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Erector spinae plane block (ESPB) enhances hemodynamic stability decreasing analgesic requirements in surgical stabilization of rib fractures (SSRFs)

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Abstract

Objective To evaluate the efficacy of erector spinae plane block (ESPB) on intraoperative hemodynamic stability, opioid and inhalation anesthetic requirements and postoperative analgesic effects in patients undergoing surgical stabilization of rib fractures (SSRFs).

Methods We retrospectively reviewed 173 patients who underwent surgical stabilization of rib fractures between May 2020 and December 2023. The patients were allocated into the ESPB group or the control group. Demographic data, intraoperative hemodynamic parameters, total intraoperative opioid consumption, the average minimum alveolar concentration (MAC) of inhalational anesthetics, postoperative simple analgesics and opioid consumption and the length of hospital stay were included in the analysis.

Results Compared with the control group, the ESPB group had a lower heart rate (HR) in the first 90 min after surgical incision and lower systolic blood pressure (SBP) and mean arterial pressure (MAP) at the beginning of surgery. Intraoperatively, a notable reduction in fentanyl consumption was observed in the ESPB group ($p=0.004$), whereas no significant difference was observed in the average MAC of inhalational agents ($p=0.073$). Postoperatively, the ESPB group required fewer doses of simple analgesics in the first 24 h ($p<0.001$) and 48 h ($p=0.029$). No statistically significant difference in the length of hospital stay ($p=0.608$) was observed between the groups.

Conclusion ESPB was shown to enhance intraoperative hemodynamic stability, reduce opioid consumption and decrease postoperative analgesic consumption in patients who underwent SSRF. These results suggest that ESPB may serve as a valuable component of multimodal analgesia protocols for SSRF. Larger prospective studies are warranted to confirm the results and evaluate long-term outcomes.

Keywords Erector spinae plane block, ESP, Rib fracture, Surgical stabilization of rib fracture, SSRF, Hemodynamics

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Background

Rib fractures occur in approximately 10% of patients with trauma, and the number, location and pattern of rib fractures are associated with mortality and morbidity. Common complications correlated with rib fractures include pneumonia, pulmonary effusion, aspiration, acute respiratory distress syndrome and atelectasis in addition to the risks of cardiovascular and cerebrovascular events and the development of chronic pain [1, 2]. To decrease morbidity, early implementation of multimodal pain management, pulmonary hygiene and surgical fixation have been suggested to improve patient outcomes [3]. Multimodal analgesia (MMA), which involves the administration of various analgesic modalities, has demonstrated a plethora of benefits, including lower consumption of opioids, expedited mobilization, a reduced incidence of adverse events, and a decline in morbidity [4–6]. Early surgical fixation of multiple rib fractures has also been shown to significantly decrease the duration of chest tube insertion, length of hospital stays and mortality benefit [7–9]. With advances in real-time imaging, ultrasound-guided peripheral nerve blocks play an important role in the MMA for the management of rib fractures.

Peripheral nerve or plane block is a procedure in which local anesthetics are deposited in the region of the targeted nerve or fascial plane, which in turn blocks the transmission of sensory signals and, in some circumstances, motor function, depending on the clinical requirements [10]. Nerve blocks have been demonstrated to reduce the consumption of opioids and pain scores and to facilitate faster functional recovery [11]. ESPB is a well-established technique that was first described by Forero et al. in 2016 in two patients with severe neuropathic pain [12]. In ESPB, the analgesic agent is deposited into the fascial plane between the erector spinae muscle and the vertebral transverse process. The level of injection is determined by the dermatome corresponding to the site of injury [13]. Moreover, the anatomical structure of the erector spinae fascia allows the analgesic to travel at least three vertebrae cranially and four vertebrae caudally [14]. Since its initial description, the safety and efficacy of ESPB has been demonstrated as part of MMA in acute pain management in rib fractures and in various surgical procedures [15–19]. In addition to its analgesic effect, ESPB may have exhibited the capacity to maintain intraoperative hemodynamic stability during mastectomy and lumbar spine surgery and reduce opioid consumption [20–22]. However, until the completion of the study, no similar studies in literature have demonstrated the efficacy of ESPB for SSRF intraoperatively and postoperatively. In this retrospective analysis, we aim to evaluate the real-world efficacy of ESPB in patients with multiple rib fractures requiring SSRF.

