RESEARCH

Comparison of Ultrasound Guided Continuous Paravertebral Block with Serratus Anterior Block for Chest Trauma Patients

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Abstract:

Context: Adequate analgesia, chest physical therapy, and respiratory care serve as the cornerstones of management for patients with numerous rib fractures. The purpose of this study was to compare two distinct approaches. **Methods and Material:** Using the sealed envelope method, two groups of 20 patients each, Group 1 (group SA) and Group 2 (group PV), each with 40 patients, were assigned to receive treatment for isolated chest trauma and unilateral rib fracture. According to the study protocol, the study proforma included information about the patients' demographics, parameters linked to injuries, and procedure-related data. **Statistical analysis:** Mode of injury in the two groups as well as Abbreviated Injury Score, Static VAS and Dynamic VAS; PaO2 to FiO2 ratio; P (A-a) O2 and Spirometry failed to reveal any statistically significant difference on intergroup comparison. There was no statistically significant difference between the two groups for procedural complications other than problematic insertion, although there was no statistically significant difference for other complications. However, none of the procedures was found to be superior to the other in this regard. The study demonstrated a notable analgesic efficacy of both techniques in isolated unilateral chest injuries. The study showed improved patient outcomes in all groups across a range of study parameters, with the exception of a slightly lower incidence of problematic insertion in the serratus anterior plane block group compared to the prevertebral block group; otherwise, all other problems were nearly equal. **Conclusions:** With the exception of some higher reported difficult insertions in the paravertebral group compared to the serratus anterior group, the two procedures were equivalent .

INTRODUCTION

Numerous ribs protect the thoracic cavity, that contains several essential organs. The most common cause of morbidity and mortality worldwide is chest wall trauma.[1] Multiple rib fractures commonly occur as a result of high-velocity trauma, such as those caused by falls from heights, assaults, being struck by an animal, or even violent coughing. These high-velocity trauma scenarios include car accidents with motorcycle crush or car vs. pedestrian collisions.[2] Pain is one of the most typical signs of rib fractures. When you breathe in and cough, the pain could get worse. diminished respiratory effort is linked to pain from multiple rib fractures, which can result in lung atelectasis, an inability to remove secretions, and ultimately diminished vital capacity. Hypoxemia, pneumonia, and abrupt respiratory failure can all follow from this. Underlying structures sustain further harm as a result of complex rib fractures. A potentially fatal disease known as pneumothorax results from the sharp shattered end of the rib puncturing the lung. These wounds can cause pain, as well as breathing difficulties and a drop in blood oxygen levels. An underlying pulmonary contusion that might cause acute lung injury and acute respiratory distress syndrome (ARDS) is generally seen with a flail chest. Additionally, the paradoxical motion of the flail segment may make breathing more difficult and painful.

Symptoms of multiple rib fractures can be relieved and additional respiratory issues can be avoided with adequate pain treatment.[3] Providing appropriate analgesics, chest physical therapy, and respiratory care are the cornerstones of managing patients with numerous rib fractures.[4]

For pain reduction, a variety of modalities have been used, such as multimodal analgesic drugs, regional analgesia, and neuraxial analgesia. The incidence of narcotic-related adverse effects, such as drowsiness, respiratory depression, nausea, vomiting, and ileus, is increased when high dose opioids are used. Only a few recent research .[5] have discussed the usefulness of ultrasound-guided truncal blocking. When a patient suffers a unilateral multiple rib fracture, continuous analgesia can be effectively administered with a thoracic paravertebral block.[4] A new local approach called an ultrasound guided serratus anterior block completely anaesthetizes the hemithorax.The current study's hypothesis was that a more recent modality (Serratus Anterior Plane Block) would be more effective, easier to perform technically, and less likely to cause adverse effects than a more traditional technique like paravertebral block.

This prospective study compares the effects of continuous thoracic paravertebral block and serratus anterior plane block on analgesia, respiratory parameters, chest physiotherapy, and complications

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MATERIAL and METHODS

This prospective randomized study was conducted on patients of either sex who had isolated chest trauma and a single rib fracture between the ages of 18 and 65 were included in the study. Exclusion criteria for the trial included patients with invasive ventilation, allergies to local anaesthetics, diabetes mellitus, hypertension, asthma, COPD, and other lung conditions, second- or third-degree heart blocks, renal insufficiency, hepatic insufficiency, and bleeding disorders.

