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ORIGINAL ARTICLE

Efficacy of erector spinae plane block on postoperative pain in patients undergoing lumbar spine surgery

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Abstract

Background Major lumbar spine surgery causes severe pain in the postoperative period. There are few studies regarding the effect of erector spinae plane block (ESPB) effect on lumbar surgery and its effect is still controversial. Therefore, the study aimed to investigate the effect of ultrasound-guided low thoracic ESPB on opioid consumption and postoperative pain score.

Material and methods Seventy-eight patients undergoing elective open lumbar spine surgery were randomized into two groups. In ESPB group ($n=35$) received ultrasound-guided ESPB and in the control group ($n=35$), there was no block. Postoperative opioid consumption as morphine equivalent dose, numerical rating scale, mobilization time, discharge time and side effects, bolus deliveries, rescue analgesia doses were evaluated.

Results Total opioid consumption as morphine equivalent was higher in the control group than the ESPB group ($p=0.000$). Compare with the control group, the numeric rating scale scores were lower in the ESPB group at the 6th, 12th, and 24th hours ($p<0.05$). The patient-controlled analgesia button pressing number in the postoperative 24-h period was lower in the ESPB group ($p=0.000$). In the postoperative 24-h period, the need for paracetamol in the ESPB group was lower and the difference between the groups was statistically significant ($p=0.008$). Rescue analgesia (diclofenac) doses were higher in the control group ($p<0.05$). There was no statistically significant difference in terms of side effects and mobilization times.

Conclusion ESPB is adequate for postoperative analgesia in patients undergoing lumbar spine surgery and can reduce opioid consumption compared with standard analgesia.

Keywords Erector spinae plane block · Lumbar spine surgery · Patient-controlled analgesia · Postoperative pain · Acute pain management

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Introduction

Lumbar vertebral surgery is one of the most common spinal surgical operations. The primary purpose of vertebral surgery in congenital, degenerative, and oncological diseases and traumas of the spine is to reduce the pain of the patients, improve their quality of life, return them to daily life in a short time, and prolong their life [1, 2]. Especially after instrumentation is applied in spinal surgical operations, severe pain may be encountered, delaying discharge, rehabilitation time, and returning to everyday life [3]. The pain seen in the early period after spinal surgical interventions is an acute pain that starts with the inflammatory tissue response and decreases dramatically with wound healing, with a risk of becoming chronic if not treated [4].

Multimodal analgesia techniques are considered to provide adequate analgesia for postoperative pain control. Conventional opioid-based analgesia techniques include some side effects such as nausea, vomiting, pruritus, and respiratory depression. Epidural analgesia is the gold standard for postoperative analgesia in lumbar surgery [5]. However, epidural catheter insertion preoperatively may interfere with the surgical area. Intraoperative insertion may be useful, but surgery can damage the dura mater, causing a risk of intrathecal leakage of local anesthesia [6]. Also, the epidural technique is related to infections, hematomas, and other adverse effects [7, 8].

Plane blocks using ultrasound in local anesthesia practice have gained popularity because of their low complication rate, ease of application, and adequate postoperative analgesia [9]. Recently, the erector spinae plane block (ESPB) was described by Forreoro et al. in 2016 [10]. ESPB has been used to provide postoperative analgesia in breast surgery, thoracic, upper abdominal surgery, and bariatric surgery. In recent years, ESPB has also been used to provide postoperative analgesia in vertebral surgery [11]. The mechanism of ESPB is still unclear but it can block dorsal ramus of the spinal nerve and provide a paraspinal effect by diffusing the local anesthetic [12]. In the current literature, few studies focus on ESPB in lumbar surgery. Therefore, we conducted a randomized controlled study to evaluate the efficacy of ultrasound-guided low thoracic ESPB in lumbar surgery.

