



A PROSPECTIVE RANDOMIZED CONTROLLED TRIAL EVALUATING ULTRASOUND-GUIDED THORACIC ERECTOR SPINAE PLANE BLOCK VERSUS PARAVERTEBRAL BLOCK FOR ANALGESIA IN PATIENTS WITH MULTIPLE RIB FRACTURES IN A TERTIARY CARE HOSPITAL

Dr Jayakumar C¹, Dr Preethi P^{2*}

¹Professor, Department of Anaesthesia, Sree Mookambika Institute of Medical Sciences, Kanyakumari, Tamil Nadu, India.

²Junior Resident, Department of Anaesthesia, Sree Mookambika Institute of Medical Sciences, Kanyakumari, Tamil Nadu, India.

Corresponding Author*: Dr Preethi P, Junior Resident, Department of Anaesthesia, Sree Mookambika Institute of Medical Sciences, Kanyakumari, Tamil Nadu, India.

Email ID: preethidaniel2695@gmail.com

DOI: <https://doi.org/10.59551/IJHMP/25832069/2026.7.2.105>

How to cite this article: Jayakumar C, Preethi P. A Prospective Randomized Controlled Trial Evaluating Ultrasound-Guided Thoracic Erector Spinae Plane Block Versus Paravertebral Block for Analgesia in Patients with Multiple Rib Fractures in a Tertiary Care Hospital. *Indian J. Health Care, Med. Pharm. Pract.* 2026;7(2):29-34.

COPYRIGHT@ 2026, IJHMP | This work is licensed under a [Creative Commons Attribution 4.0 International Licence](https://creativecommons.org/licenses/by/4.0/) 

Received: 15 April, 2026, Decision for Acceptance: 11 July, 2026

ABSTRACT

Background: Multiple rib fractures are commonly associated with severe pain, impaired respiratory function, and increased risk of pulmonary complications. Effective analgesia is essential to improve patient outcomes. Ultrasound-guided regional techniques such as thoracic erector spinae plane block (ESPB) and paravertebral block (PVB) are increasingly used, but comparative evidence remains limited.

Methods: This prospective randomized controlled trial was conducted in 100 patients with multiple rib fractures between June 2024 and June 2026. Patients were randomly allocated into two groups: ESPB group (n=50) and PVB group (n=50). Hemodynamic parameters, Visual Analog Scale (VAS) pain scores, fentanyl consumption, and time to rescue analgesia were assessed at predefined intervals up to 48 hours.

Results: Baseline characteristics were comparable between the groups. There was no statistically significant difference in heart rate, mean arterial pressure, or VAS pain scores at rest and during movement at any time interval ($p>0.05$). However, fentanyl consumption was significantly lower in the ESPB group ($134.9\pm35.8\text{ }\mu\text{g}$) compared to the PVB group ($176.87\pm27.5\text{ }\mu\text{g}$) ($p=0.0001$). Additionally, time to rescue analgesia was significantly prolonged in the ESPB group (154 minutes) compared to the PVB group (74 minutes) ($p=0.027$).

Conclusion: Ultrasound-guided ESPB provides analgesia comparable to PVB with reduced opioid requirement and longer duration of action, making it a favorable option in managing pain due to multiple rib fractures.

KEYWORDS: Erector Spinae Plane Block, Paravertebral Block, Rib Fractures, Analgesia, Ultrasound-Guided Block, Randomized Controlled Trial.

Introduction

Rib fractures are a common consequence of blunt chest trauma and are reported in more than half of such cases, contributing substantially to morbidity, prolonged disability,

and increased mortality[1,2]. The management of rib fractures does not fall within a single specialty; rather, it involves a multidisciplinary approach including orthopedics, trauma surgery, anesthesiology, and thoracic surgery. Core aspects of care encompass initial stabilization, effective

pain control, appropriate selection of surgical fixation when indicated, and measures to improve long-term functional outcomes and quality of life[2].

