

To Determine Analgesic Effect of Ultrasound Guided Thoracic Paravertebral Block in Rib Fractures

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ABSTRACT

Introduction: In patients presenting to the emergency department with chest trauma, rib fractures are associated with significant morbidity and mortality. Pain due to rib fractures cause impaired ventilation. Paravertebral block reduces pain and improves the respiratory mechanics. Ultrasound guidance reduces the complication rate. In our study, we have documented the degree of pain relief after giving paravertebral block. Study aimed to determine the degree of pain relief after giving ultrasound guided thoracic paravertebral block in patients presenting to the emergency department with traumatic injuries.

Material and method: In the emergency department, using radiological diagnosis, patients with traumatic injuries were evaluated for rib fractures, their sites and number, and ultrasound guided thoracic paravertebral block was given using 0.3 ml/kg of 0.5% bupivacaine for pain relief. Using Numerical Rating Scale pre and post procedure pain score of the patient was recorded.

Results: Mean age of patients involved was 46.12 ± 12.22 years. Majority of the patients (70%) had history of road traffic accident. Majority patients had 3-5 rib fractures. There was significant improvement in respiratory function after thoracic paravertebral block. 95% patients had significant analgesic effect as per Numerical Rating Scale.

Conclusion: Ultrasound guided thoracic paravertebral block is effective analgesia for patients with multiple rib fractures.

Keywords: Thoracic Paravertebral Block, Rib Fractures, Numerical Rating Scale

- Hematoma
- Epidural injection
- Pneumothorax
- Pleural puncture
- Hypotension

Contraindications for paravertebral block are:

Absolute contraindications:

- Allergy to local anaesthetic agent
- Local sepsis
- Coagulopathy
- Concurrent anticoagulation therapy
- Patient refusal

Relative contraindications:

- Severe respiratory distress
- Abnormal thoracic anatomy
- Tumour located in paravertebral space
- Systemic sepsis
- Diaphragmatic paresis⁵

Moreover, it can spread to adjacent dermatomes from a single site of injection resulting in block at multiple vertebral levels.⁵ Using ultrasound can decrease the complication rate further. The failure rate of landmark based paravertebral block is around 6.8%. The overall incidence of complications after giving block is as follows: Inadvertent vascular puncture (6.8%), hypotension (4%), epidural or intrathecal spread (1%), pleural puncture (0.8%), pneumothorax (0.5%), hematoma (2.4%) and skin puncture (1.3%). The incidence of pneumothorax is higher when giving bilateral blocks (3%) vs unilateral block (0.4%).

INTRODUCTION

In a patient of polytrauma presenting to the emergency department, rib fractures are associated with significant morbidity and mortality.^{1,2} Multiple rib fractures cause pain which restricts pulmonary function. This causes reduced inspiratory capacity and decreased ability to remove secretions which in turn leads to reduced functional residual capacity and sputum retention. All this affects ventilation and perfusion of the patient ultimately resulting in respiratory failure.³ Reducing pain causes an improvement in lung function.⁴ To achieve this, either systemic analgesics or thoracic paravertebral block can be used. Paravertebral block results in ipsilateral, somatic and sympathetic nerve blockade.

It has fewer complications, for example:

- Infection
- Nerve injury
- Allergic reactions
- Vascular puncture

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Incidence of inadvertent vascular puncture is also increased with bilateral blocks (9%) vs unilateral (5%) block.⁶ Whereas when using real time ultrasound guidance, the complication rate decreases significantly. The incidence of hypotension was 0.46%, incidence of toxicity from local anaesthetic spread was 0.23% whereas incidence of pneumothorax and spread of local anaesthetic outside the paravertebral space was 0%. The incidence of unilateral complications was less (0.35%) than bilateral complications (0.88%).⁷ In this study we have documented the degree of pain relief in patients with rib fractures after giving ultrasound guided thoracic paravertebral block. Ultrasound guidance was used in this study to reduce the incidence of complications. The objective of this study is to determine effect of ultrasound guided thoracic paravertebral block on pain relief in patients with traumatic injuries presenting in the emergency department.

