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Analgesic effect of rhomboid intercostal block with sub serratus plane block versus thoracic erector Spinae block in multiple rib fractures: A randomized study

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Abstract
Background: Managing pain in patients with rib fractures poses significant challenges, the medical community has developed ultrasound (US)-guided myofascial plane blocks. These blocks have shown to be a useful method of delivering analgesia while minimizing the occurrence of unwanted effects. The objective of this research is to compare and evaluate the analgesic efficacy of US-guided rhomboid intercostal block in combination with sub-serratus plane block (RISS) with that of US-guided thoracic erector spinae block (ESPB) in patients with numerous rib fractures.
Methods: A comparative prospective randomized double-blind study involving 90 patients who had sustained unilateral multiple fractures (≥ three ribs) was conducted. Patients were categorized equally into 2 groups. Group I: received ESPB in the form of a bolus dose of 30 mL of bupivacaine 0.25% and group II: received RISS block using a mixture of 30 ml of bupivacaine 0.25%.
Results: Total morphine consumption during the first 24 hours was significantly high in ESPB group. The time to first analgesic requirement was significantly short in ESPB group. Peak expiratory flow rate in ESPB group and RISS group showed significant elevation at 30 min and 6 hrs., 12 hr. and 24 hr. post block as compared to admission, while it showed significant elevation at 12 hrs in RISS group as compared to ESPB group. Numerical pain rating scale was significantly higher in ESPB group at 12 hours.
Conclusions: RISS block is more effective for pain relief at 12 hours, for increasing time to first analgesic requirement and for decreasing total morphine consumption than ESPB.

Keywords: Rhomboid intercostal block, Sub serratus plane block, thoracic ESPB, rib fractures

Introduction
Rib fractures may develop as a consequence of severe acute chest trauma and are associated with increased mortality and morbidity. Individuals may potentially encounter intense and painful discomfort associated with the presence of many rib fractures [1]. Insufficient attention to pain management may lead to patients encountering challenges in coughing and exhibiting shallow respirations, thereby giving rise to respiratory issues such as diminished respiratory capacity, retention of sputum, atelectasis, and pneumonia [2].
Managing pain in people with rib fractures may present significant difficulties. Historically, healthcare practitioners have used intravenous patient-controlled analgesia (IVPCA) using epidural and paravertebral blocks as well as opioids. However, it is important to note that certain procedures may not be suitable or may have restricted applicability in specific patient populations [3].
In recent times, viable alternatives have surfaced in the form of US-guided myofascial plane blocks, including the erector spinae plane block (ESPB), rhomboid intercostal block, and serratus anterior plane (RISS) block. These blocks provide excellent analgesia while inducing minimal adverse effects [4]. ESPB It has been effectively used to treat severe neuropathic pain caused by ribs [5].
Anaesthesia is administered to the lateral cutaneous branches of the thoracic intercostal nerves as part of the RISS technique. It has been demonstrated that this technique effectively administers analgesics for a variety of clinical situations involving the upper abdomen and thoracic wall [6].

The RISS block has been shown to provide effective pain relief in individuals suffering from numerous rib fractures [7].

This objective of this research was to assess the efficacy of US guided RISS versus US guided thoracic ESPB for analgesia in multiple rib fractures.

Design: The research design encompasses a prospective comparative randomized clinical trial (RCT).

Sitting: the study was conducted at Tanta University hospitals.

Patients and Methods

From February 2022 to January 2023, this prospective randomized double-blind comparative study was conducted on 90 patients aged 21 to 60 years who had unilateral multiple fractures of three or more ribs. Approval for the research protocol was obtained from the Ethics Committee of the Faculty of Medicine at Tanta University, which is located locally (approval code: 35235/1/22). A written consent form was endorsed by each patient as an indication of diligence.

Exclusion criteria were any contraindication for regional block as (bleeding disorders, infection at the injection site), unstable cardiac conditions, known hypersensitivity to the study drugs, unconscious patients, Significant trauma outside the chest wall, such as an acute spine or pelvic fracture, severe traumatic brain or spinal cord injury, or abdominal visceral injuries, chronic opioid users, uncooperative patients, or patients with psychiatric illness, patients with indications for immediate surgery for other associated injuries, and patients with hemodynamic instability.

Patients were categorized equally using opaque sealed envelopes into 2 groups. Group I: received ESPB and Group II: received RISS block. The study was double blinded in which the approach was hidden from the patients and result evaluators.

