Der Anaesthesist

Originalien

Anaesthesist 2020 · 69:742–750
https://doi.org/10.1007/s00101-020-00848-w
Received: 4 May 2020
Revised: 27 July 2020
Accepted: 17 August 2020
Published online: 21 September 2020

M. B. Eskin[1] · A. Ceylan[1] · M. Ö. Özhan[2] · B. Atik[3]

[1] Gülhane Medical School, University of Medical Science, Ankara, Turkey
[2] Özel Çankaya Hospital, Ankara, Turkey
[3] Balıkesir University Medical School, Balıkesir, Turkey

Ultrasound-guided erector spinae block versus mid-transverse process to pleura block for postoperative analgesia in lumbar spinal surgery

Introduction

More than half of the patients experienced moderate to severe pain after spinal surgery and nociceptive, neuropathic, and inflammatory sources are involved in the pain mechanism [1]. Ineffective pain management leads to several complications including immobilization, thromboembolism, persisting chronic pain, increased opioid consumption, and delayed hospital discharge [1, 2]. Multimodal analgesic (MMA) regimens using several drugs and techniques are considered to be necessary for postoperative pain relief. Regional anesthesia techniques, mainly epidural analgesia and more recently, paravertebral blocks became crucial parts of a MMA regimen after the introduction of ultrasound (US) in the regional anesthesia practice [3]. Erector spinae plane (ESP) block and mid-transverse to pleura (MTP) block are the latest developments in postoperative pain therapy.

The ESP block was first described in 2016 [4]. In this block, local anesthetics (LAs) are injected into the plane between the erector spinae muscle (ESM) and transverse process of the vertebra. The LA spreads cranially and caudally in the plane that enables a blockade of both dorsal and ventral rami of spinal nerves and sympathetic nerve fibers in a multilevel direction along the vertebral column [4]. The MTP block was first described as a modified paravertebral block in 2017 [5]. The LAs are administered between the transverse process and the pleura. This results in a LA spread to the dorsal and ventral rami in the paravertebral space through the fenestrations in the superior costotranverse ligament at the level of injection, and frequently to adjacent levels [5].

Both techniques were used for pain relief after mastectomy, thoracic, abdominal, and spinal surgery and were found effective due to their simplicity and lower risks compared to epidural analgesia [3]; however, no study exists in the literature that compares these blocks in spinal surgery.

The aim of this prospective and randomized study was to compare the effect of US-guided bilateral ESP block and MTP block in MMA regimens on postoperative pain relief in patients who underwent elective lumbar decompression surgery under general anesthesia (GA). Primary outcome measure was mean pain scores. Secondary outcome measures were consumption of opioid rescue analgesic and the amount of analgesic which was delivered by the patient-controlled analgesia (PCA) in the postoperative period.

Material and methods

Study design

The trial was conducted in the operating theatres of the University of Health Sciences, Gulhane Training and Research Hospital between 17 October 2019 and 31 March 2020 after hospital ethic committee approval (date 12 October 2019, protocol no.19/342). The trial was registered with the Clinical Trials.gov (NCT04193488). Written informed consent was obtained from all patients. The study was designed according to the consolidated standards of reporting trials (CONSORT) criteria (**Fig. 1**).

Inclusion criteria

This study included 120 patients with American Society of Anesthesiologists (ASA) physical status 1–3 , aged between 18 and 80 years, who were scheduled for elective lumbar decompression surgery for one or two vertebral levels under general anesthesia.

Exclusion criteria

Exclusion criteria included patient refusal, pregnancy, and history of allergy to study drugs, neurological and cognitive disorders, coagulopathy, chronic

