International Journal of Medical and Pharmaceutical Research

Online ISSN-2958-3683 | Print ISSN-2958-3675
Frequency: Bi-Monthly
Available online on: https://ijmpr.in/

Original Article

A Comparative Evaluation of Postoperative Analgesia Using 0.375% Ropivacaine Versus 0.25% Bupivacaine for Bilateral Ultrasound- Guided Transversus Abdominis Plane Block in Elective Upper Abdominal Surgeries

Dr Shikha Sankla[1], Dr Uma Hariharan[2], Dr Ashok Kumar[3], Dr Vijay Kumar Nagpal[4]

[1]Senior Resident, Anaesthesiology, Atal Bihari Vajpayee Institute of Medical Sciences and Dr Ram Manohar Lohia Hospital New Delhi
[2]Professor, Critical Care Medicine, Atal Bihari Vajpayee Institute of Medical Sciences and Dr Ram Manohar Lohia Hospital New Delhi
[3]Director Professor, Anaesthesiology, Atal Bihari Vajpayee Institute of Medical Sciences and Dr Ram Manohar Lohia Hospital New Delhi
[4]Professor, Anaesthesiology, ESIC Model Hospital and Medical College, Basaidarapur, Ring Road, Delhi

Corresponding Author:

Dr Uma Hariharan
Professor, Critical Care Medicine, Atal Bihari Vajpayee Institute of Medical Sciences and Dr Ram Manohar Lohia Hospital New Delhi
Email: uma1708@gmail.com

Received: 01-06-2026
Accepted: 15-06-2026
Available online: 20-07-2026

ABSTRACT

Background: Effective postoperative pain control is a key component of enhanced recovery following upper abdominal surgery. Ultrasound-guided transversus abdominis plane (TAP) block has emerged as an effective regional analgesic technique that provides significant postoperative pain relief while reducing opioid requirements and their associated adverse effects, especially in upper abdominal surgeries. However, limited literature exists comparing lower concentrations of ropivacaine and bupivacaine for this purpose.

Materials and Methods: This prospective, randomized, double-blinded study involved 50 adult patients (ASA physical status I–II) scheduled for elective open upper abdominal surgery under general anesthesia. The patients were randomly allocated into two groups: Group A received an ultrasound-guided bilateral subcostal TAP block with 0.375% ropivacaine, while Group B received 0.25% bupivacaine. Postoperative pain was evaluated using the Visual Analog Scale (VAS) at predetermined time intervals. The primary outcome measured was postoperative pain scores, whereas secondary outcomes included duration of analgesia, time to first rescue analgesic, and the incidence of adverse effects.

Results: Demographic parameters were comparable between groups. Early postoperative VAS scores were similar in both groups. However, Group A demonstrated significantly lower VAS scores at 4 and 8 hours postoperatively ($p < 0.001$). The duration of analgesia was significantly prolonged in the ropivacaine group (14.75 ± 2.96 hours) compared to the bupivacaine group (7.24 ± 1.79 hours; $p < 0.001$). No significant adverse effects, including postoperative nausea, vomiting, or block-related complications, were observed in either group.

Conclusion: Ultrasound-guided TAP block provides effective postoperative analgesia for upper abdominal surgeries. The use of 0.375% ropivacaine offers superior and longer-lasting analgesia compared to 0.25% bupivacaine, with an excellent safety profile, making it a valuable component of multimodal analgesia protocols.

Keywords*: Transversus abdominis plane block; Subcostal approach; Ropivacaine; Bupivacaine; Ultrasound-guided regional anesthesia; Postoperative analgesia; Upper abdominal surgery; VAS scores.*

INTRODUCTION

Upper abdominal surgery involves incisions between the xiphoid process (T6) and the umbilicus (T10) and includes procedures such as cholecystectomy and hernia repairs. The abdominal wall is innervated by T7–L1 spinal nerves, including the lower six thoracic, iliohypogastric, and ilioinguinal nerves. [1]

Incisions in the anterolateral abdominal wall are a major source of postoperative pain, which if poorly controlled, can trigger serious complications, including myocardial ischemia and the development of chronic pain states. [2][15]

The usual management of acute pain following abdominal surgeries [3] involves multi modal analgesia like systemic analgesics, nerve blocks and central neuraxial techniques.

