Section: Anesthesia

Original Research Article

COMPARATIVE EVALUATION OF 0.5% BUPIVACAINE WITH FENTANYL AND 0.75% ROPIVACAINE WITH FENTANYL IN THORACIC SEGMENTAL SPINAL ANAESTHESIA FOR LAPAROSCOPIC CHOLECYSTECTOMY: A PROSPECTIVE RANDOMIZED STUDY

Raghavendra Singh[1], Rangit Priyakar Pandey[2], Nilotpal Mrinal[1]

[1] *Junior Resident, Department of Anaesthesia, Rajshree Medical Research Institute, Bareilly, Uttar Pradesh, India*
[2]*Professor, Department of Anaesthesia, Rajshree Medical Research Institute, Bareilly, Uttar Pradesh, India*

Received *: 22/12/2025*
Received in revised form *: 03/02/2026*
Accepted *: 20/02/2026*

Corresponding Author:
Dr. Raghavendra Singh,
Department of Anaesthesia, Rajshree Medical Research Institute, Bareilly, Uttar Pradesh, India.
Email: singhraghavendra53@gmail.com

DOI: 10.70034/ijmedph.2026.1.415

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2026; 16 (1); 2399-2402

ABSTRACT

Background: Thoracic segmental spinal anaesthesia (TSSA) has emerged as an effective alternative to general anaesthesia for selected laparoscopic procedures, offering superior postoperative analgesia, haemodynamic stability, and reduced recovery times. Among local anaesthetics, bupivacaine and ropivacaine, when combined with opioids such as fentanyl, provide synergistic effects; however, their comparative clinical profiles in TSSA for laparoscopic cholecystectomy remain underexplored. The aim is to compare the efficacy and safety of 0.5% bupivacaine with fentanyl versus 0.75% ropivacaine with fentanyl in TSSA for laparoscopic cholecystectomy, focusing on block characteristics, haemodynamic stability, analgesia duration, and side effects.

Materials and Methods: Sixty ASA I–II patients (aged 20–60 years) scheduled for elective laparoscopic cholecystectomy were randomized into two equal groups: Group B received 0.5% bupivacaine 1.8 ml + fentanyl 25 µg; Group R received 0.75% ropivacaine 1.8 ml + fentanyl 25 µg via TSSA at T8–T9. Onset times, block durations, haemodynamic parameters, $ETCO_2$, postoperative VAS scores, analgesia duration, and side effects were recorded. Statistical analysis was performed with $p<0.05$ considered significant.

Results: Demographics were comparable. Group R demonstrated significantly shorter motor block duration (167.8±12.5 vs 196.7±13.4 min, $p<0.001$) and earlier sensory regression (175.5±14.3 vs 204.3±15.1 min, $p<0.001$) than Group B. Intraoperative SBP was better maintained in Group R, with fewer hypotensive episodes (10% vs 20%). Postoperative analgesia lasted longer in Group B (249.3±19.2 vs 221.4±17.8 min, $p<0.001$). VAS scores were comparable in the first 2 hours but lower in Group B thereafter. Side effects were infrequent in both groups.

Conclusion: Both regimens provided effective anaesthesia for laparoscopic cholecystectomy under TSSA. Ropivacaine offered faster recovery and superior haemodynamic stability, while bupivacaine provided longer postoperative analgesia. Choice of agent may be guided by surgical duration, desired recovery profile, and patient comorbidities.

Keywords: Thoracic spinal anaesthesia, bupivacaine, ropivacaine, fentanyl, laparoscopic cholecystectomy, haemodynamic stability.

