e-ISSN: 0976-822X, p-ISSN:2961-6042

Available online on http://www.ijcpr.com/

International Journal of Current Pharmaceutical Review and Research 2026; 18(3); 1912-1919

Original Research Article

Comparison of Erector Spinae Plane Block versus Quadratus Lumborum Block for Postoperative Analgesia after Laparoscopic Abdominal Surgery: A Randomized Controlled Trial

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Received: 01-12-2025 / Revised: 15-01-2026 / Accepted: 21-02-2026
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Conflict of interest: Nil

Abstract

Background: Effective postoperative pain management is essential following laparoscopic abdominal surgery to facilitate early recovery and reduce opioid-related adverse effects. Ultrasound-guided fascial plane blocks, particularly the Erector Spinae Plane Block (ESPB) and Quadratus Lumborum Block (QLB), have emerged as promising components of multimodal analgesia. However, evidence comparing their analgesic efficacy remains limited.

Methods: This prospective randomized controlled trial included 180 adult patients undergoing elective laparoscopic abdominal surgery under general anaesthesia. Patients were randomly allocated into two equal groups: Group E (n=90) received ultrasound-guided bilateral ESPB, while Group Q (n=90) received ultrasound-guided bilateral QLB. The primary outcome was postoperative pain intensity assessed using the Numerical Rating Scale (NRS). Secondary outcomes included time to first rescue analgesia, total postoperative opioid consumption, rescue analgesic requirements, postoperative nausea and vomiting (PONV), patient satisfaction, time to ambulation, hospital stay, and block-related complications.

Results: Baseline demographic and perioperative characteristics were comparable between the groups. QLB produced significantly lower postoperative NRS pain scores at all assessment intervals ($p<0.001$) and significantly prolonged the time to first rescue analgesia (14.2 ± 3.1 vs. 10.4 ± 2.6 hours, $p<0.001$). Twenty-four-hour morphine consumption (10.6 ± 3.8 vs. 15.8 ± 4.5 mg), rescue analgesic doses (1.4 ± 0.6 vs. 2.3 ± 0.8), and the proportion of patients requiring rescue analgesia (54.4% vs. 82.2%) were significantly lower in the QLB group (all $p<0.001$). Patients receiving QLB also experienced a lower incidence of PONV (10.0% vs. 20.0%, $p=0.048$), higher patient satisfaction scores (9.1 ± 0.7 vs. 8.2 ± 0.9, $p<0.001$), earlier ambulation (8.9 ± 2.1 vs. 10.6 ± 2.5 hours, $p<0.001$), and shorter hospital stay (4.3 ± 1.0 vs. 4.8 ± 1.2 days, $p=0.003$). Both blocks demonstrated high success rates and comparable safety profiles.

Conclusion: Both ESPB and QLB were safe and effective regional analgesic techniques for laparoscopic abdominal surgery. However, QLB provided superior postoperative analgesia, prolonged analgesic duration, reduced opioid consumption, improved patient satisfaction, and enhanced postoperative recovery, supporting its incorporation into multimodal analgesic and Enhanced Recovery After Surgery (ERAS) protocols.

Keywords: Erector Spinae Plane Block, Quadratus Lumborum Block, Laparoscopic Abdominal Surgery, Postoperative Analgesia, Regional Anaesthesia, Opioid Consumption, Multimodal Analgesia, Randomized Controlled Trial.

DOI: 10.25258/ijcpr.18.3.315

Introduction

Colorectal cancer (CRC) is one of the leading causes of cancer-related morbidity and mortality worldwide, with its incidence continuing to rise because of population aging and lifestyle-related risk factors [1]. Surgical resection remains the primary curative treatment, and laparoscopic colorectal surgery has become the preferred approach owing to reduced surgical trauma, lower blood loss, shorter hospital stay, and faster recovery. Currently, laparoscopic procedures account for nearly 60% of colorectal cancer resections in many centers [2,3]. Despite these advantages, patients frequently experience moderate to severe postoperative pain resulting

from trocar insertion, pneumoperitoneum, visceral manipulation, and inflammatory responses. Poorly controlled pain can impair respiratory function, delay mobilization, prolong hospitalization, increase opioid consumption, and negatively affect patient recovery and satisfaction [4].

