THE EUROPEAN SOCIETY OF MEDICINE
Medical Research Archives, Volume 14 Issue 2

RESEARCH ARTICLE

Comparative Efficacy of the Erector Spinae Plane Block and Serratus Posterior Superior Intercostal Plane Block in Breast Surgery: A Randomised Trial

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OPEN ACCESS

PUBLISHED
28 February 2026

CITATION
Sayan, M., et al., 2026. Posterior Superior Intercostal Plane Block in Breast Surgery: A Randomised Trial. Medical Research Archives, [online] 14(2).

ISSN
2375-1924

ABSTRACT

Background: Regional anesthesia manages pain and supports recovery following breast surgery. However, achieving adequate analgesia can be challenging because breast and chest wall innervation is complex and variable.

The serratus posterior superior intercostal plane (SPSIP) block provides broad coverage and may enhance pain relief. This study compares pain control, opioid use, and patient satisfaction between the erector spinae plane (ESP) and SPSIP blocks.

Method: This randomized, single-blind study included 75 patients undergoing reduction mammoplasty, modified radical mastectomy, or breast implant surgery between June 2024 and January 2025. Patients were assigned to ESP, SPSIP, or control groups. Outcomes included numeric rating scale pain scores at multiple time points, total opioid consumption, nausea and vomiting, time to mobilization, time to discharge, and satisfaction.

Results: Postoperative pain scores, measured at multiple time points, differed significantly among groups. Pain scores were lower in the SPSIP group than in the ESP and control groups (all Bonferroni-adjusted $p < 0.05$). Total opioid consumption was lowest in the SPSIP group and highest in the control group (3.24±3.64 vs 6.28±4.95 vs 9.60±3.74 MME; one-way ANOVA with Tukey post hoc, $p < 0.05$). No patients in the SPSIP group required rescue analgesia, whereas rescue analgesia was required in 4 patients in the erector spinae plane block group and 14 in the control group ($p < 0.001$). Mobilization occurred earlier in the SPSIP group (3.76±3.11 vs 6.44±4.36 vs 7.80±3.43 hours; $p<0.05$), and they were discharged sooner (21.88±8.02 vs 25.08±3.75 vs 29.52±8.43 hours; $p=0.001$). Satisfaction was highest in the SPSIP group (84% "very satisfied" vs 56% vs 20%; $p<0.001$). Nausea and vomiting rates were comparable across groups ($p=0.237$).

Conclusion: Both fascial plane blocks relieved pain after surgery in comparison to the control group. The Serratus Posterior Superior Intercostal Plane block group had better outcomes in the first 24 hours, including lower pain levels, reduced use of opioids, and faster recovery. The Serratus Posterior Superior Intercostal Plane block might be an effective method to manage pain following breast surgery with a single injection, though larger studies are needed to confirm these results.

Trial Registration: NCT06611644

Keywords: Regional Anesthesia, Postoperative Pain, Mammaplasty, Modified Radical Mastectomy, Breast Implant, Ultrasonography

Introduction

Following breast surgery, whether for cosmetic or cancer-related reasons, 50–60% of patients experience moderate to severe acute pain.[1,2] Poorly managed acute postoperative pain impairs early recovery and substantially increases the risk of chronic pain, which affects about 35% of patients and negatively impacts long-term quality of life and patient satisfaction.[3] Accordingly, Enhanced Recovery After Surgery (ERAS) pathways recommend an opioid-sparing, multimodal analgesic strategy to optimize recovery in breast surgery.[4]

In this context, postoperative pain control typically relies on a multimodal strategy combining systemic analgesics with regional anesthesia. Regional techniques are particularly important because they can reduce opioid requirements and support faster recovery.[3] Several regional anesthesia options have been described for breast surgery, including fascial plane blocks, intercostal nerve blocks, and paravertebral blocks (PVB). However, achieving sufficient analgesia is challenging because of the breast's complex innervation, which involves the anterior and lateral cutaneous branches of the T2–T6 intercostal nerves as well as contributions from the pectoral nerves, the long thoracic nerve, and the supraclavicular nerves; this complexity can make it difficult for a single regional technique to consistently cover the entire surgical field.[5] Consistent with this, a meta-analysis of single-injection fascial plane blocks reported that, although these approaches generally improve postoperative analgesia and reduce opioid consumption compared with control, no technique demonstrated a consistent and clinically meaningful superiority over the others.[6] Therefore, finding optimal regional anesthesia methods remains essential for improving pain management.

The Erector Spinae Plane (ESP) block, first described by Forero et al. in 2016, provides postoperative analgesia by targeting thoracic nerves within the posterior fascial plane.[7] As a Plan A block, the ESP block has been shown to reduce postoperative morphine consumption by 65% and promote early mobilization after breast surgery.[8,9] However, some studies show that the ESP block is less effective for pain relief and reducing opioid use than the paravertebral block or Pectoral Nerves (PECS) Type 2 block.[10,11] The area covered by the ESP block also varies between individuals, which may limit its efficacy in breast surgery by restricting the extent of neuraxial blockade.

The serratus posterior superior intercostal plane (SPSIP) block, introduced by Tulgar et al. in 2023, is a novel periparavertebral fascial-plane technique targeting the space between the serratus posterior superior and intercostal muscles.[12] Cadaveric and preliminary clinical studies show a broad craniocaudal distribution, potentially covering dermatomes relevant to breast surgery, such as the axilla and upper chest. Because of this wide coverage, the SPSIP block may provide better pain relief after surgery than other fascial plane blocks in specific breast procedures.

