BMC Anesthesiology

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Comparison of analgesic efficacy of erector spinae plane block at different levels in laparoscopic cholecystectomies: a randomized controlled trial

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Abstract

Background Erector Spinae Plane Block (ESPB) is employed as a component of multimodal analgesia in laparoscopic cholecystectomy (LC) procedures. The objective of this study is to assess the impact of ESPB performed at different levels during LC operations on postoperative pain scores and opioid consumption.

Methods A total of 103 patients undergoing LC were divided into three groups: Group Th7 (ESPB administered at the 7th thoracic vertebra level), Group Th9 (ESPB administered at the 9th thoracic vertebra level), and the control group. Patients were evaluated at 30 min, 1, 4, 8, 12, and 24 h postoperatively. Morphine consumption within the first 24 h postoperatively, resting and dynamic Numeric Rating Scale (NRS) scores, and complication rates were assessed.

Results When comparing morphine consumption among the groups, it was observed that patients who received ESP blocks had significantly lower morphine consumption at 1, 4, 8, 12, and 24 h compared to the control group. However, no significant difference was found between Group Th7 and Group Th9. In Group Th7 and Group Th9, the resting NRS scores at 30 min, 1, 4, and 24 h, as well as all dynamic NRS scores except at the 8th hour, were significantly lower compared to the control group. However, there was no significant difference between Group Th7 and Group Th9.

Conclusion In LC surgeries, ESPB administered at the Th7 and Th9 levels exhibited similar analgesic efficacy. ESPB applied at the Th7 and Th9 levels can be utilized as part of multimodal analgesia.

Keywords Enhanced recovery after surgery, Erector spinae plane block, Laparoscopic cholecystectomy, Multimodal analgesia, Opioid free analgesia, Postoperative analgesia

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Introduction

Laparoscopic cholecystectomy (LC) is a commonly performed surgical procedure. The pain experienced after LC differs from that of open cholecystectomy and can range from moderate to severe. Due to the limited incisions in the thoracic entry areas during LC, somatic pain is reduced. However, peritoneal distension caused by CO_2 insufflation and inflammation associated with gallbladder resection manifest as visceral pain. Additionally, diaphragmatic irritation due to peritoneal distension can result in referred pain in the shoulders, making the pain mechanism and type different from those in open cholecystectomy [1–3].

In the postoperative period, the goal is to expedite recovery according to Enhanced Recovery After Surgery (ERAS) protocols by minimizing pain, enhancing patient comfort, and reducing the potential side effects of opioid analgesics [4].

Various modalities contribute to postoperative analgesia management, including paracetamol, nonsteroidal anti-inflammatory drugs (NSAIDs), local anesthetic infiltration at incision sites, preemptive analgesia techniques, intravenous opioids, and regional anesthesia techniques as part of multimodal analgesia [5].

Opioids are commonly used in these patients for pain management. However, concerns about their side effects have prompted anesthesiologists to explore alternative approaches. In recent years, the widespread use of ultrasound (US), advancements in US technology, and the development of fascial plane block techniques have brought various ultrasound-guided trunk blocks into focus for postoperative pain management in patients undergoing LC [6, 7].

The erector spinae plane block (ESPB) was initially used for the treatment of thoracic neuropathic pain and has gained popularity in recent years as an effective regional analgesia technique and a component of multimodal analgesia in thoracic and abdominal surgeries [8–12].

It is believed that ESPB provides both somatic and visceral analgesia by allowing local anesthetic agents to spread to the sympathetic chain via the dorsal ramus, ventral ramus, and ramus communicans of the intercostal nerves [13–16].

In the literature, different levels of ESPB application have been reported in LC surgeries. Tulgar et al. [6] performed ESPB at the T9 vertebral level, Cesur et al. [17] at the T8 level, and Dilva et al. [18] at the T7 level, reporting effective analgesia with ESPB in patients undergoing LC surgery. However, we have not found a study in the literature that determines which ESPB level provides the most effective analgesia for LC operations.

The anatomical structure of the erector spinae and back muscles varies throughout the vertebral column. The erector spinae muscles become thicker as they descend toward the lumbar region.

In a study by Dautzenberg et al. [19], the spread of ESPB performed at the 2nd and 8th thoracic levels was investigated in 11 cadavers, and it was reported that upper-level ESPB resulted in greater paravertebral and epidural spread. They also found unpredictable spread in fresh cadavers and individual variations. These results were attributed to anatomical barriers affecting the distribution of local anesthetics.

In regions where the ligamentum flavum is thinner and the transitional anatomy between the erector spinae muscle and the paravertebral space varies, a broader spread is expected. Although no significant sonographic morphological differences were observed between the Th7 and Th9 levels, the characteristics of the paraspinal muscles and fascial structures at these levels may contribute to potential variations in local anesthetic distribution.

For all these reasons, we considered that ESPB, which relies on the distribution of local anesthetics between fascial layers, may provide varying analgesic effectiveness at different levels.

The aim of this prospective, randomized controlled study is to compare the analgesic effectiveness of ESPB applied at the 7th and 9th thoracic vertebral levels during the first 24 h postoperatively in patients undergoing LC.

Materials and methods

This study was designed as a prospective, randomized, single-blinded trial. It received approval from the Gaziosmanpasa Training and Research Hospital Clinical Research Ethics Committee on 25/12/2019 (decision no: 2019/168) and was registered on ClinicalTrials.gov (registration no: NCT04316416).