Materials and methods

This double-blinded, single-centered, prospective, randomized, controlled study was conducted by the permission of the ethics committee between May 2019 and February 2020 (NCT03997227). Verbal and written informed consents were obtained from all participants. Patients aged 18–75 years with a physical status I–III according to the American Society of Anesthesiologists (ASA) and who were scheduled to undergo elective spinal surgery with instrumentation involving single or multi levels in the lumbar or thoracic regions were included. Patients with hypersensitivity to the drugs, chronic analgesic use, infection during surgical intervention, bleeding disorders, and psychiatric diseases were excluded. Also, patients with a surgical intervention time less than 60 min or longer than 300 min, cases where no instrumentation was used, and patients who were taken to the intensive care unit during the postoperative period were excluded. Patient randomization numbers were concealed in opaque envelopes that were opened by the researcher who did the block, with 35 patients in each group. These patients were randomized into two different groups as ESPB (ESPB group) or non-ESPB (control group) and standard general anesthesia was applied to both groups. Recovery room and ward follow-up were performed by a medical staff who were blinded to the groups. The patients were blinded to their groups as well, since the block was performed before they were awoken. The use of the patient-controlled (intravenous) IV analgesia (PCA) device for pain management and the visual analog scale at rest/coughing were explained to the patients. The study was conducted according to CONSORT criteria (Fig. 1).

Anesthesia technique

Anesthesia was induced with 2 mg/kg propofol, 1 µg/kg fentanyl, and 0.6 mg/kg rocuronium. For anesthesia maintenance, 3 l/min flow 50/50 O_2/air mixture, and sevoflurane 2% were used. For intraoperative analgesia, remifentanil was provided with a dose of 0.05 mcg/kg for 1 min. To provide postoperative analgesia, 1 mg/kg tramadol and 1 g paracetamol IV were applied to both groups 30 min before the end of the surgical procedure. Patients undergoing standard general anesthesia protocol were given 2 mg/kg IV sugammadex at the end of surgery and then extubated and taken to the recovery unit.

Ultrasound-guided ESP block technique

Before the patients were awoken at the end of the surgery, the ESPB group was applied ESPB in the prone position. A high-frequency linear ultrasound probe (10–15 mHz Logiq-e GE, USA) was paced sagittally 3 cm lateral of the T10 spinous process. The transverse process and the erector spinae muscle were visualized and the needle was advanced through the transverse process, touching the bone. Thereafter, the needle position was confirmed by giving a 0.5–1 mL 0.9% NaCl test dose between the

