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BILATERAL ERECTOR SPINAE PLANE BLOCK IN OPEN SPINAL FIXATION SURGERY: A COMPARATIVE STUDY OF SAFETY AND CLINICAL OUTCOMES

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Abstract

Objective: Open thoracic and lumbar spinal fixation surgery is associated with severe postoperative pain resulting from extensive tissue injury, muscle dissection, periosteal trauma, and instrumentation. Effective postoperative analgesia is essential for early mobilization and functional recovery. Regional anesthesia techniques have become increasingly important components of multimodal analgesic protocols aimed at reducing perioperative opioid exposure and opioid-related adverse effects. The primary objective of this study was to evaluate the safety profile of bilateral erector spinae plane block (ESPB) in patients undergoing open thoracic and lumbar spinal fixation surgery.

Secondary objectives included assessment of intraoperative and postoperative opioid requirements, postoperative pain intensity during the first 48 hours, length of hospital stay, postoperative nausea and vomiting.

Materials and Methods: We performed a comparative clinical study involving 100 patients scheduled for open thoracic or lumbar spinal fixation surgery. Patients were divided into two groups, each comprising 50 patients.

The opioid group (OG) received intermittent fentanyl-based analgesia, whereas the ESPB group (ESPBG) underwent bilateral ultrasound-guided erector spinae plane block with administration of 10 mL of 1% lidocaine and 20 mL of 0.25% bupivacaine on each side.

Postoperative pain intensity was assessed using the Numeric Rating Scale (NRS) at 1, 4, 8, 12, 24, 36, and 48 hours after surgery. Statistical analysis included Student's t-test, Mann–Whitney U test, Pearson chi-square analysis, Cramer's V coefficient, Friedman ANOVA, and Pearson correlation analysis.

Results: Compared with intermittent opioid analgesia, bilateral ESPB was associated with significantly lower fentanyl and tramadol consumption, lower postoperative pain scores, shorter hospital stay, and reduced incidence of postoperative nausea and vomiting.

No major block-related complications were observed.

Conclusion: Bilateral erector spinae plane block demonstrated a favorable safety profile and significant opioid-sparing effects in patients undergoing spinal fixation surgery. These findings support the incorporation of ESPB into multimodal analgesic protocols and enhanced recovery pathways.

Keywords: *enhanced recovery after surgery; erector spinae plane block; fentanyl; multimodal analgesia; opioid consumption.*

Introduction

Open thoracic and lumbar spinal fixation surgery is associated with substantial postoperative pain due to extensive tissue injury, periosteal trauma, muscle dissection, instrumentation, and activation of inflammatory pathways (1,2). Inadequately controlled acute pain delays mobilization, impairs rehabilitation, prolongs hospital stay, and contributes to the development of persistent postsurgical pain (3,4).

Although opioids remain the cornerstone of perioperative analgesia, their use is limited by adverse effects such as postoperative nausea and vomiting, sedation, respiratory depression, ileus, urinary retention, opioid-induced hyperalgesia, and the risk of prolonged opioid exposure (2,5).

Consequently, contemporary perioperative pain management increasingly emphasizes multimodal analgesic strategies designed to minimize opioid consumption while maintaining adequate analgesia (6,7).

The erector spinae plane block (ESPB), first described by Forero et al. in 2016, represents a relatively novel ultrasound-guided interfascial plane block initially introduced for the treatment of thoracic neuropathic pain (8). Since its original description, the indications for ESPB have expanded considerably, including thoracic, breast, abdominal, cardiac, orthopedic, and spinal surgery (9-11).

The technique involves deposition of local anesthetic deep to the erector spinae muscle and superficial to the transverse process, resulting in cranio-caudal spread and multisegmental analgesia through effects on the dorsal and ventral rami of spinal nerves (12,13). Cadaveric and imaging studies have demonstrated extension of local anesthetic toward the paravertebral space and neural foramina, supporting the anatomical basis of the block (12).

