



Research Article

Erector Spinae Plane Block for Thoracoscopic Surgeries: A Single-center Retrospective Investigation into Patient-controlled Analgesia and Pain

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Abstract

Erector spinae plane blocks are increasingly incorporated into thoracic surgical analgesia practices, yet evidence regarding its effect on postoperative opioid requirements following video-assisted thoracoscopic surgery remains mixed. The objective of this study was to evaluate whether erector spinae plane blocks reduce postoperative opioid consumption without differences in patient-reported pain scores in patients undergoing video-assisted thoracoscopic surgery. We conducted a retrospective single-center cohort study at a tertiary academic hospital including adult patients who underwent video-assisted thoracoscopic surgery between October 2021 and October 2024. Procedures included lobectomy, wedge resection, and other pulmonary or pleural operations; patients with chronic pain, opioid dependence, conversion to thoracotomy, or incomplete data were excluded. Erector spinae plane blocks were performed at the discretion of the attending anesthesiologist using bupivacaine or ropivacaine, and all patients received multimodal analgesia with postoperative patient-controlled analgesia. Primary outcomes were patient-controlled analgesia morphine milligram equivalents and total postoperative morphine milligram equivalents. Secondary outcomes included pain scores at 0, 12, and 24 hours, adjunct analgesic use, and hospital and post-anesthesia care unit length of stay. Among 418 patients, erector spinae plane blocks were associated with lower patient-controlled analgesia morphine milligram equivalents (17 vs 24, $p < 0.001$) and lower total postoperative morphine milligram equivalents (33 vs 43, $p < 0.001$), without differences in pain scores, adjunct analgesic use, or length of stay. Multivariable linear regression confirmed independent reductions of 3.5 morphine milligram equivalents for patient-controlled analgesia use and 7.5 morphine milligram equivalents for total postoperative opioid consumption. Erector spinae plane blocks were associated with statistically significant reductions in postoperative opioid requirements without differences in patient-reported pain scores. The magnitude and clinical relevance of this reduction require further evaluation in prospective randomized trials.

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Keywords

Erector Spinae Plane Block, Video-assisted Thoracoscopic Surgery, Postoperative Pain, Patient-controlled Analgesia, Opioid Consumption, Regional Anesthesia, Multimodal Analgesia

1. Introduction

1.1. Background

Regional anesthesia has demonstrated efficacy in decreasing pain and narcotic usage for patients after thoracic surgeries. Thoracic epidural analgesia (TEA), traditionally used for thoracotomies, remains the preferred method due to its benefits in lowering early postoperative pain, supraventricular arrhythmias, renal issues, and respiratory complications [1-3]. A similar technique, thoracic paravertebral blocks (PVBs), has been shown to provide non-inferior pain control while reducing side effects associated with TEA, including hypotension, pruritus, nausea, vomiting, and urinary retention [4]. With TEAs, The reported incidence of pruritus is dose-dependent (range, 1.8–16.7%), making it the most common side effect of neuraxial opioids, while postoperative nausea and vomiting (PONV), also linked to opioid administration, occurred in 1.8% of patients.

1.2. Erector Spinae Plane Block (ESPB)

Despite the benefits of TEAs and PVBs, there is growing interest in less invasive regional anesthesia for thoracic surgery. In 2016, Forero et al. introduced erector spinae plane blocks (ESPBs) for managing chronic thoracic neuropathic and post-thoracotomy pain [5]. ESPBs involve injecting local anesthetics into the erector spinae muscle fascial plane above the transverse process, targeting both dorsal and ventral rami of the spinal nerves. This provides multi-dermatomal anesthesia of the chest wall and may offer visceral analgesia via the rami communicantes [6]. With the injection administered away from the pleura, major blood vessels, and neuraxis, ESPB has a strong safety profile and minimal risk of severe complications. It is safe for patients with coagulopathy or thrombocytopenia, can be easily performed under ultrasound guidance, and offers coverage across multiple thoracic segments, making it a valuable option for multimodal analgesia.

ESPB has been successfully used in cardiac surgeries as an opioid-sparing technique. A meta-analysis by Li et al. reported reduced pain scores, incidence of nausea and vomiting, and decreased patient-controlled analgesia (PCA) use [7]. Reduced opioid consumption following ESPB has been characterized in the setting of rib fractures [8] and hip surgery [9].

