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Management of Unilateral Fracture Ribs using Ultrasound Guided Erector Spinae Plane Block versus Paravertebral Block

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ABSTRACT

Background: For many different purposes, paravertebral plane block (PVB) has been the favoured regional anaesthesia treatment for postoperative analgesia. The initial definition of erector spinae plane (ESP) block was as a new analgesic technique for thoracic neuropathic pain.

Objective: To improve pain management in patients with fracture ribs through setting regional blocks as a protocol at Suez Canal University Hospitals.

Patients and methods: This study included 70 patients with unilateral multiple rib fracture. They were divided into two groups: Group (E) patients who received ultrasound-guided ESP block with 20 ml of bupivacaine 0.25% as a loading dose and group (p) patients who received ultrasound-guided PVB block with 20 ml of bupivacaine 0.25% as a loading dose.

Results: Age, sex, weight, and the number of fractured ribs between the two groups did not differ statistically. There was a significantly lower TLC in the E group at 48 h compared to the P group as well as the baseline value. In both groups, there was a significantly lower neutrophil count at 24 h and 48 h compared to the respective baseline value. In group P, there was a significantly higher lymphocyte count at 24 h compared to the baseline value. Moreover, there was a significantly higher lymphocyte count at 48 h compared to the baseline value in both groups.

Conclusion: Both continuous ESPB and TPVB can be used for pain control of unilateral multiple fracture ribs.

Keywords: Unilateral fracture ribs, ESP, Paravertebral block.

INTRODUCTION

Multiple fractured ribs (MFR) from thoracic trauma are still frequent [(1)]. In contrast to the substantial chest discomfort brought on by numerous rib fractures, which can be difficult to manage and increase hospital stays, medical costs, and impaired pulmonary function, the pain brought on by a single broken rib is often straightforward to manage [(2)].

Various degrees of chest discomfort are a common first symptom in patients with traumatic rib fractures, which can affect pulmonary mechanics and cause the retention of trachea-bronchial secretions as well as atelectasis [(3)]. In addition to substantially impairing respiratory mechanics, multiple rib fractures also aggravate underlying lung damage and pre-existing respiratory illness, which increases the risk of respiratory failure [(4)].

An effective analgesic may aid in enhancing the patient's respiratory mechanics, prevent the need for tracheal intubation for ventilatory assistance, and so significantly modify the course of recovery [(4)]. Early implementation of a successful pain alleviation is the cornerstone of managing chest discomfort [(5)].

Systemic opioids, non-steroidal anti-inflammatory medications, or transcutaneous electrical nerve stimulation can all be used to produce analgesia. As an alternative, effective regional analgesic methods include intercostal nerve block, epidural analgesia, intrathecal opioids, intra-pleural analgesia, and thoracic epidural and thoracic paravertebral block. Regional blocks are often more effective than systemic opioids and have fewer systemic side effects, although being more intrusive [(4, 6)]. Specifically upper abdominal procedures and thoracic surgery are favourites of PVB. It is a sophisticated method with possible dangers and problems, while being efficient for delivering appropriate postoperative analgesia. Due to the paravertebral spaces' near closeness to the pleura, many medical professionals are hesitant to employ this method [(7, 8)]. Due to their simplicity of usage and generally safe block area, ESP blocks are becoming more and more popular [(9)].

Therefore, this study aimed to determine analgesic efficacy of continuous infusion ESP block compared to continuous infusion thoracic paravertebral block in patients with rib fracture using post block total morphine consumption.

PATIENTS AND METHODS

This study was done on patients with rib fracture at Suez Canal University Hospital. Pre-procedure steps included the explanation of the procedure and reassurance of the patient.

Patients were split into two equal groups at random:

1- Group I received ultrasound-guided ESP block with 20 ml of bupivacaine 0.25% as a loading dose. Bupivacaine 0.125% was used for continuous infusion of local anesthetic. It was titrated for effect, at 0.1-0.2 mL/kg/hr.

2- Group II received ultrasound-guided PVB with 20 ml of bupivacaine 0.25% as a loading dose. Bupivacaine 0.125% was used for continuous infusion of local anesthetic. It was titrated for effect, at 0.1-0.2 mL/kg/hr.

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Study Procedure:

I - Clinical evaluation:

A) Medical history:

Medical disorders such as diabetes mellitus, cardiovascular diseases, renal diseases and hepatic disorders. Past history of operations or hospitalization. Any drug allergy experienced by the patients.

