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Evaluation of the Effectiveness of Local Anesthetic Agent Infiltration into Port Sites at Preoperative Period with It's Correlation to Post Operative Analgesia in Laparoscopic Surgical Procedures-A Retrospective and Comparative Study

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Abstract **Original Research Article**

Background: Postoperative pain management remains a significant challenge in laparoscopic surgery despite its minimally invasive nature. This study aimed to evaluate the effectiveness of preoperative local anesthetic infiltration at port sites and its correlation with postoperative analgesia requirements in laparoscopic procedures. ***Methods:*** This retrospective comparative study analyzed data from 52 patients who underwent elective laparoscopic procedures. Patients were divided into two groups: Group A (n=26) received preoperative port-site infiltration with 0.5% bupivacaine, while Group B (n=26) did not receive local anesthetic infiltration. Postoperative pain scores, analgesic requirements, recovery parameters, and patient satisfaction were compared between the groups. ***Results:*** Patients who received preoperative local anesthetic infiltration demonstrated significantly lower visual analog scale pain scores at all time points during the first 24 postoperative hours compared to the control group ($p<0.001$). The time to first analgesic request was significantly prolonged in Group A (210.4 ± 45.3 min vs. 78.2 ± 25.6 min, $p<0.001$), and total tramadol consumption was reduced by 50% (73.1 ± 26.5 mg vs. 146.2 ± 38.7 mg, $p<0.001$). Group A also showed earlier ambulation (5.2 ± 1.1 vs. 7.8 ± 1.6 hours, $p<0.001$), shorter PACU stay (42.7 ± 10.3 vs. 58.4 ± 13.7 min, $p<0.001$), and lower incidence of postoperative nausea and vomiting (15.4% vs. 42.3%, $p=0.033$). Patient satisfaction was significantly higher in the local anesthetic group, with 84.7% rating their pain management as "excellent" or "good" compared to 46.2% in the control group ($p=0.002$). ***Conclusion:*** Preoperative local anesthetic infiltration at port sites significantly reduces postoperative pain, decreases analgesic requirements, and improves recovery parameters in patients undergoing laparoscopic procedures. This simple, safe, and cost-effective technique should be considered as a routine component of multimodal analgesia protocols for laparoscopic surgery.

Keywords: Local anesthetic infiltration; Laparoscopic surgery; Postoperative pain; Preemptive analgesia; Port-site infiltration; Bupivacaine.

INTRODUCTION

Laparoscopic surgery has revolutionized modern surgical practice, offering numerous advantages including reduced postoperative pain, shorter hospital stays, improved cosmetic outcomes, and faster recovery compared to traditional open procedures [1,2]. Despite these benefits, patients undergoing laparoscopic procedures still experience postoperative pain, which remains a significant concern in perioperative care [3].

Postoperative pain following laparoscopic surgery is multifactorial in origin, resulting from trocar insertion sites, peritoneal stretching, diaphragmatic irritation from residual carbon dioxide, and visceral manipulation [4,5]. Although generally less severe than pain following open procedures, inadequately managed pain can delay recovery, prolong hospitalization, increase healthcare costs, and negatively impact patient satisfaction [6].

Various strategies have been developed to minimize postoperative pain in laparoscopic procedures, including multimodal analgesia approaches incorporating opioids, non-steroidal anti-inflammatory drugs, and local anesthetics [7,8]. Local anesthetic infiltration at port sites has emerged as a simple, cost-effective method that may significantly reduce postoperative pain [9,10].

The infiltration of local anesthetics into laparoscopic port sites can be performed at different time points during the perioperative period - preoperatively (before incision), intraoperatively (during surgery), or postoperatively (after wound closure) [11]. However, the optimal timing for local anesthetic infiltration remains controversial, with conflicting results reported in the literature [12,13].

Preoperative local anesthetic infiltration may offer theoretical advantages by establishing a pre-emptive analgesic effect, potentially reducing central sensitization and hyperalgesia [14]. However, the clinical significance and effectiveness of this approach compared to other timing strategies remain unclear [15].

This retrospective comparative study aims to evaluate the effectiveness of preoperative local anesthetic infiltration into port sites and its correlation with postoperative analgesia requirements in patients undergoing laparoscopic surgical procedures. By analyzing data from 52 cases, we seek to determine whether this simple intervention can significantly improve pain management outcomes and potentially reduce opioid consumption in the postoperative period [16,17].