Compared with epidural analgesia and paravertebral block, ESPB is technically simpler and potentially safer because the injection site is superficial and distant from the pleura, spinal cord, and major vascular structures (9,10,14). Therefore, ESPB has emerged as an attractive component of multimodal analgesic and Enhanced Recovery After Surgery (ERAS) protocols (6,7).

Several systematic reviews and meta-analyses have demonstrated that ESPB significantly reduces postoperative pain intensity and opioid consumption following lumbar spinal surgery (15-17). Similarly, randomized clinical studies have reported improved postoperative analgesia and decreased rescue opioid requirements after lumbar ESPB (18).

Nevertheless, despite growing evidence regarding the analgesic efficacy of ESPB, additional studies evaluating its safety profile and clinical outcomes in spinal fixation surgery remain necessary.

Therefore, the present study aimed to investigate the safety and clinical efficacy of bilateral erector spinae plane block in patients undergoing open thoracic and lumbar spinal fixation surgery.

Therefore, the present study aimed to investigate the safety and clinical efficacy of bilateral erector spinae plane block in patients undergoing open thoracic and lumbar spinal fixation surgery. The primary objective of the present study was to evaluate the safety profile of bilateral erector spinae plane block (ESPB) in patients undergoing open thoracic and lumbar spinal fixation surgery.

Secondary objectives included evaluation of: intraoperative fentanyl consumption; postoperative tramadol requirements; postoperative pain intensity during the first 48 hours; length of hospital stay; incidence of postoperative nausea and vomiting (PONV); occurrence of vertigo and nystagmus.

Materials and Methods

Study Design

The research is a randomized, prospective, interventional clinical study using parallel groups of randomly selected patients. A comparative clinical study involving 100 patients undergoing open thoracic or lumbar spinal fixation surgery was performed.

The randomization of patients was done using computer software that randomly allocated the study participants to one of the two groups (www.randomizer.org)

After induction of anesthesia, patients were divided into 2 groups:

- Group 1 (OG-opioid group): 50 patients who received intermittent opioid – fentanyl as analgesia

- Group 2 (ESPBG): 50 patients who received bilateral ESPB under ultrasound guidance after being placed in the prone position and marked with X-ray. The block was performed one level above the injury, using 10 ml Lidocaine 1% and 20 ml Bupivacaine 0.25% on each side.

Patients received Dexamethasone 0.1 mg/kg and 1 g. Paracetamol before induction of anesthesia (as preemptive analgesia). Immediately after intubation, an i.v. Ketamine 0.5 mg/kg and continuous intravenous (iv) infusion of Magnesium sulfate 1.5 g was given.

Fentanyl was added intermittently during surgery, if there was an increase in blood pressure (BP) and heart rate (HR) by over 20% of the initial (baseline) value without blood loss and sweating of the patient

Postoperative Analgesia

Patients from the opioid group (OG) for postoperative analgesia received amp. Metamizole 2 gr. every 12 hours and amp. Paracetamol 1 gr. every 8 hours.

Postoperatively, patients from group 2 (ESPBG) received a continuous intravenous 0.10 mg/kg/bw/hour Ketamine infusion for 48 hours, amp. Metamizole 2 g every 12 hours and amp Paracetamol 1 g every 8 hours. Amp. Dexamethasone 8 mg for 3 days, and another 3 days of 4 mg.

The NRS score at rest was monitored in each of the groups, and if the NRS score was above 7, Tramadol 100 mg was administered.

Patient Characteristics

Patients in both groups were classified according to the American Society of Anesthesiologists (ASA) physical status classification system.

The following demographic and perioperative variables were analyzed: age; sex; body mass index (BMI); fixation level; duration of surgery; postoperative pain intensity; opioid consumption; postoperative complications; duration of hospitalization.

Inclusion Criteria were: adult patients undergoing elective open thoracic or lumbar spinal fixation surgery; ASA physical status I–III; availability of complete perioperative and postoperative records.

Exclusion Criteria were: known allergy to local anesthetics; infection at the puncture site; coagulopathy or anticoagulant therapy contraindicating regional anesthesia; severe hepatic or renal dysfunction; incomplete clinical data.

