



Can the Serratus Posterior Superior Intercostal Plane Block Become a Component of Multimodal Analgesia in Open-Heart Surgery?

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ABSTRACT

Objectives: To evaluate the analgesic efficacy of the serratus posterior superior intercostal plane block (SPSIPB) as a component of multimodal analgesia in patients undergoing open-heart surgery via median sternotomy.

Methods: This retrospective observational study included 10 ASA III patients undergoing open-heart surgery. All patients received bilateral ultrasound-guided SPSIPB with 30 mL of 0.25% bupivacaine per side. Postoperative pain was assessed using the Numeric Rating Scale (NRS) at sternotomy and drain sites during the first 24 hours after extubation. Opioid consumption, rescue analgesia requirements, mechanical ventilation time, ICU and hospital length of stay, and postoperative complications were recorded.

Results: Mean resting and dynamic NRS scores remained low at both sternotomy and drain sites throughout the first 24 hours. Six patients required rescue analgesia, whereas four required none. No block-related complications were observed. Opioid consumption was limited, and patient satisfaction was high.

Conclusion: SPSIPB provided effective postoperative analgesia following open-heart surgery and appears to be a promising component of multimodal pain management strategies.

Keywords: Multimodal analgesia, open cardiac surgery, regional anesthesia, serratus posterior superior intercostal plane block

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Introduction

Median sternotomy, which is the standard approach in open-heart surgery, is frequently associated with prolonged hospital stay due to severe postoperative pain.^[1] In open-heart surgery, postoperative pain may arise from multiple sources, including positional pain related to surgery, rib traction, chest and back pain due to sternotomy and sternal retraction, pain caused by thoracic and mediastinal drains, and pain from saphenous vein dissection. Since postoperative pain is associated with reduced respiratory capacity, pulmonary complications,

and the development of chronic pain, multimodal analgesic approaches are currently recommended.

For postoperative analgesia in patients undergoing open-heart surgery, the PROSPECT protocols recommend the use of a regional anesthesia technique such as the parasternal block in combination with simple analgesics like paracetamol and NSAIDs.^[2] The superficial parasternal block (PSB) targets the anterior cutaneous branches between the T2 and T6 levels, making it an appropriate option for sternotomy incisions.^[3] However, because postoperative

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pain does not originate solely from the sternotomy and mediastinal and chest drains significantly contribute to pain, interest in alternative regional techniques has increased.

The serratus posterior superior intercostal plane block (SPSIPB), first described by Tulgar et al.^[4] in 2023, is a novel interfascial block that provides extensive dermatomal analgesia from C3 to T10 by injecting local anesthetic between the serratus posterior superior and intercostal muscles. Due to this anatomical feature, it may theoretically offer an advantage in open-heart surgery by allowing diffusion to the dorsal ramus and the lateral cutaneous branches of the intercostal nerves.

This retrospective observational study aimed to evaluate pain scores, extubation time, pulmonary complications, and ICU and hospital length of stay in patients undergoing open-heart surgery who received SPSIPB.

Methods

Study Design

This study was designed as a retrospective, observational, single-center analysis conducted between March 2024 and December 2024 at the Department of Anesthesiology and Reanimation, University of Health Sciences, Bursa Yuksek Ihtisas Training and Research Hospital. Following approval from the University of Health Sciences, Bursa Yuksek Ihtisas Training and Research Hospital Ethics Committee (Approval No: 2024-TBEK 2024/03-08), and in accordance with the Declaration of Helsinki, medical records of ten ASA III patients who underwent elective open-heart surgery via median sternotomy and received bilateral serratus posterior superior intercostal plane block (SPSIPB) were reviewed.

Patient Selection

Patients were included if they were classified as ASA physical status III, underwent elective open-heart surgery, and received SPSIPB for postoperative analgesia. Patients with incomplete or missing medical records, known allergy to local anesthetics, or those undergoing emergency surgical procedures were excluded. Written informed consent for the procedure and publication of data had been obtained from all patients.

Data Collection

Demographic characteristics, surgical type, surgical duration, cardiopulmonary bypass time, intraoperative opioid consumption, postoperative pain scores, rescue analgesia requirements, mechanical ventilation duration, intensive care unit length of stay, hospital length of stay, postoperative complications, and patient and surgeon satisfaction scores were obtained from patient records.