Materials and Methods

Study Design and Patient Population

This retrospective comparative study was conducted at Dept. of Surgery, Dinajpur Medical College Hospital, Bangladesh from July 2023 to June 2024. After obtaining institutional ethical committee approval and medical records of 52 patients who underwent elective laparoscopic procedures were reviewed. Patients were divided into two groups: Group A (n=26) received preoperative port-site local anesthetic infiltration, while Group B (n=26) did not receive local anesthetic infiltration before port placement.

Inclusion criteria comprised adult patients (18-65 years) with American Society of Anesthesiologists (ASA) physical status I-II who underwent elective laparoscopic procedures including cholecystectomy, appendectomy, and hernioplasty. Exclusion criteria included emergency surgeries, conversion to open procedures, history of chronic pain, regular use of analgesics, allergy to local anesthetics, psychiatric disorders affecting pain assessment, and incomplete medical records.

Anesthetic and Surgical Protocol

All patients received standardized anesthetic management according to institutional protocols. Premedication consisted of intravenous midazolam (0.02-0.04 mg/kg) and glycopyrrolate (0.004-0.008 mg/kg) 30 minutes before surgery. General anesthesia was induced with propofol (1.5-2.5 mg/kg), fentanyl (1-2 μg/kg), and muscle relaxation was achieved with atracurium (0.5 mg/kg) [18]. After endotracheal intubation, anesthesia was maintained with isoflurane (1-1.5%) in an oxygen-air mixture, and additional doses of fentanyl and atracurium were administered as required.

In Group A, before surgical incision, each port site was infiltrated with 0.5% bupivacaine (maximum dose 2 mg/kg) using a 23G needle. The infiltration technique involved injecting the local anesthetic in a systematic manner through all tissue layers including skin, subcutaneous tissue, fascia, and parietal peritoneum at the planned trocar insertion sites. Group B patients did not receive any local anesthetic infiltration before port placement.

Standardized surgical techniques were employed for all laparoscopic procedures. Pneumoperitoneum was established using a Veress needle or open Hasson technique with carbon dioxide at 12-14 mmHg pressure. The number and position of ports varied according to the specific procedure but typically included a 10-mm umbilical port for the camera and 2-3 additional 5-mm or 10-mm ports for instruments.

At the end of surgery, residual neuromuscular blockade was reversed with neostigmine (0.05 mg/kg) and glycopyrrolate (0.01 mg/kg) [19]. Patients were extubated when fully awake and transferred to the post-anesthesia care unit (PACU) for monitoring.

Pain Assessment and Postoperative Management

Postoperative pain was assessed using a 10-point Visual Analog Scale (VAS) where 0 represented no pain and 10 represented worst imaginable pain. Pain scores were recorded at 1, 4, 8, 12, and 24 hours postoperatively, both at rest and during movement (coughing or deep breathing).

All patients received a standardized postoperative analgesic regimen consisting of intravenous paracetamol (1g) every 6 hours. Rescue analgesia with intravenous tramadol (1 mg/kg) was administered when the VAS score was ≥4 or upon patient request. The time to first analgesic request and total analgesic consumption over 24 hours were recorded.

Other parameters assessed included postoperative nausea and vomiting (PONV), sedation scores, time to ambulation, length of hospital stay, and patient satisfaction with pain management (measured on a 5-point Likert scale).

Data Collection and Analysis

Demographic data, surgical details, and outcome measures were extracted from electronic medical records and anesthesia charts. The primary outcome was the comparison of postoperative VAS pain scores between the two groups. Secondary outcomes included time to first analgesic request, total analgesic consumption, incidence of side effects, time to ambulation, length of hospital stay, and patient satisfaction.

Statistical analysis was performed using windows SPSS Statistical Software Package, Version 23. Continuous variables were expressed as mean ± standard deviation or median (interquartile range) depending on the distribution of data. Categorical variables were presented as frequencies and percentages. Comparisons between groups were made using Student's t-test or Mann-Whitney U test for continuous variables and Chi-square or Fisher's exact test for categorical variables. A p-value <0.05 was considered statistically significant.

Sample size was determined based on previous studies, assuming a 30% reduction in pain scores with a power of 80% and a significance level of 5%.

