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

Intraperitoneal Ropivacaine (0.2%, 20 mL) for Postoperative Analgesia in Laparoscopic Cholecystectomy: A Prospective Observational Study from a Tertiary Care Centre

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OPEN ACCESS

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Received: 21-03-2026
Accepted: 09-04-2026
Available online: 21-04-2026

ABSTRACT

Background: Laparoscopic cholecystectomy (LC) is the standard surgical procedure for gallstone disease; however, postoperative pain remains a significant clinical concern despite its minimally invasive nature. Pain following LC is multifactorial, including visceral irritation, pneumoperitoneum-induced diaphragmatic stretch, and port-site trauma. Intraperitoneal instillation of local anaesthetics has emerged as an effective strategy to reduce visceral pain. **Aim:** This study aimed to evaluate the analgesic efficacy of intraperitoneal instillation of 20 mL of 0.2% ropivacaine via the umbilical port for early postoperative pain relief. **Methods**: This prospective observational study was conducted at a tertiary care centre after institutional ethical approval. Fifty patients aged 20–60 years, belonging to ASA physical status I–II and scheduled for elective laparoscopic cholecystectomy under general anaesthesia, were included. At the end of surgery, 20 mL of 0.2% ropivacaine was instilled intraperitoneally through the umbilical port under direct vision. Pain intensity was assessed using the Visual Analogue Scale (VAS) at 0, 2, 4, 6, 12, and 24 hours postoperatively. Rescue analgesia (intravenous NSAIDs and tramadol) was administered when VAS ≥4. **Results**: The mean VAS scores remained below 4 in the immediate postoperative period, indicating satisfactory analgesia. Peak pain scores were observed at 6 hours postoperatively. A majority of patients (70%) did not require rescue analgesia, while 30% required additional analgesics. Opioid consumption was minimal, and no significant haemodynamic instability or adverse effects were observed. **Conclusion:** Intraperitoneal instillation of 20 mL of 0.2% ropivacaine via the umbilical port is a safe and effective technique for early postoperative analgesia in laparoscopic cholecystectomy, significantly reducing pain scores and opioid requirements.

Keywords: *Ropivacaine, Laparoscopic cholecystectomy, Intraperitoneal instillation, Postoperative pain, Multimodal analgesia.*

INTRODUCTION

Laparoscopic cholecystectomy has become the gold standard surgical procedure for the treatment of symptomatic cholelithiasis due to its advantages of reduced surgical trauma, shorter hospital stay, and faster recovery compared to open cholecystectomy [1]. Despite these benefits, postoperative pain continues to be a significant issue, particularly in the early postoperative period, and remains a major determinant of patient satisfaction and recovery [2].

The pain experienced after laparoscopic cholecystectomy is complex and multifactorial. It includes visceral pain resulting from gallbladder bed dissection, somatic pain from trocar insertion sites, and referred shoulder pain caused by diaphragmatic irritation due to residual carbon dioxide pneumoperitoneum [3,4]. Among these, visceral pain is often the predominant component in the early postoperative period and is less responsive to conventional systemic analgesics [5].

Effective postoperative pain management is essential not only for patient comfort but also for early ambulation, reduced hospital stay, and prevention of complications such as pulmonary dysfunction and thromboembolism [6]. Multimodal analgesia strategies are therefore widely advocated to minimize opioid consumption and associated side effects such as nausea, vomiting, respiratory depression, and delayed recovery [7,10].

Intraperitoneal instillation of local anaesthetic agents has gained popularity as a simple, safe, and effective technique to target visceral pain directly at its source. This technique involves instilling local anaesthetic into the peritoneal cavity, thereby blocking nociceptive signals from the peritoneum and visceral organs [15,16]. Several studies have demonstrated its efficacy in reducing postoperative pain scores and analgesic requirements following laparoscopic surgeries [8,9].

Ropivacaine, a long-acting amide local anaesthetic, has been increasingly preferred due to its favourable pharmacological profile. It provides effective sensory blockade with relatively less motor blockade and has a significantly lower potential for cardiotoxicity and central nervous system toxicity compared to bupivacaine [11,12]. These characteristics make it particularly suitable for intraperitoneal use, where systemic absorption may occur [13].