SPSIPB Technique

All blocks were performed under aseptic conditions using a linear ultrasound probe (GE ML6-15-D Matrix Linear). Patients were placed in the sitting position with the ipsilateral arm adducted and internally rotated. The probe was positioned parallel to the spine and advanced medially to identify the second and third ribs. A 22-G, 50-mm short-beveled needle (Stimuplex Ultra®, Braun, Melsungen, Germany) was inserted using an in-plane approach and advanced caudocranially through the trapezius, rhomboid major, and serratus posterior superior muscles toward the third rib. After hydrodissection with 5 mL saline, 30 mL of 0.25% bupivacaine was injected into the interfascial plane. The ultrasound anatomy and needle trajectory are shown in Figure 1. The procedure was repeated on the contralateral side.

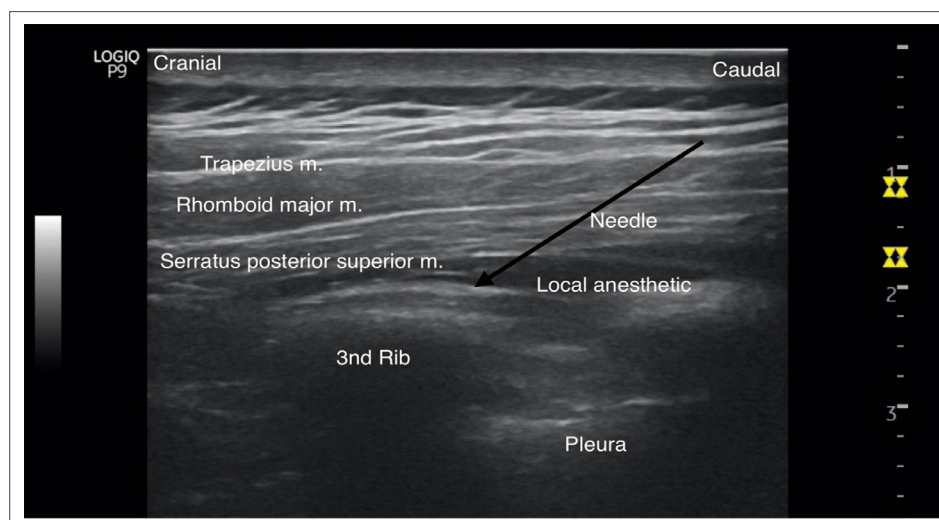


Figure 1. Ultrasound image of the SPSIPB showing the serratus posterior superior muscle, intercostal muscles, and needle trajectory.

SPSIPB: Serratus posterior superior intercostal plane block.

Table 1. Demographic and intraoperative data

| Patient | Age | Sex | BMI | EuroSCORE | Pre-op EF (%) | Surgery type | CPB time (min) | Surgery duration (min) | Intraop fentanyl (mcg) |
|------------------|------------|-----|------------------|-----------|---------------|--------------|----------------|------------------------|------------------------|
| 1 | 70 | M | 32.9 | 4 | 30 | CABG | 48 | 150 | 450 |
| 2 | 76 | M | 26.2 | 3 | 55 | CABG | 138 | 280 | 650 |
| 3 | 68 | M | 27.7 | 7 | 35 | CABG | 106 | 270 | 400 |
| 4 | 54 | F | 41 | 3 | 60 | MVR+TRA | 110 | 190 | 350 |
| 5 | 73 | M | 23.4 | 5 | 45 | CABG | 107 | 167 | 575 |
| 6 | 56 | M | 27.2 | 11 | 25 | CABG | 105 | 250 | 450 |
| 7 | 71 | F | 39 | 7 | 65 | AVR | 80 | 145 | 400 |
| 8 | 65 | M | 27.7 | 7 | 30 | CABG | 80 | 155 | 500 |
| 9 | 66 | M | 27.8 | 7 | 60 | CABG | 90 | 165 | 550 |
| 10 | 49 | M | 27.5 | 3 | 60 | CABG | 84 | 145 | 375 |
| Median (min-max) | 67 (49–76) | – | 27.7 (23.4–41.0) | 6 (3–11) | 50 (25–65) | – | 97.5 (48–138) | 166 (145–280) | 450 (350–650) |

BMI: Body mass index; EF: Ejection fraction; CPB: Cardiopulmonary bypass; CABG: Coronary artery bypass grafting; MVR: Mitral valve replacement; TRA: Tricuspid ring annuloplasty; AVR: Aortic valve replacement; M: Male; F: Female.

