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Original Research Article

Comparison of Ultrasound-Guided Erector Spinae Plane Block versus Serratus Anterior Plane Block for Postoperative Analgesia after Breast Surgery

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Conflict of interest: Nil

Abstract

Introduction: Breast surgery is associated with significant postoperative pain requiring effective multimodal analgesia. This study compared the analgesic efficacy of ultrasound-guided erector spinae plane block (ESPB) and serratus anterior plane block (SAPB) after breast surgery.

Materials and Methods: A prospective randomized comparative study was conducted on 100 patients undergoing breast surgery. Patients were allocated into two groups: ESPB group (n=50) and SAPB group (n=50). Postoperative pain scores, opioid consumption, time to first rescue analgesia, duration of analgesia, patient satisfaction, and complications were assessed.

Result: ESPB provided significantly better analgesia compared with SAPB, with lower VAS scores at 4, 6, 12, and 24 hours postoperatively. Postoperative opioid consumption was significantly lower in the ESPB group (36.4 ± 12.8 mg vs 48.7 ± 15.6 mg; $p<0.001$). ESPB prolonged the duration of analgesia (12.8 ± 3.4 hours vs 10.2 ± 2.9 hours; $p<0.001$) and improved patient satisfaction (4.5 ± 0.6 vs 4.1 ± 0.7; $p=0.003$). No significant difference in adverse events was observed between groups.

Conclusion: Ultrasound-guided ESPB provides superior postoperative analgesia compared with SAPB after breast surgery, with reduced opioid requirement, prolonged analgesic duration, and improved patient satisfaction. ESPB may be preferred as an effective component of multimodal analgesia.

Keywords: Erector spinae plane block; Serratus anterior plane block; Breast surgery; Postoperative analgesia; Regional anaesthesia; Opioid-sparing analgesia.

Introduction

Breast surgery, particularly modified radical mastectomy, is associated with significant postoperative pain due to extensive surgical dissection involving the skin, subcutaneous tissues, breast parenchyma, pectoral muscles, and axillary structures [1]. Inadequately controlled acute postoperative pain may increase opioid consumption, opioid-related adverse effects, delay mobilization, impair shoulder function, prolong hospital stay, and contribute to the development of chronic post-mastectomy pain syndromes. Therefore, effective perioperative analgesia remains an important component of enhanced recovery pathways in breast surgery. [2,3]Traditionally, postoperative analgesia after breast surgery has relied on systemic analgesics, including opioids and non-opioid medications, along with regional anaesthetic techniques such as thoracic epidural analgesia and thoracic paravertebral block. Although paravertebral block provides effective analgesia, it may be technically challenging and is associated with potential complications, including pneumothorax, hypotension, and unintended neuraxial spread. These limitations have led to increasing interest in ultrasound-guided fascial plane blocks as safer and technically simpler alternatives for perioperative analgesia. [4]The serratus anterior plane block (SAPB), introduced by Blanco et al., is an ultrasound-guided interfascial plane block that provides analgesia of the anterolateral chest wall [5]. Local anaesthetic deposited either superficial or deep to the serratus anterior muscle blocks the lateral cutaneous branches of thoracic intercostal nerves and provides sensory blockade over multiple thoracic dermatomes. Clinical studies and systematic reviews have demonstrated that SAPB reduces postoperative pain intensity and opioid consumption after breast surgery.

However, because SAPB primarily targets lateral cutaneous branches, analgesic coverage of medial breast structures supplied by anterior cutaneous branches may be incomplete. [6,7]The erector spinae plane block (ESPB) is a relatively newer ultrasound-guided fascial plane technique introduced for thoracic analgesia. It involves injection of local anaesthetic deep to the erector spinae muscle at the level of the transverse processes, allowing longitudinal spread along the fascial plane with possible extension into the paravertebral space[8]. Through blockade of dorsal and ventral rami of spinal nerves, ESPB provides extensive thoracic analgesia and has gained popularity because of its ease of performance, favourable safety profile, and applicability in breast and thoracic procedures. [9] Both ESPB and SAPB have demonstrated effectiveness as opioid-sparing regional analgesic techniques. Comparative studies suggest that ESPB may provide broader dermatomal analgesia due to involvement of multiple neural pathways and potential paravertebral spread, whereas SAPB provides targeted analgesia of the anterolateral chest wall [10]. However, available randomized trials and systematic reviews have reported variable results regarding postoperative pain scores, opioid consumption, duration of analgesia, and recovery outcomes. [11,12]