Therefore, this randomized, single-blind trial aimed to compare the serratus posterior superior intercostal plane and erector spinae plane blocks, with a control group, by evaluating postoperative pain scores over the first 24 hours, total opioid consumption, rescue analgesia requirements, and patient satisfaction in patients undergoing breast surgery.

Materials and Methods

CLINICAL RESEARCH AND ETHICAL APPROVAL

This study was approved by the Institutional Clinical Research Ethics Committee (Approval No: 2023/250, 12/27/2023) and relevant national regulatory authorities. It was registered on clinicaltrials.gov (NCT06611644) and conducted in accordance with the Declaration of Helsinki and Good Clinical Practice guidelines.

STUDY DESIGN AND RANDOMIZATION

This prospective, randomized and blinden for both patients and outcome assessors (single-blind) study was conducted between June 2024 and January 2025. Patients were divided into three groups: the ESP block (ESP), the SPSIP block (SPSIP), and the no-block control (Control).

Randomization was performed in a 1:1:1 ratio using a computer-generated, stratified block randomization scheme based on surgical procedure (unilateral mastectomy with axillary dissection vs bilateral procedures, including breast implant surgery and reduction mammoplasty) to ensure balance across procedure types. Group allocations were concealed using sequentially numbered, sealed, opaque envelopes. Blinding was implemented at the patient and postoperative outcome-assessor levels; both were unaware of group assignment. Intraoperative staff were aware of whether the patient belonged to the control group; however, in patients receiving a regional block, they were blinded to the specific block type (SPSIP vs ESP). To ensure ethically appropriate analgesia, patients in the control group received a predefined intraoperative analgesic regimen (including intravenous tramadol 100 mg), as NSAID-only analgesia was considered insufficient. General anesthesia, intraoperative management, and postoperative analgesic protocols were otherwise standardized across groups.

Sample Size and Power Analysis

Sample size calculation was performed using G*Power based on preliminary morphine consumption data (mean ± SD) of 3.75 ± 3.8 MME in the SPSIP group (n=32), 5.07 ± 3.05 MME in the ESP group (n=14), and 7.81 ± 1.4 MME in the Control group (n=21), yielding an estimated effect size (Cohen's f)=0.5734. This analysis indicated a minimum required sample size of 11 patients per group. However, to increase statistical power, improve the precision and robustness of parametric comparisons (e.g., one-way ANOVA), and better satisfy distributional assumptions, we enrolled 25 patients per group.

PARTICIPANTS

Seventy-five female patients undergoing reduction mammoplasty, modified radical mastectomy, or breast implant surgery were included (Figure 1).

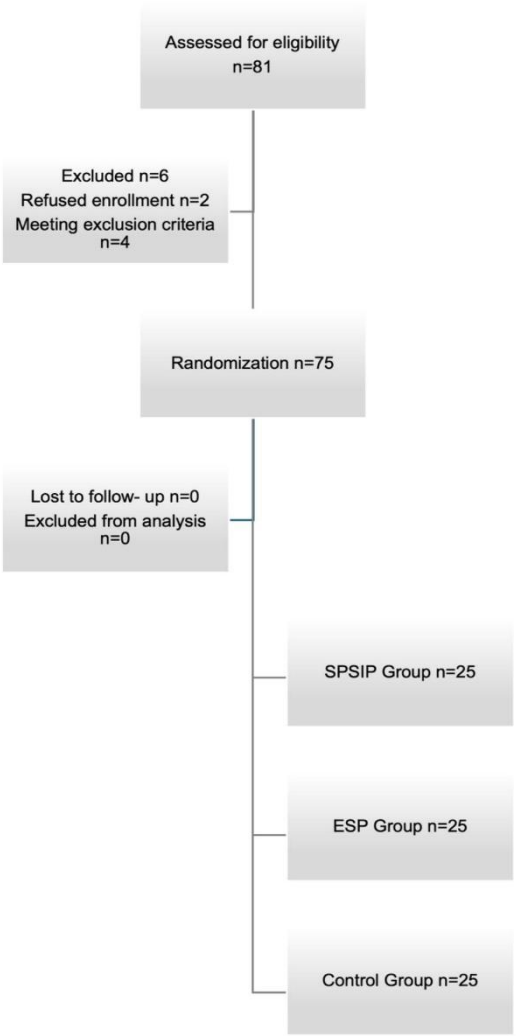

Figure 1: Study flow diagram

Inclusion Criteria:

- Age 18-80 years
- Elective breast surgery
- American Society of Anesthesiologists status classification (ASA) I-III
- Written informed consent

Exclusion Criteria:

- Coagulation disorders or anticoagulant use
- Chronic opioid use
- Allergy to local anesthetics
- Infection or skin lesions at the block site
- Thoracic deformity
- Emergency surgery

Written informed consent was obtained from all participants after they were provided with detailed information about the study.

Data Collection and Outcomes

Preoperative variables included age, height, weight, body mass index (BMI), comorbidities, medications, ASA classification, and surgical type. Total remifentanil consumption, surgical duration, and excised tissue weight were recorded as intraoperative data.

The primary outcome was postoperative pain intensity assessed using the numerical rating scale (NRS; 0-10, where 0=no pain and 10=worst imaginable pain) at 0, 2, 6, 12, and 24 hours. Dynamic NRS was assessed during standardized movement (arm abduction of the operated side to approximately 90°), whereas static NRS was assessed at rest. Patients received patient-controlled analgesia (PCA) with 2 mg/mL tramadol (bolus: 10 mg, lockout: 20 min). Total postoperative opioid consumption was calculated over 0-24 h as the sum of PCA-delivered opioid and rescue opioid administration, converted to MME (conversion factor: 0.1). Intraoperative opioids were analyzed separately. Rescue analgesia (2 mg IV morphine) was administered for NRS >4, repeated every 15 minutes until NRS <4.

