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ORIGINAL ARTICLE

Comparison of the analgesic effects of the erector spinae plane block and thoracic paravertebral block in patients undergoing video-assisted thoracoscopic surgery

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SUMMARY

Objectives: To compare the effects of paravertebral block (PVB) and erector spinae plane block (ESPB) on intraoperative and postoperative analgesia and pulmonary function in patients undergoing video-assisted thoracoscopic surgery (VATS).

Methods: A total of 49 patients aged 18–70 years with ASA scores of 2–3 who underwent elective VATS were included in the study. Patients were randomized into two groups using a web-based system. Those who received thoracic PVB were assigned to Group I, and those who received ESPB to Group II. Patients were monitored using the surgical plethysmographic index and bispectral index during the intraoperative period. Preoperative, intraoperative, and postoperative blood gas samples were analyzed to assess the impact on pulmonary function. Block application time, intraoperative and postoperative analgesic consumption, the presence of block-related complications, and length of hospital stay were recorded.

Results: There was no significant difference between the groups in terms of intraoperative and postoperative analgesic consumption, operation time, or length of hospital stay ($p>0.05$). Postoperative VAS scores were similar, and there was no significant difference in preoperative, intraoperative, or postoperative arterial blood gas values between the two groups ($p>0.05$).

Conclusion: ESPB is as effective as PVB in controlling acute postoperative pain and is easier to perform.

Keywords: Erector spinae plane block; postoperative pain; regional anesthesia; thoracic paravertebral block; video-assisted thoracoscopic surgery.

Introduction

Video-assisted thoracoscopic surgery (VATS) is gradually becoming the main approach in the treatment of surgical lung diseases. Compared to thoracotomy, it offers numerous benefits, including less postoperative pain, faster recovery of respiratory function, shorter hospitalization, and lower costs.[1] In recent years, the development of more effective, safe, straightforward, and minimally invasive regional anesthetic techniques has become increasingly pivotal in multimodal analgesia, as they contribute to reducing postoperative pain, analgesic consumption, and analgesic-related adverse effects following VATS.[2] Especially, paravertebral block (PVB) has been a commonly used regional technique for analgesia following thoracic surgery.[3] However, this block, which is a relatively difficult technique, has epidural area spreading and a risk of pneumothorax. In recent years, many types of blocks have been used for postoperative analgesia in thoracic surgery, and erector spinae plane block (ESPB) is one of these blocks. ESPB is a new block technique that is simple to apply.[4] Both blocks can reduce postoperative pulmonary complications and complications associated with the analgesic technique.[5]

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This study aimed to compare the effects of ESPB and PVB on arterial blood gas values, intraoperative and postoperative analgesia in patients undergoing VATS.

Materials and Methods

This prospective, randomized, double-blinded clinical trial was conducted at Afyonkarahisar Health Science University Hospital, in the anesthesiology and reanimation clinic and the thoracic surgery clinic. All methods used in research involving human subjects complied with the ethical standards set forth in the 2013 Declaration of Helsinki and its subsequent revisions, the institutional and/or national research ethics committee, or equivalent ethical guidelines.

Patients aged 18 to 70 years with an ASA score of 2 or 3 who underwent elective VATS were enrolled in the study after obtaining approval from the Afyonkarahisar Health Science University Clinical Research Ethics Committee (Date: 04.12.2020, Number: 2011-KAEK-2). The study was also subsequently registered on anzctr.org.au under registration code ACTRN12624001093572, retrospectively. After giving their written informed consent, participants were admitted to the study.

Patients with ASA score ≥4, bleeding diathesis, drug allergy, anticoagulant or chronic analgesic use, local or systemic infection, severe arrhythmia, diabetes mellitus, respiratory, cardiac, hepatic, or renal disease were excluded. Demographic data and operation types of patients were recorded.

Patients were randomized into 2 separate groups with the enrollment number using the website (www.randomizer.org). Patients who had thoracic PVB were assigned to Group I, while patients who had ESPB were assigned to Group II. A researcher was designated for the distribution and preservation of the randomization list. When the practitioner shared the enrollment number, the researcher shared the patient's block type according to the randomization list. Both blocks were performed unilaterally under ultrasonography guidance (Usmart®-3200T Nexgen, Terason). The participants were blinded to the allocation. The surgeon and the anesthetists who administered general anesthesia and monitored the patient following the procedure were unaware of the block type.