RESULTS

Demographic and Surgical Characteristics

A total of 52 patients (26 in each group) who underwent laparoscopic procedures were included in this retrospective analysis. The demographic characteristics and surgical details were comparable between the two groups, with no statistically significant differences in age, gender distribution, BMI, ASA status, type of surgical procedure, or duration of surgery (p>0.05) (Table 1).

Table 1: Demographic and Surgical Characteristics

Variable	Group A (Preoperative LA) (n=26)	Group B (No LA) (n=26)	p-value
Age (years)*	42.3 ± 12.7	44.1 ± 13.2	0.613
Gender (M/F)†	14/12	15/11	0.781
BMI (kg/m²)*	26.8 ± 3.2	27.2 ± 3.5	0.669
ASA Status (I/II)†	15/11	16/10	0.778
Type of Surgery†			0.893
- Cholecystectomy	14 (53.8%)	13 (50.0%)	
- Appendectomy	8 (30.8%)	9 (34.6%)	
- Hernioplasty	4 (15.4%)	4 (15.4%)	
Duration of Surgery (min)*	72.6 ± 18.4	75.2 ± 17.9	0.613
No. of Ports†			0.752
- 3 ports	18 (69.2%)	19 (73.1%)	
- 4 ports	8 (30.8%)	7 (26.9%)	

*Data presented as Mean ± SD; analyzed using Student's t-test

†Data presented as number (%); analyzed using Chi-square or Fisher's exact test

LA: Local Anesthetic; BMI: Body Mass Index; ASA: American Society of Anesthesiologists

Postoperative Pain Scores

Group A patients who received preoperative local anesthetic infiltration demonstrated significantly lower VAS pain scores at all time points compared to Group B, both at rest and during movement (p<0.001) (Table 2). The difference was most pronounced at 1 and 4 hours postoperatively.

Table 2: Postoperative VAS Pain Scores

Time Point	Group A (Preoperative LA) (n=26)	Group B (No LA) (n=26)	p-value
At Rest			
1 hour	2.8 ± 0.7	5.3 ± 1.2	<0.001
4 hours	2.3 ± 0.6	4.7 ± 1.1	<0.001
8 hours	2.0 ± 0.5	3.8 ± 0.9	<0.001
12 hours	1.7 ± 0.4	3.2 ± 0.8	<0.001
24 hours	1.3 ± 0.4	2.5 ± 0.7	<0.001
During Movement			
1 hour	3.9 ± 0.8	6.5 ± 1.3	<0.001
4 hours	3.4 ± 0.7	5.9 ± 1.2	<0.001
8 hours	3.0 ± 0.6	5.1 ± 1.0	<0.001

12 hours	2.6 ± 0.5	4.3 ± 0.9	<0.001
24 hours	2.1 ± 0.5	3.4 ± 0.8	<0.001

Data presented as Mean ± SD; analyzed using Student's t-test
VAS: Visual Analog Scale; LA: Local Anesthetic