INTRODUCTION

Thoracic segmental spinal anaesthesia (TSSA) is increasingly recognized as a feasible and effective anaesthetic technique for selected upper abdominal laparoscopic procedures, particularly in patients who may be unsuitable for general anaesthesia (GA). Several studies have demonstrated that TSSA provides rapid onset of anaesthesia, dense segmental sensory blockade, superior postoperative analgesia, and attenuation of perioperative stress responses when compared with GA.[1,2] In addition, TSSA has been associated with reduced postoperative nausea and vomiting, earlier ambulation, and shorter hospital stays.[3,4]

Among long-acting amide local anaesthetics, bupivacaine has traditionally been the agent of choice for spinal anaesthesia due to its reliable sensory block and prolonged duration of action.[5] However, its relatively intense motor blockade and well-documented potential for cardiotoxicity have encouraged the search for safer alternatives.[6] Ropivacaine, a pure S-enantiomer, has emerged as a favourable option owing to its lower lipid solubility, reduced cardiotoxicity, and greater sensory–motor differentiation, allowing earlier postoperative mobilisation [7–9]. The addition of intrathecal opioids such as fentanyl enhances the quality of spinal anaesthesia by producing synergistic analgesia without significantly prolonging motor blockade [10]. This combination is particularly beneficial for minimally invasive procedures like laparoscopic cholecystectomy, where adequate intraoperative analgesia and rapid recovery are essential. Although bupivacaine and ropivacaine have been extensively studied in various spinal anaesthesia settings, comparative data evaluating these agents specifically in thoracic segmental spinal anaesthesia for laparoscopic cholecystectomy remain limited [11–13]. Therefore, the present study was designed to compare the efficacy, block characteristics, haemodynamic stability, duration of postoperative analgesia, and adverse effect profile of 0.5% bupivacaine with fentanyl versus 0.75% ropivacaine with fentanyl in patients undergoing laparoscopic cholecystectomy under TSSA.

MATERIALS AND METHODS

Study Design and Setting: A prospective, randomized, parallel-group comparative study was conducted at the Department of Anaesthesiology, Rajshree Medical Research Institute, from January 2023 to December 2023 after obtaining Institutional Ethics Committee approval and written informed consent from all participants.

Inclusion Criteria

- Age 20–60 years
- ASA physical status I or II
- Scheduled for elective laparoscopic cholecystectomy
- BMI 18–30 kg/m²

Exclusion Criteria

- Refusal to participate
- Contraindications to spinal anaesthesia (coagulopathy, infection at puncture site)
- Known hypersensitivity to study drugs
- Severe cardiovascular, respiratory, hepatic, or renal disease
- Pregnancy
- History of chronic opioid use

Randomization and Group Allocation

Sixty eligible patients were randomized using computer-generated random numbers into:

- Group B (n=30) – 0.5% bupivacaine heavy 1.8 ml + fentanyl 25 µg
- Group R (n=30) – 0.75% ropivacaine 1.8 ml + fentanyl 25 µg

Anaesthetic Technique: Patients fasted overnight and received oral ranitidine and metoclopramide premedication. Standard monitors (ECG, NIBP, SpO_2, capnography) were applied. Intravenous access was secured with an 18G cannula, and preloading with 10 ml/kg Ringer's lactate was performed.

Under aseptic precautions, with the patient in a sitting position, a 25G Quincke spinal needle was introduced at the T8–T9 interspace. The allocated drug combination was injected after confirming free CSF flow. Patients were immediately placed supine with a 10° head-up tilt.

Measured Parameters

- Demographic variables: age, sex, weight, ASA grade
- Block characteristics: sensory onset, motor onset, maximum sensory level, duration of sensory and motor block, time to two-segment regression
- Intraoperative haemodynamics: SBP, DBP, HR, SpO_2, $ETCO_2$ at baseline, 5, 10, 20, 30, 45 min, and at the end of surgery
- Postoperative analgesia: VAS scores at 0, 1, 2, 4, and 6 hours; time to first rescue analgesia
- Adverse effects: hypotension (SBP drop >20% from baseline), bradycardia (HR <50 bpm), nausea/vomiting, pruritus

Statistical Analysis: Data were analysed using SPSS v25. Continuous variables were expressed as mean ± SD, categorical variables as frequency and percentages. Student's t-test was used for continuous variables, Chi-square/Fisher's exact test for categorical variables. $p<0.05$ was considered statistically significant.

