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Comparison of erector spinae plane block and thoracic paravertebral block for analgesia after thoracotomy

Faik Celik, Ayse Mizrak, Elzem Sen, Lutfiye Pirbudak, Ayse Nur Eser

Department of Anesthesiology and Reanimation, University of Gaziantep, Gaziantep, Turkey

ORCID of the author(s)

FC: https://orcid.org/0000-0003-1294-6779
AM: https://orcid.org/0000-0001-5999-4810
ES: https://orcid.org/0000-0003-3001-7324
LP: https://orcid.org/0000-0002-3474-1056
ANS: https://orcid.org/0009-0005-5088-7273

Corresponding Author
Elzem Sen
Gaziantep University Medical Faculty, Department of Anesthesiology and Reanimation, 27310 Gaziantep, Turkey
E-mail: drelzemsen@gmail.com

Ethics Committee Approval
The study was approved by the Gaziantep University Clinical Research Ethics Committee (decision no: 2021/241, dated 2021 July 7). All procedures in this study involving human participants were performed in accordance with the 1964 Helsinki Declaration and its later amendments.

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No conflict of interest was declared by the authors.

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Abstract

Background/Aim: Post-thoracotomy pain is severe and often necessitates effective regional analgesia. We aimed to compare the postoperative analgesic efficacy of ultrasound-guided erector spinae plane block (ESPB) versus thoracic paravertebral block (TPVB).
Methods: We retrospectively evaluated 130 adults (ESPB, n=65; TPVB, n=65) undergoing thoracotomy. The primary outcome was pain at rest, assessed using the visual analogue scale (VAS) at 0, 3, 6, 12, and 24 hours postoperatively. Secondary outcomes included postoperative opioid consumption (tramadol, morphine) and adverse events. A prespecified sensitivity analysis adjusted comparisons for sex.
Results: Resting VAS scores did not differ significantly between the ESPB and TPVB groups at any time point (all $P>0.05$). Postoperative tramadol and morphine consumption were comparable ($P=0.093$ and $P=0.560$, respectively). The incidence of adverse events (postoperative nausea/vomiting, shoulder pain, pruritus) was also similar between groups. In sex-adjusted analyses, all group differences remained non-significant.
Conclusion: ESPB and TPVB provide comparable postoperative analgesia and opioid-sparing effects after thoracotomy. Given its potential for greater technical ease and similar efficacy, ESPB represents a reasonable alternative to TPVB. Further prospective research is required to validate these results and assess long-term outcomes.

Keywords: thoracotomy, erector spinae plane block, postoperative analgesia, paravertebral block, visual analog scale, opioid consumption

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Introduction

Thoracic surgery is notoriously painful and, if inadequately managed, can lead to significant complications, including respiratory compromise, prolonged hospitalization, and the development of chronic post-surgical pain. The pain is multifactorial, originating from surgical incisions, rib retraction, chest tubes, and suturing [1, 2]. A multimodal approach integrating systemic and regional analgesia is the gold standard for managing postoperative pain and facilitating recovery.

In this context, the adoption of ultrasound (US)-guided techniques has significantly advanced the application of regional analgesic methods. Among these, the erector spinae plane block (ESPB), first described by Forero et al. [3] for thoracic neuropathic pain, has gained considerable attention. The ESPB is an ultrasound-guided fascial plane technique where local anesthetic is injected deep to the erector spinae muscle at the level of the transverse process. This injection achieves a cranio-caudal spread, potentially blocking multiple dermatomes. Compared to more invasive techniques like thoracic epidural anesthesia, or other plane blocks, ESPB is often considered technically simpler, faster to perform, and associated with a more favorable safety profile [4, 5].

Thoracic paravertebral block (TPVB), a well-established technique, provides potent unilateral thoracic analgesia by delivering local anesthetic into the paravertebral space to block the ventral and dorsal rami of spinal nerves. Both ESPB and TPVB are widely used for post-thoracotomy pain control. However, rigorous head-to-head comparisons of their clinical efficacy are still emerging, providing the rationale for the present study [6].

This study aims to compare the postoperative pain relief provided by ultrasound-guided ESPB versus TPVB in patients undergoing thoracotomy. The primary outcome was the Visual Analog Scale (VAS) score for pain at rest, assessed at 0, 3, 6, 12, and 24 hours postoperatively. Secondary outcomes included cumulative 24-hour tramadol and morphine consumption.