Despite increasing clinical use, evidence directly comparing ultrasound-guided ESPB and SAPB specifically in breast surgery remains limited. Determining the relative effectiveness of these techniques may assist anaesthesiologists in selecting an optimal regional analgesic approach for improving postoperative pain control and patient recovery after breast surgery. Therefore, the present study was designed to compare ultrasound-guided erector spinae plane block versus serratus anterior plane block for postoperative analgesia after breast surgery.

Materials and Methods

This prospective, randomized comparative clinical study was conducted in the Department of Anaesthesiology at a tertiary care teaching hospital. The study protocol was registered appropriately, and written informed consent was obtained from all participants before enrolment. The study was designed to compare the analgesic efficacy of ultrasound-guided erector spinae plane block (ESPB) and serratus anterior plane block (SAPB) for postoperative analgesia in patients undergoing breast surgery.

Study Population: A total of 100 patients scheduled for elective breast surgery, including modified radical mastectomy and other major breast procedures, were enrolled in the study. Patients were randomly allocated into two equal groups of 50 patients each:

- Group E (n=50): Patients receiving ultrasound-guided erector spinae plane block.
- Group S (n=50): Patients receiving ultrasound-guided serratus anterior plane block.

Randomization was performed using a computer-generated random allocation sequence. Allocation concealment was maintained using sequentially numbered, opaque sealed envelopes.

Inclusion Criteria: Patients fulfilling the following criteria were included:

- Adults aged 18–70 years.
- Patients undergoing elective breast surgery under general anaesthesia.
- American Society of Anesthesiologists (ASA) physical status I–III.
- Patients willing to participate and provide written informed consent.
- Patients with no contraindication to regional anaesthetic techniques.

Exclusion Criteria

Patients were excluded if they had:

- Refusal to participate in the study.
- Known allergy to local anaesthetic agents.
- Infection at the site of block administration.
- Coagulopathy or abnormal coagulation profile.
- Significant hepatic or renal dysfunction.
- Chronic opioid use or chronic pain disorders.
- Altered sensorium or inability to assess postoperative pain.
- Pregnancy.
- Previous thoracic or breast surgery affecting the block area.

Preoperative Assessment: All patients underwent detailed preoperative evaluation, including complete medical history, physical examination, airway assessment, routine investigations, and evaluation of ASA physical status. Baseline demographic parameters such as age, sex, body mass index (BMI), type of surgery, and duration of surgery were recorded. Patients were educated regarding postoperative pain assessment using the visual analogue scale (VAS) before surgery.

Anaesthetic Technique: All patients were kept fasting according to standard preoperative fasting guidelines. Standard monitoring, including electrocardiography, non-invasive blood pressure, pulse oximetry, and end-tidal carbon dioxide monitoring, was applied after arrival in the operating room. General anaesthesia was induced using standard intravenous anaesthetic agents and maintained with inhalational anaesthesia and controlled ventilation. Intraoperative analgesia was provided according to institutional protocol. At the end of surgery, patients were reversed from neuromuscular blockade and shifted to the post-anaesthesia care unit (PACU) for postoperative monitoring.

Ultrasound-Guided Erector Spinae Plane Block (Group E): In patients allocated to Group E, ESPB was performed under ultrasound guidance after induction of anaesthesia. The patient was positioned in the lateral or sitting position, and a high-frequency linear ultrasound probe was placed in a parasagittal orientation to identify the transverse process and erector spinae muscle. After identification of anatomical landmarks, a needle was advanced using an in-plane technique until the tip reached the plane deep to the erector spinae muscle. After negative aspiration, local anaesthetic solution was injected, and adequate spread along the fascial plane was confirmed.