Postoperative Assessment

Pain was assessed using the Numeric Rating Scale (NRS) at the sternotomy and mediastinal and thoracic drain sites at 1, 4, 8, 16, and 24 hours after extubation, both at rest and during coughing. Rescue analgesia was administered when NRS scores were ≥ 4 or upon patient request, beginning with intravenous paracetamol, followed by NSAIDs when appropriate, and opioids if required.

Statistical Analysis

Given the descriptive nature of the study and the small sample size, analyses were limited to descriptive statistics. Continuous variables are presented as median (minimum–maximum), and categorical variables as number (percentage). Postoperative NRS pain scores for sternotomy and drain sites at each time point (1, 4, 8, 16, and 24 hours, at rest and during coughing) are reported descriptively in the tables. Statistical analyses were performed using IBM SPSS Statistics for Windows, Version 26.0 (IBM Corp., Armonk, NY, USA).

Results

Ten patients were included in the study. Demographic and intraoperative characteristics are summarized in Table 1. Surgical procedures consisted of coronary artery bypass grafting in eight patients, aortic valve replacement in one patient, and combined mitral valve replacement with tricuspid ring annuloplasty in one patient. The mean surgical duration was 191.7 minutes, mean cardiopulmonary bypass time was 94.8 minutes, and mean intraoperative fentanyl consumption was 470 μg .

Postoperative pain scores during the first 24 hours after extubation are presented in Table 2. Mean resting and dynamic NRS scores were 0.58 and 1.42 at the sternotomy site, 0.42 and 1.16 at the mediastinal drain site, and 0.80 and 1.85 at the thoracic drain site, respectively. Maximum resting and dynamic NRS scores reached 2 and 5 at the sternotomy site, 5 and 7 at the mediastinal drain site, and 3 and 5 at the thoracic drain site.

Rescue analgesia requirements are detailed in Table 3. Intravenous paracetamol was administered to four patients, paracetamol combined with an NSAID to one patient, and paracetamol with intramuscular pethidine to one patient for refractory pain. Four patients required no additional analgesia within the first 24 hours.

Postoperative clinical outcomes are shown in Table 3. The mean duration of mechanical ventilation was 348 minutes, mean intensive care unit stay was 87 hours, and mean hospital length of stay was 8.9 days. Pulmonary complications occurred in three patients, including atelectasis, hypercapnic respiratory failure, and desaturation. Cardiac arrhythmias, including atrial fibrillation and supraventricular tachycardia, were observed in three patients.

Discussion

Postoperative pain following open-heart surgery develops due to multiple factors such as sternotomy, thoracic drains, saphenous vein dissection, and sternal retraction.^[2,5] Severe pain is associated with increased pulmonary complications, prolonged mechanical ventilation, and the development of chronic pain.^[6,7] For this reason, multimodal analgesic strategies that include regional techniques in combination