The study was conducted in the general surgery operating room, following the principles of the Helsinki Declaration, between 15/02/2020 and 02/06/2021. Written and verbal informed consent was obtained from all patients.

Patients aged between 18 and 65 years with an American Society of Anesthesiologists (ASA) physical status classification of I or II (characterized by well-controlled comorbidities such as hypertension, asthma, type 2 diabetes mellitus, hypothyroidism, mild anemia, and a solitary kidney with normal renal function) were included in the study.

Patients who declined to participate, those with severe lung or heart diseases, BMI ≥ 35, a history of local anesthetic allergy, bleeding disorders, a history of anticoagulant use, infection at the application site, severe kidney or liver diseases, psychiatric or neurological disease history, previous spinal or thoracic surgery within the T6-T12 dermatome area, or an operation duration longer than 90 min were excluded from the study.

Patients were randomized into three groups: Group Th7, Group Th9, and the control group (Group C).

The randomization sequence was generated using a computer program and stored in sealed, numbered envelopes. Each participant was assigned to a group by opening the next envelope in sequence. Patients in the Group Th7 received bilateral ESPB at the level of the 7th thoracic vertebra under US guidance. Patients in the Group Th9 received bilateral ESPB at the level of the 9th thoracic vertebra under US guidance. ESPB was performed in both groups after the completion of the surgical procedure and before extubation. No block was applied in the control group. ESPB was performed by the same researcher. The researcher who performed ESPB did not participate in the postoperative follow-up or data collection, which were conducted by a blinded anesthesiologist.

All patients received a standard general anesthesia regimen. Induction of anesthesia involved intravenous administration of midazolam (0.04 mg/kg), lidocaine (0.5 mg/kg), propofol (2 mg/kg), fentanyl (1 μg/kg), and rocuronium (0.6 mg/kg). Anesthesia was maintained using sevoflurane and remifentanil. A remifentanil infusion at 0.05–2 μg/kg/min was administered to maintain hemodynamic parameters within 20% of baseline values. The same surgical team performed laparoscopic cholecystectomy (LC) using the standard four-port technique with carbon dioxide pneumoperitoneum. Pneumoperitoneum pressure was maintained below 12 mmHg throughout the procedure. Ondansetron (4 mg) was administered prophylactically to prevent postoperative nausea and vomiting. For postoperative analgesia, all patients received intravenous morphine hydrochloride (4 mg), paracetamol (1 g), and dexketoprofen (50 mg) as part of the standard multimodal analgesia protocol during the intraoperative period.

After the surgical procedures were completed, the block was administered. ESPB was performed in the Group Th7 and the Group Th9. The block was administered by the same anesthesiologist, who had sufficient experience in trunk blocks. To minimize patient movement during the procedure, the blocks were performed under general anesthesia.

After the block procedures were completed, the patients were extubated. All patients were transferred to the ward after being monitored for 30 min in the postoperative care unit. Postoperatively, all patients were scheduled to receive paracetamol (4 × 1 g) and morphine hydrochloride via patient-controlled analgesia (PCA) for the first 24 h. No basal infusion was administered through the PCA device (Accumate 1100, Anesmed, Istanbul, Turkey). A bolus dose of 1 mg with a lockout interval of 10 min, a 4-hour limit of 6 mg, and a daily total limit of 20 mg were set in order to minimize opioid-related side effects. Patients were evaluated by a blinded researcher at postoperative 30 min, and at the 1st, 4th, 8th, 12th, and 24th hours. Resting and dynamic (during coughing) NRS scores, morphine consumption, time to first rescue analgesia, timing of morphine administration, and complications such as nausea, vomiting, and shoulder pain were recorded.

Patients experiencing nausea and vomiting received an additional 4 mg dose of ondansetron. Pain was assessed using the NRS scale, ranging from 0 (no pain) to 10 (unbearable pain).

ESPB application

In Group Th7, all patients were positioned in the right lateral decubitus position before tracheal extubation. After ensuring aseptic conditions, a linear ultrasound probe (6–12 MHz) (MyLabSeven; Esaote Europe, Netherlands) was placed in a longitudinal parasagittal plane approximately 3 cm lateral to the spinous process of the Th7 vertebra. Once the erector spinae muscle and the transverse process of the Th7 vertebra were visualized, an 80-mm peripheral nerve block needle (Stimuplex® Ultra; B. Braun Melsungen AG, Germany) was advanced in a cranial-to-caudal direction with the needle tip visualized between the transverse process and the posterior fascia of the erector spinae muscle. After hydrodissection with 1–2 ml of 0.9% saline, a mixture of 15 ml of 0.5% bupivacaine and 5 ml of 2% lidocaine was injected under ultrasound guidance, lifting the erector spinae muscle and ensuring its linear spread. The same procedure was performed on the opposite side at the same level using the same amount of local anesthetic.

The same procedure was applied in Group Th9 using the same technique, 3 cm lateral to the 9th thoracic vertebra.

The primary objective of this study is to evaluate the effect of ESPB performed at different levels during LC on postoperative morphine consumption. The secondary objectives are to compare postoperative NRS scores (at rest and during movement), the time to first rescue analgesia, and postoperative side effects that may occur.

Statistically analyze

A pilot study including 10 patients per group was conducted to assess the mean morphine consumption in the two groups, which was found to be 6.0 ± 5.3 mg and 10.0 ± 5.9 mg, respectively. Based on these preliminary data, a power analysis was performed using G*Power. With a significance level of 5% (95% confidence interval), a power of 80%, and an estimated standardized effect size of 0.71, it was determined that a minimum of 31 patients per group would be required for the study [20].

