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RESEARCH

Effect of low thoracic erector spinae block on postoperative pain management in patients undergoing lumbar microdiscectomy surgery

Lomber mikrodiskektomi ameliyatı geçiren hastalarda alt torasik erektör spina bloğunun postoperatif ağrı yönetimine etkisi

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Abstract

Purpose: Lumbar disk hernia is very common reason for spinal surgery and usually treats with surgical interventions. The primary aim of this randomized controlled study was to determine the effect of low thoracic ultrasound guided erector spinae plane (ESP) block on postoperative pain management in lumbar microdiscectomy surgery.

Materials and Methods: Totally 42 adults scheduled for elective lumbar microdiscectomy surgery and assigned into two groups as Group ESP and Group Control. Anesthesia was induced with propofol 2mg/kg, rocuronium 0.6 mg/kg, fentanil 2μg/kg and maintained with total intravenous anesthesia (propofol 4-8 mg/kg/h and remifentanil 0.03-0.05 μg/kg/min), N_2O/O_2 mixture %60/40 for all patients. When patients were positioned at prone, ESP or sham block performed bilaterally. ESP performed with bupivacain 0.5% 15 mL+lidocain 2% 5 mL in ESP group and saline 20 mL for sham group at the T10 level of spine. The postoperative analgesia provided with morphine 0.1 mg/kg intravenously and diclofenac Na 75 mg intramuscularly at last 30 minutes of surgery for all patients. Postoperative visual analog scale (VAS) scores, meperidine requirements and patients' satisfaction were recorded.

Results: There were significant differences between Group ESP and Group Control in meperidine requirement, VAS scores at rest and leg movement and patients' satisfaction. Time to first analgesic need was median 62.5 min (interquartile range 5-180) in Group ESP and median 7.50 min (interquartile range 5-10) in Group Control.

Conclusion: ESP can significantly reduce postoperative pain scores (VAS at rest and leg movement), meperidine

Öz

Amaç: Lomber disk hernisi spinal cerrahi için çok yaygın bir nedendir ve genellikle cerrahi müdahalelerle tedavi edilir. Bu randomize kontrollü çalışmanın birincil amacı, lomber mikrodiskektomi cerrahisinde ultrason kılavuzluğunda alt torasik erektör spina plan (ESP) bloğunun postoperatif ağrı yönetimine etkisini belirlemektir.

Gereç ve Yöntem: Elektif lomber mikrodiskektomi ameliyatı planlanan toplam 42 erişkin, Grup ESP ve Grup Kontrol olmak üzere iki gruba ayrıldı. Anestezi indüksiyonu propofol 2mg/kg, roküronyum 0,6 mg/kg, fentanil 2μg/kg ile sağlandı ve total intravenöz anestezi (propofol 4-8 mg/kg/sa ve remifentanil 0,03-0,05 μg/kg/dk), N_2O/O_2 %60/40 karışım ile tüm hastalara anestezi idamesi sağlandı. Hastalar yüzüstü pozisyondayken bilateral olarak ESP veya sham blok uygulandı. ESP grubuna 15 mL bupivacain %0,5 +5 mL lidocain %2, sham grubuna ise salin 20 mL ile omurganın T10 seviyesinden ESP uygulandı. Tüm hastalara ameliyatın son 30 dakikasında morfin 0,1 mg/kg intravenöz ve diklofenak Na 75 mg intramüsküler olarak postoperatif analjezi sağlandı. Postoperatif vizüel analog skala (VAS) skorları, meperidin gereksinimleri ve hasta memnuniyeti kaydedildi.

Bulgular: Grup ESP ve Grup Kontrol arasında meperidin gereksinimi, istirahat ve bacak hareketi sırasındaki VAS skorları ve hasta memnuniyeti açısından anlamlı fark vardı. İlk analjezik ihtiyacına kadar geçen süre, Grup ESP' de ortanca 62,5 dakika (çeyrekler arası aralık 5-180) ve Grup Kontrol' de ortanca 7,50 dakika (çeyrekler arası aralık 5-10) idi.