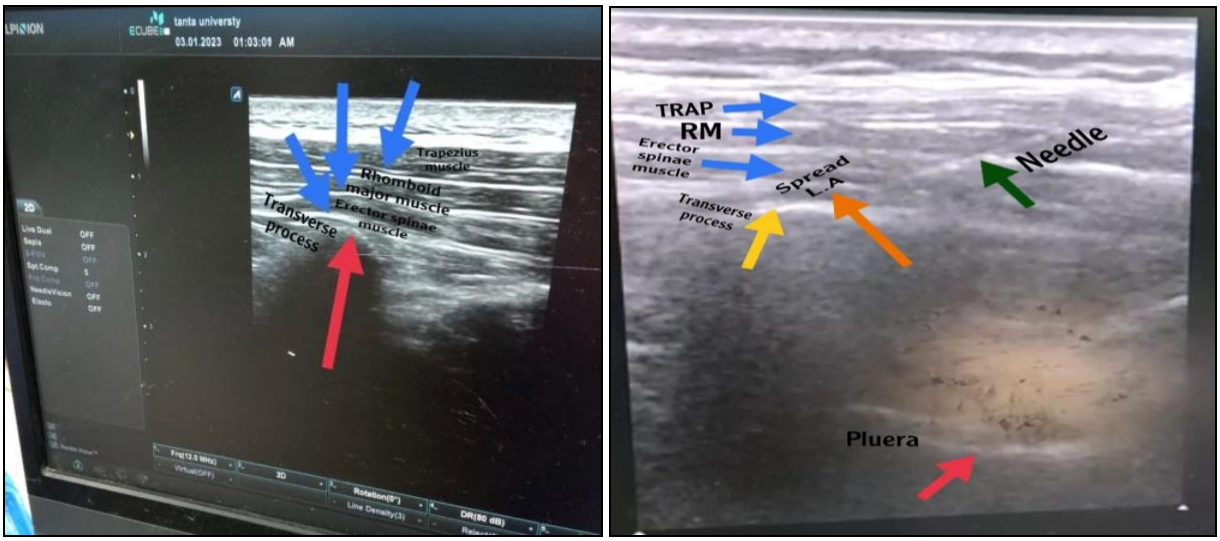
All patients undergo a thorough physical examination as well as laboratory evaluations of their bleeding and coagulation profiles (prothrombin time, partial thromboplastin time, INR, and platelet count), hepatic and kidney function, serum electrolytes, complete blood count (CBC), and arterial blood gases (ABGs).

All patients received respiratory treatment in the form of frequent chest physiotherapy. Coughing out secretions and deep breathing exercises were suggested for the patients. On alternating days, a series of chest x-rays were obtained. Patients who developed fever or other symptoms of illness were given sputum, urine, and blood samples for culture and sensitivity testing.

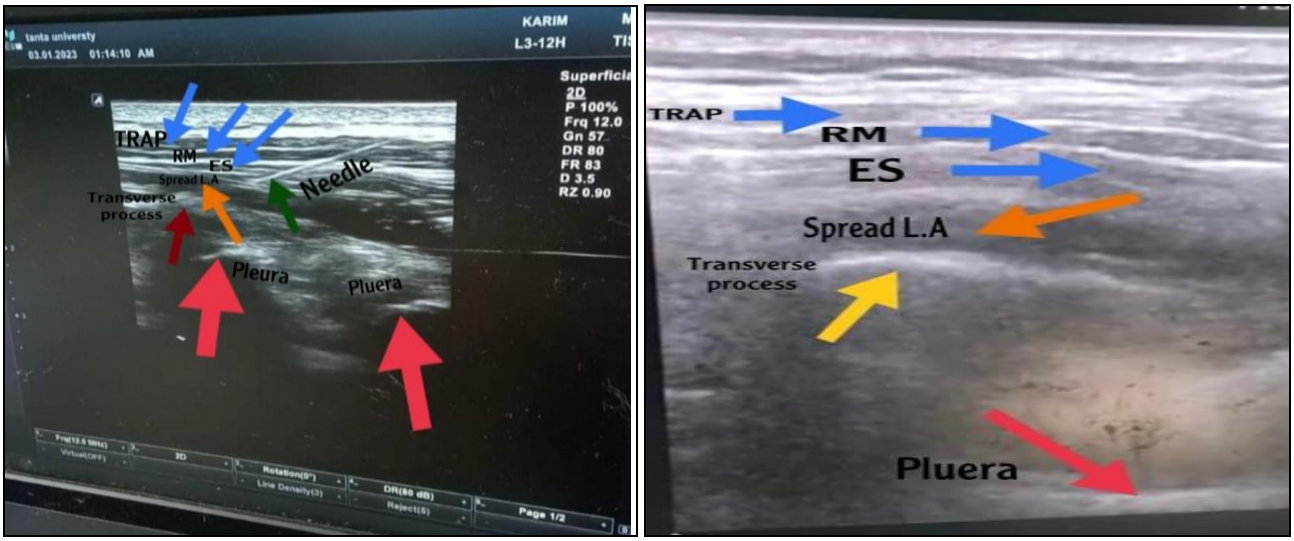
After complications of polytrauma survey and insertion of chest tube (if needed), patients were admitted to intensive care unit (ICU). On admission to the ICU, Patients were given O2 using a nasal cannula at a rate of 4 L/Min and were monitored using ECG, pulse oximetry, and non-invasive blood pressure. All patients had an IV access set up using an 18 G cannula for the block.

Both blocks were performed in the ICU by the same investigator after ensuring hemodynamic stability while the patient is connected to the monitor and insertion of the chest tube if needed. US machine (ALPINION ™ E-CUBE 8, Serial Number: L04980) equipped with high frequency probe was used.