Secondary outcomes included postoperative nausea and vomiting (PONV) assessed by the Verbal Descriptive Scale (0-4), patient satisfaction measured using a Likert scale (1-4), and time to first mobilization and hospital discharge.

Block Procedure

Blocks were performed preoperatively under monitoring, with sedation administered using midazolam (1-2 mg) and fentanyl (50 mcg) before appropriate positioning.

All blocks were performed preoperatively under ultrasound (Samsung HM70A Plus device with an LA3-16AD high-frequency linear probe) guidance.

For the Serratus Posterior Superior Intercostal Plane block, patients were positioned with the upper thoracic region and medial scapular border as landmarks, optimizing access by instructing them to grip the opposite shoulder. The probe was placed transversely at the scapular spine, then rotated parasagittally. Using an in-plane approach, a 20G 100 mm needle (Stimuplex® Ultra 360®) was advanced medially to the scapula into the fascial plane between the serratus posterior superior and intercostal muscles at the third rib level. After confirming placement, 25 mL of 0.25% bupivacaine was administered, ensuring cephalocaudal spread (Figure 2A).

For the erector spinae plane block, patients were positioned sitting with the fifth thoracic vertebra as a reference. The ultrasound probe was placed sagittally to visualize the erector spinae muscle and transverse process. Using the in-plane technique, a 20-G, 100 mm needle (Stimuplex Ultra® 360®) was advanced to the transverse process, and 20 mL of 0.25% bupivacaine was injected under ultrasound guidance, ensuring proper spread (Figure 2B).

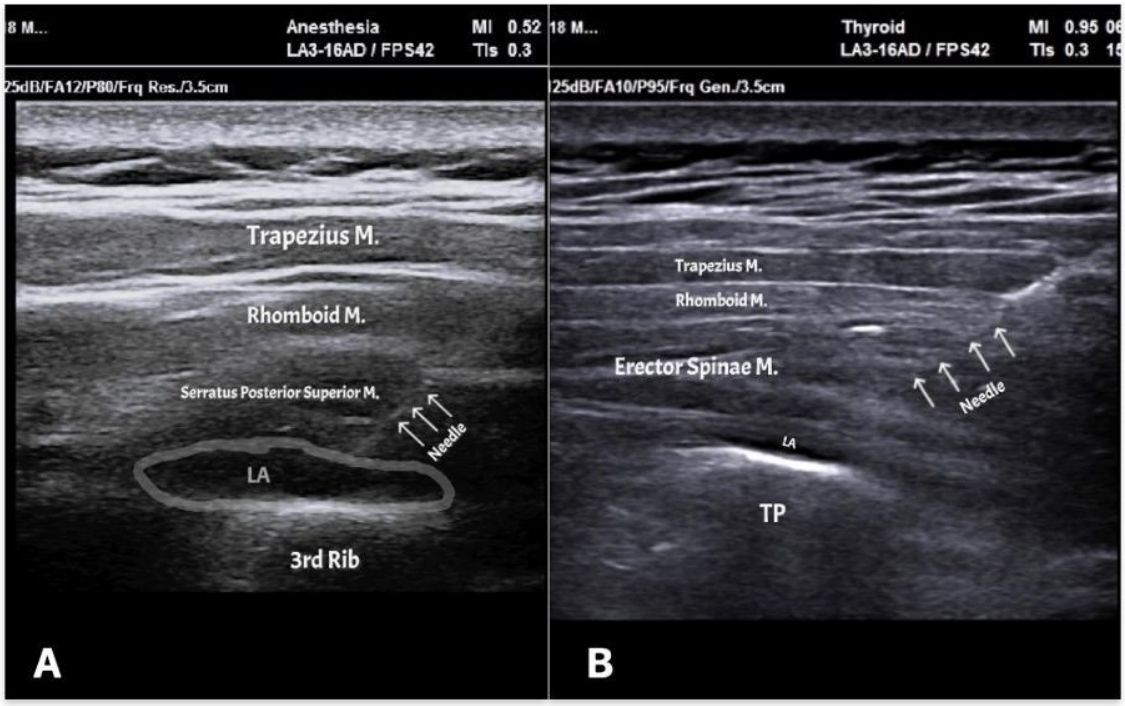

Figure 2. Ultrasound Imaging of Block Procedures. (A) Serratus Posterior Superior Intercostal Plane (SPSIP) block, (B) Erector Spinae Plane (ESP) block. LA: Local anesthetic, M: Muscle, TP: Transverse process of the 5th vertebra.

No regional anesthesia was performed to the control group. For ethical reasons, a sham injection was not performed in the control group. Instead, patients were taken to the block unit, received the same sedation, and were then transferred to the operating room.

Mastectomy procedures were unilateral; therefore, the SPSIP and ESP blocks were performed unilaterally on the operated side. All other breast procedures were bilateral, and the assigned block was applied bilaterally (on both sides) using the same ultrasound-guided technique and local anesthetic concentration per side. Total local anesthetic dose remained within institutional safety limits.

General Anesthesia Management

Standard monitoring included electrocardiography, peripheral oxygen saturation, end-tidal carbon dioxide, and blood pressure. Induction was achieved with midazolam (0.02 mg/kg), fentanyl (1 mcg/kg), propofol (2 mg/kg), and rocuronium (0.6 mg/kg). Anesthesia was maintained with sevoflurane (2-3%). At the end of surgery, sugammadex (2 mg/kg) reversed neuromuscular blockade.

Multimodal analgesia included intravenous paracetamol 1 g and dexketoprofen 50 mg administered toward the end of surgery. In the control group, an additional intravenous tramadol 100 mg was administered near the end of surgery. Postoperatively, all patients received routine analgesia with dexketoprofen 50 mg intravenously every 12 hours.