Sonuç: ESP, postoperatif ağrı skorlarını (istirahat ve bacak hareketinde VAS), meperidin gereksinimini önemli ölçüde

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requirement and can provide better patients' satisfaction, postoperatively.
Keywords:. Erector spinae plane block;,spinal surgery, postoperative analgesia, low thoracic erector spinae block, regional analgesia, pain management.

azaltabilir ve postoperatif hasta memnuniyetini daha iyi sağlayabilir.
Anahtar kelimeler: Erektör spina plan bloğu, spinal cerrahi, postoperatif analjezi, alt torasik erektör spina bloğu, bölgesel analjezi, ağrı yönetimi.

INTRODUCTION

Lumbar disc hernia is very common reason for spinal surgery. Ineffective postoperative analgesia can result in low patient satisfaction scores, prolonged postoperative recovery, longer hospital stays and increased costs. Therefore, as with all surgical procedures, effective postoperative pain management is crucial in patients undergoing spinal surgery.

Although many analgesia regimens have been proposed, to improve outcomes and increase patient satisfaction, peripheral nerve blocks have become popular analgesia techniques as a part of enhanced recovery after surgery (ERAS) pathways. Most recent studies have demonstrated better pain control with regional blocks than with opioid-based analgesia techniques[1,2]. Furthermore, regional blocks lead to improved pain control, lower analgesia requirement, earlier patient mobilization and lower opioid-related side effects[3,4].

The erector spinae plane block (ESPB) is a popular regional analgesia technique that has recently been proposed for perioperative analgesia as a successful interfascial block. The use of ESPB for the management of thoracic neuropathic pain was first described by Forero and colleagues[5] in 2016. This technique can sufficiently anesthetize the multidermatomal sensation from T1 to L3 when administered at T5. ESPB is safer than other fascial plane blocks because the site of application is far from vascular structures, spinal cord and pleura. Blockage of the dorsal and ventral rami of the abdominal and thoracic spinal nerves via ESPB leads to sensory block in limited thoracic-abdominal dermatomes. Additionally, the thoracolumbar fascia helps spread local anesthetics (LAs) through the posterior thoracic wall and abdomen; thus, sensory block may have expanded further, three to four levels both cranially and caudally from the LA injection site[6,7]. Therefore, ESPB can prefer for the pathologies from cervical to lumbar regions[8-10].

In the literature, except for a few clinical trials and case reports, there are limited studies which evaluated the effect of ultrasound-guided (US-G) low thoracic ESPB on postoperative pain management in spinal surgery[11-13].

We aimed to test the hypothesis that US-G low thoracic ESPB effectively reduces postoperative pain scores and lowers analgesic requirement in patients undergoing lumbar microdiscectomy surgery compared to the control group (the patients used sham block). Thus, the primary outcome of this study was considered as postoperative pain score (visual analog scale [VAS]) and the secondary outcome was meperidine consumption at 24 hours.

MATERIALS AND METHODS

Study design

This randomized, prospective, double-blind, controlled study was performed between 2018-2020 years at University hospital following Çukurova University Ethical Committee approval (8 May 2019, decision number: 106/10) and registration at clinicaltrials.gov (identifier: NCT04148729), After obtaining written informed consent from each participant, 42 patients with American Society of Anesthesiologists physical status (ASA) I to II, ages of 18 and 65 years were scheduled and recruited for elective lumbar microdiscectomy surgery at Çukurova University Faculty of Medicine, Department of Neurosurgery and Anesthesiology and Reanimation. Exclusion criteria were the presence of renal, respiratory or hepatic disease; chronic severe pain history; ASA III-IV status; or a body mass index >35 $kg.m^2$. The collected patient data has not been shared anywhere, taking into account patient privacy.

