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Comparison of thoracic epidural and peripheral regional analgesia techniques for postoperative pain management in video-assisted thoracoscopic surgery (VATS) procedures: a retrospective study

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ABSTRACT

Aims: Effective postoperative analgesia is essential in thoracic surgery to preserve respiratory function, facilitate early mobilization, and reduce pulmonary complications. Thoracic epidural analgesia (TEA) has traditionally been regarded as the gold standard for pain control. However, the increasing use of minimally invasive approaches such as video-assisted thoracoscopic surgery (VATS) has prompted the adoption of ultrasound-guided peripheral regional anesthesia techniques, including the paravertebral block (PVB), erector spinae plane block (ESPB), and serratus anterior plane block (SAPB). This study aimed to compare TEA and peripheral regional blocks in terms of postoperative pain scores, opioid consumption, and recovery parameters in patients undergoing VATS procedures.

Methods: This retrospective study included patients who underwent elective VATS between January 2023 and January 2025. Based on the analgesic technique received, patients were divided into two groups: TEA (n=82) and peripheral block group (PER, n=65). Pain was assessed using the Visual Analog Scale (VAS) at the post-anesthesia care unit (PACU) and at 24, 48, and 72 hours postoperatively. Opioid doses were standardized to morphine milligram equivalents (MME). Additional outcomes included intraoperative opioid use, postoperative rescue analgesia, length of hospital stay (LOS), complication rates, and 90-day mortality.

Results: Patients in the TEA group had significantly lower VAS scores at all time points compared to the PER group ($p<0.001$). PACU opioid administration and total MME consumption were also significantly reduced in the TEA group (0 mg [IQR 0–2] vs. 2 mg [IQR 0–4], $p<0.001$). Although intraoperative opioid use was generally similar, TEA provided greater opioid-sparing effects. No significant differences were observed between groups in LOS, complication rates, or 90-day mortality.

Conclusion: TEA demonstrated superior efficacy in postoperative pain control and opioid reduction compared to peripheral regional anesthesia techniques in patients undergoing VATS. While TEA remains the preferred option when feasible, ultrasound-guided peripheral blocks offer a valuable alternative, particularly in patients with contraindications to neuraxial techniques.

Keywords: Thoracic epidural analgesia, video-assisted thoracoscopic surgery, paravertebral block, erector spinae plane block, serratus anterior plane block, postoperative pain

INTRODUCTION

Postoperative pain following thoracic surgery remains a major clinical concern due to its negative impact on respiratory mechanics, delayed mobilization, and increased risk of pulmonary complications.[1] Effective pain control not only improves patient comfort but also contributes to preserving pulmonary function, minimizing complications, and reducing hospital length of stay (LOS).[2]

Thoracic epidural analgesia (TEA) has traditionally been considered the gold standard for postoperative pain management in thoracic procedures. By blocking nociceptive transmission at the spinal level, TEA provides effective and comprehensive analgesia.[3] However, its routine clinical use is often limited due to technical complexity, the risk of severe central complications, and contraindications in specific patient populations.[4,5]

In recent years, ultrasound-guided peripheral regional anesthesia techniques have gained significant attention as alternative approaches to TEA.[6] Among these, interfascial plane blocks such as the paravertebral block (PVB), erector spinae plane block (ESPB), and serratus anterior plane block (SAPB) have emerged as technically simpler, safer options associated with lower complication rates. PVB and ESPB are

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strongly recommended by the PROSPECT group after VATS, and SAPB is also among the techniques that can provide effective analgesia.[7] Although ESPB demonstrates superiority in intraoperative analgesia, it has also been shown that ESPB and SAPB provide similar efficacy in postoperative pain management.[8] The safety and efficacy of these blocks are increasingly supported by case reports and clinical trials.[9] As regional anesthesia approaches in thoracic surgery continue to evolve,[10] there remains a need for further comparative analyses between TEA and these newer techniques.