The transversus abdominis plane (TAP) block is a widely recognized technique for providing postoperative analgesia in abdominal surgeries and can be administered using either landmark-based or ultrasound-guided methods. The different types of TAP block include : Subcostal, lateral, posterior, oblique and four-quadrant. It serves as an effective component of multimodal analgesia for multiple upper abdominal procedures.[4][5][11][14]

Bupivacaine hydrochloride is a long-acting amino amide local anesthetic (1-butyl-2′,6′-pipecoloxylidide monohydrochloride monohydrate) commonly used for a variety of regional techniques including plane blocks.[6]

Ropivacaine hydrochloride((S)-N-(2,6-dimethylphenyl)-1-propylpiperidine-2-carboxamide) is a newer long-acting amino amide local anesthetic with lower systemic toxicity. Its reduced lipophilicity and stereoselective properties result in less cardiotoxicity and CNS toxicity compared to bupivacaine. [7][8][9][10]

We compared the post-operative analgesia using 0.375% Ropivacaine with 0.25% Bupivacaine in ultrasound guided TAP block for adult patients undergoing upper abdominal surgery under general anaesthesia. There is paucity of literature on the use of lower concentrations of ropivacaine for USG-guided TAP blocks.

MATERIALS AND METHODS

This prospective, randomized, double-blinded comparative study was conducted after obtaining institutional ethical approval and was carried out over a period of 14 months, from 1 May 2023 to 30 June 2024. The study was registered with the Clinical Trials Registry of India (CTRI) under registration number CTRI/2023/05/052181.

The primary objective of this study was to compare the efficacy of postoperative analgesia provided by 0.375% ropivacaine and 0.25% bupivacaine following ultrasound-guided transversus abdominis plane (TAP) block in adult patients undergoing elective upper abdominal surgeries including open surgeries such as open cholecystectomy, exploratory laparotomy, umbilical hernia repair, sleeve gastrectomy, hiatal hernia repair and gastrojejunostomy under general anaesthesia. The secondary objectives included assessment of the duration of analgesia, defined as the time to first requirement of rescue analgesia, and evaluation of the incidence of adverse effects during the postoperative period.
The sample size for this study was determined based on a previous study titled *"An evaluation of 0.25% bupivacaine vs. 0.5% ropivacaine for postoperative analgesia using ultrasound-guided transversus abdominis plane block for abdominal surgeries: A comparative study"* conducted by Sharma N. et al. in 2016. Based on this reference, the calculated sample size was 25 participants in each group, resulting in a total sample size of 50 patients.

The formula for calculated sample size is given below:

$$n = \frac{(\sigma 1^2 + \sigma 2^2) \cdot [Z\ 1-\alpha/2 + Z\ 1-\beta]^2}{(M1 - M2)^2}$$

Where, Zα/2 is the critical value of the Normal distribution at α/2 (for a confidence level of 95%, α is 0.05 and the critical value is 1.96)

Zβ is the critical value of the Normal distribution at β (for a power of 90%, β is 0.2 and its critical value is 1.282)
σ 1 and σ 2 are the Standard deviations of the two groups M1 and M2 are the means of two groups.

The study included adult patients who met the predefined inclusion and exclusion criteria, provided informed consent, and were scheduled for elective open upper abdominal surgeries. Patients aged 18–60 years, with a BMI between 18–30 kg/m², classified as ASA physical status I or II, and undergoing elective upper abdominal surgery under standard general

anesthesia were included. Patients were excluded if they were pregnant, had known allergies to opioids, amide local anesthetics, or NSAIDs, had coagulopathy or bleeding disorders, infection at the block site, or had significant cardiovascular, pulmonary, or neurological diseases.

Patients were randomized into Group A (0.375% ropivacaine) or Group B (0.25% bupivacaine) using computer-generated allocation with sealed opaque envelopes.
They were educated regarding pain assessment using a 100mm -Visual Analog Scale (VAS). The score is determined by measuring the distance (in mm or cm) from the "no pain" i.e. 0 end to the patient's mark. VAS of >4 is used as a threshold to start or escalate analgesia for the patients. Standard preoperative care was provided as per institutional protocol.

Intra-operative period
After positioning the patient supine, standard ASA monitors (ECG, non-invasive blood pressure, SpO_2, and $EtCO_2$) were applied and baseline vitals recorded. An 18G or 20G intravenous cannula was secured, and Ringer lactate or 0.9% normal saline infusion was started. Standard general anesthesia was induced (opioids were administered at the time of induction, i.e. fentanyl citrate 2mcg/kg) followed by endotracheal intubation and maintenance of anesthesia with oxygen–nitrous oxide (50:50) mixture and sevoflurane. Fentanyl top ups of 30mcg were given throughout the surgery at hourly basis. No opioid topups were administered 30 minutes prior to administering the nerve block. All patients received ondansetron 0.1 mg/kg intravenously 30 minutes before the end of surgery for PONV prophylaxis.