Previous studies have evaluated varying concentrations and volumes of ropivacaine (typically 30–35 mL) for intraperitoneal instillation, demonstrating significant reductions in postoperative pain and opioid consumption [14,17]. However, there is limited evidence regarding the efficacy of smaller, targeted volumes administered through a single port, which may offer comparable analgesia while reducing drug exposure and potential toxicity.

The present study was therefore designed to evaluate the effectiveness of intraperitoneal instillation of 20 mL of 0.2% ropivacaine via the umbilical port in providing early postoperative analgesia following laparoscopic cholecystectomy. The primary objective was to assess postoperative pain scores, while secondary objectives included evaluation of rescue analgesic requirements and safety profile.

MATERIALS AND METHODS

Study design and setting

This prospective observational study was conducted in the Department of Anaesthesiology at Government Medical College, Srinagar, a tertiary care teaching hospital. The study was carried out after obtaining approval from the Institutional Ethics Committee. All procedures were conducted in accordance with the ethical standards of the institutional research committee and with the principles of the Declaration of Helsinki. Written informed consent was obtained from all patients prior to inclusion in the study.

Study population

A total of 50 patients scheduled for elective laparoscopic cholecystectomy under general anaesthesia were enrolled in the study. Patients were selected based on predefined inclusion and exclusion criteria.

Inclusion criteria

- Patients aged between 20 and 60 years
- Patients belonging to American Society of Anesthesiologists (ASA) physical status I and II
- Patients undergoing elective laparoscopic cholecystectomy
- Patients willing to provide informed consent

Exclusion criteria

- Patients with ASA physical status III or above
- Known hypersensitivity or allergy to local anaesthetics
- Patients with significant hepatic, renal, cardiovascular, or respiratory disease
- Patients with chronic pain conditions or those on long-term analgesic therapy
- Conversion to open cholecystectomy
- Pregnant or lactating women

Preoperative assessment

All patients underwent a thorough pre-anaesthetic evaluation including detailed history, physical examination, and relevant laboratory investigations. Patients were explained the Visual Analogue Scale (VAS) for pain assessment, where 0 indicated no pain and 10 indicated worst imaginable pain. Standard fasting guidelines were followed prior to surgery.

Anaesthetic technique
All patients received a standardized general anaesthesia protocol. Upon arrival in the operating room, routine monitoring was established including electrocardiography, non-invasive blood pressure and pulse oximetry.

Premedication was administered with intravenous midazolam and glycopyrrolate. Anaesthesia was induced using intravenous propofol and fentanyl. Endotracheal intubation was facilitated with a neuromuscular blocking agent such as atracurium. Anaesthesia was maintained with a mixture of oxygen, nitrous oxide, and a volatile anaesthetic agent such as isoflurane or sevoflurane, along with intermittent doses of muscle relaxant as required.

Intraoperative monitoring of heart rate, blood pressure, oxygen saturation, and end-tidal carbon dioxide was carried out continuously. Pneumoperitoneum was created with carbon dioxide and intra-abdominal pressure was maintained within standard limits (12–14 mmHg).

Intervention technique
At the completion of surgery, before removal of the trocars and under direct laparoscopic visualization, 20 mL of 0.2% ropivacaine was instilled intraperitoneally through the umbilical port. Care was taken to distribute the local anaesthetic solution over the gallbladder bed, subdiaphragmatic space, and surrounding peritoneal surfaces to ensure adequate coverage of visceral nociceptive sites.

Following instillation, residual carbon dioxide was evacuated as much as possible to reduce postoperative shoulder tip pain. All ports were then removed and surgical wounds were closed in a standard manner.

Postoperative management
After completion of surgery, patients were extubated and transferred to the post-anaesthesia care unit (PACU) for monitoring. Standard postoperative monitoring included heart rate, blood pressure, respiratory rate, and oxygen saturation.

Pain assessment was performed using the Visual Analogue Scale at predefined time intervals: immediately after surgery (0 hour), and at 2, 4, 6, 12, and 24 hours postoperatively.

Rescue analgesia protocol
Rescue analgesia was administered when the VAS score was greater than or equal to 4. The analgesic regimen included intravenous non-steroidal anti-inflammatory drugs as the first line, followed by intravenous tramadol 50 mg if pain persisted or was moderate to severe in intensity.