1.3. ESPB in Thoracoscopic Surgery

The role of ESPB in minimally invasive thoracoscopic surgery remains an area of ongoing investigation, with heterogeneous findings reported in VATS populations. For example, Shim et al. reported reduced pethidine requirements in the post-anesthesia care unit (PACU) [10], but Klaibert et al. found no difference in opioid consumption [11]. Furthermore, Hong et al. found that continuous ESPB was less effective than TEA for VATS analgesia, with increased morphine consumption in the ESPB group despite fewer side effects [12]. Thus, findings remain mixed regarding opioid consumption with ESPB in VATS. While recent randomized controlled trials have investigated the efficacy of ESPB in VATS, the results were inconsistent. Clairoux et al conducted a multicenter, randomized, double-blinded trial evaluating single-shot ESPB in VATS and found no significant reduction in postoperative opioid consumption, pain scores, or quality of recovery compared to placebo [13], while Ergun et al found reduction in postoperative opioid consumption, improved pain score, earlier mobility and oral intake [14]. Thus, the effect of ESPB on opioid consumption in VATS remains uncertain, and calls for further investigation.

1.4. Study Objective and Hypothesis

To address this knowledge gap, we conducted a retrospective study to evaluate the association between ESPB use and postoperative opioid consumption in patients undergoing minimally invasive thoracoscopic surgery at our institution. We hypothesized that ESPB would lead to a meaningful reduction in postoperative opioid consumption, reported in morphine milligram equivalents (MME), both in terms of PCA-administered opioids (PCA-MME) and total opioid use (Total-MME, which includes both PCA and other postoperative opioids), without compromising pain control compared to standard analgesic management. Our primary objectives are to compare (1) morphine milligram equivalent (MME) use and (2) postoperative pain scores at 0, 12, and 24 hours between the ESPB and matched non-ESPB groups. The results of this study aim to clarify the role of ESPB in VATS analgesia and inform evidence-based postoperative pain management strategies within enhanced recovery pathways.

2. Methods

2.1. Study Design and Setting

This single-center retrospective cohort study at a tertiary academic hospital was approved by the NYU Langone Health IRB (#124-01353) on November 11, 2024.

2.2. Ethics Approval and Consent to Participate

This study was conducted in accordance with the ethical principles of the Declaration of Helsinki and was approved by the NYU Grossman Long Island School of Medicine Institutional Review Board (IRB), the ethics committee of NYU Grossman Long Island School of Medicine. The requirement for informed consent was waived by the NYU Grossman Long Island School of Medicine Institutional Review Board due to the retrospective nature of the study.

2.3. Patient Selection

All patients undergoing video-assisted thoracoscopic surgery (VATS)—including lobectomy, wedge resection, and other pulmonary or pleural procedures—from October 2021 to October 2024 were identified. Clinical data were extracted from the electronic medical record and anesthesia management system. Patients were excluded if they had chronic pain or opioid dependence, converted to open thoracotomy, received awake VATS under sedation, required prolonged postoperative ventilation, or received regional blocks other than or in addition to ESPB, yielding 1,077 patients initially. Further exclusions included non-intubated patients, those receiving ESPB without bupivacaine or ropivacaine, or incomplete analgesic/pain score data. The final sample included 418 adults, categorized into ESPB and non-ESPB groups.

2.4. ESPB Administration

ESPB administration was at the attending anesthesiologist's discretion, generally based on patient comorbidities and provider preference. Data collected included demographics (age, sex, BMI, race), clinical variables (ASA classification, surgery and anesthesia duration), and ESPB details (block laterality, anesthetic agent, volume, timing relative to induction). In addition to the primary analyses, we conducted exploratory subgroup analyses on patients who received ESPB to examine the impact of block timing, laterality, and local anesthetic type, volume, and concentration.

2.5. Outcome Measures

The primary outcome was MME consumption at 12 and 24 hours. All opioid dosages were converted to morphine milligram equivalents (MME) using standardized equianalgesic conversion factors to allow comparison across different opioid

medications. It included all postoperative opioid medications administered via any route, including hydromorphone, morphine, tramadol, oxycodone, and fentanyl. Other opioids were not administered during the study period and were therefore not included in MME calculations. Postoperative opioid use was examined in two categories: (1) PCA-MME, representing opioids administered exclusively via patient-controlled analgesia, and (2) Total-MME, representing the total postoperative opioid consumption, including both PCA and non-PCA routes. These measurements reflected medication administration up to 48 hours postoperatively. Secondary outcomes included patient-reported pain scores recorded using the standard 0–10 numeric rating scale (NRS), assessed at PACU arrival (0 hours), and at 12 and 24 hours postoperatively as documented in the electronic medical record, PACU duration, and total hospital length of stay. Intraoperative MME as well as other postoperative analgesics were also recorded, including methocarbamol, gabapentin, and ketorolac.

2.6. Statistical Analysis

Analyses were performed using R version 4.0. Normality was assessed with Shapiro-Wilk tests, revealing many analgesia-related variables were non-normal. Thus, nonparametric tests were used as appropriate. Mann-Whitney U tests compared continuous variables (age, BMI, pain scores, opioid use) between groups. Categorical variables (sex, ASA class, PCA use) were analyzed with Pearson's chi-square or Fisher's exact tests. The Kruskal-Wallis test was used for comparisons of more than two groups. Statistical significance was set at $p < 0.05$.