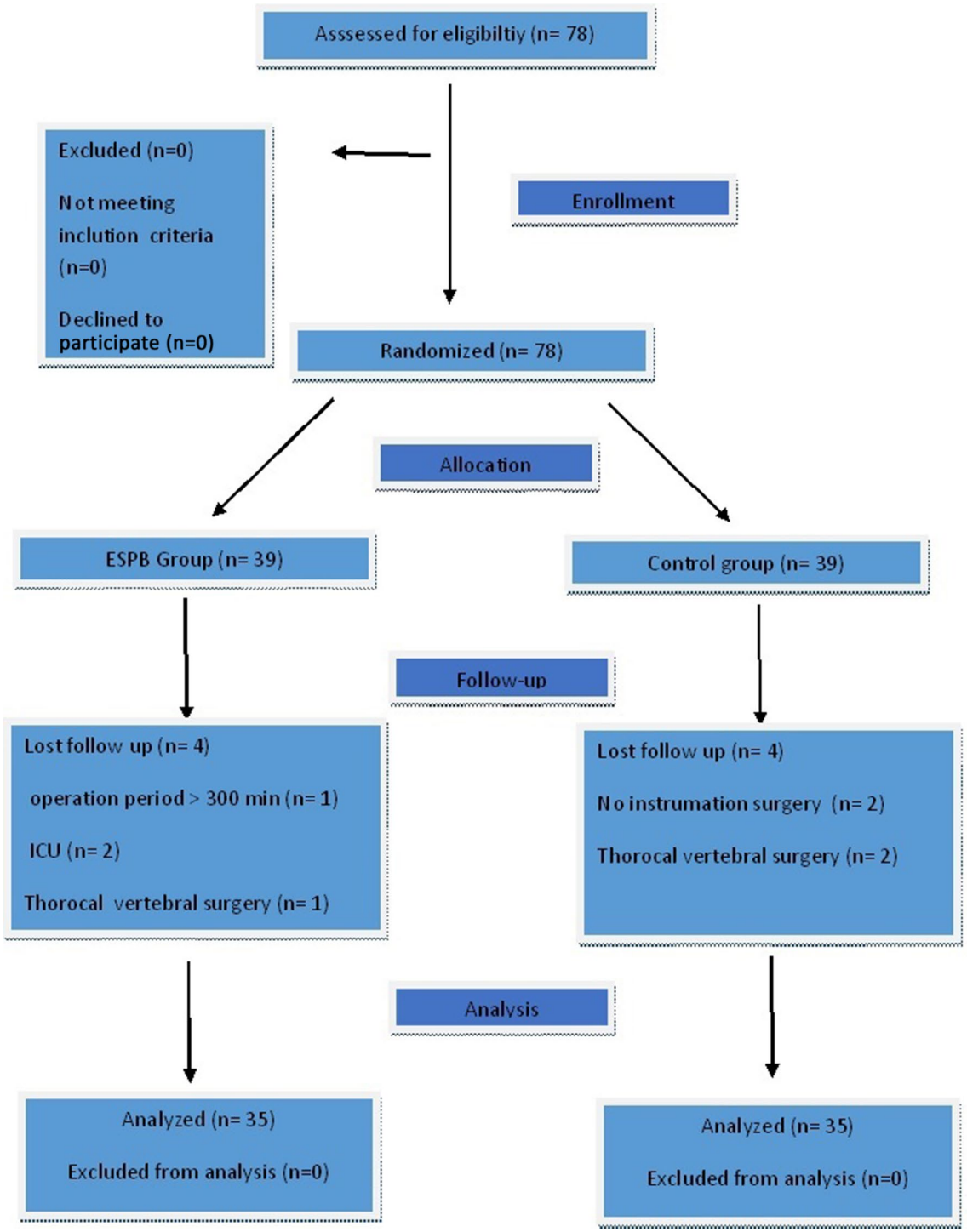

Fig. 1 CONSORT diagram

erector spinae muscle fascia and the transverse process and a total 20 ml volume consisting of 10 ml of 0.5% bupivacaine, 5 ml of 2% lidocaine, and 5 ml of 0.9% NaCl was administered into the facial plane between the erector spinae muscle and the transverse process (Fig. 2). The similar procedure was applied for the opposite side of each patient, thus applying a total volume of 40 ml of fluid for each.