The Kolmogorov-Smirnov and Shapiro-Wilk tests were used to assess normality. Based on the results, parametric and/or non-parametric tests were selected as

appropriate. Differences in proportions between groups were compared using the Chi-Square or Fisher's Exact test, where applicable. Survival estimations for the time to first analgesic requirement were performed using the Kaplan-Meier method, and comparisons between groups were evaluated using the Log-rank test. Mean and median survival times were reported with their standard errors and 95% confidence intervals. General descriptive statistics are presented as counts and percentages for categorical variables and as Mean ± Standard Deviation or Median (Min-Max) for continuous variables. Differences between three groups, six time points, and their interaction were analyzed using two-way repeated measures ANOVA. The sphericity assumption was tested using Mauchly's test of sphericity. In cases where this assumption was violated, Wilk's Lambda statistic was used for multivariate test results. Additionally, line graphs with standard errors were included to better visualize the results of the repeated measures ANOVA. IBM SPSS Statistics for Windows, Version 27.0, was used for statistical analyses, and a p-value of less than 0.05 was considered statistically significant.

Data Availability

The data associated with this paper are not publicly available but may be obtained from the corresponding author upon reasonable request.

Results

This study includes 103 patients. The patient flow diagram is shown in Fig. 1.

When comparing the patients' demographic data (age, gender, BMI, ASA classifications, and comorbidities), no significant differences were found among the groups (Table 1). The distribution of diabetic patients was homogeneous across the groups, with each group having two diabetic patients. A comparison of anesthesia durations revealed that the mean duration in the Th7

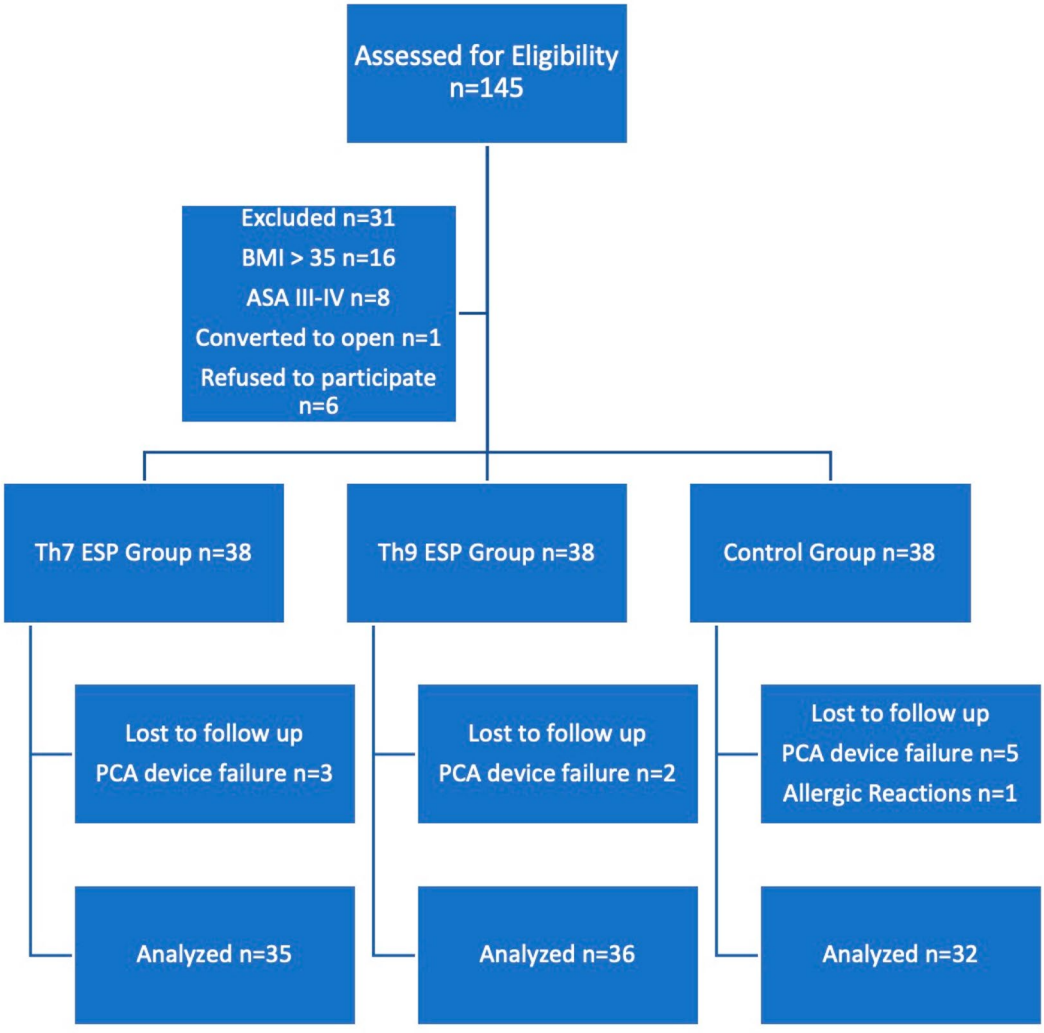

Fig. 1 CONSORT flow diagram of the study

Table 1 Comparison of demographic data

	Group Th7 (*n* = 35)	Group Th9 (*n* = 36)	Group C (*n* = 32)	*p* values
Gender (M/F, n)	9/26	8/28	8/24	0.937
	Mean ± SD	Mean ± SD	Mean ± SD	
Age (years)	44.7 ± 11.9	42.8 ± 10.8	45.5 ± 12.2	0.607
BMI (kg.m^{-2})	27.9 ± 3.6	27.5 ± 3.7	28.1 ± 4.2	0.762
Anesthesia duration (min)	61.11 ± 16.73[a]	52.47 ± 13.79[b]	52.10 ± 14.71[b]	**0.023**
	n (%)	**n (%)**	**n (%)**	
ASA I	24 (68.6%)	23 (63.9%)	18 (56.3%)	0.506
ASA II	11 (31.4%)	13 (36.1%)	14 (43.7%)	
Comorbidities				
No	26 (75.3%)	24(66.7%)	21(65.6%)	0.674
Yes	9 (25.7%)	12(33.3%)	11 (34.4%)	