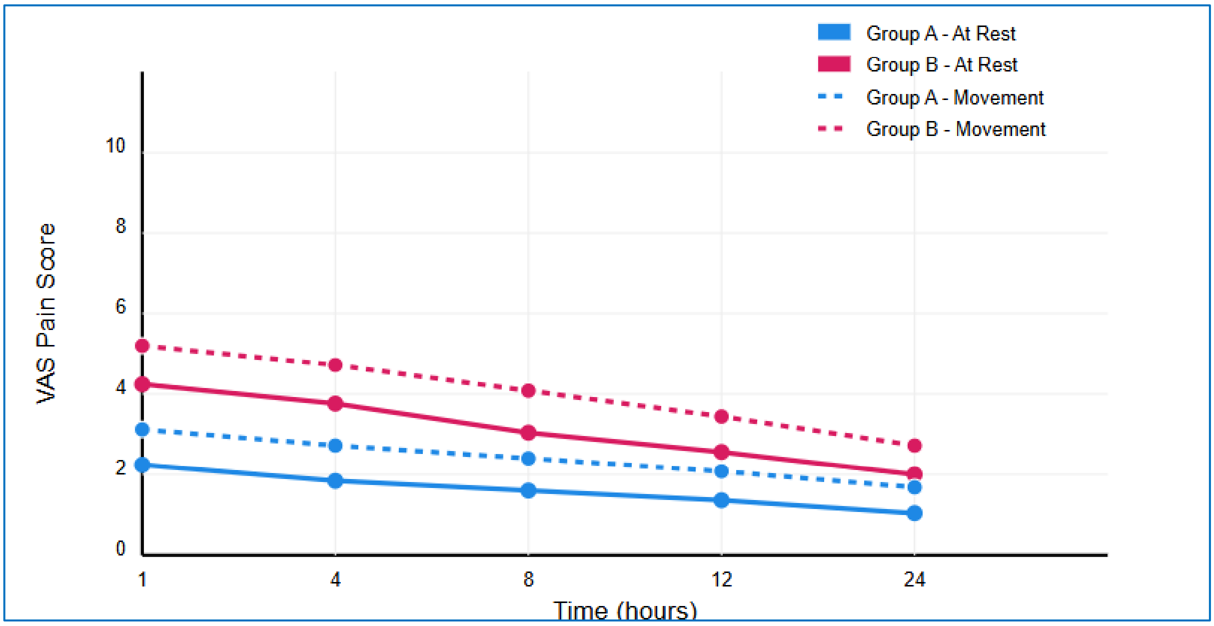

Fig 1: Line graph showing the trend of VAS pain scores at rest and during movement over 24 hours for both groups, highlighting the consistently lower pain scores in Group A compared to Group B.]

Analgesic Requirements

The time to first analgesic request was significantly longer in Group A compared to Group B (210.4 ± 45.3 min vs. 78.2 ± 25.6 min, p<0.001). Total tramadol consumption during the first 24 hours was also significantly lower in Group A (73.1 ± 26.5 mg vs. 146.2 ± 38.7 mg, p<0.001) (Table 3). Fewer patients in Group A required rescue analgesia compared to Group B (15 [57.7%] vs. 26 [100%], p<0.001).

Table 3: Postoperative Analgesic Requirements

Variable	**Group A (Preoperative LA) (n=26)**	**Group B (No LA) (n=26)**	**p-value**
Time to first analgesic request (min)*	210.4 ± 45.3	78.2 ± 25.6	<0.001
Patients requiring rescue analgesia†	15 (57.7%)	26 (100%)	<0.001
Total tramadol consumption in 24h (mg)*	73.1 ± 26.5	146.2 ± 38.7	<0.001
Number of analgesic doses in 24h*	1.2 ± 0.8	2.7 ± 0.9	<0.001

*Data presented as Mean ± SD; analyzed using Student's t-test
†Data presented as number (%); analyzed using Chi-square test
LA: Local Anesthetic