At the end of surgery, an ultrasound-guided bilateral subcostal transversus abdominis plane (TAP) block was performed. Group A patients received 15 ml of 0.375% ropivacaine on each side (maximum dose 2.5 mg/kg), while Group B patients were administered 15 ml of 0.25% bupivacaine on each side (maximum dose 2 mg/kg). Reversal of neuromuscular blockade and extubation were carried out according to standard protocols. Postoperative pain was evaluated using the Visual Analog Scale (VAS) at 30 minutes after the TAP block and subsequently at 2, 4, 8, 12, and 24 hours postoperatively.

Blinding technique:
Participants were randomized into two equal groups i.e. Group A = 0.375% Ropivacaine and Group B = 0.25% Bupivacaine (1:1 allocation ratio) using a computer-generated simple randomization sequence. Allocation concealment was ensured using sequentially numbered, opaque, sealed envelopes prepared by an independent investigator. The study drugs were prepared and administered by an anesthesiologist not involved in postoperative assessment. Both the patients and the independent observer responsible for monitoring postoperative pain scores were blinded to group allocation.

Technique of ultrasound-guided TAP block:
The subcostal TAP approach was used for upper abdominal surgeries bilaterally. Following aseptic skin preparation and draping, a high-frequency linear ultrasound probe (6–13 MHz) was positioned just below the xiphoid process and then advanced obliquely along the sub-costal margin to identify the rectus abdominis which tapers and then, as we move laterally; the three lateral wall muscles appear i.e. External oblique, Internal oblique and transversus abdominis respectively.

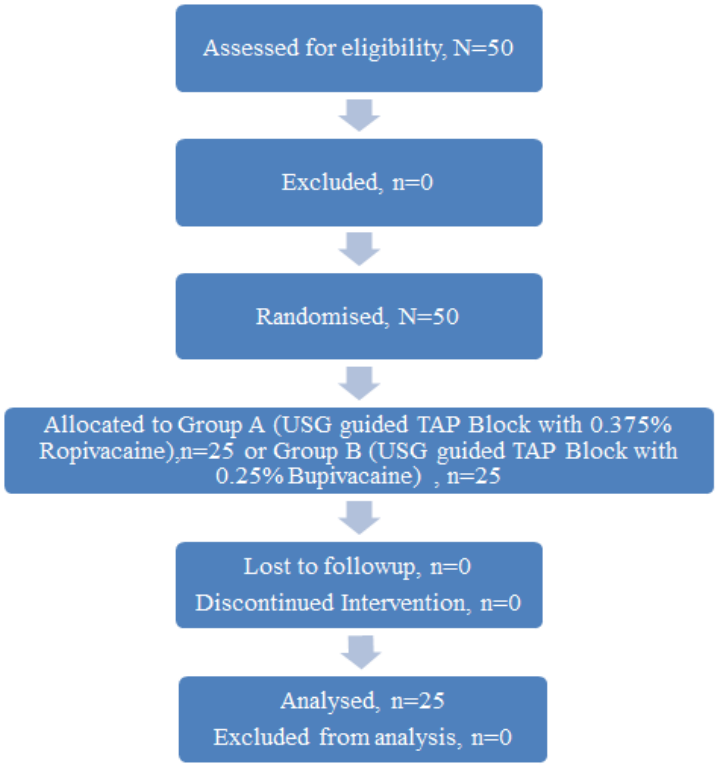
An in-plane technique was used to advance a 22G echogenic block needle into the fascial plane between the internal oblique and transversus abdominis muscles. Needle placement was verified by hydrodissection with 1–2 ml of normal saline, after which 15 ml of the study drug was injected gradually while observing the spread of the local anesthetic within the TAP plane under ultrasound guidance.

Patients were continuously monitored, and pain was assessed using VAS at 30 minutes after the block and subsequently at 2, 4, 8, 12, and 24 hours until the first rescue analgesia. As per institutional guidelines (in alignment with ASA guidelines and ERAS protocol), protocolised post operative rescue analgesia was administered as per patient clinical profile and pain assessment. Initially, non opioid drug i.e. Paracetamol 1 g IV was administered followed by weak opioid analgesic, Tramadol 50mg iv slowly when the VAS score exceeded 4. No strong opioid rescue analgesia was required to be administered in our study. The duration of analgesia was defined as the time interval between TAP block administration and the first requirement of rescue analgesia. VAS scores recorded after the administration of rescue analgesia were excluded from the analysis.