Statistical Analysis

Continuous variables are presented as mean ± SD, and categorical variables as n (%). Baseline and secondary outcomes measured once were compared among the three groups using one-way ANOVA with Tukey's post hoc test for pairwise comparisons. Categorical variables were analyzed using the Pearson chi-square test. Repeated pain outcomes (static and dynamic NRS at 0, 2, 6, 12, and 24 h) were analyzed using a repeated-measures GLM, including the group×time interaction; pairwise comparisons at each time point were based on estimated marginal means with Bonferroni adjustment. A two-sided p-value <0.05 was considered statistically significant. Statistical analyses were performed using IBM SPSS Statistics (v26.0).

Results

A total of 75 patients were randomized into three groups (SPSIP, n=25; ESP, n=25; Control, n=25). Baseline characteristics, including age, BMI, surgical type and duration, and excised breast tissue weight, were comparable across groups (all p>0.05; Table 1).

Table 1: Patient Characteristics and Perioperative Data

Variables	SPSIP (n=25)	ESP (n=25)	Control (n=25)	p-value
Age (years), mean ± SD	43.4 ± 14.9	47.2 ± 17.4	44.3 ± 15.2	0.672
BMI (kg/m²), mean ± SD	26.5 ± 3.7	26.5 ± 6.1	28.6 ± 6.2	0.365
Comorbidities n-%				
None	12 (48%)	15 (60%)	13 (52%)	0.127
One	8 (32%)	6 (24%)	12 (48%)	
Two or more	5 (20%)	4 (16%)	0	
ASA classification, n-%				0.482
ASA I	10 (40%)	9 (36%)	11 (44%)	
ASA II	13 (52%)	12 (48%)	8 (32%)	
ASA III	2 (8%)	4 (16%)	6 (24%)	
Surgery Type, n-%				1
Reduction mammaplasty	13 (52%)	13 (52%)	13 (52%)	
Breast implant Surgery	4 (16%)	4 (16%)	4 (16%)	
Modified radical mastectomies and axillary dissection	8 (32%)	8 (32%)	8 (32%)	
Operation Duration (min) mean ± SD	234.8 ± 84.3	245.4 ± 71.5	235.2 ± 63.9	0.847
Excised Breast Tissue (g) mean ± SD	720 ± 541	766 ± 555	740 ± 545	0.957

Pearson Chi-square, One-way ANOVA

SPSIP: Serratus Posterior Superior Intercostal Plane Block, ESP: Erector Spinae Plane Block, BMI: Body Mass Index, ASA: American Society of Anesthesiologists Physical Status Score

POSTOPERATIVE PAIN AND OPIOID CONSUMPTION

For static NRS scores assessed at 0, 2, 6, 12, and 24 hours, repeated-measures GLM showed a significant main effect of time (Greenhouse-Geisser: F=22.21, p<0.001, partial η^2=0.236) and a significant main effect of group (F=45.37, p<0.001, partial η^2=0.558). Overall, mean static NRS values were lowest in the SPSIP group and highest in the control group (SPSIP=1.12, ESP=2.63, Control=4.28; Table 2). The time × group interaction was significant (Greenhouse-Geisser: p <0.001; partial η^2=0.110), indicating different temporal patterns across groups. Within-subject contrast analyses demonstrated that between-group differences in change from baseline became significant from 12 hours onward (12 vs 0: p=0.026) and were most pronounced at 24 hours (24 vs 0: p<0.001). Time-specific pairwise comparisons showed that the SPSIP group yielded lower static NRS than ESP and control at all time points, and the ESP group was lower than control throughout (all Bonferroni-adjusted p<0.05; Supplementary Table S1).

Table 2: Comparison of Static and Dynamic NRS Pain Scores Over Time Among the SPSIP, ESP, and Control Groups

Time	SPSIP (n=25)	ESP (n=25)	Control (n=25)	p-value*
Static NRS Scores mean ± SD				
0. hour	1.44 ± 1.39	3.56 ± 1.76	5.60 ± 2.00	**<0.001**
2. hours	1.12 ± 1.62	2.64 ± 1.71	4.48 ± 1.90	**<0.01**
6. hours	1.04 ± 1.31	2.16 ± 1.34	4.44 ± 1.71	**<0.05**
12. hours	1.08 ± 1.47	2.76 ± 1.56	3.92 ± 1.19	**<0.05**
24. hours	0.92 ± 1.08	2.04 ± 0.94	2.96 ± 0.89	**<0.01**
Dynamic NRS Scores mean ± SD				
0. hour	2.04 ± 1.70	4.12 ± 2.07	6.44 ± 2.12	**≤0.001**
2. hours	1.44 ± 1.71	3.08 ± 1.94	5.32 ± 2.06	**≤0.01**
6. hours	1.32 ± 1.65	2.56 ± 1.71	5.28 ± 1.95	**<0.05**
12. hours	1.16 ± 1.65	3.20 ± 1.89	4.56 ± 1.39	**<0.05**
24. hours	1.00 ± 1.23	2.24 ± 1.13	3.28 ± 1.02	**<0.01**

Repeated-measures GLM

Abbreviations: SPSIP: Serratus Posterior Superior Intercostal Plane Block, ESP: Erector Spinae Plane Block, NRS: Numerical Rating Scale.

* P values were obtained from pairwise between-group comparisons at each time point based on estimated marginal means from the repeated-measures GLM, with Bonferroni adjustment. For each time point, the table reports the largest (least significant) adjusted p value as a summary measure. The complete set of Bonferroni-adjusted p values for all pairwise comparisons is provided in Supplementary Table S1.