RESULTS

Table 1: Demographic Characteristics

Parameter	Group B (n=30)	Group R (n=30)	p-value
Age (years)	41.3 ± 7.9	40.2 ± 7.1	0.53
Sex (M/F)	9 / 21	10 / 20	0.78
Weight (kg)	65.4 ± 7.8	64.3 ± 7.0	0.54
ASA Grade I / II	12 / 18	13 / 17	0.79

No significant differences were observed between groups.

Table 2: Block Characteristics

Parameter	Group B	Group R	p-value
Sensory onset (min)	4.5 ± 0.5	4.3 ± 0.5	0.11
Motor onset (min)	6.5 ± 0.6	6.2 ± 0.6	0.04*
Duration of sensory block (min)	204.3 ± 15.1	175.5 ± 14.3	<0.001*
Duration of motor block (min)	196.7 ± 13.4	167.8 ± 12.5	<0.001*
Time to first analgesia request (min)	249.3 ± 19.2	221.4 ± 17.8	<0.001*

*Significant at $p<0.05$.

Haemodynamic Trends – SBP

Group R maintained higher mean SBP throughout, with fewer hypotensive dips.

$ETCO_2$ Trends

Both groups showed mild increases intraoperatively, stabilising toward the end.

Postoperative VAS Scores

Group B showed lower VAS scores after 2 hours, consistent with longer analgesia.

Table 3: Side Effects

Side Effect	Group B (%)	Group R (%)	p-value
Hypotension	20	10	0.28
Bradycardia	13.3	6.6	0.39
Nausea/Vomiting	10	6.6	0.64
Pruritus	3.3	3.3	1.0

Incidences were low and comparable.

DISCUSSION

The present study demonstrates that both 0.5% bupivacaine with fentanyl and 0.75% ropivacaine with fentanyl provide effective thoracic segmental spinal anaesthesia for laparoscopic cholecystectomy. While ropivacaine was associated with shorter motor block duration and better haemodynamic stability, bupivacaine offered significantly longer postoperative analgesia. Our findings are consistent with those of Kumar et al. [3] and Mantouvalou et al. [4], who reported shorter sensory and motor block duration with ropivacaine compared to bupivacaine in spinal anaesthesia. Similarly, Casati et al. [11] and Gautier et al. [12] observed faster motor recovery with ropivacaine, making it more suitable for procedures requiring early ambulation.

With regard to haemodynamic stability, the lower incidence of hypotension observed in the ropivacaine group in our study aligns with previous reports highlighting its reduced cardiovascular depressant effects when compared to bupivacaine [5,8]. Pere et al. [5] and Knudsen et al. [8] attributed this advantage to the lower cardiotoxic potential and reduced sympathetic blockade associated with ropivacaine.

The prolonged duration of postoperative analgesia seen with bupivacaine in our study is in agreement with earlier investigations demonstrating its stronger affinity for sodium channels and more intense sensory blockade [6,15]. These properties, while beneficial for extended analgesia, may delay motor recovery.

The pharmacological differences between the two agents explain the observed clinical outcomes. Ropivacaine's lower lipid solubility and preferential sensory nerve blockade result in faster motor recovery and improved haemodynamic stability [9,14]. In contrast, bupivacaine produces a denser motor block, which contributes to prolonged analgesia but may delay postoperative mobilisation [15,16].

Clinical Implications

Ropivacaine may be preferred in patients where rapid postoperative recovery and haemodynamic stability are priorities, such as in ambulatory or high-risk patients. Conversely, bupivacaine may be advantageous in cases where prolonged postoperative analgesia is desired.

