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THORACIC ERECTOR SPINAE PLANE BLOCK VERSUS PARAVERTEBRAL BLOCK UNDER ULTRASOUND GUIDANCE IN PAIN MANAGEMENT OF PATIENTS WITH MULTIPLE RIB FRACTURES. A RANDOMIZED CONTROL TRIAL

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Abstract:

Background: Pain associated with traumatic multiple fracture ribs is usually severe, difficult to control, frequently alters pulmonary mechanics, and may even limit movement ability.Thoracic epidural and paravertebral blocks (PVB) have traditionally been employed but they are technically complex, are associated with adverse effects and are often not feasible in the presence of conditions such as coagulopathy, hemo-dynamic instability and vertebral fractures. ESPB is a simple block in terms of easy identification of landmarks with ultrasound and safe block with no neurovascular structures in the ESP. Hence the current study was undertaken to assess clinical utility of this block (ESPB) in comparison with paravertebral blocks (PVB) for pain relief in multiple rib fractures.

Methodology: A prospective, randomized, double-blinded study was conducted in 100 adult patients with traumatic multiple rib fractures, during April 2020 to February 2023 after obtaining institutional ethical committee approval. ESPB and PBV was performed under ultrasound guidance. Haemodynamic changes, opioid consumption, time to recue analgesia and VAS scores in both the groups were recorded. Statistical analysis done using independent sample T test when data was normally distributed and Mann whitney U test for skewed distribution with outliers with $P<0.05$ as statistically significant. SPSS version 20 was the statistical software used.

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Results: Mean of HR and MAP showed no significant difference in both the groups. 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).VAS static and dynamic showed no significant difference in both the groups when measured periodically in the first 48 hours.

Conclusions: In conclusion, ESPB and PVB blocks in multiple rib fractures are effective methods for pain relief with similar haemodynamic effects. ESPB has the advantage of significant decrease in fentanyl consumption and increased time to rescue analgesia compared to PVB.

Key words: Rib fractures, Pain management, Paravertebral block, Erector spinae plane block.

INTRODUCTION

Rib fractures are seen in more than 50% of patients with blunt chest trauma can cause significant morbidity, long-term disability and mortality with no clear disciplinary boundry for treating [1, 2].Orthopedics, traumatologists, anesthetics, and thoracic surgeons, and others are all involved in the treatment of rib fractures. The core management of rib fractures includes, damage control, pain management, fixation selection, and quality of life [2].

Pain associated with traumatic multiple fracture ribs is usually severe, difficult to control, frequently alters pulmonary mechanics, and may even limit movement ability[3,4]. Increased pain during breathing causes shallow breath and ineffective coughing, which results in insufficient clearance of airway secretions and retention of sputum, which often precipitates secondary complications [3,4,5]. Pulmonary condition is worsened in these patients because of diminished gas exchange [6,7,8,9].Adequate analgesia is paramount in enhancing pulmonary hygiene aimed at preventing atelectasis and pneumonia.

Thoracic epidural and paravertebral blocks (PVB) have traditionally been used but they are complex to perform, are associated with adverse effects and are often not feasible when there is coagulopathy, hemo-dynamic instability and vertebral fractures[10]. More recently, ultrasound-guided fascial plane block techniques, such as the erector spinae plane block (ESPB)and serratus anterior plane block, have emerged as alternatives that are expected to provide excellent analgesia while being simpler and theoretically safer to perform [11,12].

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ESPB is a simple block in terms of easy identification of landmarks with ultrasound and safe block with no neurovascular structures in the ESP[13,14,15]. Furthermore, it avoids the complications of other regional techniques (hypotension of epidural analgesia, epidural spread and vascular puncture of paravertebral block, local anaesthetic toxicity and pneumothorax of intercostal nerve and interpleural block).

Hence the current study was undertaken to assess clinical utility of this block (ESPB) in comparison with paravertebral blocks (PVB) for pain relief in rib fractures in a randomised controlled trial.