Table 2. Resting/dynamic NRS scores during the first 24 hours after extubation

| Patient | Location | 1h NRS | 4h NRS | 8h NRS | 16h NRS | 24h NRS |
|---------|-------------------|--------|--------|--------|---------|---------|
| 1 | Sternotomy | 0/0 | 0/1 | 1/2 | 1/2 | 1/4 |
| | Mediastinal drain | 0/0 | 0/1 | 5/7 | 3/4 | 3/4 |
| | Thoracic drain | 0/0 | 0/2 | 1/2 | 2/4 | 3/4 |
| 2 | Sternotomy | 0/1 | 0/2 | 1/3 | 1/2 | 1/3 |
| | Mediastinal drain | 0/0 | 0/1 | 1/2 | 1/2 | 1/2 |
| | Thoracic drain | 1/1 | 1/2 | 1/2 | 1/2 | 1/2 |
| 3 | Sternotomy | 0/0 | 0/0 | 0/0 | 1/2 | 0/3 |
| | Mediastinal drain | 0/0 | 0/0 | 0/0 | 1/2 | 0/2 |
| | Thoracic drain | 0/0 | 1/3 | 2/3 | 2/3 | 1/3 |
| 4 | Sternotomy | 0/0 | 0/0 | 0/0 | 0/0 | 0/0 |
| | Mediastinal drain | 0/0 | 0/1 | 0/1 | 0/1 | 0/0 |
| | Thoracic drain | – | – | – | – | – |
| 5 | Sternotomy | 0/0 | 0/0 | 2/5 | 2/4 | 2/3 |
| | Mediastinal drain | 0/0 | 0/0 | 0/0 | 1/2 | 0/2 |
| | Thoracic drain | 0/0 | 0/0 | 3/5 | 0/1 | 0/0 |
| 6 | Sternotomy | 0/0 | 0/0 | 1/3 | 0/0 | 0/0 |
| | Mediastinal drain | 0/0 | 0/0 | 0/0 | 0/0 | 0/0 |
| | Thoracic drain | 0/0 | 0/0 | 0/0 | 0/0 | 0/0 |
| 7 | Sternotomy | 0/0 | 0/0 | 0/0 | 1/2 | 2/2 |
| | Mediastinal drain | 0/0 | 0/0 | 0/0 | 0/0 | 0/0 |
| | Thoracic drain | – | – | – | – | – |
| 8 | Sternotomy | 0/0 | 0/0 | 2/3 | 2/5 | 2/4 |
| | Mediastinal drain | 0/0 | 1/2 | 2/2 | 1/3 | 1/3 |
| | Thoracic drain | 0/1 | 1/3 | 2/4 | 2/4 | 1/4 |
| 9 | Sternotomy | 0/0 | 2/2 | 2/2 | 1/1 | 1/1 |
| | Mediastinal drain | 0/0 | 0/1 | 0/2 | 0/2 | 0/3 |
| | Thoracic drain | 1/2 | 2/3 | 1/3 | 0/2 | 1/3 |
| 10 | Sternotomy | 0/0 | 0/0 | 0/2 | 0/4 | 0/3 |
| | Mediastinal drain | 0/0 | 0/0 | 0/2 | 0/2 | 0/2 |
| | Thoracic drain | 0/0 | 0/0 | 1/3 | 0/2 | 0/1 |

NRS: Numeric rating scale.

Table 3. Postoperative outcomes

| Patient | MV duration (min) | ICU stay (h) | Hospital stay (days) | Additional analgesia | Post-op complications | Satisfaction |
|------------------|-------------------|--------------|----------------------|--------------------------------------|--|--------------|
| 1 | 380 | 72 | 8 | Paracetamol 1g IV | AF | 2/2 |
| 2 | 360 | 43 | 6 | Paracetamol 1g IV | – | 1/2 |
| 3 | 405 | 45 | 6 | Tenoxicam 20mg IV; Paracetamol 1g IV | – | 2/2 |
| 4 | 270 | 46 | 13 | – | Surgical site infection | 1/1 |
| 5 | 420 | 214 | 16 | Paracetamol 1g IV | Hypercapnic resp. failure (reintubation) | 2/2 |
| 6 | 315 | 120 | 9 | Paracetamol 1g IV; Pethidine 50mg IM | Atelectasis, AF | 1/1 |
| 7 | 415 | 192 | 12 | – | Desaturation (NIMV) | 1/1 |
| 8 | 300 | 46 | 7 | Paracetamol 1g IV | SVT | 2/2 |
| 9 | 240 | 44 | 6 | – | – | 1/2 |
| 10 | 375 | 48 | 6 | – | – | 1/1 |
| Median (min-max) | 367.5 (240–420) | 47 (43–214) | 7.5 (6–16) | – | – | – |

MV: Mechanical ventilation; ICU: Intensive care unit; IV: Intravenous; IM: Intramuscular; AF: Atrial fibrillation; SVT: Supraventricular tachycardia; NIMV: Non-invasive mechanical ventilation.

with systemic analgesics are recommended in current guidelines, particularly in the PROSPECT and ERACS protocols.^[5,8] In recent years, minimal-access and alternative approaches have gained increasing interest in cardiac surgery.^[9]