Methods

Patient selection

This was a retrospective comparative analysis. The study was approved by the Institutional Review Board of Chang Gung Memorial Hospital (CGMH IRB 202401596B0) and was conducted in accordance with the ethical principles of the Helsinki declaration. As a result of the retrospective nature of the study, the need to obtain written informed consent was waived. The trauma registry database of Linkou CGMH was reviewed to identify all patients who were diagnosed with multiple rib fractures and who received internal fixation surgery under general anesthesia from May 2020 to December 2023. Following a comprehensive review of our trauma registry database, a total of 177 patients were identified, with 4 patients excluded based on the exclusion criteria. Among the remaining 173 patients, 55 patients received ESPB (ESPB group), whereas 118 patients (control group) did not, as shown in Fig. 1. The exclusion criteria were as follows: age < 18 years, a history of coagulation dysfunction, severe liver or renal dysfunction, chronic use of analgesic medications, and body mass index (BMI) ≥ 40 kg/m². The patients who received ESPB and those in the control group who did not receive ESPB prior to surgery were allocated to the ESPB group.

Intraoperative management

All patients received standardized monitoring, including electrocardiogram (ECG), noninvasive blood pressure (NIBP), and oxygen saturation (SpO_2), upon arrival at the operating room. General anesthesia was induced with intravenous propofol (1.5 mg/kg), fentanyl (0.5 μg/kg), and cisatracurium (0.2 mg/kg) or rocuronium (1 mg/kg) and maintained with sevoflurane or desflurane, the concentration of which was adjusted to adjuvants with fentanyl or other vasoactive agents to maintain hemodynamic stability. For patients who received ESPB, after the induction of general anesthesia, they were placed in the lateral decubitus position, and ESPB was performed under ultrasound guidance 0.5% ropivacaine mixed with 5 mg of dexamethasone (20–40 ml) according to the span of the rib fractures. Invasive radial arterial catheters were also inserted in both groups for close monitoring of blood pressure throughout the surgery. During surgery, patients stayed in the lateral decubitus position under one-lung ventilation. After the fractured ribs were identified for open reduction internal fixation (ORIF), titanium plates were placed on the outer cortex of the rib and screwed into place. Thoracoscopic examination of the pleural cavity was then conducted to assess hemostasis. Pneumolysis with massive irrigation with blood clot evacuation was implemented, followed by an air leakage test. Upon completion of the procedure, a Hemovac and 20 fr chest tube were placed, and the wound