Effective postoperative analgesia is a key component of Enhanced Recovery after Surgery (ERAS) protocols, which aim to reduce complications, facilitate early ambulation, and accelerate recovery [5]. Although opioids have traditionally been the cornerstone of postoperative pain management, their use is associated with adverse effects such as postoperative nausea and vomiting, ileus, respiratory depression, urinary retention, sedation, delayed gastrointestinal recovery, and the risk of persistent opioid use. Consequently, multimodal opioid-sparing analgesic strategies have become increasingly important [6]. Thoracic epidural analgesia has long been considered the gold standard for major abdominal surgery but is limited by technical difficulty, hypotension, motor blockade, urinary retention, and contraindications in patients receiving anticoagulants or with coagulation disorders [7]. Ultrasound-guided fascial plane blocks have emerged as effective alternatives because they are relatively easy to perform, provide satisfactory postoperative analgesia, reduce opioid requirements, and have a favorable safety profile. Among these, the erector spinae plane block (ESPB) and quadratus lumborum block (QLB) are increasingly incorporated into multimodal analgesic protocols for abdominal surgery [8].The ESPB, first described by Forero et al. in 2016, involves injection of local anesthetic deep to the erector spinae muscle, allowing spread along the fascial plane and into the paravertebral space. This results in blockade of the dorsal and ventral rami of the spinal nerves, producing extensive thoracoabdominal analgesia. Studies have demonstrated reduced postoperative pain scores and opioid consumption following thoracic and abdominal surgery, with analgesic efficacy approaching thoracic epidural analgesia in selected procedures [9–11].

The QLB involves deposition of local anesthetic adjacent to the quadratus lumborum muscle, enabling spread through the thoracolumbar fascia to the thoracic paravertebral space and sympathetic chain. The anterior (transmuscular) approach provides extensive sensory blockade from T7 to L2, offering prolonged somatic and visceral analgesia after abdominal surgery [12–14].Although both ESPB and QLB have shown promising results, evidence comparing their effectiveness remains inconsistent because of differences in surgical procedures, block techniques, local anesthetic regimens, and outcome measures. Direct comparative data in laparoscopic colorectal surgery are particularly limited [15–17]. Therefore, this randomized controlled trial was undertaken to compare ultrasound-guided ESPB and QLB in patients undergoing laparoscopic colorectal surgery. The primary objective was to compare postoperative pain intensity and duration of analgesia, while secondary outcomes included opioid consumption, time to first rescue analgesia, postoperative nausea and vomiting, block-related complications, patient satisfaction, and quality of recovery. The findings may help identify the optimal regional analgesic technique for incorporation into ERAS-based perioperative care.

Materials and Methods

This prospective, randomized, parallel-group, controlled trial was conducted in the Department of Anaesthesiology at a tertiary care teaching hospital after obtaining approval from the Institutional Ethics Committee. Adult patients scheduled to undergo elective laparoscopic colorectal surgery under general anaesthesia were screened for eligibility. Patients fulfilling the inclusion criteria and willing to participate were enrolled in the study.

Inclusion Criteria

Patients who met all of the following criteria were included:

- Age between 18 and 70 years.
- American Society of Anesthesiologists (ASA) physical status I–III.
- Scheduled for elective laparoscopic colorectal surgery under general anaesthesia.
- Ability to understand the pain assessment scale and provide informed consent.

Exclusion Criteria

Patients were excluded if they had:

- Refusal to participate.
- Allergy or hypersensitivity to local anaesthetic agents.
- Infection at the site of needle insertion.
- Coagulopathy or ongoing anticoagulant therapy contraindicating regional anaesthesia.
- Severe hepatic, renal, or cardiac dysfunction.
- Body mass index (BMI) >35 kg/m².
- Pregnancy or lactation.
- Chronic opioid use or opioid dependence.
- Pre-existing neurological deficits involving the thoracoabdominal region.
- Conversion to open surgery.

Randomization and Allocation Concealment: Eligible patients were randomly allocated into two equal groups using a computer-generated randomization sequence. Allocation was concealed using sequentially numbered, opaque, sealed

envelopes that were opened immediately before administration of the regional block.

- **Group E (ESPB group):** Patients received an ultrasound-guided bilateral erector spinae plane block.
- **Group Q (QLB group):** Patients received an ultrasound-guided bilateral quadratus lumborum block.