Materials and methods

This retrospective, observational study received ethical approval from the Clinical Research Ethics Committee (decision no. 2021/241, 7 July 2021) and adhered to the principles of the 2013 Declaration of Helsinki. We reviewed the medical records of patients who underwent thoracotomy between 1 October 2020 and 31 May 2021. At our institution, patients provide prospective written consent for their surgical/anesthetic care and for the potential research use of de-identified data; therefore, the need for study-specific informed consent was waived. No study-specific interventions were performed. The study was retrospectively registered at ClinicalTrials.gov (NCT06778161).

We included 130 patients aged 18–75 years with American Society of Anesthesiologists (ASA) physical status I–III who underwent thoracotomy and received either ultrasound-guided ESPB or TPVB for postoperative analgesia. The study excluded emergency cases and patients with ASA IV–V, peripheral vascular disease, pregnancy, heart failure, known allergy to local anesthetics, or incomplete medical documentation.

Patients were categorized into two groups (n=65 each) based on the regional analgesia technique administered: **Group ESPB** (Erector spinae plane block) and **Group TPVB** (Thoracic paravertebral block). We retrospectively collected data on patient demographics (age, gender, height, body weight, BMI), ASA classification, comorbidities, smoking status, indication for thoracotomy, side of surgery, duration of operation, postoperative VAS scores (at 0, 3, 6, 12, and 24 hours), total tramadol and morphine consumption, and the incidence of postoperative nausea, pruritus, and shoulder pain.

All patients received standard intraoperative monitoring (ECG, SpO_2, non-invasive blood pressure) and underwent general anesthesia using conventional induction and maintenance agents. Lung-protective ventilation strategies and hemodynamic management followed standardized institutional protocols.

After surgery but before extubation, all regional blocks were performed by a single senior anesthesiologist to minimize inter-operator variability. Patients were positioned laterally, and the procedure was conducted under full aseptic conditions using ultrasound guidance (GE Logiq E, 10–12 MHz linear probe, in-plane technique).

ESPB Procedure: The transverse process at the T5 level was identified. Following negative aspiration, 20 mL of 0.5% bupivacaine was injected into the fascial plane deep to the erector spinae muscle, confirming proper spread.

TPVB Procedure: Using a similar probe position, the paravertebral space at the T5 level was visualized. After the needle penetrated the superior costotransverse ligament, 20 mL of 0.5% bupivacaine was injected under direct ultrasound guidance following negative aspiration.

Prior to completing surgery, all patients received standard multimodal analgesia consisting of tramadol 100 mg IV and antiemetic prophylaxis with metoclopramide 10 mg IV. Following uneventful extubation, patients were transferred to the post-anesthesia care unit (PACU) for monitoring. Once a Modified Aldrete Score of ≥9 was achieved, patients were transferred to the intensive care unit (ICU).

Postoperative pain scores were recorded using the Visual Analogue Scale (VAS, 0–100 mm) at 0, 3, 6, 12, and 24 hours. A standardized rescue analgesia protocol was applied to both groups based on the Numerical Rating Scale (NRS, 0-10) or equivalent VAS scores:

- Patients reporting **NRS 4–5** (or VAS 40–59 mm) received intravenous **tramadol 100 mg**.
- Patients reporting **NRS ≥ 6** (or VAS ≥ 60 mm) received subcutaneous **morphine 5 mg**.
- No additional analgesia was administered if the NRS was ≤ 3 (or VAS ≤ 39 mm).

This fixed-dose, as-needed regimen was identical for both the ESPB and TPVB groups.

Statistical Analysis

Statistical analysis was performed using SPSS 22.0. Continuous data are presented as mean (SD) and categorical data as n (%). Baseline comparisons were made using independent-samples t-tests for continuous variables and χ^2 or Fisher's exact tests for categorical variables.

Due to a significant baseline difference in sex distribution, primary and secondary outcomes were adjusted for sex. VAS scores were analyzed using a repeated-measures general linear model (ANCOVA) with group, time, and sex as factors

(Greenhouse–Geisser correction applied where necessary). The secondary opioid outcome was dichotomized (any rescue opioid: yes/no) and analyzed using sex-adjusted logistic regression. Results are presented as adjusted mean differences (MD) or adjusted odds ratios (OR) with 95% confidence intervals (CIs). A two-sided α of 0.05 was considered statistically significant; *P*-values are reported to three decimals or as *P*<0.001.

Results

The groups were broadly comparable at baseline. The only statistically significant difference was sex distribution, with a higher proportion of males in the TPVB group (89.2%) compared to the ESPB group (75.4%) (OR 2.71, 95% CI 1.03–7.11; *P*=0.039). All other demographic variables (age, height, weight, BMI, ASA class, and smoking status) showed no significant between-group differences (Table 1).