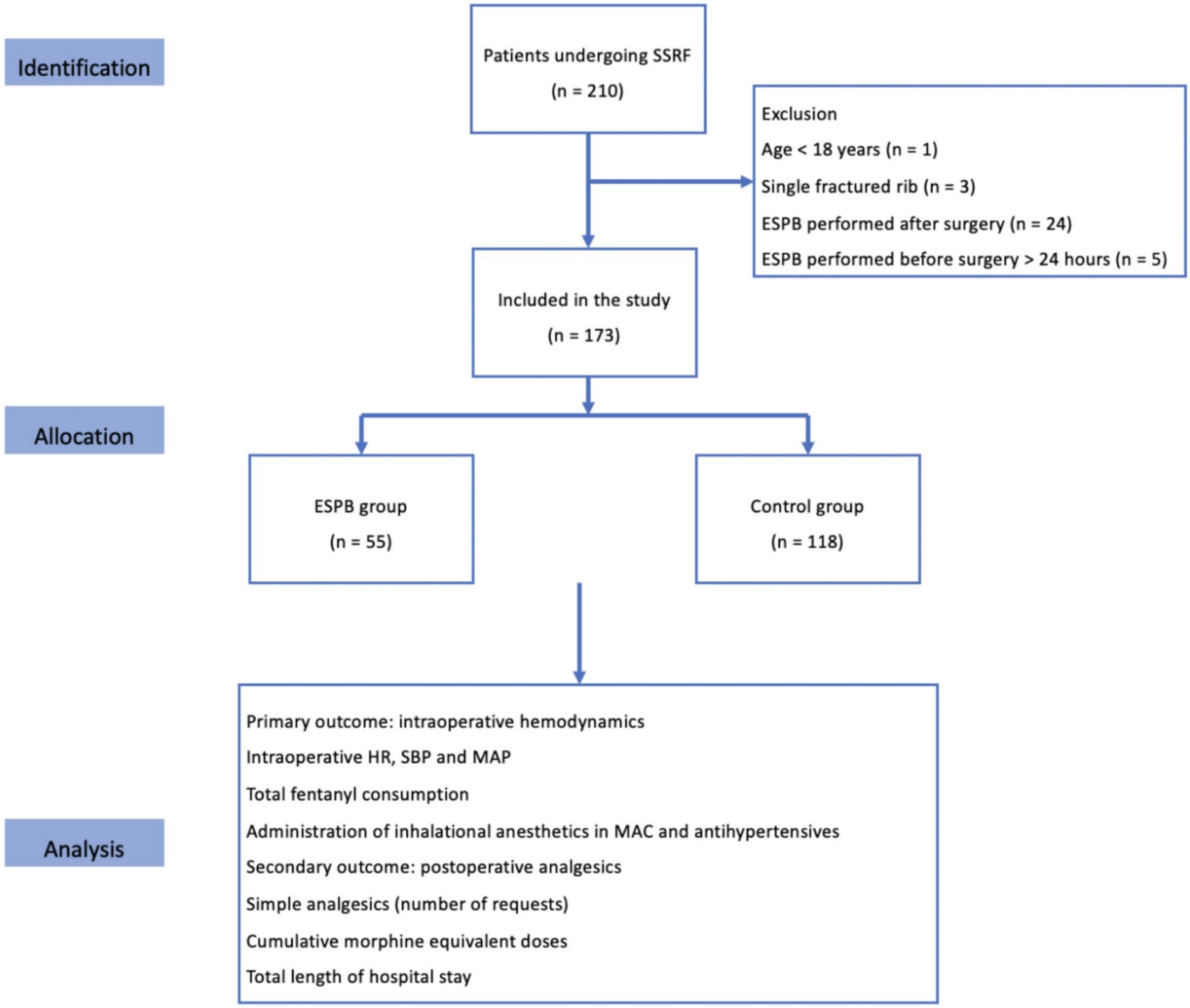

Fig. 1 Flow chart of patient identification, exclusion and allocation

was subsequently closed layer by layer. After extubation, patients were monitored in the postanesthesia care unit (PACU) for at least one hour before they met the discharge criteria for the surgical ward. Patients unsuitable for extubation were transferred to the surgical intensive care unit (SICU) for further care. Standardized multimodal analgesia, including acetaminophen, nonsteroidal anti-inflammatory drugs (NSAIDs) and opioids, was administered postoperatively.

Data collection

Demographic and clinical data were retrospectively obtained from the electronic medical records. Demographic variables such as sex, age, height, weight, BMI, American Society of Anesthesiologists (ASA) classification, injury severity score (ISS), and pattern of injury, including the number and location of rib fractures and injuries other than rib fractures and systemic diseases, were collected. Perioperative variables such as the number of operated ribs, surgical time, blood loss, intraoperative requirement of antihypertensives and fentanyl and hemodynamic parameters were also recorded. Preoperative baseline hemodynamics were obtained as the last reading in the ward before patients were sent to the operating room.

Statistical analysis

Statistical analysis was performed via SPSS software, version 29.0 (SPSS Inc., Chicago, IL, USA). Statistical significance was defined as a two-sided p value of <0.05. The Kolmogorov–Smirnov test was used to assess the normality of the data distribution. Continuous variables are presented as the means $\pm$ standard deviations or as medians and interquartile ranges, and categorical variables are presented as numbers and percentages. Parametric data were analyzed via the independent t test

