



Original Article

Comparison of PECS II Block Versus Erector Spinae Plane Block for Modified Radical Mastectomy

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ABSTRACT

Introduction: Modified radical mastectomy (MRM) is associated with significant postoperative pain requiring effective opioid-sparing analgesic strategies. This study compared the analgesic efficacy of ultrasound-guided PECS II block and erector spinae plane (ESP) block in patients undergoing MRM.

Materials and Methods: A prospective randomized comparative study was conducted on 80 patients undergoing elective MRM under general anaesthesia. Patients were allocated into two groups (n=40 each) to receive ultrasound-guided PECS II block or ESP block. Postoperative pain scores, duration of analgesia, opioid consumption, haemodynamic parameters, and block-related complications were assessed.

Results: Both blocks provided effective postoperative analgesia. However, PECS II block resulted in significantly lower VAS scores at 2, 4, 6, and 12 hours postoperatively. The duration of analgesia was longer in the PECS II group (12.8 ± 2.6 vs 10.6 ± 2.4 hours; $p < 0.001$), with lower 24-hour tramadol consumption (82.5 ± 31.4 vs 112.8 ± 38.6 mg; $p < 0.001$). Intraoperative fentanyl requirement was also reduced with PECS II block (82.6 ± 18.5 vs 96.4 ± 22.1 µg; $p = 0.003$). No major block-related complications were observed.

Conclusion: PECS II and ESP blocks provide effective analgesia after MRM; however, PECS II block offers superior pain control with prolonged analgesia and reduced opioid requirement.

Keywords: PECS II block; Erector spinae plane block; Modified radical mastectomy; Postoperative analgesia; Regional anaesthesia.

INTRODUCTION

Breast cancer is one of the most commonly diagnosed malignancies among women worldwide and remains a major cause of cancer-related morbidity and mortality. Modified radical mastectomy (MRM), involving breast tissue removal with axillary lymph node dissection, is a frequently performed procedure for locally advanced breast cancer [1]. However, extensive surgical dissection involving skin, pectoral muscles, axillary structures, and intercostal nerves often results in significant postoperative pain. Poorly controlled acute pain may delay recovery, increase opioid requirements, impair shoulder function, prolong hospital stay, and contribute to chronic post-mastectomy pain syndrome. [1] Effective perioperative analgesia is therefore an important component of enhanced recovery following breast surgery. Although opioids and systemic analgesics remain commonly used, concerns regarding opioid-related adverse effects have promoted the use of multimodal opioid-sparing analgesic techniques. [2] Thoracic epidural and paravertebral blocks have traditionally been used for breast surgery analgesia; however, their technical complexity and potential complications such as pneumothorax, vascular puncture, and nerve injury limit their application. [3] The evolution of ultrasound-guided regional anaesthesia has led to newer interfascial plane blocks with improved safety and feasibility. The pectoral nerve block type II (PECS II), described by Blanco et al., is an ultrasound-guided fascial plane block involving local anaesthetic deposition between the pectoralis minor and serratus anterior muscles. It provides blockade of the pectoral nerves, lateral cutaneous branches of thoracic intercostal nerves, long thoracic nerve, and thoracodorsal nerve, thereby providing analgesia

for breast and axillary procedures. [4] PECS II block has demonstrated effectiveness in reducing postoperative pain and opioid consumption following breast surgery. [5,6] The erector spinae plane (ESP) block, introduced by Forero et al., is another ultrasound-guided interfascial plane technique involving injection of local anaesthetic deep to the erector spinae muscle at the transverse process level. Its cranio-caudal spread along the paravertebral fascial plane results in blockade of thoracic spinal nerve branches and provides extensive unilateral thoracic analgesia. [7] Due to its technical simplicity, broad sensory coverage, and favorable safety profile, ESP block has gained increasing application in thoracic and breast surgeries. [8] Several studies have evaluated the analgesic efficacy of PECS II and ESP blocks in breast surgery, demonstrating reductions in postoperative pain and opioid requirements. [9,10] However, comparative studies in patients undergoing MRM have shown variable outcomes regarding analgesic duration, opioid consumption, and recovery parameters. [9,11] A randomized controlled trial comparing ESP and PECS II blocks also reported effective analgesia with both techniques, although differences in efficacy were observed. [12] Despite increasing evidence, the optimal regional analgesic technique for MRM remains uncertain due to differences in anatomical coverage, local anaesthetic spread, and clinical outcomes. Therefore, the present study was undertaken to compare ultrasound-guided PECS II block versus erector spinae plane block in patients undergoing modified radical mastectomy, evaluating postoperative pain scores, duration of analgesia, opioid consumption, haemodynamic response, and block-related complications.