Ultrasound-Guided Serratus Anterior Plane Block (Group S): In patients allocated to Group S, SAPB was performed under ultrasound guidance after induction of anaesthesia. With the patient positioned appropriately, the ultrasound probe was placed at the level of the mid-axillary line to identify the serratus anterior muscle and surrounding structures. The needle was advanced using an in-plane technique, and local anaesthetic was deposited either superficial or deep to the serratus anterior muscle after confirming correct placement.

Postoperative Analgesia Assessment: Postoperative pain intensity was assessed using the Visual Analogue Scale (VAS) at predefined time intervals:

- Immediately after recovery from anaesthesia (0 hour)
- 2 hours
- 4 hours
- 6 hours
- 12 hours
- 24 hours postoperatively

Pain assessment was performed both at rest and during movement. Rescue analgesia was administered when VAS score exceeded the predefined threshold according to institutional protocol. Total opioid consumption during the first 24 postoperative hours was recorded.

Study Outcomes

Primary Outcome: The primary outcome was comparison of postoperative analgesic efficacy between ESPB and SAPB groups, assessed by postoperative pain scores during the first 24 hours after surgery.

Secondary Outcomes

Secondary outcomes included:

- Total postoperative opioid requirement.
- Time to first rescue analgesic requirement.
- Duration of analgesia.
- Intraoperative opioid consumption.
- Haemodynamic parameters.
- Patient satisfaction score.
- Incidence of block-related complications.
- Postoperative nausea and vomiting.

Statistical Analysis: Data analysis was performed using appropriate statistical software. Continuous variables were expressed as mean ± standard deviation or median (interquartile range), depending on data distribution. Categorical variables were presented as frequency and percentage. Comparison of continuous variables between groups was performed using the independent sample t-test or Mann–Whitney U test. Repeated postoperative pain scores were analysed using repeated measures analysis of variance (ANOVA). Categorical variables were compared using the Chi-square test or Fisher's exact test wherever appropriate. A p-value of <0.05 was considered statistically significant. All statistical analyses were performed using two-tailed tests.

Results

A total of 100 patients undergoing elective breast surgery were enrolled and randomly allocated into two groups: Group E receiving ultrasound-guided erector spinae plane block (ESPB) (n=50) and Group S receiving ultrasound-guided serratus anterior plane block (SAPB) (n=50). All patients completed the study protocol and were included in the final analysis.