ESPB group; In adherence to aseptic protocols, patients were administered ESPB while seated. A high-frequency linear US transducer was positioned longitudinally at a point equidistant from the highest and lowest fractured rib, 3 cm from the midline. A superficial location appears to be attributed to three muscles in the shadow cast by the transverse process of hyperechoic light. The trapezius, erector spinae, and rhomboid major comprise these muscles. Following the administration of 2-3 ml of 2.0% lignocaine by local infiltration at the needle insertion site, an 18G Tuohy needle was inserted in a cranial-caudal orientation towards the transverse process (TP) in-plane with the US (US) transducer. The cannula was inserted into the TP and advanced until it made contact with it, then passed through each muscle. The cannula was inserted precisely by means of hydro dissection utilizing two to three milliliters of saline. After administering 3 mL of normal saline containing epinephrine at a ratio of 1:200,000 as an initial injection, a bolus dose of 30 mL bupivacaine 0.25% was utilized. Figure 1



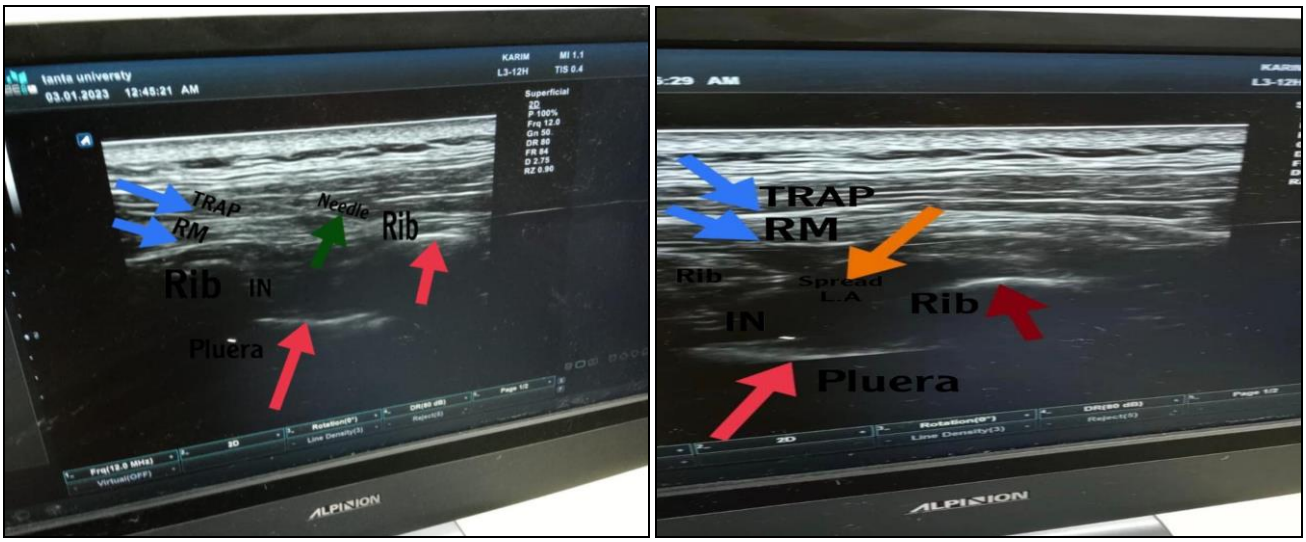
(A) (B)



