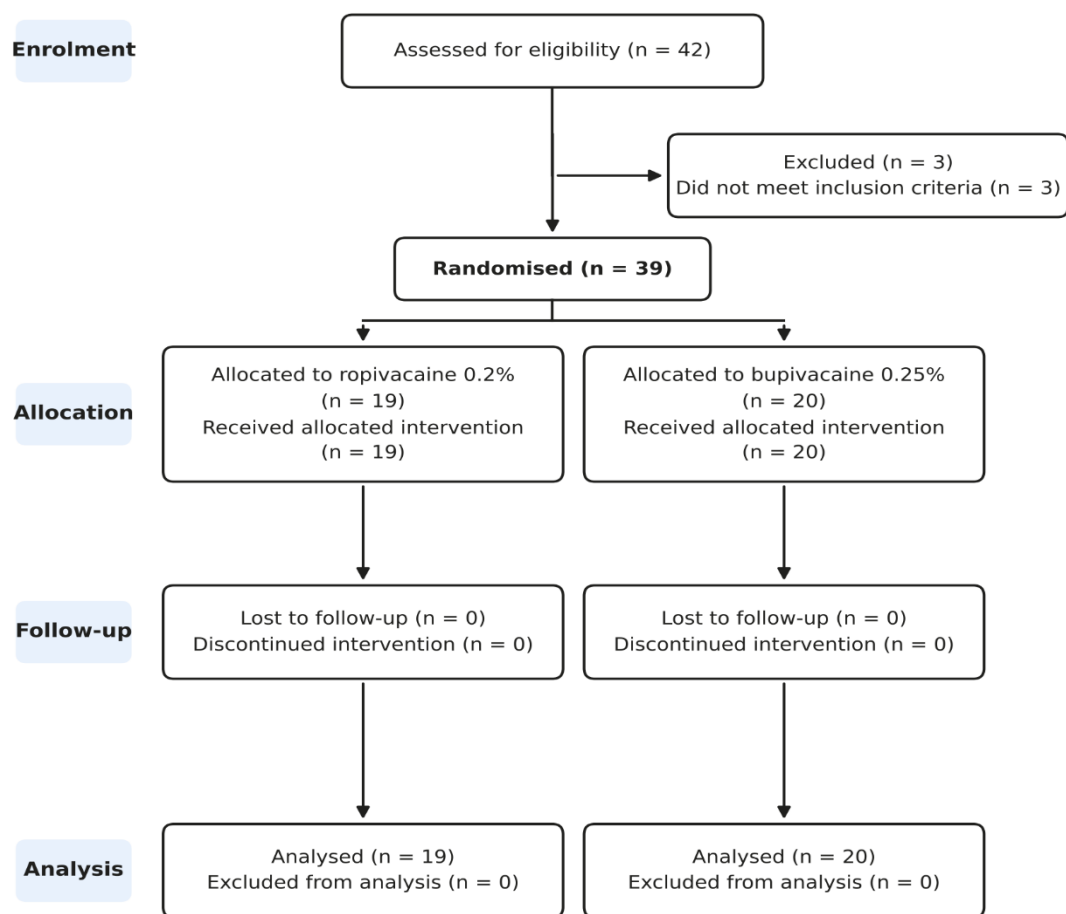


Figure 1. CONSORT flow diagram of patient enrolment, allocation, follow-up and analysis.

Table 2. Analgesic outcomes and adverse effects. Values are median (IQR) or n (%).

Outcome	Group R (n = 19)	Group B (n = 20)	P
Duration of analgesia, min	480 (370–540)	300 (195–345)	< 0.001
Time to first rescue request, min	520 (465–660)	315 (215–352.5)	< 0.001
VAS AUC 0–24 h	51.7 (40.0–57.3)	62.7 (57.1–66.5)	0.001
Single tramadol dose (100 mg) sufficient	14 (73.7)	4 (20.0)	0.001
Tramadol 200 mg in 24 h	4 (21.1)	16 (80.0)	
Nausea	2 (10.5)	8 (40.0)	0.065
Hypotension, bradycardia, arrhythmia, LAST	0	0	—