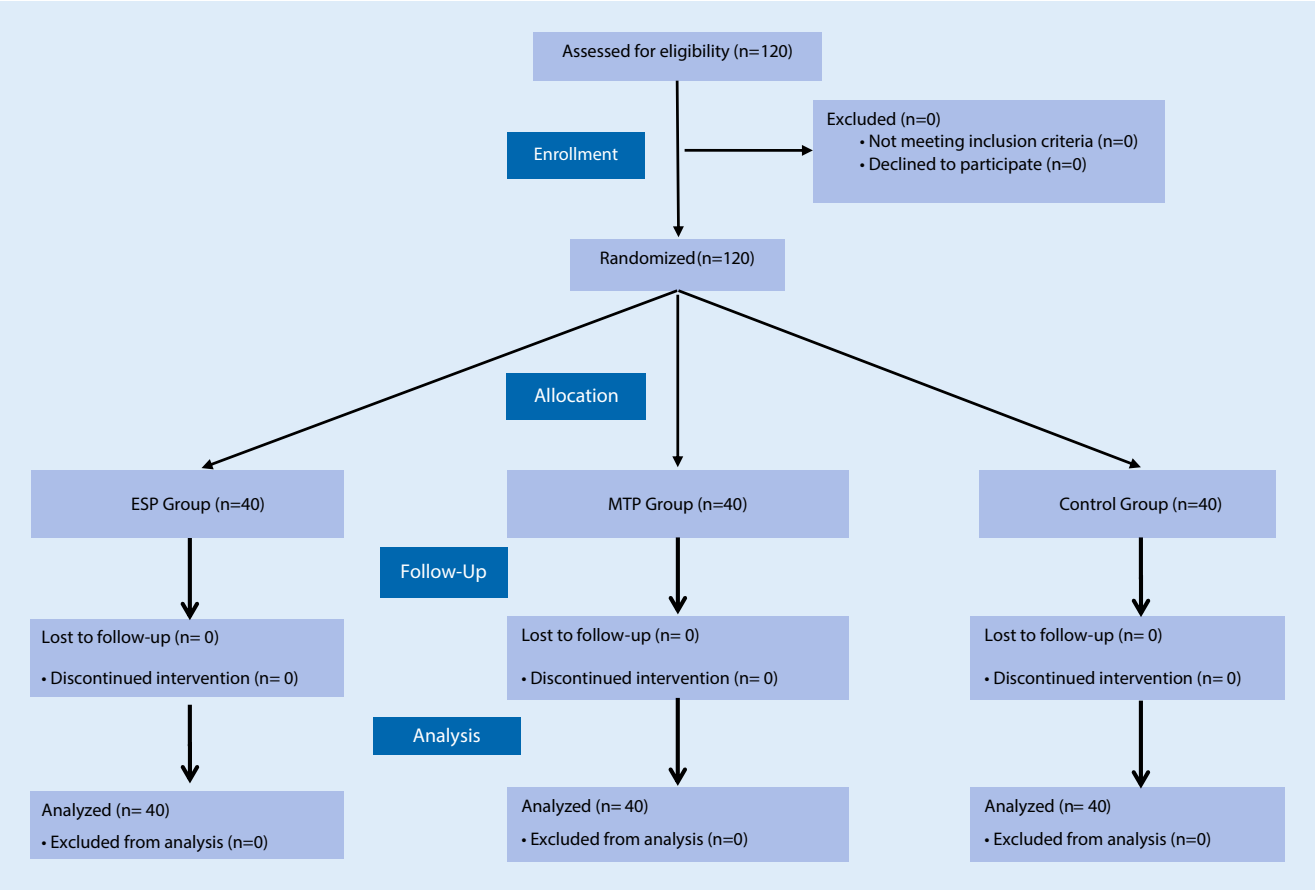

Fig. 1 ▲ Study flow diagram. *ESP* erector spinae plane, *MTP* mid-transverse to pleura

pain disorders and infections at the injection site.

Allocation and randomization

A sealed, opaque envelope containing allocated randomization was opened in the operating room after induction of GA. The patients were allocated in a 1:1:1 ratio to one of three groups: group erector spinae plane (group ESP, $n = 40$), group mid-transverse to pleura (group MTP, $n = 40$), and group Control (group C, $n = 40$).

Anesthesia procedure

All patients were given midazolam (2–3 mg) for sedation, ranitidine 50 mg for gastric protection, and ondansetron 4 mg to prevent postoperative nausea and vomiting after establishing an intravenous (IV) access at the ward. After arriving in the operating room, the patients were monitored with an electrocardiogram, pulse oximetry, and noninvasive blood pressure.

General anesthesia

General anesthesia was induced using IV propofol (2 $mgkg^{-1}$), rocuronium (0.6 $mgkg^{-1}$), and fentanyl (1 μgkg^{-1}). A cuffed and armored endotracheal tube (no. 7–8.5) was placed to secure the airway. The patients were placed in the prone position. A total intravenous anesthesia technique based on infusions of propofol (3 $\mu gkg^{-1}h^{-1}$) and remifentanil (2 $\mu gkg^{-1}h^{-1}$) was used for the maintenance. Nitroglycerin was administered by an IV infusion to achieve a controlled hypotension. Tranexamic acid (10 $mgkg^{-1}$) was given IV to reduce perioperative blood loss. All patients received IV paracetamol (10 $mgkg^{-1}$) and tenoxicam (10 mg) for postoperative pain relief.

Block procedure

The blocks were performed by the same anesthesiologist who is experienced in US-guided regional anesthesia. In the group ESP, a high-frequency linear US probe (HFL-50, 15–6 MHz) was placed vertically and approximately 3 cm lateral to the vertebra in the middle of the incision line. The transverse process and the overlying erector spinae muscles (ESM) were identified under a parasagittal scanning. A 22 G, 50 mm block needle (Sono-TAP, Pajunk, Geisingen, Germany) was inserted at a 30–40° angle in the cranial to caudal direction using an in-plane approach and advanced into the plane between the fascia of ESM and transverse process under sterile conditions. The correct needle position was confirmed after a hydrodissection with 3 ml of isotonic saline, and then 20 mL of 0.25% bupivacaine was injected in the interfascial plane between the rhomboideus major muscle and ESM. The LA spread was vi-

Anaesthesist 2020 · 69:742–750 https://doi.org/10.1007/s00101-020-00848-w

M. B. Eskin · A. Ceylan · M. Ö. Özhan · B. Atik

Ultrasound-guided erector spinae block versus mid-transverse process to pleura block for postoperative analgesia in lumbar spinal surgery

Abstract

Background. In recent years, promising results were achieved with the use of ultrasound (US)-guided interfascial plane blocks for effective postoperative analgesia in several surgeries. Erector spina plane (ESP) block and mid-transverse to pleura plane (MTP) block are the latest techniques in this area. The aim of this prospective and randomized study was to compare the postoperative analgesic efficacy of bilateral ESP and MTP blocks in patients undergoing lumbar spinal surgery under general anesthesia (GA).
Methods. A total of 120 adult patients were included in the study and randomized into 3 groups: group ESP ($n = 40$), group MTP ($n = 40$) and group Control ($n = 40$). The patients in the group ESP received a bilateral block by injecting 20 ml of 0.25% bupivacaine at a vertebrae level in the mid-point of the incision before GA. The same LA was administrated bilaterally at the T12/L1 level in the group MTP. Postoperatively, a multimodal analgesic regimen including an intravenous tramadol patient-controlled analgesia (PCA), paracetamol and dexketoprofen was used in all groups. Postoperative pain was assessed using a visual analogue scale (VAS) during the first 48 postoperative hours. Pethidine was used as a rescue analgesic when VAS score was >3. Primary outcome measure was mean pain scores. Secondary outcome measures were consumption of rescue analgesic and the amount of tramadol delivered by PCA. A $p < 0.05$ was considered statistically significant.
Results. Mean VAS scores were significantly higher in the group Control than in the group MTP and group ESP at all-time points during 48 h (Control > MTP > ESP; $p < 0.001$). Mean VAS scores were lower in group ESP than group MTP in postoperative 12 h ($p < 0.001$). Rescue analgesic consumption, number of bolus demand on PCA, PCA bolus demand dose, total PCA dose, and complications related to opioid consumption were highest in control group and lowest in ESP group (Control > MTP > ESP; $p < 0.001$).
Conclusion. Both ESP and MTP blocks provided effective pain relief after lumbar spinal surgery but the ESP block was superior to MTP block regarding postoperative analgesia in the first 24 h.