Pain resulting from multiple rib fractures is typically severe and often challenging to manage. It significantly interferes with normal respiratory mechanics and can restrict chest wall movement[3,4]. Patients frequently experience exacerbation of pain during inspiration, leading to shallow breathing and impaired cough effort. This, in turn, results in inadequate clearance of airway secretions and sputum retention, predisposing patients to complications such as atelectasis and pneumonia[3–5]. Furthermore, compromised ventilation contributes to impaired gas exchange, thereby worsening overall pulmonary function and increasing the risk of respiratory failure[6–9]. Hence, effective analgesia plays a pivotal role not only in improving patient comfort but also in preventing pulmonary complications and enhancing recovery.

Regional anesthesia techniques have emerged as key components in the multimodal management of rib fracture pain. Among these, thoracic paravertebral block (PVB) has long been considered a standard technique due to its ability to provide unilateral, segmental analgesia with favorable effects on respiratory function. However, it is technically demanding and carries risks such as pneumothorax and vascular injury. More recently, the erector spinae plane block (ESPB) has gained popularity as a relatively simpler and safer alternative. Performed under ultrasound guidance, ESPB involves the deposition of local anesthetic in the fascial plane deep to the erector spinae muscle, resulting in effective analgesia over multiple dermatomes.

Despite increasing use, there remains a need for high-quality evidence comparing the analgesic efficacy and safety profiles of ESPB and PVB in patients with multiple rib fractures. Therefore, this randomized controlled trial aims to evaluate and compare ultrasound-guided thoracic erector spinae plane block and paravertebral block in the management of pain in this patient population.

Aim

To compare the effectiveness of ultrasound-guided thoracic erector spinae plane block and thoracic paravertebral block in providing analgesia for patients with multiple rib fractures.

Objectives

Primary Objective

To evaluate and compare the analgesic efficacy of ultrasound-guided thoracic erector spinae plane block and paravertebral block using pain scores (e.g., VAS/NRS) in patients with multiple rib fractures.

Secondary Objectives

To compare opioid/analgesic consumption between the two groups.

To assess improvement in respiratory parameters (such as respiratory rate, oxygen saturation, and incentive spirometry performance).

Materials and Methods

This prospective, randomized controlled trial was conducted at Sree Mookambika Institute of Medical Sciences, a tertiary care teaching hospital, over a period of two years from June 2024 to June 2026, following approval from the Institutional Ethics Committee. Written informed consent was obtained from all participants or their legally authorized representatives prior to inclusion in the study. Adult patients aged 18 years and above presenting with multiple rib fractures secondary to blunt chest trauma and experiencing moderate to severe pain (Visual Analog Scale [VAS] score ≥ 4) were enrolled. Patients were recruited from the emergency department and intensive care units. Individuals who refused consent, had known hypersensitivity to local anesthetics, coagulopathy, were on anticoagulant therapy, had infection at the site of injection, severe head injury with altered consciousness, pre-existing chronic pain conditions, opioid dependence, or hemodynamic instability were excluded from the study.

The sample size was calculated based on previous studies, considering a power of 80% and a significance level of 5%, and a total of ____ patients were included. Participants were randomly allocated into two groups using a computer-generated randomization sequence with allocation concealment achieved through sealed opaque envelopes. Group E received ultrasound-guided thoracic erector spinae plane block (ESPB), while Group P received ultrasound-guided thoracic paravertebral block (PVB). All procedures were performed under strict aseptic precautions by experienced anesthesiologists using ultrasound guidance. For the ESPB, a high-frequency linear probe was used to identify the transverse process and the overlying erector spinae muscle at the appropriate thoracic level, and local anesthetic was injected into the fascial plane after confirmation of needle placement. In the PVB group, the thoracic paravertebral space was identified under ultrasound guidance, and local anesthetic was administered after careful needle placement and negative aspiration.

Pain intensity was assessed using the VAS score at baseline and at predefined intervals (1, 6, 12, 24, and 48 hours) following the procedure. Secondary outcomes included total opioid consumption within 48 hours, respiratory parameters such as respiratory rate, oxygen saturation, and incentive spirometry performance, incidence of pulmonary complications including atelectasis and pneumonia, duration of analgesia, patient satisfaction, and any procedure-related complications such as pneumothorax, hypotension, or local anesthetic toxicity. All relevant clinical and demographic data were recorded using a structured data collection form, and patients were monitored throughout their hospital stay. Statistical analysis was performed using appropriate

software, with continuous variables expressed as mean $\pm$ standard deviation and compared using the independent t-test, while categorical variables were analyzed using the chi-square test or Fisher's exact test. A p-value of less than 0.05 was considered statistically significant.

