

# Effect of ultrasound-guided bilateral erector spinae plane block for postoperative analgesia in patients undergoing multilevel posterior spinal instrumentation

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**Abstract. – OBJECTIVE:** Patients undergoing spinal fusion surgery suffer from severe postoperative pain. The study aims to investigate the effectiveness of ultrasound-guided erector spinae plane block in alleviating pain following multilevel spinal fusion with instrumentation.

**PATIENTS AND METHODS:** Forty-two patients, who were in classes I-II-III according to the American Society of Anesthesiologists (ASA) classification and were scheduled for lumbar spinal fusion surgery, were randomly divided at a ratio of 1:1 into the erector spinae plane block (ESPB) group and the control group. While an erector spinae plane block was applied before surgery in the ESPB group, no block was involved in the control group. A patient-controlled analgesia pump containing morphine was attached to each patient after surgery. The primary outcome was the amount of morphine used in 24 hours. The secondary outcomes included pain scores and rescue analgesia requirements at different time points.

**RESULTS:** The 24-hour morphine consumption level of the ESPB group was significantly lower than that of the control group ( $p=0.005$ ). Pain intensity, which was assessed using The Numerical Rating Scale (NRS), was found to be significantly lower in the ESPB group ( $p<0.05$ ). NRS scores of the two groups were similar at the 12<sup>th</sup> and 24<sup>th</sup> hours (respectively,  $p=0.097$  and  $p=0.157$ ). While rescue analgesia was administered to 71.4% of the patients in the control group, it was administered to 28.6% of those in the ESPB group. The difference between the groups was significant ( $p=0.005$ ).

**CONCLUSIONS:** Ultrasound-guided bilateral erector spinae plane block in multilevel spinal fusion surgery with instrumentation alleviates severe postoperative pain and reduces opioid consumption.

## Key Words:

Erector spinae plane block, Multilevel, Lumbar fusion, Pain score, Postoperative pain, Multimodal analgesia.

## Introduction

Spinal fusion is a surgical procedure that has been performed for more than a century. Its frequent indications include spinal deformities, spondylolisthesis, spondylolysis, and spinal instability that develops depending on various causes<sup>1</sup>. It causes severe postoperative pain due to the comprehensive dissection of cutaneous, subcutaneous, bone, muscle, and connective tissue. In a cohort study<sup>2</sup> that included 179 surgical procedures, the highest pain intensity was observed following spinal surgery. Additionally, it has been reported<sup>3,4</sup> that inadequate pain management after spinal surgery is prevalent. This situation reduces the satisfaction levels of patients, it can delay postoperative recovery, ambulation, and discharge from the hospital, and it can lead to hospitalizations after discharge. For this reason, achieving optimal management of postoperative pain in spinal fusion surgery patients has critical importance<sup>5-8</sup>.

As a part of multimodal analgesia, regional anesthesia is frequently preferred in several surgical interventions<sup>9,10</sup>. The erector spinae plane block (ESPB) is a novel block defined by Forero et al<sup>11</sup>. It is administered by injecting local anesthetic agents between the deep fascia of the erector spinae muscle and the vertebral transverse process. Recently, it has gained popularity as a part of opioid-sparing multimodal analgesic regimens in the scope of postoperative analgesia following spinal surgery<sup>12</sup>.

It was observed that ESPB lowered opioid consumption and pain scores in two patients who underwent multilevel fusion surgery<sup>13</sup>. However, evidence of its effectiveness in multilevel spinal instrumentation surgery is insufficient. We conducted this study to investigate the effects of

ESPB on 24-hour opioid consumption in multilevel spinal instrumentation surgery.

### Patients and Methods

Approval to conduct this study was obtained from the Clinical Studies Ethics Committee of the Faculty of Medicine at Kahramanmaraş Sütçü İmam University (2020/12-04). The study was registered to the Clinical Trials platform (NCT05983393), and all procedures were carried out in line with the principles of the Declaration of Helsinki. The reporting of the study follows the guidelines of the CONSORT statement, and its flow diagram is presented in Figure 1.

The sample of the study included patients aged 18-75, who were scheduled for lumbar fusion surgery with instrumentation at the levels of 2-5, signed the written informed consent form for their

participation in the study, and were in ASA classes I-II-III indicative of their physiological state. The exclusion criteria were an ASA class of IV or higher, a history of previous lumbar surgery, chronic opioid usage, bleeding disorders, signs of infection in the injection site, severe cardiac, renal, and hepatic diseases, and allergies to the drugs to be used in the study. Using the close envelope method, the patients were divided at a ratio of 1:1 into the ultrasound-guided lumbar ESPB group and the control group, in which no block was applied.