Pain Assessment

Postoperative pain intensity was evaluated using the Numeric Rating Scale (NRS), where:

- 0 represented no pain;
- 10 represented the worst imaginable pain.

Measurements were obtained at: 1 hour; 4 hours; 8 hours; 12 hours; 24 hours; 36 hours; 48 hours after surgery.

Outcome Measures

Primary outcome were safety profile of bilateral ESPB. Secondary outcomes were: intraoperative fentanyl consumption; postoperative tramadol requirements; total tramadol dose; postoperative pain scores; length of hospital stay; postoperative nausea and vomiting; vertigo and nystagmus; chronic postoperative pain.

Statistical Analysis

Statistical analysis was performed using standard descriptive and inferential statistical methods. Continuous variables were expressed as mean ± standard deviation, minimum, and maximum values. Categorical variables were presented as absolute numbers and percentages. Comparisons between groups were performed using: Student's t-test; Mann–Whitney U test; Difference test; Pearson chi-square test; Cramer's V coefficient; Friedman analysis of variance (ANOVA); Pearson correlation analysis. A p value lower than 0.05 was considered statistically significant.

Results

Demographic and Operative Characteristics

A total of 100 patients were included in the study, with 50 patients in each group.

The groups were comparable with regard to age and duration of surgery. No statistically significant differences were observed between groups concerning baseline characteristics (Table 1.).

Table 1. Demographic and Operative Characteristics

Parameter	Opioid Group (n=50)	ESPB Group (n=50)	p value
Age (years)	51.9 ± 11.2 (21–78)	51.7 ± 14.1 (21–71)	0.918918
Operative duration (min)	201.8 ± 55.8 (150–400)	200.4 ± 51.5 (100–350)	0.896568
Male sex	37 (74.0%)	28 (56.0%)	0.0592
Female sex	13 (26.0%)	22 (44.0%)	0.0592

Distribution of Instrumented Levels

The most commonly instrumented vertebral levels were L1 and Th12 (Table 2).

Table 2. Distribution of Fixation Levels

Level	Opioid Group n (%)	ESPB Group n (%)
L1	16 (32.0%)	22 (44.0%)
L2	8 (16.0%)	6 (12.0%)
L3	3 (6.0%)	4 (8.0%)
L4	4 (8.0%)	3 (6.0%)
L5	0	1 (2.0%)
Th3	1 (2.0%)	1 (2.0%)

Th4	1 (2.0%)	0
Th7	1 (2.0%)	1 (2.0%)
Th8	1 (2.0%)	1 (2.0%)
Th10	3 (6.0%)	0
Th11	1 (2.0%)	3 (6.0%)
Th12	11 (22.0%)	8 (16.0%)

Opioid Consumption

Patients receiving bilateral ESPB required significantly lower doses of fentanyl and tramadol (Table 3).

Table 3. Fentanyl and Tramadol Consumption

Parameter	Opioid Group	ESPB Group	p value
Fentanyl (μg)	480.0 ± 76.9	113.0 ± 24.3	<0.001
In-hospital tramadol (mg)	1010.0 ± 548.9	222.0 ± 154.2	<0.001

Total tramadol dose (mg)	412.0 ± 96.1	128.6 ± 48.8	0.000057

Postoperative Pain Intensity

Pain scores were significantly lower in the ESPB group throughout the first 48 postoperative hours (Table 4.)

Table 4. Postoperative NRS Pain Scores

Time after surgery	Opioid Group	ESPB Group	p value
1 hour	6.5 ± 0.8	3.2 ± 1.8	<0.001
4 hours	7.3 ± 0.6	4.1 ± 1.2	<0.001
8 hours	7.2 ± 0.7	4.1 ± 1.4	<0.001
12 hours	6.4 ± 0.9	3.6 ± 1.4	<0.001
24 hours	5.6 ± 0.9	3.0 ± 1.0	<0.001
36 hours	4.8 ± 0.7	2.7 ± 1.0	<0.001
48 hours	4.3 ± 0.8	2.6 ± 1.0	<0.001

Friedman ANOVA demonstrated a statistically significant reduction in pain scores over time in both groups ($p < 0.001$).