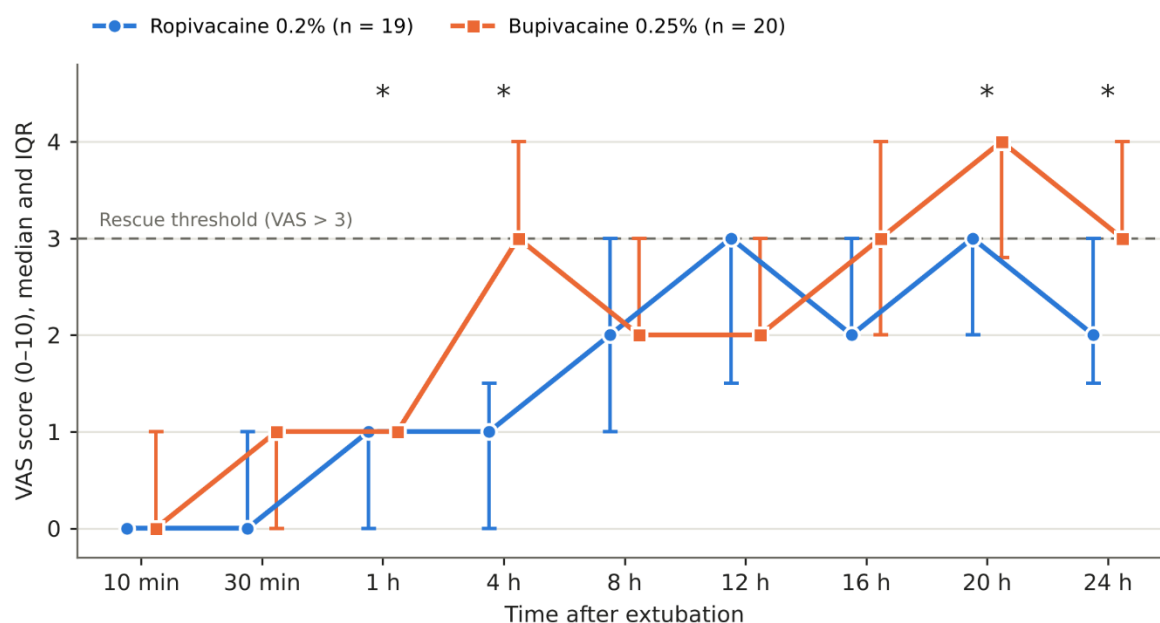
One Group R patient received neither 100 mg nor 200 mg; percentages use the full group. AUC, area under the curve; LAST, local anaesthetic systemic toxicity; VAS, visual analogue scale.

Analgesia lasted a median of 180 min longer with ropivacaine, and the first request for rescue analgesia came a median of 205 min later (Table 2). On multivariable regression, ropivacaine was associated with 214.8 min (95% CI 128.2 to 301.4) more analgesia, whereas age, sex and ASA status had no significant effect. The estimate barely changed when diagnosis (β 208.0 min, 95% CI 122.8 to 293.2) or surgical approach (β 216.5 min, 95% CI 129.0 to 304.1) was added to the model.

Table 3. VAS scores, median (IQR).

Time	Group R (n = 19)	Group B (n = 20)	P
10 min	0 (0–0)	0 (0–1)	0.349
30 min	0 (0–1)	1 (0–1)	0.269
1 h	1 (0–1)	1 (1–1)	0.032

4 h	1 (0–1.5)	3 (3–4)	0.001
8 h	2 (1–3)	2 (2–3)	0.636
12 h	3 (1.5–3)	2 (2–3)	0.488
16 h	2 (2–3)	3 (2–4)	0.091
20 h	3 (2–3)	4 (2.8–4)	0.014
24 h	2 (1.5–3)	3 (3–4)	0.001



* P < 0.05, Mann-Whitney U test (unadjusted). IQR, interquartile range; VAS, visual analogue scale.

Figure 2. Median visual analogue scale scores (interquartile range) over 24 h in the ropivacaine and bupivacaine groups.

Pain scores were low in both groups during the first 30 min. They were lower with ropivacaine at 1 h and 4 h, similar between 8 and 16 h, and lower again at 20 h and 24 h (Table 3, Figure 2). Within each group, VAS changed significantly over time (Friedman $P = 0.001$). In the unadjusted mixed model, time had a significant effect ($P < 0.001$), but neither group ($P = 0.256$) nor the group $\times$ time interaction ($P = 0.077$) did. Once age, sex and ASA status were taken into account, ropivacaine was associated with lower VAS scores across the 24 h (estimate -0.43 ; $P = 0.015$), and the interaction remained non-significant ($P = 0.197$).