### Ultrasound-Guided Bilateral Lumbar ESPB

The patients were brought to the preoperative preparation room 30 minutes before the operation. Standard anesthesia monitoring (electrocardiography, non-invasive blood pressure, and peripheral oxygen saturation) was performed. After establishing peripheral intravenous vascular access, the patients were given sedation using

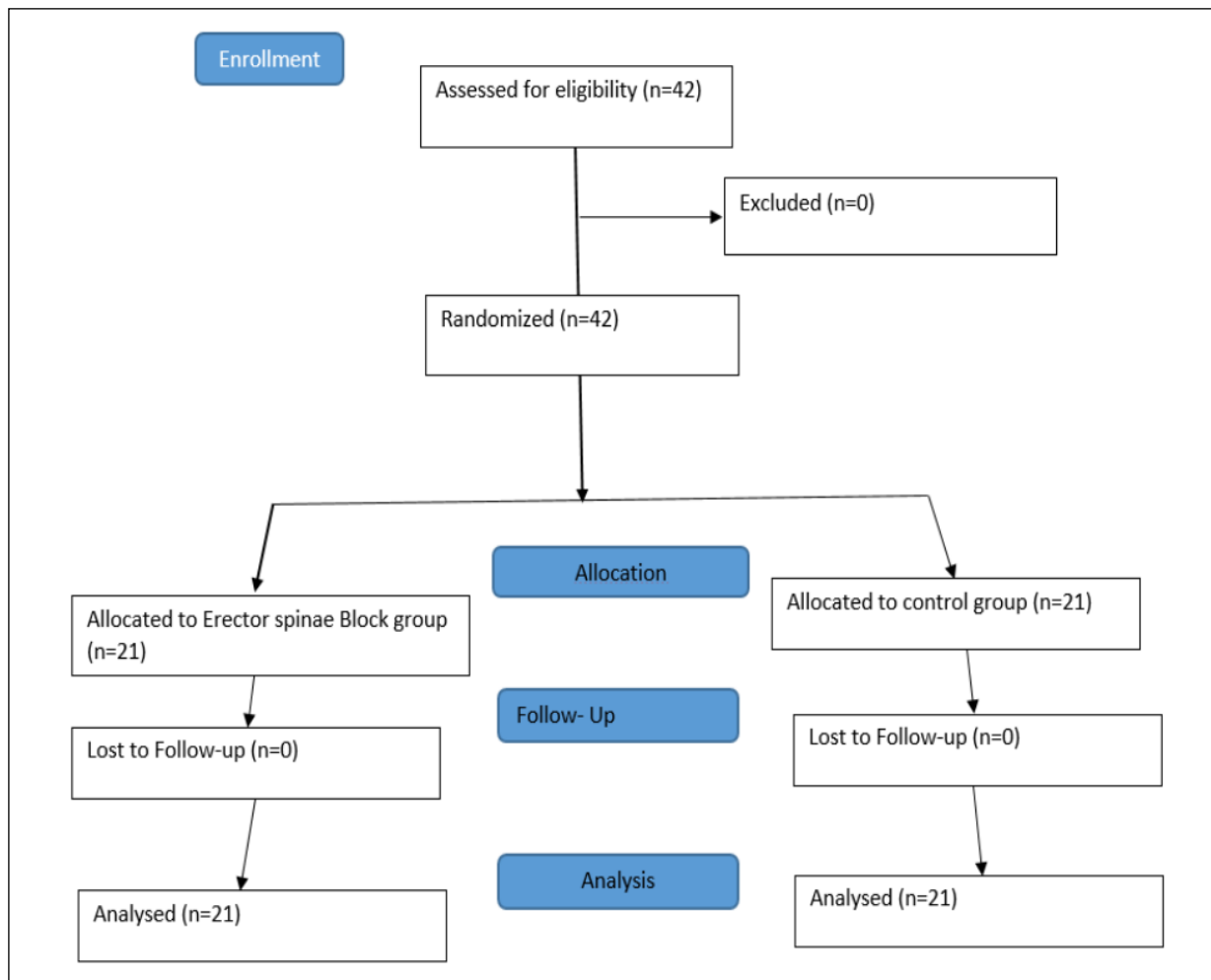


Figure 1. Consort flow chart describing participant progression through the study.