Supplementary Table S1. Bonferroni-adjusted pairwise comparisons of static and dynamic NRS scores between groups at each time point

Outcome	Time point	Comparison (I - J)	Mean difference	SE	95% CI (Lower, Upper)	p (Bonferroni)
Static NRS	0 h	SPSIP - ESP	-2.120	0.490	(-3.322, -0.918)	<0.001
Static NRS	0 h	SPSIP - Control	-4.160	0.490	(-5.362, -2.958)	<0.001
Static NRS	0 h	ESP - Control	-2.040	0.490	(-3.242, -0.838)	<0.001
Static NRS	2 h	SPSIP - ESP	-1.520	0.493	(-2.728, -0.312)	0.009
Static NRS	2 h	SPSIP - Control	-3.360	0.493	(-4.568, -2.152)	<0.001
Static NRS	2 h	ESP - Control	-1.840	0.493	(-3.048, -0.632)	0.001
Static NRS	6 h	SPSIP - ESP	-1.120	0.414	(-2.136, -0.104)	0.026
Static NRS	6 h	SPSIP - Control	-3.400	0.414	(-4.416, -2.384)	<0.001
Static NRS	6 h	ESP - Control	-2.280	0.414	(-3.296, -1.264)	<0.001
Static NRS	12 h	SPSIP - ESP	-1.680	0.400	(-2.661, -0.699)	<0.001
Static NRS	12 h	SPSIP - Control	-2.840	0.400	(-3.821, -1.859)	<0.001
Static NRS	12 h	ESP - Control	-1.160	0.400	(-2.141, -0.179)	0.015
Static NRS	24 h	SPSIP - ESP	-1.120	0.274	(-1.793, -0.447)	<0.001
Static NRS	24 h	SPSIP - Control	-2.040	0.274	(-2.713, -1.367)	<0.001
Static NRS	24 h	ESP - Control	-0.920	0.274	(-1.593, -0.247)	0.004
Dynamic NRS	0 h	SPSIP - ESP	-2.080	0.558	(-3.447, -0.713)	0.001
Dynamic NRS	0 h	SPSIP - Control	-4.400	0.558	(-5.767, -3.033)	<0.001
Dynamic NRS	0 h	ESP - Control	-2.320	0.558	(-3.687, -0.953)	<0.001
Dynamic NRS	2 h	SPSIP - ESP	-1.640	0.539	(-2.961, -0.319)	0.010
Dynamic NRS	2 h	SPSIP - Control	-3.880	0.539	(-5.201, -2.559)	<0.001
Dynamic NRS	2 h	ESP - Control	-2.240	0.539	(-3.561, -0.919)	<0.001
Dynamic NRS	6 h	SPSIP - ESP	-1.240	0.502	(-2.470, -0.010)	0.048
Dynamic NRS	6 h	SPSIP - Control	-3.960	0.502	(-5.190, -2.730)	<0.001
Dynamic NRS	6 h	ESP - Control	-2.720	0.502	(-3.950, -1.490)	<0.001
Dynamic NRS	12 h	SPSIP - ESP	-2.040	0.468	(-3.188, -0.892)	<0.001
Dynamic NRS	12 h	SPSIP - Control	-3.400	0.468	(-4.548, -2.252)	<0.001
Dynamic NRS	12 h	ESP - Control	-1.360	0.468	(-2.508, -0.212)	0.015
Dynamic NRS	24 h	SPSIP - ESP	-1.240	0.319	(-2.022, -0.458)	0.001
Dynamic NRS	24 h	SPSIP - Control	-2.280	0.319	(-3.062, -1.498)	<0.001
Dynamic NRS	24 h	ESP - Control	-1.040	0.319	(-1.822, -0.258)	0.005

Notes: Time points correspond to 0, 2, 6, 12, and 24 hours. Mean differences are reported as I - J (negative values indicate lower NRS in group I). Pairwise comparisons are based on estimated marginal means from the repeated-measures GLM with Bonferroni adjustment.

For dynamic NRS scores, the main effects of time ($p<0.001$; partial $\eta^2=0.306$) and group ($F=41.55$, $p<0.001$; partial $\eta^2=0.536$) were significant, with a significant time×group interaction (Greenhouse–Geisser: $p<0.001$; partial $\eta^2=0.109$). Contrast testing indicated that group differences in change from baseline were evident at 24 hours (24 vs 0: $p<0.001$), whereas the 12-hour contrast did not reach statistical significance (12 vs 0: $p=0.089$). These findings were consistent with the estimated marginal mean profiles (Figure 3).