M: Male, F: Female, BMI: Body Mass index, SD: Standard deviation

[a, b]: Means indicated with the same subscript are identical, and with different subscripts are statistically

group (61.11 ± 16.73 min) was longer than in the Th9 and control groups (52.47 ± 13.79 and 52.10 ± 14.71 min, respectively).

When the groups were compared in terms of morphine consumption, the number of patients requiring morphine at postoperative 1, 4, 8, 12, and 24 h was significantly lower in Group Th7 and Group Th9 compared to the control group. However, there was no significant difference between Group Th7 and Group Th9 (Table 2).

At the 1st hour, morphine consumption in Group Th7 and Group Th9 was significantly lower than in the control group ($p < 0.001$). Additionally, 10% of patients in Group Th7, 20% in Group Th9, and 70% in the control group required additional analgesics within the first hour (Table 2).

When morphine consumption was compared among the groups, it was significantly lower in the Th7 and Th9 groups than in the control group during the 31 min–1 h and 1–4 h time intervals. Additionally, morphine consumption during the 8–12 h time interval was significantly lower in the Th7 group than in the control group (Table 3).

Table 2 Comparison of the total number of patients consuming morphine at different time points among groups

	Group Th7		Group Th9		Group C		*p*
	n	%	*n*	%	*n*	%	
T30 (+)	2	5.7	2	5.6	2	6.3	1.000
T30 (-)	33	94.3	34	94.4	30	93.8	
T1 (+)	2	5.7	4	11.1	14	43.8	< 0.001
T1 (-)	33	94.3	32	88.9	18	56.3	
T4 (+)	20	57.1	23	63.9	30	93.8	0.002
T4 (-)	15	42.9	13	36.1	2	6.3	
T8 (+)	28	80.0	27	75.0	32	100.0	0.004*
T8 (-)	7	20.0	9	25.0	0	0.0	
T12 (+)	28	80.0	31	86.1	32	100.0	0.020*
T12 (-)	7	20.0	5	13.9	0	0.0	
T24 (+)	29	82.9	33	91.7	32	100.0	0.039*
T24 (-)	6	17.1	3	8.3	0	0.0	

*Fisher's exact p value and all others from Chi-square tests

T30, T1, T4, T8, T12, T24: Represents the total number of patients who consumed morphine (+) or did not consume morphine (-) at specific postoperative time points (30 min, 1 h, 4 h, 8 h, 12 h, and 24 h)

Table 3 Comparison of morphine consumption between groups

	Grup Th7 (*n* = 35)	Group Th9 (*n* = 36)	Group C (*n* = 32)	*p*	Difference (Tukey)
	Mean±SD (mg)	Mean±SD (mg)	Mean±SD (mg)		
0–30 min	0.06±0.24	0.06±0.23	0.06±0.25	0.992	-
31 min–1 h	0.03±0.17	0.08±0.37	0.50±0.67	**< 0.001***	C > Th7,Th9
1–4 h	1.23±1.66	1.56±1.70	3.59±3.44	**< 0.001***	C > Th7,Th9
4–8 h	2.09±1.95	1.36±2.00	2.16±2.46	0.232	-
8–12 h	0.94±1.30	1.2±0.97	1.78±1.54	**0.030***	C > Th7
12–24 h	1.66±1.80	2.89±2.94	2.41±2.30	**0.99**	
Total Morphine Consumption	6.00±5.0	7.19±5.2	10.50±5.7	**0.003***	C > Th7,Th9

SD: Standard deviation, $p < 0.05$

Table 4 Comparison of estimated mean and median times for the first rescue analgesic requirement times across groups

	Mean				Median				*p*
	Estimate	Std. Error	95% Confidence Interval		Estimate	Std. Error	95% Confidence Interval		
			Lower	Upper			Lower	Upper	
Group Th7	235.52[a]	37.90	161.23	309.81	180.00	26.78	127.51	232.49	< 0.001
Group Th9	279.41[a]	43.98	193.22	365.61	150.00	19.44	111.90	188.10	
Group C	92.03[b]	14.73	63.16	120.91	80.00	10.29	59.84	100.16	
Overall	204.08	22.01	160.95	247.22	120.00	9.73	100.92	139.08	

[a, b]: Means indicated with the same subscript are identical, and with different subscripts are statistically different $p < 0.05$)