1-2 mg midazolam. The patients were put in the prone position, and the region to be blocked was aseptically prepared. Using a convex ultrasound probe (Logiq, GE Healthcare, Milwaukee, WI, USA) covered in a sterile sheath, the L3 vertebral level was identified by paramedian scanning starting from the sacral region. The transverse process was imaged by moving the probe towards the 3-4 cm lateral of the medial line. With the in-plane technique, using a 22-gauge 100 mm echogenic block needle (Uniplex, Pajunk, Geisingen, Germany), the transverse process was contacted, bypassing the skin, subcutaneous tissue, the trapezius muscle, and the erector spinae muscle. After the position of the needle was confirmed by applying hydro dissection between the erector spinae muscle and the transverse process, the ESPB was performed by administering 20 ml of a block combination consisting of 0.25% bupivacaine and 4 mg dexamethasone. The same procedure was applied to the contralateral side.

### **General Anesthesia**

Anesthesia was induced using 2-3 mg/kg propofol and 1-2 mcg/kg fentanyl. To facilitate the intubation, 0.6 mg/kg rocuronium was added to the protocol. The patient was put in the prone position after endotracheal intubation. In the maintenance of anesthesia, sevoflurane in 50% oxygen-50% air mixture and 0.1-0.2 mcg/kg/min remifentanyl infusion was preferred. When the blood pressure dropped to 20% below the baseline value, 5 mg ephedrine was administered. Bradycardia was corrected by administering 0.5 mg of atropine. Toward the end of the surgery, each patient was administered 100 mg tramadol and 1,000 mg paracetamol. At the end of the surgery, the neuromuscular blockade was antagonized, extubation was performed when the patient could breathe sufficiently, and the patient was transferred to the postoperative care unit. When their Modified Aldrete score became  $\geq 9$ , the patient was brought to the neurosurgery inpatient clinic.

The severity of the pain experienced by the patients after surgery was assessed using the 11-point NRS. According to this scale, a score of 0 indicates the absence of pain, while a score of 10 indicates the most unbearable pain imaginable. A patient-controlled analgesia (PCA) pump, containing 0.5 mg of morphine per milliliter, was attached to each patient. The PCA pump was programmed with a 10-minute locking period, without a basal infusion, to provide 1 mg of morphine as a bolus. Paracetamol was administered

every 8 hours in the postoperative period. The patients were given the necessary explanations about how to use the PCA device and the NRS scoring procedure before the procedure and after they woke up from general anesthesia. Dexketoprofen was planned as rescue analgesia if NRS  $\geq 4$ . NRS scores, postoperative morphine consumption, postoperative nausea/vomiting, and patient satisfaction status were recorded at 30 minutes and at the 1<sup>st</sup>, 2<sup>nd</sup>, 4<sup>th</sup>, 6<sup>th</sup>, 12<sup>th</sup>, and 24<sup>th</sup> hours after surgery. The primary outcome was the amount of morphine used in 24 hours. The secondary outcomes included pain scores and rescue analgesia requirements at different time points.

### **Statistical Analysis**

To determine the minimum required sample size, we conducted a pilot study evaluating 24-hour morphine consumption as the primary outcome measure. The results of the pilot study showed a morphine consumption of  $15.6 \pm 5.7$  mg in the group that underwent ESPB and  $20.8 \pm 5.4$  mg in the control group. Based on an alpha value of 0.05 and 85% power, we determined that each group should include at least 18 patients. Considering potential data losses, we decided to include 42 patients, 21 in each group.

The data that were collected in the study were analyzed using the SPSS (Statistical Package for the Social Sciences) for Windows 25.0 program (IBM Corp, Armonk, NY, USA). A value of  $p < 0.05$  was considered statistically significant. Descriptive statistics (frequency, percentage, median, mean, and standard deviation) were calculated. Skewness and kurtosis values were checked to test the normality of the distribution of the collected data. In the analyses of the differences between the two groups for the normally distributed quantitative data, independent-samples *t*-tests were utilized. For the non-normally distributed quantitative data, the Mann-Whitney U test was utilized. Chi-squared tests were performed to test the relationships between the categorical variables.

## **Results**

The demographic characteristics, ASA scores, and operative times of the patients were similar between the two groups. The distribution of the patients into the two groups was homogeneous in terms of their fusion levels (Table I).