Monitoring and measurements

All participants were monitored using electrocardiogram (ECG), peripheral oxygen saturation (SpO_2), noninvasive arterial blood pressure, and heart rate (HR). The hemodynamic variables heart rate, diastolic blood pressure (DBP), mean blood pressure (MBP), systolic blood pressure (SBP), and were followed up at 5-min intervals during anesthesia; however, only SBP values were recorded intraoperatively at baseline 0, 5, 15, 30, 45 and 60 min

and postoperative 5, 10 and 30 min and 1, 2, 4, 8, 12 and 24 hours. Postoperative follow-ups were limited to 24 h, as the surgical team wanted to be discharged within 24 h considering ERAS protocols unless any complications developed[13].

Anesthesia management

Propofol 2mg.kg^{-1} and fentanil 2µg.kg^{-1} combination used for induction and anesthesia maintained by total intravenous anesthesia (TIVA; remifentanil 0.03-0.05 µg.kg.min^{-1} and propofol 4-8 mg.kg.h^{-1}) with an N_2O/O_2 mixture of %60/40 in all patients. Neuromuscular block was initiated with rocuronium 0.6 mg.kg^{-1} and maintained by repeated doses. After induction of anesthesia, patients were positioned in the prone position and bilateral US-G ESPB was applied to all patients, and then the surgical procedure was started.

All patients received intravenous morphine 0.1 mg.kg^{-1} and intramuscular diclofenac sodium (75 mg) 30 min before the end of surgery for postoperative analgesia. Diclofenac sodium 75 mg twice daily was prescribed for the management of postoperative pain. Whenever patients requested analgesia it was regarded as an indication for administration of analgesic (meperidine 0.4 mg.kg^{-1}, intravenously).

Randomization and blinding

Patients were randomly allocated into one of two groups, the ESP and the control group, in a 1: 1 ratio by a computer-generated randomization table. An investigator blinded to the study group prepared two injectors. The first injector comprised of bupivacaine 0.5% 15 mL plus lidocaine 2% 5 mL combination in the ESP group whereas the second injector consisted of 20 mL of 0.9 % saline in the control (sham) group. The patients and anesthesiologists who performed the block were blinded to the study groups.

Technique of ultrasound-guided erector spinae plane block

All ESPBs were performed by an experienced anesthesiologist. The spinous processes were palpated from C7 downward and then the T10 spinous process was identified using a linear array high-frequency ultrasound (Esaote, MyLab^{tm}Six) probe in prone position. The transverse process and muscles (erector spinae, trapezius and rhomboid major) (Figure 1) were identified from superficial to deep. A block needle (22-gauge short bevel; Spinocan; B. Braun Melsungen AG, Germany) was then attached in the in-plane through to the erector spinae muscle from caudal to cephalad. After aspiration, and correction, a total of 20 mL of block solution was administered. While in ESP group, bupivacaine 0.5% 15 mL plus lidocaine 2% 5 mL combination was used; in the control group, 0.9 % of saline 20 mL was administered. The same injection was administered to the opposite side.

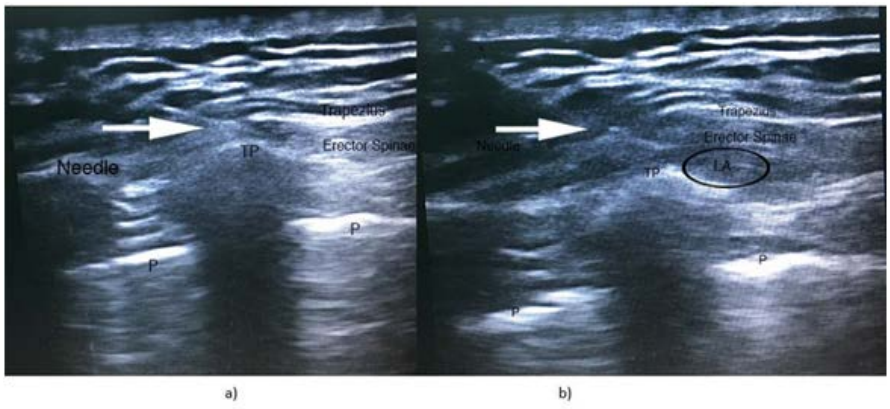

Figure 1. ESPB performing with US at the T10 level of spine a). Ultrasound image of block site and needle. The block needle inserted to the transverse process of the T10 vertebrae. b.)Ultrasound image of local anesthetic spread after injection.
TP; transvers process, P; pleura, LA; local anesthetics. White arrow shows block needle.