All patients were premedicated with intravenous (IV) 1 mg midazolam and 50 µg fentanyl. ECG, noninvasive blood pressure, heart rate, and SpO_2 monitoring were performed.

In Group I, the paravertebral area was identified with ultrasound guidance by marking 2.5–3 cm lateral to the 4th thoracic vertebra spinous process as the injection point, and the needle was advanced into the thoracic paravertebral area with the longitudinal in-plane technique until the superior costotransverse ligament was crossed. After confirming that there was no vascular intervention by aspiration, 3 mL of saline was administered, ventral movement of the parietal pleura was observed to confirm the needle location, then 20 mL of 0.25% bupivacaine was administered and thoracic paravertebral block was performed.

In Group II, the injection point was determined as PVB at the T4 level. The transverse process and the erector spinae muscle were identified under ultrasound guidance, and the needle was advanced with the longitudinal in-plane technique between the anterior fascia of the erector spinae muscle group and the vertebral transverse process. Again, after confirming that there was no vascular intervention by aspiration, 3 mL of saline was administered, the needle site was confirmed by monitoring the distribution with hydrodissection by ultrasound, and 20 mL of 0.25% bupivacaine was administered and erector spinae plane block was performed. Block application time was defined as the time from insertion of the block needle into the skin to its removal.

Radial artery cannulation was performed in the operating room and a preoperative arterial blood gas sample was obtained. During induction, IV 1 mg midazolam, 2 µg.kg^{-1} fentanyl, 1 mg.kg^{-1} lidocaine, 2 mg.kg^{-1} propofol, and 0.6 mg.kg^{-1} rocuronium were administered with invasive arterial pressure monitoring. Patients were intubated with an appropriately sized double-lumen tube after approximately 3 minutes when adequate depth of anesthesia was achieved. Tube placement was confirmed by auscultation after the entubation and patients were placed in the lateral position. Patients were ventilated with 50% O_2–air mixture and anesthesia was maintained with 2% sevoflurane. Rocuronium 10 mg was administered every 30 minutes during the surgery.

The patients were followed up with the surgical plethysmographic index (SPI) and bispectral index (BIS) during the intraoperative period. BIS was planned to be kept in the range of 40–60 and SPI below 50. When the SPI value rose above 50 for more than 15 seconds, 25 µg of fentanyl was added. A rescue medication (propofol 1 $mg.kg^{-1}$) was administered when there was an increase above 60 in BIS. Intraoperative arterial blood gas sample was taken at the 30th minute of one-lung ventilation.

Patients received 1 g paracetamol IV 10 minutes before the end of the operation. After the inhaler agent was removed, patients were awakened with 2 $mg.kg^{-1}$ sugammadex and taken to the recovery room.

In the recovery room, the observer assessed pain and recorded resting VAS-0 at rest and dynamic VAS-0 by asking the patient to cough. At the 2nd, 4th, 8th, 12th, and 24th hours, resting and dynamic VAS scores were followed up in the thoracic surgery clinic. The VAS score results of the patients were grouped as 0–3 tolerable pain, 4–5 mild pain, 6–8 moderate pain, and 9–10 intolerable pain. Analgesic step therapy was performed according to the VAS scores of the patients at follow-up. Mild pain was planned to be treated with dexketoprofen, moderate pain with tramadol, and intolerable pain with meperidine. If the patient's VAS score was >3 1 hour after analgesic administration, it was planned to move to the next step. Postoperative arterial blood gas sample was taken at the first postoperative hour.

The time of the first analgesic requirement and the amount of analgesic used in the first 24 hours postoperatively were identified. The presence of nausea and vomiting, block-related complications, and the duration of hospitalization were recorded.

Statistical Analysis

Software called SPSS version 25.0 (IBM Corporation, USA) was used to conduct statistical analyses. Continuous variables were presented as mean±SD or median (minimum–maximum), depending on the normality of their distribution, which was assessed using the Shapiro-Wilk test. Non-normal continuous outcomes were analyzed using the Mann-Whitney U test. Categorical variables were analysed using the Chi-square test or Fisher's exact test. $p<0.05$ was considered significant.