The morphine consumption levels of the patients were significantly lower in the ESPB

**Table I.** Demographic characteristics and surgical levels of the patients.

	ESPB group (n=21)	Control group (n=21)	p
Age (Mean±SD)	51.90±12.32	50.71±13.56	0.767
Sex			
Male n (%)	13 (61.9)	8 (38.1)	0.123
Female n (%)	8 (38.1)	13 (61.9)	
Weight (Mean±SD)	81.00±11.24	79.52±10.79	0.666
Height (Mean±SD)	168.95±9.08	164.05±8.71	0.082
ASA			
I n (%)	2 (9.5)	1 (4.8)	0.828
II n (%)	11 (52.4)	12 (57.1)	
III n (%)	8 (38.1)	8 (38.1)	
Level			
2 n (%)	10 (47.6)	5 (23.8)	0.094
3 n (%)	4 (19.0)	9 (42.9)	
4 n (%)	3 (14.4)	6 (28.6)	
5 n (%)	4 (19.0)	1 (4.8)	
Operation time (min)	272±85.67	242±70.26	0.249

Age year, Weight kg, Height cm, ESPB: erector spinae plane block, ASA: American Society of Anesthesiologist Classification, min: Minute.

**Table II.** Numeric Rating Scale (NRS) scores and morphine consumption at postoperative time points.

	ESPB group (n=21)	Control group (n=21)	p
Comparison of NRS scores at postoperative time points			
½ h	4.24±2.55	6.48±2.69	0.009*
1 h	3.90±2.36	5.62±2.46	0.027*
2 h	3.43±2.01	4.90±2.14	0.027*
4 h	2.76±1.26	4.19±1.91	0.007*
6 h	2.67±1.15	3.90±1.97	0.018*
12 h	2.43±1.16	3.19±1.69	0.097
24 h	2.38±1.28	3.00±1.55	0.157
Morphine consumptions at postoperative time points			
0-4	4.1±2.81	7.76±3.32	0.000*
4-8	7.14±4.07	13.62±4.64	0.000*
8-24	13.33±8.24	20.43±7.19	0.005*

\* $p < 0.05$ ; ESPB, erector spinae plane block.

group at the 4<sup>th</sup>, 8<sup>th</sup>, and 24<sup>th</sup> postoperative hours (respectively,  $p < 0.001$ ,  $p < 0.001$ , and  $p = 0.005$ ) (Table II, Figure 2).

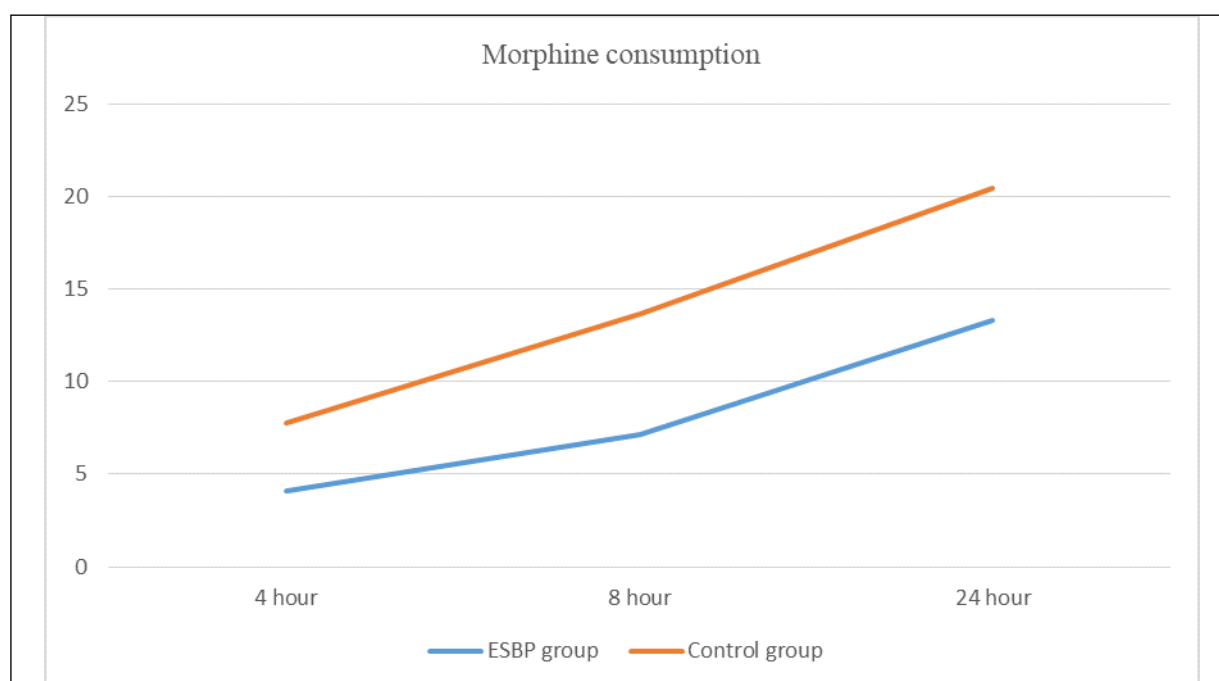
The 24-hour NRS scores of the patients were recorded. The pain scores in the control group were determined to be greater than those in the ESPB group at 30 minutes and at the 1<sup>st</sup>, 2<sup>nd</sup>, 4<sup>th</sup>, 6<sup>th</sup> hours after surgery (respectively,  $p = 0.009$  and  $p = 0.027$ ,  $p = 0.027$ ,  $p = 0.007$ , and  $p = 0.018$ ). There was no significant difference between the 12<sup>th</sup>-hour and 24<sup>th</sup>-hour NRS scores of the patients in the two groups (respectively,  $p = 0.097$  and  $p = 0.157$ ) (Table II, Figure 3).