With the ongoing evolution of minimally invasive techniques, video-assisted thoracoscopic surgery (VATS) has become a preferred surgical approach due to reduced postoperative pain, shorter hospitalization, and fewer complications compared to open thoracotomy. The smaller incisions and limited tissue dissection in VATS procedures have encouraged the broader adoption of less invasive analgesic methods, particularly ultrasound-guided peripheral nerve blocks.[11]

Given the growing clinical experience and patient satisfaction associated with peripheral blocks, questions have emerged regarding their potential to replace TEA as the standard of care. In this context, the present retrospective study aimed to compare TEA and ultrasound-guided peripheral regional anesthesia techniques in terms of postoperative pain control, opioid consumption, and recovery outcomes in patients undergoing VATS. This study seeks to contribute to the ongoing optimization of analgesic strategies in thoracic surgery.

METHODS

Ethics

Ethical approval was obtained from the Koç University Committee on Human Researches (Date: 18.07.2025, Decision No: 2025.327.IRB1.054). The study was conducted in accordance with the principles outlined in the Declaration of Helsinki.

Study Design and Setting

This retrospective study was conducted using the shared clinical database of the Departments of Anesthesiology and Thoracic Surgery at Koç University Hospital. The study included patients who underwent VATS between January 2023 and January 2025.

Patient Selection

Patients were categorized into two groups based on the postoperative analgesic technique received: the TEA group, n=82 and the peripheral regional block group (PER group, n=65). Group allocation was determined according to standard clinical practice at the time of surgery, without randomization.

Inclusion criteria were as follows: age ≥18 years, elective VATS procedure (wedge resection, segmentectomy, or lobectomy), and availability of complete perioperative data. Exclusion criteria included thoracotomy, emergency surgery, incomplete medical records, reoperation within 72 hours, chronic opioid use prior to surgery, major intraoperative hemorrhage (>1.5 L), contraindications to regional anesthesia (e.g., coagulopathy or local infection), and procedures limited to diagnostic or minimal interventions (e.g., thoracentesis). Patients admitted to the intensive care unit (ICU) postoperatively were also excluded. Only those transferred to the ward after a standardized 1-hour follow-up in the post-anesthesia care unit (PACU) were included.

All VATS procedures were performed using a standardized two-port technique. The first (camera) port was placed in the 5th or 6th intercostal space along the mid-axillary line. The second (working) port was located in the 4th or 5th intercostal space, positioned either anteriorly or posteriorly depending on lesion location and surgical requirements. All operations were performed under general anesthesia using double-lumen endotracheal intubation to allow for single-lung ventilation.

Regional Anesthesia Techniques

All regional anesthesia procedures were performed under ultrasound guidance by an experienced anesthesiologist (M.M.), with over 10 years of experience in thoracic anesthesia and regional techniques. The block was administered at the end of surgery, immediately prior to extubation. Analgesic approaches included TEA, PVB, ESPB, or SAPB. The choice of technique was guided by surgical requirements and patient-specific anatomy, without a predetermined preference or bias. Patients in the TEA group received postoperative analgesia via epidural patient-controlled analgesia (PCA), while patients in the PER group received intravenous PCA.

Data Collection

Demographic data (age, height, weight), American Society of Anesthesiologists (ASA) physical status classification, and surgical parameters (type of VATS procedure, pleurodesis, mediastinal lymph node dissection [MLND], and operative time) were retrieved from electronic health records

Intraoperative opioid use was recorded and converted to morphine milligram equivalents (MME) to standardize comparisons. Postoperative opioid administration in the PACU was noted as present or absent, and total administered doses were also converted to MME (mg). Pain was assessed using the Visual Analog Scale (VAS; 0–10) at four time points: PACU, and 24, 48, and 72 hours postoperatively, based on nursing records. Other outcomes included LOS, postoperative complications, unplanned reintubation, and 90-day mortality.

