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RESEARCH ARTICLE

Erector Spinae vs Parasternal Block for Early Postoperative Pain After Open-Heart Surgery

Açık Kalp Cerrahisi Sonrası Erken Postoperatif Ağrıda Erektör Spinae Bloğu ile Parasternal Bloğun Karşılaştırılması

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ABSTRACT

Objective: Both parasternal and erector spinae plane blocks are used for analgesia after median sternotomy. This study compared these techniques with a focus on procedural practicality and clinical workflow.

Material and Method: In this retrospective study, 60 adult cardiac surgery patients receiving either parasternal and erector spinae plane blocks were analyzed. Postoperative pain, opioid consumption, extubation time, complications, and block procedure duration were compared. Erector spinae plane and superficial parasternal blocks were performed at a single level bilateral using 2 × 20 mL mixture of local anesthetic (15 mL of 0.5% bupivacaine and 5 mL of 2% lidocaine).

Results: Analgesic outcomes, opioid requirements, extubation times, and complication rates were comparable between groups. However, parasternal block was performed in a significantly shorter time and under general anesthesia in the supine position. Although differences in analgesic efficacy were not statistically significant, the proportion of patients reporting sternal pain was consistently lower in the parasternal group. Sternal pain, opioid consumption, complications, and extubation times were comparable between the groups at five postoperative time points (4th, 6th, 10th, 15th, and 24th hours). In the just erector spinae plane group, one patient developed complications.

Conclusion: Postoperative sternal pain, opioid consumption, extubation times, and complication rates were comparable between parasternal (PRS) and erector spinae plane (ESP) blocks in patients undergoing cardiac surgery with median sternotomy. The shorter procedure time and practical advantages of the PRS block support its consideration as a time-efficient alternative to the ESP block (2, 14, 20-24, 26).

Keywords: Erector Spinae Plane Block, Parasternal Intercostal Block, Cardiac Surgery, Postoperative Pain.

ÖZET

Amaç: Median sternotomi sonrası analjezi için parasternal ve erektor spinae plan blokları kullanılmaktadır. Bu çalışma, bu iki tekniği özellikle işlemsel pratiklik ve klinik iş akışı açısından karşılaştırmayı amaçladı.

Gereç ve Yöntem: Bu retrospektif çalışmada, parasternal veya erektor spinae plan bloğu uygulanan 60 erişkin kalp cerrahisi hastası analiz edildi. Postoperatif ağrı, opioid tüketimi, ekstübasyon süresi, komplikasyonlar ve blok uygulama süresi karşılaştırıldı. Erektör spinae plan ve yüzeyel parasternal bloklar, tek seviyeden bilateral olarak 2 × 20 mL lokal anestezik karışımı (15 mL %0,5 bupivakain ve 5 mL %2 lidokain) kullanılarak uygulandı.

Bulgular: Analjezik sonuçlar, opioid gereksinimi, ekstübasyon süreleri ve komplikasyon oranları gruplar arasında benzerdi. Ancak parasternal blok, anlamlı derecede daha kısa sürede uygulanmış ve supin pozisyonda genel anestezi altında gerçekleştirilmiştir. Analjezik etkinlik açısından istatistiksel olarak anlamlı fark saptanmamakla birlikte, sternal ağrı bildiren hasta oranı parasternal blok grubunda tutarlı biçimde daha düşüktü. Sternal ağrı, opioid tüketimi, komplikasyonlar ve ekstübasyon süreleri postoperatif beş zaman noktasında (4., 6.,

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10., 15. ve 24. saatler) gruplar arasında benzerdi. Yalnızca erektor spinae plan blok grubunda bir hastada komplikasyon gelişti.
Sonuç: Parasternal blok, erektor spinae plan blok ile karşılaştırılabilir analjezi sağlarken; işlemsel verimlilik, pratiklik ve hasta konforu açısından belirgin avantajlar sunmaktadır. Bu bulgular, parasternal bloğun rutin kalp cerrahisi pratiğinde pragmatik bir alternatif olarak kullanımını desteklemektedir.
Anahtar Sözcükler: Erektör Spina Düzlem Bloğu, Parasternal Blok, Kardiyavasküler Cerrahi, Postoperatif Ağrı.

