Original Article

Efficacy of ultrasound-guided erector spinae plane block versus paravertebral block for postoperative analgesia in single-port video-assisted thoracoscopic surgery: a retrospective study

Gokhan Sertcakacilar[1,2]^, Yaser Pektas[2]^, Gunes Ozlem Yildiz[2]^, Ozgur Isgorucu[3]^, Selcuk Kose[4]^

[1]Department of Outcomes Research, Anesthesiology Institute, Cleveland Clinic, Cleveland, OH, USA; [2]Department of Anesthesiology and Reanimation, University of Health Science, Bakırköy Dr. Sadi Konuk Training and Research Hospital, Istanbul, Turkey; [3]Department of Thoracic Surgery, University of Health Science, Yedikule Pulmonary Diseases and Thoracic Surgery Education and Research Hospital, Istanbul, Turkey; [4]Department of Thoracic Surgery, University of Health Science, Bakırköy Dr. Sadi Konuk Training and Research Hospital, Istanbul, Turkey

Contributions: (I) Conception and design: All authors; (II) Administrative support: G Sertcakacilar, Y Pektas, O Isgorucu, GO Yildiz; (III) Provision of study materials or patients: G Sertcakacilar, Y Pektas, O Isgorucu, S Kose; (IV) Collection and assembly of data: G Sertcakacilar, GO Yildiz, O Isgorucu; (V) Data analysis and interpretation: G Sertcakacilar, Y Pektas, S Kose; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

Correspondence to: Gokhan Sertcakacilar, MD. Department of Outcomes Research, Anesthesiology Institute, Cleveland Clinic, Cleveland, OH 44195, USA. Email: drgokhansertcakacilar@gmail.com.

Background: Thoracic paravertebral block (TPVB) is an analgesic method recommended in the enhanced recovery after surgery (ERAS) protocol and proven successful in thoracoscopic surgery. The study aimed to investigate whether the erector spinae plane block (ESPB) administered single-injection in uniportal video-assisted thoracoscopic surgery (VATS) can be an alternative to TPVB as an analgesic method.

Methods: In this study, American Society of Anesthesiologists (ASA) physical status class I-II-III patients aged between 18–70 years who underwent thoracoscopic wedge resection surgery were analyzed retrospectively; 136 patients in the ESPB group and 114 patients in the TPVB group were included in the study. Postoperative cumulative morphine consumption numerical rating scale (NRS) scores were compared at 1, 6, 12, and 24 hours after surgery at rest and during coughing between the groups. Also, rescue analgesia requirements, postoperative nausea, vomiting and other complications were evaluated.

Results: The mean cumulative morphine consumption in the postoperative 24 hours was 20.06 mg in the ESPB group and 11.35 mg in the TPVB group. A statistically significant difference was observed between groups in terms of total morphine consumption in the postoperative 24 hours (P<0.001). NRS score was significantly lower in the TPVB group at postoperative 6th and 24th hours during coughing (P=0.003 and P=0.034, respectively) and at 24th hour at rest (P=0.008) than ESPB group. Median NRS scores at rest were low (<4) in both groups. There was no significant difference between the groups in terms of postoperative pulmonary complications as atelectasis and length of hospital stay (LOS) (P=0.643 and P=0.867 respectively).

Conclusions: Ultrasound (US)-guided single-injection TPVB provided superior analgesia in patients undergoing single-port VATS than ESPB. In addition to this, TPVB showed more opioid sparing by reducing morphine consumption.

Keywords: Thoracic paravertebral block (TPVB); erector spinae plane block (ESPB); numerical rating scale (NRS); video-assisted thoracoscopic surgery (VATS); postoperative pain

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^ ORCID: Gokhan Sertcakacilar, 0000-0002-4574-0147; Yaser Pektas, 0000-0002-7820-7103; Gunes Ozlem Yildiz, 0000-0002-4557-9517; Ozgur Isgorucu, 0000-0001-7325-0412; Selcuk Kose, 0000-0003-3430-3379.