Table 1: Demographic data of the patients

	Group ESPB (n=65)	Group TPVB (n=65)	Effect estimate (95% CI)	*P*-value
Age (years)	55.3 (14.1)	53.2 (11.1)	MD 2.1(-2.3 to 6.5)	0.411
Sex, male (n) (%)	49 (75.4%)	58 (89.2%)	OR 2.71(1.03-7.11)	0.039*
Height (m)	1.7 (0.1)	1.7 (0.1)	MD 0.00 (-0.034 to 0.034)	0.636
Weight (kg)	75.4 (15.5)	72 (14.5)	MD 3.4 (-1.76 to 8.56)	0.194
BMI (kg/m^2)	27.2 (5.9)	25.6 (4.9)	MD 1.6 (-0.26 to3.469	0.104
Smokers (n) (%)	46 (70.8%)	47 (72.3%)	OR 0.93 (0.43-1.99)	0.846
ASA (I/II/III)	2/ 23/40	5 /26 /34	χ^2	0.376

*Significant at p<0.05, BMI: Body Mass Index, ASA: American Society of Anesthesiologists Classification

While the ESPB group had a greater prevalence of hypertension, other comorbid conditions were similarly distributed across groups (Table 2). Indications for thoracotomy, side of surgery, and mean operative duration did not differ significantly between the ESPB and TPVB groups.

The primary outcome, resting postoperative VAS scores, did not differ significantly between the ESPB and TPVB groups at any measured time point (0, 3, 6, 12, and 24 hours). Mean scores were comparable at all intervals (e.g., 0 h: 31.5 (14.0) vs. 30.5 (10.7); 24 h: 24.4 (10.8) vs. 24.7 (13.9)). Mean differences were small and not statistically significant (all *P*>0.05) (Table 3).

Secondary outcomes were also similar. Total 24-hour opioid consumption did not differ between groups for either tramadol (MD 20.0 mg, 95% CI −3.5 to 43.5; *P*=0.093) or morphine (MD 0.4 mg, 95% CI −0.9 to 1.7; *P*=0.560). The incidence of adverse events, including PONV (OR 1.00), shoulder pain (OR 1.21), and pruritus (OR 1.00), was comparable (all *P*>0.05) (Table 4).

Given the baseline imbalance in sex, we performed the prespecified sex-adjusted analyses. These adjusted comparisons confirmed the primary findings: there were no significant intergroup differences in VAS scores at any time interval (all *P*>0.05). Furthermore, the likelihood of requiring any rescue analgesia (modeled as a binary outcome) was also similar between groups after adjusting for sex (adjusted OR 1.41, 95% CI 0.65–3.03, *P*=0.383).

Table 3: Postoperative VAS scores of the ESPB and TPVB groups

Time point	ESPB group (n=65)	TPVB group (n=65)	Mean difference (95%CI)	*P*-value
0 h	31.46 (14.02)	30.46 (10.74)	1.00 (-3.29 to 5.29)	0.734
3 h	33.31 (10.8)	32.46 (10.24)	0.85 (-2.77 to 4.47)	0.570
6 h	36.31 (12.22)	35.38 (10.58)	0.93 (-3.00 to 4.86)	0.723
12 h	30.92 (14.28)	30.46 (12.49)	0.46 (-4.15 to 5.07)	0.996
24 h	24.38 (10.84)	24.69 (13.86)	-0.31 (-4.59 to 3.979	0.590

Values are mean (SD). MD: Mean difference; CI: Confidence interval; VAS: Visual Analog Scale (0–100).

Discussion

This retrospective analysis of 130 thoracotomy patients compared the analgesic outcomes of ESPB and TPVB. While thoracic epidural analgesia and TPVB are considered cornerstone techniques for managing post-thoracotomy pain, the technically simpler ESP block has emerged as a viable alternative [7-9].

Our findings of non-inferiority contrast with some previous research. For example, a study by Das et al. [10] evaluating ESPB, TPVB, and serratus anterior plane block (SAPB) demonstrated that ESPB provided superior pain relief, delayed the need for rescue analgesia, and reduced total opioid consumption compared to TPVB and SAPB. Conversely, another study by Duran et al. [11] comparing PVB and ESPB reported that PVB resulted in significantly lower morphine consumption during the first 24 hours, although pain scores at rest and during coughing were similar. Our study aligns with the latter finding (no difference in pain scores) but conflicts with the former, as we identified no significant difference in opioid consumption. These discrepancies across studies likely reflect variations in methodology, patient populations, block techniques, and specific analgesic protocols.