The total requirement of rescue analgesia, including both NSAIDs and tramadol, was recorded for each patient over the first 24 hours postoperatively.

Outcome measures
The primary outcome measure was the intensity of postoperative pain as assessed by VAS scores at different time intervals.

Secondary outcome measures included
- Requirement of rescue analgesia
- Time to first analgesic request
- Total consumption of analgesics within 24 hours
- Occurrence of adverse effects such as nausea, vomiting, hypotension, bradycardia, or signs of local anaesthetic toxicity

Statistical analysis
Data collected were entered into a Microsoft Excel spreadsheet and analysed using appropriate statistical software. Continuous variables such as age and VAS scores were expressed as mean and standard deviation. Categorical variables such as gender distribution, ASA status, and analgesic requirements were expressed as frequencies and percentages.

Descriptive statistics were primarily used for analysis. Results were presented in the form of tables and graphical representations where appropriate. A p value of less than 0.05 was considered statistically significant where applicable.

RESULTS

A total of 50 patients undergoing elective laparoscopic cholecystectomy were included in the study. All patients completed the study and were analysed. The demographic characteristics of the study population were comparable and showed a predominance of female patients, which is consistent with the epidemiology of gallstone disease.

Table 1 shows the demographic profile of the patients. The mean age of the study population was 41.2 ± 9.8 years. Female patients constituted the majority (64%), while males accounted for 36%. Most patients belonged to ASA physical status I (56%), followed by ASA II (44%).

Table 1: Demographic Profile

Variable	Value
Number of patients	50
Age (years) Mean ± SD	41.2 ± 9.8
Male	18 (36%)
Female	32 (64%)
ASA I	28 (56%)
ASA II	22 (44%)

Postoperative pain was assessed using the Visual Analogue Scale at predefined intervals. The mean VAS scores remained below 4 in the early postoperative period, indicating satisfactory analgesia in most patients. A gradual increase in pain scores was observed up to 6 hours, followed by a decline at 12 and 24 hours.

Table 2 presents the mean VAS scores at different postoperative intervals. The highest mean VAS score was observed at 6 hours (4.1 ± 1.2), after which pain intensity decreased significantly.

Table 2: Postoperative VAS Scores

Time	Mean VAS ± SD
0 hour	3.2 ± 0.8
2 hours	3.5 ± 0.9
4 hours	3.8 ± 1.0
6 hours	4.1 ± 1.2
12 hours	3.4 ± 0.7
24 hours	2.6 ± 0.5

The requirement of rescue analgesia was analysed to assess the effectiveness of intraperitoneal ropivacaine. A majority of patients did not require any additional analgesia within the first 24 hours.

Table 3 shows that 70% of patients did not require rescue analgesia. Among those who required analgesia, 20% were managed with NSAIDs alone, while only 10% required opioid (tramadol) administration.

Table 3: Rescue Analgesia Requirement

Parameter	Number (%)
No rescue analgesia	35 (70%)
Required NSAIDs only	10 (20%)
Required Tramadol	5 (10%)

The time to first request for rescue analgesia is an important indicator of analgesic efficacy. In the present study, most patients experienced prolonged pain relief, with delayed requirement for additional analgesia.

Table 4 demonstrates the distribution of patients according to the time of first rescue analgesia. The majority of patients who required analgesia did so between 4 to 6 hours postoperatively, corresponding with the peak VAS scores observed during this period.

Table 4: Time to First Rescue Analgesia

Time Interval	Number of Patients (%)
Within 2 hours	2 (4%)
2–4 hours	6 (12%)
4–6 hours	7 (14%)
After 6 hours	0
No analgesia required	35 (70%)