Introduction

Most of the surgical procedures requiring thoracotomy can be performed with video-assisted thoracoscopic surgery (VATS). A thoracoscopic method is frequently used in the surgical treatment of pneumothorax for prolonged air leak and recurrence. Compared with conventional thoracoscopic surgery, single-port VATS uses a single incision. Therefore, patients may have less pain and better respiratory function after surgery. Studies have shown that, uniportal VATS has advantages in terms of less pain, complication rate and length of hospital stay (LOS) compared to open surgery and multiport thoracoscopic techniques (1,2).

After the widespread use of ultrasound (US), new regional anesthesia techniques on the trunk are used as an analgesic method in thoracic surgery and are called truncal blocks (3). In VATS, thoracic paravertebral block (TPVB) is a successful method of providing postoperative analgesia and is recommended by the enhanced recovery after surgery (ERAS) protocol (4). Although the risk of complications is minimized with the use of US, it requires advanced experience owing to its proximity to the pleura, epidural, and subarachnoid distance (5,6). Considering its advantages in the postoperative period, less invasive, easier and safer applicable plane blocks may be sufficient for analgesia after uniportal VATS. The erector spinae plane block (ESPB) is a new technique that is easier to visualize and perform because it is more superficial. Owing to these advantages, it has been preferred frequently for postoperative analgesia in different types of operations such as thorax, abdomen, hip, and lumbar surgeries in recent years (7-10).

To the best of our knowledge, there is no study in the literature where a single-injection of ESPB and TPVB has been performed for postoperative analgesia in uniportal VATS. In this study, it was aimed to compare the analgesic effects of ESPB and TPVB, which were performed as a single injection in uniportal VATS. We present the following article in accordance with the STROBE reporting checklist (available at https://apm.amegroups.com/article/view/10.21037/apm-22-75/rc).

Methods

Study design and patient selection

A total of 548 patients who underwent wedge resection by uniportal VATS technique under general anesthesia with a diagnosis of prolonged pneumothorax between Jan 2017 and Jul 2021 were retrospectively analyzed. TPVB was performed to all patients until Dec 2018 who underwent VATS, and then ESPB was applied for the purpose of clinical experience, although different opinions were presented about its effectiveness. In the retrospective review, patients who were made performed block by a single clinician to provide a standard and homogeneous group comparison were included in the study. The selection included the patients who met the criteria and applied consecutively. In this study, the authors included 114 patients who had TPVB application between Jan 2017 and Dec 2018 and 136 patients who had ESPB application between Jan 2019 and Jul 2021. This study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Ethics Committee of the Bakırköy Dr. Sadi Konuk Training and Research Hospital (No. 2021-20-27/2019-250) and individual consent for this retrospective analysis was waived.

The demographic and clinical data of patients were obtained from the corporate computer-based documentation system. Patients aged between 18–70 years, having body mass index (BMI) <35 kg/m^2, being in the American Society of Anesthesiologist (ASA) physical status classification of I–III, and underwent uniportal VATS were evaluated within the scope of this study. Patients first having uniportal VATS and later undergoing thoracotomy during the operation, with a serious psychiatric history, chronic pain or chronic opioid use (at least 3 months) and who underwent second surgery or emergency surgery were excluded from the study. A total of 250 patients were included in the study (*Figure 1*).

The patients were known to the anesthesiologist since all the applied blocks were performed by a single clinician. However, the practitioners on duty at the statistical and writing stage did not know which patients belonged to which group. Likewise, anesthesia nurses who were tasked with evaluating the results such as postoperative pain severity were independent from the study and were blinded by the block type which was performed. In addition, independent from the study, each patient was informed about the procedure to be done and their consent was obtained.