Blinding: The study was conducted in a double-blinded manner. The anaesthesiologist performing the block was not involved in postoperative assessment. Patients, surgeons, nursing staff, and investigators responsible for postoperative data collection and statistical analysis remained blinded to group allocation.

Preoperative Assessment: All patients underwent a detailed pre-anaesthetic evaluation one day before surgery. Demographic data including age, sex, body weight, height, BMI, ASA physical status, diagnosis, and planned surgical procedure were recorded. Routine laboratory investigations were reviewed. Patients were educated regarding the Numerical Rating Scale (NRS), where 0 represented no pain and 10 represented the worst imaginable pain.

Anaesthetic Technique: All patients fasted according to standard fasting guidelines and received routine premedication as per institutional protocol. In the operating room, standard American Society of Anesthesiologists monitoring, including electrocardiography, non-invasive blood pressure, pulse oximetry, and capnography, was instituted.

Baseline heart rate, blood pressure, oxygen saturation, and respiratory rate were recorded. General anaesthesia was induced with intravenous fentanyl (2 μg/kg), propofol (2–2.5 mg/kg), and rocuronium (0.6 mg/kg) to facilitate endotracheal intubation. Anaesthesia was maintained using oxygen, air, sevoflurane, and intermittent doses of rocuronium as required. Intraoperative analgesia and fluid management were standardized for all patients.

Ultrasound-Guided Erector Spinae Plane Block: Patients allocated to Group E received an ultrasound-guided bilateral erector spinae plane block after induction of general anaesthesia and before surgical incision.

A high-frequency linear ultrasound probe was placed longitudinally approximately 3 cm lateral to the T8 transverse process. After identification of the erector spinae muscle and transverse process, a 22-gauge echogenic block needle was advanced using an in-plane approach until the tip reached the fascial plane deep to the erector spinae muscle. Following negative aspiration, hydrodissection with normal saline confirmed correct needle placement. Subsequently, 20 mL of 0.25% bupivacaine was injected on each side under ultrasound visualization.

Ultrasound-Guided Quadratus Lumborum Block: Patients allocated to Group Q received an ultrasound-guided bilateral anterior (transmuscular) quadratus lumborum block after induction of anaesthesia. A low-frequency curvilinear ultrasound probe was positioned over the flank to identify the quadratus lumborum, psoas major, and erector spinae muscles. Using an in-plane approach, a 22-gauge echogenic needle was advanced between the quadratus lumborum and psoas major muscles. After negative aspiration and confirmation of correct needle placement by hydrodissection, 20 mL of 0.25% bupivacaine was injected on each side.

Postoperative Analgesia: All patients received standardized multimodal analgesia consisting of intravenous paracetamol 1 g every 8 hours and intravenous ketorolac 30 mg every 12 hours unless contraindicated. Rescue analgesia was administered when the NRS pain score was ≥4. Intravenous morphine (or tramadol, according to institutional protocol) was administered in incremental doses until adequate analgesia was achieved. The total opioid consumption during the first 24 postoperative hours was recorded and converted into morphine milligram equivalents where applicable.

Outcome Measures

Primary Outcome: The primary outcome was postoperative pain intensity assessed using the Numerical Rating Scale at rest and during movement at 1, 2, 4, 6, 12, and 24 hours after surgery.

Secondary Outcomes

The secondary outcomes included:

- Time to first rescue analgesia.
- Total postoperative opioid consumption during the first 24 hours.
- Number of rescue analgesic doses.
- Intraoperative opioid requirement.
- Postoperative nausea and vomiting.
- Hemodynamic parameters.
- Block-related complications.
- Patient satisfaction score at 24 hours.
- Duration of hospital stay.

Data Collection: Postoperative pain scores, opioid consumption, adverse events, and recovery parameters were recorded by an investigator blinded to treatment allocation. Patients were monitored for hypotension, bradycardia, local anaesthetic systemic toxicity, hematoma, infection, pneumothorax, lower limb weakness, urinary retention, and any neurological complications.

Statistical Analysis: The collected data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics version 25 (IBM Corp., Armonk, NY, USA).

Continuous variables were expressed as mean ± standard deviation or median (interquartile range), depending on data distribution, whereas categorical variables were presented as frequency and percentage.