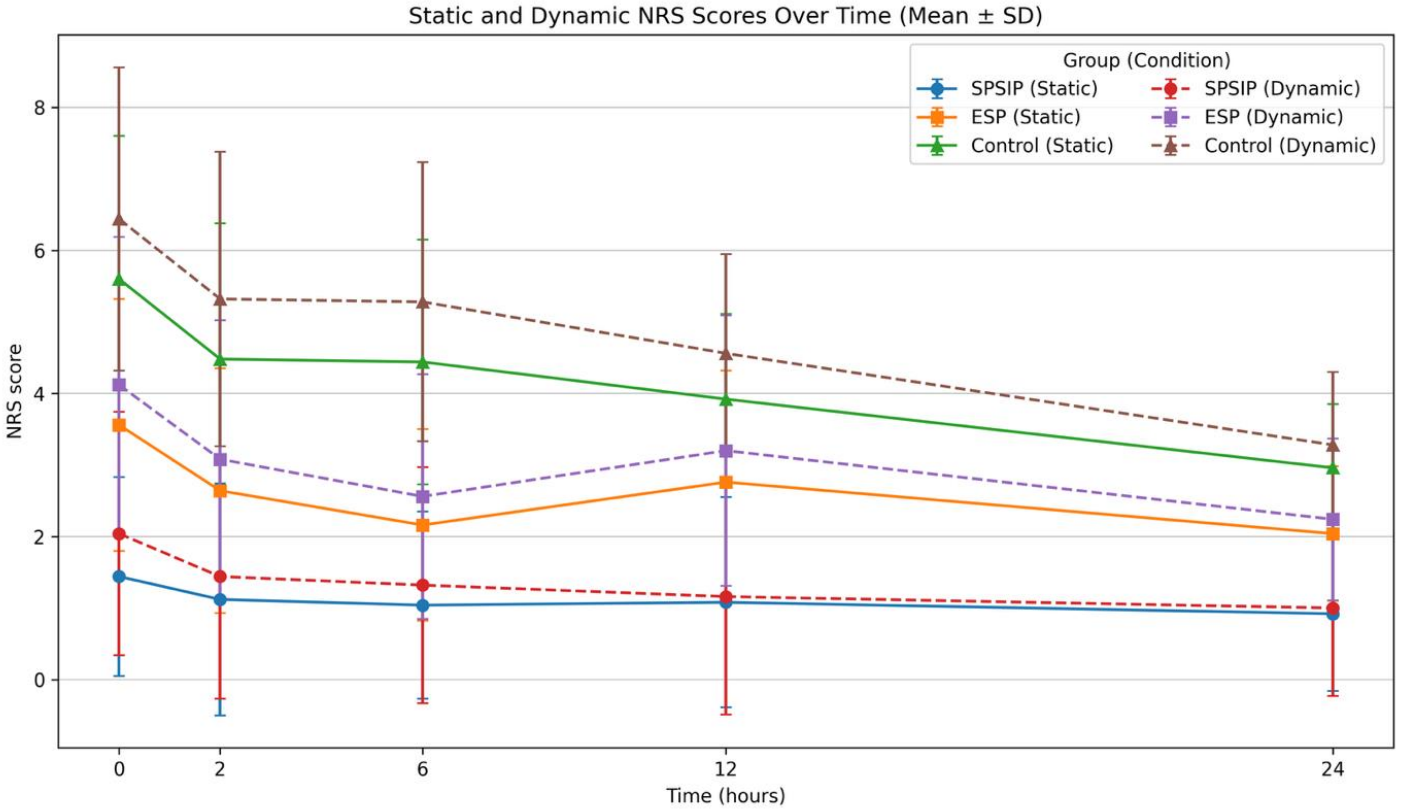

Figure 3. Static and dynamic Numerical Rating Scale (NRS) pain scores over time in the SPSIP, ESP, and control groups. Values are presented as mean ± SD at 0, 2, 6, 12, and 24 hours. Solid lines indicate static NRS; dashed lines indicate dynamic NRS. SPSIP: Serratus Posterior Superior Intercostal Plane block; ESP: Erector Spinae Plane block

Total postoperative opioid consumption (MME) differed among groups and was lowest in the SPSIP group (3.24±3.64 vs 6.28±4.95 vs 9.60±3.74 MME; $p<0.05$; Table 3). Rescue analgesia was required in 0% of patients in the SPSIP group, compared with 16% in the ESP group and 56% in the control group ($p<0.001$; Table 3). PCA attempts and PCA-delivered doses were lower in the SPSIP group (Table 3).

Intraoperative remifentanil consumption was similar between SPSIP and ESP, whereas both were lower than in the control group ($p<0.001$; Table 3).

FUNCTIONAL OUTCOMES AND PATIENT SATISFACTION

PONV rates did not differ among groups ($p=0.237$; Table 3). No block-related complications (hematoma, pneumothorax, or neurological deficit) were observed.

Mobilization occurred earlier (3.76±3.11 vs 6.44±4.36 vs 7.80±3.43 h; $p<0.05$) and discharge time was shorter (21.88±8.02 vs 25.08±3.75 vs 29.52±8.43 h; $p=0.001$) in the SPSIP group (Table 3). Patient satisfaction differed across groups ($p<0.001$), with the highest "very satisfied" rate in the SPSIP group (84%) compared with ESP (56%) and control (20%) (Table 3).

Table 3: Analgesia and Recovery Outcomes: Comparison of SPSIP, ESP, and Control Groups

Variables mean ± SD, n (%)	SPSIP (n=25)	ESP (n=25)	Control (n=25)	p-value*
Intraoperative Remifentanyl comsumption (mcg)	256.00 ± 203.35	324.80 ± 238.91	690.80 ± 287.10	**<0.001**‡, § 0.585†
Opioid Consumption (MME)	3.24 ± 3.64	6.28 ± 4.95	9.60 ± 3.74	**<0.05**†,#,§
Salvage Analgesia	0	4 (16%)	14 (56%)	**<0.001**
Nausea- vomiting scores				0.237
No nausea	21 (84%)	15 (60%)	14 (56%)	
Mild nausea	3 (12%)	5 (20%)	4 (16%)	
Severe nausea	1 (4%)	3 (12%)	6 (24%)	
One time vomiting	0	2 (8%)	1 (4%)	
PCA attempts (count)	4.84 ± 7.66	11.12 ± 14.12	14.36 ± 11.72	>0.05†,§ **0.012**‡
PCA Delivered (count)	3.24 ± 3.64	5.80 ± 4.53	7.80 ± 3.46	>0.05†,§ **<0.001**‡
Mobilization Time (hours)	3.76 ± 3.11	6.44 ± 4.36	7.80 ± 3.43	**<0.05** †‡ 0.395§
Discharge Time (hours)	21.88 ± 8.02	25.08 ± 3.75	29.52 ± 8.43	**0.001**† >0.05‡,§
Patient Satisfaction				**<0.001**
Very satisfied	21 (84%)	14 (56%)	5 (20%)	
Satisfied	4 (16%)	6 (24%)	6 (24%)	
Generally satisfied	0	3 (12%)	9 (36%)	
Dissatisfied	0	2 (8%)	5 (20%)	

Pearson Chi-square, One-way ANOVA

*P values were calculated using one-way ANOVA with Tukey's post hoc test for multiple comparisons.