Baseline demographic and perioperative characteristics were comparable between both groups, with no significant differences in age, BMI, gender distribution, ASA status, type of surgery, or duration of surgery ($p>0.05$) (Table 1).The mean age was 49.2 ± 8.6 years in the ESPB group and 48.7 ± 9.1 years in the SAPB group ($p=0.78$). The mean BMI was 25.6 ± 3.2 kg/m² and 25.9 ± 3.4 kg/m², respectively ($p=0.65$). The majority of patients underwent modified radical mastectomy in both groups (76% vs 78%; $p=0.81$), with comparable surgical duration (132.4 ± 24.6 vs 134.1 ± 26.2 minutes; $p=0.74$) (Table 1).Postoperative pain assessment using VAS showed effective analgesia in both groups; however, ESPB provided significantly lower pain scores at most postoperative intervals (Table 2). At rest, VAS scores were comparable immediately after surgery (1.8 ± 0.7 vs 2.0 ± 0.8; p=0.24). However, ESPB showed significantly lower VAS scores at 2 hours (1.9 ± 0.6 vs 2.2 ± 0.7; p=0.03), 4 hours (2.1 ± 0.6 vs 2.6 ± 0.7; p=0.001), 6 hours (2.3 ± 0.7 vs 2.9 ± 0.8; p<0.001), 12 hours (2.0 ± 0.6 vs 2.5 ± 0.7; p=0.001), and 24 hours (1.7 ± 0.5 vs 2.1 ± 0.6; p=0.002) (Table 2). During movement, pain scores were also significantly lower in the ESPB group at 2 hours (2.8 ± 0.8 vs 3.2 ± 0.9; p=0.02), 4 hours (3.0 ± 0.8 vs 3.5 ± 0.9; p=0.004), 6 hours (3.1 ± 0.8 vs 3.8 ± 0.9; p<0.001), 12 hours (2.8 ± 0.7 vs 3.4 ± 0.8; p<0.001), and 24 hours (2.4 ± 0.6 vs 2.9 ± 0.7; p=0.001) (Table 2). The comparison of VAS scores is shown in (Figure 1).ESPB was associated with significantly better analgesic outcomes compared with SAPB (Table 3). Mean postoperative opioid consumption was lower in the ESPB group (36.4 ± 12.8 mg morphine equivalents) compared with the SAPB group (48.7 ± 15.6 mg morphine equivalents) (p<0.001). The time to first rescue analgesia was significantly prolonged with ESPB (8.6 ± 2.1 hours vs 6.4 ± 1.8 hours; p<0.001). Fewer patients required rescue analgesia in the ESPB group compared with SAPB (36% vs 62%; p=0.009), and the mean number of rescue analgesic doses was also lower (0.8 ± 0.6 vs 1.4 ± 0.7; p<0.001) (Table 3). These findings are illustrated in (Figure 2). The duration of analgesia was significantly longer in the ESPB group compared with SAPB (12.8 ± 3.4 vs 10.2 ± 2.9 hours; p<0.001). Patient satisfaction scores were also higher with ESPB (4.5 ± 0.6 vs 4.1 ± 0.7; p=0.003) (Table 3).Intraoperative haemodynamic parameters remained comparable between groups. Mean heart rate was 78.6 ± 8.4 beats/min in the ESPB group and 80.1 ± 8.7 beats/min in the SAPB group (p=0.38), while mean arterial pressure was 86.5 ± 7.8 mmHg and 87.2 ± 8.1 mmHg, respectively (p=0.65) (Table 4). Postoperative adverse events were infrequent and comparable between groups. Nausea and vomiting occurred in 6 (12%) patients in the ESPB group and 8 (16%) patients in the SAPB group (p=0.56). No cases of pneumothorax, local anaesthetic systemic toxicity, or neurological complications were observed in either group (Table 4). The comparison of haemodynamic parameters and postoperative complications is presented in (Figure 3).

Table 1: Demographic and Perioperative Characteristics of Study Participants

Parameter	ESPB Group (n=50)	SAPB Group (n=50)	p-value
Age (years), Mean ± SD	49.2 ± 8.6	48.7 ± 9.1	0.78
BMI (kg/m²), Mean ± SD	25.6 ± 3.2	25.9 ± 3.4	0.65
Gender, n (%)			
Male	4 (8%)	5 (10%)	0.73
Female	46 (92%)	45 (90%)	
ASA physical status, n (%)			
ASA I	18 (36%)	20 (40%)	0.68
ASA II	28 (56%)	26 (52%)	
ASA III	4 (8%)	4 (8%)	
Type of surgery, n (%)			
Modified radical mastectomy	38 (76%)	39 (78%)	0.81
Breast conserving surgery	12 (24%)	11 (22%)	
Duration of surgery (min), Mean ± SD	132.4 ± 24.6	134.1 ± 26.2	0.74

Table 2: Comparison of Postoperative Pain Scores (VAS) Between ESPB and SAPB Groups