Surgical approach details

Microdiscectomy was performed unilaterally and at one level by the same surgeon in all patients. The surgeon removed small fragments of the disc, ligaments, and bone for frees to the nerves with a small incision. All patients were mobilized at the postoperative 6th hours. If no complications were observed, all patients were discharged at postoperative day 1 according to the ERAS protocols.

Data collection

Demographic data, ASA scores, level of surgical intervention, duration of anesthesia, and surgery were recorded for all patients. Postoperative pain was evaluated (at rest and leg movement) using a 10 cm VAS (0-10), at the following time intervals: 5, 10, 30 min and 1, 2, 4, 8, 12 and 24 h postoperatively.

The first meperidine requirement in both groups was recorded as "time to first analgesic need". At the time of 24 h after surgery, patients were asked to grade their satisfaction as follows: 1= very good; 2 = good; 3 = moderate; 4= poor.

Side effects and complications of ESPB including LA toxicity, severe sedation, nausea, vomiting, motor block and respiratory depression (defined as breath rate < 10 bpm or SpO2 < 89 %) in the first 24h postoperatively were also recorded.

Statistical analysis

As a result of the pilot study with 10 patients, the mean of the VAS score at the 2nd hour in motion was 3.5±1.5 in the control group and 1.65±1.7 in the ESPB group. Based on these values, for an effect size of 1.15 units, α error of 5% and power of 90%, the sample size was determined as 17 patients per group at. Assuming a dropout rate of approximately 20%, we recruited 21 patients in each group. The sample size calculation was based on VAS score with a 2-sample independent t-test (2-sided).

IBM SPSS Statistics Version 20.0 statistical software package (SPSS reference: IBM Corp. Released 2011. IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp.) used for analyses. Variables were defined as percentages, numbers, means, standard deviations, medians and IQR where appropriate. The normality of distribution was confirmed with the Shapiro Wilk test. The chi-square test was used to compare categorical variables between the groups. Whether the statistical hypotheses were fulfilled, the Student's t-test or Mann-Whitney U test was used. The statistical significance level for all tests was assumed to be 0.05. Independent T-test, Chi-Square Test and Mann-Whitney Test were used for demographic data, surgical levels, duration of anesthesia and surgery. Chi-Square Test was used for meperidine requirement and patient's satisfaction.

RESULTS

A totally of 42 patients undergoing lumbar microdiscectomy surgery were assessed for eligibility, and all patients were enrolled and randomly assigned into the ESPB group (n=21) or Control group (n = 21). (Figure 2).

Demographic data and surgery characteristics (ASA status, level of surgical intervention, duration of anesthesia and surgery) were presented in Table 1. There were no significant differences between the groups in regards to demographic data and surgery characteristics, with the exception of patient weight. Perioperative SBP, DBP and HR were similar and there was no significant difference between the groups; perioperative SBP values is shown in Figure 3.

Despite postoperative VAS scores at movement and rest were significantly lower in the block group than in the control group, median VAS scores in the control group throughout the study periods was found around 4, suggesting patients in control group achieved their analgesia with cost of higher opioid (meperidine) consumption (Figure 4).

In postoperative period, there were statistically significant differences in postoperative meperidine requirement between ESP and control group (p=0.006) (Table 2). Seventeen participants in the ESP group and seven participants in the control group did not demand analgesic at postoperative 24 hours. Total meperidine consumption was 156.8 mg for Group ESP and 670.8 mg for Group Control in the postoperative 24th h, respectively.