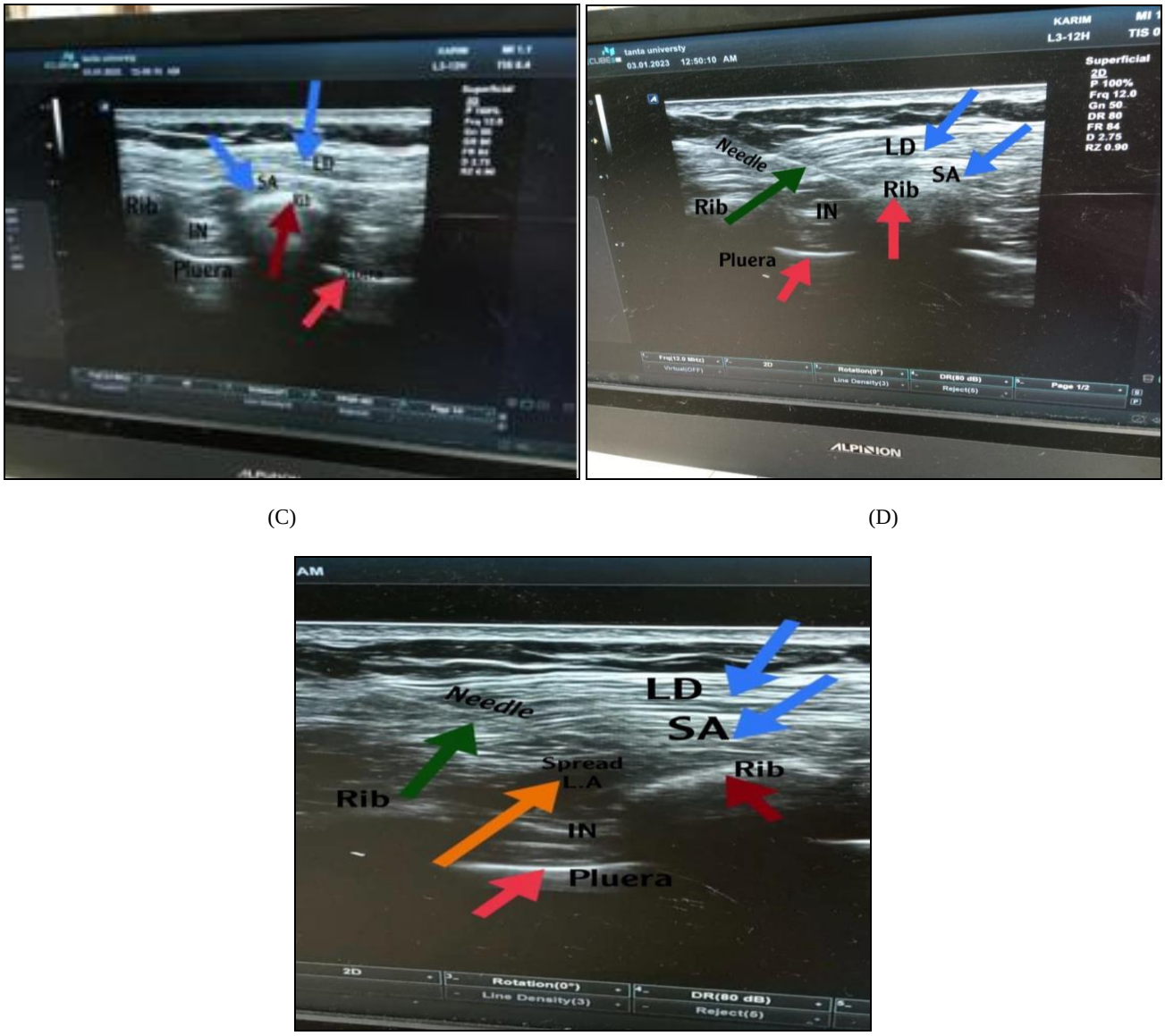
(C) (D)

Fig 1: US imaging showing (A, B) Anatomy of ESPB and (C, D) spread of local anesthetic.

RISS group; The individuals were placed in the lateral decubitus position, wherein the arm was extended across the torso in adduction, along the same side as the body. This particular position enabled the scapula to undergo lateral movement. A 30 ml solution was generated, which was composed of 15 ml of bupivacaine 0.5% and 15 ml of normal saline. Utilizing a high-frequency linear instrument, the procedure was carried out in a sterile environment. The ultrasound transducer was positioned in the oblique sagittal plane, specifically at the T5-T6 level, 1-2 cm medial to the medial scapula. By employing ultrasonic imaging techniques, the trapezius muscle, rhomboid major muscle, ribcage, intercostal muscles, and pleura were observed. After administering a volume of 2-3 ml of 2.0% lignocaine, infiltration was conducted locally at the site of needle insertion. By employing the in-plane technique, an 18-gauge needle was inserted in a caudal to cranial direction. The needle was inserted into the space located between the rhomboid major muscle and the fascia of the intercostal muscles. The needle's placement was verified by administering a test dose of 3 mL of normal saline with epinephrine (1:200,000), followed by the administration of 20 mL of a local anesthetic combination. In order to determine the plane between the serratus anterior and intercostal muscle for the sub-serratus block at T9 level, the instrument was subsequently advanced caudally and laterally. In order to validate the needle's location, a test dose of 3 mL of normal saline containing epinephrine (1:200,000) was administered, followed by the injection of a 10 mL local anesthetic mixture between the serratus and intercostal muscle fascia.



(A) (B)



(C) (D)

(E)

Fig 2: US imaging showing Rhomboid intercostal plane block (A) anatomy of with the needle and (B) spread of local Anesthetic, Sub serratus plane block (C, D) anatomy and (E) spread of local Anesthetic.

The following measurements were recorded: numerical pain rating Scale (NPRS) at rest and on coughing at admission, 30 minutes, 6 h, 12 h and 24 h post block. Rescue analgesia in the form of incremental IV Morphine (0.05 mg /kg) were given if NPRS ≥4. Total consumptions were recorded during the first 24 hours. Time to first rescue analgesia was recorded. Peak expiratory flow rate (PEFR) (L\ min) at admission, 30 minutes, 6 hr, 12 hr and 24 hr post block.

Study findings

The 1st outcome was to total rescue analgesics consumption (morphine).

The 2nd outcome was NPRS, complications occurrence (hypotension, pneumothorax, local anaesthetic systemic toxicity (LAST), failure of block, length of ICU stays, length of hospital stays and changes of pulmonary functions: PEFR.