The flow chart for enrolling subjects in research is shown in Figure 1. Fifty six patients were initially enrolled in the study to determine eligibility, and following receiving written informed consent, 16 patients were disqualified due to invasive ventilation (n=4), allergies to local anaesthetics (n=2), renal insufficiency (n=2), hepatic insufficiency (n=3), diabetes mellitus (n=2), hypertension (n=2), and chronic obstructive pulmonary disease (COPD) (n=1). Hence this prospective randomized study was carried out on 40 patients with isolated chest injuries.

The patients were randomized by computer generated randomization into two groups of 20 each, which were sealed in an opaque envelop. Group 1 (Group SA) - Serratus Anterior Plain Block) and Group 2 (Group PB - Paravertebral Block). All patients' cardiovascular stability and intravenous access were established. Age, sex, weight, and injury information, including the mechanism of injury, the number of fractured ribs, the chest Abbreviated Injury Score (AIS), and hemodynamic condition upon admission, were all documented for each patient. Additionally noticed were the existence or absence of flail chest, pneumothorax, hemothorax, pulmonary contusion, and subcutaneous emphysema. Before starting the blocks, any hemothoraxes or pneumothoraces were emptied.

Patients in group 1 (SA group) were seated with their left arm resting on a table in the group. Using a 2-5 MHz curvilinear ultrasound probe in strict asepsis, the serratus anterior muscle was located over the fifth rib in the posterior axillary line in the vertical axis. The probe was then placed parallel to the rib's long axis. 18 G Touhy needle was introduced utilising an in-line needle approach under real-time ultrasound guidance from the posterior to anterior-caudal direction. The needle entrance location was first numbed with 1% lignocaine. The tip of the needle was positioned on the rib's surface beneath the serratus anterior muscle between the posterior and mid-axillary lines. An 18 G epidural catheter was pushed via the epidural needle to a depth of 4 cm beyond the needle tip and tunnelled subcutaneously to prevent dislodgment after the needle tip's location was confirmed by hydro dissecting using 3 mL of saline. In all groups, a test dosage was followed by a continuous infusion of bupivacaine 0.25% at a rate of 0.1 mL/kg/hr to 0.2 mL/kg/hr, followed by a bolus dose of bupivacaine 0.5% in a volume of 0.3 mL/kg (1.5 mg/kg) with 1 microgram/mL of fentanyl. In both groups, VAS pain scores at rest, while coughing, and during physical therapy were noted prior to block administration at 1, 3, and 5 days, respectively. Injection If the VAS is greater than 4, 1 mg/kg of tramadol was given as a rescue analgesic. Additionally, the ability to walk and respiratory physiotherapy using incentive spirometry were recorded as parameters. On days 0, 1, 3, and 5, alveolar arterial gradient of oxygen (P (A-a) 02) and the partial pressure of oxygen to fraction of inspired oxygen (Pao2/Fio2) ratio (ABG parameter) were also recorded. Any difficulties arising from the two methods were identified and dealt with accordingly. Inconspicuous blood pressure readings and baseline heart rate were taken. Hypotension was treated, if necessary, with rapid intravenous fluids and vasopressors, when blood pressure dropped by more than 20% from baseline. Six days later, the catheter was taken out. If discomfort continues after the catheter has been removed, intravenous diclofenac (1 mg/kg) was given.

The paravertebral space was located in group 2 (PV group) patients by using real-time ultrasound guidance and a 12 MHz linear type probe while they were seated and under complete aseptic technique. An 18 gauge Touhy needle was used to thread an epidural catheter, which was advanced 3–4 cm into the paravertebral space after local infiltration of the skin and underlying tissues with 3 ml of 1% lidocaine solution. After the needle was removed, the 18 G catheter was tunnelled subcutaneously and fixed to the patient's back. After the procedure, the patient was placed supine and 3 ml of 2% lidocaine with 5 g/ml epinephrine was injected as a test dose after a negative blood aspiration or Cerebrospinal Fluid (CSF) procedure was carried out while the patient was in a sitting position at a spinal level halfway between the highest and lowest fractured rib.

The data was analysed using SPSS® (version 23.0; SPSS Inc., Chicago, IL, USA) for statistical analysis. For numerical variables, the data had been summarised using the mean and standard deviation, and for categorical variables, count and percentages. Fischer Exact and Chi-Square tests were used for statistical analysis. Statistics were considered significant at p-values under 0.05. The paper was organised in accordance with the CONSORT recommendations [Figure 1].