Statistical Analysis

The data analyses were conducted using IBM SPSS Statistics version 27.0 (IBM Corp., Armonk, NY, USA). The Shapiro–Wilk test was used to assess the normality of distribution for continuous variables. Normally distributed variables were presented as mean±standard deviation (SD), and non-normally distributed variables were expressed as median and interquartile range (IQR; 25th–75th percentile). Between-group comparisons were made using the independent samples t-test or Mann–Whitney U test for continuous variables, and the Chi-square test or Fisher's exact test for categorical variables. A two-tailed p-value <0.05 was considered statistically significant.

RESULTS

A total of 415 thoracic surgical procedures were reviewed. After applying inclusion and exclusion criteria, 147 patients were included in the final analysis: 82 in the TEA group and 65 in the PER group (**Figure 1**).

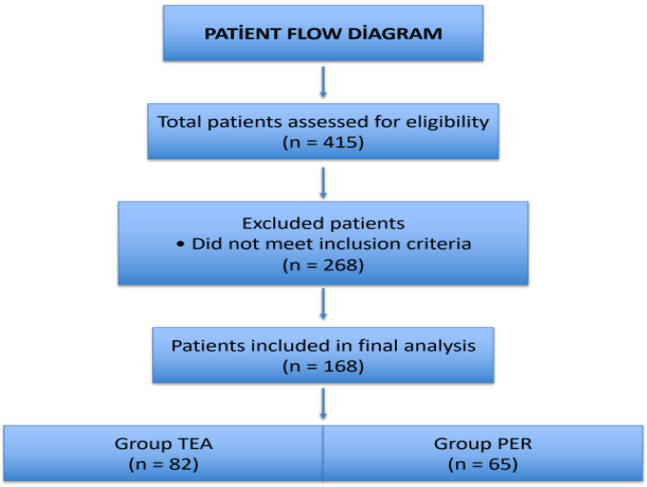

Figure 1. Patient flow diagram
TEA: Thoracic epidural analgesia, PER: Peripheral regional block

Demographic and Surgical Characteristics

The two groups were comparable in terms of baseline characteristics. The mean age was 62.41±13.53 years in the TEA group and 64.46±12.54 years in the PER group (p=0.344). No significant differences were observed in height (167.04±9.12 cm vs. 166.63±10.14 cm, p=0.802) or weight (73.37±14.76 kg vs. 74.35±13.16 kg, p=0.669). ASA physical status distribution (I/II/III) was similar between groups (TEA: 2/65/15 vs. PER: 1/57/7, p=0.401).

VATS performed—wedge resection, segmentectomy, or lobectomy—did not differ significantly between the groups (p=0.474). Pleurodesis was performed in four patients in the TEA group and two in the PER group (p=0.584). MLND was conducted in 54 of 82 patients in the TEA group and 38 of 65 in the PER group (p=0.358). The median operative time was 125 minutes (IQR 110–150) in the TEA group and 120 minutes (IQR 112.5–142.5) in the PER group, with no statistically significant difference (p=0.070).

Intraoperative and Postoperative Opioid Use

Intraoperative fentanyl (75 µg vs. 100 µg, p=0.735) and remifentanil (300 µg vs. 250 µg, p=0.994) doses were similar between groups. However, the use of other intraoperative opioids (converted to MME) was significantly lower in the TEA group (median 2 mg [IQR 2–2]) compared to the PER group (2 mg [IQR 2–3], p=0.000).

PACU, opioid use was significantly less frequent in the TEA group (32.9%) than in the PER group (70.8%) (p=0.000). Additionally, the median PACU opioid dose was significantly lower in the TEA group (0 mg [IQR 0–2]) than in the PER group (2 mg [IQR 0–4], p=0.000).

Postoperative Pain Scores

VAS scores were consistently lower in the TEA group at all time points:

PACU: TEA 2.00 [0.00–5.00] vs. PER 5.00 [3.00–6.00], p=0.000

24 hours: TEA 1.00 [0.00–3.00] vs. PER 3.00 [1.00–4.00], p=0.000

48 hours: TEA 0.00 [0.00–2.00] vs. PER 3.00 [1.00–4.00], p=0.000

72 hours: TEA 0.00 [0.00–1.00] vs. PER 2.00 [0.00–3.00], p=0.000 (**Figure 2**).