General anesthesia and truncal blocks technique

In our clinic, a standard anesthesia protocol is applied in all patients. Electrocardiography, non-invasive blood pressure and peripheral oxygen saturation monitorizations were performed as a standard. Midazolam (0.03–0.05 mg/kg) was administered intravenously (IV) as premedication,

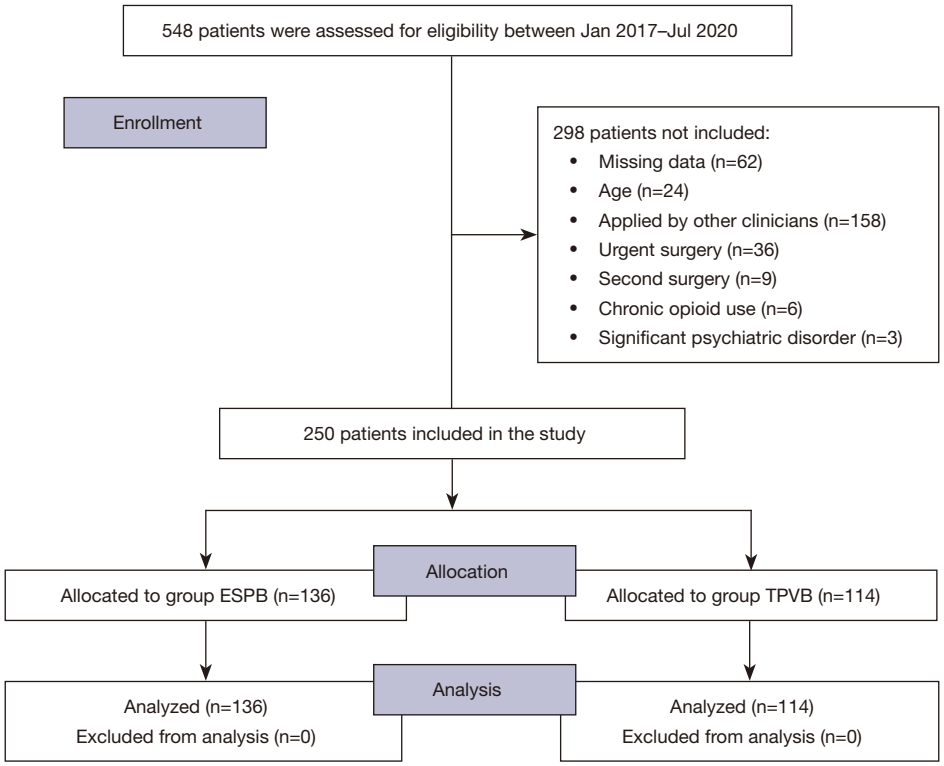

Figure 1 Flow chart of the study. ESPB, erector spinae plane block; TPVB, thoracic paravertebral block.

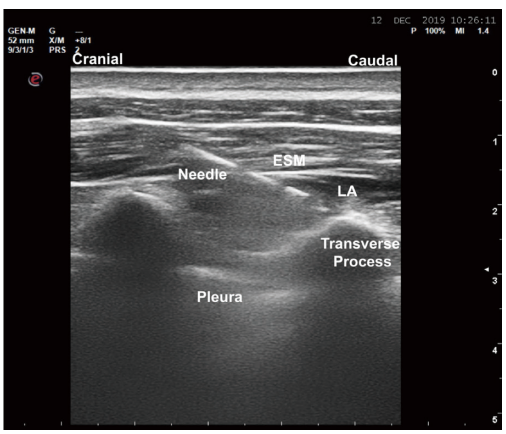

Figure 2 Ultrasound image of ESPB. ESM, erector spinae muscle; LA, local anesthetic; ESPB, erector spinae plane block.

and isotonic saline infusion (8 mL/kg/h) was initiated by inserting a 22-gauge venous line. After the required asepsis conditions in the block area were met, while the patient was in the sitting position, by using US (Esaote MyLabSeven/ Esaote S.p.A, Genoa, Italy) a linear multifrequency 12 L probe and a 20-gauge 100 mm peripheral nerve block needle (Stimupleks Ultra 360 30°—BRA-04892510-01/B. Braun Melsungen AG, Hessen, Germany), the one-sided truncal block was performed.