MATERIAL AND METHODS

This prospective cross-sectional interventional study was conducted in Emergency department of B.J. Medical college and Civil Hospital Ahmedabad, from July 2019 – October 2019 in patients who required management of acute pain due to traumatic rib fractures. Those patients were included who were between the age group of 20-60 years, fully conscious and who required pain control due to traumatic rib fractures. After taking approval from the Ethical Committee, patients were recruited during the period between July and October 2019 and simultaneously their relevant data was collected and intervention started. Patients were followed up every hourly to determine the effect of paravertebral block. Their vitals and percentage saturation of oxygen using pulse oximetry, as well as their degree of pain relief was recorded during the one hourly intervals. Follow up was done every hourly until the time a rescue analgesic was required as determined by the pain score as per Numerical Rating Scale. After that, patients were followed up daily until discharge from hospital to detect any complications of paravertebral block detected radiologically.

After taking informed written consent, and as per the inclusion-exclusion criteria, first the vitals of the patient were recorded. Patients with suspected rib fractures went through diagnostic evaluation through radiographs, and ultrasound, and traumatic injuries including rib fractures were identified. The patient was asked to record the degree of pain he was experiencing by noting it on the pain scale. We used the Numerical Rating Scale for the degree of pain experienced by the patient. The Numerical Rating Scale is an 11-point scale which ranges from point '0' which mean 'no pain' to point '11' which means 'extreme pain'. After taking informed written consent, and using portable ultrasound machine, the procedure was carried out. The 10 MHz linear transducer probe was placed over the midline at the chosen vertebral level, and rib, intercostal muscle and underlying pleura was identified. The needle was passed through the intercostal muscle and the tip of the needle was progressed until it reached a hypochoic triangular space formed by the acoustic shadow underneath the transverse process medially,

pleural antero-laterally and the lower border of the intercostal muscle posteriorly.

Placement of the needle in the thoracic paravertebral space was confirmed by the anterior displacement of pleura upon injection of a small bolus of saline. Once confirmed, 0.3ml/kg of bupivacaine 0.5% was injected after careful aspiration into the paravertebral space.

After the procedure, vitals of the patient and the degree of pain experienced by the patient were again recorded on the pain scale. Hourly monitoring of pain score was done to determine how long the analgesia lasts and whether any rescue analgesic is required. When pain recurred, a rescue analgesic was intravenously administered to the patient and the time taken to administer a rescue analgesic when pain recurred was noted as well as any complications if any were recorded. The objective of this study was to determine effect of thoracic paravertebral block in pain relief in patients with traumatic injuries presented in the emergency department. There was potential for interviewer bias as the effects of the intervention was known. But magnitude of bias was less as the results depended on the patient's perception of pain. There was potential for transfer bias as there could have been loss to follow up after shifting patient to ward from emergency department for prevention of which we took full details of the patients before transfer to reduce potential loss to follow up. There were no missing data as the patients were recruited from the emergency department as well as the intervention and the results of pain score were recorded in the emergency department. We used Microsoft Excel 2019 and Microsoft Word 2019 for our statistical analysis. The Ethical Committee approval was taken.

Inclusion criteria

1. Patients who experience acute pain after blunt or penetrating thoracic trauma with rib fracture(s).
2. Patient who is fully conscious.
3. Patients of either sex between the age group 20-60 years.

Exclusion criteria:

1. Tumour in the paravertebral space.
2. Empyema
3. Infection at the site of block
4. Patient who is not fully conscious.
5. Those patients who do not give consent.
6. Inability to perform the test due to anatomical limitations.