RESULTS

There were 20 patients in each of the two study groups, all of similar age and gender. Both the Abbreviated Injury Score (AIS) and the manner of injury were comparable between the two groups [Table 1]. Baseline static and dynamic visual analogue scores greater than 4 in the two groups indicated severe pain scores in the two groups on day 0 prior to operation. [Table 2]. Table 2 compares the variables PaO2 to FiO2 ratio, Static VAS (SVAS) and Dynamic VAS (DVAS), as well as P (A-a)O2. The intergroup comparison of all the aforementioned factors, however, came up empty in terms of any statistically significant differences. But as indicated in Table 3, there has been a statistically significant decline in the intragroup comparison of SVAS and DVAS.

Table 4 displays an intergroup comparison of spirometry and procedural complications. Between the two groups, there was no statistically significant difference in the spirometer results. Similar to several attempts, hypotension, fever, pneumothorax, and convulsions, neither group's risk experienced a discernible difference. However, just one patient in group 1 reported a problematic insertion, compared to six patients in group 2, which proved to be a statistically significant difference.

Table 1: Patient and injury variables in two groups

	Group 1 (n=20)	**Group 2 (n=20)**	**p-value**
Age (years)	40.00±12.131	36.00±11.498	0.291
Sex (M/F)	11/9	13/7	0..519
Mode injury RTA Fall from height Hit by animal	 11 (55.0) 6 (30.0) 3 (15.0)	 8 (40.0) 8 (40.0) 4 (20.0)	0.637
AIS 2 3 4	 3 (15.0) 12 (60.0) 5 (25.0)	 4 (20.0) 8 (40.0) 8 (40.0)	0.728

Table 2: Intergroup Comparison of Parameters of Study

		Group 1 (n=20)	Group 2 (n=20)	p-value
SVAS				
Day 0	0-2 2-4 >4	0 0 20 (100)	0 0 20 (100)	
Day 1	0-2 2-4 >4	18 (90.0) 2 (10.0) 0	17 (85) 3 (15.0) 0	0.633
Day 3	0-2 2-4 >4	20 (100) 0 0	18 (90.0) 2 (10.0) 0	0.147
Day 5	0-2 2-4 >4	20 (100) 0 0	20 (100.0) 0 0	
DVAS				
Day 0	0-2 2-4 >4	0 0 20 (100)	0 0 20 (100.0)	
Day 1	0-2 2-4 >4	14 (70.0) 6 (30.0) 0	16 (80.0) 4 (20.0) 0	0.465
Day 3	0-2 2-4 >4	20 (100) 0 0	19 (95.0) 1 (5.0) 0	0.311
Day 5	0-2 2-4 >4	20 (100) 0 0	20 (100.0) 0 0	
PaO2/FiO2				
Day 0	>400 300-400 200-300 150-200 <150	0 1 (5.0) 15 (75.0) 4 (20.0) 0	0 0 (0.0) 16 (80.0) 4 (20.0) 0	0.597
Day 1	>400 300-400 200-300 150-200 <150	0 18 (90.0) 2 (10.0) 0 0	0 17 (85.0) 3 (15.0) 0 0	0.633
Day 3	>400 300-400 200-300 150-200 <150	6 (30.0) 14 (70.0) 0 0 0	4 (20.0) 16 (80.0) 0 0 0	0.465
Day 5	>400 300-400 200-300 150-200 <150	8 (40.0) 12 (60.0) 0 0 0	4 (20.0) 16 (80.0)	0.168
PaO_2-$A0_2$				
Day 0	10-20 20-30 >30	0 6 (30.0) 14 (70.0)	0 8 (40.0) 12 (60.0)	0.507
Day 1	10-20 20-30 >30	5 (25.0) 15 (75.0) 0	9 (45.0) 11 (55.0)	0.185
Day 3	10-20 20-30 >30	15 (75.0) 5 (25.0) 0	18 (90.0) 2 (10.0) 0	0.212
Day 5	10-20 20-30 >30	20 (100) 0 0	20 (100) 0 0	

Table 3: Intragroup Comparison of Parameters of Study

		Group 1 (n=20)		Group 2 (n=20)	
SVAS					
Day 0	0-2 2-4 >4	0 0 20 (100)	-	0 0 20 (100)	-
Day 1	0-2 2-4 >4	18 (90.0) 2 (10.0) 0	<0.001	17 (85) 3 (15.0) 0	<0.001
Day 3	0-2 2-4 >4	20 (100) 0 0	<0.001	18 (90.0) 2 (10.0) 0	<0.001
Day 5	0-2 2-4 >4	20 (100) 0 0	<0.001	20 (100.0) 0 0	<0.001
DVAS					
Day 0	0-2 2-4 >4	0 0 20 (100)	-	0 0 20 (100.0)	--
Day 1	0-2 2-4 >4	14 (70.0) 6 (30.0) 0	<0.001	16 (80.0) 4 (20.0) 0	<0.001
Day 3	0-2 2-4 >4	20 (100) 0 0	<0.001	19 (95.0) 1 (5.0) 0	<0.001
Day 5	0-2 2-4 >4	20 (100) 0 0	<0.001	20 (100.0) 0 0	<0.001