Postoperative nausea and vomiting were assessed using a four-point scale, with ondansetron 0.1 mg/kg IV given for scores ≥ 2, and patients were monitored for any other postoperative adverse events.

Statistical analysis was conducted using SPSS for Windows (version 28.0). Continuous variables were presented as mean ± standard deviation (SD) or median with interquartile range (IQR), as appropriate, while categorical variables were expressed as frequencies and percentages. Comparisons between the groups were performed using the unpaired t-test or Mann–Whitney U test for continuous variables, and the chi-square test or Fisher's exact test for categorical variables. A p value of < 0.05 was considered statistically significant.

FLOWCHART



RESULTS

The demographics of both groups were comparable with no statistically significant difference noted.

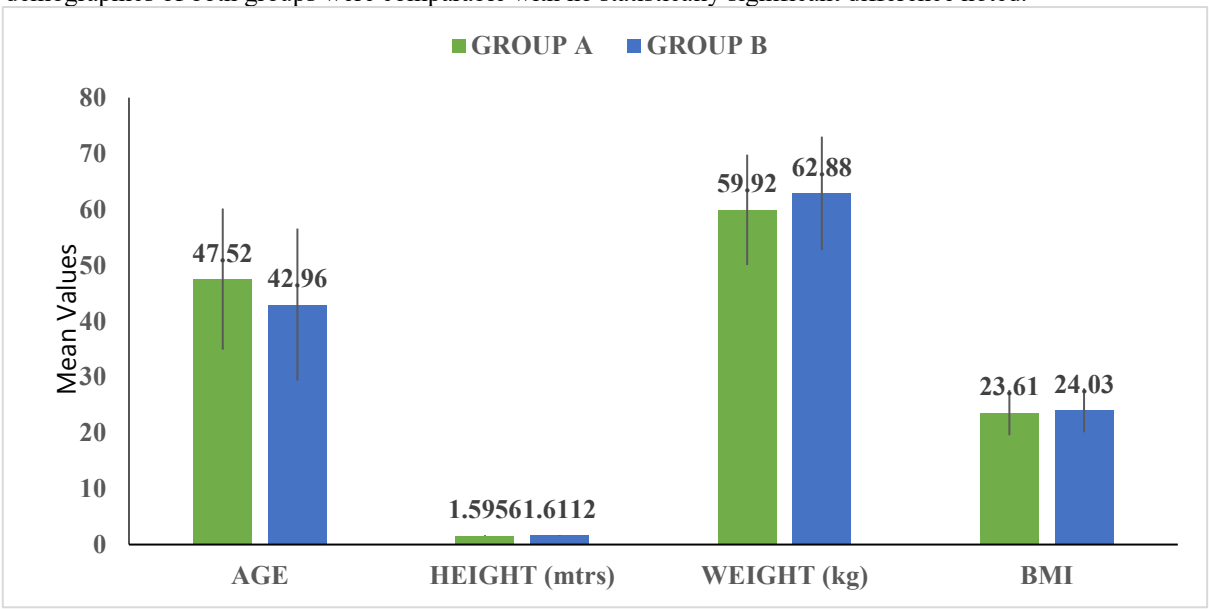


TABLE-1 The demographic and anthropometric variables (age, height, weight, and BMI) were comparable between Group A (0.375% ropivacaine) and Group B (0.25% bupivacaine), with no statistically significant differences (all P > 0.05).

Postoperative pain assessment using the Visual Analog Scale (VAS) demonstrated comparable analgesic efficacy between the two groups during the early postoperative period. At 30 minutes and at 2 hours following administration of the TAP block, median VAS scores were identical in both groups, and the difference was not statistically significant ($p = 1.000$), indicating similar immediate postoperative pain control with both 0.375% ropivacaine and 0.25% bupivacaine. However, as the postoperative period progressed, a clear divergence in analgesic efficacy became evident. At the 4th postoperative hour, patients in Group A reported significantly lower pain scores compared to those in Group B, and this difference remained highly significant at the 8th postoperative hour ($p < 0.001$ at both time points). Beyond the 8th hour, the majority of patients in Group B required rescue analgesia, which precluded further meaningful comparison of VAS scores at the 12th and 24th postoperative hours.