RESULTS

Total 40 patients of traumatic injuries to chest who were eligible for our study presenting to emergency department were evaluated with mean age of 46.12 ± 12.22 years after applying the exclusion criteria. Out of which 36 patients were male, and 04 patients were female. All patients were included in the study and followed up till their discharge. Majority of the patients (70%) had history of road traffic accident while fall from height, stab injury, assault and other mechanism of injury had been observed in 12.5%, 2.5%, 12.5% and 2.5% patients respectively. 1 patient had history of gas pipe

Pulse (per min)	<60	60-100	100-120	>120
(n=40) (Before)	00	02 (5%)	02 (5%)	36 (90%)
(n=40) (After)	00	02 (5%)	02 (5%)	36 (90%)
BP (mmHg)	1-49	50-75	76-89	>89
(n=40) (Before)	0	3 (7.5%)	04 (10%)	33 (82.5%)
(n=40) (After)	0	00	01 (2.5%)	39 (97.5%)
RR (per min)	1-5	6-9	10-29	>29
(n=40) (Before)	0	0	06 (15%)	34 (85%)
(n=40) (After)	0	0	28 (70%)	12 (30%)
SpO2	<50	51-60	61-90	91-100
(n=40) (Before)	0	0	06 (15%)	34 (85%)
(n=40) (After)	0	0	02 (5%)	38 (95%)

Table-1: Distribution of the patients according to Vitals before and after giving paravertebral block: (n=40)

Severity	Pain score	Number of patients (Before block)	Number of patients (After block)
Mild	0-3	00	38 (95%)
Moderate	4-6	04 (10%)	02 (5%)
Severe	>6	36 (90%)	00 (00%)

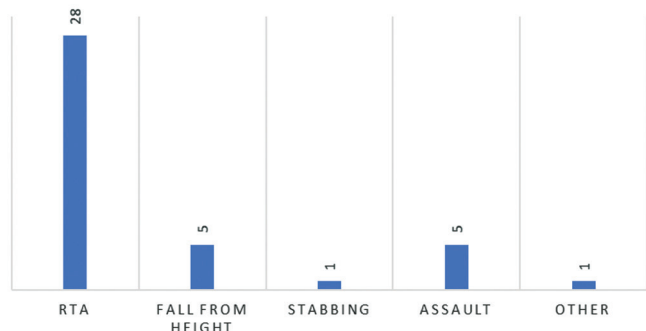
Table-2: Distribution of the patients according to Numeric rating scale before and after giving PVB: (n=40)

ISS	0-25	25-50	50-75
Number of the patients	02 (5%)	30 (75%)	08 (20%)

Table-3: Distribution of the patients according to Injury Severity Score (ISS): (n=40)

Rib Fractures	Number of the patients
>6	9 (22.5%)
3-5	17 (42.5%)
2	5 (12.5%)
1	9 (22.5%)

Table-4: Distribution of the patients according to Rib fractures: (n=40)



Graph-1: Distribution of the patients according to mechanism of injury (n=40)

explosion with chest injury was included in other injury. All the patients had chest injury and rib fractures. Associated head injury, facial injuries, abdominal injury, extremity injury and external soft tissue injuries were observed in 17.5%, 12.5%, 15%, 27.5% and 53.5% respectively. Majority of the patients (75%) had Injury severity score in between 25-50 while in 20% of the patients had severe injury according to injury severity score. Majority patients had 3-5 rib fractures in this study. 22.5% patients had >6 ribs fractured. 85% patients had difficulty in breathing due to severe pain and chest injury before giving paravertebral block. 8 patients

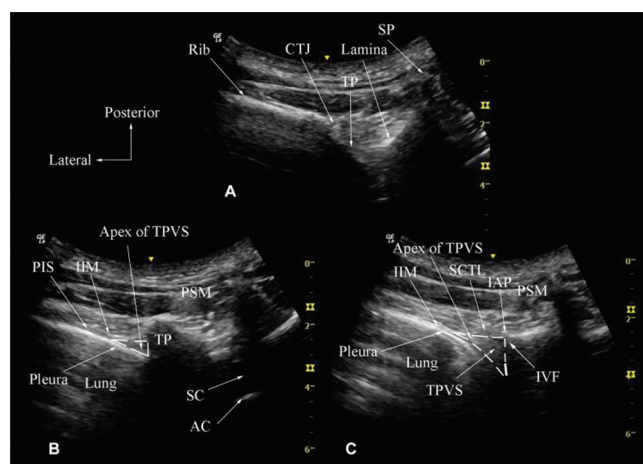


Figure1: Paramedian transverse sonograms of the thoracic paravertebral region with the ultrasound beam being insonated (A) at the level of the rib and transverse process (position 1 in Figure 1); (B) at the level of the transverse process (position 2 in Figure 2), and (C) at the level of the inferior articular process (position 3 in Figure 3).