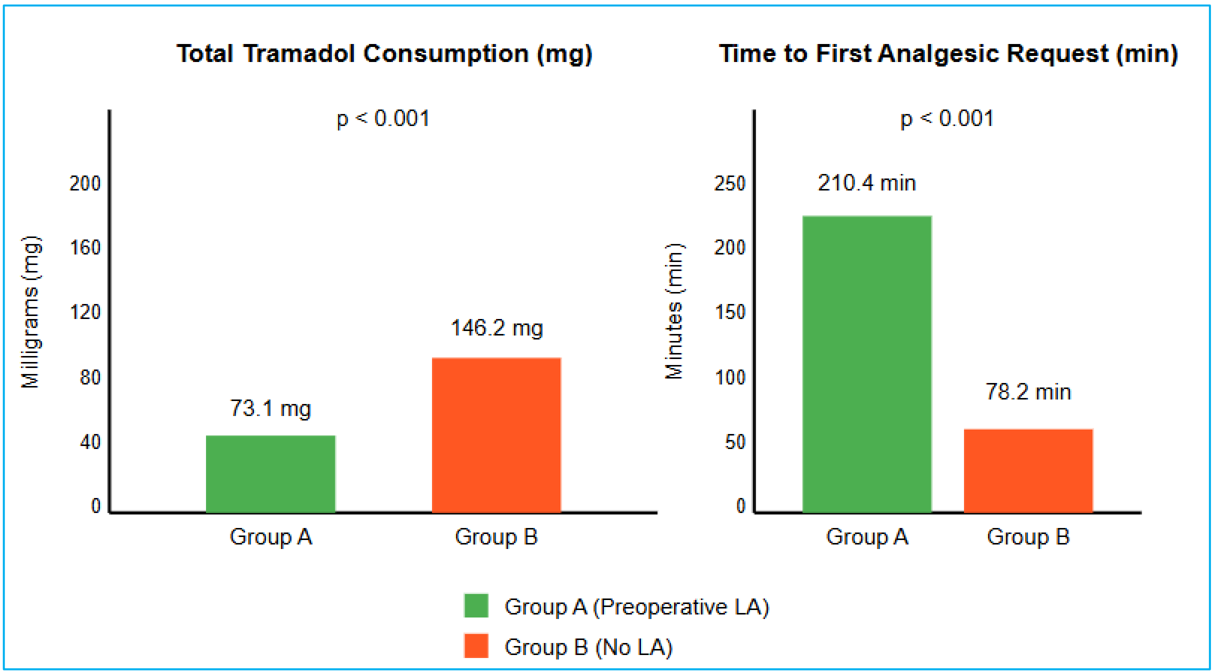

Fig 2: Bar graph comparing the mean total tramadol consumption and mean time to first analgesic request between the two groups

Postoperative Recovery Parameters

Group A demonstrated more favorable recovery profiles with earlier ambulation, shorter PACU stay, and reduced incidence of postoperative nausea and vomiting (PONV) compared to Group B (Table 4). The length of hospital stay was also shorter in Group A, although the difference did not reach statistical significance (p=0.086).

Table 4: Postoperative Recovery Parameters

Variable	Group A (Preoperative LA) (n=26)	Group B (No LA) (n=26)	p-value
Time to ambulation (hours)*	5.2 ± 1.1	7.8 ± 1.6	<0.001
PACU stay (min)*	42.7 ± 10.3	58.4 ± 13.7	<0.001
PONV†	4 (15.4%)	11 (42.3%)	0.033
Use of antiemetics†	3 (11.5%)	9 (34.6%)	0.047
Hospital stay (days)*	1.3 ± 0.5	1.6 ± 0.7	0.086

*Data presented as Mean ± SD; analyzed using Student's t-test
†Data presented as number (%); analyzed using Chi-square test
LA: Local Anesthetic; PACU: Post-Anesthesia Care Unit; PONV: Postoperative Nausea and Vomiting

Patient Satisfaction

Patient satisfaction with pain management was significantly higher in Group A compared to Group B (Table 5). A higher proportion of patients in Group A rated their satisfaction as "excellent" or "good" compared to Group B.

Table 5: Patient Satisfaction with Pain Management

Satisfaction Level	Group A (Preoperative LA) (n=26)	Group B (No LA) (n=26)	p-value
Excellent	12 (46.2%)	4 (15.4%)	0.002
Good	10 (38.5%)	8 (30.8%)	
Satisfactory	3 (11.5%)	9 (34.6%)	
Poor	1 (3.8%)	5 (19.2%)	
Very Poor	0 (0%)	0 (0%)	

Data presented as number (%); analyzed using Chi-square test
LA: Local Anesthetic