Table 4: Intergroup Comparison of Spirometry and Procedural Complications

		Group 1 (n=20)	Group 2 (n=20)	p-value
Spirometry				
Day 0	<600 ml 6001-900 ml 901-1200 ml >1200 ml	20 (100) 0 0 0	20 (100) 0 0 0	
Day 1	<600 ml 6001-900 ml 901-1200 ml >1200 ml	2 (10.0) 12 (60.0) 6 (30.0) 0	0 (0) 13 (65.0) 7 (35.0) 0	0.347
Day 3	<600 ml 6001-900 ml 901-1200 ml >1200 ml	0 2 (10.0) 15 (75.0) 3 (15.0)	0 4 (20.0) 16 (80.0) 0	0.157
Day 5	<600 ml 6001-900 ml 901-1200 ml >1200 ml	0 0 3 (15.0) 17 (85.0)	0 0 5 (25.0) 15 (75.0)	0.429
Complication				
	Multiple attempts	1 (5.0)	3 (15.0)	0.605
	Difficult insertion	1 (5.0)	6 (30.0)	0.037
	Hypotension	2 (10.0)	3 (15.0)	0.632
	Fever	0	0	
	Pneumothorax	0	2 (10.0)	0.487
	Convulsions	0	1 (5.0)	0.999

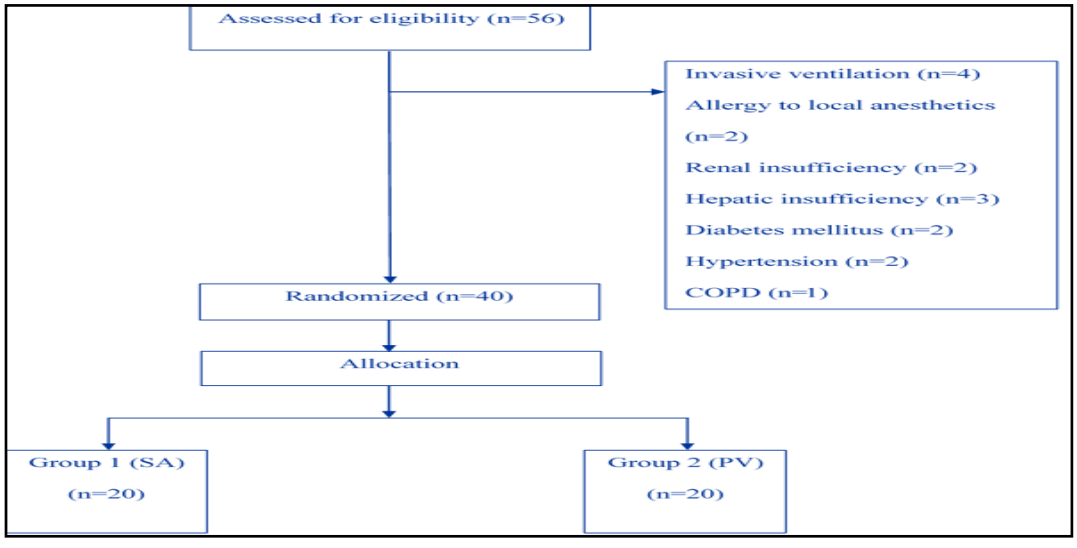

Figure 1: CONSORT Flow Chart showing enrolment of patients for study

DISCUSSION

Although there are restrictions on its usage in elderly patients and those with many co-morbidities, the continuous thoracic epidural is recognised as the most common technique for analgesic management following chest trauma.[6] The risk of hypotension caused by the bilateral thoracic sympathectomy and the procedural challenges associated with inserting an epidural catheter at a thoracic level have also been significant factors.[6] As serratus anterior plane block and paravertebral block, two of the more recent methods, have demonstrated encouraging results due to their lower risk and complication rates.

An innovative regional aesthetic approach for breast and chest wall procedures, including breast reconstruction surgeries, has been discovered: the ultrasound guided serratus anterior plane block[7,8] By inhibiting the lateral branches of the intercostal nerves, local anaesthetics injected superficially or deeply beneath the serratus anterior give predictable and comparatively long-lasting localised anaesthesia and analgesia to the hemi thorax.[7] In critical care patients with MRF, SAP block has also been observed to offer analgesia and aid weaning from mechanical breathing.[9] Technically straightforward and safe to execute as a bedside operation, SAP block.