In cardiac surgery, parasternal block (PSB), erector spinae plane block (ESPB), serratus anterior plane block (SAPB), and the recto-intercostal fascial plane block (RIB) are commonly used regional analgesia methods.^[3,10,11] However, these blocks are generally limited to the T2–T6 dermatomes and may not adequately control pain originating from mediastinal or thoracic drains.^[10,12] In addition, the variable craniocaudal spread of ESPB may render its analgesic effect unpredictable.^[11]

The serratus posterior superior intercostal plane block (SPSIPB), described by Tulgar et al.^[4] in 2023, provides wide dermatomal analgesia from C3 to T10 through diffusion of local anesthetic between the serratus posterior superior and intercostal muscles toward the dorsal ramus and lateral cutaneous branches of the intercostal nerves. This anatomical property may enable effective control of drain-related pain in addition to sternotomy pain. Thus, SPSIPB may target a broader sensory area compared to anterior blocks such as PSB or SAPB.

Recent studies have shown that SPSIPB provides effective analgesia in thoracoscopic surgery,^[13] breast surgery,^[14] and cardiac surgery.^[12,15] Avci et al.^[13] reported that SPSIPB significantly reduced opioid consumption and NRS scores in VATS procedures. Ciftci et al.^[14] demonstrated its use in breast surgery, Dost et al.^[15] in open-heart surgery, and Akin et al.^[12] showed effective analgesia with continuous SPSIPB catheter use after minimally invasive atrial surgery. In our series, low NRS scores at sternotomy and drain sites, limited need for additional analgesics, and high patient and surgeon satisfaction were observed. These results are consistent with the multimodal and opioid-sparing goals of ERACS protocols.^[5,8] A case-based view of our cohort suggests that analgesia was generally consistent across sternotomy and drain sites; however, higher dynamic pain scores were occasionally observed at drain locations, highlighting the multifactorial nature of post-sternotomy pain. Patients who exhibited higher early dynamic NRS scores were more likely to receive rescue paracetamol and/or an NSAID, while the majority maintained low pain scores without escalation. These observations support the potential role of SPSIPB in covering both sternal and drain-related pain components within a multimodal strategy.

Effective pain control may help preserve deep breathing and coughing ability, thereby reducing the risk of pulmonary complications such as atelectasis or respiratory insufficiency.^[6,7] Although pulmonary complications

(atelectasis, hypercapnic respiratory failure, and desaturation) were observed in three patients in our series, these conditions were thought to be associated with risk factors such as high EuroSCORE, low ejection fraction, and prolonged cardiopulmonary bypass duration. Therefore, SPSIPB should be considered not as a method that prevents complications on its own, but as a valuable component of multimodal analgesic strategies that facilitates early mobilization through effective pain control.

Potential risks of the method include local anesthetic systemic toxicity (LAST) due to the high volume used and the risk of pneumothorax due to the proximity to the pleura. However, no such complications were observed either in this series or in the literature.^[4,13–15] Performing the block under ultrasound guidance by experienced practitioners significantly reduces these risks.

The limitations of our study include the small sample size (n=10) and the absence of a control group. Although the retrospective observational design prevented the acquisition of comparative results, the study provides preliminary clinical insights into the analgesic efficacy of SPSIPB. Additionally, the lack of objective confirmation of block spread through ultrasound imaging or dermatomal sensory testing represents a methodological limitation. The absence of long-term outcome assessment is another limitation.

Conclusion

SPSIPB provided effective analgesia at both the sternotomy and drain sites, demonstrating low pain scores, limited need for additional analgesics, reduced opioid consumption, and high patient satisfaction. In conclusion, SPSIPB appears to be a promising and reliable component of multimodal analgesia in cardiac surgery. However, larger, prospective, and randomized controlled studies are needed to clearly determine its efficacy and safety profile.

Disclosures

Ethics Committee Approval: The study was approved by the University of Health Sciences, Bursa Yuksek Ihtisas Training and Research Hospital Ethics Committee (no: 2024-TBEK 2024/03-08, date: 20/03/2024).

Informed Consent: Written informed consent was obtained from all participants prior to inclusion in the study.

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