Time interval	ESPB Group (n=50) Mean ± SD	SAPB Group (n=50) Mean ± SD	p-value
VAS at rest			
0 hour	1.8 ± 0.7	2.0 ± 0.8	0.24
2 hours	1.9 ± 0.6	2.2 ± 0.7	0.03
4 hours	2.1 ± 0.6	2.6 ± 0.7	0.001
6 hours	2.3 ± 0.7	2.9 ± 0.8	<0.001
12 hours	2.0 ± 0.6	2.5 ± 0.7	0.001
24 hours	1.7 ± 0.5	2.1 ± 0.6	0.002
VAS on movement			
2 hours	2.8 ± 0.8	3.2 ± 0.9	0.02
4 hours	3.0 ± 0.8	3.5 ± 0.9	0.004
6 hours	3.1 ± 0.8	3.8 ± 0.9	<0.001
12 hours	2.8 ± 0.7	3.4 ± 0.8	<0.001
24 hours	2.4 ± 0.6	2.9 ± 0.7	0.001

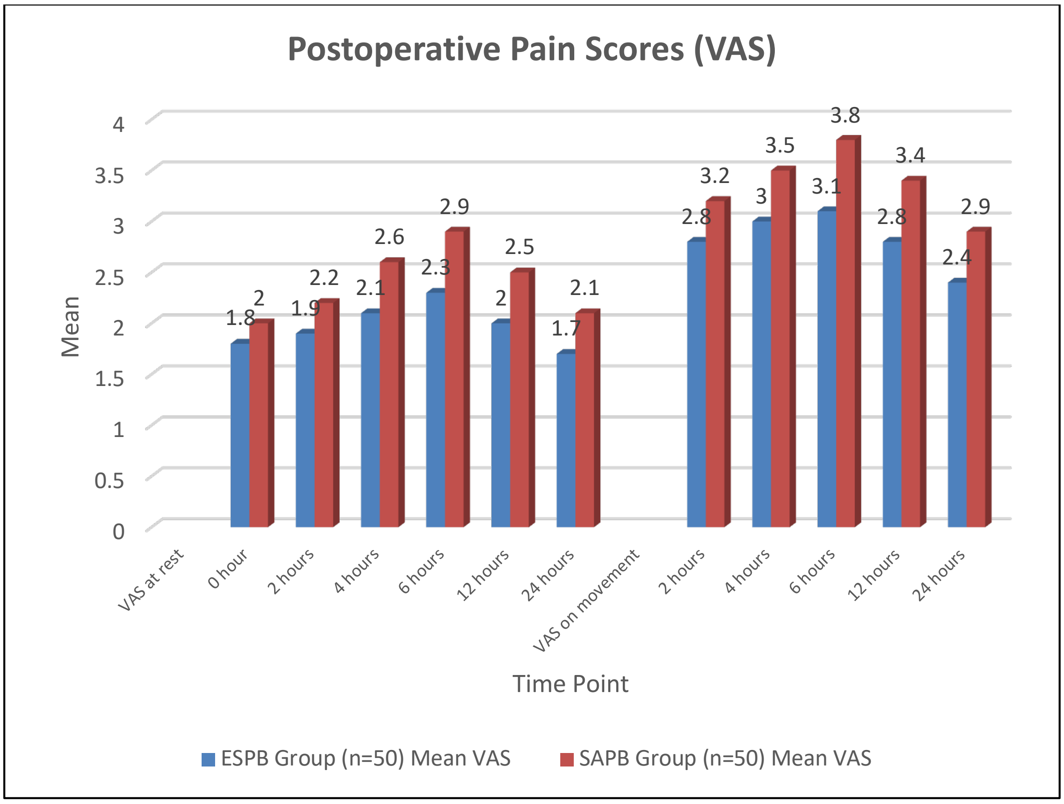

Figure 1: Comparison of Postoperative Pain Scores (VAS) Between ESPB and SAPB Groups

Table 3: Comparison of Analgesic Outcomes between ESPB and SAPB Groups

Parameter	ESPB Group (n=50)	SAPB Group (n=50)	p-value
Total postoperative opioid consumption (mg morphine equivalent), Mean ± SD	36.4 ± 12.8	48.7 ± 15.6	<0.001
Time to first rescue analgesia (hours), Mean ± SD	8.6 ± 2.1	6.4 ± 1.8	<0.001
Duration of analgesia (hours), Mean ± SD	12.8 ± 3.4	10.2 ± 2.9	<0.001
Patients requiring rescue analgesia, n (%)	18 (36%)	31 (62%)	0.009
Number of rescue analgesic doses, Mean ± SD	0.8 ± 0.6	1.4 ± 0.7	<0.001
Patient satisfaction score (0–5), Mean ± SD	4.5 ± 0.6	4.1 ± 0.7	0.003