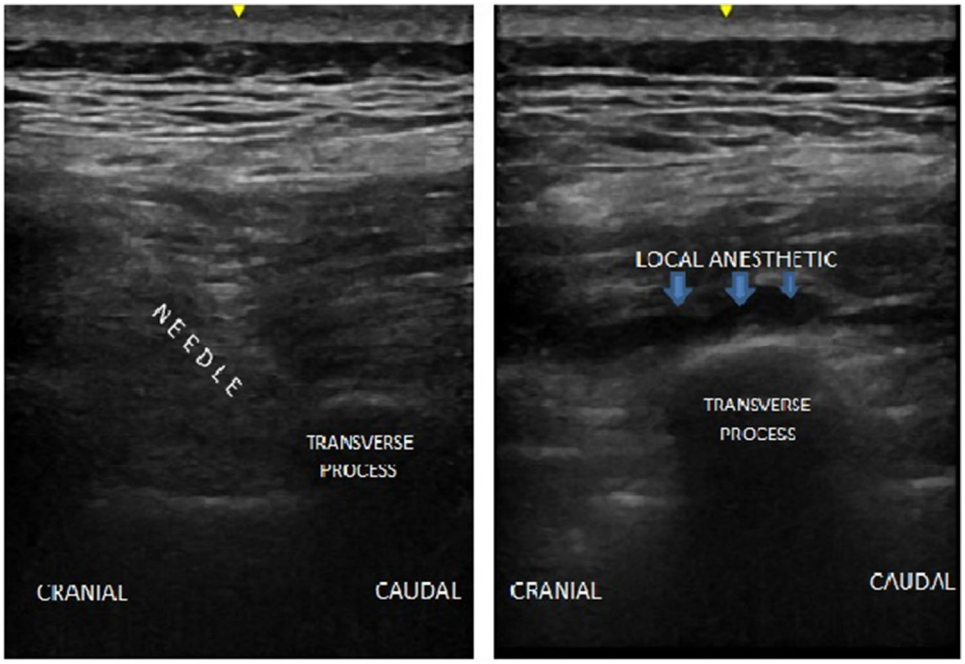

Fig. 2 **a** Ultrasoud image of the block. **b** Local anestetic diffusion between erector spinae muscle and transverse process

Postoperative analgesia protocol

PCA with tramadol was started to maintain postoperative analgesia in both groups before the patients were taken to the recovery room at the end of block procedure. The bolus dose of tramadol was prepared as 0.06 mg/kg and bolus dose drug administration was provided in each press with a lock-in time of 20 min without basal infusion. An 11-point numerical rating scale ranging from 0 to 10 (0 = no pain, 10 = worst imaginable pain) was used for numeric rating scale (NRS) score assessment. Meperidine (0.5 mg x kg) IV was given to patients who had pain (NRS > 4) as an additional analgesic during follow-up in the recovery unit and the applied dose was recorded. In service follow-up, 1 gr IV paracetamol 3 × 1 was started as routine for both groups (NRS was < 4 and if the patient did not request it, the analgesic paracetamol dose would not be given). Despite receiving paracetamol doses, patients with NRS > 4 were injected with 75 mg of diclofenac sodium intramuscularly (IM) as rescue analgesic. If nausea and vomiting were determined, 4 mg IV ondansetron was administered and, if need, repeated once in 8 h.

Recording of the data

All demographic and surgery-related data, including age, height, weight, sex, comorbidity, ASA scores, number of surgeries, and operation times were recorded for both groups. The primary outcome was opioid consumption during the first 24 h postoperatively in milligrams, calculated as the morphine equivalent dose. About IV tramadol consumption was measured for 24 h using the electronic memory of the PCA and meperidine dose was also recorded. Total morphine equivalent dose was calculated for 24 h. NRS scores were recorded at 30 min, 1, 6, 12, and 24 h to assess whether ESPB could provide analgesic effects during the early hours after surgery. The number of successful bolus deliveries and postoperative nausea, vomiting, itching, and the amount of paracetamol and rescue analgesic were recorded. Whether nausea, vomiting, and itching were present as side effects was also monitored and recorded. Besides, the first postoperative mobilization time and discharge time of the patients, as well as the complications that developed in the first 24-h period were followed and recorded.

Statistical analysis

The SPSS 21.0 statistical software was used for data analysis. The statistical analysis plan was developed before patient enrolment. Sample size was based on opioid consumption. Taking as a reference the recent study of Singh et al. [13], the effect size was found to be 3.28 to compare total morphine consumption between study and control groups. To reach sufficient sampling, we aimed to reach 68 people with 90% power, 5% margin of error, and 0.8 effect size. The conformity of continuous variables to normal distribution was investigated using visual (histogram and probability graphs) and analytical methods (Kolmogorov–Smirnov/Shapiro–Wilk tests). For descriptive statistics, normally distributed [mean and standard deviation (SD)] and non-normally distributed (median) data are shown as minimum and maximum. The Chi-squared test was used to show differences between

Table 1 Demographic and operative characteristics of study patients

	Control group ($n=35$)	ESPB group ($n=35$)	P value
Age (years)	58.49 ± 8.77	61.86 ± 9.46	0.066
Weight (kg)	80.80 ± 12.42	79.83 ± 15.95	0.777
Body mass index (kg/m^2)	31.02 ± 5.07	31.25 ± 5.74	0.920
Sex (M/F)	11/24	6/29	0.163
ASA status (I/II/III)	6/19/10	5/22/8	0.766
Duration of surgery (min)	231.43 ± 32.78	213.00 ± 32.90	0.841
Postoperative mobilization time (h)	17.83 ± 1.84	17.46 ± 3.18	0.381
Postoperative discharge time (h)	89.51 ± 13.47	87.31 ± 14.49	0.528