Results

Effect of paravertebral block versus erector spinae block was assessed in 100 patients with multiple rib fractures with respect to haemodynamic status, VAS pain score, fentanyl consumption and time to rescue analgesia after block.

Mean of age of patients in ESPB group (52.7 with range

32-75 years) was slightly more than PVB group (49.1 with range 34-72 years) but was not significant statistically with P value- 0.0607. Mean weight and BMI of patients in both the groups were comparable. Mean of number of fractured ribs were slightly more in PVB (4.8) compared to ESPB (4.3) group but this difference was not significant statistically (Table 1).

Mean of heart rate in patients of either groups showed no significant difference at baseline, immediately after block and at intervals of 30 mins, 60 mins, 4 hours, 8 hours, 12 hours, 16 hours, 20 hours, 24 hours and 48 hours (with $P > 0.05$ at all the intervals).

Table 1: Distribution by patients characteristic

Variable (Mean $\pm$ SD)	ESPB (n=50)	PVB(n=50)	Independent sample t test/ p value
Age in years	52.7 $\pm$ 7.82	49.12 $\pm$ 10.81	1.897/ 0.0607 Not significant
Weight in kgs	62.6 $\pm$ 12.84	63.63 $\pm$ 10.75	0.338/0.737 Not significant
BMI	21.6 $\pm$ 2.28	22.1 $\pm$ 1.9	1.19/0.236 Not significant
No. of fractured ribs	4.3 $\pm$ 2.2	4.8 $\pm$ 1.8	1.24/0.216 Not significant

Table 2: Mean heart rate in group ESPB versus PVB

Heartrate	Group	Mean	Std. Deviation	T statistic/p value
Heartrate baseline	ESPB	79.7	25.1	0.53/ 0.59
	PVB	77.3	20.2	
HR Immediate	ESPB	72.3	15.6	-0.317/0.75
	PVB	73.4	18.9	
30 mins	ESPB	89.7	9.5	-0.049/0.96
	PVB	89.8	10.8	
60 mins	ESPB	89.8	13.9	0.571/ 0.570
	PVB	87.6	12.5	
4hrs	ESPB	88.5	16.8	0.832/ 0.407
	PVB	86.7	14.4	
8hrs	ESPB	88.5	13.6	1.63/ 0.106
	PVB	83.9	14.6	
12hrs	ESPB	85.6	12.5	0.773/ 0.441
	PVB	83.3	16.9	
16hrs	ESPB	87.1	14.1	0.904/ 0.368
	PVB	89.8	15.7	
20hrs	ESPB	91.7	13.6	0.62/ 0.53
	PVB	89.9	15.3	
24hrs	ESPB	91.7	12.7	1.28/ 0.204
	PVB	87.8	13.9	
48 hrs	ESPB	88.5	13.6	1.63/ 0.106
	PVB	83.9	14.6	