Robust linear regression evaluated ESPB's independent effect on PCA-MME and Total-MME, adjusting for age, sex, race, BMI, ASA classification, procedure duration, and intraoperative MME. Results are presented as β coefficients with 95% confidence intervals; significance was based on intervals excluding zero.

3. Results

3.1. Patient Characteristics

A total of 418 patients were included in the analysis, with 177 (42.3%) receiving ESPB while 241 (57.7%) did not. Median age was comparable with 65 years old in the non-ESPB group and 67 in the ESPB group ($p=0.2$). The racial demographics were similar, with the vast majority of patients in both the non-ESPB group (83%) and ESPB group (85%) being white ($p=0.8$). The median BMI was comparable, 28.5 kg/m² (SD: 6.1) in the non-ESPB group and 28.2 kg/m² (SD: 5.3) in the ESPB group ($p=0.8$). The distribution of ASA status differed significantly between groups ($p = 0.006$). The majority of patients in both groups were classified as ASA 3, with a higher proportion in the ESPB group (92% vs. 83%). The ASA 4 classification was notably lower in the ESPB group

(1.7% vs. 9.1%). The proportion of ASA 2 patients was similar between groups (6.8% vs. 7.5%) (Table 1). These findings indicate a difference in preoperative health status between the

groups, with the ESPB group having fewer ASA 4 patients compared to the non-ESPB group.

Table 1. Baseline Patient Characteristics by ESPB Status.

Demographic (N = 418)	No ESPB, N = 241 ¹	ESPB, N = 177 ¹	p-value ²
Sex			0.13
F	132 (55%)	110 (62%)	
M	109 (45%)	67 (38%)	
Age at procedure	65 (14)	67 (12)	0.2
Race			0.7
Non-White	37 (15%)	22 (12%)	
Unreported	5 (2.1%)	4 (2.3%)	
White	199 (83%)	151 (85%)	
BMI	28.5 (6.1)	28.2 (5.3)	0.8
ASA status			0.006
2	18 (7.5%)	12 (6.8%)	
3	201 (83%)	162 (92%)	
4	22 (9.1%)	3 (1.7%)	

¹n (%); Mean (SD)

² Pearson's Chi-squared test; Wilcoxon rank sum test; Fisher's exact test

3.2. Perioperative Outcomes

Surgical duration was similar between the ESPB and non-ESPB groups, with a mean time of 101 vs 98 minutes ($p = 0.5$). Anesthesia duration was longer in the ESPB group compared to the non-ESPB group ($p = 0.031$). The median anesthesia

duration was 166 minutes in the ESPB group, compared to 157 minutes in the non-ESPB group. Intraoperative opioid administration was determined at the discretion of the attending anesthesiologist. Patients who received ESPB received 12.5% lower intraoperative morphine milligram equivalents compared to those who did not (21 vs 24; $p < 0.001$) (Table 2).

Table 2. Secondary Perioperative and Postoperative Outcomes by ESPB Status.

Secondary Outcome	N	No ESPB, N = 241 ¹	ESPB, N = 177 ¹	p-value ²
Surgical duration, in minutes	418	98 (40)	101 (41)	0.5
Anesthesia duration, in minutes	418	157 (45)	166 (46)	0.031
Intraoperative (MME)	418	24 (9)	21 (7)	<0.001
Post-Op Pain Score (0 hr)	417	6.4 (3.0)	6.8 (2.7)	0.2
Post-Op Pain Score (12 hr)	412	3.15 (2.71)	3.60 (2.57)	0.062
Post-Op Pain Score (24 hr)	413	3.18 (2.86)	3.06 (2.64)	0.8
PACU Time (min)	412	690 (555)	594 (514)	0.12
Length of Stay Duration (min)	418	3,975 (6,320)	3,306 (2,759)	0.2

Secondary Outcome	N	No ESPB, N = 241 ¹	ESPB, N = 177 ¹	p-value ²
¹ Mean (SD)				
² Wilcoxon rank sum test				

3.3. Postoperative Pain, Opioid, and Adjunct Analgesic Use

A statistically significant reduction in PCA-MME (24 vs 17, $p < 0.001$) and Total-MME (43 vs 33, $p < 0.001$) was observed postoperatively. Our results demonstrate an absolute reduction of 10 intravenous MMEs in the postoperative phase, equivalent to 30 oral MMEs, corresponding to a relative reduction of 23.3%. The use of

adjunct analgesics, including IV and oral methocarbamol, gabapentin, and IV ketorolac did not differ significantly between groups. Pain scores at 0, 12, and 24 hours showed no statistically significant differences between groups at any time point (0 hours: $p = 0.2$; 12 hours: $p = 0.062$; 24 hours: $p = 0.8$). No difference in length of hospital stay (3,975 minutes [66.25 hours] vs. 3,306 minutes [55.1 hours], $p = 0.2$) or PACU duration (690 minutes [11.5 hours] vs. 594 minutes [9.9 hours], $p = 0.12$) was observed (Table 3).