Sample size calculations

The statistical software Epi-Info, version 2002, developed by the Centers for Disease Control and Prevention and the World Health Organization in Atlanta, Georgia, USA, was utilized to determine the sample size and conduct power analysis [9]. The calculation of the sample size was based on the following criteria: The study has an 80% power level, a 95% confidence interval, and an anticipated nerve block of 90% in the most favourable treatment group, compared to 65% in the least favourable treatment group. As per the aforementioned criteria, the sample size for each cohort was determined to be N>44. To accommodate cases of attrition, the researcher augmented the sample size to 45.

Statistical analysis

The statistical analysis was performed utilizing SPSS v27, an IBM (Chicago, IL, USA) software application. The Shapiro-Wilks test and histograms were employed to evaluate the normality of the distribution of the data. In order to analyse quantitative parametric data, the mean and standard deviation (SD) values were presented. A post hoc Tukey test was utilized to analyze the data. The Mann Whitney test was utilized to analyse quantitative non-parametric data, which were subsequently displayed in the form of the median and interquartile range (IQR). The

analysis employed the frequency and percentage (%) values of qualitative variables, utilizing the Chi-square test or Fisher's exact test as applicable statistical tests. Considered to indicate statistical significance was a two-tailed P value below 0.05.

Results

90 patients were enrolled in the research and were catogarized equally using opaque sealed envelopes into 2 groups; Group I:(N=45) patients received ESPB and Group II: (N=45) patients received RISS block. Figure 1

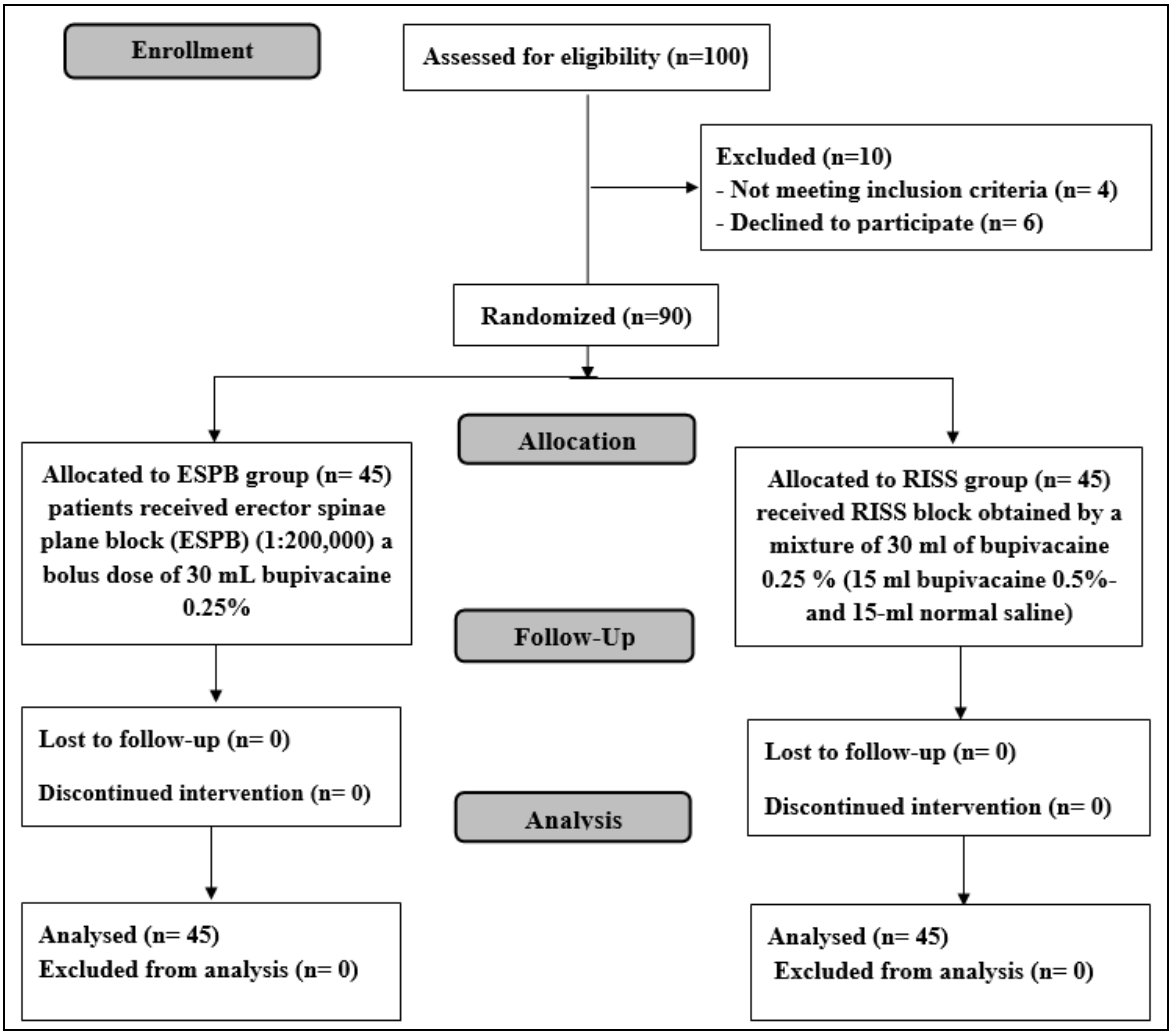


Fig 3: CONSORT flow chart of the studied groups

According to injury data and patients' features, there was no significant difference between 2 groups. Table 1