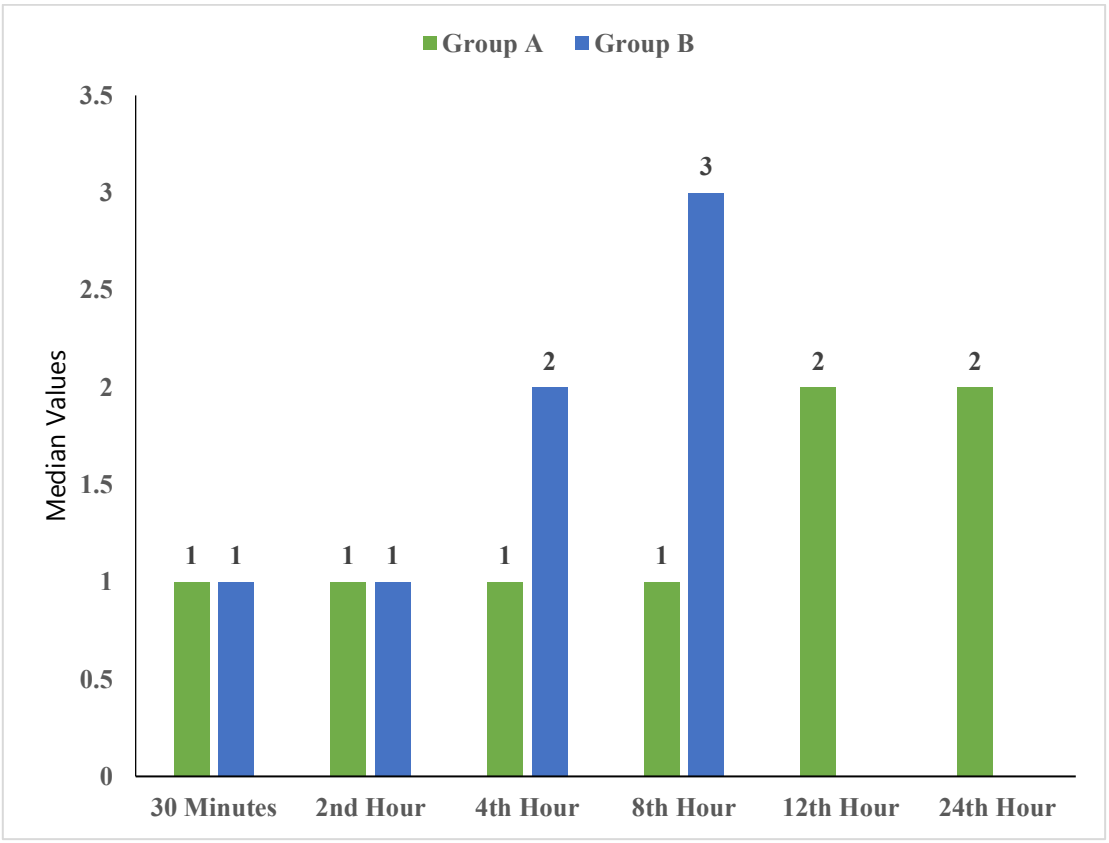


TABLE 2 - Median VAS scores were comparable between both groups at 30 minutes and 2 hours, but were significantly higher in Group B at 4 and 8 hours, indicating inferior analgesia. At 12 and 24 hours, only Group A data were available, showing a gradual decline in pain scores, with no comparable data from Group B.

The duration of analgesia is defined as the time from administering TAP block to the requirement of rescue analgesia for the first time, was significantly prolonged in Group A. Patients receiving 0.375% ropivacaine experienced a mean analgesic duration of 14.75 ± 2.96 hours, whereas those receiving 0.25% bupivacaine had a substantially shorter duration of analgesia of 7.24 ± 1.79 hours. The difference between time intervals for which p value < 0.001 was statistically significant which indicates superior and longer-lasting analgesic efficacy of ropivacaine in ultrasound-guided TAP block. Additionally, no episodes of postoperative nausea and vomiting or other adverse effects were observed in either groups, suggesting that both local anesthetic agents were safe and well tolerated in the studied population.