The transverse process was visualized by placing the probe approximately 3 cm lateral to the spinous process of the T5 vertebrae for ESPB. When the needle was advanced in the cranio-caudal direction with an angle of 30–40° and touched the transverse process, the presence of blood and/ or air was checked by aspiration. Hydro-dissection was performed with 2–3 mL isotonic saline and 20 mL 0.25% bupivacaine (Marcaine 0.5%, 5 mg/mL) was injected by observing that the erector spinae muscle (ESM) was separated from the transverse process (*Figure 2*). In the TPVB procedure, the probe was placed in the paramedian sagittal plane immediately lateral to the T5 vertebra spinous process, and the needle was advanced in-plane in the cranio-caudal direction at an angle of 30–40°. After passing the existing muscle groups on this plane, it was entered under the superior costotransverse ligament. Hydro dissection was performed with 2–3 mL of isotonic saline, and the pleura were pushed down, then 20 mL of 0.25% bupivacaine was injected (*Figure 3*).

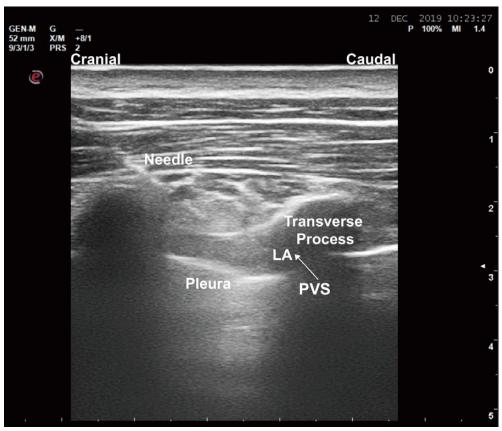

Figure 3 Ultrasound image of TPVB. PVS, paravertebral space; LA, local anesthetic; TPVB, thoracic paravertebral block.

Standard anesthesia induction after truncal block was performed with propofol (2–3 mg/kg), fentanyl (1–2 μg/kg) and rocuronium (0.6–0.8 mg/kg). Anesthesia was maintained with sevoflurane (0.7 MAC) and IV remifentanil infusion (0.05–0.1 μg/kg/min). At the end of the surgery, 8 mg ondansetron as prophylactic antiemetic and 1 g paracetamol and 100 mg tramadol hydrochloride IV were given. After the operation, the patients were transferred to post-anesthesia care unit (PACU) for close hemodynamic follow-up for the first 24 hours. The evaluation of postoperative pain and opioid consumption was performed by an anesthesiologist independent of the work in the PACU team.

Surgical procedures

In our bullectomy operations with single-port VATS, a 2.5 cm incision was made at the level of the 5th intercostal space in the median axillary line, after entering the thorax with a 10 mm 30° video thoracoscope, the thoracoport was retracted and two rotary instruments (Roticulator Endograsp and EndoGIA Universal, Covidien Ilc, Mansfield, MA, USA) was placed. Tube thoracostomy incisions made from the 5th intercostal space were used in the emergency department, which was enlarged for the uniportal incision, and the thorax was entered with finger dissection, taking into account the lung adhesions that may occur in these incisions. By removing the thoracoport, excessive pressure on the intercostal neurovascular bundle that could cause chronic pain was avoided. Usually two endostapes were placed and wedge resection was performed. A standard pleurectomy was performed using endoscopic kitner dissectors and a curved ovarian clamp. A 32 Fr thorax drain was placed through the same incision and underwater drainage was taken.