Keywords

Lumbar spinal surgery · Erector spinae plane block · Mid-tranverse to pleura block · Postoperative analgesia · Visual Analogue Scale

Ultraschallgeführter „Erector-spinae-plane"-Block gegenüber „Mid-transverse-to-pleura"-Block für die postoperative Analgesie in der lumbalen Wirbelsäulenchirurgie

Zusammenfassung

Hintergrund. In den letzten Jahren wurden vielversprechende Ergebnisse mit den Ultraschall(US)-geführten Faszienblockaden für die effektive postoperative Analgesie in mehreren Operationen erzielt. Der „Erector-spinae-plane"(ESP)-Block und der „Mid-transverse-to-pleura"(MTP)-Block sind die neuesten Techniken in diesem Bereich. Das Ziel dieser prospektiven und randomisierten Studie war es, die postoperative analgetische Wirksamkeit der bilateralen ESP- und MTP-Blöcke in der lumbalen Wirbelsäulenchirurgie unter der Vollnarkose zu vergleichen.
Methoden. Insgesamt 120 erwachsene Patienten wurden in 3 Gruppen randomisiert: Gruppe ESP ($n = 40$), Gruppe MTP ($n = 40$), und Kontrollgruppe ($n = 40$). Die Patienten in den Gruppen erhielten vor der Vollnarkose eine bilaterale Blockade durch Injektion von 20 ml 0,25 %iger Bupivacainlösung an der Wirbelebene in der Mitte der Inzision. Das gleiche LA wurde bilateral in die T12/L1-Wirbelebene in der Gruppe MTP verabreicht. Postoperativ wurde ein multimodales analgetisches Regime, bestehend aus i.v.-Tramadol-Gabe in Form der Patientenkontrollierte Analgesie (PKA), Paracetamol und Dexketoprofen in allen Gruppen angewendet. Die Schmerzintensität wurde auf der visuellen Analogskala (VAS) während der ersten postoperativen 48 h ermittelt. Pethidin wurde als „Rescue"-Analgetikum verwendet, wenn der VAS-Wert >3 war. Primärer Endpunkt war der mittlere Schmerz-Score. Sekundäre Endpunkte waren der Verbrauch des Rescue-Analgetikums und der PKA. Ein $p < 0,05$ wurde als statistisch signifikant angesehen.
Ergebnisse. Die mittleren VAS-Werte waren in der Kontrollgruppe signifikant höher als in den Gruppen ESP und MTP zu allen Zeitpunkten während der 48 h (Kontrolle > MTP > ESP; $p < 0,001$). Die VAS-Werte waren in der Gruppe ESP niedriger als in der Gruppe MTP in den postoperativen 12 h ($p < 0,001$). Der Verbrauch von Rescue-Analgetikum, die Anzahl des Bolusbedarfs bei PCA, die PCA-Bolusbedarfsdosis, die Gesamt-PCA-Dosis und die Komplikationen im Zusammenhang mit dem Opioidkonsum waren in der Kontrollgruppe am höchsten und in der ESP-Gruppe am niedrigsten (Kontrolle > MTP > ESP; $p < 0,001$).
Schlussfolgerung. Es wird der Schluss gezogen, dass beide ESP- und MTP-Blöcke nach der lumbalen Wirbelsäulenchirurgie eine wirksame Schmerzlinderung zeigten. Die Verwendung des ESP-Blocks war für die Schmerzlinderung in den ersten 24 h wirksamer als der MTP-Block.

Schlüsselwörter

Wirbelsäulenchirurgie · Erector-spinae-plane-Block · Mid-transverse-to-pleura-Block · Postoperative Analgesie · Visuellen Analogskala

Table 1 Comparison of the demographic data between study groups

		Group ESP ($n = 40$)	Group MTP ($n = 40$)	Group Control ($n = 40$)	p
Gender	Female	24 (60%)	25 (62.5%)	23 (57.5%)	0.595
	Male	16 (40%)	15 (37.5%)	17 (42.5%)	
Age (years)		58.0 ± 5.2	58.8 ± 4.7	57.8 ± 5.2	0.398
Body mass index (kgm^{-2})		25.6 ± 3.1	25.5 ± 5.2	25.5 ± 2.2	0.437
ASA status	1	5 (12.5%)	3 (7.5%)	3 (7.5%)	0.112
	2	28 (70.0%)	31 (77.5%)	30 (75.0%)	
	3	7 (17.5%)	6 (15%)	7 (17.5%)	
Surgical level	1	19 (47.5%)	20 (50%)	18 (45%)	0.562
	2	21 (52.5%)	20 (50%)	22 (55%)	
The level of the surgery	L1-L2	2 (5%)	4 (10%)	3 (7.5%)	0.738
	L2-L3	6 (15%)	9 (22.5%)	6 (15%)	
	L3-L4, L4-L5	21 (52.5%)	20 (50%)	22 (55%)	
	L4-L5	11 (27.5%)	7 (17.5%)	9 (22.5%)	
The level of the blocks	T12-L1	1 (2.5%)	40 (100%)	0	<0.001
	L1-L2	1 (2.5%)	0	0	
	L2-L3	6 (15%)	0	0	
	L3-L4	21 (52.5%)	0	0	
	L4-L5	11 (27.5%)	0	0	
Duration of the surgery (min)		124.3 ± 8.9	130.6 ± 5.5	128.3 ± 7.8	0.344