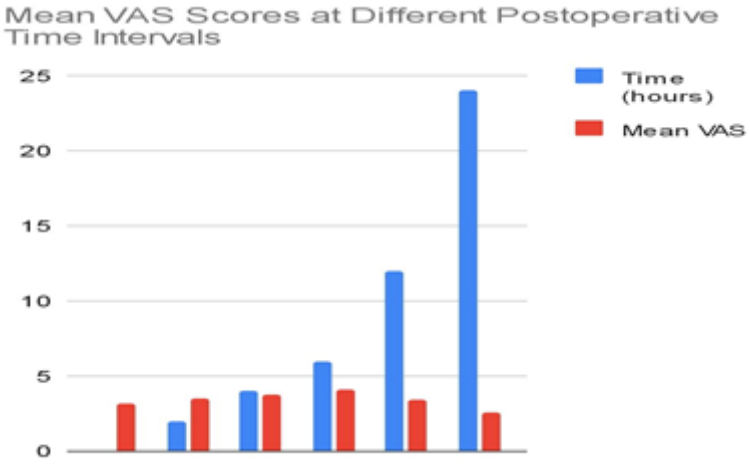
Haemodynamic parameters remained stable throughout the postoperative period, and no significant adverse effects related to intraperitoneal ropivacaine were observed. This highlights the safety of the technique.

Table 5 summarizes the incidence of postoperative adverse effects. A small proportion of patients experienced nausea and vomiting, which were managed conservatively. No cases of hypotension, bradycardia, or local anaesthetic toxicity were reported.

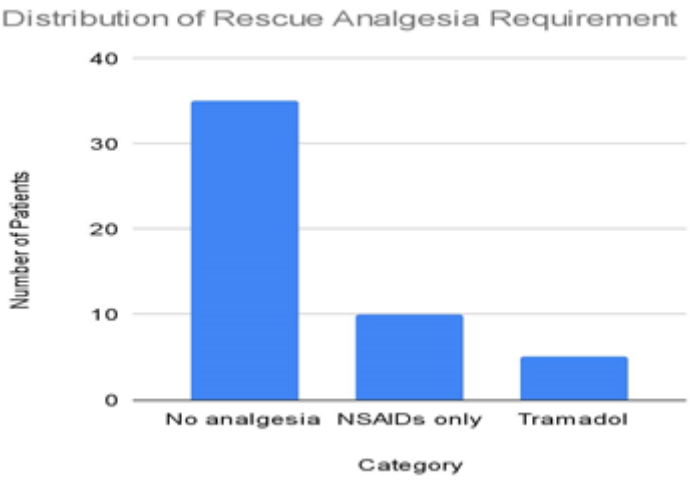
Table 5: Postoperative Adverse Effects

Adverse Effect	Number (%)
Nausea	6 (12%)
Vomiting	4 (8%)
Hypotension	0
Bradycardia	0
Local anaesthetic toxicity	0

Overall, the results of the study demonstrate that intraperitoneal instillation of 20 mL of 0.2% ropivacaine provides effective early postoperative analgesia, with low pain scores, minimal opioid requirement, and a favourable safety profile.



Bar graph 1: Mean VAS Scores at Different Postoperative Time Intervals.



Bar graph 2: Distribution of Rescue Analgesia Requirement.

DISCUSSION

Effective postoperative pain control remains a crucial component of enhanced recovery following laparoscopic cholecystectomy. Although the laparoscopic approach significantly reduces surgical trauma compared to open procedures, patients frequently experience moderate pain in the early postoperative period, which may delay ambulation and discharge if inadequately managed. The present study evaluated the efficacy of intraperitoneal instillation of 20 mL of 0.2% ropivacaine administered via the umbilical port and demonstrated satisfactory analgesia with low opioid requirement and minimal adverse effects.

In this study, the mean VAS scores remained below 4 in the immediate postoperative period and up to 4 hours, indicating effective early analgesia. The peak pain intensity was observed at 6 hours (VAS 4.1 ± 1.2), after which pain scores declined progressively. This pattern is consistent with the pharmacokinetic profile of ropivacaine, which provides prolonged sensory blockade with gradual systemic absorption [18]. Similar temporal patterns of pain relief have been reported in previous studies evaluating intraperitoneal local anaesthetics [19,20].

The mechanism of pain following laparoscopic cholecystectomy is multifactorial, with visceral pain being the predominant component in the early postoperative period. Intraperitoneal instillation of local anaesthetic acts directly on peritoneal nociceptors, reducing afferent pain transmission from the surgical site [21]. Additionally, it may attenuate the inflammatory response associated with pneumoperitoneum, thereby further contributing to analgesia [22].