Length of Hospital Stay

Hospital stay was significantly shorter in patients receiving ESPB (Table 5.).

Table 5. Length of Hospital Stay

Parameter	Opioid Group	ESPB Group	p value
Hospital stay (days)	13.0 ± 3.9	10.1 ± 4.0	0.0005 61

Adverse Events and Safety Outcomes

Postoperative nausea and vomiting occurred significantly less in the ESPB group (Table 6.).

Table 6. Adverse Events

Outcome	Opioid Group	ESPB Group	p value
PONV – Yes	13 (26.0%)	5 (10.0%)	0.0373
PONV – No	37 (74.0%)	45 (90.0%)	0.0373
Vertigo/Nystagmus – Yes	1 (2.0%)	5 (10.0%)	0.0921
Vertigo/Nystagmus – No	49 (98.0%)	45 (90.0%)	0.0921

No severe block-related complications, including infection, hematoma, neurological deterioration, or local anesthetic systemic toxicity were observed.

Moderate positive correlations were identified between tramadol consumption and duration of hospital stay (Table 7.).

Table 7. Correlation Analysis

Correlation	r	p value
Tramadol consumption vs. hospital stay (OG)	0.4606	0.001
Tramadol consumption vs. hospital stay (ESPBG)	0.4605	0.001
Fentanyl dose vs. BMI (OG)	0.2891	0.042
Fentanyl dose vs. BMI (ESPBG)	-0.0064	0.965

Discussion

The present study demonstrated that bilateral erector spinae plane block (ESPB) provided superior postoperative analgesia and significant opioid-sparing effects in patients undergoing open thoracic and lumbar spinal fixation surgery. Compared with conventional intermittent opioid analgesia, patients receiving ESPB experienced significantly lower fentanyl and tramadol consumption, reduced postoperative pain scores, shorter hospital stay, and a lower incidence of postoperative nausea and vomiting.

The findings of the present investigation are consistent with the growing body of evidence supporting the use of ESPB in spine surgery and other major procedures (8,9,15,19).

Open spinal fixation surgery is associated with extensive tissue injury and activation of inflammatory pathways, resulting in severe postoperative pain (1,2). Inadequately controlled acute pain may impair rehabilitation and contribute to the development of chronic postsurgical pain through mechanisms involving peripheral and central sensitization (3,4).

The most prominent finding of the present study was the marked reduction in intraoperative fentanyl requirements. Mean fentanyl consumption in the ESPB group was approximately four times lower than that observed in the opioid group. These findings are consistent with the report by Chin and Lewis, who demonstrated successful opioid-free posterior spinal fusion surgery using ESPB as part of a multimodal analgesic regimen (19).

Similarly, Oh et al. performed a systematic review and meta-analysis and concluded that ESPB significantly reduced opioid consumption and postoperative pain intensity after lumbar spine surgery (15). Comparable results were reported by Fu et al., whose meta-analysis showed improved postoperative analgesia and lower opioid requirements in patients receiving ESPB (16).

More recently, Wilson et al. confirmed that ESPB significantly decreases cumulative opioid consumption and pain intensity following lumbar spine procedures (17). Likewise, randomized controlled studies conducted by Zhao et al. demonstrated superior analgesic efficacy and reduced rescue analgesic requirements after lumbar ESPB (18).

The mechanism of action of ESPB remains incompletely understood. Cadaveric and radiological investigations suggest cranio-caudal spread of local anesthetic with extension toward the dorsal rami, ventral rami, and paravertebral space (12,13). These anatomical characteristics explain ESPB's ability to provide multisegmental analgesia. Interfascial plane blocks have become essential components of modern regional anesthesia practice (14).

The favorable safety profile observed in our study deserves particular emphasis. No severe complications, including local anesthetic systemic toxicity, infection, hematoma formation, or neurological deterioration, were identified. Similar findings have been reported by Oezel et al., who reported a very low incidence of procedure-specific complications after lumbar ESPB (20).