The time until the first requirement of analgesics was 60 minutes in the ESPB group and 30 minutes in the control group, and the difference

between the groups was statistically significant ( $p = 0.006$ ). While rescue analgesia was administered to 71.4% of the patients in the control group, it was administered to 28.6% of those in the ESPB group. The difference between the groups was significant ( $p = 0.005$ ).

Postoperative nausea/vomiting was seen in 4 patients in the ESPB group and 9 in the control group, and the results of the two groups were similar ( $p = 0.095$ ).

It was determined that 61.9% of the patients in the ESPB group were satisfied with the process, and 38.1% were highly satisfied. In the control group, 19% were somewhat satisfied, 66.7% were satisfied, and 14.3% were highly satisfied. The difference between the two groups was found to be significant



**Figure 2.** Morphine consumptions at postoperative time points.

**Table III.** Other postoperative outcomes.

	ESPB group (n=21)			Control group (n=21)			p
	Min	Max	Median	Min	Max	Median	
First analgesic use (min)	30	360	60	10	110	30	0.006*
	<b>n (%)</b>			<b>n (%)</b>			
Rescue analgesia							
Yes	6 (28.6)			15 (71.4)			0.005*
No	15 (71.4)			6 (28.6)			
Nausea							
Yes	4 (19)			9 (42.9)			0.095
No	17 (81)			12 (57.1)			
Satisfaction							
Somewhat satisfied	0 (0)			4 (19)			0.043*
Satisfied	13 (61.9)			14 (66.7)			
Highly satisfied	8 (38.1)			3 (14.3)			

\* $p < 0.05$ , ESPB: erector spinae plane block, min: Minute.