Normality of continuous data was assessed using the Shapiro–Wilk test. Continuous variables were compared using the independent Student's t-test for normally distributed data or the Mann–Whitney U test for non-normally distributed data. Categorical variables were compared using the Chi-square test or Fisher's exact test as appropriate. Repeated postoperative pain scores were analyzed using repeated-measures analysis of variance with appropriate post hoc comparisons. A two-tailed p-value of <0.05 was considered statistically significant.

Results

A total of 180 patients were enrolled and randomized equally into two groups, with 90 patients receiving ultrasound-guided Erector Spinae Plane Block (Group E) and 90 patients receiving ultrasound-guided Quadratus Lumborum Block (Group Q). All randomized patients completed the study and were included in the final analysis. The baseline demographic and clinical characteristics were comparable between the two groups, with no statistically significant differences in age, sex distribution, body mass index, ASA physical status, or duration of surgery (all p>0.05), indicating successful randomization and homogeneity of the study population (Table 1).Comparison of block characteristics demonstrated that the ESPB required significantly less time to perform than the QLB (8.1 ± 1.3 vs. 9.4 ± 1.5 minutes; p<0.001). However, patients receiving the QLB experienced a significantly longer duration of postoperative analgesia, with a prolonged time to first rescue analgesia (14.2 ± 3.1 vs. 10.4 ± 2.6 hours; p<0.001). The block success rate was high and comparable between the two groups (97.8% vs. 98.9%; p=0.561) (Table 2).Postoperative pain assessment using the Numerical Rating Scale (NRS) revealed significantly lower pain scores in the QLB group at all postoperative assessment intervals. The mean NRS scores were significantly lower in the QLB group in the recovery room (3.2 ± 0.8 vs. 3.8 ± 0.9), at 2 hours (2.8 ± 0.7 vs. 3.4 ± 0.8), 6 hours (2.4 ± 0.6 vs. 3.1 ± 0.8), 12 hours (2.2 ± 0.6 vs. 2.9 ± 0.7), and 24 hours (1.9 ± 0.5 vs. 2.3 ± 0.6), with all comparisons reaching statistical significance (p<0.001) (Table 3, Figure 1). Analysis of postoperative analgesic requirements showed that patients in the QLB group required significantly less opioid analgesia than those in the ESPB group. The mean 24-hour morphine consumption was significantly lower in the QLB group (10.6 ± 3.8 mg vs. 15.8 ± 4.5 mg; p<0.001). Similarly, the number of rescue analgesic doses (1.4 ± 0.6 vs. 2.3 ± 0.8) and the proportion of patients requiring rescue analgesia (54.4% vs. 82.2%) were significantly reduced in the QLB group (all p<0.001) (Table 4). Postoperative recovery and adverse events were comparable between the two groups with respect to sedation, hypotension, bradycardia, and block-related complications (all p>0.05). However, the incidence of postoperative nausea and vomiting was significantly lower among patients receiving the QLB than those receiving the ESPB (10.0% vs. 20.0%; p=0.048) (Table 5, Figure 2). Assessment of recovery outcomes demonstrated significantly greater patient satisfaction in the QLB group, with a mean satisfaction score of 9.1 ± 0.7 compared with 8.2 ± 0.9 in the ESPB group (p<0.001). Patients who received the QLB also achieved earlier ambulation (8.9 ± 2.1 vs. 10.6 ± 2.5 hours; p<0.001) and had a significantly shorter duration of hospital stay (4.3 ± 1.0 vs. 4.8 ± 1.2 days; p=0.003) (Table 6, Figure 3).

Table 1: Baseline Demographic and Clinical Characteristics

Variable	Group E (ESPB) (n=90)	Group Q (QLB) (n=90)	p-value
Age (years), Mean ± SD	54.6 ± 10.2	55.1 ± 9.8	0.728
Male, n (%)	56 (62.2)	58 (64.4)	0.760
Female, n (%)	34 (37.8)	32 (35.6)	
BMI (kg/m²), Mean ± SD	25.1 ± 3.2	24.8 ± 3.0	0.514
ASA I, n (%)	24 (26.7)	22 (24.4)	0.893
ASA II, n (%)	48 (53.3)	50 (55.6)	
ASA III, n (%)	18 (20.0)	18 (20.0)	
Duration of surgery (min), Mean ± SD	134.6 ± 28.4	137.3 ± 30.2	0.541