The median time to first meperidine requirement was significantly longer in the ESP group than in the Control group; it was 62.5 min (interquartile range 5-180) in the ESP group versus 7.50 min (interquartile range 5-10) in the control group (p=0.001) (Table 2).

Ten patients in the ESP group defined their postoperative satisfaction scores as '1= very good'

whereas none in the Control group. Patient satisfaction scores were found significantly lower in the ESP group (Table 2) than in the Control group (p=0.01).

None of the patients experienced nausea, vomiting, motor block or any other side effects related with techniques or the study drugs.

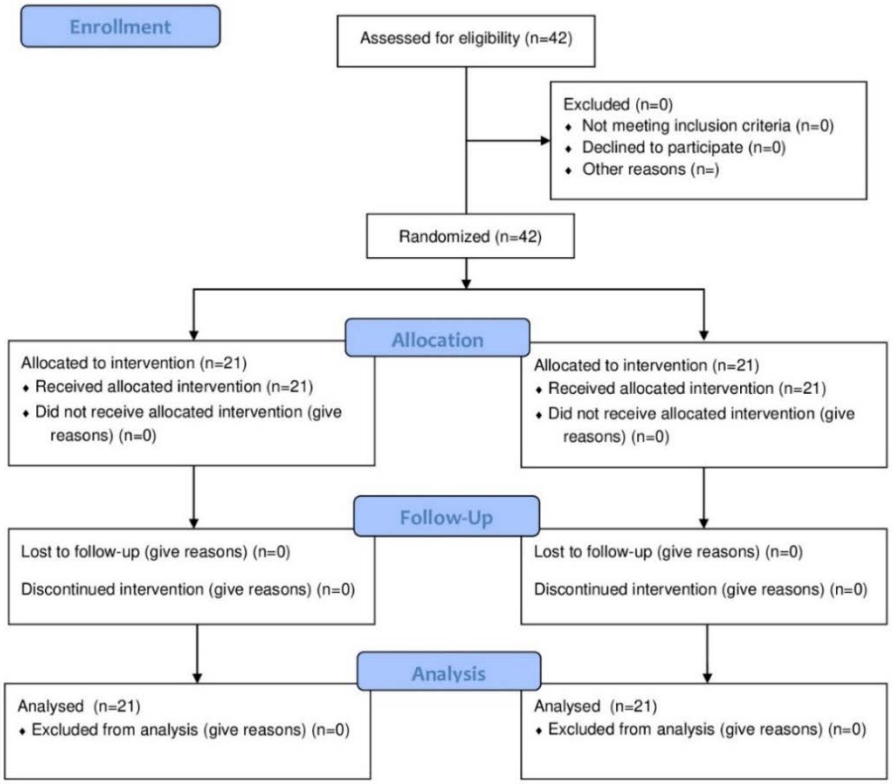

Figure 2. Consort Flow Diagram

Table 1. Demographics of patients and surgery

	Group ESP (N:21)	Group Control (N:21)	P value
Age	52.33±12.7	52.95±9.7	0.86*
Male	12 (57.1)	10 (47.6)	
Female	9 (42.9)	11 (52.4)	0.53[a]
Weight (kg)	75.6±7.4	83.8±9.7	0.04*
Height (cm)	168.7±8.8	166.4±7.2	0.36*
ASA I	9 (42.9)	8 (38.1)	0.85[a]
ASA II	12 (57.1)	13 (61.9)	
Surgical Level			
L2-3	12(57.1)	12(57.1)	
L3-4	8(38.1)	7(33.3)	1.0[a]
L4-5	1(4.8)	2(9.5)	
Duration of Anesthesia (min)	105.81±7.97	104.57±12.28	0.22[b]
Duration of surgery (min)	90.14±6.24	89.52±11.93	0.22[b]