Table 1 Demographic characteristics

	ESPB group ($n=55$)	Control group ($n=118$)	p value
Age (years)	59.09 ± 14.766	54.33 ± 15.785	0.061
Gender: Female/Male	19/55 (34.55%)	26/118 (22.03%)	0.081
Body Weight (kg)	67.94 ± 12.955	71.217 ± 14.002	0.144
BMI (kg/m^2)	25.014 ± 3.920	25.849 ± 4.145	0.289
ASA			0.361
II	3	9	
III	52	101	
IV	0	3	
ISS score			0.684
< 16	7 (12.72%)	12 (10.17%)	
16–24	31 (56.36%)	62 (52.54%)	
> 24	17 (30.90%)	44 (37.28%)	
Number of fractured ribs			0.539
< 5	11 (20%)	20 (16.95%)	
5–7	42 (76.36%)	89 (75.42%)	
> 7	2 (3.63%)	9 (7.63%)	
Rib fracture site			0.266
Unilateral	50 (90.91%)	100 (84.75%)	
Bilateral	5 (9.09%)	18 (15.25%)	
Concomittent clavicular fracture	20(36.36%)	39(33.05%)	0.669
Concomittent scapular fracture	12(21.82%)	24(20.34%)	0.823
Other injuries			0.401
None	12 (21.82%)	19 (16.10%)	
1	24 (43.64%)	53 (44.92%)	
2	11 (20%)	24 (20.34%)	
3	4 (7.27%)	18 (15.25%)	
4	4 (7.27%)	3 (2.54%)	
5	0	1 (0.85%)	
Anatomical location of other injuries			0.86
Head	9 (16.36%)	23 (19.49%)	
Pulmonary / Mediastinal	6 (10.91%)	24 (20.34%)	
Intra-abdominal	10 (18.18%)	21 (17.80%)	
Spine	7 (12.73%)	16 (13.56%)	
Upper limb	30 (54.55%)	61 (51.69%)	
Lower limb / pelvis	11 (20%)	25 (21.19%)	
Systemic diseases			
Hypertension	23 (41.82%)	31 (26.27%)	0.040*
Diabetes mellitus	17 (30.91%)	25 (21.19%)	0.165
History of CAD	1 (1.82%)	2 (1.69%)	0.954
Preoperative baseline hemodynamics			
HR (bpm)	79.47 ± 16.66	81.51 ± 16.465	0.403
SBP (mmHg)	136.96 ± 18.468	134.8 ± 18.531	0.474
MAP (mmHg)	97.56 ± 12.316	97.88 ± 13.869	0.885
Other concurrent surgery	9 (16.36%)	32 (27.1%)	0.121

ESPB, erector spinae plane block; kg, killograms; BMI, body mass index; ASA, American Society of Anesthesiologists; ISS, injury severity score; CAD, coronar artery disease; HR, heart rate; SBP, systolic blood pressure; MAP, mean arterial pressure; bpm, beat per minute

Table 2 Intraoperative outcomes

	ESPB group ($n=55$)	Control group ($n=118$)	p value
Number of operated ribs			0.384
< 3	10(18.18%)	18 (15.25%)	
3–5	39 (70.91%)	92 (77.97%)	
> 5	6 (10.91%)	8 (6.78%)	
Surgical fixation site			0.689
Unilateral	53 (96.36%)	115 (97.46%)	
Bilateral	2 (3.64%)	3 (2.54%)	
Surgical time (minutes)	262.4 ± 92.47	237.82 ± 80.91	0.077
Blood loss (ml)	175.09 ± 150.909	203.14 ± 216.667	0.460
Inhalational agents (MAC)	1.363 ± 0.247	1.443 ± 0.282	0.073
Intravenous fluid adminstration (ml)	1224.55 ± 417.762	1254.24 ± 579.735	0.987
Fentanyl administration (μg)	71.85 ± 55.082	98.09 ± 59.928	0.004*
Anti-hypertensives	0.56 ± 1.344	0.77 ± 1.317	0.164

ESPB, erector spinae plane block; HR, heart rate; SBP, systolic blood pressure; MAP, mean arterial pressure; ml, millilitres; MAC, minimal alveolar concentration; μg, micrograms

for normally distributed variables and the Mann−Whitney test for nonnormally distributed variables, and categorical variables were analyzed via the chi−square test. Hemodynamic parameter variability between groups was analyzed via repeated-measures ANOVA (RM-ANOVA), adjusted for age and intraoperative fentanyl use. The analysis incorporated within-subject variation across 19 time points, measured at 5-minute intervals, with the first time point measured right before the first surgical incision.