Data are expressed as mean ± SD or ratio

Table 2 Comparison of number of surgical levels

Number of levels	Control group ($n=35$)	ESPB group ($n=35$)	P value
One level	n = 1 (2.9%)	$n=3$ (8.6%)	0.785
Two levels	$n=9$ (25.7%)	$n=7$ (20%)	
Three levels	$n=9$ (25.7%)	$n=9$ (25.7%)	
Four levels	$n=10$ (28.6)	$n=11$(31.4%)	
Five levels	$n=3$ (8.6%)	$n=4$(11.4%)	
Six levels	$n=3$ (8.6%)	$n=1$ (2.9%)	

categorical variables. Student's t-test or One-Way ANOVA was used to compare continuous variables with parametric properties in independent groups and the Mann–Whitney U Test or the Kruskal–Wallis Analysis of Variance was used to compare continuous variables with parametric properties in independent groups. Level of statistical significance was set at a p value less than 0.05.

Results

A total of 78 patients were enrolled in the study, although 4 patients in the control group and 4 in the ESPB group were excluded during the intraoperative and postoperative periods. Thus, statistical evaluation was made on 70 patients (Fig. 1).

Considering the demographic data, there was no statistically significant difference between the groups in terms of sex, age, weight, height, BMI, or ASA scores ($p>0.05$) (Table 1). There was no statistically significant difference between the surgical procedure levels of the two groups ($p=0.785$). The mean duration of surgery was 213 ± 33 min in the ESPB group and 231.5 ± 33 min in the control group, with no statistically significant difference ($p=0.84$) (Table 1). Surgical etiologies in the ESPB and control groups were spondylolisthesis (18 patients vs 20 patients), lumbar stenosis (12 patients vs 11 patients), and lumbar vertebral fracture (5 patients vs 4 patients), respectively; there was no difference between the ESPB group and the control group ($p=0.77$). Surgical levels were not found to be statistically significant in both groups ($p=0.785$) (Table 2). Postoperative mobilization and discharge times were not found to be statistically significant in both groups ($p=0.38$ and $p=0.52$, respectively) (Table 1). During the period from the postoperative rest room to the service, meperidine was administered to only 1 (2.9%) patient in the ESPB group, while meperidine was administered to 6 (17.1%) patients in the control group, and a statistically significant difference were found between the two groups ($p=0.046$) (Table 3).

Table 3 shows the total opioid consumption as morphine equivalent dose in the postoperative 24 h. We found that opioid consumption was higher in the control group compared to the ESPB group ($p=0.000$). The total number of bolus deliveries in the postoperative 24 h was compared between the groups; the mean number was 12.71 in the ESPB group and 19.37 in the control group and the difference between the groups was statistically significant ($p=0.000$) (Table 3). This result confirms that

Table 3 Postoperative patient-controlled analgesia (PCA) device pressing the button and analgesic amounts

	Control group ($n=35$)	ESPB group ($n=35$)	P value
Total paracetamol consumption, mean ± SD (mg)	1876.57 ± 581.71	1368.29 ± 795.50	**0.003**
PCA button pressing number	19.37 ± 5.21	12.71 ± 5.71	**0.000**
Rescue diclofenac amount, mean ± SD (mg)	23.57 ± 35.33	8.57 ± 24.21	**0.043**
Meperidin requirement in PACU (yes/no)	6/29	1/34	**0.046**
Total morfin consumption, mean ± SD (mg)	10.12 ± 3.29	6.21 ± 3.28	**0.000**