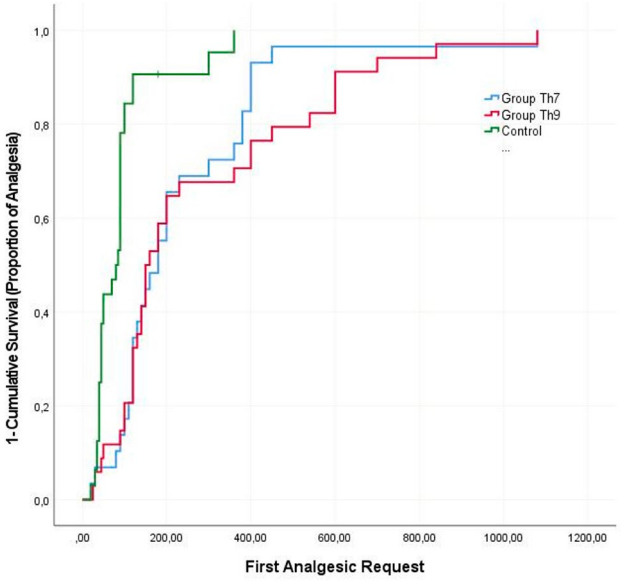

Fig. 2 Kaplan-Meier analysis of time to first analgesic request among the groups. Group Th7 (ESP block at Th7), Group Th9 (ESP block at Th9) and the Control group

Total morphine consumption was significantly higher in the control group compared to the groups that received ESP blocks. However, there was no significant difference between Group Th7 and Group Th9 (Table 3).

When the time to first rescue analgesic requirement was analyzed among the groups using Kaplan-Meier analysis, it was found to be significantly shorter in the control group than in the other two groups (Table 4). The Kaplan-Meier graph (Fig. 2) demonstrates that analgesic requests in the control group began earlier and increased rapidly, whereas in the Th7 and Th9 groups, analgesic requirements started later, with fewer patients needing rescue analgesia.

When comparing the groups, resting NRS scores in the ESP block groups were significantly lower than those in the control group at 30 min, the 1st, 4th, and 24th hours. However, there was no significant difference between Group Th7 and Group Th9 (Fig. 3).

When comparing dynamic NRS values between groups, significantly lower values were observed in Group Th7 and Group Th9 compared to the control group at 30 min, the 1st, 4th, 12th, and 24th hours. However, there was no

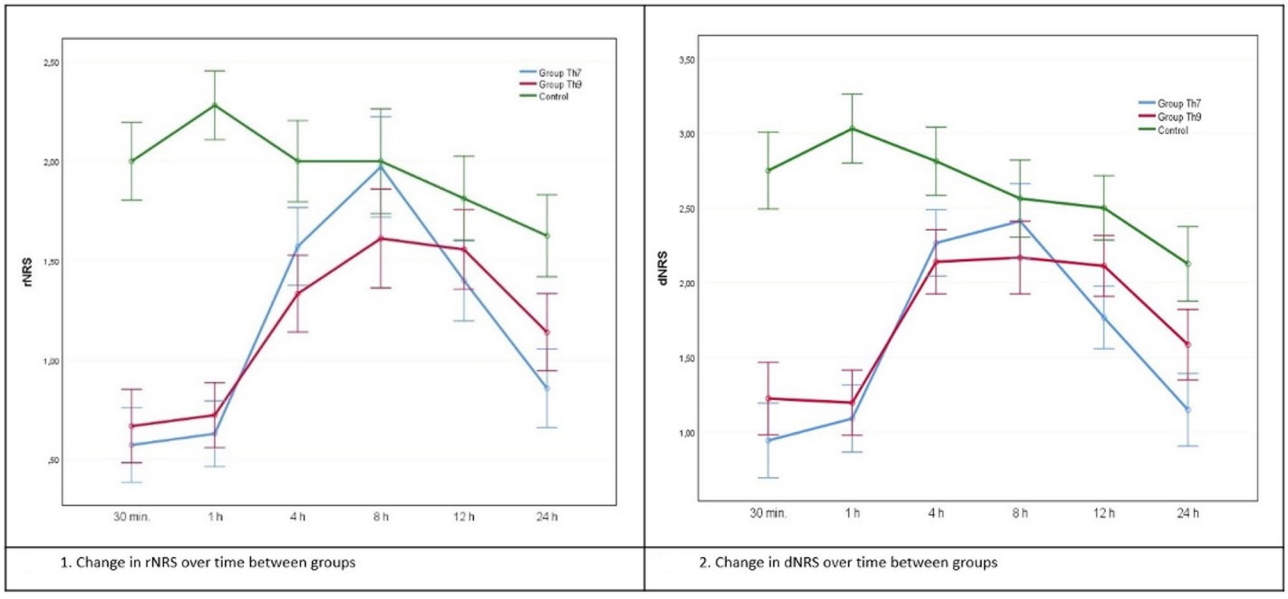

Fig. 3 Change in rest and dynamic NRS scores over time among the groups

Table 5 The evaluation of postoperatif nausea and vomiting (PONV) among the groups

n (%)	PONV		p
	No	Yes	
Group Th7 (*n* = 35)	24 (36.4)[a]	11 (29.7)[a]	**0.043**
Group Th9 (*n* = 36)	27 (40.9)[a]	9 (24.3)[a]	
Group C (*n* = 32)	15 (22.7)[a]	17 (45.9)[b]	

[a,b]; Each subscript letter denotes a subset of PONV categories whose column proportions do not differ significantly from each other at the 0,05 level

significant difference between Group Th7 and Group Th9 (Fig. 3).

When compared in terms of shoulder pain, two patients in the Th7 group experienced shoulder pain, while four patients in the Th9 group and three patients in the control group reported shoulder pain. There was no significant difference between the groups.