B) Physical examination:

General examination. Vital signs including (BP, HR, RR and temperature). Chest, heart and abdominal examination.

C) Laboratory investigations:

CBC, PT, INR, PTT and RBS. Also, chest X-ray, electrocardiogram, urine analysis and sensitivity test for local anesthetics were documented.

Criteria of discharge of patient out of the intensive care unit :

- Hemodynamic stability.
- No signs of respiratory distress.
- Control of pain with oral medications.
- Normothermia.
- No signs or symptoms of deep venous thrombosis or pulmonary embolism.
- Management of side effects encountered:
  - **1-** Back pain: Topical analgesics
  - **2-** Vomiting: Control of it using antiemetic such as metoclopramide or ondansetron.
  - **3-** Epidural block: Treatment of hypotension caused by such block using crystalloid.
  - **4-** Hematoma at puncture site: Hot fomentations and topical anti thrombotic.
  - **5-** Atelectasis: Instruct the patient to perform deep-breathing exercises (incentive spirometry).

The catheter was removed according to the guidelines of regional anesthesia protocol for placement and removal of catheters.

The guidelines:

Required supplies include an occlusive dressing, sterile gloves, and an antibacterial skin washing solution.

The steps in the technique included washing hands, donning sterile gloves, opening the dressing pack, removing the dressing from the patient, applying traction to the catheter, inspecting the catheter tip to make sure it is intact, cleaning the skin with the antibacterial solution, allowing drying, and donning an occlusive dressing. To make sure the patient was comfortable he was repositioned. Elimination of garbage, washing of hands, recording of the operation and providing the patient with the right observation. After removal of the catheter, the access site was examined routinely for redness, discomfort, or swelling. A clear occlusive dressing was used.

Ethical approval: Suez Canal Medical Ethics Committee of the Suez Canal Faculty of Medicine gave its approval to this study. All participants gave written consents after receiving all information. The Helsinki Declaration was followed throughout the study's conduct.

Statistical analysis

Microsoft Excel SPSS V. 20.0 programme was used to import the data for analysis. Quantitative data were grouped and represented by mean ± SD whereas qualitative data were represented as numbers and percentages. ANOVA was used for quantitative independent multiple differences. P value ≤ 0.05 was regarded as significant.

RESULTS

No statistically significant differences were existed between the two groups in terms of their age (p = 0.807), sex (p = 0.454), weight (p = 0.714), and number of fractured ribs (p = 0.095) (Table 1).

Table (1): Demographic characteristics of the studied groups

		Group E (n= 35)	Group P (n= 35)	95% CI	P
Age (years)		34.34 ± 9.698	33.77 ± 9.747	-4.1, 5.2	0.807
Sex	Males	68.6% (24)	60.0% (21)	-0.3, 0.1	0.454
	Females	31.4% (11)	40.0% (14)		
Weight (kg)		83.94 ± 13.681	82.77 ± 12.918	-5.2, 7.5	0.714
Number of fractured ribs		3.03 ± 0.568	3.26 ± 0.561	-0.5, 0.0	0.095

Concerning the average pre-block VAS during rest and coughing in the groups under study, it was discovered that neither the VAS at rest nor the VAS on coughing values between the two groups were statistically significantly different (Table 2).

Table (2): Baseline VAS at rest and on coughing in the studied groups

		Group E (n= 35)	Group P (n= 35)	95% CI	P
VAS at rest	Pre-block	4.69 ± 0.758	4.66 ± 0.725	-0.33, 0.38	0.872
VAS on coughing	Pre-block	5.83 ± 0.822	5.71 ± 0.710	-0.25, 0.48	0.536