Patients in Group R needed less tramadol over 24 h (Mann-Whitney $P < 0.001$). After adjustment for age, sex, ASA status, procedure and diagnosis, ropivacaine was associated with 59.6 mg less tramadol (95% CI 30.7 to 88.5). None of the patients developed hypotension, bradycardia, arrhythmia or signs of systemic toxicity, and we saw no complications related to the block.

DISCUSSION

In this trial, a bilateral EOI block with ropivacaine 0.2% gave about 3 h more analgesia than one with bupivacaine 0.25%. Patients asked for rescue analgesia later, had less pain overall across the first day, and were less likely to need a second dose of tramadol. The difference in duration remained after we adjusted for patient and surgical factors.

The durations we saw are in keeping with earlier work on this block. Trials comparing the EOI block with no block or with the subcostal transversus abdominis plane block report times to first rescue of roughly 6–8 h after a single injection of bupivacaine or ropivacaine.[13,14,16–18] Meta-analyses agree that the EOI block reduces opioid use and delays the need for rescue analgesia, although whether it is better than other fascial plane blocks is still unclear.[15,28] Our findings suggest that the choice of drug may also make a difference.

We did not expect the result to go in this direction. Ropivacaine is less lipid-soluble than bupivacaine and roughly 40% less potent, and in peripheral nerve blocks bupivacaine or levobupivacaine usually gives analgesia that lasts at least as

long.[22,23,25] In a similar trial of transversus abdominis plane block after laparoscopic cholecystectomy, ropivacaine 0.375% gave better pain scores than bupivacaine 0.25% only during the first hour, and rescue requirements over 24 h were the same.[29] In our study, the dose of ropivacaine (80 mg) was also lower than that of bupivacaine (100 mg). One possible explanation is that ropivacaine constricts local blood vessels at low concentrations, as has been shown after intradermal injection in volunteers, whereas bupivacaine tends to dilate them. Slower absorption from the well-perfused intercostal plane could then keep the drug at the nerves for longer.[22,30] We did not test this, however, and other explanations are possible. These include chance in a small sample, the subjective nature of an endpoint triggered by the VAS score, and imbalance in factors we did not measure, such as the length of the incision.

The pain scores themselves do not show a consistent advantage for ropivacaine. Pain was lower in Group R at 1, 4, 20 and 24 h but not between 8 and 16 h, by which time many patients in Group B had already received tramadol. The group effect was also significant only in the adjusted mixed model and not in the unadjusted one. The cumulative pain score and the proportion of patients needing a second dose of tramadol both reflect the full 24 h, and both favoured ropivacaine, so we consider them the more reliable measures. A difference of 1 point on the VAS is close to the smallest change that patients regard as clinically important after surgery.[31]

Nausea was less common with ropivacaine (10.5% vs 40.0%), but the difference did not reach significance, and the study was not powered to detect it. Both drugs were used at doses below the recommended maximum and no toxicity occurred, but a trial of 39 patients cannot rule out rare complications.[24] The lower cardiotoxicity of ropivacaine is still a practical advantage when large volumes are injected on both sides.[19–21]

Our study has some limitations. It was carried out in a single centre with 39 patients, and the sample size was based on a one-tailed calculation. We followed patients for only 24 h and did not assess quality of recovery, mobilisation or chronic pain. We did not map the extent of sensory block or test motor function, so block success could not be confirmed directly. The study included both laparoscopic and open operations, although adjusting for surgical approach did not change the result. The sex distribution differed between the groups by chance. Finally, the two concentrations are not equipotent, so our comparison reflects two solutions in common clinical use rather than equivalent doses.

CONCLUSION

In adults undergoing upper abdominal surgery, a bilateral EOI block with 20 mL per side of ropivacaine 0.2% gave longer postoperative analgesia, less pain overall and lower tramadol requirements than bupivacaine 0.25%, with no complications in either group. Because this result runs against what the potency of the two drugs would predict, it should be confirmed in larger multicentre trials with sensory mapping and longer follow-up before ropivacaine is recommended as the preferred drug for this block.

Ethics and registration: Institutional Ethics Committee, D. Y. Patil Medical College, Kolhapur (DYPMC/IEC/53/2024, 11 July 2024). CTRI/2025/02/080575. Written informed consent obtained from every participant.

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Conflicts of interest: None declared.

Data availability: De-identified data and the study protocol are available from the corresponding author on reasonable request.

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