Table 1: Patients' features and injury data in 2 groups

		ESPB group (n=45)	RISS group (n=45)	P value
Age (years)		42.64±11.15	40.16±12.65	0.325
Gender	Male	29 (64.44%)	25 (55.56%)	0.519
	Female	16 (35.56%)	20 (44.44%)	
Weight (kg)		84.04±12.36	82.87±12.27	0.651
Height (m)		1.66±0.14	1.67±0.15	0.590
BMI (kg/m2)		31.3±6.21	30.8±7.26	0.767
Number of fractured ribs		5.16±1.31	5.09±1.35	0.813
Side	Right	19 (42.22 %)	28 (62.22 %)	0.058
	Left	26 (57.78%)	17 (37.78%)	
Flail segment		7 (15.56%)	5 (11.11%)	0.535
Hemothorax		14 (31.11%)	11 (24.44%)	0.480
Pneumothorax		6 (13.33%)	7 (15.56%)	0.764
Hemopneumothorax		4 (8.89%)	8 (17.78%)	0.353
Chest tube		19 (42.22%)	16 (35.56%)	0.517
Pulmonary contusion		22 (48.89%)	20 (44.44%)	0.673
Subcutaneous emphysema		22 (48.89%)	25 (55.56%)	0.527

Data are demonstrated as mean±SD or number (%). ESPB: Erector spinae plane block, RISS: Rhomboid intercostal and sub serratus plane block, BMI: Body mass index.

Physical examination showed significant reduction at 12 hrs in RISS group as compared to ESPB group. Oxygen saturation showed an insignificant difference between both groups at the admission, 30 min, 6 hrs, and 24 hrs post block, while oxygen saturation was better in RISS group than ESPB group. Ratio of partial pressure of oxygen in arterial blood to inspired oxygen concentration showed an insignificant difference between 2 groups at the admission, 30 min and at 6 hrs post block. Table 2

Table 2: This table shows relation physical examination (Vital signs) in 2 groups

		Admission	30min	6 h	12 h	24 h
Heart rate	ESPB group (n=45)	107.44±10.75	81.93±11.20	85.51±11.63	89.29±12.58	92.42±17.07
	RISS group (n=45)	109.20±11.45	83.33±12.02	83.58±11.88	83.40±13.85	91.58±15.99
	P value	0.479	0.601	0.650	0.038*	0.809
Arterial blood pressure	ESPB group (n=45)	99.13±9.31	81.29±9.48	83.49±10.13	85.64±9.60	88.18±12.52
	RISS group (n=45)	98.02±10.96	80.56±10.91	80.71±11.40	80.67±10.67	85.40±14.32
	P value	0.606	0.734	0.225	0.022*	0.330
Respiratory rate	ESPB group (n=45)	26.76±2.01	17.64±2.32	18.42±3.06	19.82±3.36	20.89±3.87
	RISS group (n=45)	27.11±2.26	18.07±2.26	18.27±2.52	18.42±3.06	20.29±4.30
	P value	0.433	0.384	0.793	0.042*	0.488
Oxygen saturation	ESPB group (n=45)	92.18±1.54	96.64±1.26	96.87±1.38	96.53±2.56	96.93±1.40
	RISS group (n=45)	92.40±1.40	96.78±1.38	97.13±1.34	97.51±1.80	96.27±2.61
	P value	0.477	0.634	0.354	0.039*	0.134
PaO2/FiO2	ESPB group (n=45)	254.11±28.95	305.00±36.45	311.33±36.42	-	-
	RISS group (n=45)	249.56±29.83	306.89±35.87	307.56±33.13	-	-
	P value	0.464	0.805	0.608	-	-

Data are demonstrated as mean±SD. ESPB: Erector spinae plane block, RISS: Rhomboid intercostal and sub serratus plane block. *: Significant

PEFR demonstrated significant elevation at 12 hrs in RISS group as compared to ESPB group. NPRS was insignificantly different between 2 groups at Admission, 30min, 6 and 24 hours (P = 0.429, 0.894, 0.494 and 0.346 respectively) and was significantly higher in ESPB group. Table 3

Table 3: Peak expiratory flow rate (PEFR) (L/ min) and numerical pain rating scale (NPRS) in 2 groups

		Admission	30min	6 h	12 h	24 h
PEFR	ESPB group (n=45)	336.22±71.48	448.22±70.47	400.33±45.21	436.67±64.63	400.33±45.21
	RISS group (n=45)	327.44±70.25	457.11±67.84	398.78±43.72	465.11±67.07	398.78±43.72
	P value	0.558	0.544	0.869	0.043*	0.869
NPRS	ESPB group (n=45)	7 (6-8)	2 (1-3)	2 (1-3)	3 (2-3)	3 (2-5)
	RISS group (n=45)	7±6-8	2 (1-3)	2 (1-3)	2 (1-3)	3 (2-4)
	P value		0.429	0.894	0.494	<0.001*

Data are demonstrated as mean±SD or median (IQR). PEFR: Peak expiratory flow rate. NPRS: Numerical pain rating scale. ESPB: Erector spinae plane block, RISS: Rhomboid intercostal and sub serratus plane block. *: Significant.