Regarding TLC, it was found that there was no statistically significant difference between the 2 groups regarding their pre-block TLC ($p = 0.511$), and 24 h TLC ($p = 0.511$) values. However, there was a significantly lower TLC in the ESPB at 48 h compared to the PVB group ($p = 0.006$). In group E, there was a statistically significant decrease in the TLC at 48 h compared to the respective pre-block value ($p < 0.05$). **Regarding the neutrophil count**, it was found that it was significantly lower in the group E compared to the group P at the pre-block ($p = 0.008$), and 48 h ($p = 0.005$) values. However, there was no statistically significant difference between the 2 groups regarding their 24 h neutrophil value ($p = 0.351$). In addition, in both of group E and group P, there was a significantly lower neutrophil count at 24 h and 48h compared to the respective pre-block value ($p < 0.05$). **Regarding the lymphocyte count**, it was found that there was no statistically significant difference between the 2 groups regarding their baseline lymphocyte ($p=0.072$). However, the lymphocyte count was significantly lower in the E group compared to the P group at 24 h ($p = 0.021$) and 48 h ($p < 0.001$). In addition, in group P, there was a significantly higher lymphocyte count at 24 h compared to the baseline value. Moreover, in both of group E and group P, there was a significantly higher lymphocyte count at 48 h compared to the pre-block value ($p < 0.05$) (Table 3).

Table (3): Pre-block and follow-up values of WBCs in the studied groups

		Time interval	Group E (n= 35)	Group P (n= 35)	95% CI	P
WBCs	TLC	Pre-block	10124 ± 1510	10346 ± 299	-894.6, 449.3	0.511
		24 hours	9784 ± 134	10083 ± 617	-1202.6, 604.0	0.511
		48 hours	8835 ± 660*	10207 ± 338	-2338.7, -403.9	0.006
	Neutrophil	Pre-block	7105 ± 322	7862 ± 90	-1307.7, -205.0	0.008
		24 hours	6545 ± 497*	6864 ± 340*	-996.8, 359.1	0.351
		48 hours	5323 ± 247*	6192 ± 277*	-1471.6, -267.1	0.005
	Lymphocyte	Pre-block	1763 ± 432	1505 ± 52	-23.5, 538.5	0.072
		24 hours	1921 ± 470	2274 ± 60*	-650.2, -55.2	0.021
		48 hours	2362 ± 83*	3668 ± 68*	-1646.7, -963.6	< 0.001

There was no statistically significant difference was detected between both groups regarding VAS values at rest at 6 h, 24 h, 36 h, and 48 h as well as VAS values on coughing at 6 h, 24 h, 36 h, and 48 h post block (Table 4).

Table (4): Post-procedure analgesic profile in the studied groups

	Time interval	Group E (n= 35)	Group P (n= 35)	95% CI	P
VAS at rest	6 hours	3.31 ± 0.471	3.14 ± 0.355	-0.028, 0.370	0.090
	12 hours	3.43 ± 0.502	3.46 ± 0.505	-0.269, 0.212	0.811
	24 hours	4.71 ± 0.458	4.80 ± 0.473	-0.308, 0.136	0.470
	36 hours	3.11 ± 0.323	3.26 ± 0.505	-0.345, 0.059	0.140
	48 hours	2.29 ± 0.458	2.29 ± 0.458	-0.219, 0.219	1
VAS on coughing	6 hours	4.20 ± 0.406	4.00 ± 0.767	-0.093, 0.493	0.177
	12 hours	4.23 ± 0.426	4.14 ± 0.355	-0.101, 0.273	0.360
	24 hours	5.31 ± 0.796	5.14 ± 0.430	-0.134, 0.477	0.088
	36 hours	3.86 ± 0.550	3.86 ± 0.430	-0.235, 0.235	0.939
	48 hours	2.83 ± 0.382	2.69 ± 0.530	-0.078, 0.363	0.169

The total morphine consumption 48 hr post block showed no statistically significant difference between the two groups ($p = 0.398$) (Table 5).

Table (5): Total morphine consumption (mg) 48hr post block

	Group E (n= 35)	Group P (n= 35)	95% CI	P
Total morphine consumption 48hr post block (mg)	4.17 ± 1.465	3.89 ± 1.345	-0.4, - 0.96	0.398

DISCUSSION

The most common cause of acute pain that impairs respiratory function, ups the risk of pulmonary infections, aggravates underlying lung damage or preexisting lung disorders, and may induce respiratory failure is multiple rib fractures. In patients with traumatic chest injuries, adequate pain management is currently regarded as the cornerstone of managing numerous rib fractures since it can improve the patient's ability to cough, inhale deeply, and adhere to chest physiotherapy [4, 5, 10, 11].

By reviewing the literature, no available studies comparing the efficacy of both techniques on pain relief in patients with traumatic rib fractures. However, each block per se was previously described in case reports, case series, retrospective cohort or prospective cohort study or compared to different appropriate regional blocks [12].