METHODOLOGY

A prospective, randomized, double-blinded study was conducted inpatients with traumatic multiple rib fractures (>2 ribs involved), during April 2020 through February 2023 after obtaining institutional ethical committee approval. A written informed consent was obtained from each patient before participation in the study. Adult patients of either sex who were coherent and well oriented were included. Patients who are unable to communicate effectively, who has psychiatric disorders, those with sternal fractures, a visual analog scale (VAS) score < 7, preexisting spinal deformity, local sepsis at the site of injection, coagulopathy, known allergy to the local anesthetic, those having severe polytrauma and those who did not give consent were excluded. Surgical or medical intervention (draining hemithorax, pneumothorax and surgical stabilization of rib fractures etc) was performed when needed before the block.

Purposive sampling method was used and 100 patients were selected and randomly allocated into 2 equal groups:

- PVB group: patients received pain relief by paravertebral injection of plain bupivacaine 0.5% and dexamethasone.
- ESPB group: patients received thoracic erector spinae injection of plain bupivacaine 0.5% and dexamethasone.

After block all the haemodynamic parameters were recorded periodically. Patients pain score using visual analogue score was recorded after the block, when the patient reported pain score of

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VAS>4 fentanyl was given as rescue analgesia. Time to rescue analgesia and amount of fentanyl consumption was also recorded.

Under aseptic conditions ESPB and PVB were performed under ultrasound guidance (GE ultrasound system, Logiq F6). A linear 10-15hzultrasound probe was used to identify the spinous process, transverse process, pleura, superior costotransverse ligament and the paravertebral space at the target level. Midazolam 1.5mg was given as premedication.Skin and subcutaneous infiltration was done with 3ml of 2% xylocaine.

To perform PVB a 21G needle was inserted under ultrasound guidance,at the spinal level midway between the uppermost fractured rib and lower most fractured rib, or 2 segments below the upper most fractured rib in sitting position to enter(1-2 ml of saline is infiltrated observing for the pleural displacement) paravertebral space. The needle was advanced by lateral to medial in-plane needle insertion technique. Later 0.5% of bupivacaine was injected after negative aspiration to blood and air.

To perform ESPB patient was made to sit and target vertebral level was marked (midpoint of the extent of fractured ribs). Under ultrasound guidance tip of the transverse process of the target vertebra was identified. A 21G needle was inserted in-plane to the ultrasound beam in a cephalocaudal direction to contact the transverse process. Correct needle tip position was confirmed by saline infiltration and visualizing its linear spread in to erector spinae muscle. Later 0.5% bupivacaine was injected. Nerve blocks in both groups were confirmed with the patient’s response of paraesthesia and pain relief when they were awake and loss of pin prick.

Statistical analysis was done using IBM SPSS version 20 with $P < 0.05$ as significance level. Independent sample t test and mannwhitney U test was used when the data was normally distributed and skewed respectively.

RESULTS

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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 ESPBgroup(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)

Table 1: Distribution by patients characteristic

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

Mean of heart rate in patients of either groups showed no significant difference at baseline, immediately after block and atintervals of30 mins, 60 mins, 4hours, 8 hours, 12hours, 16 hours, 20 hours, 24 hours and 48 hours (with P>0.05 at all the intervals).

Table 2: Mean heart rate in group ESPB versus PVB

Heart rate	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	
30mins	ESPB	89.7	9.5	-0.049/ 0.96
	PVB	89.8	10.8	
60mins	ESPB	89.8	13.9	0.571/ 0.570

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	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