Median sternotomy is routinely performed in open-heart surgeries such as coronary artery bypass grafting and valve procedures and is associated with substantial postoperative pain. Inadequate control of post-sternotomy pain may lead to delayed mobilization, prolonged mechanical ventilation, and an increased risk of persistent post-sternotomy pain syndrome (1-3). Therefore, effective and safe postoperative analgesia is considered a fundamental component of perioperative care in cardiac surgery.

Opioid-based analgesia has traditionally formed the cornerstone of pain management in cardiac surgery. However, opioid-related adverse effects-including respiratory depression, sedation, nausea and vomiting, delayed extubation, and prolonged intensive care unit stay-have increased interest in multimodal analgesic strategies (4, 5). In this context, regional anesthesia techniques have gained prominence as adjunctive approaches aimed at reducing opioid consumption.

Although thoracic epidural and paravertebral blocks provide effective analgesia, their use in cardiac surgery is often limited due to the need for systemic anticoagulation and concerns regarding neuraxial complications (4, 6). Consequently, ultrasound-guided chest wall blocks have increasingly been adopted as safer alternatives. Techniques such as pectoral nerve blocks, serratus anterior plane blocks, erector spinae plane (ESP) blocks, and parasternal (PRS) blocks have been described for providing analgesia in thoracic and cardiac surgical procedures (7, 8).

Bilateral ESP block can provide analgesia covering the sternotomy region by affecting the dorsal and ventral branches of the spinal nerves at the thoracic level (6,7). More recently, parasternal intercostal plane blocks have been introduced, targeting the anterior cutaneous branches of the intercostal nerves and focusing primarily on anterior chest wall analgesia (8-10). The superficial PRS is performed by injecting local anesthetic between the pectoralis major muscle and the intercostal muscles and offers practical advantages, as it can be applied while the patient is in the supine position under general anesthesia (11-13).

Although both block techniques have been reported to be effective for post-sternotomy analgesia, studies directly comparing these methods-particularly with respect to clinical feasibility and procedural characteristics-remain limited (9, 10). In contemporary cardiac anesthesia practice, factors such as block application time, patient positioning, intraoperative feasibility, and integration into operating room workflow are gaining increasing importance alongside analgesic efficacy.

The primary aim of this study was to compare superficial PRS and ESP block in adult patients undergoing cardiac surgery via median sternotomy, in terms of postoperative opioid consumption, pain scores, extubation time, and block-related complications. The secondary aim was to evaluate procedural characteristics, including application time and practical feasibility. We hypothesized that the superficial PRS would provide analgesic efficacy comparable to that of the ESP block while offering advantages in procedural simplicity and clinical workflow.

MATERIAL AND METHOD

This single-center retrospective observational study was conducted in accordance with the STROBE guidelines. Ethical approval was obtained from the Ordu University Clinical Research Ethics Committee (Decision No: 2023/352). Patient records of individuals who underwent cardiac surgery via median sternotomy between September 2023 and December 2023 were retrospectively reviewed.

A total of 60 patients were included in the study. Thirty patients received bilateral ESP block and 30 patients received bilateral superficial PRS block for postoperative analgesia. Both block techniques were applied during the same study period by the same anesthesiologist. The choice of block technique was based on the anesthesiologist's clinical preference within routine practice.

In this study, Mindray model 5 was used as an ultrasound device in block procedures. At the end of the surgery, patients were transferred to the intensive care unit without additional analgesia. Pain was evaluated with Numeric Rating Scale **(**NRS) in cooperative patients, and with a Behavioral Pain Scale in intubated/sedated or non-communicative patients (items: facial expression, crying/moaning, respiratory effort, activity, consolability.