$P<0.05$ is considered as a statistically significant difference

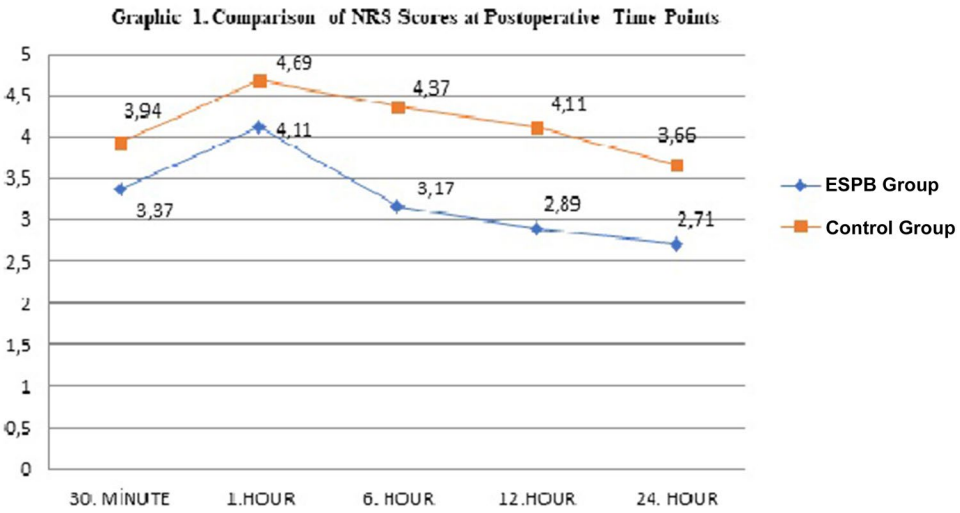

Fig. 3 The graph of numeric rating scale (NRS) scores of groups in 24 h

Table 4 Comparison of NRS (numeric rating scale) scores at postoperative time points

	Control group ($n=35$)	ESPB group ($n=35$)	*P* value
30 min	3.94 ± 2.18	3.37 ± 1.73	0.404
1 h	4.69 ± 1.49	4.11 ± 1.57	0.140
6 h	4.37 ± 1.40	3.17 ± 0.89	**0.000**
12 h	4.11 ± 1.32	2.89 ± 1.18	**0.000**
24 h	3.66 ± 1.21	2.71 ± 1.47	**0.007**

$P<0.05$ is considered as a statistically significant difference

Table 5 The presence of nausea, vomiting, itching and antiemetic needs of the groups in the postoperative 24-h period

	Control group ($n=35$)	ESPB group ($n=35$)	*P* value
Nausea (yes/no)	10/25	6/29	0.255
Vomiting (yes/no)	6/29	5/30	0.743
Itching (yes/no)	3/32	1/34	0.307
Antiemetic drug needs (yes/no)	6/29	5/30	0.743

the ESPB group needed less opioid in the postoperative period. In the same manner, regarding the need for IV paracetamol in the postoperative 24-h period, the mean value was 1368 g for the ESPB group and 1876 g for the control group, with a statistically significant difference ($p=0.003$). The rescue analgesia requirement was statistically lower in the ESPB group than the control group ($p=0.043$) (Table 3).

Postoperative NRS scores were evaluated at the first 24-h. There was no statistically significant difference between the two groups in terms of NRS scores at 30 min and 1 h ($p=0.40$ and $p=0.14$, respectively). On the other hand, NRS scores at 6, 12, and24 h were statistically significant ($p=0.000$, $p=0.000$, and $p=0.007$, respectively) (Fig. 3, Table 4).

There was no statistically significant difference between the groups in terms of the presence of nausea, vomiting, itching, or antiemetic drug requirement in the postoperative 24-h period ($p>0.05$) (Table 5). Complications such as pneumothorax and infection were not observed in either group.

Discussion

In this study, postoperative bilateral ultrasound-guided ESPB provided decreased postoperative analgesic requirement in the experimental group compared to the control group and NRS scores were lower in the ESPB group. We found no statistically significant difference between the groups in terms of postoperative mobilization time or hospital discharge time. There were no complications related to the procedures applied to the patients.