ESP erector spinae plane, *MTP* mid-transverse to pleura, *ASA* American Society of Anesthesiologists. Values are presented as mean ± standard deviation, numbers and/or proportion (*n*, %). $p < 0.05$ was considered as statistically significant

Table 2 Comparison visual analogue scale scores between study groups

Group		ESP ($n = 40$)	MTP ($n = 40$)	Control ($n = 40$)	F	p	Partial η^2	Pairwise comparison
Postoperative VAS scores (h)	0. h (PACU)	1.9 ± 0.6	2.9 ± 0.7	4.9 ± 0.8	25.21	<0.001	0.442	ESP < MTP < C
	2. h	1.6 ± 0.5	2.8 ± 0.8	4.1 ± 1.7	28.26	<0.001	0.503	ESP < MTP < C
	4. h	1.4 ± 0.7	2.7 ± 0.5	3.9 ± 1.5	99.30	<0.001	0.664	ESP < MTP < C
	6. h	1.4 ± 0.8	2.5 ± 1.1	3.6 ± 1.3	38.00	<0.001	0.840	ESP < MTP < C
	8. h	1.8 ± 0.7	2.5 ± 0.7	3.7 ± 1.0	56.25	<0.001	0.993	ESP < MTP < C
	12. h	1.9 ± 0.5	2.4 ± 0.9	3.5 ± 0.9	402.12	<0.001	0.707	ESP < MTP < C
	18. h	2.3 ± 0.2	2.4 ± 0.7	3.3 ± 0.9	100.08	<0.001	0.651	ESP = MTP < C
	24. h	2.2 ± 0.1	2.3 ± 0.6	2.9 ± 0.8	120.99	<0.001	0.737	ESP = MTP < C
	48. h	1.9 ± 0.9	2.0 ± 0.4	2.0 ± 0.1	220.14	>0.05	0.900	ESP = MTP = C

ESP erector spinae plane, *MTP* mid-point transverse to pleura, *VAS* visual analogue scale, *PACU* postanesthesia care unit. Values are presented as mean ± standard deviation. $p < 0.05$ was considered as statistically significant

sualized in a fascial longitudinal pattern deep to the ESM. The same procedure was performed on the contralateral side.

All blocks were performed at the T12-L1 level in the group MTP, which was the lowest insertion point for the MTP blocks. The US probe was placed in the same position as in the ESP block. The block needle was inserted at a 30–40° angle in the caudal to cranial direction using an in-plane approach and targeting the paravertebral space under sterile conditions. The needle was advanced to the mid-point between the transverse process and the pleura. The correct needle position was confirmed after a hydrodissection with 3 ml of isotonic saline. Then, 20 mL of 0.25% bupivacaine was injected. Downward displacement of the pleura indicated a successful block. Same procedure was performed on the contralateral side. The patients in the group Control did not receive a block. Anesthesia was discontinued after the surgery and the patients were extubated after return of spontaneous respiration.

Follow-up period

All patients were followed for 1h in the postanesthesia care unit (PACU) and then discharged to the ward. Patients received following treatments in the multimodal analgesic regimen in the postoperative period: a) paracetamol 1000 mg IV with 8-h intervals, b) dexketoprofen 50 mg IV with 24-h intervals, and c) IV tramadol patient-controlled analgesia (IV-PCA; 4 mgh^{-1} infusion, bolus dose on demand: 5 mg, lockout

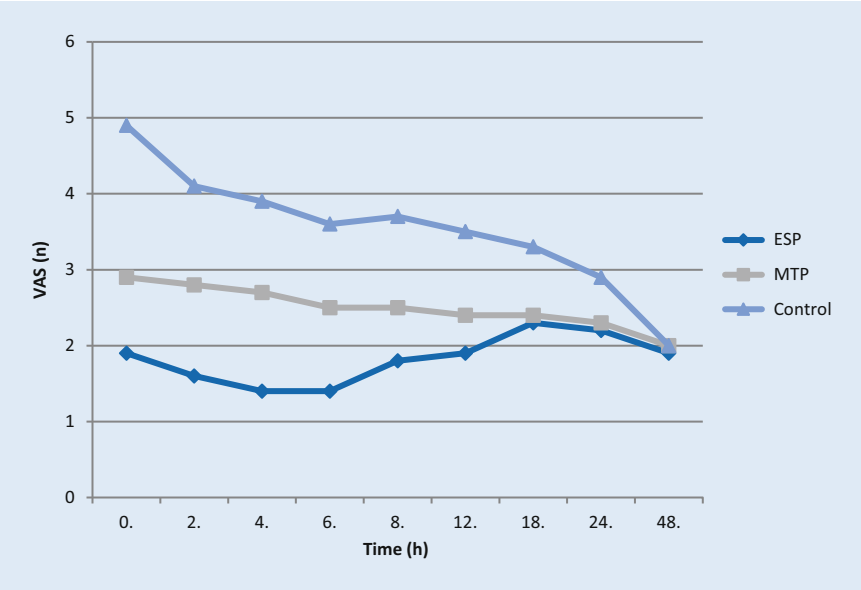

Fig. 2 ▲ Postoperative pain scores in study groups. *ESP* erector spinae plane, *MTP* mid-transverse to pleura, *VAS* visual analogue scale