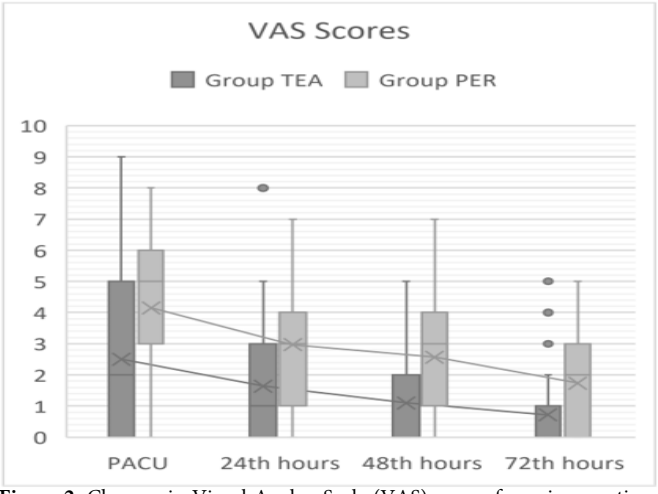

Figure 2. Changes in Visual Analog Scale (VAS) scores for pain over time, categorized by group
TEA: Thoracic epidural analgesia, PER: Peripheral regional block, PACU: Post-anesthesia care unit

Other Outcomes

LOS was 4 days in both groups (TEA: 4.00 [IQR 3–5] vs. PER: 4.00 [IQR 3–4], p=0.238). No patients in either group required unplanned reintubation or experienced weaning failure beyond 48 hours (p=1.000 for both). Ninety-day mortality was observed in one patient in the TEA group and two patients in the PER group (p=0.429). Overall postoperative complication rates were comparable (TEA: 7/82 [8.5%] vs. PER: 5/65 [7.7%], p=0.853) (**Table**).

DISCUSSION

This retrospective study compared TEA with ultrasound-guided peripheral regional anesthesia techniques in terms of postoperative pain control, opioid requirements, and recovery outcomes following VATS. The findings demonstrate that TEA provided significantly better postoperative analgesia than peripheral nerve blocks, as evidenced by consistently lower VAS scores and reduced opioid consumption at all time points up to 72 hours postoperatively.

In the TEA group, the median VAS score in the PACU was 2.00, compared to 5.00 in the peripheral block group (PER), with statistically significant differences maintained at 24, 48, and 72 hours. These findings are supported by the significantly lower need for rescue opioids in the PACU and lower total opioid consumption—expressed in MME—in the TEA group.

Table. Comparison of demographic characteristics, surgical data, analgesic requirements, and postoperative outcomes between group TEA and group PER patients undergoing video-assisted thoracoscopic surgery (VATS) procedures

	Group TEA (n=82)	Group PER (n=65)	p-value
Age (years)	62.41±13.53	64.46±12.54	0.344
Height (cm)	167.04±9.12	166.63±10.14	0.802
Weight (kg)	73.37±14.76	74.35±13.16	0.669
ASA scores I/II/III (n)	2/65/15	1/57/7	0.401
VATS wedge/segmentectomy/lobectomy (n)	41/34/7	38/24/3	0.474
Pleurodesis (-/+)	78/4	63/2	0.584
MLND (-/+)	28/54	27/38	0.358
Operative time (min)	125 (110-150)	120 (112.50-142.50)	0.070
intraoperative fentanyl (μg)	75 (50-100)	100 (50-100)	0.735
intraoperative remifentanil (μg)	300 (200-400)	250 (200-375)	0.994
Other opioid intraoperative (mg-MME)	20 (20-20)	20 (20-30)	0.000
PACU opioid use (-/+)	55/27	19/46	0.000
PACU opioid dose (mg-MME)	0 (0-20)	20 (0-40)	0.000
LOS (days)	4.00 (3-5)	4.00 (3-4)	0.238
VAS scores (PACU)	2.00 (0.00–5.00)	5 (3.00–6.00)	0.000
VAS scores (24th hours)	1.00 (0.00–3.00)	3.00 (1.00–4.00)	0.000
VAS scores (48th hours)	0.00 (0.00–2.00)	3.00 (1.00–4.00)	0.000
VAS scores (72th hours)	0.00 (0.00–1.00)	2.00 (0.00–3.00)	0.000
Complications (n)	7	5	0.853