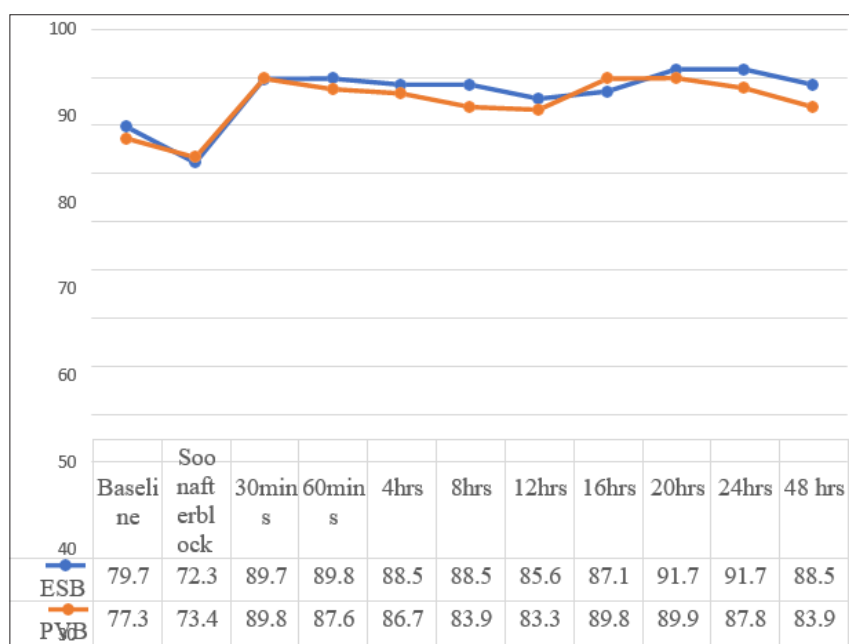


Figure 1. Mean of Heart rate in patients given ESPB versus PVB

Mean of MAP in patients of either groups decreased when compared to baseline after the block which was not significant statistically. Mean MAP showed no significant difference immediately after block and at intervals of 30 mins, 60 mins, 4 hours, 8 hours, 12 hours, 16 hours, 20 hours, 24 hours and 48 hours (with $P > 0.05$ at all the intervals).

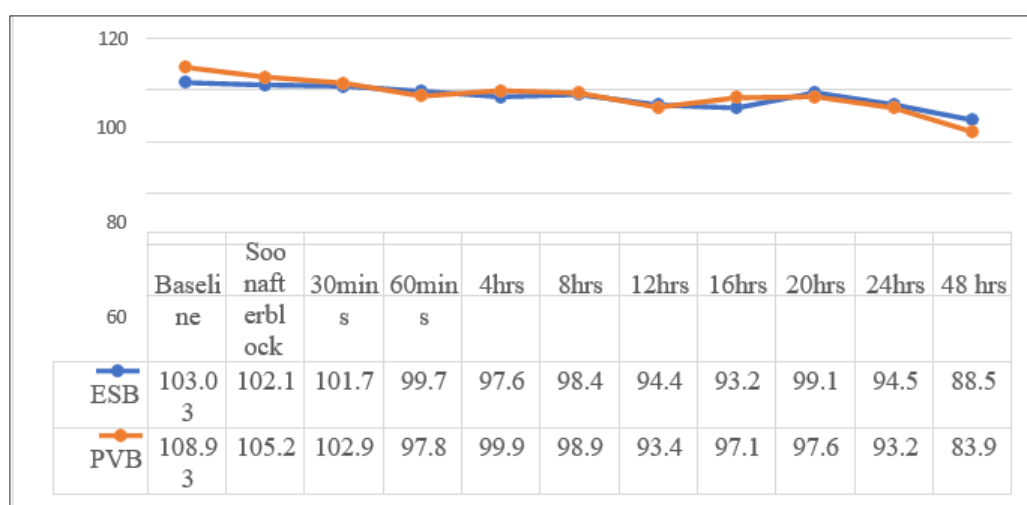


Figure 2. Mean arterial pressure in group ESPB versus PVB

Mean and SD of fentanyl consumption in patients of group PVB (176.87 ± 27.5 microgram) was more which was statistically significant when compared to group ESPB (134.9 ± 35.8 microgram) with t statistic 6.58 and p value 0.0001.