When evaluating postoperative side effects such as nausea and vomiting (PONV), the incidence of PONV was significantly higher in the control group compared to Group Th7 and Group Th9 (Table 5). However, there was no significant difference between Group Th7 and Group Th9. PONV was observed in 11 patients in the Th7 group, nine patients in the Th9 group, and 17 patients in the control group. For nausea and vomiting, ondansetron was administered to four patients in the Th7 group, three patients in the Th9 group, and 11 patients in the control group during the first 24 h postoperatively. One patient in the control group experienced itching during the postoperative period.

Discussion

This study observed that ultrasound-guided bilateral ESPB performed at the Th7 and Th9 levels provided significant analgesic effects compared to the control group in patients undergoing elective LC. It also reduced opioid consumption in the first 24 h postoperatively. However, there was no significant difference in postoperative analgesic efficacy between bilateral ESPB performed at the Th7 and Th9 levels in LC surgeries.

Cadaveric and radiological imaging studies have demonstrated that local anesthetic applied between the transverse process of the vertebra and the erector spinae muscle surrounds the dorsal and ventral rami. Additionally, it can spread to the sympathetic chain in the paravertebral area via the ramus communicans [13–16, 21]. It has been observed that the spread of local anesthetic occurs both craniocaudally and laterally [19, 22]. Craniocaudal spread results in the involvement of multiple dermatomes. Lateral spread is thought to occur via the costotransverse foramen, allowing diffusion into the intercostal spaces and affecting the ventral rami of the intercostal nerves. This is believed to provide analgesia to the anterolateral thorax and abdominal wall. Following ESPB applications, epidural and paravertebral spread has occasionally been observed, which may contribute to visceral analgesia. Epidural and paravertebral spread is more frequently reported at upper thoracic levels.

The literature suggests that both individual anatomical variations and the level at which the ESP block is performed influence the distribution of local anesthetics. Larger volumes of local anesthetic are associated with increased spread. A single-level ESP block is expected to provide interfascial spread up to five levels and epidural/transforaminal spread across two to three levels [23]. Bilevel ESPB applications have been introduced in surgeries with wider surgical fields, such as thoracic and scoliosis surgeries, to enhance spread and analgesic effects. Studies report that bilevel ESPB applications increase the spread of local anesthetics and provide broader analgesic coverage [23–24].

In this study, a single-level application was preferred, as very high pain intensity was not anticipated in the patient population. Effective analgesia was achieved at both levels. For ESP blocks applied in LC surgeries, a single level appears to be sufficient.

The duration of anesthesia in the Th7 group was approximately nine minutes longer than in the Th9 and control groups; however, this difference was not considered clinically significant. The longer anesthesia duration in the Th7 group was attributed to patient-specific surgical characteristics, technical challenges of the procedure, or the experience of staff handling patient positioning for the blocks. Since short-acting remifentanil was used for anesthesia maintenance and surgical durations were not prolonged, we believe this did not impact postoperative analgesia.

The similarity in morphine consumption among all groups in the first 30 min was attributed to the onset of the effect of local anesthetics in fascial blocks and the analgesic effect of intraoperatively administered analgesics during the early postoperative period.

The significant decrease in morphine consumption in Group Th7 and Group Th9 compared to the control group during the 31st minute to 1-hour and 1–4-hour intervals demonstrated the effectiveness of ESPB. The lack of difference in morphine consumption between 4 and 8 h was likely due to the increased opioid use in the control group during the previous time periods. In the 8–12-hour interval, morphine consumption in the Th7 group was significantly lower than in Group C.

When the number of patients requiring morphine was compared among the groups, the total number of patients requiring morphine at 1, 4, 8, 12, and 24 h was significantly higher in the control group compared to the Th7 and Th9 groups. There was no significant difference between the Th7 and Th9 groups.

Total morphine consumption in the first 24 h was significantly lower in patients who received ESP blocks compared to the control group. These findings indicate that ESP blocks provided effective analgesia at both levels, ensuring sufficient spread in the interfascial space.

When the time to first rescue analgesia was compared, the time to analgesic request in the control group was significantly shorter than in patients who received ESP blocks. This result was consistent with other studies in the literature [6, 17, 18]. The times to rescue analgesia were similar between the Th7 and Th9 groups.

NRS scores were not high in any of the groups. This was attributed to the analgesic efficacy of ESPB in the groups that received the block. In the control group, NRS scores were also not very high compared to the groups that received ESPB. This was related to the higher morphine consumption rates in the control group.

While there was no significant difference in the rates of shoulder pain between the groups, PONV was significantly lower in Group Th7 and Group Th9 compared to the control group. We attributed this to higher postoperative opioid usage in the control group during the first 24 h. We also considered itching in one patient in the control group as a side effect of morphine.

In their cadaver study, Adhikari et al. [14] demonstrated that ESPB applied at the Th5 level had a wider craniocaudal spread compared to retrolaminar blocks. However, the spread varied among the three cadavers. It was observed that studies used the same volume of local anesthetic as ours. After ESPB at the Th5 level, contrasted local anesthetic spread was observed in anatomical dissections, consistent with MR imaging, showing C6–Th12 in the first cadaver, C7–L1 in the second cadaver, and Th1–Th9 in the third cadaver. The spread in the epidural space, neural foramina, and intercostal space varied among the three cadavers.