Inclusion and Exclusion Criteria

Adult patients undergoing median sternotomy for coronary artery bypass grafting, valve surgery, or aortic surgery were included. Patients younger than 18 years, pregnant or breastfeeding women, patients with known local anesthetic allergy, emergency or revision surgeries, patients unable to communicate,

and procedures not involving sternotomy were excluded.

Anesthesia Management

Perioperative management for all patients was conducted in accordance with the standard care protocols for cardiac anesthesia at the hospital. Before induction, patients were monitored using electrocardiography (ECG), noninvasive arterial blood pressure, and arterial oxygen saturation via pulse oximetry. Following monitoring, anesthesia induction was performed with intravenous midazolam (0.05-0.1 mg/kg), fentanyl (2-5 μg/kg IV), propofol (1-2 mg/kg), and rocuronium (1 mg/kg), followed by tracheal intubation. Furthermore, anesthesia maintenance was achieved with sevoflurane (MAC 1), oxygen/air (FiO_2 0.40), fentanyl (2-5 μg/kg/h), and rocuronium (0.2-0.4 mg/kg). Invasive (radial or femoral) arterial catheterization and central venous (jugular, subclavian, or femoral) catheterization were performed in sedated patients. At the end of the surgery, patients were transferred to the intensive care unit without administration of additional analgesics.

Ultrasound-Guided ESP Block

After noninvasive monitoring in the operating room, patients were placed in a seated position and sedated with midazolam (0.02 mg/kg IV) and fentanyl (0.5-1 μg/kg IV). Aseptic conditions were ensured for the T2-T9 vertebral area and ultrasound probe. With the patient seated, the physician positioned the high-frequency linear probe longitudinally at the T5-T6 spinous process level, approximately 2-3 cm lateral to the midline, with the ultrasound monitor placed on the opposite side (Figur 1).

Figure 1. ESP Block.

After identifying the transverse processes, a 21-gauge, 50-mm block needle was advanced using an in-plane technique until contact with the transverse process was made. Moreover, negative aspiration was performed to confirm the absence of blood, followed by a test injection of 1 mL of saline to verify spread (Figur 2).

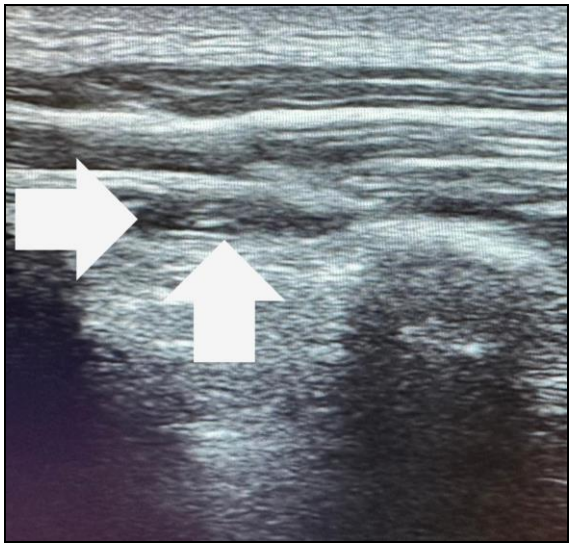

Figure 2. ESP Block Ultrasound Image.

Once the separation of the erector spinae muscle from the transverse process was observed caudally and cranially, 20 mL of local anesthetic mixture (15 mL of 0.5% bupivacaine and 5 mL of 2% lidocaine) was injected between the transverse process and the erector spinae muscle. We used the combination to achieve rapid onset (lidocaine) and prolonged analgesia (bupivacaine), consistent with our institutional practice. Recommended maximum doses were not exceeded. The same procedure was repeated on the contralateral side. The patient was then induced with intravenous anesthetic agents and tracheally intubated.