Results

As shown in Table 1, the average ages of the patients in the ESPB and control groups were 59.09±14.766 and 54.33±15.785 years, respectively. In both groups, the pattern of injuries was similar in both groups in that the majority of the patients were males with an ISS of 16–24 on admission, more than 75% of the patients sustained 5–7 rib fractures, and the fracture site was mainly unilateral. These patients may also suffer injuries in other organ systems or skeletal parts, such as the clavicles, scapulas and limbs. Injuries to the upper limbs followed by the lower limb/pelvis accounted for approximately 70% of the additional injuries. However, no statistically significant differences were observed between the ESPB and control groups. Although hypertension was more prevalent in the ESPB group than in the control group ($p=0.040$), the preoperative baseline hemodynamics obtained from the ward were not significantly different between the two groups.

As shown in Table 2, most of these patients received an average of 3–5 rib fixations for rib fractures, and the

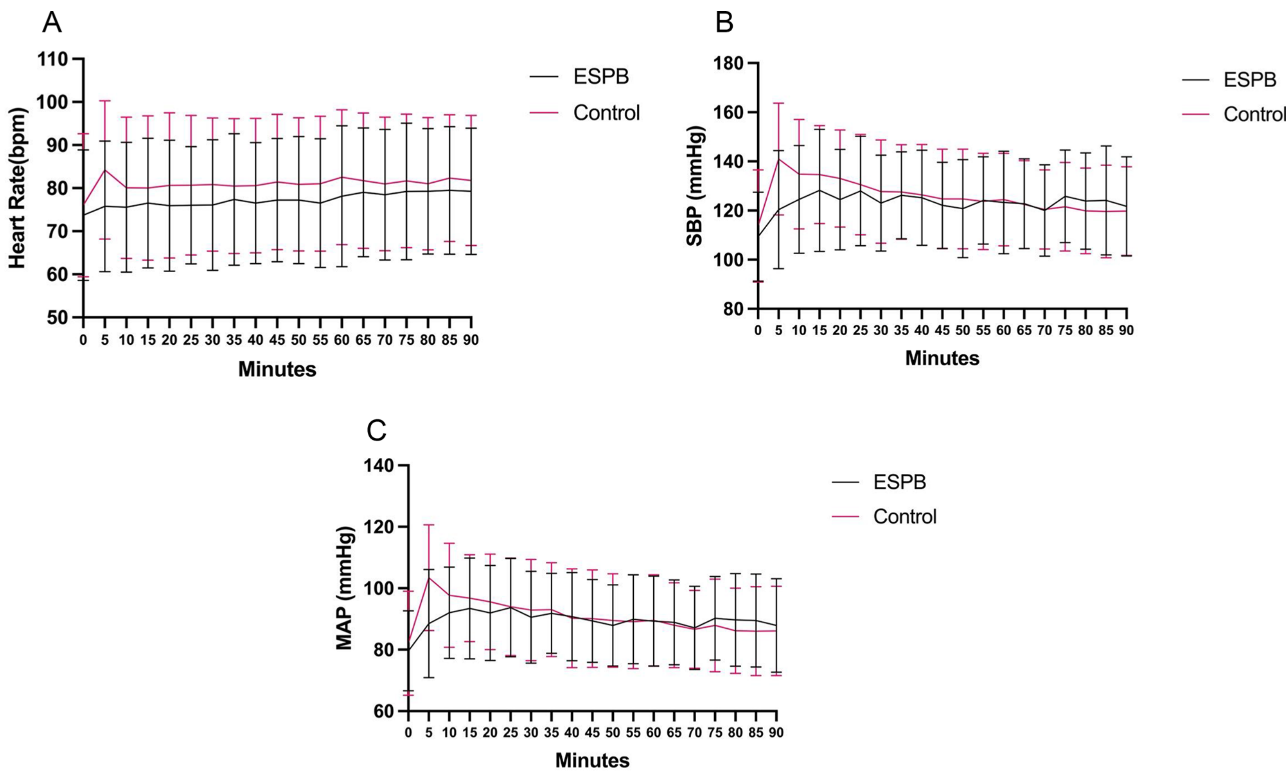

Fig. 2 (**a**) A comparison of the trend in the intraoperative heart rate between the study groups. ESPB, erector spinae plane block. (**b**): A comparison of the trend in the intraoperative systolic blood pressure between the study groups. ESPB, erector spinae plane block; SBP, systolic blood pressure. (**c**) A comparison of the trend in intraoperative mean arterial pressure between the study groups. ESPB, erector spinae plane block; MAP, mean arterial pressure

surgical site was nearly all unilateral. No significant difference in surgical time or blood loss was observed between the ESPB and control groups. Intraoperatively, the administration of antihypertensive agents was similar in both groups ($p=0.164$).