Table 3. Postoperative Analgesic and Adjunct Medication Use by ESPB Status.

Postoperative Analgesic and Adjunct Medication	N	No ESPB, N = 241 ¹	ESPB, N = 177 ¹	p-value ²
PCA-MME	418	24 (18)	17 (13)	<0.001
Total-MME	418	43 (32)	33 (26)	<0.001
Oral Methocarbamol (mg)	394	2,767 (1,239)	2,738 (1,184)	0.8
IV Methocarbamol (mg)	32	588 (152)	783 (558)	0.5
Gabapentin (mg)	368	1,282 (543)	1,183 (521)	0.1
IV Ketorolac (mg)	98	26 (19)	25 (17)	0.6
¹ n (%); Mean (SD)				
² Pearson's Chi-squared test; Wilcoxon rank sum test				

3.4. Robust Multivariable Analysis

A robust multivariable regression analysis adjusting for age, sex, BMI, ASA classification, and intraoperative MME requirement confirmed that receiving an ESPB was independently associated with a reduction of 3.5 units in PCA-MME (95% CI: -6.0 to -1.0) and 7.5 units in Total-MME (95% CI: -12.0 to -2.8). Increased age was associated with

a decrease in PCA-MME ($\beta = -0.42$, 95% CI: -0.52 to -0.33) and Total-MME ($\beta = -0.54$, 95% CI: -0.72, -0.36). Higher BMI was demonstrated to be an independent positive modulator of PCA-MME usage (0.24, 95% CI: 0.03 to 0.45); however, this association was not significant for total-MME (0.11, 95% CI: -0.28 to 0.51). We did not observe independent associations for PCA-MME and Total-MME for surgical duration, anesthesia duration, sex, race, or ASA status (Table 4).

Table 4. Robust Multivariable Regression of Postoperative Opioid Consumption Adjusted for Patient and Perioperative Characteristics.

	PCA-MME		Total-MME	
Confounding Variable	Beta	95% CI ¹	Beta	95% CI ¹
Received ESPB				
N	—	—	—	—

	PCA-MME		Total-MME	
Y	-3.5	-6.0, -1.0	-7.5	-12, -2.8
Surgical duration, in minutes	0.03	-0.04, 0.09	0.05	-0.08, 0.18
Anesthesia duration, in minutes	-0.03	-0.09, 0.03	0.02	-0.10, 0.13
Intraoperative-MME	0.1	-0.04, 0.24	0.22	-0.04, 0.49
Age at procedure	-0.42	-0.52, -0.33	-0.54	-0.72, -0.36
Sex				
F	—	—	—	—
M	0.42	-2.0, 2.9	-6.6	-11, -2.0
Race				
Non-White	—	—	—	—
Unreported	-1.4	-10, 7.3	4.3	-12, 21
White	3.2	-0.26, 6.6	3.6	-2.7, 10
BMI	0.24	0.03, 0.45	0.11	-0.28, 0.51
ASA status				
2	—	—	—	—
3	-3.7	-8.7, 1.3	-2	-11, 7.3
4	-2.6	-9.6, 4.4	1.9	-11, 15

¹CI = Confidence Interval
 “—” denotes category reference

3.5. Subgroup Analyses: ESPB Timing, Laterality, and Agent

Potential confounding factors were considered in the ESPB group, including block side, agent, and time of delivery with relationship to induction. A comparison was made between preinduction ESPB and post-induction ESPB. There were no significant differences in PCA-MME (18 vs 17, $p = 0.4$) or Total-MME (34 vs 32, $p = 0.4$), or postoperative pain scores at 12 hours (3.16 vs. 3.82, $p = 0.10$) and 24 hours (2.81 vs. 3.18, $p = 0.3$). However, postoperative pain scores at 0 hours were significantly lower in the post-induction ESPB group (6.2 vs. 7.2, $p = 0.025$).

Considering block side, 109 patients (61.6%) received a right-sided block, while 68 (38.4%) received a left-sided block. There were no significant differences in PCA-MME (17 vs 17, $p > 0.9$) or Total-MME (33 vs 33, $p = 0.3$) or postoperative pain scores at 0 hours (7.2 vs. 6.6, $p = 0.14$), 12 hours (3.64 vs. 3.57, $p = 0.9$), or 24 hours (3.06 vs. 3.06, $p = 0.7$). We further compared blocking agents and concentrations. There were no significant differences in PCA-MME ($p = 0.3$) or Total-MME ($p = 0.3$), or postoperative pain scores at 0 hours ($p > 0.9$), 12 hours ($p = 0.5$), or 24 hours ($p = 0.4$) across the different local anesthetic groups (Bupivacaine 0.25%, 30 mL; Bupivacaine 0.25%, <30 mL; Bupivacaine 0.5%, <30 mL; and Ropivacaine 0.5% <30mL) (Table 5).