The absence of major adverse events may be explained by the anatomical characteristics of the block. In contrast to epidural analgesia and paravertebral block, ESPB is performed in a superficial fascial plane remote from major vascular structures, pleura, and the neuraxis (9,10). Consequently, the technique is generally considered technically simple and relatively safe (10).

Patients receiving ESPB also experienced a significantly lower incidence of postoperative nausea and vomiting. This finding most likely reflects reduced opioid exposure. Opioid-related adverse effects remain among the principal obstacles to enhanced postoperative recovery (2,5).

The approximately three-day reduction in hospital stay observed in our study is clinically important. Enhanced Recovery After Surgery (ERAS) programs emphasize multimodal analgesia, opioid minimization, and early mobilization as key factors contributing to improved surgical outcomes (6,7). Kehlet and colleagues have repeatedly highlighted the importance of effective analgesia in promoting postoperative recovery and reducing morbidity (1,4,7).

Persistent postsurgical pain represents a significant long-term complication following spinal surgery (3,4). Chronic pain is believed to result from sustained nociceptive input and central sensitization mechanisms. Adequate perioperative analgesia and reduction of opioid

exposure may contribute to lowering the incidence of chronic pain, although further prospective studies are necessary to confirm this hypothesis.

The moderate positive correlation observed between tramadol consumption and duration of hospital stay suggests that increased analgesic requirements may be associated with delayed recovery. Similar associations between pain severity and prolonged hospital stay have been reported in previous investigations (1,2).

Overall, the present study supports the integration of bilateral ESPB into multimodal perioperative analgesic protocols and ERAS pathways for spinal surgery. The technique provided effective analgesia, reduced opioid consumption, decreased opioid-related adverse effects, and demonstrated a favorable safety profile consistent with contemporary literature (15–19).

Clinical Implications

The results of the present study have several important clinical implications.

First, bilateral ESPB may be incorporated into standardized multimodal analgesic protocols for thoracic and lumbar spinal fixation surgery.

Second, reduction of opioid consumption may decrease opioid-related complications and facilitate earlier mobilization and rehabilitation.

Third, the favorable safety profile observed in the present study supports broader implementation of ultrasound-guided ESPB in routine clinical practice.

Finally, integration of ESPB into ERAS pathways may contribute to shorter hospital stay and improved postoperative outcomes.

Study Limitations

Several limitations should be acknowledged.

First, the present study was based on aggregated statistical data and lacked complete access to individual patient-level variables.

Second, standardization of surgical procedures and postoperative rehabilitation protocols was limited.

Third, rare complications could not be adequately assessed because of the relatively small sample size.

Nevertheless, despite these limitations, the consistency of the results across multiple clinical outcomes strongly supports the beneficial effects of bilateral ESPB.

Conclusion

Bilateral erector spinae plane block demonstrated a favorable safety profile and significant analgesic efficacy in patients undergoing open thoracic and lumbar spinal fixation surgery.

Compared with intermittent opioid analgesia, ESPB was associated with significantly lower fentanyl and tramadol requirements, lower postoperative pain scores during the first 48 hours, shorter hospital stay, and reduced incidence of postoperative nausea and vomiting. No major block-related complications were observed.

These findings support the incorporation of bilateral ESPB into multimodal perioperative analgesic protocols and Enhanced Recovery After Surgery programs for spinal fixation procedures.

Further prospective randomized studies with larger patient populations are warranted to confirm these findings and to evaluate long-term outcomes.

Declarations

Ethics approval and consent to participate: The study has approval from the Ethics Committee for Research on Humans at the Faculty of Medicine - Skopje, approval no. 03-2031/9 dated 16.04.2024 The present study was performed using anonymized clinical and statistical data without personal identifiers. The investigation was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki and Good Clinical Practice guidelines.

Informed consent: Written informed consent was obtained from all participants included in the study.

Conflict of Interest: The author declares that there are no conflicts of interest related to this study.

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Authors' contributions: A.D contributed to the study design, data collection, analysis, interpretation of results, and manuscript preparation.

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