Total morphine consumption (mg) during the first 24 hours ranged from 3-10 mg with a mean±SD of 6.4±2.2 mg in ESPB group and ranged from 3-10 mg with a mean±SD of 4.52±1.43 mg in RISS group. Total morphine consumption during the first 24 hours was significantly higher in ESPB group . Figure 1

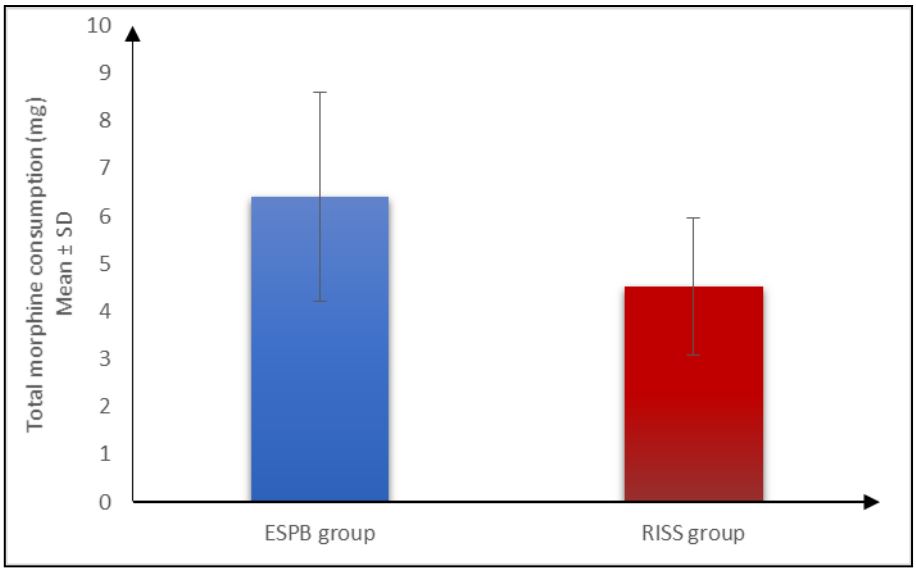


Fig 4: Total morphine consumption (mg) in both groups

The time to first analgesic requirement was significantly shorter in ESPB group. Figure 2

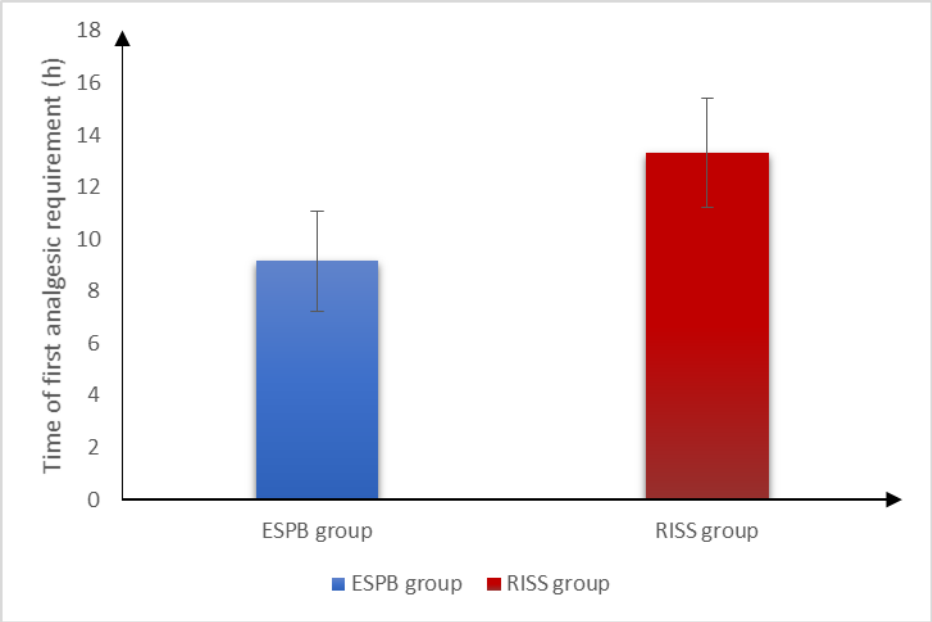


Fig 5: Time to first analgesic requirement in both groups (during the first 24 hours)

ICU stay, hospital stay and subcutaneous emphysema were insignificantly different between both groups. LAST and respiratory depression didn't occur in both groups. Table 4

Table 4: ICU stay, hospital stay (days) and adverse effects in both groups

	ESPB group (n=45)	RISS group (n=45)	P value
ICU stay	3.69±1.5	3.27±1.37	0.168
Hospital stay	7.67±1.99	6.96±2.2	0.112
Subcutaneous emphysema	4 (8.89%)	2 (4.44%)	0.677
LAST	0 (0%)	0 (0%)	-
Respiratory depression	0 (0%)	0 (0%)	-

Data are demonstrated as mean±SD. ESPB: Erector spinae plane block, RISS: Rhomboid intercostal and sub serratus plane block. ICU: intensive care unit. LAST: Local Anaesthetic Systemic Toxicity.