Pain management

Standard postoperative analgesia was performed using a patient-controlled analgesia (PCA) device (CADD-Legacy PCA Ambulatory Infusion Pump, Model 6300/Smiths Medical, Dublin, OH, USA) using IV morphine infusion. Morphine solution (0.5 mg/mL) prepared in 100 mL isotonic saline; and the PCA was adjusted as 1 mg bolus, lockout interval of 10 minutes, 1-hour limit dose 4 mg, and no basal infusion. All patients' 1st-6th-12th-24th hour numerical rating scale (NRS) scores were examined in the pain follow-up form. For rescue analgesia, patients received a non-steroidal anti-inflammatory agent in two doses of IV ibuprofen 800 mg per day for a total of 1,600 mg. Morphine consumption was evaluated in terms of bolus number and converted as milligrams.

Outcome measurements

The primary outcome measure was postoperative cumulative morphine consumption in the first 24 hours. The secondary outcome measures were the NRS scores at rest (static) and while coughing (dynamic) examined at four different time periods (1st, 6th, 12th, and 24th hours). Furthermore, these measures, intraoperative opioid requirement, postoperative rescue analgesic requirement, perioperative complications including bradycardia, nausea and vomiting, postoperative pulmonary complications as atelectasis, effusion and pneumonia were also evaluated.

Statistical analysis

The G*Power 3.1.9.2 programme was used to calculate the sample size of the study. A pilot retrospective study was conducted with twenty patients from each group to determine the minimal sample size for the primary outcome. The mean morphine consumption was 19.25±8.75 in the group ESPB and 14.47±6.22 in the group TPVB. An effect size 0.546 and α error =0.05 with a power of 95% was assumed so that each group had at least 93 participants. We included 136 patients in group ESPB and 114 patients in group TPVB due to the possibility of dropouts. Patient data from the pilot study were not included in the main study.

Table 1 Comparison of the demographical data between groups

Characteristics	ESPB group (n=136)	TPVB group (n=114)	P value
Age	33.93±11.51	30.14±8.1	0.151
Gender			0.740
Female	22 (16.2%)	16 (14.03%)	
Male	114 (83.8%)	98 (86.9%)	
Height	175.04±7.65	174.54±6.81	0.718
Weight	65.17±6.11	64.85±9.77	0.832
BMI	21.39±2.24	20.99±2.73	0.379
ASA			0.965
I	24 (17.6%)	22 (19.3%)	
II	104 (76.5%)	86 (75.4%)	
III	8 (5.9%)	6 (5.3%)	

Data are presented as mean ± SD or number (%). ESPB, erector spinae plane block; TPVB, thoracic paravertebral block; BMI, body mass index; ASA, American Society of Anesthesiologists; SD, standard deviation.

The data obtained from the research were analyzed with SPSS 22.00 program. Mean, standard deviation (SD), median, lowest highest, frequency, and ratio values were used in descriptive statistics of the data. The distribution of variables was measured by the Kolmogorov Simonov test. Independent sample *t*-test and Mann-Whitney U test were used for the analysis of quantitative independent data. The chi-square test was used for the analysis of qualitative independent data, and the Fischer test was used when the chi-square test conditions were not met. P<0.05 was accepted for the significance level.

Results

Among participants, 84.8% were male and the mean age was 32.4 years. The ASA score and the other descriptive variables of the patients in the two groups were not different (*Table 1*). There was no significant difference between the groups in the intraoperative remifentanil consumption (P=0.251). There was no statistically significant difference in terms of hemodynamic parameters in the intraoperative period of the patients (*Table 2*). Although the incidence of opioid-related side effects in the postoperative period was higher in the ESPB group with a significantly higher morphine consumption, no statistically significant difference was found between the groups. The number of PCA button presses (demand dose) was significantly higher in the ESPB group, regardless of the lockout interval (P<0.001) (*Table 3*).

Similarly, cumulative morphine consumption in the postoperative 12th and 24th hours was significantly higher in the ESPB group (P<0.001 and P<0.001, respectively). Static NRS scores were lower in the TPVB group at 24th hour (P=0.008). In addition, NRS scores at rest were lower than four in both block groups (*Table 3*). Dynamic NRS scores were significantly lower in the TPVB group at postoperative 6th and 24th hours (P=0.003 and P=0.034, respectively).