Table 5. Subgroup Analysis of Postoperative Opioid Consumption and Pain Scores by Block Timing, Laterality, and Block Agent.

Variable	Post-Induction, N = 59 ¹	Pre-Induction, N = 118 ¹	Laterality Group	Laterality Group	p-value ²
Block Timing					
PCA-MME	18 (13)	17 (13)			0.4
Total-MME	34 (24)	32 (28)			0.4
Post-Op Pain Score (0 hr)	6.2 (2.9)	7.2 (2.6)			0.025

Variable	Post-Induction, N = 59 ¹	Pre-Induction, N = 118 ¹	Laterality Group	Laterality Group	p-value ²
Post-Op Pain Score (12 hr)	3.16 (2.68)	3.82 (2.50)			0.1
Post-Op Pain Score (24 hr)	2.81 (2.79)	3.18 (2.56)			0.3
Block Laterality			Left, N = 68 ¹	Right, N = 109 ¹	p-value ³
PCA-MME			17 (12)	17 (13)	>0.9
Total-MME			33 (22)	33 (29)	0.3
Post-Op Pain Score (0 hr)			7.2 (2.7)	6.6 (2.7)	0.14
Post-Op Pain Score (12 hr)			3.64 (2.36)	3.57 (2.71)	>0.9
Post-Op Pain Score (24 hr)			3.06 (2.37)	3.06 (2.81)	0.7
Block Agent	Bupivacaine 0.25%, 30 mL, N = 134 ¹	Bupivacaine 0.25%, <30 mL, N = 6 ¹	Bupivacaine 0.5%, <30 mL, N = 14 ¹	Ropivacaine 0.5%, N = 23 ¹	p-value ³
PCA-MME	17 (13)	21 (15)	13 (8)	20 (15)	0.3
Total-MME	32 (24)	33 (23)	22 (15)	42 (40)	0.3
Post-Op Pain Score (0 hr)	6.9 (2.5)	6.7 (3.4)	7.1 (2.5)	6.3 (3.7)	>0.9
Post-Op Pain Score (12 hr)	3.64 (2.55)	2.17 (3.71)	3.79 (2.75)	3.59 (2.34)	0.6
Post-Op Pain Score (24 hr)	3.05 (2.51)	1.67 (2.58)	3.93 (3.08)	2.91 (3.07)	0.4

¹ Mean (SD)

² Wilcoxon rank sum test

³ Kruskal-Wallis rank sum test

4. Discussion

4.1. Opioid Consumption and Analgesic Outcomes

In this retrospective cohort of patients undergoing minimally invasive thoracic surgery, ESPB use was associated with reduced intraoperative and postoperative opioid consumption as measured by PCA-MME and Total-MME. Within a multimodal analgesic framework, this finding suggests a potential opioid-sparing association, as no differences in patient-reported pain scores were observed. PCA-MME was selected as the primary outcome because it reflects patient-initiated analgesic demand and therefore serves as a clinically relevant measure of perceived analgesic adequacy, in contrast to intraoperative opioid administration or length of stay, which may be influenced by inter-provider variability and non-analgesic factors. Although intraoperative MME administration was not a prespecified primary endpoint, it was

also lower in the ESPB group, further supporting a consistent pattern of reduced opioid exposure. Secondary outcomes, including self-reported pain scores and adjunct multimodal analgesic use, did not differ significantly between groups. Pain scores did not differ between groups at any measured time point, suggesting that lower opioid consumption in the ESPB group was not accompanied by higher reported pain. These findings are consistent with the interpretation that ESPB may reduce opioid requirements while maintaining comparable analgesia. Compared to other studies evaluating ESPBs, the reduction in PCA-MME and Total-MME usage in our ESPB group aligns with the opioid-sparing effects observed elsewhere [8-10]. The implementation of ESPB resulted in a relative opioid reduction of 23.3%, corresponding to a decrease of 10 intravenous MMEs, or 30 mg when converted to oral MMEs. A meta-analysis evaluating ESPBs determined the minimum clinically important difference (MCID) in opioid consumption to be 30 mg of morphine [15]. Our observed reduction approaches this proposed threshold; however, the clinical significance of this finding remains uncertain. Although statistically significant, a reduction of this magnitude

may not translate into meaningful improvements in recovery, opioid-related adverse effects, or patient satisfaction, particularly within a multimodal analgesic regimen where baseline opioid exposure is already limited.