Table 3: Fentanyl consumption in group ESPB versus PVB

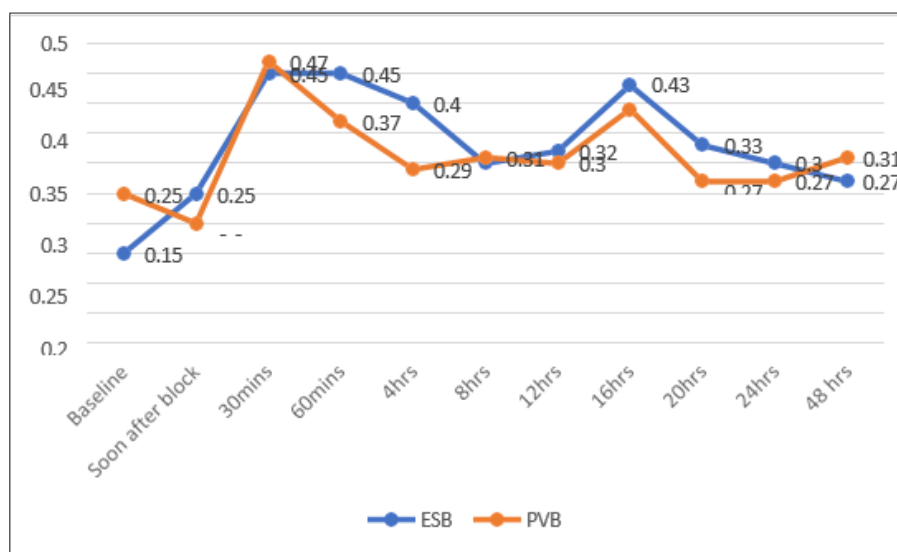
Fentanyl Consumption				
Group	Mean	N	Std. Deviation	T-test/ P-value
ESPB	134.9	50	35.8	6.58/0.0001
PVB	176.87	50	27.5	
Total	142.42	60	36.085	

Mean, median and range for time to rescue analgesia was more in ESPB group (154 minutes, 0 min, 0 min to 1280 minutes) compared to PVB group (74 minutes, 0 mins and 0 min to 1020 minutes). Mann whitney U test showed that, this difference was significant statistically with p value 0.027.

Table 4: Timetorescue Analgesia in group ESPB versus PVB

Group	Timetorescue analgesic	Statistic in minutes	Mannwhitney Utest /P value
ESPB	Mean (SD)	154 (239)	9.37 / 0.027
	Range	0 – 1280 minutes	
	Median (interquartile range)	0min (0 min)	
PVB	Mean (SD)	74 (248)	
	Range	0-1020 minutes	
	Median (interquartile range)	0min (0 min)	

No significant difference in VAS scores in both the groups (at rest or on movement) when measured at baseline, immediately after block and at intervals of 30 mins, 60 mins, 4hours, 8 hours, 12hours, 16 hours, 20 hours, 24 hours and 48 hours (with $P>0.05$ at all the intervals).

**Figure 3. Mean VAS scores in group ESPB versus PVB on movement**

Discussion

The present randomized controlled trial compared the analgesic efficacy and safety of ultrasound-guided thoracic erector spinae plane block (ESPB) and thoracic paravertebral block (PVB) in patients with multiple rib fractures. The baseline characteristics, including age, weight, body mass index, and number of fractured ribs, were comparable between both groups, indicating appropriate randomization and homogeneity of the study population. This similarity reduces confounding factors and strengthens the validity of outcome comparisons[8].

Hemodynamic parameters, including heart rate and mean arterial pressure (MAP), remained stable in both groups throughout the observation period. Although a slight reduction in MAP was observed following the block in both groups, it was not statistically significant. These findings suggest that both ESPB and PVB are relatively safe techniques with minimal hemodynamic compromise, which is particularly important in trauma patients who may already be physiologically unstable[9]. Similar findings have been reported in previous studies where regional

analgesic techniques for rib fractures demonstrated stable cardiovascular profiles[10].

Pain assessment using the Visual Analog Scale (VAS), both at rest and during movement, showed no statistically significant difference between the ESPB and PVB groups at any time interval. This indicates that both techniques provide comparable analgesic efficacy in controlling acute pain associated with rib fractures. Effective pain relief is crucial in these patients, as inadequate analgesia can impair respiratory function and predispose to pulmonary complications [11]. The comparable VAS scores observed in this study align with earlier research demonstrating that ESPB can provide analgesia equivalent to PVB in thoracic pain conditions[12].

However, a significant difference was noted in fentanyl consumption, with patients in the PVB group requiring higher doses compared to the ESPB group. This suggests that ESPB may provide more sustained or effective background analgesia, thereby reducing the need for rescue opioid administration. Reduced opioid consumption is clinically beneficial, as it minimizes opioid-related adverse effects

such as respiratory depression, sedation, and nausea, which are particularly undesirable in patients with compromised pulmonary function[13].