When the intragroup values were compared using the repeated measurement test, there was no significant difference in dynamic NRS scores in the TPVB group as time from the 1st hour to the 24th hour (*Table 3*). Both groups were found to be similar to each other in terms of the LOS (PACU and ward) of the patients (P=1.000 and P=0.867, respectively).

Discussion

For VATS, which is considered a minimally invasive surgical approach, TPVB is now accepted as a first-line local site technique rather than thoracic epidural analgesia (TEA) (4). Although other truncal blocks have become widespread as postoperative analgesia techniques, less invasive methods alternative to TPVB have been reported in VATS (5,11,12). ESPB is a new and up-to-date method, and when compared with TPVB, there are not enough studies in the literature in VATS (5,12).

Unlike in uniportal VATS, the incision is limited to

Table 2 Comparison of perioperative data between groups

Item	ESPB group (n=136)	TPVB group (n=114)	P value
Duration of anesthesia (min)	127.94±46.14	117.94±35.39	0.169
Duration of surgery (min)	96.89±45.76	94.28±33.18	0.927
Mean remifentanil use (μg/kg/min)	0.044±0.276	0.041±0.030	0.251
Intraoperative complications			
Bradycardia	8 (5.9%)	8 (7.0%)	0.796
Tachycardia	18 (13.2%)	22 (19.3%)	0.357
Hypotension	68 (50.0%)	74 (64.9%)	0.094
Hypertension	14 (10.3%)	18 (15.8%)	0.360
Postoperative complications			
Hematoma	4 (2.9%)	4 (3.5%)	0.857
PONV	24 (17.6%)	16 (14.0%)	0.583
Pruritus	4 (2.9%)	2 (1.8%)	0.666
PPC	18 (13.2%)	12 (10.5%)	0.643
Chest tube removal (day)	4.31±2.77	4.42±2.16	0.649
LOS (day)			
PACU	1 (100.0%)	1 (100.0%)	1.000
Ward	5.44±2.26	5.38±2.02	0.867

Data are presented as mean ± SD or number (%). ESPB, erector spinae plane block; TPVB, thoracic paravertebral block; PONV, postoperative nausea and vomiting; PPC, postoperative pulmonary complication; LOS, length of hospital stay; PACU, post-anesthesia care unit; SD, standard deviation.

an intercostal space. The length and number of incisions are less than that of the conventional approach of VATS. Therefore, anatomical structures such as muscles, nerves, and blood vessels are exposed to less trauma and clinically less postoperative pain is provided (13-15). This study was conducted to compare the postoperative analgesic efficacy of single-injection TPVB and ESPB in uniportal VATS. The most important finding of the present study is that TPVB provides superior postoperative analgesia and less opioid consumption than ESPB with a single level and single-injection in uniportal thoracoscopic surgery. Since morphine consumption is considered as an indicator in the evaluation of analgesic efficacy, morphine consumption was evaluated in our study. It was noted that morphine consumption was significantly lower in the TPVB group in the first 24 hours postoperatively. Morphine consumption in the first hour was similar between the two groups. It may depend on the analgesia which was applied at the end of surgery. Morphine consumption was higher in the ESPB group in all periods after 1st hour; however static NRS values did not show any statistically significant difference between the two groups except for the 24th hour. These results may be related to two reasons. Firstly, it was probable that intense morphine consumption used in the ESPB group could be effective when NRS scores were examined. Secondly, ESPB has a better effect on moderate pain during resting but is insufficient in severe pain caused by physical activity such as coughing. Because, when the dynamic NRS values were examined, it was found to be significantly higher in the ESPB group at 6th and 24th hours.

Similarly, another study found that morphine consumption and VAS scores were lower in the TPVB group (5). However, in the presented study, it is important to obtain similar results with the single-level application of TPVB. The objectivity and consistency of the results of this study are higher since both blocks were performed from a single level and a more homogenous group was evaluated.