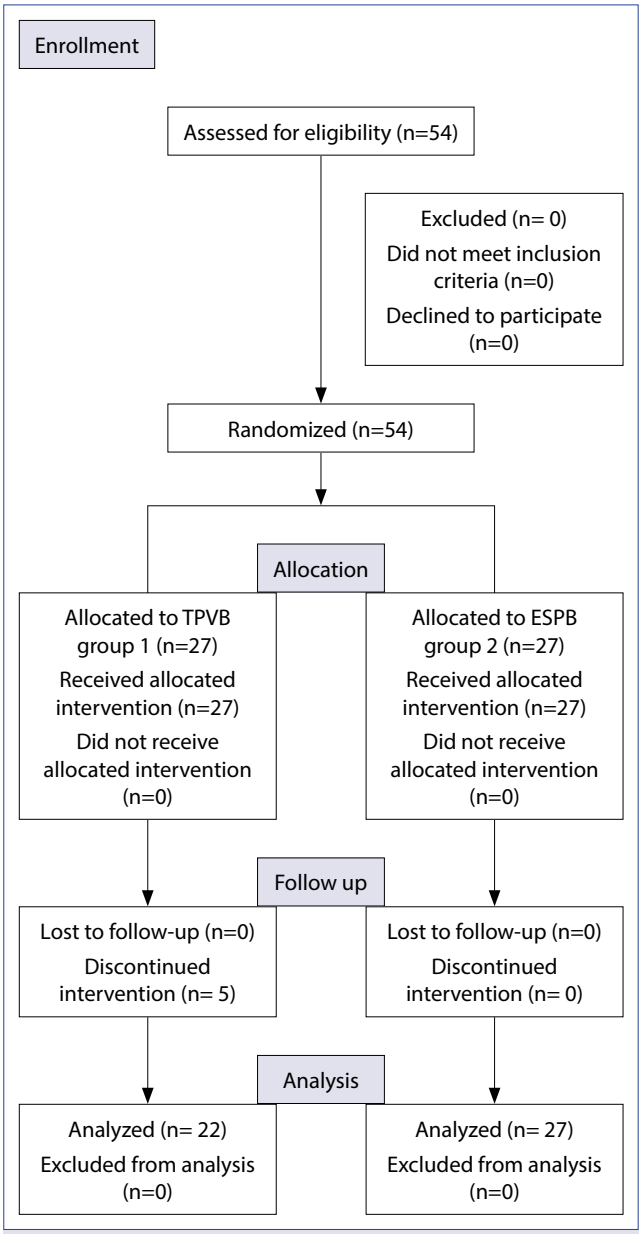

Figure 1. CONSORT diagram.

Sample Size

The sample size was established prior to the data collection phase using the G-Power 3.1.9.7 tool (Faul, Erdfelder, Lang, and Buchner, 2007). Based on the effect size (=1.97) for opioid consumption in the study of Çiftçi et al.,[6] the sample size was calculated to be 46 in total, under one-way conditions, at 95% power and at an error level of α=0.05. Considering possible losses of 15%, it was planned to include 27 patients in each group, for a total of 54 patients.

Table 1. Comparison of demographic and medical data of patients according to block types

	Group I TPVB (n=22)	Group II ESPB (n=27)	Total (n=49)	p
Gender				0.869*
Female	7 (30.6%)	8 (29.6%)	15 (30.6%)	
Male	15 (69.4%)	19 (70.4%)	34 (69.4%)	
Age, Median (Min–Max)	44 (19–70)	53 (21–70)		0.204**
BMI, Mean±SD	24.5±3.6	25.7±3.9		0.166#
ASA score				**0.034**##
II	7 (31.8%)	2 (7.4%)	9 (18.3%)	
III	15 (68.2%)	25 (92.6%)	40 (81.7%)	
Type of operation				0.910*
Wedge resection	15 (68.2%)	18 (66.7%)	33 (67.3%)	
Lobectomy	7 (31.8%)	9 (33.3%)	16 (32.7%)	

Min: Minimum; Max: Maximum; SD: Standart deviation; TPVB: Thoracic paravertebral block; ESPB: Erector spinae plane block; BMI: Body mass index; ASA: American Society of Anesthesiology; *: Pearson Chi-Square Test; **: Mann-Whitney U Test; #: Student t Test; ##: Fisher's Exact Test.