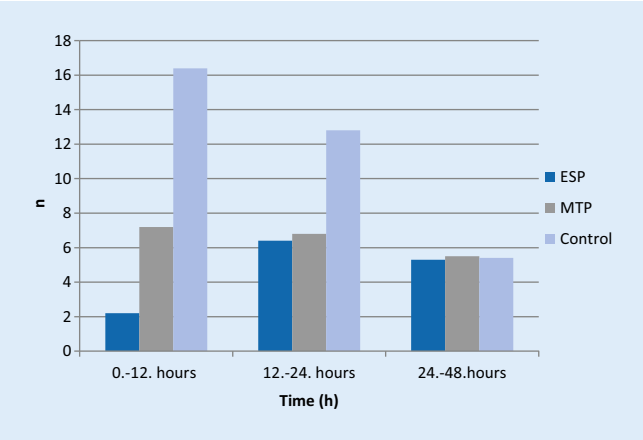

Fig. 3 ◀ Bolus doses on PCA demand in study groups. *ESP* erector spinae plane, *MTP* mid-transverse to pleura, *PCA* patient-controlled analgesia

time: 30 min, 4-h limit: 60 mg). Postoperative pain was evaluated using a visual analogue scale (VAS 0: no pain, 10 cm: worst pain ever) with 15 min intervals in PACU (0h.), then at postoperative 2., 4., 6., 8., 12., 18., 24., and 48. hours at the ward by a research assistant who was blinded to the study groups. Pethidine 0.5 $mgkg^{-1}$ was IV given as a rescue analgesic when the VAS score was >3. The amount of rescue analgesic (pethidine) and tramadol consumption by PCA were recorded between postoperative 0.–12., 12.–24., and 24.–48. hours. Patients with normal vital parameters were discharged from hospital after 48 h when the VAS score was <3. Patient's satisfaction level was assessed by VAS ranging from not satisfied (score 0) to fully satisfied (score 10) with the treatment outcomes at discharge.

The following criteria were recorded and compared between groups: demographic data, mean operative times (min), VAS scores, time to first rescue analgesic (h), rescue analgesic consumption (mg), number of PCA bolus on demand, bolus dose on demand (mg), and total PCA consumption (mg), patient's satisfaction score (0–10), and complications. Complications were defined as complications related to the block and the surgery (nerve damage, LA toxicity, pneumothorax, bleeding, infection, and thromboembolism), and related to the GA and systemic analgesics (respiratory depression, nausea and vomiting, hemodynamic instability, itching, constipation, and dizziness).

Statistical analysis

Statistical analysis was performed using IBM SPSS Statistics version 21 (IBM SPSS Inc., Chicago, IL, USA). The sample size was calculated using a power analysis to detect a minimum clinically important difference of 20% in the VAS scores between 3 groups. A preliminary study involving 30 patients (10 patients in each group) indicated that a minimum of 102 cases would be needed to achieve 80% power with an alpha error of 0.05; equivalent to an effect size of 0.8. Estimating that 10% of patients may drop out of the study due to different reasons, the sample size was increased to 120 patients (40 patients in each group). Descriptive statistics were used as mean, standard deviation, and median for continuous data, and frequency and percentage for categorical data. Continuous data were assessed for normality using the Kolmogorov-Smirnov test. The χ^2-test was used to compare categorical data. The interaction effect between treatment groups, and VAS scores, PCA use, and rescue analgesic consumption were assessed with factorial repeated measures ANOVA. Pairwise differences at different time points were estimated from the model including Bonferroni adjustment for multiple comparisons between groups. Partial η^2 statistic was used to interpret the effect sizes for clinical significance for ANOVA. The suggested norms for the partial eta squared are: small = 0.01, medium = 0.06, and large = 0.14. A $p < 0.05$ was considered as statistically significant.

Results

The study included 120 patients of which 68.3% were female and 31.7% were male. Mean age was 58.2 ± 3.3 years. There was no significant difference between groups in terms of demographic data, duration and vertebral level of the surgery ($p > 0.05$; **Table 1**).

Table 3 Comparing postoperative analgesia, complications, and patient satisfaction scores between groups

		ESP ($n = 40$)	TMP ($n = 40$)	Control ($n = 40$)	F	p	Partial η^2	Pairwise comparison
Time to first rescue analgesic (h)		14.2 ± 1.6	0.8 ± 0.4	0.3 ± 0.1	26.95	<0.001	0.435	ESP > MTP > C
Rescue analgesia (yes/no)		7/33	22/18	34/6	29.13	<0.001	0.447	ESP < MTP < C
Rescue analgesic consumption (mg)	0.–12. h	0.0 ± 0.0	10.5 ± 4.5	18.6 ± 6.3	106.27	<0.001	0.751	ESP < MTP < C
	12.–24. h	5.2 ± 1.8	12.8 ± 2.6	20.3 ± 5.4	36.00	<0.001	0.500	ESP < MTP < C
	24.–48. h	4.8 ± 0.9	5.1 ± 0.7	5.2 ± 0.8	46.69	0.211	0.672	ESP < MTP = C
PCA bolus on demand (*n*)	0.–12. h	2.2 ± 0.3	7.2 ± 2.2	16.4 ± 4.3	564.23	<0.001	0.942	ESP < MTP < C
	12.–24. h	6.4 ± 1.1	6.8 ± 1.9	12.8 ± 2.6	100.08	<0.001	0.719	ESP < MTP = C
	24.–48. h	5.3 ± 1.6	5.5 ± 0.8	5.4 ± 1.3	86.12	0.608	0.703	ESP = MTP = C
Bolus PCA dose on demand (mg)	0.–12. h	10.8 ± 1.9	36.8 ± 4.1	81.6 ± 9.5	111.99	<0.001	0.754	ESP < MTP < C
	12.–24. h	32.4 ± 4.6	35.1 ± 2.3	65.1 ± 10.1	65.07	<0.001	0.637	ESP = MTP < C
	24.–48. h	28.3 ± 4.2	29.0 ± 3.1	28.8 ± 3.9	220.13	0.433	0.844	ESP = MTP = C
Total PCA dose (mg)	0.–12. h	48.0 ± 1.0	84.9 ± 4.0	130.8 ± 9.9	506.94	<0.001	0.916	ESP < MTP < C
	12.–24. h	81.2 ± 4.4	83.6 ± 5.1	114.9 ± 6.5	72.59	<0.001	0.670	ESP = MTP < C
	24.–48. h	124.9 ± 5.8	125.2 ± 8.3	125.0 ± 7.2	136.13	0.566	0.767	ESP = MTP = C
Complications	PONV	1 (2.5%)	4 (10%)	7 (17.5%)	80.95	0.027	0.652	ESP < MTP < C
	Itching	1 (2.5%)	3 (7.5%)	6 (15%)	190.65	0.034	0.821	ESP < MTP < C
Satisfaction score (0–10)		8.2 ± 1.4	7.1 ± 0.9	5.6 ± 0.4	323.99	0.013	0.880	ESP > MTP > C