Data presented as mean±standard derivation, median with interquartile range (25th–75th percentile) and n/n. TEA: Thoracic epidural analgesia, PER: Peripheral regional block, ASA: American Society of Anesthesiologists, VATS: Video-assisted thoracoscopic surgery, MLND: Mediastinal lymph node dissection, Min: Minimum, MME: Morphine milligram equivalent, PACU: Post-anesthesia care unit, LOS: Length of stay, VAS: Visual Analog Scale

Our results align with the findings of Adiyeke et al.,[12] who reported that although TEA and PVB yielded similar outcomes in terms of early pain scores and ICU admission, TEA demonstrated superiority in several secondary parameters. This advantage may be attributable to the broader analgesic coverage provided by TEA, which includes both parietal and visceral components of thoracic pain through blockade of sympathetic and visceral fibers.[13]

Among the peripheral techniques evaluated in this study, PVB is generally considered the most centrally acting, with some literature reporting analgesic efficacy comparable to that of TEA. However, unless contraindicated, TEA continues to be regarded as the gold standard for thoracic surgical analgesia due to its depth and duration of effect.[14] Similarly, TEA provides a broader range of analgesia by targeting both visceral and parietal pain components, giving it an advantage over peripheral techniques.[15] In our study, this clinical superiority was supported not only by subjective pain scores but also by objective measures, including reduced PACU opioid demand and lower analgesic consumption over the first three postoperative days.

In the study by Jo et al.,[16] it was found that all three procedures (PVB, ESPB and SAPB) reduced opioid use after VATS. PVB and ESPB were found to provide better pain control than SAPB. In contrast, a meta-analysis by Scorsese et al.[17] found no statistically significant advantage of TEA over peripheral blocks such as PVB, ESPB, and SAPB. Despite the lack of significance, TEA consistently achieved greater analgesic efficacy. These discrepancies in findings across studies may stem from variations in block techniques, catheter use (single-shot vs. continuous), local anesthetic volumes, and study design. Similarly, our study showed no significant differences between the groups in terms of LOS, or pulmonary complications. Notably, the use of epidural PCA in the TEA group versus IV PCA in the peripheral group may explain the observed superiority in VAS scores in the TEA group.

In a systematic review of 16 randomized controlled trials, Lin et al.[9] found that TEA, PVB and ESP provided effective postoperative analgesia after 24 hours, regardless of whether the single-shot or continuous catheter technique was used and excluding placebo or sham procedures. Despite the differences in PCA modality between the groups in our study, TEA showed superiority in both perioperative analgesic consumption and VAS scores up to 72 hours.

In our study, although TEA showed clear superiority in analgesic outcomes, there were no significant differences in LOS, complication rates, or 90-day mortality between the groups. This may be explained by the relatively low-risk nature of our patient, all of whom underwent minimally invasive VATS procedures and were managed postoperatively in the general ward.

It is important to emphasize that the inferior performance of peripheral blocks in our study should not imply ineffectiveness. Peripheral nerve blocks, especially ESPB and PVB, remain valuable options, particularly for patients with contraindications to neuraxial techniques or when TEA is technically challenging.[18] ESPB, in particular, is widely adopted due to its ease of use and low complication

rate, although its analgesic spread may be limited to parietal structures and may not adequately cover visceral pain.[19]

The significantly lower intraoperative opioid requirements in the TEA group further support the depth of analgesia provided by this technique. Effective intraoperative pain control has been associated with reduced postoperative opioid consumption and improved recovery trajectories. Our findings are consistent with previous studies demonstrating the widespread use and clinical effectiveness of regional anesthesia techniques in postoperative pain management after thoracic surgery. They are also in line with observations that TEA remains the most effective method following thoracotomy, while less invasive fascial plane blocks are preferred in VATS procedures.[20]