Table 2. Comparison of some medical data according to block types

	Group I TPVB (n=22)	Group II ESPB (n=27)	p
Block application time (minute)	11.05±2.01	7.56±1.92	<**0.001***
Block releated complication	0	0	–
Intraoperative fentanyl consumption	225 (50–500)	200 (50–600)	0.746#
Length of operation(minute)	105 (60–270)	115 (65–240)	0.354#
Time of first analgesic requirement (hour)	6 (0–12)	2 (0–15)	0.267#
Length of hospital stay (day)	4;3	6;6	0.079#

Min: Minimum; Max: Maximum; SD: Standart deviation; TPVB: Thoracic paravertebral block; ESPB: Erector spinae plane block; *: Student t Test; #: Mann-Whitney U Test.

Results

A total of 54 patients were included in the study; however, 5 patients in Group I were excluded from the intervention. In 2 patients, VATS could not be maintained and was converted to open surgery. Extubation could not be achieved in 3 patients, and they were followed in the intensive care unit for weaning. The study was completed with a total of 49 patients: 22 patients in Group I and 27 patients in Group II (Fig. 1). Demographic data did not significantly differ between the groups (p>0.05). A statistical difference was observed between the ASA scores of the patients (p=0.034). ASA scores were lower in Group I (Table 1).

In the comparisons between the groups given in Table 2, the duration of block application was found to be 11 minutes in Group I, while it was approximately 7 minutes in Group II (p<0.001). No complications related to the blocks were observed in either group. There was no difference between the groups in terms of intraoperative fentanyl consumption (p=0.746), length of operation (p=0.354), time of first analgesic requirement (p=0.267), and length of hospital stay (p=0.079). When the types of analgesics used in the postoperative period were compared, no statistically significant difference was found (p=0.524) (Table 2).

When preoperative, intraoperative, and postoperative arterial blood gas values were compared, no significant differences were found between the groups (p>0.05) (Table 3).

Table 3. Comparison of preoperative, intraoperative and postoperative blood gas values according to block types

	Group I TPVB	Group II ESPB	p
Preop.			
pH	7.37 (7.22–7.50)	7.37 (7.22–7.50)	0.936*
pO_2	115 (85–197)	115 (85–197)	0.091*
pCO_2	41.48±8.01	41.48±8.01	0.941#
Hb	11.84±1.83	11.84±1.83	0.333#
HCO_3	23.18±2.95	23.18±2.95	0.931#
Intraop.			
pH	7.31±0.08	7.31±0.08	0.980#
pO_2	108 (71.5–220)	108 (71.5–220)	0.087*
pCO_2	41.79±8.15	41.79±8.15	0.689#
Hb	11.54±2.00	11.54±2.00	0.939#
HCO_3	21.15±2.65	21.15±2.65	0.875#
Postop.			
pH	7.34±0.07	7.34±0.07	0.726#
pO_2	102 (59–219)	102 (59–219)	0.319*
pCO_2	43.26±5.40	43.26±5.40	0.415#
Hb	11.11±1.80	11.11±1.80	0.542#
HCO_3	21.38±3.14	21.38±3.14	0.632#

Preop: Preoperative; Intraop: Intraoperative; Postop: Postoperative; Min: Minimum; Max: Maximum; SD: Standart deviation; Tpvb: Thoracic paravertebral block; Espb: Erector spinae plane block; *: Mann-Whitney U Test; #: Student t Test.

When the resting VAS scores in Table 4 were compared, there was a non-significant increase in VAS scores at the 12th hour in Group I compared to Group II (p>0.05). In Table 5, when the dynamic VAS scores were compared, VAS scores were found to be higher in Group I at the 12th hour, but not statistically significant (p>0.05).

Discussion

In our study, the effects of thoracic PVB and ESPB on intraoperative and postoperative analgesia and pulmonary functions in VATS were compared, and no superiority was shown between them. The amount of analgesic consumed intraoperatively and postoperatively, VAS scores, and perioperative blood gas values were similar in both groups.