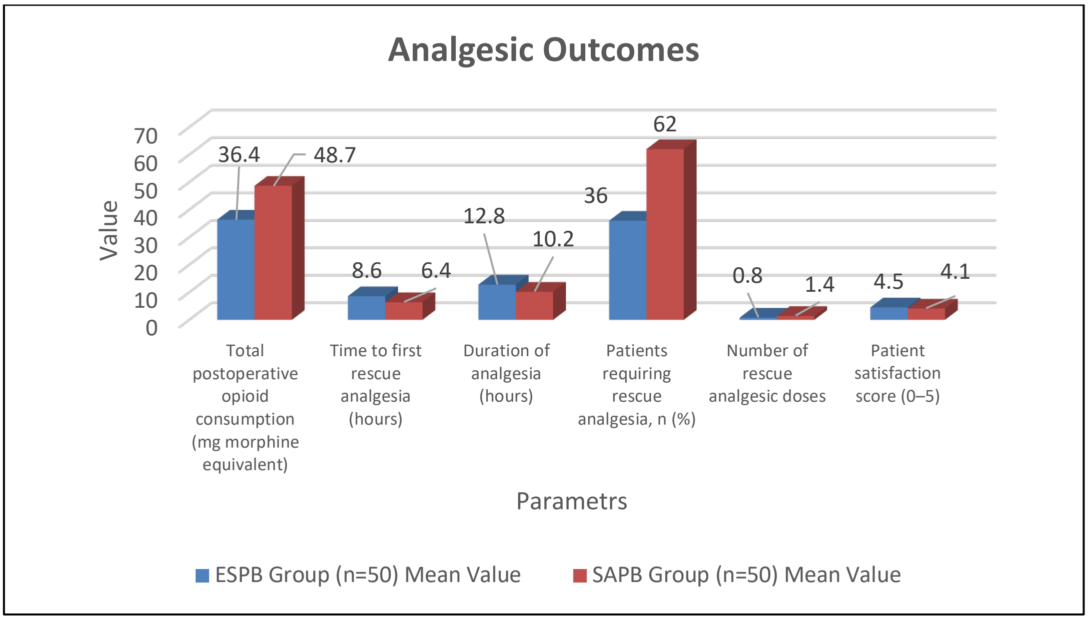

Figure 2: Comparison of Analgesic Outcomes between ESPB and SAPB Groups

Table 4: Comparison of Haemodynamic Parameters and Postoperative Adverse Events

Parameter	ESPB Group (n=50)	SAPB Group (n=50)	p-value
Haemodynamic parameters			
Mean heart rate intraoperative (beats/min), Mean ± SD	78.6 ± 8.4	80.1 ± 8.7	0.38
Mean arterial pressure intraoperative (mmHg), Mean ± SD	86.5 ± 7.8	87.2 ± 8.1	0.65
Postoperative adverse events			
Nausea and vomiting, n (%)	6 (12%)	8 (16%)	0.56
Pruritus, n (%)	2 (4%)	3 (6%)	0.65
Injection site discomfort, n (%)	1 (2%)	2 (4%)	0.56