Abbreviations: SPSIP, Serratus Posterior Superior Intercostal Plane block; ESP, Erector Spinae Plane block; PCA, patient-controlled analgesia.

† SPSIP vs ESP

‡ SPSIP vs Control

§ ESP vs Control

Discussion

This randomized single-blind trial, to our knowledge, is one of the earliest prospective comparisons of the SPSIP and ESP blocks for analgesia in the postoperative period of breast surgery. This trial contributes to the field of research by integrating a current control group across blocks and concurrently exploring pain and recovery outcomes. Overall, both types of regional anesthesia improved analgesia in the postoperative period and decreased opioid consumption compared with the control group. While some outcomes were favorable for the SPSIP in the first 24 hours, they remain exploratory until further research validates them.

The erector spinae plane block is frequently utilized as postoperative analgesia in breast surgeries.[13] A systematic review by Leong et al., including 13 randomized controlled trials (RCTs) with 861 patients, reported that the ESP block significantly reduced opioid consumption and pain scores within the first 24 hours compared to general anesthesia. However, its efficacy was similar to PVB but less effective than the PECS II block.[14] Similarly, a meta-analysis by Hong et al. evaluated the effectiveness of PECS II and ESP blocks in oncologic breast surgery, including 17 RCTs. While both techniques significantly reduced opioid consumption, the PECS II block demonstrated a higher reduction.[15] A recent systematic review by Shaikh et al. compared the ESP block and the Serratus Anterior Plane Block (SAPB) in breast surgery, analyzing data from nine RCTs. While no significant difference in pain scores was observed, the ESP block was associated with lower opioid consumption at 24 hours and a delayed first analgesic request.[16]

The erector spinae plane block provides analgesia primarily by targeting the ventral and dorsal rami of the thoracic spinal nerves.[7] Studies suggest that its analgesic effect is similar to PVB due to overlapping anatomical target areas.[10,14] Additionally, its broader vertebral approach may provide superior opioid-sparing effects compared to lateral chest wall blocks.[16] However, its limited coverage of the brachial and cervical plexuses results in restricted analgesia, limiting its overall efficacy. This limitation is regarded as a key factor in the enhanced analgesic effectiveness of the PECS II blockcompared to the ESP block[14,15]

The serratus posterior superior intercostal plane block is a relatively new approach to the fascial planes in the periparavertebral region. Cadaveric studies and clinical data have shown a wide distribution in the craniocaudal extent, potentially involving dermatomes involved in breast surgery, such as the axillary area.[12] Currently available clinical data are largely limited to a series of individual cases or small numbers of patients. In this context, Ciftci et al. and Kültüroğlu et al. applied the SPSIP block in two and three oncologic breast surgery cases, respectively, reporting postoperative NRS scores below 3 for the first 24 hours with no additional opioid requirement.[17,18] Similarly, Balci et al. evaluated seven oncologic breast surgery cases, observing postoperative NRS scores ≤4, with three patients requiring no opioids.[19] Gundogdu et al. assessed the SPSIP block in 10 reduction mammoplasty patients and observed dynamic NRS scores above 4 in five patients at the 1-hour mark. This finding was attributed to the block's delayed onset when administered at the end of surgery, similar to other fascial plane blocks.[20] A more recent controlled study in breast cancer patients compared the SPSIP block with the ESP block and reported similar pain scores but also potentially lower opioid requirements in the SPSIP block group.[21]

In this trial, both block groups had a more favorable postoperative pain profile and lower use of opioids than the control group. At postoperative hour 0, the static NRS values were lower in the SPSIP group (1.44 ± 1.39) compared with the ESP group (3.56 ± 1.76) and the control group (5.60 ± 2.00), and both differences were maintained throughout the 24 hours postoperatively for both static and dynamic pain profiles (Bonferroni-corrected $p < 0.05$). The postoperative use of opioids was also lower in the SPSIP group (3.24 ± 3.64 MME) compared with the ESP group (6.28 ± 4.95 MME) and the control group (9.60 ± 3.74 MME). Some differences between this

study and the previous study may be due to variations in the types of surgical cases and the trial design. While the previous trial assessed a more homogeneous population of breast cancer patients undergoing oncologic breast surgery, this series assessed a wider range of procedures, with an equal number of subjects randomly assigned to each group, and a greater variety of methods, which may have resulted in a higher nociceptive intensity and more variable sources of pain, contributing to a more disparate divergence of pain scores between groups. Some differences between studies, such as perioperative analgesic regimens, timing of regional block administrations, and modeling of group and time interactions, may have influenced results and should be interpreted with caution rather than as proof that one method is superior to another.

The distribution of the regional block may also account for the differences across groups. Compared with the erector spinae plane block, the serratus posterior superior intercostal plane block provides broader craniocaudal coverage that is particularly relevant to breast surgery, including the axilla (Figure 4). The mechanisms underlying fascial plane blocks remain poorly understood; however, analgesia is thought to result from the diffusion of local anesthetics along fascial planes, with modification of sensory afferent impulses possibly facilitated by the tissue planes that surround them.[22,23] The serratus posterior superior intercostal plane block, in fact, has been proposed to include spreading along the planes of contact with the erector spinae and intercostal muscles, as well as along the deep fasciae of surrounding muscles, which may help explain a wider and clinically relevant field of analgesia.