Table 2: Comparison of Block Characteristics

Parameter	Group E (ESPB)	Group Q (QLB)	p-value
Block performance time (min)	8.1 ± 1.3	9.4 ± 1.5	<0.001
Block success rate (%)	97.8	98.9	0.561
Time to first rescue analgesia (hours)	10.4 ± 2.6	14.2 ± 3.1	<0.001

Table 3: Postoperative Pain Scores (NRS)

Time	Group E	Group Q	p-value
Recovery room	3.8 ± 0.9	3.2 ± 0.8	<0.001
2 hours	3.4 ± 0.8	2.8 ± 0.7	<0.001
6 hours	3.1 ± 0.8	2.4 ± 0.6	<0.001
12 hours	2.9 ± 0.7	2.2 ± 0.6	<0.001
24 hours	2.3 ± 0.6	1.9 ± 0.5	<0.001

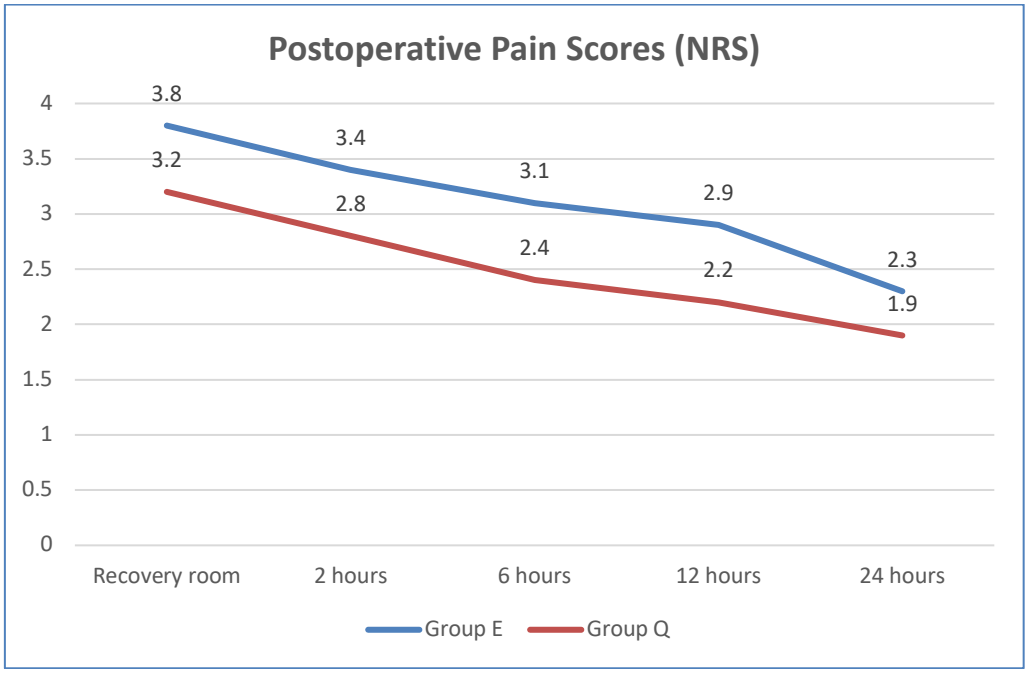

Figure 1: Postoperative Pain Scores (NRS)

Table 4: Analgesic Requirement

Parameter	Group E	Group Q	p-value
Total morphine consumption (24 h), mg	15.8 ± 4.5	10.6 ± 3.8	<0.001
Rescue analgesic doses	2.3 ± 0.8	1.4 ± 0.6	<0.001
Patients requiring rescue analgesia, n (%)	74 (82.2)	49 (54.4)	<0.001

Table 5: Postoperative Recovery and Adverse Events

Variable	Group E	Group Q	p-value
PONV, n (%)	18 (20.0)	9 (10.0)	0.048
Sedation, n (%)	7 (7.8)	5 (5.6)	0.552
Hypotension, n (%)	3 (3.3)	4 (4.4)	0.701
Bradycardia, n (%)	2 (2.2)	2 (2.2)	1.000
Block-related complications, n (%)	1 (1.1)	2 (2.2)	0.559