ESP; Erector spinae plane block, min; minute
Data are presented as mean±SD and percentages are presented as % within group
*Independent T test, [a] Chi-Square Test, [b]Mann-Whitney Test

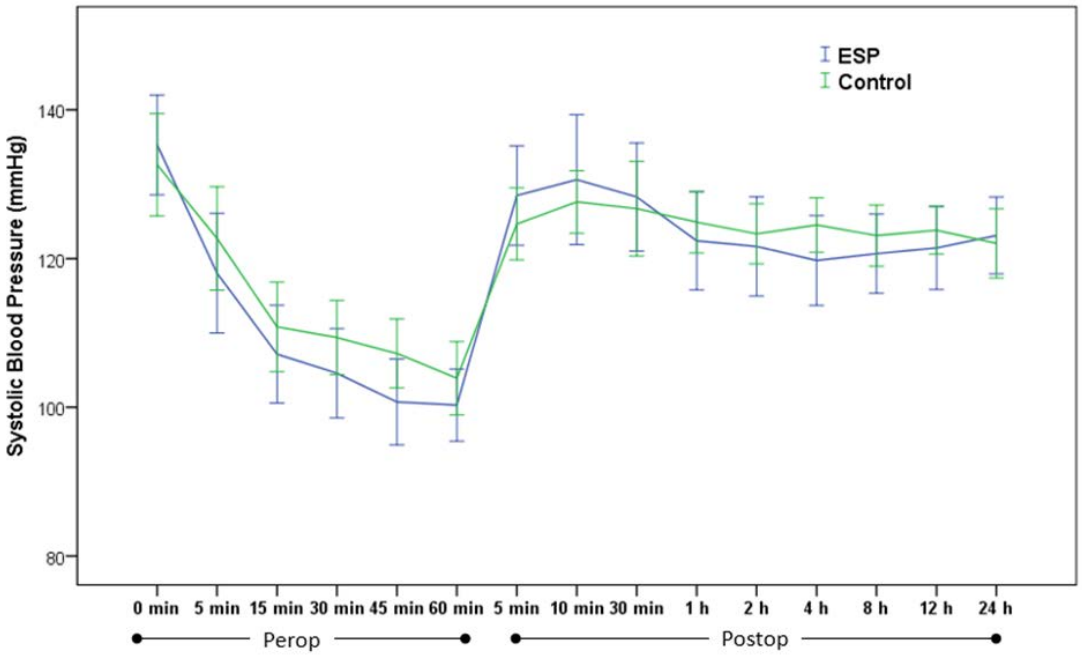

Figure 3. Perioperative Systolic Blood Pressure

ESP; Erector spinae plane block

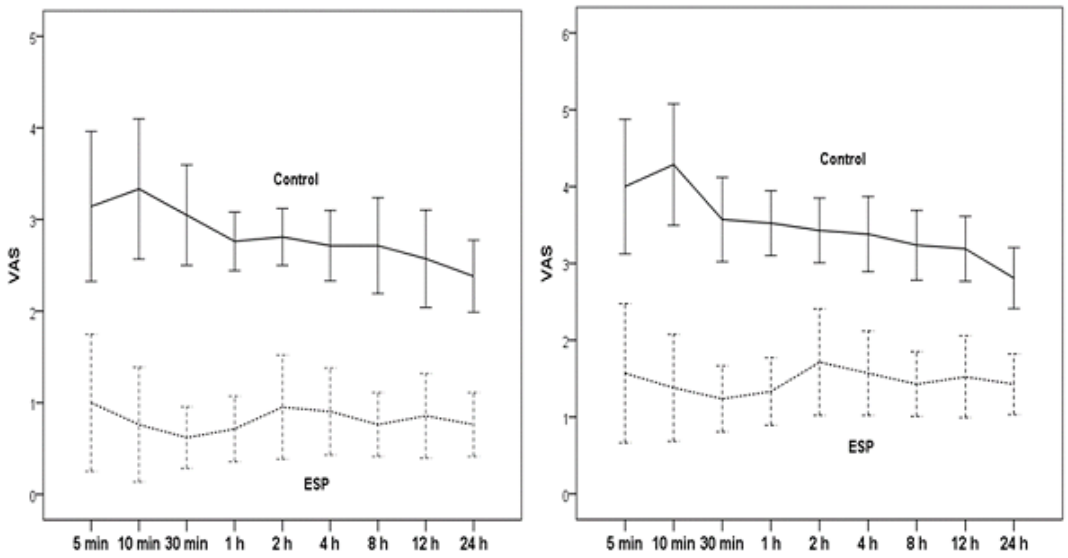

Figure 4. Postoperative VAS Scores at Rest and Leg Movement

a) At rest, b) At Leg movement

ESP; Erector Spinae Plane Block, VAS; visual analog scale

Table 2. Postoperative meperidine requirement and the patients' satisfaction

Variable	Group ESP (N:21)	Group Control (N:21)	P value
Meperidine Requirement			
None	17(81)	7(33.3)	0.006*
For once	3(14.3)	9(42.9)	
Two times	1(4.8)	5(23.8)	
Time to first Analgesic Need (min) median (IQR)	62.50 (5-180)	7.50 (5-10)	0.001**
Patients' Satisfaction			
Very Good	10(47.6)	0(0)	0.00*
Good	8(38.1)	5(23.8)	
Moderate	0(0)	10(27.6)	
Poor	3(14.3)	6(28.6)	

ESP; Erector spinae plane block, min; minute, IQR; Interquartile range
Data are presented as number and percentages (%) within group
* Chi-Square Test; ** Mann-Whitney U Test

DISCUSSION

The main finding of the present study was that US-G low thoracic segment ESPB can significantly reduce postoperative pain scores (VAS at rest and with leg movement), decrease the meperidine requirements, prolong the duration of the first analgesic (meperidine) requirement and provide better patient satisfaction.

The results of this study are consistent with those of previous studies that also demonstrated that postoperative pain scores and opioid consumption were significantly reduced by ESPB[13,14]. A few randomized, controlled studies have demonstrated the effectiveness of ESPB for postoperative analgesia and opioid consumption, particularly after spinal surgery. Singh et al. compared the effect of preoperative US-G ESPB on 24-hour postoperative morphine consumption, pain scores and patient satisfaction