Selvi et al. [25] evaluated 100 ESPBs performed bilaterally at the T9 level in 50 patients undergoing LC. When assessing sensory blocks using the pinprick test, they reported that ESPB had varying segmental spreads, with differences in each patient involving different dermatomes and quadrants. Seven out of 100 blocks were considered complete block failures. When evaluating sensory blocks in each quadrant from the T9 level, successful block coverage rates were reported as 67% for the dorsomedial, 58% for the dorsolateral, 69% for the ventrolateral, and 55% for the ventromedial quadrants. Sensory block coverage below L1 and above Th5 was 30%, and coverage decreased as the distance from the injection point increased. In their study, symmetrical dermatomal and quadrant involvement was not observed, but unexpected and missed dermatomal involvements were noted. They stated that in some cases, the sensory block may skip one or two levels above or below the expected levels and could be observed in more distant dermatomes. Unusual, unpredictable, and patchy sensory blocks were considered to be dependent on the unpredictable spread of the local anesthetic and whether it effectively surrounded the intercostal nerve.

Sørenstua et al. [16] evaluated the distribution of local anesthetic using MRI in 10 volunteers who received a unilateral ESPB at the Th7 level. In their study, they reported that sensory blockades and local anesthetic distribution varied among the volunteers. They found that after ESPB, the local anesthetic spread to the intercostal space, paravertebral space, and neural foramina, with epidural spread in four volunteers and extensive epidural spread, including contralateral epidural spread, in one volunteer. Additionally, they reported that the sensory blockade levels 60 min after the application were not consistent with the MRI spread results.

Analgesia in the Th6–Th12 dermatome areas of the abdominal wall is required for LC surgeries. The results of this study suggest that although sufficient analgesia can be achieved with ESPB, there is a possibility of unpredictable spread at different dermatomal levels with the applied blocks. To provide effective analgesia in these dermatomes, both the Th7 and Th9 levels could be considered.

Our study has certain limitations. We could have monitored the dermatomal area after ESPB in patients; however, since the block was performed at the end of the surgical operation and the patients were under the influence of analgesic drugs, our assessment of the dermatomal area would not have been objective. Additionally, we were unable to assess analgesic use beyond the first 24 postoperative hours because patients undergoing laparoscopic surgery are discharged from our center after 24 h. We were unable to distinguish between somatic and visceral analgesia in the patients. In the early postoperative period, this distinction may not have been objective due to the continued effect of the anesthetic. The difference in anesthesia durations among the groups is a limitation of this study. Additionally, separately recording the surgical and block durations could have improved objectivity. In this study, we primarily focused on postoperative analgesia; therefore, the number of needle redirections and operator satisfaction were not recorded.

Lower analgesic consumption and NRS scores were observed in patients undergoing LC with ESPB in the first postoperative 24 h. ESPB performed at the Th7 and Th9 levels showed similar analgesic efficacy and both levels can be used as part of a multimodal analgesia approach for postoperative analgesia.

Notes

This study was presented as an oral presentation at the 18th National (Internationally Attended) Regional Anesthesia Congress, which took place in Çeşme (Turkey) on May 19–21, 2022, and at the Euroanaesthesia 2024 Congress, which was held in Munich on May 25–27, 2024.

Abbreviations

ESPB	Erector Spinae Plane Block
LC	Laparoscopic Cholecystectomy
ASA	American Society of Anesthesiologists
ERAS	Enhanced Recovery After Surgery
NRS	Numeric Rating Scale
MR	Magnetic Resonance
PONV	Postoperative Nausea and Vomiting
BMI	Body Mass Index
PCA	Patient-Controlled Analgesia
US	Ultrasound
Th7	Thoracic 7th Vertebra
Th8	Thoracic 8th Vertebra
Th9	Thoracic 9th Vertebra

Acknowledgements
We would like to thank all participant patients in our study, our colleagues and nursing staff in Gaziosmanpasa Training and Research Hospital.

Author contributions
Data collection: SŞ, ÜY, AKG, ÜAT, DGM, MÖ. Data analysis: SŞ, ÜY, AKG, ÜAT, DGM, MÖ. Writing: SŞ, ÜY, AKG, ÜAT, DGM, MÖ. Revising: SŞ, ÜY, AKG, ÜAT, DGM, MÖ. Study design: SŞ, ÜY, AKG, ÜAT, DGM, MÖ. Patient recruitment: SŞ. All authors contributed equally to this work. The author(s) read and approved the final manuscript.

Funding
None.

Data availability
The data associated with the paper are not publicly available but are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
It received approval from the Gaziosmanpaşa Training and Research Hospital Clinical Research Ethics Committee on 25/12/2019 (decision no: 2019/168) and was registered on ClinicalTrials.gov (Registration no: NCT04316416). The study was conducted in the general surgery operating room, following the principles of the Helsinki Declaration, between 15/02/2020 and 02/06/2021. Written and verbal informed consent was obtained from all patients.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Received: 19 September 2024 / Accepted: 19 May 2025
Published online: 26 May 2025