Table 3 Comparison of morphine consumptions and NRS scores between groups

Item	ESPB group (n=136)	TPVB group (n=114)	P value
PCA demand dose	36.64±26.9	18.82±13.67	<0.001*
PCA delivered dose			
PO 0–1st h	3.17±1.34	2.01±1.12	0.863
PO 0–6th h	8.76±4.92	4.02±1.78	0.006*
PO 0–12th h	16.69±8.56	9.65±5.49	<0.001*
PO 0–24th h	20.06±9.98	11.35±7.08	<0.001*
Rescue analgesia requirement	24 (17.6%)	22 (19.3%)	0.812
S-NRS			
PO 1st h	3 [0–7]	3 [0–7]	0.783
PO 6th h	2 [0–5]	2 [0–5]	0.059
PO 12th h	2 [0–6]	3 [0–6]	0.350
PO 24th h	3 [0–5]	2 [0–4]	0.008*
D-NRS			
PO 1st h	3 [1–5]	3 [0–8]	0.346
PO 6th h	4 [1–7]	3 [1–7]	0.003*
PO 12th h	4 [1–7]	3 [0–7]	0.514
PO 24th h	4 [1–8]	3 [0–7]	0.034*

Data are presented as mean ± SD, median (IQR) or number (%). *, P<0.05. ESPB, erector spinae plane block; TPVB, thoracic paravertebral block; PCA, patient-controlled analgesia; PO, postoperative; h, hour; S-NRS, static numerical rating scale; D-NRS, dynamic numerical rating scale; SD, standard deviation.

In uniportal thoracoscopy, the authors determined the effective level and obtained similar results with single point TPVB, so the authors do not recommend multiple injections at least in single-port VATS.

In the cadaver study comparing the TPVB and ESPB spread, it was reported that the spread in the ESPB to the thoracic paravertebral area was inconsistent and that there was no spread to the epidural area, therefore ESPB could not be equivalent to single and multiple injections of TPVB (16). Recently, Lonnqvist *et al.* (17) reported that there was insufficient evidence for the spread of local anesthesia in ESPB and that the anterior part of the intercostal nerve was not reliably affected, so it could not create analgesia in the anterior part of the trunk. In the presented study, it was found that ESPB could not provide as analgesic efficacy as TPVB even in this type of surgery associated with less surgical trauma.

In previous studies, it is noteworthy that different results have appeared due to the differences in the positions of the patients during the block technique (6,12). In a recent review, it has been reported that when performing ESPB, the patient's position may affect the spread of local anesthesia and therefore the effect and quality of the block. Still, no studies are investigating this effect (18). The primary purpose of the study is not to investigate the relationship between the position of the patient and the analgesic effect of the block, but there are different application techniques in the literature. In this study, both blocks were applied in the sitting position. Therefore, since the conditions valid for the distribution of local anesthetic (LA) are the same for TPVB, it cannot be considered to affect the study results.

The authors have some limitations in the present study. Firstly, it was retrospective, based on a single center's experience. Secondly, it had not a control group where both blocks were not applied. Moreover, after additional procedures, the authors could not evaluate the dermatome area affected by the block in every patient owing to temporal limitations. However, this study will contribute significantly to the literature since there are a limited

number of studies in thoracoscopic surgery.

Conclusions

The present study shows that TPVB is still a superior analgesic method in thoracoscopic surgery. ESPB could not provide as adequate analgesia as TPVB in this type of surgery, associated with less surgical trauma. However, our data should be confirmed by prospective and larger sampled, multi-centric randomized controlled trials.

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://apm.amegroups.com/article/view/10.21037/apm-22-75/rc

Data Sharing Statement: Available at https://apm.amegroups.com/article/view/10.21037/apm-22-75/dss

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://apm.amegroups.com/article/view/10.21037/apm-22-75/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. This study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Ethics Committee of the Bakırköy Dr. Sadi Konuk Training and Research Hospital (No. 2021-20-27/2019-250) and individual consent for this retrospective analysis was waived.

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