Table 2: Clinical characteristics and operative data of the ESPB and TPVB groups

Variable	ESPB group (n=65)	TPVB group (n=65)	Effect estimate (95% CI)	*P*-value
Comorbidity, any	50 (76.9%)	45 (69.2%)	OR 1.48 (0.68–3.24)	0.323
Diabetes mellitus	19 (29.2%)	11 (16.9%)	OR 2.04 (0.86–4.81)	—
Hypertension	19 (29.2%)	7 (10.7%)	OR 3.44 (1.33–8.93)	—
COPD	5 (7.6%)	4 (6.1%)	OR 1.27 (0.33–4.86)	—
Asthma	3 (4.6%)	3 (4.6%)	OR 1.00 (0.20–4.95)	—
Coronary artery disease	7 (10.7%)	10 (15.3%)	OR 0.66 (0.23–1.93)	—
Chronic renal failure	2 (3.1%)	0 (0%)	—	—
Pulmonary malignancy	20 (30.7%)	16 (24.6%)	OR 1.36 (0.64–2.88)	—
Extrapulmonary malignancy	9 (13.8%)	10 (15.3%)	OR 0.89 (0.34–2.34)	—
Other diseases	16 (24.6%)	13 (20.0%)	OR 1.31 (0.57–3.00)	—
Indication for thoracotomy	Mass 46 (70.8%) Malignancy 14 (21.5%) Hydatid cyst 5 (7.7%) Bronchiectasis 0 (0%)	Mass 38 (58.5%) Malignancy 16 (24.6%) Hydatid cyst 9 (13.8%) Bronchiectasis 2 (3.1%)	χ^2 test	0.257
Thoracotomy side	Right 35 (53.8%) Left 30 (46.2%)	Right 39 (60.0%) Left 26 (40.0%)	OR 0.78 (0.39–1.56)	0.479
Duration of operation, min	190.92 (31.84)	185.77 (33.54)	MD 5.2 (−6.2 to 16.6)	0.371

Values are n (%) or mean (SD). OR: Odds Ratio; CI: Confidence Interval; COPD: Chronic Obstructive Pulmonary Disease.

Table 4: Opioid consumption (mg) and adverse effects of the ESPB and TPVB groups

Variable	ESPB group (n=65)	TPVB group (n=65)	Effect estimate (95% CI)	*P*-value
Tramadol consumption, mg	126.1 (69.1)	106.1 (70.4)	MD 20.0 (−3.5 to 43.5)	0.093
Morphine consumption, mg	1.8 (3.1)	1.4 (2.4)	MD 0.4 (−0.9 to 1.7)	0.560
PONV	10 (15.4%)	10 (15.4%)	OR 1.00 (0.38–2.65)	1.000
Shoulder pain	34 (52.3%)	31 (47.7%)	OR 1.21 (0.60–2.45)	0.725
Pruritus	3 (4.6%)	3 (4.6%)	OR 1.00 (0.20–5.03)	1.000

Values are mean (SD) or n (%). MD: Mean Difference; OR: Odds Ratio; CI: Confidence Interval; PONV: Postoperative nausea and vomiting.

Our results are consistent with a growing body of evidence, including several meta-analyses, that suggests comparable analgesic efficacy between ESPB and TPVB for thoracic surgery [12–16]. A key strength of our study is the confirmation of this equivalence even after performing a sensitivity analysis to adjust for a significant baseline sex imbalance. After adjustment, both VAS scores and the use of rescue opioids remained similar. Collectively, our findings support ESPB as a clinically equivalent alternative to TPVB, offering a practical option where technical ease and safety profile are prioritized.

Interpretation of these findings is subject to several limitations. The retrospective design is inherently susceptible to selection bias and documentation errors. While we identified a significant sex imbalance between groups, we attempted to mitigate this by performing sex-adjusted analyses, which confirmed the primary results. Furthermore, the fixed-dose rescue protocol (100 mg tramadol or 5 mg morphine) limited our ability to detect finer variations in opioid requirements and may have biased the VAS scores. Finally, this was a single-center study with no follow-up beyond 24 hours, precluding assessment of long-term outcomes like chronic pain. Prospective, multicenter, randomized controlled trials (RCTs) are warranted to confirm these findings.

Conclusion

In conclusion, this study found that ultrasound-guided ESPB and TPVB provide comparable postoperative analgesia and have similar opioid-sparing effects following thoracotomy. While TPVB is a well-established standard, ESPB appears to be a clinically equivalent alternative, potentially offering advantages in technical simplicity. The choice between these techniques should be guided by patient-specific factors, surgical context, and institutional expertise. Further large-scale, prospective RCTs are needed to confirm these findings and evaluate long-term outcomes.

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