In contrast to the recent randomized, double-blinded trial by Clairoux et al., which did not demonstrate reduced opioid consumption or improved recovery following single-shot ESPB in VATS, our observational findings suggest a modest association between ESPB use and reduced total opioid exposure [13]. Supporting the finding of reduced opioid consumption, another randomized controlled trial by Ergun et al also found better postoperative pain scores in addition to other recovery outcomes [14]. Differences in study design, including randomized standardized conditions versus clinician-directed analgesic management, as well as differences in outcome definitions and sample size, may partially explain these divergent findings.

We did not collect data on opioid-related adverse effects, including nausea, sedation, respiratory depression, or measures of patient-reported comfort, which limits our ability to determine whether the observed opioid reduction translated into meaningful improvements in recovery. Although reductions of this magnitude have been proposed as potentially clinically relevant, prospective studies with more uniform perioperative management and patient-centered outcome assessment are needed to clarify the true clinical significance of these findings.

4.2. PACU and Hospital Length of Stay

Despite prior studies indicating that ESPBs reduce PACU and hospital length of stay and our data demonstrating shorter PACU and length of stay on average, our results were not statistically significant [10, 16]. These findings suggest that ESPB was associated with reduced opioid requirements without prolonging recovery time. The lack of significant differences in recovery time may be due to factors such as variability in patient responses to regional anesthesia, the use of additional pain management strategies, and overall complexity of postoperative recovery. In retrospective studies without standardized perioperative management, length of stay is influenced by multiple non-standardized factors including discharge criteria variability, social determinants, and institutional practice patterns rather than pain relief alone.

Additionally, complications during or after surgery can prolong recovery time, potentially masking the benefits of ESPB. Factors such as patient comorbidities, the extent of the surgical procedure, and varying postoperative care management may also contribute to variability in length of stay. Furthermore, these comorbidities appear to influence the decision to administer ESPB, as our cohort had a statistically significant reduction in ESPB use among those with ASA 4. This may be driven by concerns about the safety and efficacy of the procedure in this patient population by healthcare providers.

4.3. Procedural Factors

We also examined procedural factors such as ESPB side administration, block timing and choice of local anesthetic, but found no significant impact on PCA-MME consumption or postoperative pain scores. This suggests that the analgesic benefits of ESPB remain consistent regardless of procedural details. Patients who received ESPB post-induction reported lower pain scores at hour 0. There were no significant differences in surgical duration between the groups and only an average of 9-minute difference in anesthesia duration. This is important, as surgical and anesthesia time could confound the duration of ESPB, but since no clinically significant differences were found, the reduction in pain at hour 0 may be attributed to the subjective nature of pain score reporting. The increase in total anesthesia duration reflects the additional time required for ESPB administration. Regarding block agent, concentration, and volume, previous studies have evaluated bupivacaine concentration and volume in ESPB for thoracic surgery which demonstrated reduced opioid consumption and pain scores [16-18]. However, our study did not replicate these results, finding no significant difference. Furthermore, these studies only evaluated bupivacaine. Further research into the effects of ropivacaine concentration and volume into ESPB is required. These results suggest that ESPB contributes to reduced opioid consumption, independent of patient characteristics and procedural factors.

4.4. Age and BMI Associations with Opioid Use

Our results indicate that individuals with a higher BMI required more PCA analgesia, possibly due to the lack of weight adjustment in ESPB local anesthetic volume as well as in PCA dosage measurements. In addition, studies have shown that obese patients experience higher failure rates and postoperative pain with various block types in the domain of regional anesthesia [19, 20]. We observed that older age was correlated with decreased hydromorphone PCA-MME and Total-MME; Lautenbacher et al.'s meta-analysis on pain thresholds and tolerance indicated that pain thresholds increase with age, suggesting that older adults experience reduced sensitivity to lower-intensity pain [21]. While our findings suggest possible associations between pain outcomes with both age and BMI, these relationships should be interpreted with caution and explored further through subgroup analyses that control for potential confounders.

4.5. Limitations

This study has several limitations. First, the retrospective design limits our ability to account for perioperative factors that were not consistently documented and prevents control over non-uniform perioperative management variables that may act as confounders, weakening the interpretation of observed differences. Additionally, ESPB administration was performed at the discretion of the attending anesthesiologist