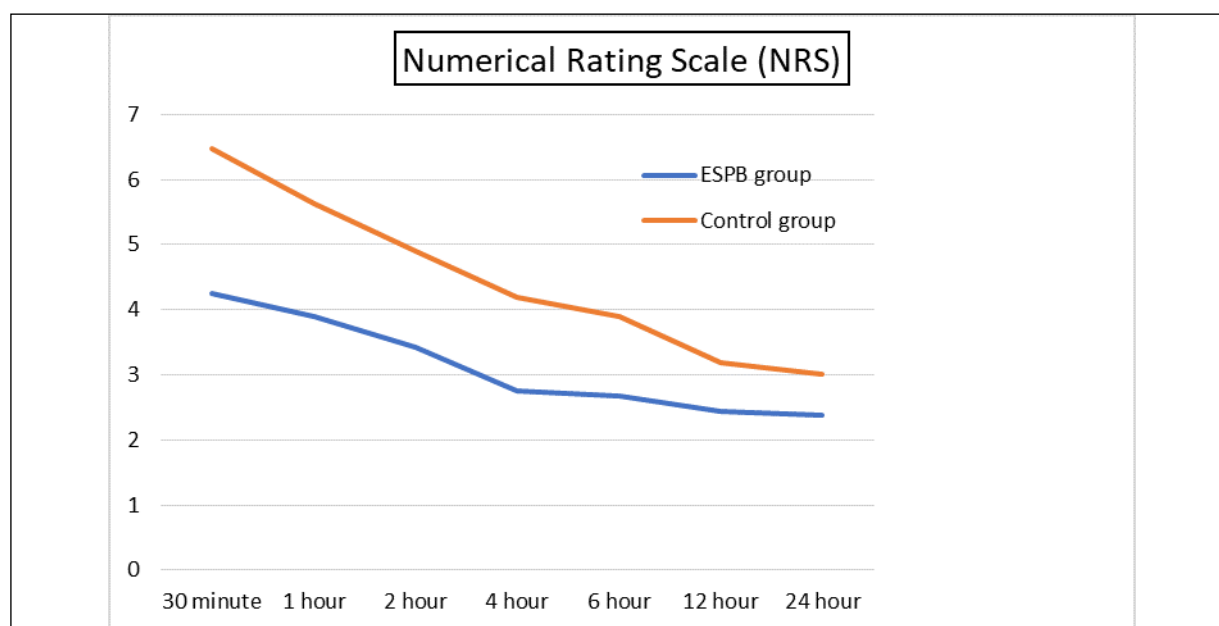
( $p = 0.043$ ) (Table III). Complications such as pneumothorax, local anesthetic systemic toxicity, and infection were not seen in any of our patients.

## Discussion

The results of this study showed that ultrasound-guided bilateral lumbar ESPB reduced opioid consumption at 4, 8, and 24 hours after fusion surgery with lumbar posterior spinal in-

strumentation and lowered the NRS scores of the patients at 30 minutes and at the 1<sup>st</sup>, 2<sup>nd</sup>, 4<sup>th</sup>, 6<sup>th</sup> hours in the postoperative period.

Following spinal surgery, 30 to 64% of patients experience poorly managed pain, and this leads to patient dissatisfaction and unfavorable outcomes<sup>14</sup>. Spinal fusion surgery with instrumentation is a major spinal procedure that causes acute severe postoperative pain. The optimal management of postoperative pain affects postoperative success to a significant extent. Opioids are frequently used



**Figure 3.** Numerical Rating Scale (NRS) scores at postoperative time points.

for this purpose. However, at high doses, the side effects of opioids influence the process negatively and reduce postoperative satisfaction. This is why opioid-sparing multimodal analgesic regimens are preferred in the postoperative period<sup>15-17</sup>. Peripheral nerve blocks have a significant place among opioid-sparing strategies. The success of different peripheral nerve blocks in managing postoperative pain has been demonstrated in the context of several different surgical procedures<sup>18-21</sup>. Recently, peripheral nerve blocks have also been tested in postoperative analgesia in spinal procedures, and successful results have been reported<sup>12</sup>. In the study where they applied ESPB in lumbar disk hernia repair procedures, Yörükoğlu et al<sup>22</sup> found that compared to the control group, ESPB lowered 24-hour morphine consumption by 57%.

In the ERAS guidelines<sup>23</sup>, which provide recommendations for perioperative care following lumbar spinal fusion, regional techniques are stated as a part of multimodal opioid-sparing analgesia, when perioperative care is provided with a comprehensive ERAS approach, a decrease in opioid consumption and pain results in faster mobilization, shortened hospitalization, and a lower risk of thromboembolism.

In their retrospective study where 242 patients who underwent lumbar spinal fusion surgery were examined, Soffin et al<sup>24</sup> reported a significantly lower 24-hour opioid consumption level in the ESP group compared to the group without the

usage of a block, but they stated that the routine usage of this block as a part of standard care could not guarantee favorable results. In a study<sup>25</sup> that investigated the effect of bilateral ESPB in open posterior lumbar spinal surgery, when the patients were evaluated by being divided into the decompressive laminectomy group and the group of decompressive fusion surgery with instrumentation, 24-hour morphine consumption values were determined to be significantly lower in the ESPB groups for both procedures. NRS scores, on the other hand, were lower in the ESPB group, but were statistically significant only at the 24<sup>th</sup> hour. In another study<sup>26</sup>, which was conducted with a randomized controlled design, the ESP group was found to have significantly lower 48-hour opioid consumption values, intraoperative opioid consumption levels, and pain scores. Our study also revealed results similar to those of the studies mentioned above. A recent comprehensive study<sup>27</sup> that included patients who underwent emergency and elective fusion surgery involving at most four consecutive thoracic and lumbar spine levels provided similar results to those in our study and the abovementioned studies. Forty-eight-hour opioid consumption values and NRS scores up to the 36<sup>th</sup> hour were significantly lower in the ESPB group compared to the control group. In our study, while NRS scores were significantly lower in the ESPB group up to the 6<sup>th</sup> hour, there was no significant difference between the two groups at the 12<sup>th</sup> and