Ultrasound-Guided PRS Block

Following tracheal intubation and before initiation of surgery, the T3-T6 region and ultrasound probe were prepared under aseptic conditions with the patient in a supine position. A linear transducer was positioned longitudinally at the T4 level, approximately 2-3 cm lateral to the midline at the sternum (Figur 3).

Figure 3. PRS Block.

Using an in-plane technique, a 21-gauge, 50-mm block needle was advanced cephalad from a caudal

approach until it reached the space between the pectoralis major and external intercostal muscles. After a zipper-like separation was observed on ultrasound, negative aspiration was performed to confirm the absence of blood (Figur 4).

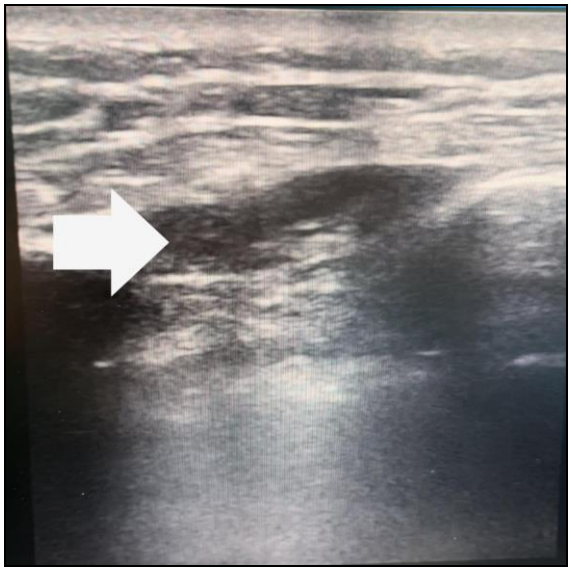

Figure 4. PRS Block Ultrasound Image.

A total of 20 mL of local anesthetic (15 mL of 0.5% bupivacaine and 5 mL of 2% lidocaine) was injected. We used the combination to achieve rapid onset (lidocaine) and prolonged analgesia (bupivacaine), consistent with our institutional practice. Recommended maximum doses were not exceeded. The same procedure was performed on the contralateral side. The patient was then transferred to the surgical team.

Intensive Care Follow-up

At the end of the surgery, patients were moved to the intensive care unit while intubated and were subsequently monitored. Extubation was performed when predefined criteria were met-stable hemodynamics, adequate analgesia, sufficient oxygenation/ventilation (serial blood gas measurements), normothermia and controlled bleeding. Once these criteria were satisfied, extubation was carried out; a fixed clock-based timeline or physician-dependent preferences were not used. Because adherence to this protocol was standardized across the unit, the presence of different ICU physicians did not meaningfully affect extubation time. Before patients regained consciousness, analgesic agents were not administered unless there was an increase of more than 20% in blood pressure and heart rate compared to preoperative baseline values. Once patients regained consciousness, presence of pain and its localization were evaluated. Patients reporting pain in the sternum area were initially administered intravenous nonsteroidal anti-inflammatory drugs. Those whose pain persisted after reassessment were administered intravenous opioids. Given potential sedation and ongoing intubation in the early postoperative period, the primary analysis window was prespecified as 6-24 hours; the 4-hour measurements were treated as exploratory. In addition to pain and opioid requirements, records regarding extubation times and any complications related to local anesthetic or the applied block were reviewed during the postoperative intensive care period.

Statistical Analysis

Data were analyzed using the IBM SPSS Statistics Standard Concurrent User V26 software package (IBM Corp., Armonk, New York, USA). Descriptive statistics were presented as frequency (n), percentage (%), mean (X), standard deviation (SD), median (M), minimum (min), and maximum (max) values. Normal distribution of numerical variables was assessed using the Shapiro–Wilk test. Data followed a normal distribution. Independent Samples t-test was used to compare numerical descriptive characteristics between groups, and Chi-Square tests (Pearson Chi-Square/Fisher's exact test) were applied to compare categorical variables. One-Sample Chi-Square Test was used to compare variables over time within groups. Normality was assessed per variable; when assumptions were not met, Mann-Whitney U was used for continuous data and Fisher's exact test for categorical data. A p-value of <0.05 was considered statistically significant in all analyses. Secondary comparisons across multiple time points are presented as exploratory, with p-values not formally adjusted for multiplicity. In addition to p-values, effect size measures were calculated to assess the magnitude of between-group differences. Cohen's d was used for t-test comparisons and eta-squared (η^2) was estimated for variance explanation when appropriate.