The variability in findings across the literature reflects the complex and multifactorial nature of regional anesthesia efficacy.[17,21] Factors such as patient anatomy, practitioner experience, type and timing of the block, and the local anesthetic regimen all influence clinical outcomes. In this context, recent clinical practice has reported the use of rhomboid intercostal plane block,[22] serratus superior posterior plane block,[23,24] the combined application of different regional techniques (e.g., PVB+ESPB),[25,26] or the use of the same block with different approaches (e.g., superficial+deep SAPB)[27] as additional options for enhancing postoperative analgesia after VATS. Furthermore, the extensive anatomical coverage of the recto-intercostal plane block—extending from the subxiphoid region to the lateral abdominal wall, as demonstrated in the cadaveric study by Tulgar et al.[28]—may help explain its potential clinical utility in thoracic and upper abdominal procedures. Future prospective studies with standardized protocols are needed to more clearly define the role of each technique in thoracic surgery.

Limitations

This study has several limitations that should be acknowledged. First, the PER group included a heterogeneous set of techniques—PVB, ESPB and SAPB—which differ anatomically, in mechanism of action, and in their potential for visceral spread. This heterogeneity limits the ability to make definitive conclusions about any single peripheral technique.

Second, the retrospective design of the study inherently carries risks of selection bias and unmeasured confounding variables. Although group allocation was based on standard clinical practice and not randomized, the possibility of differences in clinical decision-making that influenced the choice of analgesic technique cannot be excluded.

Third, different modes of postoperative analgesia were used across groups: epidural PCA in the TEA group and intravenous PCA in the PER group. This discrepancy may have affected pharmacokinetics and analgesic effectiveness, potentially biasing the comparison in favor of TEA.

Fourth, the study was conducted at a single academic center with a dedicated thoracic anesthesia team, which may limit generalizability to other clinical settings with different levels of expertise or resources.

Lastly, the study population consisted exclusively of relatively low-risk patients undergoing elective VATS. Therefore, the findings may not apply to patients undergoing thoracotomy, those at higher perioperative risk, or those requiring ICU management. Future prospective, multicenter randomized controlled trials focusing on standardized peripheral techniques and consistent analgesic protocols are necessary to validate and expand upon these findings.

CONCLUSION

This retrospective study demonstrated that TEA was superior to ultrasound-guided peripheral regional anesthesia techniques—specifically PVB, ESPB, and SAPB—in providing postoperative analgesia for patients undergoing VATS. TEA was associated with significantly lower VAS pain scores and reduced opioid requirements in both the intraoperative and early postoperative periods.

These findings support the continued use of TEA as the gold standard for postoperative pain management in thoracic surgery, particularly in patients who are eligible for neuraxial techniques and who may benefit from visceral as well as somatic analgesia. Nonetheless, ultrasound-guided peripheral nerve blocks remain valuable alternatives, offering effective and safe pain control, especially in cases where TEA is contraindicated or technically unfeasible.

As the use of minimally invasive surgical techniques continues to expand, further high-quality randomized controlled trials are warranted to clarify the comparative benefits of peripheral blocks and to optimize analgesic strategies tailored to individual patient profiles.

HIGHLIGHTS

- TEA provided significantly lower postoperative pain scores than peripheral regional techniques following VATS.
- TEA was associated with a substantial reduction in both intraoperative and postoperative opioid requirements, as measured by MME.
- Peripheral nerve blocks, including PVB, ESPB, and SAPB, were effective but less potent compared to TEA in managing postoperative pain.
- Despite differences in analgesic outcomes, LOS, complication rates, and 90-day mortality were similar between TEA and peripheral block groups.
- Ultrasound-guided peripheral blocks remain safe and viable alternatives, especially when TEA is contraindicated or technically challenging.

ETHICAL DECLARATIONS

Ethics Committee Approval

Ethical approval was obtained from the Koç University Committee on Human Researches (Date: 18.07.2025, Decision No: 2025.327.IRB1.054).

Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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