ESP erector spinae plane, *MTP* mid-transverse to pleura, *PCA* patient-controlled analgesia, *PONV* Postoperative nausea and vomiting. Values are presented as mean ± standard deviation, numbers and/or proportion (*n*, %). $p < 0.05$ was considered as statistically significant

Primary outcome measure. The mean VAS scores were significantly lower in the group MTP and group ESP than in the group Control at all time points during postoperative 48. hours (group ESP < group MTP < group Control; $p < 0.05$, **Table 2**; **Fig. 2**). The VAS scores remained lower than 3 in the groups MTP and ESP throughout the study period but were between 3.3 and 4.9 in the group Control in the first postoperative 24 h. A pairwise comparison between MTP and ESP groups revealed that mean VAS scores were lower in group ESP than group MTP at postoperative 0., 2., 4., 6., 8., and 12 h. ($p < 0.05$; **Table 2**; **Fig. 2**). The results of the partial-η^2 statistic were higher than 0.14 at all time points, which represented a clinical significance with a large effect size according to the ANOVA test.

Secondary outcome measures. Time to first rescue analgesic were lower in the group Control compared to ESP and MTP groups (Control < MTP < ESP; $p < 0.05$, **Table 3**; **Fig. 3**). All patients in the group Control and 8 patients in the group MTP were given rescue analgesic in the postoperative first hour during the PACU care. Rescue analgesic was not required in the first postoperative 12 h in the group ESP. The number of patients who required rescue analgesic and total consumption was higher in the group Control compared to the groups ESP and MTP during the first postoperative day ($p < 0.001$, **Table 3**). A pairwise comparison between MTP and ESP groups showed that time to first rescue analgesic was higher, the number of the patients who were given rescue analgesic and the consumption of the rescue analgesic was significantly lower with a large effect size in the group ESP than the group MTP in the first postoperative 24 h ($p < 0.001$; partial-η2 >0.14, **Table 3**). Number of bolus demand, bolus PCA doses and total PCA doses were also higher in the group Control compared to the groups ESP and MTP in the postoperative 24 h ($p < 0.001$, **Table 3**; **Fig. 3**). A pairwise comparison between MTP and ESP groups showed that number of bolus demands, bolus PCA doses and total PCA doses were significantly lower with a large effect size in the group ESP than the group MTP in the postoperative first postoperative 12 h ($p < 0.001$, partial-η^2 >0.14, **Table 3**; **Fig. 3**). There were no signs and symptoms related to local anesthetic toxicity observed. More patients in the group Control suffered from postoperative nausea and vomiting and itching compared to the other groups ($p = 0.027$, **Table 3**). Mean patient satisfaction scores were highest in the group ESP and lowest in the group Control (ESP > MTP > Control; $p = 0.013$, **Table 3**).

Discussion

To our knowledge, this is the first prospective and randomized clinical study which compared ESP and MTP blocks regarding postoperative analgesia in lumbar surgery. The results of the study showed that both ESP and MTP blocks provided superior pain relief than the group Control in the postoperative first 24 h. This was compatible with previous reports that revealed lower pain scores (NRS = Numerical Rating Scale, between 0–4, mainly <3) and opioid consumption with the use of interfascial plane blocks compared to control groups [6]. Main advantages of both blocks were procedural simplicity and safety. Sonoanatomy was easily determined and the injection point was not close to the spinal cord and the pleura that reduced risks for pneumothorax

and sympathetic blockade compared to the epidural techniques. If necessary, a catheter can also be inserted to prolong postoperative analgesia [7–9].

When reviewing the results, VAS scores were found to be significantly lower in the group ESP than the group MTP at every time point during the postoperative first 12 h which remained lower than 2 in the group ESP but were between 2.4 and 2.9 in the group MTP ($p < 0.001$). The VAS scores were similar after 12. hours between groups ESP and MTP, which might be attributable to the duration of action in single-shot peripheral nerve blocks using long-acting local anesthetics, such as bupivacaine. Since the same amount of LA was used for the blocks in both groups, it can be stated that ESP block provided more effective postoperative analgesia compared to the MTP block. Postoperative VAS scores in both groups indicated that ESP and MTP blocks provided an effective pain relief compared to the group Control, which resulted in postoperative pain scores lower than 3. The difference in VAS scores in favor of the ESP block relative to the MTP block was supported with the lower use of rescue analgesic and PCA in the group ESP. The patients in the group ESP did not require a rescue analgesic in the immediate postoperative period during the PACU care and also the time to first rescue analgesic was significantly longer in the group ESP than the group MTP (14.2 h vs. 0.8 h; $p < 0.001$). The number of patients who required rescue analgesic, rescue analgesic consumption, the number of PCA bolus demand and total PCA bolus dose were significantly lower in the group ESP than the group MTP in the postoperative first 12 h ($p < 0.001$). The lower amounts of pethidine and tramadol consumption resulted in the lower incidence of postoperative nausea and vomiting and itching in the group ESP compared to the group MTP that are the main complications related to the opioid use ($p = 0.027$ and $p = 0.034$, respectively). Also, the satisfaction score was higher in the group ESP than the group MTP which may indicate better postoperative pain relief and lower incidence of complications with the use of ESP block (8.2 ± 1.4 vs. 7.1 ± 0.9; $p < 0.013$, respectively).

There is a continuing debate about the exact mechanism of the blocks. It remains unclear whether the blocks exert the effects via the spread of LA to intercostal nerves or to nerve roots in the paravertebral space [10, 11]. It is also unclear whether the LA spread depends on its volume because the spread pattern does not necessarily correlate with the extent of somatic blockade [11].