Abbreviations: SP, spinous process; TP, transverse process; CTJ, costotransverse junction; PSM, paraspinal muscles; TPVS, thoracic paravertebral space; IIM, internal intercostal membrane; PIS, posterior intercostal space; SC, spinal canal; AC, anterior complex; IAP, inferior articular process; SCTL, superior costotransverse ligament; IVF, intervertebral foramen.⁸

had haemothorax and 12 patients had pneumothorax and 3 patients had haemo-pneumothorax. 4 patients had flail chest. In all these patients, intercostal drainage tubes were inserted first and after that TPVB (Thoracic Paravertebral Block) was given. After giving TPVB there was significant improvement in breathing difficulty. 90% patients had severe chest pain and

10% patients had moderate chest pain according to Numeric rating scale before giving TPVB. There was significant improvement observed in NRS after giving TPVB. 95% patients had mild; 5% patients had moderate chest pain after TPVB. Rescue analgesia was needed in 5% of the patients. There were no complications in our study.

DISCUSSION

Thoracic paravertebral block is an effective method of providing pain relief in rib fractures.^{9,10,11} Other analgesics like opioids have more side effects and less potency as compare to TPVB. TPVB will give pain relief for mean duration of 10 hrs. TPVB is superior to intravenous analgesia in pain relief and preservation of pulmonary function in patients with multiple rib fractures.¹² Adequate analgesia is also necessary for chest physiotherapy and removal of bronchial secretions. Ultrasound guided TPVB has more advantages. Ultrasound guided visualisation of needle and pleura during procedure may decrease the risk of the complications. One can confirm local anaesthetic spread in the paravertebral space observing displacement of the pleura. Ultrasound can diagnose possible pneumothorax, haemothorax and hemopneumothorax in case of multiple rib fractures. Larger volumes of local anaesthetic solution may be necessary for pain relief in patients with multiple rib fractures.^{12,13} Pusch et al¹⁴, O'riain et al¹⁵, and Hara et al¹⁶ used 0.5% Bupivacaine 0.3ml/kg with epinephrine, 0.25% Bupivacaine 0.3ml/kg and 0.5% Ropivacaine 15ml respectively and achieved 100% success rates, while in present study 0.5% bupivacaine 0.3ml/kg was used and 95% success rates had been observed. Ge Yeying et al did a study on thoracic paravertebral block versus intravenous patient-controlled analgesia for pain treatment in patients with multiple rib fractures. In their study they observed that the Visual Analog Scores were significantly lower in the TPVB group than the intravenous analgesia group at rest and during coughing. Patients in the TPVB group had a higher PaO₂ and PaO₂/FiO₂.¹⁷ We concluded from our study that ultrasound guided thoracic paravertebral block provides pain relief for a mean duration of 10 hours during which majority of patients have improvement in symptoms and decrease in pain. Our study sample is not representative of the population.

Limitations of this study

This was a single centre convenient sampling study with a small number of study population. Ultrasonography is provider dependent and different providers may possess different skills with ultrasonographic image and acquisition and interpretation. Anatomical and physiologic limitations like patients with deformed spine, severe respiratory distress, subcutaneous emphysema, local sepsis and coagulopathy or concurrent anticoagulation therapy patients were not ideal candidates for the study so they were excluded. Bupivacaine was the only analgesic used, so effects of other analgesics could not be determined. As the results depended on the patient's perception of pain, only fully conscious patients with rib fractures were taken, so effect of paravertebral block in patients with Glasgow Coma Scale of less than 15 could

not be assessed.

CONCLUSION

We concluded that thoracic paravertebral block is an effective method for pain relief in patients with traumatic rib fractures and ultrasound guidance decreases the complication rate of the procedure as well as helps to find out associated diagnosis at the bedside.

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