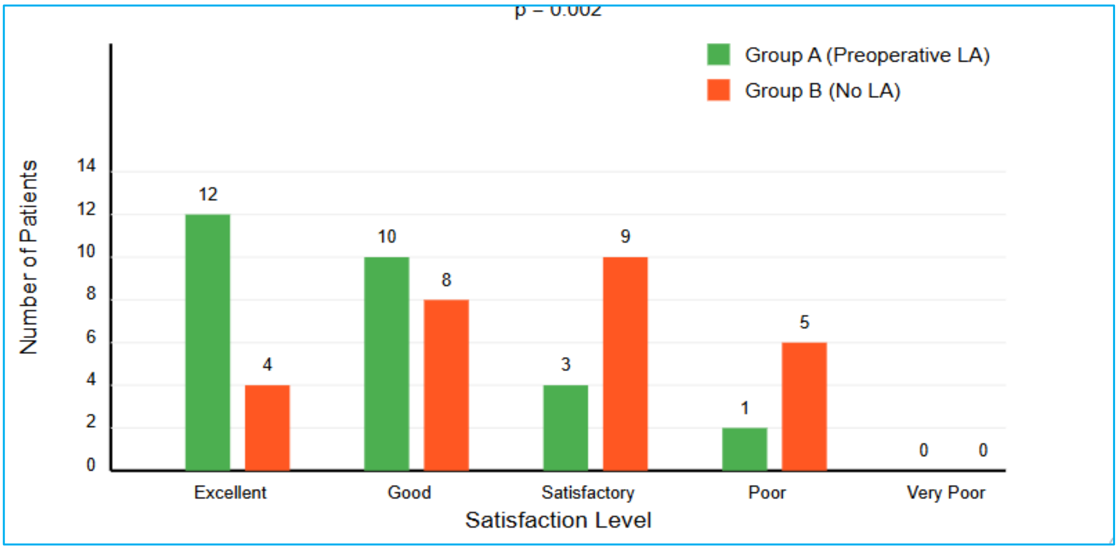

Fig 3: Stacked bar chart showing the distribution of patient satisfaction levels between the two groups

Complications

No significant complications related to local anesthetic infiltration were observed in Group A. Two patients in Group A experienced mild bruising at the port sites, which resolved spontaneously. There were no reported cases of local anesthetic toxicity, allergic reactions, or wound complications in either group.

DISCUSSION

This retrospective comparative study demonstrates that preoperative infiltration of local anesthetic at laparoscopic port sites significantly reduces postoperative pain, decreases analgesic requirements, and improves early recovery parameters in patients undergoing elective laparoscopic procedures. These findings support the incorporation of this simple, cost-effective technique into multimodal analgesic protocols for laparoscopic surgery.

The significant reduction in postoperative pain scores observed in our study aligns with several previous investigations. Ahn *et al.*, [20] reported that preoperative port-site infiltration with 0.5% bupivacaine resulted in significantly lower pain scores during the first 24 hours after laparoscopic cholecystectomy compared to a control group. Similarly, Hasaniya *et al.*, [21] demonstrated that preincisional local anesthetic infiltration significantly reduced both somatic and visceral pain components following laparoscopic procedures.

The timing of local anesthetic administration remains a subject of debate in the literature. Our results favor preoperative infiltration, which is consistent with the findings of Barczyński *et al.*, [22], who compared preemptive versus preventive analgesia in laparoscopic cholecystectomy. They reported that preincisional bupivacaine infiltration provided superior analgesia compared to port-site infiltration at the end of surgery. This supports the concept of preemptive analgesia, which aims to prevent central sensitization by blocking nociceptive input before surgical trauma [23].

Conversely, some studies have found no significant difference between preoperative and postoperative local anesthetic infiltration. Cantore *et al.*, [24] reported similar analgesic efficacy regardless of the timing of administration. Khubutiya *et al.*, [25] suggested that the advantage of preincisional infiltration may be limited to the early postoperative period only. These conflicting results might be attributed to variations in surgical technique, infiltration method, local anesthetic agents, doses, and assessment tools used across studies.

The prolonged time to first analgesic request observed in our Group A (210.4 ± 45.3 min) is comparable to findings by Eldaba *et al.*, [26], who reported a mean time of 225 ± 62 min following preoperative infiltration with bupivacaine. This extended duration of analgesia suggests that preoperative local anesthetic infiltration can effectively bridge the immediate postoperative period when pain intensity is typically highest [27].

Our study demonstrated a 50% reduction in opioid consumption in the preoperative infiltration group. This finding is particularly significant given the current emphasis on opioid-sparing analgesia in perioperative care [28]. Reduced opioid requirements correlate with fewer opioid-related side effects, as evidenced by the lower incidence of PONV in Group A (15.4% vs. 42.3%, p=0.033). This observation is supported by Elhakim *et al.*, [29], who reported similar reductions in opioid consumption and associated side effects following local anesthetic infiltration.

The improved recovery profile observed in our study, including earlier ambulation and shorter PACU stay, may be attributed to better pain control and reduced opioid consumption. These findings are consistent with those of Pavlidis *et al.*, [30], who demonstrated that effective port-site infiltration facilitates early mobilization and enhances recovery after laparoscopic surgery. Although we observed a trend toward shorter hospital stay in Group A, the difference did not reach statistical significance (p=0.086). This is similar to findings by Ortiz *et al.*, [31], who noted improved early recovery parameters without significant reduction in overall hospitalization time.