Erector spinae complex includes a group of muscles and tendons which is located in the lumbar, thoracic and cervical regions. Thence, this plane covers multiple dermatomes and allows wide cranial-caudal spread of LA [12]. A cadaveric study has confirmed that the dye spreads cranially and caudally from C5-T2 to L2-L3 dermatome levels and reached both the ventral and dorsal rami after injecting 20 mL of contrast agent at T7 level [4]. Tulgar et al. reviewed dermatomal distribution of the sensory block in ESP blocks [6]. When analyzing the data, dermatomal sensory distribution was between 5–10 levels (mean 7.3) with 20 ml of LA (the same amount as in the current study), which was administered at upper thoracic levels higher than T7. We found 8 reports (6 case reports and 2 randomized studies) in the literature that have investigated postoperative analgesia after lumbar or sacral surgery in adult patients using bilateral ESP blocks. The blocks were performed at lower thoracic (T10 and T12), lumber (L2–L4) or sacral levels [7, 8, 13–18]. Dermatomal sensory distributions were between 4–10 levels (median 5.6). Although dermatomal distribution of the sensory block was not recorded after the surgery in the current study, which was a major limitation, the lumbar surgeries were performed in a level between 4–6 dermatomes. A recent study revealed that a significant spread was observed between transverse process of T12-L5 and erector spinae muscle, and between the multifidus muscle and iliocostal muscle at the L2–4 levels after an injection of a 40 ml mixture containing contrast agent and LA at the L4 level [19].

In MTP blocks, it was advocated that LA is deposited superficial to the superior costotransverse ligament (SCTL) which results in a variable LA spread in the paravertebral space and erector spinae plane [20, 25]. There are only 8 case reports with 13 patients of MTP blocks in the literature and none were performed in the lumbar spine surgery. Single-level or multi-level (3 levels) MTP blocks were performed at thoracic levels between T2–T7 using 10–27 ml of LA [3, 5, 9, 21–25]. Dermatomal distribution differed between 2–7 levels (mean 5.3).

According to these data, it was difficult to make a reliable statement about which block is superior to the other for postoperative pain relief after lumbar spinal surgery. A possible explanation for the difference between ESP and MTP blocks in this study could be due to a better LA spread of the ESP block to multiple levels. We suppose that the LA provided analgesia in MTP blocks by spreading craniocaudally from the lateral part of SCTL to the paravertebral region. It might lead to more LA spread to the anteroposterior plane than to the craniocaudal plane, which resulted in a decrease of LA spread to higher dermatome levels. It may be necessary to increase the amount of LA in MTP blocks according to the dermatome area to be affected.

Another advantage in favor of the ESP blocks could be that the ESP blocks can be performed at every level of the lumbar spine. In contrast, the lowest insertion point of the MTP block was at T12/L1 level. The studies of the MTP block showed that the sensorial distribution was between 1–5 levels under the injection level that could limit the analgesic effect of the block for surgery at lower lumbar vertebrae [3, 5, 9, 21–25].

There are several limitations of the study. Firstly, the block distribution was not recorded after the surgery, which could provide valuable information about LA spread. The second limitation was the VAS scores of the patients were recorded only when the patients were at rest. Unfortunately, there were different decisions of the neurosurgeons on the time of the patient's mobilization after the surgery. Therefore, we decided to record VAS

measurements at the same time points after surgery and to exclude VAS score recordings under the movement.

Conclusion

As a result, ESP and MTP blocks are simple, safe and effective in the management of postoperative analgesia as a part of multimodal analgesic regimen. Hopefully, there are also promising results that revealed surgical anesthesia was achieved with both blocks [19, 22–27]. It is concluded that ESP blocks provided superior postoperative pain relief than MTP blocks in patients undergoing lumbar decompression surgery. Further prospective and randomized studies are required.

Corresponding address

M. Ö. Özhan, M.D.
Özel Çankaya Hospital
Ankara, Turkey
metozhan2003@yahoo.com

Compliance with ethical guidelines

Conflict of interest. M. B. Eskin, A. Ceylan, M. Ö. Özhan and B. Atik declare that they have no competing interests.

Ethical standards. All procedures performed in studies involving human participants or on human tissue were in accordance with the ethical standards of the institutional and/or national research committee and with the 1975 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