Limitations

Single-centre design

Relatively small sample size

Inclusion limited to ASA I–II patients

Recommendations

Future multicentric studies with larger sample sizes and inclusion of higher-risk patients are warranted to further establish the optimal local anaesthetic choice for thoracic segmental spinal anaesthesia.

CONCLUSION

Both drugs are effective for TSSA in laparoscopic cholecystectomy. Ropivacaine offers quicker recovery and greater haemodynamic stability, whereas bupivacaine prolongs analgesia.

REFERENCES

1. McNamee DA, Parks L, McClelland AM, Scott S, Milligan KR, Ahlén K, et al. Intrathecal ropivacaine for total hip arthroplasty: A dose-finding study. Anesth Analg. 2002;95(5):1343–1347.
2. Malinovsky JM, Charles F, Kick O, Lepage JY, Malinge M, Cozian A, et al. Intrathecal anesthesia: Ropivacaine versus bupivacaine. Anesth Analg. 2000;91(6):1457–1460.
3. Kumar P, Sahu S, Chandra G, Meena S. Comparative study between 0.5% bupivacaine and 0.75% ropivacaine in lower limb surgeries under spinal anesthesia. Indian J Anaesth. 2020;64(3):229–235.
4. Mantouvalou M, Ralli S, Arnaoutoglou E, Tziris G, Papadopoulos G. Spinal anesthesia: Comparison of plain ropivacaine, bupivacaine, and levobupivacaine for lower abdominal surgery. Acta Anaesthesiol Belg. 2008;59(2):65–71.
5. Pere PJ, Salonen M, Jokinen M, Rosenberg PH. Cardiovascular and central nervous system effects of ropivacaine and bupivacaine in conscious volunteers. Anesth Analg. 1996;82(4):744–749.
6. McDonald SB, Liu SS, Kopacz DJ, Stephenson CA. Hyperbaric spinal ropivacaine: A comparison to bupivacaine in volunteers. Anesth Analg. 2004;98(2):577–581.
7. Parmar V, Kalia P, Nair A, Jacob R. Comparative evaluation of intrathecal ropivacaine and bupivacaine in elderly patients. J Anaesthesiol Clin Pharmacol. 2019;35(2):192–198.
8. 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):507–514.
9. Chung CJ, Choi SR, Yeo KH, Park HS, Lee SI, Chin YJ. Hyperbaric spinal ropivacaine for cesarean delivery: A comparison to bupivacaine. Anesth Analg. 2001;93(1):157–161.
10. Singh S, Aggarwal A, Gupta R, Tandon M. Comparative evaluation of intrathecal ropivacaine and bupivacaine for lower abdominal surgeries. J Clin Diagn Res. 2018;12(9):UC06–UC10.
11. Casati A, Fanelli G, Danelli G, Berti M, Ghisi D, Cedrati V, et al. Spinal anesthesia with ropivacaine for outpatient knee arthroscopy: A comparison with bupivacaine. Anesth Analg. 2003;96(4):1161–1166.
12. Gautier PE, De Kock M, Huberty L, Demir T, Izydorczic M, Vanderick B. Comparison of ropivacaine and bupivacaine in spinal anesthesia for outpatient knee arthroscopy. Anesth Analg. 1999;89(3):574–579.
13. Kallio H, Snäll EV, Tuomas CA, Rosenberg PH. Comparison of hyperbaric spinal ropivacaine and bupivacaine for lower limb surgery. Anesth Analg. 2004;99(3):713–717.
14. Gaurav A, Sharma P, Kumar A. Pharmacodynamics of ropivacaine: A review. J Anaesthesiol Clin Pharmacol. 2019;35(3):289–294.
15. Butterworth JF. Clinical pharmacology of local anesthetics. In: Miller RD, ed. Miller's Anesthesia. 9th ed. Elsevier; 2020. p. 1049–1070.
16. Feldman HS, Covino BG. Comparative motor-blocking effects of bupivacaine and ropivacaine in dogs. Anesth Analg. 1988;67(11):1045–1049.