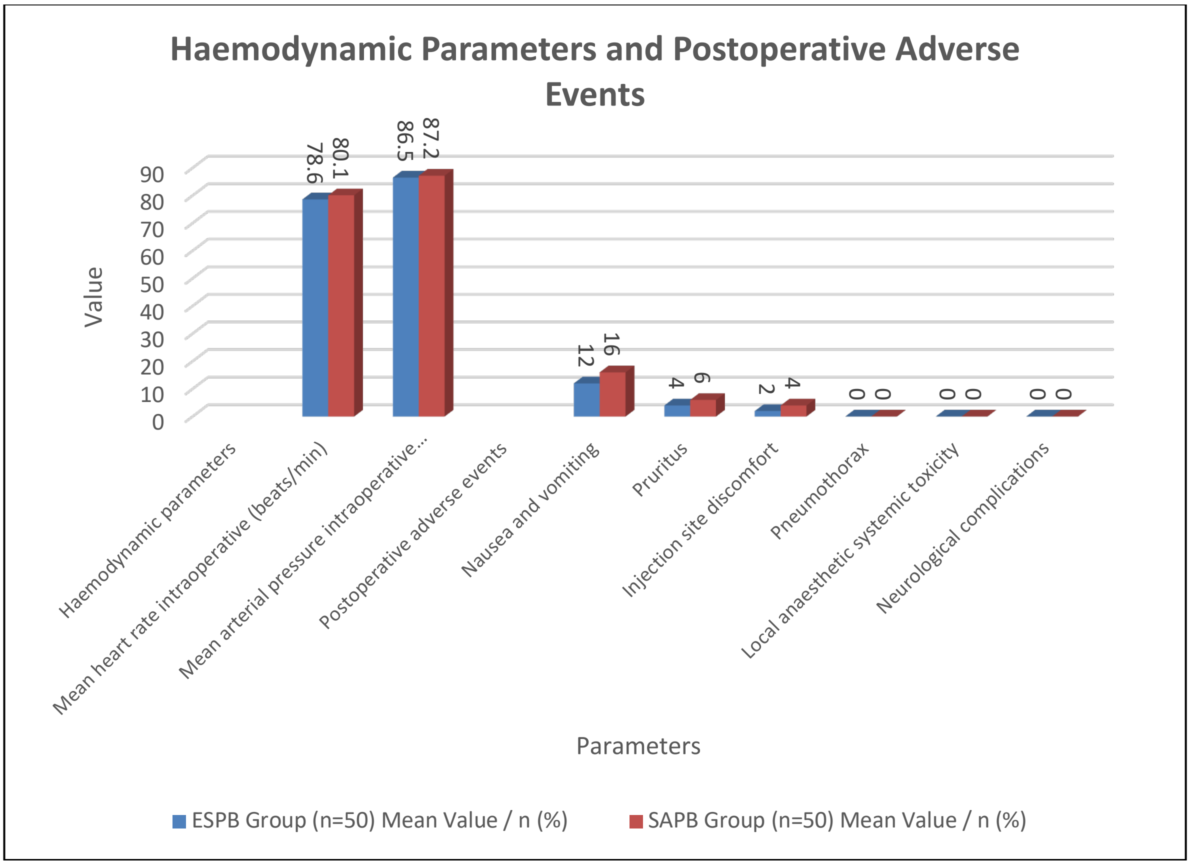

Figure 3: Comparison of Haemodynamic Parameters and Postoperative Adverse Events

Discussion

The present randomized comparative study evaluated the analgesic efficacy of ultrasound-guided erector spinae plane block (ESPB) and serratus anterior plane block (SAPB) in 100 patients undergoing breast surgery. ESPB demonstrated superior analgesic efficacy, with significantly lower postoperative pain scores, reduced opioid consumption, prolonged duration of analgesia, and improved patient satisfaction. The mean postoperative opioid consumption was significantly lower in the ESPB group compared with the SAPB group (36.4 ± 12.8 mg vs 48.7 ± 15.6 mg morphine equivalents; $p<0.001$), and the time to first rescue analgesia was significantly longer (8.6 ± 2.1 hours vs 6.4 ± 1.8 hours; $p<0.001$). The better analgesic effect of ESPB may be attributed to its anatomical mechanism, where local anaesthetic deposited deep to the erector spinae muscle spreads along the transverse processes and may reach the paravertebral space, resulting in blockade of both dorsal and ventral rami of spinal nerves. In contrast, SAPB mainly targets lateral cutaneous branches of intercostal nerves, providing analgesia predominantly to the anterolateral chest wall.