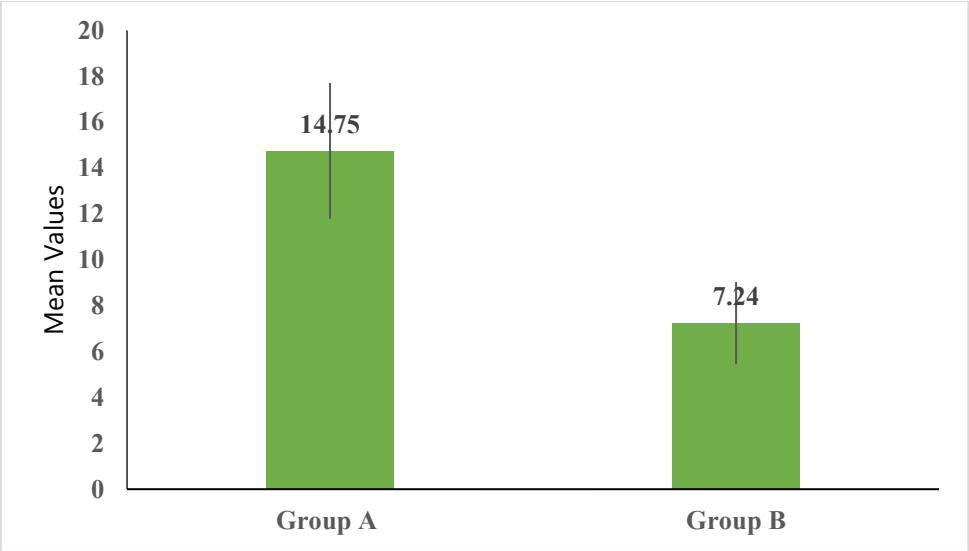


TABLE 3- Group A had a significantly longer time to rescue analgesia (14.75 ± 2.96 h) compared to Group B (7.24 ± 1.79 h; p < 0.001), indicating prolonged analgesic effect with ropivacaine.

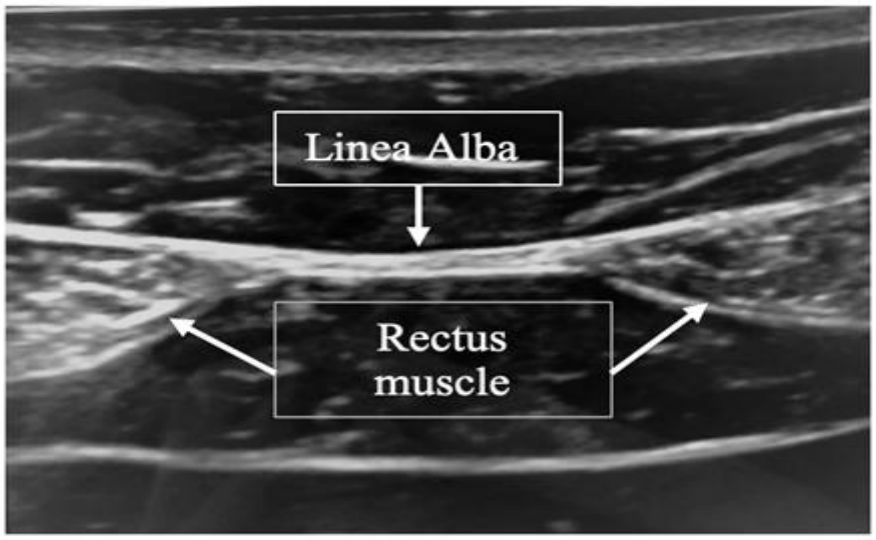


Image 1 – Keep the ultrasound probe over the xiphi sternum in the center so that bilateral rectus abdominis muscles (butterfly shape) with linea alba is seen as depicted in the above ultrasound image.

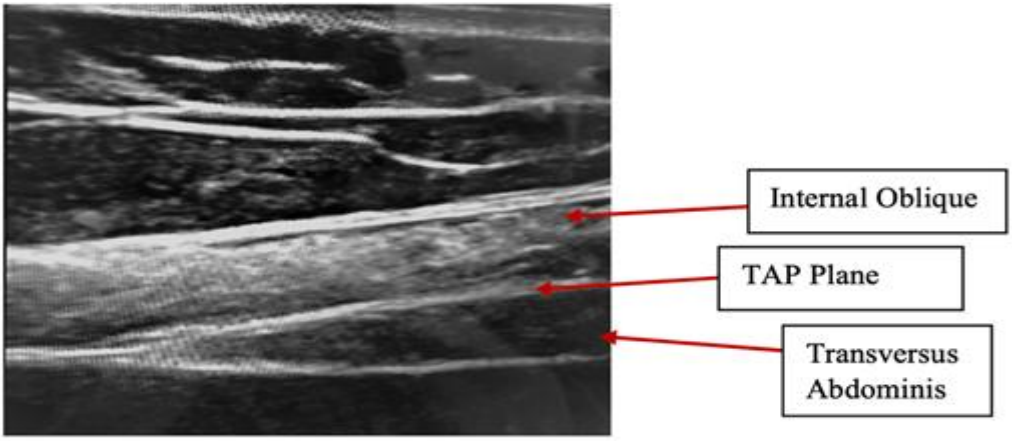


Image 2- Move the ultrasound probe over the subcostal margin on either side. Appearance of transversus abdominis muscle below the rectus abdominis muscle is observed and the drug is deposited in this plane between these two muscles