Power Analysis

A priori power analysis was conducted using G*Power software (version 3.1) to estimate the required sample size. Assuming a medium-to-large effect size (Cohen's d =0.8), a two-tailed alpha of 0.05, and a power of 0.80, the analysis indicated that at least 26 patients per group were required to detect a significant difference. In the present study, each group included 30 patients, confirming adequate statistical power to support the validity of the results.

RESULTS

This study compared postoperative sternum pain, opioid requirements, complications, extubation times and block procedure durations in patients undergoing two different trunk blocks before cardiac surgery through median sternotomy.

Table 1 presents the distribution of the descriptive characteristics of the participants.

Table 1. Comparison of the descriptive characteristics of participants by groups (n = 60).

	Group		p-value
	ESP n =30	PRS n =30	
Age, (years)			
X ± SD	64.87 ± 7.10	64.23 ± 9.95	0.778 †
M (min–max)	65 (53–81)	66 (45–89)	
Duration of surgery, (minutes)			
X ± SD	175.67 ± 12.02	167.60 ± 15.40	0.537 †
M (min–max)	175 (140–195)	170 (130–190)	
Gender			
Male	18 (60%)	22 (73.3%)	0.500 ϕ
Female	12 (40%)	8 (26.7%)	
Comorbidities			
No	4 (13.3%)	5 (16.7%)	0.347 ϕ
Yes	26 (86.7%)	25 (83.3%)	
ASA (American Society of Anesthesiologists)			
III	5 (16.7%)	5 (16.7%)	0.500 ϕ
IV	25 (83.3%)	25 (83.3%)	
Block procedure duration (minutes)			
5–10	4 (13.3%)	30 (100%)	p < 0.001 ϕ
11–15	26 (86.7%)	0 (0%)	

Independent Samples t-Test (†); Chi-Square Test (ϕ); Descriptive statistics presented as mean (X), standard deviation (SD), median (M), minimum (min), maximum (max), frequency (n), and percentage (%). Statistically significant (p <0.05).

The study included a total of 60 participants; 30 patients in the ESP block group and 30 in the PRS block group. The descriptive characteristics of the participants in both groups (age, American Society Of Anesthesiologists (ASA), gender, comorbidities) were similar (homogeneous), and there was no statistically significant difference between the groups in terms of mean duration of surgery. However, block procedure duration was significantly shorter in the PRS block group (p <0.05). The procedure duration was significantly shorter in the PRS block group (mean: 7 min) compared to the ESP block group (mean: 13 min), p <0.001.

Table 2 presents the findings on the comparison of sternum pain, opioid use, complication status, and extubation times between the groups at different follow-up periods.

Table 2. Comparison of sternum pain, opioid use, complications, and extubation status across follow-up times by groups (n = 60).