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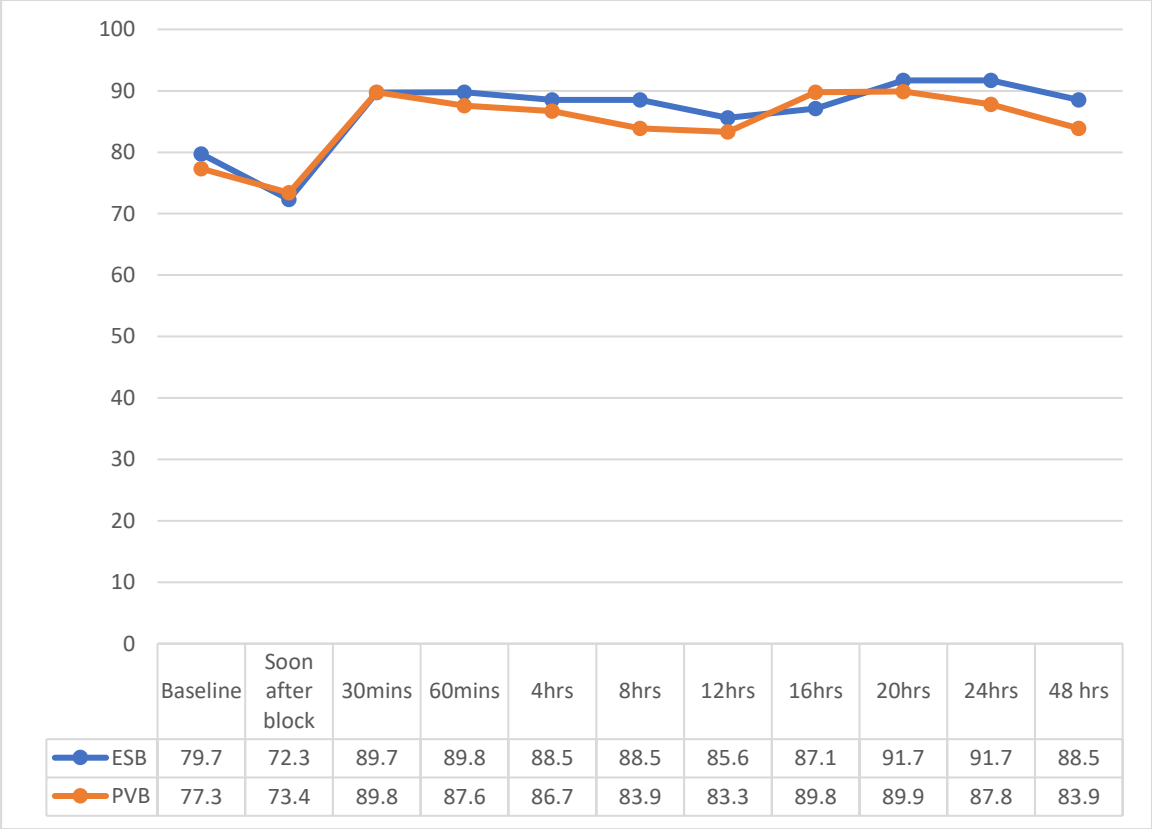

	Baseline	Soon after block	30mins	60mins	4hrs	8hrs	12hrs	16hrs	20hrs	24hrs	48 hrs
ESB	79.7	72.3	89.7	89.8	88.5	88.5	85.6	87.1	91.7	91.7	88.5
PVB	77.3	73.4	89.8	87.6	86.7	83.9	83.3	89.8	89.9	87.8	83.9

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, 4hours, 8 hours, 12hours, 16 hours, 20 hours, 24 hours and 48 hours (with $P>0.05$ at all the intervals).