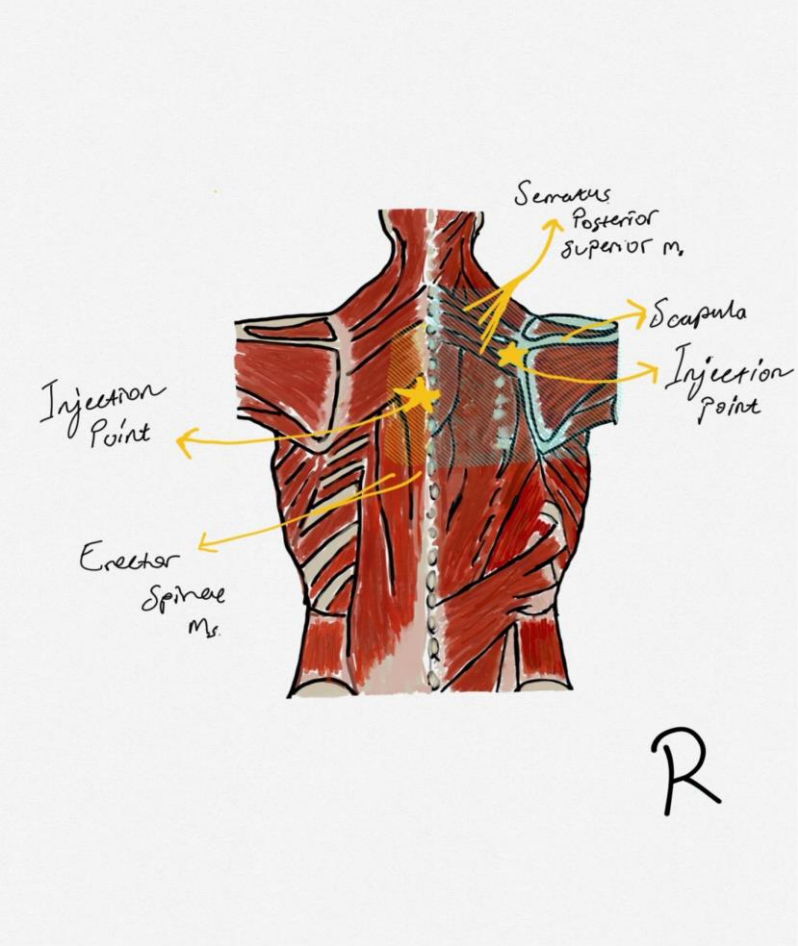

Figure 4: Schematic illustration of the approximate spread of local anesthetic in the ESP and SPSIP blocks, based on cadaveric studies. The blue-shaded area on the right indicates the estimated spread in the SPSIP block, while the yellow-shaded area on the left corresponds to the ESP block. Asterisks denote injection points. R: right; M: muscle; ESP: erector spinae plane; SPSIP: serratus posterior superior intercostal plane.

The higher pain scores and opioid requirements observed in the ESP group, compared to other studies, could be due to differences in the types of procedures and the known variability in how single-shot fascial plane techniques spread across dermatomes. Additionally, using a fixed-volume, single-injection ESP block approach might not provide enough pain relief for procedures that involve a greater extent of the axilla or for patients experiencing higher levels of pain. Future studies investigating dose–response, adding adjuvants, or using catheter-based continuous ESP block methods may clarify whether these modifications can improve the consistency of pain control.

In addition to pain outcomes, patients in the block groups, especially SPSIP, were discharged earlier. While better pain relief may partly explain this, hospital routines, patient preferences, and discharge procedures also influence these results. So these results should be viewed with caution. Still, both regional techniques appeared to support faster recovery.

Patient satisfaction depends on pain control, the need for additional pain medication, side effects, and the overall experience with surgery. In our study, both regional techniques led to higher satisfaction than the control group, with the SPSIP group rating highest. This may be due to more reliable early pain relief and fewer extra interventions, rather than the block type itself. Larger studies with standard care routines are needed to confirm this.

Limitations

This study has some limitations. It was conducted at a single center with a small sample size, which may limit generalizability. We did not assess long-term outcomes, such as postsurgical pain, recovery at 24 hours, or quality of life. We also did not consider psychological factors that might influence pain or the need for pain medicine. For ethical reasons, we did not use a sham block, which may have reduced blinding effectiveness. To reduce expectancy bias, control patients were cared for in the same block as the experimental patients. The control group received 100 mg of tramadol during surgery, which might have lessened differences in opioid-related outcomes after surgery. We also did not formally check for differences between operators performing the block. Future research should include more participants from multiple centers, use standardized protocols, and follow patients for a longer time to confirm these results.

Conclusion

This randomized trial found that both the SPSIP and ESP blocks improved pain control and reduced opioid use after breast surgery compared to no block. The serratus posterior superior intercostal plane block showed greater benefit in the first 24 hours. The serratus posterior superior intercostal plane block may offer a practical single-injection option for pain relief in select breast surgery patients. Further large, well-designed studies with standardized recovery protocols and extended follow-up are needed to confirm these findings.

Written informed consent was obtained from the participants.

Conflicts of Interest:

The authors declare no conflicts of interest.

Funding:

None

Data availability:

Data could be shared with reasonable requests.

Contributions

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The authors declare that this study has been reported honestly, accurately, and transparently, and that they have approved the final version. They accept overall responsibility for the study's integrity and accuracy, ensuring that any issues related to its validity are investigated and resolved.

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