with standard (opioid-based) analgesia in patients scheduled for elective lumbar spine surgery under general anesthesia[15]. In that study, the authors used bupivacaine 0.5% 20 mL for each side and found that postoperative morphine consumption, pain control and patient satisfaction were significantly better in the ESPB group than in opioid-based analgesia group. Our study is in accordance with that study on lower pain scores and reduced opioid consumption in the ESPB groups. However, in the present study, we performed ESPBs after anesthesia induction because of patient discomfort. Yayık et al.[16] reported a randomized controlled study evaluating the effect of US-G bilateral ESPB (at level L3) with bupivacaine 0.25% 20 mL on pain scores and tramadol consumption in patients undergoing open lumbar spinal decompression surgery. The authors found that ESPB significantly decreased postoperative pain scores and reduced tramadol consumption by 28 % compared with the control group. Finally, they suggested that the ESPB block can reduce opioid consumption and relieve acute postoperative pain as a part of multimodal analgesia after lumbar decompression surgery. The results of that study are consistent with those of our study that which also demonstrated lower postoperative pain scores and reduced opioid consumption with lower levels of ESPB. Ueshima et al.[17] retrospectively analyzed 41 patients who underwent lumbar spine surgery, 23 of who received only general anesthesia while the other 18 patients received ESPB with general anesthesia. The results of their study revealed that the group receiving ESPB with general anesthesia had lower NRS scores and less fentanyl requirements in the postoperative period. In that study, the authors also suggested that in patients undergoing lumbar spine surgery, ESPBs were performed at a lumbar vertebral site, however, they

did not specifically state exact level at which the block was performed.