Table 3: Mean arterial pressure in group ESPB versus PVB

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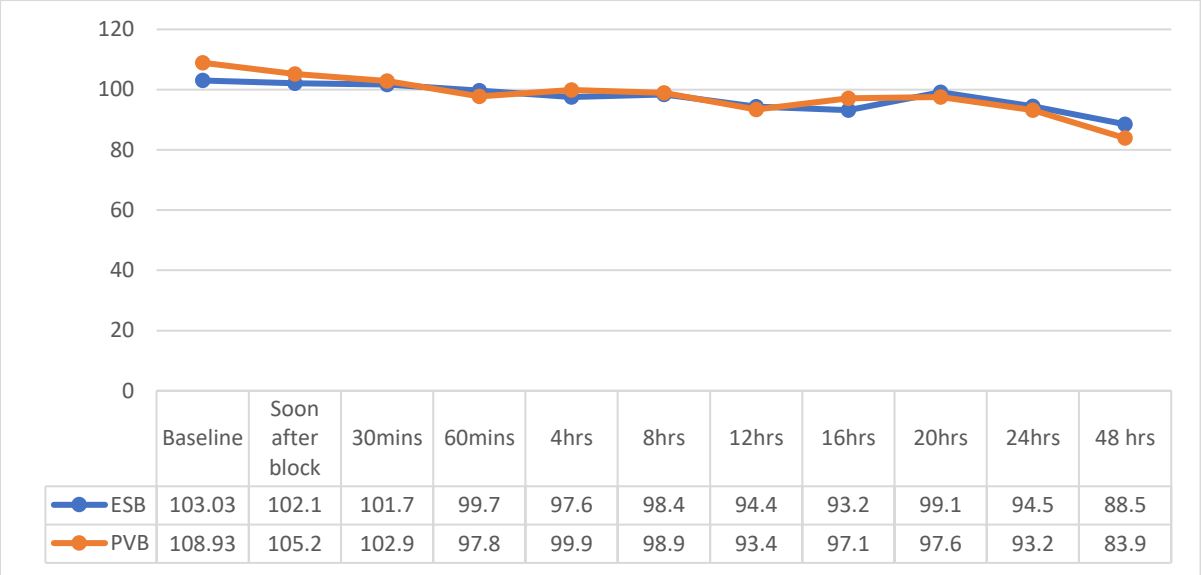

Mean and SD of fentanyl consumption in patients of group PVB(176.87± 27.5 microgram) was more which was statistically significant when compared to group ESPB(134.9± 35.8 microgram) with t statistic 6.58 and p value 0.0001.

Table 4: 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 0min to 1020 minutes). Mann whitney U test showed that, this difference was significant statistically with p value 0.027.

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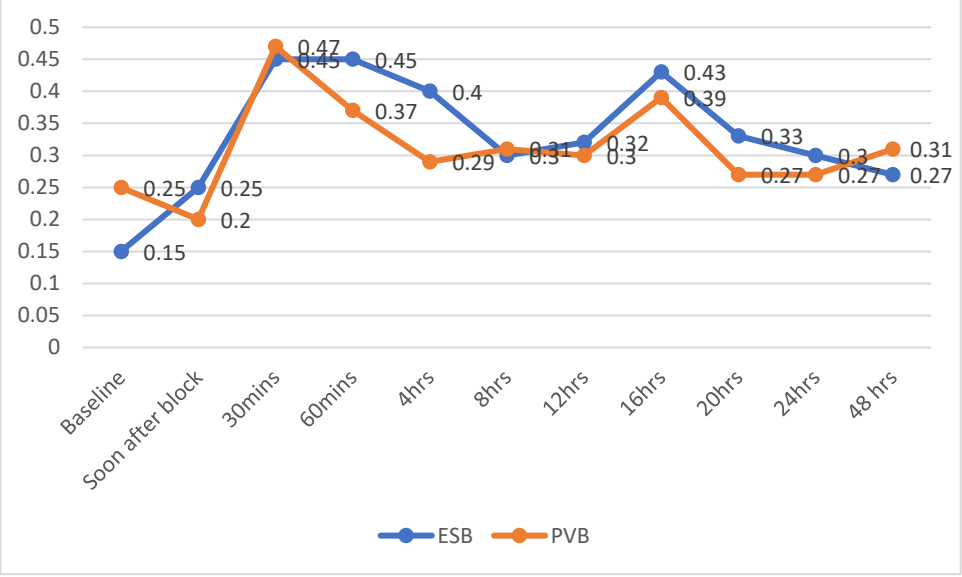
Table 5: time to rescue analgesia in group ESPB versus PVB