rather than according to standardized institutional criteria. As a result, the decision to administer ESPB may have been influenced by patient comorbidities, perceived surgical complexity, or provider preference, introducing potential selection bias and confounding by indication. Evidence of this selection pattern is suggested by the imbalance in ASA classification between groups, including a lower proportion of ASA class IV patients receiving ESPB compared with the non-ESPB group (1.7% vs 9.1%, $p = 0.006$). Because ASA classification is associated with perioperative risk and postoperative analgesic requirements, this imbalance may partially confound the observed association between ESPB and opioid consumption. As a single-center study, the findings may not be generalized to other institutions with different patient populations, surgical practices, or institutional anesthesia practice patterns. Additionally, relatively small sample size may limit the power to detect significant differences, particularly in secondary outcomes like PACU stay or hospital length of stay. Furthermore, variability in ESPB administration (e.g., injectant volume, needle insertion depth, and anatomical targeting) could have introduced inconsistencies in block effectiveness. Another limitation relates to the inherent subjectivity of patient-reported pain scores, which may vary based on individual perception and reporting. Because pain assessments were derived from routine clinical documentation rather than standardized research assessments, measurement variability may have been introduced. The retrospective nature of the study also limits our ability to fully control confounders despite our statistical adjustments. Although multivariable regression was used to adjust for measured confounders such as age, BMI, ASA classification, and intraoperative opioid administration, residual confounding from unmeasured variables cannot be excluded. Consequently, causal inference regarding the effect of ESPB on opioid consumption should be interpreted cautiously.

4.6. Conclusion

In this retrospective cohort, ESPBs were associated with statistically significant reductions in postoperative opioid consumption following VATS. However, the absolute reduction of 10 intravenous MMEs (equivalent to 30 oral MMEs), while statistically significant, represents a modest effect that must be interpreted cautiously given the study's limitations, including the retrospective nature and variation in clinician practice patterns. The clinical relevance of this reduction in the context of multimodal analgesia remains uncertain. These findings suggest ESPB may modestly reduce opioid exposure; however, its clinical impact on recovery and patient-centered outcomes remain uncertain. While ESPB may reduce opioid requirements, it does not fully eliminate the need for multimodal analgesia. The continued opioid use, despite ESPB, likely reflects the complexity of thoracic surgery pain, which stems from multiple sources, including somatic, visceral, and neuropathic components. Although ESPB has been previously evaluated in randomized and observational studies, our findings

contribute additional real-world data regarding its use within contemporary multimodal analgesic protocols for minimally invasive thoracic surgery. Future studies with larger sample sizes, randomized controlled designs, long-term follow-up, and patient-reported satisfaction measures are needed to better understand the full benefits and limitations of ESPB in thoracic surgery.

Abbreviations

ASA	American Society of Anesthesiologists
CI	Confidence Interval
ESPB	Erector Spinae Plane Block
NRS	Numerical Rating Scale
PACU	Post-Anesthesia Care Unit
PCA	Patient-Controlled Analgesia
PCA-MME	Patient-Controlled Analgesia Morphine Milligram Equivalents
PONV	Postoperative Nausea and Vomiting
MME	Morphine Milligram Equivalents
Total-MME	Total Morphine Milligram Equivalents
SD	Standard Deviation
TEA	Thoracic Epidural Analgesia
VATS	Video-Assisted Thoracoscopic Surgery

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Data Availability Statement

The datasets generated and analyzed during this study con-

tain sensitive patient information and are not publicly available. Data cannot be shared to protect patient privacy and comply with institutional regulations. De-identified data can be shared with qualified researchers following approval by the NYU Langone Health Institutional Review Board.

Conflicts of Interest

The authors declare that they have no competing interests.