24<sup>th</sup> hours, and their NRS scores were lower than 4. This situation may be a consequence of the applied multimodal analgesia regimen. To prolong the effect duration of ESPB, we added dexamethasone as an adjuvant agent to bupivacaine. Dexamethasone is a steroid that can reduce pain and the inflammatory response to tissue injury. A current study<sup>28</sup> recommended the usage of adjuvant agents to prolong regional anesthesia and emphasized the status of dexamethasone as the most effective option as an adjuvant agent. A Cochrane study<sup>29</sup> showed that dexamethasone added to peripheral nerve blocks could extend the duration of sensory blocks and effectively reduce postoperative pain severity and opioid consumption. It was also highlighted in the same study that the effects of intravenous and perineural dexamethasone application were similar. A situation that is wondered about and considered a source of concern regarding the application of ESPB in spinal surgery is its potential to prevent intraoperative neuromonitoring. According to the results of the retrospective cohort study conducted by Pan et al<sup>30</sup>, ESPB did not seem to prevent intraoperative monitoring. Nonetheless, we believe that this potential should be investigated more comprehensively.

The studies cited above have not reported a serious complication in relation to ESPB, and they have revealed that ESPB is a safe and easily applicable block. While our study did not show any statistical data, we did not observe any ESPB-related complications. We also think ESPB is a safe, effective, and simple block. A reason for the preference for ESPB may be the convenience of the ultrasound-guided imaging of the lumbar vertebral transverse processes compared to other blocks that can be performed in lumbar surgery, such as thoracolumbar interfascial blocks. The effect mechanism of ESPB is debated. Some of its potential effect mechanisms are neural blockade through the direct dispersion of the local anesthetic substance into the paravertebral or epidural space, analgesia mediated by the increased plasma concentrations of the local anesthetic due to systemic absorption, the immunomodulatory effects of local anesthetics, and analgesia mediated by the mechanical sensory characteristics of the thoracolumbar fascia<sup>31</sup>. With its broad area of application, it is a unique block, and in addition to spinal surgery, it is used in surgeries of the trunk, the lower and upper extremities, and the heart, as well as various cases of acute and chronic pain<sup>32</sup>.

### **Limitations**

Our study had some limitations. A placebo block was not performed due to concerns about potential harm. This is why our patients could not be blinded to the process. To avoid keeping the surgical team waiting and prevent delays, we started the operation without performing dermatome examinations on the patients to which we provided preoperative ESPB. If we could perform dermatome examinations, we would be able to identify the region that would be blocked by the injection that was administered at a single level.

### **Conclusions**

The results of our study demonstrated that lumbar ESPB performed by a single injection in fusion surgery with lumbar spinal instrumentation at the levels of 2-5 was an effective block for postoperative analgesia through the achievement of lower consumption of opioids and better pain scores. As a part of multimodal analgesia, lumbar ESPB can be preferred in spinal fusion surgery. Nevertheless, it is necessary to investigate the effectiveness and reliability of ESPB to be induced by using multiple injections at different levels in multilevel major spinal surgeries. Furthermore, it should be remembered that there are questions that still need to be answered precisely in spinal surgeries in which intraoperative neuromonitoring is performed. Future studies should look for answers to these questions.

### **Conflict of Interest**

The authors declare no conflict of interest.

### **Authors' Contributions**

Conceptualization; GG and GÖ, Methodology; GG and GÖ, Formal analysis; GG and GÖ, Data curation; GG and GÖ, Writing-original draft; GG, Writing-review and editing; GÖ, Visualization; GG and GÖ, Supervision; GG. All authors have read and agreed to the published version of the manuscript.

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### **Ethics Approval**

The study was conducted in accordance with the Declaration of Helsinki and approved by the Clinical Studies Ethics Committee of the Faculty of Medicine at Kahramanmaraş Sütçü İmam University (2020/12-04).

**Informed Consent**

Informed consent was obtained from all subjects involved in the study.

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**Data Availability**

Data to support the findings of this study are available upon reasonable request.

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