Primary outcomes: intraoperative fentanyl requirements and hemodynamics

As shown in Table 2, the total intraoperative fentanyl consumption was significantly lower in the ESPB group (71.85±55.082 vs. 98.09±59.928 μg, $p=0.004$, respectively) (Table 2), whereas no significant difference was detected in the administration of inhalational anesthetics in the MAC ($p=0.073$) and antihypertensives ($p=0.164$).

To determine whether ESPB facilitated hemodynamic stability during SSRF, we conducted RM-ANOVA adjusted for age and intraoperative fentanyl consumption to compare the hemodynamics for the first 90 min of surgery between the two groups. As shown in Fig. 2(a), the ESPB group demonstrated a lower intraoperative HR than did the control group throughout the initial 90 min of surgery. Figure 1(b) and 1(c) similarly show a lower SBP and MAP in the ESPB group than in the control group. The analysis therefore revealed a significant time-by-group interaction effect on HR ($F=7.09$, $p=0.009$), SBP ($F=22.339$, $p<0.001$), and MAP ($F=19.966$, $p<0.001$) when the trend was examined. This finding indicated that the trend of HR, SBP, and MAP change over time differed significantly between the two groups.

Table 3 Postoperative outcomes

	ESPB group ($n=55$)	Control group ($n=118$)	p value
Simple analgesics 0–24 h	3.53 ± 2.53	5.62 ± 3.058	< 0.001*
Simple analgesics 24–48 h	4.82 ± 3.00	5.91 ± 2.71	0.029*
Simple analgesics 0–48 h	8.35 ± 5.05	11.53 ± 5.48	< 0.001*
OME 0–24 h (mg)	31.864 ± 50.536	32.352 ± 48.990	0.921
OME 24–48 h (mg)	17.309 ± 41.758	16.894 ± 46.041	0.295
OME 0–48 h (mg)	49.173 ± 86.798	49.246 ± 87.388	0.699
Length of hospital stay (days)	15.2 ± 19.36	13.77 ± 8.25	0.608

OME, oral morphine equivalent; mg, milligrams

Secondary outcomes: postoperative analyses

As shown in Table 3, opioid consumption was similar on postoperative days 1 and 2 in the two groups ($p=0.921$ and $p=0.295$), and no statistically significant difference in cumulative opioids in the first two days postoperatively was observed ($p=0.699$). However, the ESPB group consistently required fewer simple analgesics (number of requests) on postoperative day 1 (3.53±2.53 vs. 5.62±3.058 times, $p<0.001$) and day 2 (4.82±3.00 vs.

5.91±2.71 times, $p=0.029$) hours than did the control group. Similarly, the number of cumulative requests for simple analgesics during the first two days after SSRF was significantly lower in the ESPB group than in the control group (8.35±5.05 vs. 11.53±5.48 times, $p<0.001$). Interestingly, more simple analgesics but fewer opioids were required on postoperative day 2 for both groups, with no significant differences. No significant difference was observed in the total length of hospital stay between the two groups.

Discussion

Rib fracture is not an uncommon traumatic injury, with prognoses ranging from favorable to adverse, depending on various factors [23]. While conservative management remains the primary treatment for nonpathological or uncomplicated cases, surgical stabilization may sometimes be necessary to achieve optimal outcomes [24, 25]. With respect to conservative approaches, adequate pain management and early rehabilitation of pulmonary function, such as lung volume expansion therapy utilizing incentive spirometry, have been the focal points of care [26, 27].