Moreover, in the present study, the time to first meperidine requirement was found to be prolonged by US-G low thoracic ESPB. Our findings reinforce that ESPB can be used after induction of anesthesia but before surgical start, safely and effectively for postoperative pain management in patients undergoing lumbar microdiscectomy surgery, as it provides effective perioperative analgesia, without detrimental side effects.

Studies have demonstrated that several factors such as position, level of application, type, volume, and concentration of the LA, affect the success rate of ESPB. In the present study, low thoracic ESPB was performed because of the close surgical site of application and dermatome spread.

Local anesthetic injection between the deep fascia of the erector spinae muscles block the dorsal and ventral rami of the spinal nerves and blocks somatic and visceral pain. ESPB, applied at T5 level, has been used successfully in thoracic and abdominal surgeries for anesthesia and analgesia, however, lower and upper levels of applications for ESPBs have also been described for different kinds of surgeries and treatments such as spinal and hip surgeries or acute herpes zoster treatment[18-21]. In the present study, ESPBs were applied at the T10 level, and lower levels of ESPB application (T12 or L3) have also been reported after spinal lumbar surgery[18].

Another important factor affecting the success rate of ESPB is the volume and the concentration of LA. In a study reporting that preoperative ESPB with ropivacaine 0.4% 20 mL during lumbar spinal fusion surgery failed to prolong the duration of analgesia up to 24 hours which were inconsistent with our results[21]. However, in another retrospective study, patients applied bilateral ESPB group (bupivacaine 0.375% 20 mL for each site) had significantly lower average NRS scores and less fentanyl requirement when compared to a control group[16]. In our study, we used 2% 5 mL lidocaine and 0.5% 15 mL bupivacaine mixture for ESPB and found a prolonged duration of the first analgesic requirement, less opioid consumption and better patient satisfaction in ESPB group than in control group.

The type of local anesthetic is also another factor that affects anesthesia duration, effectiveness and density. In a randomized controlled trial, Zhang et al.[22] examined the effect of preoperative application of ESPB with ropivacaine 0.4 % 20 mL on pain scores and opioid consumption in patients undergoing lumbar spinal fusion surgery. In that study, they reported a significantly lower pain scores at rest 4-12 hours but similar pain scores 24-48 hours after surgery in ESPB group compared to the control group. Additionally, ESPB group consumed significantly less sufentanil at 12 hours postoperatively. In the present study, we used bupivacaine + lidocaine mixture (2% 5 mL lidocaine-to speed up the start of anesthesia and 0.5% 15 mL bupivacaine-to prolong the duration of anesthesia and analgesia) for ESPB.

Applying LA during ESPB at the surgical or incision site may result in washout of the LA during the surgical procedure by surgical dissection[20]. To avoid failure and to leakage of the LA from the incision site, we applied the ESPB at the lower thoracic region which is far away from the incision site. Furthermore, performing ESPB far from the surgical site may also reduce the risk of infection development. The position of the patient when performing ESPB may affect the spread of the local anesthetic and thus the success and quality of the block. Although the seated, side, lateral decubitus or prone position is generally chosen for thoracic and lumbar ESPB, we chose the prone position because of its good visualization and easy application.

This study had some limitations. First, we did not calculate total remifentanil and propofol consumption, intraoperatively. Second; we could not evaluate to the sensory block level and block success because the patients were under general anesthesia and the block was performed after anesthesia induction. Third, we did not evaluate the anti-inflammatory effect of ESPB.

In conclusion, bilaterally applied low thoracic ESPB after anesthesia induction resulted in lower VAS scores, less meperidine requirement, prolonged time to first analgesic requirement and better patient satisfaction in patients undergoing lumbar microdiscectomy surgery. Further studies can advance our knowledge and performing ESPB in lumbar surgery can be part of daily practice regarding ERAS protocols.

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