Furthermore, the time to first rescue analgesia was significantly longer in the ESPB group compared to the PVB group. This finding indicates a prolonged duration of analgesia with ESPB, which may be attributed to the spread of local anesthetic across multiple dermatomes via the fascial plane. The prolonged analgesic effect of ESPB has been highlighted in previous studies, making it an attractive alternative to more technically demanding regional blocks[14].

Although both techniques demonstrated similar efficacy in pain score reduction, the advantages of ESPB in terms of lower opioid requirement and longer duration of analgesia suggest a potential clinical preference. Additionally, ESPB is considered technically simpler and carries a lower risk of complications such as pneumothorax compared to PVB, further supporting its use in routine clinical practice[15].

Overall, this study demonstrates that while both ESPB and PVB are effective for pain management in patients with multiple rib fractures, ESPB may offer additional benefits in terms of opioid-sparing effect and prolonged analgesia, making it a valuable tool in multimodal pain management strategies.

Conclusion

Ultrasound-guided erector spinae plane block provides analgesia comparable to paravertebral block in patients with multiple rib fractures, with similar hemodynamic stability and pain scores. However, it demonstrates advantages in reducing opioid consumption and prolonging the duration of analgesia. Given its technical simplicity and favorable safety profile, erector spinae plane block may be considered a preferable option for effective pain management in such patients..

Conflict of Interest

None

References

1. Bulger EM, Arneson MA, Mock CN, Jurkovich GJ. Rib fractures in the elderly. *J Trauma*. 2000;48(6):1040–6.
2. Witt CE, Bulger EM. Comprehensive approach to the management of the patient with multiple rib fractures. *Trauma Surg Acute Care Open*. 2017;2(1):e000064.
3. Fligel BT, Luchette FA, Reed RL, Esposito TJ, Davis KA, Santaniello JM, et al. Half-a-dozen ribs: the breakpoint for mortality. *Surgery*. 2005;138(4):717–23.
4. Karmakar MK. Thoracic paravertebral block. *Anesthesiology*. 2001;95(3):771–80.
5. Truitt MS, Mooty RC, Amos J, Lorenzo M, Mangram A, Dunn E, et al. Out with the old, in with the new: a novel approach to treating pain associated with rib fractures. *World J Surg*. 2010;34(10):2359–62.
6. Ziegler DW, Agarwal NN. The morbidity and mortality of rib fractures. *J Trauma*. 1994;37(6):975–9.
7. Sirmali M, Türit H, Topçu S, Gülhan E, Yazici Ü, Kaya S, et al. A comprehensive analysis of traumatic rib fractures. *Eur J Cardiothorac Surg*. 2003;24(1):133–8.
8. Pressley CM, Fry WR, Philp AS, Berry SD, Smith RS. Predicting outcome of patients with chest wall injury. *Am J Surg*. 2012;204(6):910–4.
9. Battle CE, Hutchings H, Evans PA. Risk factors that predict mortality in patients with blunt chest wall trauma: a systematic review. *Injury*. 2012;43(1):8–17.
10. Bulger EM, Arneson MA, Mock CN, Jurkovich GJ. Rib fractures in the elderly. *J Trauma*. 2000;48(6):1040–6.
11. Karmakar MK. Thoracic paravertebral block. *Anesthesiology*. 2001;95(3):771–80.
12. Davies RG, Myles PS, Graham JM. A comparison of the analgesic efficacy and side effects of paravertebral vs epidural blockade. *Br J Anaesth*. 2006;96(4):418–26.
13. Fligel BT, Luchette FA, Reed RL, Esposito TJ, Davis KA, Santaniello JM, et al. Half-a-dozen ribs: the breakpoint for mortality. *Surgery*. 2005;138(4):717–23.
14. Forero M, Adhikary SD, Lopez H, Tsui C, Chin KJ. The erector spinae plane block: a novel analgesic technique. *Reg Anesth Pain Med*. 2016;41(5):621–7.
15. Carrier FM, Turgeon AF, Nicole PC, Trépanier CA, Fergusson DA, Thauvette D, et al. Effect of epidural analgesia in patients with traumatic rib fractures. *Can J Anaesth*. 2009;56(3):230–42.