Historically, thoracic epidural analgesia (TEA) has been identified as the preferred method to mitigate the pain associated with rib fractures [28]. Although previous studies have demonstrated the advantages of TEA in reducing mortality and duration of hospital stay and enhancing postoperative pulmonary ventilation, the application of this technique may be limited by its failure rate as high as 32% and adverse events related to either the medication applied or the catheter itself [29–31]. In fact, no obvious advantage of TEA in terms of 30-day mortality, duration of mechanical ventilation or duration of ICU stay was demonstrated, although TEA was shown to be associated with prolonged length of hospitalization [31, 32], all of which have led to a search for better analgesic methods while minimizing complications. The efficacy of various regional anesthetic techniques, including thoracic paravertebral block (TPVB), intercostal nerve block (INB), serratus anterior block (SAB) and ESPB, as components of the MMA for the management of rib fractures has been demonstrated. TPVB has been shown to be as efficacious as TEA in SSRF, with a lower incidence of hypotension and urinary retention [33]. INB also has a superb analgesic effect and improves respiratory function [34, 35]; however, INB may be limited by its analgesic duration and risk of pneumothorax and often requires multilevel injections [29, 36, 37]. Similarly, SAB has been demonstrated to have an analgesic effect on the blockade of thoracic intercostal nerves T2–T9 without multilevel injections; however, its analgesic effect on only the anterior two-thirds of the chest wall has limited its use for posterior rib fractures [36, 38–43]. ESPB has gained popularity recently for fewer technique-related complications and its versatility across a spectrum of surgical procedures [12, 44, 45]. ESPB was shown to be noninferior to TEA, with additional benefits in terms of reduced adverse events, better arterial oxygenation and pulmonary function, in addition to a lower visual analog scale (VAS) score and a more stable MAP [46–48]. Moreover, ESPB appears to have a shorter learning curve with a higher success rate among trainees [19, 49, 50]. ESPB may therefore serve as the preferred choice as part of the MMA protocol in rib fracture-related pain, without limitations and complications associated with TEA. ESPB showed comparable efficacy to TPBV in reducing pain scores and opioid consumption, but the incidence of hypertension was greater with TPVB, while TPVB may lead to a steeper learning curve and a greater complication rate of pneumothorax in clinical application [50–52]. Other novel techniques, such as retrolaminar block, rhomboid intercostal block, midpoint of transverse process block and parascapular subiliocostalis plane block, have emerged as potential alternatives; nevertheless, the evidence remains insufficient [25, 36, 37].

Despite nonoperative fracture treatment for these patients, the absence of immediate rib stabilization may leave some patients at risk of delayed complications, such as rib displacement, atelectasis, and hemopneumothorax [53]. Therefore, it is imperative that physicians remain vigilant throughout the course of initial management. Patients complicated with different conditions may require surgical intervention, and the indications for surgical stabilization of rib fractures (SSRFs) include shock or ongoing resuscitation, severe traumatic brain injury, fractures outside of ribs three to ten and acute myocardial infarction on the basis of the guidelines published by the Chest Wall Injury Society [54]. SSRF has been proven to shorten the length of hospital stay, prevent further infection and improve overall outcomes [55, 56]. The efficacy of preemptive nerve block prior to surgery remains a subject of interest. Nerve blocks have become a commonly performed intervention before surgical procedures, with the aim of mitigating surgical stress, as abrupt changes in hemodynamics, particularly heart rate, have been correlated with significant pain secondary to sympathetic activation [57, 58]. Traditionally, opioids have been employed to maintain hemodynamic stability in response to these physiological perturbations. However, such utilization is associated with a spectrum of adverse effects, such as postoperative nausea and vomiting, respiratory depression, and delayed recovery from anesthesia [59–61]. Consequently, a multitude of methodologies have been employed in the domain of anesthesia to reduce the reliance on opioid drugs.