	ESP n =30	PRS n =30	p †
Sternum pain			
Hour 4	0 (0%)	0 (0%)	0.999
Hour 6	5 (17%)	2 (7%)	0.257
Hour 10	1 (3%)	0 (0%)	0.796
Hour 15	2 (7%)	0 (0%)	0.317
Hour 24	3 (10%)	2 (7%)	0.655
p ϕ	0.264	0.999	
Opioid use			
Hour 4	4 (13%)	3 (10%)	0.705
Hour 6	3 (10%)	3 (10%)	1.000
Hour 10	3 (10%)	2 (7%)	0.655
Hour 15	0 (0%)	1 (3%)	0.796
Hour 24	1 (3%)	1 (3%)	0.999
p ϕ	0.631	0.736	
Complications			
Hour 4	1 (3%)	0 (0%)	0.796
Hour 6	1 (3%)	0 (0%)	0.796
Hour 10	1 (3%)	0 (0%)	0.796
Hour 15	1 (3%)	0 (0%)	0.796
Hour 24	1 (3%)	0 (0%)	0.796
p ϕ	0.999	0.999	
Extubation			
Hour 4	0 (0%)	0 (0%)	0.999
Hour 6	13 (43%)	12 (40%)	0.841
Hour 10	30 (100%)	30 (100%)	0.999
Hour 15	30 (100%)	30 (100%)	0.999
Hour 24	30 (100%)	30 (100%)	0.999
p ϕ	**0.036**	**0.046**	

One-Sample Chi-Square Test (χ^2), ϕ Intragroup comparison, † Intergroup comparison, Descriptive statistics are presented as number (n) and percentage (%). Statistically significant ($p < 0.05$).

No statistically significant differences were observed between the two groups regarding these parameters at five different measurement times ($p > 0.05$). Throughout all the follow-up periods, one patient (3%) in the ESP block group developed complications; no complications occurred in the PRS block group. There was no statistically significant difference in complication rates within or between the two groups ($p > 0.05$). The number of patients experiencing sternum pain at the five different measurement times was statistically similar between the groups ($p > 0.05$). Given potential sedation and ongoing intubation in the early postoperative period, the primary analysis window was prespecified as 6-24 hours.

DISCUSSION

With increasing life expectancy, the mean age of patients undergoing cardiac surgery has risen, resulting in a higher-risk population with multiple comorbidities. In this setting, optimal anesthesia management is crucial for maintaining hemodynamic stability. Moreover, advanced age is associated with a 2-3-fold increase in mortality in emergency surgeries, and age-related physiological changes increase sensitivity to the cardiovascular, respiratory, and central nervous system depressant effects of anesthetics (14-16).

In the present study, the mean age of patients in both groups was 64 years, consisting of a high-risk population with many comorbidities. No significant differences were found between the PRS block group and the ESP block group in regards to age, gender, comorbidities, and ASA score. Various regional anesthetic techniques are recommended for better control of sternum pain following cardiac surgery. Starting with neuraxial techniques, different approaches targeting the thoracic fascial plane, which includes intercostal nerves from T1 to T11, have been developed, such as pectoral, serratus anterior, PRS and ESP blocks (17, 18). Initially, ESP blocks were used for the management of chronic thoracic pain. Later, studies were conducted to investigate the role of bilateral ESP blocks in pain management in cardiac and thoracic surgery (19). Tsui et al. (20) reported a reduction in intraoperative opioid consumption, earlier extubation time, and decreased postoperative pain severity in cardiac surgery patients who received preoperative ESP block. Studies in the literature show that bilateral ESP block plays a crucial role in improving early extubation and postoperative pain scores (21). In the study by Nair et al. (2), it was observed that in pati-

ents receiving ESP block, intraoperative opioid use was reduced, pain scores improved during the first 16 hours post-extubation, and ventilation time was shortened. In the present study, patients undergoing cardiac surgery via median sternotomy who received preoperative bilateral ESP block were compared with those receiving bilateral PRS block in terms of postoperative sternal pain, opioid consumption, extubation time, complication rates, and block procedure duration. No significant differences were observed between the groups across five assessment time points, except for block procedure duration. Although not statistically significant, sternal pain scores tended to be lower in the PRS block group compared with the ESP block group.

According to recent studies by Sepolvere et al. (22, 23), PRS block is one of the more promising fascial blocks for controlling sternum pain. In the present study, sternum pain within the first 10 postoperative hours was infrequent in the PRS block group, and opioid requirements during this period were largely related to non-sternal pain sources. Extubation times were similar between groups, occurring predominantly at the 6th and 10th postoperative hours. Notably, the PRS block procedure duration was significantly shorter than that of the ESP block, highlighting its practical advantage in terms of time efficiency. As the PRS block is performed under sedation, it may also offer greater comfort for both the patient and the clinician. Given comparable analgesic outcomes, the PRS block appears to be a reasonable alternative to the ESP block, particularly in settings where procedural efficiency or staffing constraints are of importance.