DISCUSSION

Ropivacaine is often preferred over bupivacaine for regional anesthesia techniques, including transversus abdominis plane (TAP) blocks, because of its better safety profile and favourable pharmacodynamic characteristics. As a pure S(–)-enantiomer, it demonstrates significantly lower cardiotoxicity and central nervous system toxicity than racemic Bupivacaine, providing a wider therapeutic index—which is essential in high-volume fascial plane blocks. It also produces greater sensory–motor differentiation, resulting in effective analgesia with less motor blockade and facilitating early postoperative mobilization. [16,17,18] In TAP blocks, analgesic efficacy is predominantly volume-dependent rather than concentration-dependent, as adequate spread within the fascial plane is essential to cover multiple thoracolumbar nerves; hence, larger volumes at lower concentrations are typically preferred to optimize dermatomal coverage while minimizing systemic toxicity. [19,20]

Patients receiving ropivacaine demonstrated significantly lower VAS scores at the 4th and 8th postoperative hours ($p < 0.001$). Similar results were obtained by two other studies. Fuladi et al. (2014) demonstrated superior analgesic efficacy of ropivacaine over bupivacaine in TAP block for lower abdominal surgeries, with pain scores consistently lower in the ropivacaine group and a comparable duration of analgesia for 0.25% bupivacaine (7.01 ± 0.23 hours) to that observed in the present study (7.24 ± 1.79 hours). Although Fuladi et al. used a higher concentration of ropivacaine (0.5%), resulting in a longer analgesic duration, our findings confirm that even a lesser concentration of ropivacaine (0.375%) provides significantly prolonged analgesia along with similar efficacy.[12] Sinha et al. (2016) reported lower early postoperative pain scores with 0.375% ropivacaine compared to 0.25% bupivacaine, though differences in duration of analgesia were not statistically significant; in contrast, our study demonstrated a major difference in both VAS scores at later intervals and duration of analgesia.[13]

The duration of analgesia is defined as the time interval between block administration to the requirement of rescue analgesia for the first time, was considerably longer in the ropivacaine group (14.75 ± 2.96 hours) in comparison to the bupivacaine group (7.24 ± 1.79 hours; $p < 0.001$), indicating a sustained analgesic effect. Similar results were obtained by two other studies. Sharma et al. (2016) similarly found longer analgesic duration with ropivacaine compared to bupivacaine, a finding consistent with our results despite the use of a lower ropivacaine concentration.[3] Flower et al. (2023) reported a significantly longer duration of analgesia with 0.375% ropivacaine in comparison to 0.25% bupivacaine in patients undergoing upper abdominal laparoscopic surgeries, corroborating our findings.[2] However, Sinha S et al. (2016) demonstrated lower pain scores with 0.375% ropivacaine at 10 min, 20 min, and 1 hour compared to 0.25% bupivacaine, with no significant difference thereafter and similar rescue analgesia timing which was in contrast to our study which showed lower pain scores at 4 and 8 hours and a markedly prolonged duration of analgesia with ropivacaine.[13] Across these studies, including the present one, ropivacaine consistently demonstrates superior and prolonged postoperative analgesia with a favorable safety profile when used for TAP block.

LIMITATIONS

The small sample size was one of the limitations of our study. So, further large-scale Randomised Control Trials are needed with larger sample sizes which compare 0.375% Ropivacaine with 0.25% concentration of Bupivacaine in USG-guided TAP block. Secondly, the TAP block was administered after completion of surgery and not preoperatively. In addition, there are different approaches to administer the TAP block for abdominal surgeries, which can be a confounding factor.[21]

CONCLUSION

The present study demonstrates that ultrasound-guided bilateral transversus abdominis plane (TAP) block is a safe, effective, and uncomplicated technique for providing postoperative analgesia in patients who undergo upper abdominal surgery. The practice of ultrasound guidance enhances the accuracy of block placement, improves analgesic efficacy, better success rates and also the risk of complications is reduced in comparison with landmark-based approaches. There is paucity of literature comparing 0.375% ropivacaine with 0.25% bupivacaine for upper abdominal surgeries.

Our study concludes that ultrasound-guided bilateral TAP block performed using 0.375% ropivacaine provides a significantly longer duration of postoperative analgesia and better analgesic efficacy as compared to 0.25% bupivacaine in upper abdominal surgeries. Both local anesthetic agents were well tolerated, with no episodes of postoperative nausea, vomiting, or other block-related adverse effects observed in either group.