In our study, ESPB provided significantly lower VAS scores at rest at 4 hours (2.1 ± 0.6 vs 2.6 ± 0.7; $p=0.001$), 6 hours (2.3 ± 0.7 vs 2.9 ± 0.8; $p<0.001$), 12 hours (2.0 ± 0.6 vs 2.5 ± 0.7; $p=0.001$), and 24 hours (1.7 ± 0.5 vs 2.1 ± 0.6; $p=0.002$) compared with SAPB. Similarly, pain scores during movement were significantly lower with ESPB at 6 hours (3.1 ± 0.8 vs 3.8 ± 0.9; $p<0.001$) and 24 hours (2.4 ± 0.6 vs 2.9 ± 0.7; $p=0.001$). Bedewy et al. (2024) [1] compared ESPB and SAPB after modified radical mastectomy and reported that both blocks provided effective analgesia; however, ESPB resulted in lower postoperative pain scores and reduced rescue analgesic requirements, supporting our findings.

In our study, ESPB significantly reduced postoperative opioid requirements (36.4 ± 12.8 mg vs 48.7 ± 15.6 mg morphine equivalents; p<0.001) and prolonged analgesic duration (12.8 ± 3.4 hours vs 10.2 ± 2.9 hours; p<0.001) compared with SAPB. Zhang et al. (2022) [13] compared rhomboid intercostal block, ESPB, and serratus plane block during video-assisted thoracoscopic surgery and reported significantly lower opioid consumption with ESPB compared with serratus plane block, suggesting superior opioid-sparing efficacy due to wider neural blockade. Similarly, Finnerty et al. (2020) [10] demonstrated better analgesic outcomes with ESPB compared with SAPB in minimally invasive thoracic surgery and attributed this to potential paravertebral spread and broader dermatomal coverage.

These findings are consistent with our observation of reduced opioid requirement and prolonged analgesia with ESPB.

Although ESPB showed superior analgesic outcomes in our study, some studies have reported comparable efficacy between ESPB and SAPB. Zengin et al. (2022) [14] evaluated ESPB versus combined superficial and deep SAPB after video-assisted thoracoscopic surgery and reported effective analgesia with both techniques, although ESPB provided better pain control at certain postoperative intervals. Their findings support our results showing prolonged analgesic efficacy with ESPB.

Although performed in thoracic surgery patients, evidence from related procedures supports the analgesic potential of ESPB and SAPB. Das et al. (2022) [15] compared thoracic paravertebral block, ESPB, and SAPB for thoracotomy analgesia and reported effective pain control with both fascial plane blocks, with ESPB demonstrating favourable opioid-sparing effects. These findings support the application of ESPB in surgeries involving extensive chest wall dissection.

In our study, patient satisfaction was significantly higher in the ESPB group compared with the SAPB group (4.5 ± 0.6 vs 4.1 ± 0.7; p=0.003). Both techniques demonstrated favourable safety profiles, with no cases of pneumothorax, local anaesthetic systemic toxicity, or neurological complications. Postoperative nausea and vomiting were comparable between groups (12% vs 16%; p=0.56). El-Boghdadly et al. (2020) [3] highlighted that ultrasound-guided fascial plane blocks provide effective analgesia with improved safety compared with conventional neuraxial techniques, supporting the favourable safety findings observed in our study.

Conclusion

Ultrasound-guided erector spinae plane block provided superior postoperative analgesia compared with serratus anterior plane block after breast surgery, with lower pain scores and reduced opioid consumption. ESPB resulted in prolonged duration of analgesia, delayed rescue analgesic requirement, and improved patient satisfaction with a comparable safety profile.

Therefore, ESPB may be considered a preferable regional analgesic technique as part of multimodal pain management for breast surgery.

Limitations

The study was conducted at a single centre with a relatively limited sample size, which may restrict the generalizability of the findings. Long-term outcomes, including the incidence of chronic post-mastectomy pain and functional recovery, were not evaluated due to the short follow-up period.

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