In our study, we demonstrated that preemptive ESPB may provide adequate analgesia in response to surgical stress and reduce hemodynamic fluctuations and opioid requirements in SSRF. To the best of our knowledge, this is the first study to evaluate the effects of ESPB on intraoperative hemodynamics and its analgesic efficacy in SSRF. Consistent with the literature discussing abdominal surgeries, mastectomies and thoracoscopic surgeries [20, 58, 62], statistical analysis of hemodynamics revealed a relatively stable and lower HR, SBP, and MAP in a linear trend in the ESPB group than in the control group throughout the 90-minute intraoperative period after adjustment for age and intraoperative opioid consumption. These results suggest that ESPB has a beneficial effect on stabilizing intraoperative hemodynamics and controlling pain. Postoperatively, although no difference in opioid requirements was observed between the ESPB and control groups, ESPB consistently requires fewer simple analgesics on postoperative days 1 and 2, demonstrating that the efficacy of preemptive ESPB may have an effect on acute surgical pain postoperatively. Therefore, these findings suggest that ESPB produces prolonged hemodynamic stabilization and analgesic effects during the perioperative period. Together with the positive results from our study, ESPB appeared promising because of its ability to stabilize hemodynamics and analgesic effects on SSRF.

There were several limitations in our study. First, due to the nature of retrospective study, selection bias could not be entirely excluded. Whether the patients received ESPB or not were not randomized, respecting patients' choices after they were fully explained on the risks and benefits of ESPB. Secondly, there was a lack of standardized protocol for the use of anesthetics and analgesics during the perioperative period. Thirdly, complications such as postoperative nausea and vomiting, constipation and gastrointestinal symptoms were not adequately documented in the electronic medical records. Furthermore, information on the degree of displacement of rib fractures or type of surgery was not obtained due to the lack of information on the operation record. Lastly, long term outcome of SSRF with or without ESPB was not assessed. That said, to minimize biases, only patients of the same surgical team with similar surgical techniques and postoperative care practices were included in the study and ESPB was also performed by a group of anesthesiologists dedicated to the Acute Pain Service for all these patients. Although the present study has established practical implications of ESPB for SSRF perioperatively, future larger prospective studies are thus required to validate our results and assess long term outcomes.

We have demonstrated that with the implementation of ultrasound guidance, ESPB may be performed safely in the operating rooms. The findings of our study have provided valuable insight for anesthesiologists in executing ultrasound-guided ESPB as a preemptive analgesic to optimize intraoperative hemodynamic stability and as part of MMA for providing analgesia with opioid-sparing effects for perioperative pain management in the future.

Conclusion

Our study demonstrated that ESPB may offer significant benefits in patients undergoing SSRF, including enhanced intraoperative hemodynamic stability, reduced opioid and inhalation anesthetic requirements and reduced postoperative simple analgesic consumption. These results suggest that ESPB should be integrated into the MMA for the SSRF.

Abbreviations

ASA	American Society of Anesthesiologists
BMI	Body Mass Index
CGMH	Chang Gung Memorial Hospital
ECG	Electrocardiogram
ERAS	Enhanced Recovery After Surgery
ESP	Erector Spinae Plane Block
HR	Heart Rate
INB	Intercostal Nerve Block
ISS	Injury Severity Score
MAP	Mean Arterial Pressure
MAC	Minimum Alveolar Concentration
MMA	Multimodel Analgesia
NIBP	Noninvasive Blood Pressure
NSAID	Nonsteroidal Anti-Inflammatory Drug
OME	Oral Morphine Equivalent
ORIF	Open Reduction Internal Fixation
PACU	Postanesthesia Care Unit
SAB	Serratus Anterior Block
SICU	Surgical Intensive Care Unit
SBP	Systolic Blood Pressure
SSRF	Surgical Stabilization of Rib Fractures
SpO_2	Oxygen Saturation
TEA	Thoracic Epidural Analgesia
TPVB	Thoracic Paravertebral Block
VAS	Visual Analog Scale

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Author contributions
HIT contributed to the conception and design of the study.YJC and QAW contributed to the acquisition, analysis, and visualization of the data.JRL contributed to the statistical analysis, interpretation and verification of each dataset of data.SJS, CAL, CHL and SAC contributed to ESPB and SSRF. Supervision of this research, which includes responsibility for planning and executing the research activity, was oversaw by CWL and HIT.All the authors read and approved the final version of the manuscript.

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Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
The study was approved by the Institutional Review Board of Chang Gung Memorial Hospital (CGMH IRB 202401596B0) and was conducted in accordance with the ethical principles of the Helsinki declaration. As a result of the retrospective nature of the study, the need to obtain written informed consent was waived.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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