Discussion

Rib fractures result from blunt thoracic trauma that seen in road traffic accidents or falls from a height ;occur in up to 12% of all trauma patients [10].

In the present study, heart rate (HR) in ESPB group and RISS group showed significant reduction at 30 min and 6 hrs., 12 hr. and 24 hr. post block as compared to admission with insignificant difference between both groups at admission, 30 min, 6 hrs and 24 hrs post block. This result goes in hand with

Kozanhan *et al.* [11] Who carried out prospective, randomized controlled trial on forty patients who underwent thoracotomy and found that HR was significantly decreased after block compared to baseline levels in RISS block group.

MAP in ESPB group and RISS group showed significant reduction at 30 min, 6 hrs, 12 hrs and 24 hrs post block as compared to admission with insignificant difference between both groups at the admission, 30 min, 6 hrs and 24 hrs post block. This was supported by the findings of

Kim *et al.* [12], that there was insignificant difference in change of MAP from baseline and consistent over time between SPB and control group (P = .727, and P = .853), respectively.

In the present study, RR in ESPB group and RISS group showed significant reduction at 30 min, 6 hrs, 12 hrs and 24 hrs post block as compared to admission and there was no significant difference between the two studied groups. And the findings of Syal *et al.* [13] Who carried out prospective descriptive study on ten patients with multiple rib fracture using US-guided ESP block ;. They found significant reduction in RR, in ESPB and significant increases of both oxygen saturation (SpO2) and (PaO2 / FiO2) in ESPB and RISS groups at 60 min, at day 2, day 3, and day 4 post block as compared to pre-block.

Following admission, both the ESPB and RISS groups experienced a substantial decrease in the NPRS at each of the following time points: 30 minutes, 6 hours, 12 hours, and 24 hours, relative to their pain levels at admittance. There was no statistically significant difference observed in the NPRS scores between the RISS group and the ESPB group at the time of admission, 30 minutes later, and 24 hours later. Nevertheless, the ESPB group demonstrated significantly superior NPRS scores in comparison to the RISS group at the 12-hour mark. The RISS block is characterized by its superficial nature and relative ease of execution. The administration of a regional anaesthetic solution is distributed within the face plane, effectively inhibiting the ventral and dorsal branches of the thoracic intercostal nerves. This method of analgesia seems to be efficacious in managing pain for patients diagnosed with rib fractures or those necessitating the insertion of chest tubes

[14]. In agreement with our results, Zhang *et al.* [15] explained that ESP blocks the dorsal and ventral branches of the thoracic spinal nerve, causing some degree of sympathetic blockade and thus providing a good analgesia.

In disagreement with our findings , El Malla *et al.* [16] found that pain scores were significantly lower in ESPB group from 2 hour up to 24 hour post block. This difference may be because of different comparative groups as we compare between RISS and ESPB block.

In the present study, total morphine consumption during the first 24 hours was significantly higher in ESPB group. In agreement with our results, Kozanhan *et al.* [11] observed that tramadol consumption at 24 and 48 h was significantly lower in the RISS block group block.

Supporting our findings, Okmen *et al.* [17] showed that postoperative tramadol consumption at 24 h was lower in the RISS group .

Similarly, Deng *et al.* [7] found that the required dosage of sufentanil in group RISS was less than those in the group RIB at 24 h after the surgery ($p<0.001$).

In contrary, El Malla *et al.* [16] observed that there was a significant reduction in 24-hour opioid consumption in ESPB group . This difference may be because of different comparative groups as we compare between RISS and ESPB block.

Contrary to our findings, Zhang *et al.* [15] reported that there was no significant variation in sufentanil intake across the RIB (50.4±1.4 mg), ESP (50.4±1.5 mg), and SAB (51.0±1.7 mg) groups throughout the 24-48-hour timeframe (P = 0.192).

Based on our findings, there was a statistically significant difference observed in the duration (measured in hours) before the first analgesic necessity between the ESPB group and the RISS group. Consistent with our findings, Kozanhan *et al.* (11) observed that none of the patients in the RISS block group need the use of rescue analgesia.

In a similar vein, Deng *et al.* (7) observed that the duration until the first request for postoperative analgesics was shorter in the RISS group compared to the RIB group, specifically within 24 hours after the surgical procedure.

One of the limitations of this research is that it was conducted at a single location. The size of the sample was rather tiny. The duration of the follow-up period was quite brief. The incidence of Nausea and Vomiting was not assessed in the research.

Conclusions

Compared to ESPB, RISS block is more effective at providing pain relief for 12 hours, extending the time until the first analgesic requirement arises, and reducing total morphine consumption.

Conflict of Interest

Not available

Financial Support

Not available

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