Thoracoscopic surgery is preferred over open surgery because it reduces postoperative pain, in addition to having many other benefits.[7] However, VATS causes pain in the postoperative period.[8] The multimodal analgesia approach includes regional analgesia for adequate pain control.[9] In VATS, ESPB and PVB are two of the popular blocks for postoperative analgesia, but it is not clear which is superior.[10]

Table 4. Comparison of patients' postoperative resting VAS scores according to block types

	Group I TPVB	Group II ESPB	p
VAS 0	1 (0–4)	1 (0–5)	0.783
VAS 2	1 (0–6)	2 (0–5)	0.875
VAS 6	2 (0–7)	3 (0–6)	0.584
VAS 12	2.5 (0–6)	2 (0–5)	0.112
VAS 24	2 (0–6)	2 (0–4)	0.568

Mann Whitney U test Median (Min–Max); VAS: Visuel Analog Scale; TPVB: Thoracic paravertebral block; ESPB: Erector Spinae plane block.

Table 5. Comparison of postoperative dynamic VAS scores of patients according to block types

	Group I TPVB	Group II ESPB	p
VAS 0	2 (0–5)	2 (0–6)	0.899
VAS 2	2 (0–6)	2 (0–6)	0.747
VAS 6	3 (0–7)	3 (0–7)	0.932
VAS 12	3 (0–7)	3 (0–7)	0.073
VAS 24	3 (1–7)	3 (0–7)	0.489

Mann Whitney U test Median (Min–Max); VAS: Visuel Analog Scale; TPVB: Thoracic paravertebral block; ESPB: Erector Spinae plane block.

In the study of Turhan et al.[11] on thoracoscopic surgeries, thoracic PVB provided better postoperative analgesia than ESP and intercostal block. A meta-analysis concluded that thoracic PVB is better than ESPB regarding postoperative analgesia in VATS.[12]

Unlike these studies, Zengin et al.[13] compared ESPB, PVB, and the combination of the two in thoracoscopic surgeries and obtained better pain scores in the combination block group and the ESPB group. In addition, postoperative morphine requirement was found to be higher in the PVB group. In another study performed in VATS, TPVB and ESPB were applied in combination with intercostal block, and postoperative VAS scores and an-

algesic requirements were not significantly different between the two groups, similar to our study.[14] In a study comparing the pain intensity and opioid requirements of lung cancer patients operated on with VATS, pain at 24 hours was found to be lower in the ESPB group than in the PVB group.[15] In our study, opioid requirements in the postoperative period were similar, but unlike other studies, intraoperative opioid requirement was also similar in both groups.

The study by Chaudhary et al.[16] highlights the potential of ESP block as a safe and effective analgesic method to accelerate recovery after VATS, providing better pain control and preservation of lung function compared with intercostal block. In a study conducted on laparoscopic cholecystectomies, patients who underwent ESPB were compared with the control group, and spirometry analyses showed less decrease, providing more favorable respiratory outcomes in the ESPB group.[17]

The withdrawal of patients from the paravertebral group may have introduced a bias, potentially impacting the outcomes of our study. Furthermore, employing postoperative analgesia protocols utilizing methods such as patient-controlled analgesia could have provided more objective and reliable data. Notably, one patient experienced severe, unbearable pain, necessitating the use of meperidine for pain control. Although meperidine is not recommended as the first choice for postoperative pain in the literature,[18] there are also studies in which it is used for postoperative analgesia.[19] The use of alternative analgesics, such as morphine or fentanyl, could have been considered as part of the protocol. Additionally, incorporating spirometric testing could have enhanced the assessment of pulmonary function.

Conclusions

In thoracoscopic surgery, especially ESPB is an alternative to the PVB technique for multimodal analgesia. In our study, we concluded that ESPB block is as effective as PVB in controlling acute pain and is easier to perform. We believe that ESPB block will be a good option because of its advantages such as preventing chronicization of pain and reducing treatment costs and hospitalization time.

Ethics Committee Approval: The Afyonkarahisar Health Science University Non-Interventional Clinical Studies Ethics Committee granted approval for this study (date: 04.12.2020, number: 2011-KAEK-2).

Informed Consent: Written informed consents were obtained from patients who participated in this study.

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Authorship Contributions: Concept – RS, BAB, GÖ; Design – RS, BAB, GÖ; Supervision – RS, BAB, GÖ; Resources – BAB, GÖ; Materials – RS, EDB; Data collection and/or processing – BAB, EDB; Analysis and/or interpretation – RS, BAB, EDB; Literature search – RS, BAB, EDB; Writing – RS, EDB; Critical review – RS, BAB, EDB.

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