References

1. Kurd MF, Kreitz T, Schroeder G, Vaccaro AR (2017) The role of multimodal analgesia in spine surgery. J Am Acad Orthop Surg 25(4):260–268. https://doi.org/10.5435/JAAOS-D-16-00049
2. Yayik AM, Cesur S, Ozturk F, Ahiskalioglu A, Ay AN, Celik EC, Karaavci NC (2019) Postoperative analgesic efficacy of the ultrasound-guided erector spinae plane block in patients undergoing lumbar spinal decompression surgery: a randomized controlled study. World Neurosurg 126:e779–e785. https://doi.org/10.1016/j.wneu.2019.02.149
3. Bhoi D, Ranjitha N, Talawar P, Narasimhan P (2018) A novel out plane technique of midpoint transverse process to pleura block in breast surgery: a case report. Saudi J Anaesth 12(4):637–639. https://doi.org/10.4103/sja.SJA_116_18
4. Forero M, Adhikary SD, Lopez H, Tsui C, Chin KJ (2016) The erector spinae plane block: a novel analgesic technique in thoracic neuropathic pain. Reg Anesth Pain Med 41(5):621–627. https://doi.org/10.1097/AAP.0000000000000451
5. Costache I, de Neumann L, Ramnanan CJ, Goodwin SL, Pawa A, Abdallah FW, McCartney CJL (2017) The mid-point transverse process to pleura (MTP) block: a new end-point for thoracic paravertebral block. Anaesthesia 72(10):1230–1236. https://doi.org/10.1111/anae.14004
6. Tulgar S, Ahiskalioglu A, De Cassai A, Gurkan Y (2019) Efficacy of bilateral erector spinae plane block in the management of pain: current insights. J Pain Res 12:2597–2613. https://doi.org/10.2147/JPR.S182128
7. Almeida CR, Oliveira AR, Cunha P (2019) Continuous bilateral erector of spine plane block at T8 for extensive lumbar spine fusion surgery: case report. Pain Pract 19(5):536–540. https://doi.org/10.1111/papr.12774
8. Ueshima H, Inagaki M, Toyone T et al (2018) Efficacy of the erector spinae plane block for lumbar spinal surgery: a retrospective study. Asian Spine J 13:254–257
9. Syal R, Kumar R, Kamal M, Bhatia P (2019) Novel block and new indication: ultrasound-guided continuous "mid-point transverse process to pleura" block in a patient with multiple rib fractures. Saudi J Anaesth 13(4):365–367. https://doi.org/10.4103/sja.SJA_773_18
10. Costache I, Abdallah FW, Pawa A (2017) MTP block anatomy and paravertebral spread—a reply. Anaesthesia 72(12):1561–1562. https://doi.org/10.1111/anae.14128
11. Marhofer D, Marhofer P, Kettner SC, Fleischmann E, Prayer D, Schernthaner M, Lackner E, Willschke H, Schwetz P, Zeitlinger M (2013) Magnetic resonance imaging analysis of the spread of local anesthetic solution after ultrasound-guided lateral thoracic paravertebral blockade: a volunteer study. Anesthesiology 118(5):1106–1112. https://doi.org/10.1097/ALN.0b013e318289465
12. Hand WR, Taylor JM, Harvey NR et al (2015) Thoracolumbar interfascial plane (TLIP) block: a pilot study in volunteers. Can J Anaesth 62:1196–1200
13. Cesur S, Yayik A, Ozturk F, Ahiskalioglu A (2018) Ultrasound-guided low thoracic erector spinae plane block for effective postoperative analgesia after lumbar surgery: report of five cases. Cureus 10(11):e3603. https://doi.org/10.7759/cureus.3603
14. Melvin JP, Schrot RJ, Chu GM, Chin KJ (2018) Low thoracic erector spinae plane block for perioperative analgesia in lumbosacral spine surgery: a case series. Can J Anaesth 65(9):1057–1065. https://doi.org/10.1007/s12630-018-1145-8
15. Singh S, Chaudhary NK (2019) Bilateral ultrasound guided erector spinae plane block for postoperative pain management in lumbar spine surgery: a case series. J Neurosurg Anesthesiol 31(3):354. https://doi.org/10.1097/ANA.0000000000000518
16. Tulgar S, Senturk O, Thomas DT, Deveci U, Ozer Z (2019) A new technique for sensory blockage of posterior branches of sacral nerves: ultrasound guided sacral erector spinae plane block. J Clin Anesth 57:129–130. https://doi.org/10.1016/j.jclinane.2019.04.014
17. Kilicaslan A, Aydin A, Kekec AF, Ahiskalioglu A (2020) Sacral erector spinae plane block provides effective postoperative analgesia for pelvic and sacral fracture surgery. J Clin Anesth 61:109674. https://doi.org/10.1016/j.jclinane.2019.109674
18. Zhang TJ, Zhang JJ, Qu ZY, Zhang HY, Qiu Y, Hua Z (2020) Bilateral erector Spinae plane blocks for open posterior lumbar surgery. J Pain Res 13:709–717. https://doi.org/10.2147/JPR.S248171
19. Ahiskalioglu A, Tulgar S, Celik M, Ozer Z, Alici HA, Aydin ME (2020) Lumbar erector Spinae plane block as a main anesthetic method for hip surgery in high risk elderly patients: initial experience with a magnetic resonance imaging. Eurasian J Med 52(1):16–20. https://doi.org/10.5152/eurasianjmed.2020.19224
20. Hamilton DL, Manickam BP (2017) MTP block and paravertebral spread. Anaesthesia 72(12):1560–1561. https://doi.org/10.1111/anae.14109
21. Watton DE, Rose PGD, Abdallah FW, Thompson CP, Maziak DE, Costache I (2019) Midpoint transverse process to pleura catheter placement for postoperative analgesia following video-assisted thoracoscopic surgery. Anaesth Rep 7(2):65–68. https://doi.org/10.1002/anr3.12018
22. Costache I (2019) Mid-point transverse process to pleura block for surgical anaesthesia. Anaesth Rep 7(1):1–3. https://doi.org/10.1002/anr3.12003
23. Kilicaslan A, Kacira BK (2019) Awake thoracic spine surgery under bilateral ultrasound guided multiple midpoint transverse process to pleura (MTP) blocks. J Clin Anesth 58:132–133. https://doi.org/10.1016/j.jclinane.2019.07.008
24. Sharma RS, Kumar R, Kamal M, Bhatia P (2019) Use of the mid-transverse process to pleura block in a patient undergoing intercostal drain placement and rib resection. Indian J Anaesth 63:245–246. https://doi.org/10.4103/ija.IJA_728_18
25. Scimia P, Fusco P, Droghetti A, Harizaj F, Basso Ricci E (2018) The ultrasound-guided mid-point transverse process to pleura block for postoperative analgesia in video-assisted thoracoscopic surgery. Minerva Anestesiol 84(6):767–768. https://doi.org/10.23736/S0375-9393.18.12485-0
26. Kim D, Bang S, Sun WY (2019) Erector spinae plane block with sedation for surgical anesthesia in breast conserving surgery. J Clin Anesth 57:50. https://doi.org/10.1016/j.jclinane.2019.03.003
27. Kimachi PP, Martins EG, Peng P, Forero M (2018) The erector Spinae plane block provides complete surgical anesthesia in breast surgery: a case report. A A Pract 11(7):186–188. https://doi.org/10.1213/XAA.0000000000000777