It has been demonstrated that paravertebral block (PVB), which involves injecting a local anaesthetic agent near to where the spinal nerves exit the intervertebral foramina, is a reliable substitute for ipsilateral, segmental, somatic, and sympathetic nerve blocking of the highest quality.[10] In patients having esophagectomy,[11] breast surgery,[12] thoracotomy,[13] heart surgery,[14] hepatectomy,[15] inguinal herniorrhaphy,[16] percutaneous nephrolithotomy,[17] and nephrectomy, [18] PVB is a successful localised approach for pain reduction. MRFs have also seen pain alleviation with the use of thoracic paravertebral block (TPVB).[19-21] It is important to take into account the differences between TPVB and conventional analgesics for MRFs, such as thoracic epidural analgesia (TEA) and intravenous analgesia, in terms of efficacy and safety. In patients with unilateral MRFs, Mohtaet demonstrated that TPVB was just as effective in treating pain as TEA. [22] Due to the unilateral character of the sympathetic blockade, this has been proven to be not only technically simpler but also less likely to result in hypotension in patients with normovolemic patients.[23]. Hypovolemic and poorly resuscitated patients, however, may report hypotension. However hypotension might be reported in the inadequately resuscitated and hypovolemic patients. Due to the low risk of neurologic injury with this procedure, unlike thoracic epidural parts, anticoagulants or impaired coagulation are just relative contraindications for employing TPVB. The effects of a paravertebral hematoma on the nervous system are most likely minimal, even if vascular penetration occurs.[24]

For modified radical mastectomy, Gupta K et al. compared the analgesic effectiveness of serratus plane block with ultrasound-guided paravertebral block.[25] Our study, however, stands out since it is the first to compare the clinical efficacy of thoracic paravertebral block and serratus anterior plane block in the context of chest injuries. Studies that have been published in the literature have discussed the clinical benefits of serratus anterior plain block and paravertebral block in the form of individual case reports and original papers. [6,7,26,28,29] There are trials where authors have contrasted intravenous patient-controlled analgesia,[10] thoracic epidural,[22] and paravertebral block individually. Regarding the age and sex distribution of the trauma patients, the form of trauma, and the acute injury score (AIS) for chest trauma, the current study found no discernible differences between the two groups. There was no discernible difference between the static and dynamic VAS ratings when we compared the two groups. While conducting intragroup comparison, we found that both static and dynamic VAS scores significantly decreased on day 1 as compared to day zero, and that this impact persisted on days 3 and 5. This suggests that both treatments are effective at relieving pain in cases of isolated unilateral chest trauma, but it also shows that neither technique is superior to the other in this regard. Studies have also found similar outcomes regarding the analgesic potential of both approaches.[10,22,26,27,29]

Our research has demonstrated that from day 0 to day 5, the PaO2/ FiO2 ratio in both groups has improved (raised). P(A-a)O2 declined similarly in both groups from day 0 to day 5. The study's findings indicate that employing either of the two procedures improved the patients' respiratory parameters because there was no discernible difference between the two groups in the aforementioned metrics. These findings were consistent with the pattern seen in independent research on paravertebral block and serratus anterior plane block. [10,26]

When we compared the spirometry (FVC) in the two groups, we found that all of the patients had capacities of less than 600 ml on day 0, but by day 5, 75% of the patients in group 1 and 85% of the patients in group 2 had spirometry capacities of more than 1200 ml, indicating a significant improvement in the patients in both groups. However, the comparison of the results of the two groups on several days has yet to reveal any appreciable differences. We were unable to locate any study in the literature that compared FVC in comparable groups. [10,22,27]

Both of the procedures described in the literature have difficulties connected to the process that require many tries, problematic insertion, hypotension, fever, pneumothorax, and convulsion .[10,21,22] The two groups did not significantly vary in the current study when it came to the requirement for several tries, hypotension, fever, pneumothorax, and convulsion. Although it has been found that the serratus anterior plane block group has much less instances of problematic insertion (n=1) than the paravertebral block group (n=6). Although the procedures were independently reported to be associated with less complications than other treatments, this type of comparison between the two groups has not been documented in literature.

CONCLUSION

This study is distinctive in the area of the use of regional anaesthesia for analgesic effects in patients with chest trauma since it contrasted two methods that were found to each have advantages. The two procedures were found to be comparable in this study, with the exception of some higher reported problematic insertions in the paravertebral group compared to the serratus anterior group. To further validate these findings, investigations with larger sample sizes are required .

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