Group	Time to rescue analgesic	Statistic in minutes	Mann whitney U test /P value
ESPB	Mean (SD)	154 (239)	9.37 / 0.027
	Range	0 – 1280 minutes	
	Median (inter quartile range)	0min (0 min)	
PVB	Mean (SD)	74 (248)	
	Range	0- 1020 minutes	
	Median (inter quartile range)	0 min (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 PVBon movement



DISCUSSION

Rib fractures can be isolated or can be seen as a component of polytrauma, resulting in a wide clinical spectrum ranging from asymptomatic patients to respiratory insufficiency necessitating

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mechanical ventilation. [12]Inadequate analgesia leads to atelectasis, pneumonic consolidation and secondary lung injury. Various modalities of pain management such as oral analgesics, parenteral analgesics, intercostal nerve blocks, interpleural catheters, epidural analgesia and thoracic paravertebral block have been described in the literature, with regional anaesthesia being superior to oral and systemic analgesia.[16] This study compares ESPB with PVB in management of rib fractures.

In this study mean of heart rate in patients of either groups showed no significant difference at baseline, immediately after block and at all subsequent intervals up to 48 hours (with P>0.05 at all the intervals). Similarly in study by Singh swati et al, the heart rate did not show significant changes over time in either group. [17]

In this study 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, 4hours, 8 hours, 12hours, 16 hours, 20 hours, 24 hours and 48 hours (with P>0.05 at all the intervals). In contrast study by Singh swati et al, showed that MAP was significantly lower in the PVB group than in the ESPB group during the whole study period except at 42 h.[17]

In this study mean and SD of fentanyl consumption in patients of group PVB (176.87± 27.5 microgram) was more which was sttistically significant when compared to group ESPB (134.9± 35.8 microgram) with t statistic 6.58 and p value 0.0001. In study by Singh Swati et al total morphine consumption by patients in the ESPB group was 5.38 ± 2.6 mg per 48 hours, and by those in the other group was 5.22 ± 2.11 mg per 48 hours (P = 0.883). [17] In study by Elawamy A et al the median (quartiles) of rescue morphine consumption was comparable between groups (6.45 mg [0–26 mg]) in group TPVB compared to (7.85 mg [0–25.5 mg] in group TESB (P > 0.05).[18]

In this study 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).The results of the study by Elawamy A et al indicate that injecting a local anesthetic into the fascial deep into the erector spinae muscle resulted in analgesia comparable to that resulting from injecting a local anesthetic into the paravertebral space when both techniques are

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used as a part of multimodal analgesia for multiple fracture ribs. In addition, both ESPB and TPVB were found to be effective in reducing pain scores; the degree of pain relief provided by the 2 techniques was comparable. Similarly in study by Adhikary et al analyzed the efficacy of TESB in patients with unilateral multiple rib fractures. There was improvement in respiratory outcome and a modest reduction in pain scores and opioid consumption, as well as hemodynamic stability after the initial treatment.[19] Our findings were similar to study by Fang et al could not find any difference between TPVB and ESPB in patients either in pain scores at rest or during cough.[20]

In study by Murray N et al Pain scores at rest and with movement were significantly reduced in both groups. There were no statistically significant differences in post-block pain scores or time to rescue analgesia between the two groups. [21]Where as study by Syal R et al shows that the mean pain scores at rest as well as on movement showed a significant reduction from 5.9.±1.19 and 7.5.±0.26 pre block to 1.3.±0.67 and 2.5.±0.91 respectively at 96hours ($p.<0.0001$).[22]

CONCLUSION

In conclusion, ESPB and PVB blocks in multiple rib fractures are effective methods for pain relief with similar haemodynamic effects. ESPB has the advantage of significant decrease in fentanyl consumption and increase in time to rescue analgesia when compared to PVB.

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