For patients undergoing cardiac surgery with sternotomy, PRS block performed under ultrasound guidance is an effective, safe, and technically easy procedure (14). Previous studies report the positive effects of the PRS block support our findings. For example, a study by Dost et al. (2022) found no significant differences in extubation time, length of intensive care unit stay, or hospital stay between the group that received only the ESP block and the group that received both the PRS and ESP blocks (24). Similarly, in a study by Pascarella et al. (2023), it was observed that patients who received PRS block during cardiac surgery were extubated earlier compared to those in the group that did not receive the block (14). Through decreasing the consumption of opioids, ultrasound-guided PSB could relieve pain and limit opioid-related complications. Clinical outcomes, such as mechanical ventilation time, total length of ICU stay and hospital days, will also be improved (25). Maeßen et al. (2023) concluded that newer regional analgesia techniques-such as the erector spinae plane (ESP) block-cannot be recommended at present due to insufficient or limited evidence; however, they noted that favorable results from future studies could alter this assessment (26). Another result of the present study is that no complications were observed in either the ESP block or PRS block groups. In the ESP block group, one patient reported numbness in the feet approximately 10 minutes after block placement. The patient was evaluated in detail before induction; no motor block was detected and the numbness did not progress. Following surgery, the post-extubation neurological examination again showed no motor deficit or sensory complaint in the lower extremities; reflexes were normal and hemodynamics were stable. No specific treatment or imaging was required. We interpreted this as a self-limited, transient sensory phenomenon likely related to local anesthetic spread/irritation rather than neuraxial involvement. Results of the present study are supported by the findings of Krishna et al. (2023), who reported that patients who received the ESP block did not experience complications such as low cardiac output, pneumothorax, systemic local anesthetic toxicity, or cardiac arrest (3).

Taken together, the findings of the present study indicate that in patients undergoing cardiac surgery via median sternotomy, parasternal (PRS) and erector spinae plane (ESP) blocks provide comparable postoperative analgesic outcomes. However, the significantly shorter application time, ease of performance under general anesthesia, and intraoperative feasibility of the PRS block highlight its practical advantages in clinical workflow. In particular, the PRS block may be especially advantageous in high-volume centers, during busy operating days, or in clinical settings with time constraints and limited staffing. Therefore, the PRS block may be considered a safe, effective, and pragmatic alternative to the ESP block, particularly in selected clinical settings where time efficiency, patient comfort, or staffing constraints are of importance.

Limitation

In addition to the important results derived from this research, which compared the postoperative opioid need, sternum pain, complications, extubation time, and ease of application of superficial PRS block and ESP block in patients undergoing cardiac surgery with median sternotomy, there are also some limitations. Early (4-hour) pain assessments may be biased by sedation/intubation; therefore, they were analyzed exploratorily. Moreover, This study has several other limitations, including its single-center, retrospective design and small sample size, which may reduce statistical power and limit the generalizability of the findings. In this study, the choice of block technique was based on the anesthesiologist's clinical judgment rather than randomization, which may represent a potential confounding factor affecting the study outcomes. Consequently, the results should be interpreted with caution and validated in larger, prospective, multi-center cohorts.

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Availability of data and materials
The datasets analyzed in the present study are available from the corresponding author upon reasonable request.

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Conflict of interest
The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Declaration of generative AI and AI-assisted technologies in the manuscript preparation proçes: During the preparation of this manuscript, ChatGPT (OpenAI, 2025) was used for language editing and improvement of academic clarity. After using this tool, the authors critically reviewed and revised the content and take full responsibility for the final version of the manuscript.

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