There is no doubt that pain control is crucial in lumbar surgery because inadequate pain control causes increased mobilization time, length of hospital stay, cardiac and respiratory complications, risk of infections, and chronic pain syndrome [14, 15]. Paracetamol, non-steroidal anti-inflammatory drugs (NSAIDs), and opioids are routinely used as part of multimodal analgesia for postoperative analgesia in lumbar vertebral surgery [16]. However, it is difficult to say that pharmacological treatment provides effective postoperative analgesia. Also, opioid-based analgesia causes some side effects such as nausea, vomiting, hypotension, loss of consciousness, and respiratory depression [11, 12, 17]. In the last decade, with technological advancements on the guidance of ultrasonography in regional anesthesia,

analgesia techniques have been defined and like many other surgical operations, it is currently being used as a routine in lumbar vertebral surgery. As a new fascia block technique, "ESPB" was described in 2016 [10].

Although cadaveric and radiologic studies have not showed the clear mechanism of ESPB, ESPB blocks the dorsal ramus of the spinal nerve and provides improved pain score and reduced opioid consumption [18]. Case series and reports have shown that ESPB provides adequate postoperative analgesia in spinal surgeries [19–21]. There exists only a limited number of randomized controlled trials in the literature [13, 22–24]. Singh et al. recently showed that ESPB 0.25% 20 mL bupivacaine preoperatively at T10 reduced opioid consumption and improved patient satisfaction compared to the control group [13]. Singh et al. found that morphine consumption was lower in the ESPB group compared to the control group (1.4 ± 1.5 vs. 7.2 ± 2.0 mg, respectively; $P < 0.001$) [13]. Also, pain scores were lower in the ESPB group immediately after surgery ($P = 0.002$) and at 6 h after surgery ($P = 0.040$) but ESPB could last for 6–8 h after operation [13]. In the present study, we performed the block postoperatively and total morphine equivalent dose in the first 24 h was lower in ESPB group ($P = 0.000$). Looking at the first 24-h NRS scores, they were not statistically significant between the two groups at 30 min or 1 h ($p = 0.404$ and $p = 0.140$, respectively). On the other hand, the difference between NRS scores at 6, 12, and 24 h was statistically significant ($p = 0.000$, $p = 0.000$, $p = 0.007$, respectively). Since we performed the block postoperatively, we think that the lack of a significant difference between the groups in terms of NRS scores at 30 min and 1 h may be due to the inadequate analgesic distribution within the first hour. We did not assess sensory loss in the ESPB group because it might affect patient blinding.

In the current study, we did not evaluate the duration of ESPB. We only evaluated opioid consumption and NRS scores for the first 24 h, but we did perform the block postoperatively to prevent the local washout period during the surgery. Another weakness of the study was that we did not evaluate the primary outcome over the time. Recently, Eskin et al. reported similar results with ours, but they compared three groups: mid-transverse point block (MTPB), ESPB, and a control group [23]. They performed the block with 20 ml 0.25% bupivacaine and the pain scores were the highest in the control group at all time points during 48 h (Control > MTPB > ESPB; $p < 0.001$) [23]. Also, opioid consumption was the highest in the control group (Control > MTPB > ESPB; $p < 0.001$).

The main limitation of this study was the small sample size. Another limitation was that we did not obtain patients' preoperative pain scores and recorded NRS scores only at rest. We recorded total opioid consumption during the first 24 h, but we did not record it at a time point. The sensory level of the block was not assessed with pinprick sensation test. Besides, we did not review the duration of ESPB. The duration of ESPB and the safe dose of local anesthetic of ESPB for lumbar surgery is still unclear. Further studies are required to determine the efficacy of ESPB at the lower thoracic vertebra for lumbar surgery. Furthermore, we think we could not effectively evaluate the postoperative mobilization period or the discharge time from the hospital due to multifactorial reasons, including hospital functioning. Finally, there was a statistically significant decrease in opioid consumption, which might have eliminated any improvement in postoperative mobilization and hospital discharge times.

Conclusion

Based on our findings, ultrasound-guided ESPB at the low thoracic level is effective for postoperative analgesia and can reduce opioid consumption in patients undergoing lumbar spine surgery. We strongly believe that this technique has promising results for multimodal analgesia in lumbar spine surgery.

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Declarations

Conflict of interest The authors declare that they have no conflict of interest.

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