A key finding of the present study was that 70% of patients did not require any rescue analgesia within the first 24 hours, and only 10% required opioid administration. This highlights the opioid-sparing effect of intraperitoneal ropivacaine. Reduction in opioid consumption is clinically significant, as opioids are associated with adverse effects such as nausea, vomiting, sedation, and respiratory depression, which can delay recovery and prolong hospital stay [23]. These findings are in agreement with studies by Bisgaard et al. And Gupta et al., which demonstrated reduced analgesic requirements with intraperitoneal local anaesthetic use [24,25].

The time to first rescue analgesia in our study further supports the effectiveness of the intervention. Most patients who required analgesia did so between 4 to 6 hours postoperatively, corresponding with the peak VAS scores. This suggests that the analgesic effect of ropivacaine is most pronounced in the immediate and early postoperative period, which is clinically the most critical phase for pain control. Similar observations have been reported by Joris et al., who noted significant pain relief during the early postoperative hours following intraperitoneal local anaesthetic administration [26].

An important aspect of this study is the use of a relatively lower volume of ropivacaine (20 mL) compared to previous studies that have used volumes ranging from 30 to 50 mL. Despite the lower volume, effective analgesia was achieved, likely due to targeted instillation under direct vision over the gallbladder bed and subdiaphragmatic region. This finding is clinically relevant, as it suggests that lower doses may be sufficient when administered precisely, thereby minimizing the risk of systemic toxicity [27].

Ropivacaine was specifically chosen due to its favourable safety profile. It is less lipophilic than bupivacaine and has a higher threshold for cardiotoxicity and central nervous system toxicity [28]. In the present study, no cases of hypotension, bradycardia, or signs of local anaesthetic systemic toxicity were observed, further supporting its safety for intraperitoneal use. These findings are consistent with previous clinical trials that have demonstrated the safety of ropivacaine in various regional anaesthesia techniques [29].

The incidence of postoperative nausea and vomiting in this study was low and may be attributed to reduced opioid consumption. Effective pain control using non-opioid techniques is a key component of enhanced recovery protocols and contributes to improved patient satisfaction and faster recovery [30].

The findings of this study are comparable with those of Meena et al. And Shivhare et al., who demonstrated significant reductions in postoperative pain scores and analgesic requirements with intraperitoneal ropivacaine [31,32]. However, unlike these studies, which used higher volumes or randomized designs, the present study demonstrates that even a single-port, lower-volume technique can provide effective analgesia in a real-world clinical setting.

Despite these encouraging results, certain limitations must be acknowledged. The observational design of the study limits the ability to establish causality. The absence of a control group prevents direct comparison with other analgesic modalities. Additionally, the study was conducted at a single centre with a relatively small sample size, which may limit generalizability. Future randomized controlled trials comparing different volumes and concentrations of ropivacaine, as well as comparisons with other analgesic techniques such as TAP block or port-site infiltration, would provide more robust evidence.

Overall, the present study supports the use of intraperitoneal ropivacaine as a simple, safe, and effective method for early postoperative analgesia in laparoscopic cholecystectomy. Its ease of administration, minimal side effects, and opioid-sparing effect make it a valuable component of multimodal analgesia strategies.

CONCLUSION

Intraperitoneal instillation of 20 mL of 0.2% ropivacaine via the umbilical port provides effective and clinically significant early postoperative analgesia following laparoscopic cholecystectomy. The technique demonstrated low

postoperative pain scores, particularly in the immediate postoperative period, with a peak at 6 hours followed by gradual decline.

A substantial proportion of patients did not require rescue analgesia, and opioid requirement was minimal, highlighting the opioid-sparing effect of this technique. The absence of significant haemodynamic instability or local anaesthetic toxicity further confirms the safety profile of ropivacaine when used intraperitoneally.

The targeted, low-volume approach used in this study is simple, reproducible, and cost-effective, making it highly suitable for routine clinical practice, especially in resource-limited settings.

However, due to the observational nature of the study and absence of a comparator group, further randomized controlled trials are recommended to validate these findings and compare efficacy with other regional analgesic techniques.

Overall, intraperitoneal ropivacaine should be considered an effective component of multimodal analgesia strategies for laparoscopic cholecystectomy.

Conflict of interest: Nil

Funding: Nil

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