Thoracic paravertebral block (TPVB) and ESPB procedures can be carried out either with a single injection or by inserting a catheter. Despite the use of long-acting local anaesthetics, pain following single shot TPVB or ESPB injections has been observed to return quickly [13, 14]. A perineural local anaesthetic infusion (also known as a "continuous peripheral nerve block") may be given for many days because a single-injection nerve block lasts less than 24 hours, most likely because of local anaesthetic absorption. With local anaesthetic delivery by a perineural catheter as opposed to continuous thoracic PVB, the prospect of increasing the time of ESPB has not been researched. As a result, many medical professionals are switching to continuous catheters to deliver analgesia that lasts longer [13, 14]. We aimed to determine analgesic efficacy of continuous infusion ESP block compared to continuous infusion TPVB in patients with rib fracture using post-block total morphine consumption.

For patients with numerous rib fractures, single shot or continuous TPV block, whether ultrasound-guided or not, lowered pain ratings at rest, while coughing, and post-block opioid intake, according to many investigations [15–19]. In two cases, **Karmakar *et al.*** [15] came to the conclusion that thoracic paravertebral block was a viable choice for treating pain brought on by numerous rib fractures when lumbar spinal damage was also present and necessitated ongoing neurological evaluation. Furthermore, **Mohta *et al.*** [16] found that patients with unilateral cracked ribs may effectively control pain with continuous bupivacaine infusion by TPVB.

The main finding of the current study was that continuous ESPB was a straightforward, effective analgesic technique that was comparable to continuous paravertebral block in terms of pain scores at rest, on coughing, and post-block opioid consumption in patients with unilateral multiple rib fractures. In addition, relative to the pre-block ratings in both groups, the pain scores when coughing and at rest both considerably improved with time. **Chin and El-Boghdadly** [20] reviewed the ESP Block's potential procedures for functioning as a regional block. These included the following: direct local anaesthetic spread into the paravertebral or epidural space, which results in neural blockade and central inhibition, analgesia caused by increased local anaesthetic plasma concentrations as a result of systemic absorption, local anaesthetics' immunomodulatory effects and an effect mediated by the thoracolumbar fascia's mechanosensory properties. The most likely primary mechanism is a direct effect of local anaesthetic via physical spread and diffusion to neural structures in the fascial plane deep to the erector spinae muscles and adjacent tissue compartments, according to data from clinical, human cadaveric, animal, and mechanistic laboratory studies.

Leucocytes and endothelial cells create a variety of inflammatory mediators that cause pain, which endogenous opioid peptides in peripheral nerve terminals can reduce [21]. Trauma-affected regions experience inflammatory responses, which activate pain receptors [22]. The hypothalamus's ability to receive impulses is completely blocked by regional blocks, which reduces the stress response's activation. The catabolism, increased oxygen consumption, and altered immunological processes are some of the impacts of the stress response.

In the present study, it was found that there was no statistically significant differences between both groups regarding their pre-block TLC, and 24 h TLC values. However, there was a significantly lower TLC in the E group at 48 h compared to the P group as well as the pre-block value. Simple peripheral blood indicators called TLC, NLR, and PLR are employed in both surgical and trauma patients to evaluate inflammatory response, immune state, and physiological stress [23]. The utility of PLR and NLR for forecasting outcomes in trauma patients has been examined in several research [24]. Recent research on trauma patients revealed that the NLR, a measure of inflammation, was linked to death in cases where it was elevated [25–27].

For patients with abdominal trauma, early risk assessment, prompt therapy, and death prediction are all aided by on-admission PLR but not NLR [28]. The incidence of SIRS in cases of blunt abdominal trauma following a laparotomy emergency is anticipated to be predicted using NLR as a reference [29]. However, the NLR upon emergency department admission, was unable to anticipate delayed ARDS during the next 5 days in patients with acute chest trauma [30]. Therefore, a viable effective alternative to continuous thoracic paravertebral block in combination with a multimodal pain protocol for establishing acute pain relief for unilateral multiple fracture ribs is mandatory.

CONCLUSION

Both continuous ESPB and TPVB can be used for pain control of unilateral multiple fracture ribs. Continuous ESPC is an interfascial regional anaesthetic

treatment that can be used to treat patients with unilateral multiple fracture ribs. The continuous erector spinae plane block had similar analgesic effects on pain ratings and rescue analgesic intake, making it comparable to the continuous thoracic paravertebral block.

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