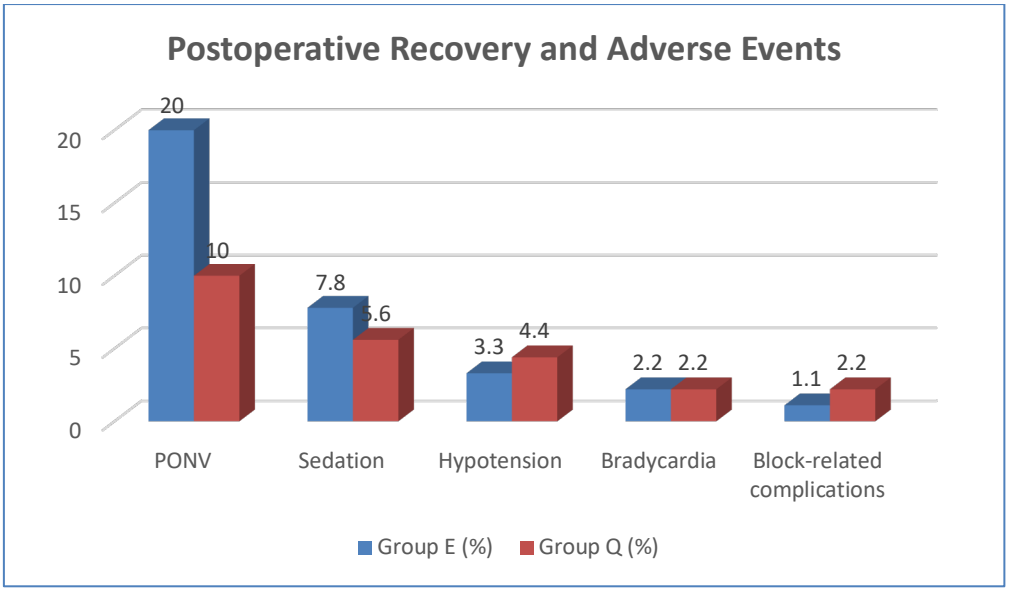

Figure 2: Postoperative Recovery and Adverse Events

Table 6: Patient Satisfaction and Recovery Outcomes

Parameter	Group E	Group Q	p-value
Patient satisfaction score (0–10)	8.2 ± 0.9	9.1 ± 0.7	<0.001
Time to first ambulation (hours)	10.6 ± 2.5	8.9 ± 2.1	<0.001
Length of hospital stay (days)	4.8 ± 1.2	4.3 ± 1.0	0.003