REFERENCES

1. Jelinek LA, Scharbach S, Kashyap S, et al. Anatomy, abdomen and pelvis: anterolateral abdominal wall fascia. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan– [updated 2017 Oct]. Available from: http://www.ncbi.nlm.nih.gov/books/NBK459392
2. Flower SJL, Nicholas AF, Devaprasath R. A randomized comparative study of transversus abdominis plane block (TAP) with 0.25% bupivacaine and 0.375% ropivacaine in the duration of post-operative analgesia in upper abdominal laparoscopic surgeries. Indian J Clin Anaesth. 2023;10(4):340–4.
3. Sharma N, Mehta N, Sharma S. Evaluation of 0.25% bupivacaine vs 0.5% ropivacaine for postoperative analgesia using ultrasound-guided transversus abdominis plane block for abdominal surgeries: a comparative study. Indian J Clin Anaesth. 2016;3(4):635–9.
4. Soliz JM, Lipski I, Hancher-Hodges S, Speer BB, Popat K. Subcostal transversus abdominis plane block for acute pain management: a review. Anesthesiol Pain Med. 2017;7.
5. Young MJ, Gorlin AW, Modest VE, Quraishi SA. Clinical implications of the transversus abdominis plane block in adults. Anesthesiol Res Pract. 2012;2012.
6. Shafiei FT, McAllister RK, Lopez J. Bupivacaine. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2020. Available from: https://www.ncbi.nlm.nih.gov/books/NBK532883/
7. George AM, Liu M. Ropivacaine. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan– [updated 2023 Jul 31]. Available from: https://www.ncbi.nlm.nih.gov/books/NBK532924/
8. Buchi J, Perlia X. Structure-activity relationships and physicochemical properties of local anesthetics. In: International Encyclopaedia of Pharmacology and Therapeutics. Section 8, Vol. 1. Oxford: Pergamon Press; 1971. p. 39–130.
9. Wildsmith JAW. Relative potencies of ropivacaine and bupivacaine. Anesthesiology. 2000;92:283.
10. Graf BM, Abraham I, Eberbach N, Kunst G, Stowe DF, Martin E. Differences in cardiotoxicity of bupivacaine and ropivacaine are due to physicochemical and stereoselective properties. Anesthesiology. 2002;96(6):1427–34.
11. Rafi AN. Abdominal field block: a new approach via the lumbar triangle. Anaesthesia. 2001;56(10):1024–6.
12. Fuladi N, Deshmukh S, Bhure A. Comparative study of bupivacaine 0.25% versus ropivacaine 0.5% in TAP block for postoperative analgesia in lower abdominal surgeries: a randomized controlled trial. J Evol Med Dent Sci. 2014;3(17):4569–76.
13. Sinha S, Palta S, Saroa R, Prasad A. Comparison of ultrasound-guided TAP block with bupivacaine and ropivacaine as adjuncts for postoperative analgesia in laparoscopic cholecystectomy. Indian J Anaesth. 2016;60(4):264–9.
14. Tsai HC, Yoshida T, Chuang TY, Yang SF, Chang CC, Yao HY, et al. Transversus abdominis plane block: an updated review of anatomy and techniques. Biomed Res Int. 2017;2017.
15. Sinatra R. Causes and consequences of inadequate management of acute pain. Pain Med. 2010;11(12):1859–71.
16. McClure JH. Ropivacaine. Br J Anaesth. 1996;76(2):300–7.
17. Knudsen K, Beckman Suurküla M, Blomberg S, Sjövall J, Edvardsson N. Central nervous and cardiovascular effects of i.v. infusions of ropivacaine, bupivacaine and placebo in volunteers. Br J Anaesth. 1997;78(5):507–14.
18. Scott DB, Lee A, Fagan D, Bowler GM, Bloomfield P, Lundh R. Acute toxicity of ropivacaine compared with that of bupivacaine. Br J Anaesth. 1989;63(6):712–6.
19. Hebbard P. Transversus abdominis plane (TAP) block. Anaesth Intensive Care. 2007;35(4):616–7.
20. Griffiths JD, Barron FA, Grant S, Bjorksten AR, Hebbard P, Royse CF. Plasma ropivacaine concentrations after ultrasound-guided TAP block. Br J Anaesth. 2010;105(6):853–6.
21. Hariharan U, Natarajan V. Tap the potential of TAP Block: A schematic representation. Indian J Anesth Analg.2018;5(1):005-007