The mechanism by which preoperative local anesthetic infiltration provides superior analgesia may involve both peripheral and central effects. Peripherally, local anesthetics block sodium channels in nociceptive nerve fibers, preventing impulse transmission [32]. When administered before surgical incision, they may prevent primary hyperalgesia at the incision site and surrounding tissues [33]. Centrally, preemptive analgesia may prevent central sensitization by blocking nociceptive input to the dorsal horn of the spinal cord, thereby reducing the development of persistent postoperative pain [34].

Several technical aspects of local anesthetic infiltration deserve attention. Møiniche *et al.*, [35] emphasized the importance of infiltrating all layers of the abdominal wall, including the parietal peritoneum, for optimal efficacy. In our study, meticulous infiltration technique was employed, ensuring adequate coverage of all tissue layers at port sites. Additionally, the concentration and volume of local anesthetic are critical factors. We used 0.5% bupivacaine, which provides a favorable balance between analgesic efficacy and safety, consistent with recommendations by Chou *et al.*, [36].

Patient satisfaction was significantly higher in Group A, with 84.7% rating their pain management as "excellent" or "good" compared to 46.2% in Group B. This improved satisfaction likely reflects the combined benefits of better pain control, reduced opioid-related side effects, and enhanced early recovery. Similar improvements in patient satisfaction have been reported by Mixter *et al.*, [37] following effective port-site analgesia.

The safety profile of local anesthetic infiltration in our study was excellent, with no serious adverse events observed. This is consistent with previous studies [38,39], which have demonstrated the safety of this technique when appropriate doses and concentrations are used. The maximum recommended dose of bupivacaine (2 mg/kg) was strictly adhered to in our protocol to minimize the risk of local anesthetic systemic toxicity.

Despite the promising results, several limitations of our study should be acknowledged. First, the retrospective design introduces potential for selection bias and confounding variables. Second, the relatively small sample size may limit the generalizability of our findings. Third, we did not assess the impact of port-site infiltration on chronic post-surgical pain, which remains an important outcome measure [40]. Finally, we did not compare different local anesthetic agents or concentrations, which might influence the magnitude and duration of analgesic effect [41].

Future prospective studies should address these limitations and explore additional aspects such as the optimal volume and concentration of local anesthetic, comparative efficacy of different agents, and long-term outcomes including chronic post-surgical pain. Additionally, investigation of enhanced delivery methods such as ultrasound-guided blocks or liposomal formulations may further optimize the analgesic efficacy of port-site infiltration [42,43].

The cost-effectiveness of this intervention also merits consideration. Savvas *et al.*, [44] demonstrated that local anesthetic infiltration is highly cost-effective, with minimal expense for the medication and no requirement for specialized equipment or training. The reduced need for postoperative opioids and associated decrease in opioid-related complications may further enhance the economic benefits of this approach [45].

CONCLUSION

This retrospective comparative study demonstrates that preoperative local anesthetic infiltration at port sites significantly improves postoperative pain management in patients undergoing laparoscopic surgical procedures. Our analysis of 52 cases revealed that patients who received preoperative local anesthetic infiltration experienced significantly lower pain scores, reduced analgesic requirements, delayed time to first analgesic request, and improved recovery parameters compared to those who did not receive this intervention.

The findings support the concept of preemptive analgesia and highlight the effectiveness of this simple, safe, and cost-effective technique as a component of multimodal pain management strategies for laparoscopic surgery. Preoperative port-site infiltration resulted in a 50% reduction in opioid consumption, which correlates with the observed decrease in opioid-related side effects such as postoperative nausea and vomiting.

The improved recovery profile, including earlier ambulation and shorter PACU stay, along with significantly higher patient satisfaction scores, underscores the clinical value of this intervention. The absence of significant complications related to local anesthetic infiltration further confirms the safety profile of this technique when performed with appropriate dosing and technique.

Based on these results, we recommend the routine incorporation of preoperative local anesthetic infiltration into standard protocols for patients undergoing laparoscopic procedures. Future prospective, randomized controlled trials with larger sample sizes are warranted to further validate these findings, explore optimal techniques and agents, and assess long-term outcomes including chronic post-surgical pain.

By implementing this evidence-based approach to perioperative pain management, clinicians can enhance recovery after laparoscopic surgery, improve patient comfort and satisfaction, and potentially reduce healthcare costs associated with prolonged recovery and analgesic-related complications.

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