References

1. Ekstein P, Szold A, Sagie B, Werbin N, Klausner JM, Weinbroum AA. Laparoscopic surgery May be associated with severe pain and high analgesia requirements in the immediate postoperative period. Ann Surg. 2006;243:41–6.
2. Dua A, Aziz A, Desai SS, McMaster J, Kuy S. National trends in the adoption of laparoscopic cholecystectomy over 7 years in the united States and impact of laparoscopic approaches stratified by age. Minim Invasive Surg 2014;635461.
3. Donatsky AM, Bjerrum F, Gögenur I. Surgical techniques to minimize shoulder pain after laparoscopic cholecystectomy. A systematic review. Surg Endosc. 2013;27(7):2275–82.
4. Feldheiser A, Aziz O, Baldini G, Cox BP, Fearon KC, Feldman LS, et al. Enhanced recovery after surgery (ERAS) for Gastrointestinal surgery, part 2: consensus statement for anaesthesia practice. Acta Anaesthesiol Scand. 2016;60(3):289–334.
5. Bisgaard T. Analgesic treatment after laparoscopic cholecystectomy: a critical assessment of the evidence. Anesthesiology. 2006;104:835–46.
6. Tulgar S, Kapakli MS, Senturk O, Selvi O, Serifsoy TE, Ozer Z. Evaluation of ultrasound-guided erector spinae plane block for postoperative analgesia in laparoscopic cholecystectomy: A prospective, randomized, controlled clinical trial. J Clin Anesth. 2018;49:101–6.
7. Shin HJ, Oh AY, Baik JS, Kim JH, Han SH, Hwang JW. Ultrasound-guided oblique subcostal transversus abdominis plane block for analgesia after laparoscopic cholecystectomy: a randomized, controlled, observer-blinded study. Minerva Anestesiol. 2014;80:185–93.
8. Forero M, Adhikary SD, Lopez H, Tsui C, Chin KJ. The erector spinae plane block: A novel analgesic technique in thoracic neuropathic pain. Reg Anesth Pain Med. 2016;41:621–7.
9. Gürkan Y, Aksu C, Kuş A, Yörükoğlu UH, Kılıç CT. Ultrasound guided erector spinae plane block reduces postoperative opioid consumption following breast surgery: A randomized controlled study. J Clin Anesth. 2018;50:65–8.
10. Chin KJ, Malhas L, Perlas A. The erector spinae plane block provides visceral abdominal analgesia in bariatric surgery: A report of 3 cases. Reg Anesth Pain Med. 2017;42:372–6.
11. De Cassai A, Bonvicini D, Correale C, Sandei L, Tulgar S, Tonetti T. Erector spinae plane block: a systematic qualitative review. Minerva Anestesiol. 2019;85:308–19.
12. Ueshima H, Inagaki M, Toyone T, Otake H. Efficacy of the erector spinae plane block for lumbar spinal surgery: A retrospective study. Asian Spine J. 2019;13:254–7.
13. Willard FH, Vleeming A, Schuenke MD, Danneels L, Schleip R. The thoracolumbar fascia: anatomy, function and clinical considerations. J Anat. 2012;221:507–36.
14. Adhikary SD, Bernard S, Lopez H, Chin KJ. Erector spinae plane block versus retrolaminar block: A magnetic resonance imaging and anatomical study. Reg Anesth Pain Med. 2018;43:756–62.
15. Schwartzmann A, Peng P, Maciel MA, Forero M. Mechanism of the erector spinae plane block: insights from a magnetic resonance imaging study. Can J Anaesth. 2018;65:1165–6.
16. Sørenstua M, Zantalis N, Raeder J, Vamnes JS, Leonardsen AL. Spread of local anesthetics after erector spinae plane block: an MRI study in healthy volunteers. Reg Anesth Pain Med. 2023;48(2):74–9.
17. Cesur S, Yörükoğlu HU, Aksu C, Kus A. Bilateral versus unilateral erector spinae plane block for postoperative analgesia in laparoscopic cholecystectomy: a randomized controlled study. Braz J Anesthesiol. 2023;73:72–7.
18. Sethi D, Garg G. Evaluation of postoperative analgesia of erector spinae plane block in elective laparoscopic cholecystectomy: a randomized controlled trial. Turk J Anaesthesiol Reanim. 2021;49:432–8.
19. Dautzenberg KHW, Zegers MJ, Bleeker CP, Tan ECTH, Vissers KCP, van Geffen GJ, et al. Unpredictable injectate spread of the erector spinae plane block in human cadavers. Anesth Analg. 2019;129:e163–6.
20. Faul F, Erdfelder E, Buchner A, Lang AG. Statistical power analyses using G*Power 3.1: tests for correlation and regression analyses. Behav Res Methods. 2009;41(4):1149–60.
21. Altinpulluk EY, Ozdilek A, Colakoglu N, Beyoglu CA, Ertas A, Uzel M, et al. Bilateral postoperative ultrasound-guided erector spinae plane block in open abdominal hysterectomy: a case series and cadaveric investigation. Rom J Anaesth Intensive Care. 2019;26(1):83–8.
22. Bonvicini D, Boscolo-Berto R, De Cassai A, Negrello M, Macchi V, Tiberio I, et al. Anatomical basis of erector spinae plane block: a dissection and histotopographic pilot study. J Anesth. 2021;35(1):102–11.
23. Tulgar S, Selvi O, Ozer Z. Clinical experience of ultrasound-guided single and bi-level erector spinae plane block for postoperative analgesia in patients undergoing thoracotomy. J Clin Anesth. 2018;50:22–3.
24. Domagalska M, Ciftsi B, Janusz P, Reysner T, Daroszewski P, Kowalski G, et al. Effectiveness of the bilateral and bilevel erector spinae plane block (ESPB) in pediatric idiopathic scoliosis surgery: A randomized, Double-Blinded, controlled trial. J Pediatr Orthop. 2024;44(7):e634–40.
25. Selvi O, Tulgar S, Serifsoy TE, Lance R, Thomas DT, Gürkan Y. Quadrant and dermatomal analysis of sensorial block in Ultrasound- guided erector spinae plane block. Eurasian J Med. 2022;54:121–6.

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