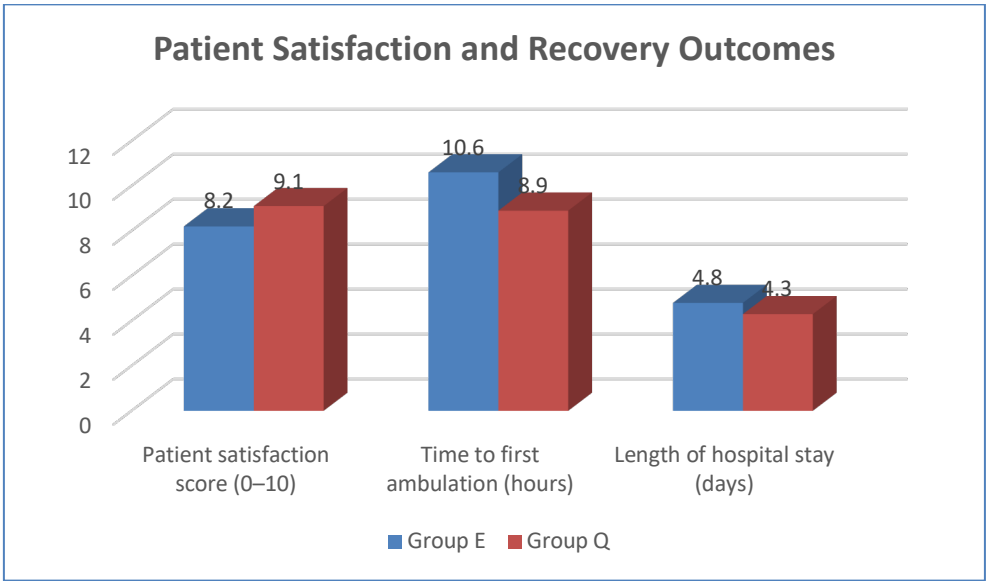

Figure 3: Patient Satisfaction and Recovery Outcomes

Discussion

The present randomized controlled trial demonstrated that the ESPB and QLB groups were comparable with respect to age, sex distribution, body mass index, ASA physical status, and duration of surgery, indicating successful randomization and minimizing baseline confounding. The mean age was 54.6 ± 10.2 years in the ESPB group and 55.1 ± 9.8 years in the QLB group (p=0.728), while the mean duration of surgery was 134.6 ± 28.4 and 137.3 ± 30.2 minutes, respectively (p=0.541). These findings are consistent with the randomized trial by Mahgoub et al. [18], who also reported comparable baseline demographic characteristics between ESPB and transmuscular QLB groups in patients undergoing laparoscopic colorectal surgery.

In the present study, ESPB required significantly less time to perform than QLB (8.1 ± 1.3 vs. 9.4 ± 1.5 minutes; p<0.001), whereas QLB provided a significantly longer duration of postoperative analgesia, with time to first rescue analgesia of 14.2 ± 3.1 hours compared with 10.4 ± 2.6 hours in the ESPB group (p<0.001). The prolonged analgesic

effect of QLB is likely related to the spread of local anesthetic through the thoracolumbar fascia into the paravertebral space, providing effective somatic and visceral analgesia. A recent systematic review and meta-analysis by Zhang et al. [19] similarly concluded that both blocks are effective, although QLB generally offers a longer duration before rescue analgesia, while ESPB is slightly quicker to perform. QLB also resulted in significantly lower postoperative pain scores throughout the first 24 hours.

The mean recovery room NRS score was 3.2 ± 0.8 in the QLB group compared with 3.8 ± 0.9 in the ESPB group, with significant differences persisting at all postoperative assessment points ($p<0.001$). However, Mahgoub et al. [18] reported contrasting findings, demonstrating superior analgesia with ESPB, including a longer time to rescue analgesia and reduced nalbuphine consumption. Likewise, Zhang et al. [19] observed that postoperative pain scores were generally comparable between ESPB and QLB across different surgical procedures, although evidence certainty remained low because of heterogeneity. Patients receiving QLB consumed significantly less morphine during the first 24 postoperative hours (10.6 ± 3.8 vs. 15.8 ± 4.5 mg; $p<0.001$), required fewer rescue analgesic doses, and experienced a lower incidence of postoperative nausea and vomiting.

These findings contrast with Mahgoub et al. [18], who reported lower opioid consumption with ESPB. Similarly, a randomized trial by Li et al. [20] in laparoscopic major liver resection found no significant difference in opioid consumption between ESPB and QLB. Such discrepancies may reflect variations in surgical procedures, QLB technique, local anesthetic regimen, and postoperative analgesic protocols. Both regional techniques demonstrated excellent safety profiles with minimal complications. Furthermore, QLB was associated with significantly greater patient satisfaction, earlier ambulation, and shorter hospital stay. Overall, the present findings suggest that although both ultrasound-guided ESPB and QLB are safe and effective for laparoscopic abdominal surgery, QLB provides superior postoperative analgesia and enhanced recovery. These results are broadly supported by recent evidence from Mahgoub et al. [18], Zhang et al. [19], and Li et al. [20], while acknowledging that differences among studies are likely attributable to variations in patient populations, surgical procedures, and block techniques.

Conclusion

Ultrasound-guided Erector Spinae Plane Block (ESPB) and Quadratus Lumborum Block (QLB) were both effective components of multimodal analgesia following laparoscopic abdominal surgery. However, the Quadratus Lumborum Block provided significantly superior postoperative analgesia, characterized by lower pain scores, prolonged duration of analgesia, reduced opioid consumption, fewer rescue analgesic requirements, and lower incidence of postoperative nausea and vomiting. In addition, QLB was associated with earlier ambulation, higher patient satisfaction, and shorter hospital stay. These findings suggest that QLB may be the preferred regional analgesic technique for enhancing postoperative recovery after laparoscopic abdominal surgery.

Limitations

The present study was conducted at a single tertiary care center, which may limit the generalizability of the findings. Postoperative outcomes were evaluated only during the first 24 hours, and long-term pain outcomes or chronic postsurgical pain were not assessed. Furthermore, different types of laparoscopic abdominal procedures were included, which may have influenced postoperative pain intensity.

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