References

- [1] Erturk E, Aydogdu Kaya F, Kutani D, et al. The Effectiveness of Preemptive Thoracic Epidural Analgesia in Thoracic Surgery. *BioMed Research International*. 2014; 2014: 1-6. <https://doi.org/10.1155/2014/673682>
- [2] Jakobsen CJ. High thoracic epidural in cardiac anesthesia: a review: A review. *Semin Cardiothorac Vasc Anesth*. 2015; 19(1): 38-48. <https://doi.org/10.1177/1089253214548764>
- [3] Romero A, Garcia JEL, Joshi GP. The state of the art in preventing postthoracotomy pain. *Semin Thorac Cardiovasc Surg*. 2013; 25(2): 116-124. <https://doi.org/10.1053/j.semtcvs.2013.04.002>
- [4] D'Ercole F, Arora H, Kumar PA. Paravertebral block for thoracic surgery. *J Cardiothorac Vasc Anesth*. 2018; 32(2): 915-927. <https://doi.org/10.1053/j.jvca.2017.10.003>
- [5] Forero M, Adhikary SD, Lopez H, Tsui C, Chin KJ. The erector spinae plane block: A novel analgesic technique in thoracic neuropathic pain. *Reg Anesth Pain Med*. 2016; 41(5): 621-627. <https://doi.org/10.1097/AAP.0000000000000451>
- [6] Kalagara HK, Deichmann P, Brooks B, Nagi P, Kukreja P. T1 Erector Spinae Plane Block Catheter As a Novel Treatment Modality for Pancoast Tumor Pain. *Cureus*. 2019 Nov 7; 11(11): e6092. <https://doi.org/10.7759/cureus.6092>
- [7] The analgesic effect of erector spinae plane block in thoracic surgery: a systematic review and meta-analysis of randomized controlled trials. *Signa Vitae*. Published online 2021. <https://doi.org/10.22514/sv.2021.124>
- [8] Liao CA, Chen YJ, Shen SJ, et al. Erector spinae plane block (ESPB) enhances hemodynamic stability decreasing analgesic requirements in surgical stabilization of rib fractures (SSRFs). *World J Emerg Surg*. 2024; 19(1): 36. <https://doi.org/10.1186/s13017-024-00567-2>
- [9] Huda AU, Ghafoor H. The use of erector spinae plane block reduces opioid consumption and pain score in postoperative period after hip surgery: A meta-analysis. *Cureus*. 2023; 15(10): e47477. <https://doi.org/10.7759/cureus.47477>
- [10] Shim JG, Ryu KH, Kim PO, et al. Evaluation of ultrasound-guided erector spinae plane block for postoperative management of video-assisted thoracoscopic surgery: a prospective, randomized, controlled clinical trial. *J Thorac Dis*. 2020; 12(8): 4174-4182. <https://doi.org/10.21037/jtd-20-689>
- [11] Klaibert B, Lohser J, Tang R, Jew M, McGuire A, Wilson J. Efficacy of ultrasound-guided single-injection erector spinae plane block for thoracoscopic wedge resection: a prospective randomized control trial. *Reg Anesth Pain Med*. 2022; 47(12): 749-754. <https://doi.org/10.1136/rapm-2022-103602>
- [12] Hong JM, Kim E, Jeon S, et al. A prospective double-blinded randomized control trial comparing erector spinae plane block to thoracic epidural analgesia for postoperative pain in video-assisted thoracic surgery. *Saudi Med J*. 2023; 44(2): 155-163. <https://doi.org/10.15537/smj.2023.44.2.20220644>
- [13] Clairoux A, Moore A, Caron-Goudreault M, et al. Erector spinae plane block did not improve postoperative pain-related outcomes and recovery after video-assisted thoracoscopic surgery: a randomised controlled double-blinded multi-center trial. *BMC anesthesiology*. 2024; 24(1): 156. <https://doi.org/10.1186/s12871-024-02544-3>
- [14] Orhon Ergun M, Guclu Ozturk E, Zengin SU. Effects of Erector Spinae Plane Block on Postoperative Pain and Quality of Recovery Questionnaire Scores in Video-Assisted Thoracoscopic Surgery: A Randomized Controlled Study. *Cureus*. Published online March 13, 2023. <https://doi.org/10.7759/cureus.36089>
- [15] Hussain N, Brull R, Noble J, et al. Statistically significant but clinically unimportant: a systematic review and meta-analysis of the analgesic benefits of erector spinae plane block following breast cancer surgery. *Regional Anesthesia & Pain Medicine*. 2020; 46(1): 3-12. <https://doi.org/10.1136/rapm-2020-101917>
- [16] Nair A, Saxena P, Borkar N, Rangaiah M, Arora N, Mohanty PK. Erector spinae plane block for postoperative analgesia in cardiac surgeries- A systematic review and meta-analysis. *Ann Card Anaesth*. 2023 Jul-Sep; 26(3): 247-259. https://doi.org/10.4103/aca.aca_148_22
- [17] Altıparmak B, Korkmaz Toker M, Uysal Aİ, Gümüş Demirebilek S. Comparison of the efficacy of erector spinae plane block performed with different concentrations of bupivacaine on postoperative analgesia after mastectomy surgery: randomized, prospective, double blinded trial. *BMC Anesthesiol*. 2019; 19(1): 31. <https://doi.org/10.1186/s12871-019-0700-3>
- [18] Zengin M, Sazak H, Baldemir R, et al. Comparison of analgesic efficacy of different local anesthetic volumes for erector spinae plane block in thoracotomy patients; a prospective randomized trial. *BMC Anesthesiol*. 2023; 23(1): 42. <https://doi.org/10.1186/s12871-023-02004-4>
- [19] Nielsen KC, Guller U, Steele SM, Klein SM, Greengrass RA, Pietrobon R. Influence of obesity on surgical regional anesthesia in the ambulatory setting: an analysis of 9,038 blocks. *Anesthesiology*. 2005; 102(1): 181-187. <https://doi.org/10.1097/00000542-200501000-00027>
- [20] Zengin M, Ulger G, Baldemir R, Sazak H, Alagoz A. Is there a relationship between body mass index and postoperative pain scores in thoracotomy patients with thoracic epidural analgesia? *Medicine (Baltimore)*. 2021; 100(50): e28010. <https://doi.org/10.1097/MD.00000000000028010>

- [21] Lautenbacher S, Peters JH, Heesen M, Scheel J, Kunz M. Age changes in pain perception: A systematic-review and meta-analysis of age effects on pain and tolerance thresholds. *Neurosci Biobehav Rev.* 2017; 75: 104-113.
<https://doi.org/10.1016/j.neubiorev.2017.01.039>