MATERIALS AND METHODS

The present study was designed as a prospective, randomized, comparative clinical study conducted in the Department of Anaesthesiology at tertiary care centre.

Study Population

The study included adult patients scheduled for elective modified radical mastectomy (MRM) under general anaesthesia. Patients fulfilling the eligibility criteria were enrolled and randomly allocated into two groups to receive either ultrasound-guided PECS II block or erector spinae plane (ESP) block as a component of multimodal analgesia.

Randomization and Group Allocation

Patients were randomly assigned using a computer-generated randomization sequence into two groups:

- **Group P (PECS II block group):** Patients received ultrasound-guided pectoral nerve block type II.
- **Group E (ESP block group):** Patients received ultrasound-guided erector spinae plane block.

Allocation concealment was maintained using sequentially numbered opaque sealed envelopes. The anaesthesiologist performing the block was not involved in postoperative assessment.

Inclusion Criteria

Patients fulfilling the following criteria were included:

- Age 18–70 years
- American Society of Anesthesiologists (ASA) physical status I–III
- Patients scheduled for elective modified radical mastectomy under general anaesthesia
- Patients willing to participate and provide written informed consent

Exclusion Criteria

Patients were excluded if they had:

- Refusal to participate
- Known allergy to local anaesthetic agents
- Coagulopathy or anticoagulant therapy
- Infection at the block site
- Significant cardiac, respiratory, renal, or hepatic dysfunction
- Chronic opioid use or chronic pain disorders
- Contraindication to regional anaesthesia

Anaesthetic Technique

All patients underwent standard preoperative evaluation including detailed history, clinical examination, and routine laboratory investigations. Patients were kept fasting as per standard guidelines and received appropriate premedication before surgery. Standard monitoring including electrocardiography, non-invasive blood pressure, pulse oximetry, and capnography was applied. General anaesthesia was induced using intravenous anaesthetic agents and maintained with inhalational agents and/or intravenous anaesthetics according to institutional protocol. Neuromuscular blockade was achieved using appropriate muscle relaxants, and mechanical ventilation was performed during surgery.

Ultrasound-Guided PECS II Block Technique

In patients allocated to Group P, PECS II block was performed under ultrasound guidance after induction of general anaesthesia. With the patient in supine position, a high-frequency linear ultrasound probe was placed in the parasagittal plane near the axillary region to identify the pectoralis major, pectoralis minor, and serratus anterior muscles. After

confirmation of anatomical structures, a needle was advanced using an in-plane technique, and local anaesthetic solution was deposited between the pectoralis minor and serratus anterior muscles.

Ultrasound-Guided ESP Block Technique

In patients allocated to Group E, ESP block was performed under ultrasound guidance after induction of general anaesthesia. The patient was positioned appropriately, and a high-frequency linear/curvilinear ultrasound probe was placed in the parasagittal orientation to identify the transverse process and erector spinae muscle. The needle was advanced using an in-plane approach, and local anaesthetic was injected deep to the erector spinae muscle at the selected thoracic vertebral level.

Postoperative Analgesia and Assessment

All patients received standardized postoperative multimodal analgesia. Pain intensity was assessed using the Visual Analogue Scale (VAS) at predefined time intervals after surgery (0, 2, 4, 6, 12, and 24 hours). Rescue analgesia was administered when patients reported significant pain according to institutional protocol.

The primary outcome was postoperative analgesic efficacy assessed by pain scores and opioid consumption. Secondary outcomes included:

- Duration of analgesia
- Total rescue analgesic requirement during 24 hours
- Haemodynamic response perioperatively
- Time to first rescue analgesic requirement
- Patient satisfaction scores
- Block-related complications such as local anaesthetic toxicity, hematoma, infection, or neurological complications

Statistical Analysis

Data were entered into Microsoft Excel and analysed using SPSS.25. Continuous variables were expressed as mean $\pm$ standard deviation or median (interquartile range), while categorical variables were presented as frequencies and percentages. Comparison of continuous variables between groups was performed using Student's t-test or Mann-Whitney U test depending on data distribution. Categorical variables were analysed using Chi-square test or Fisher's exact test. A p-value <0.05 was considered statistically significant.

RESULTS

A total of 80 patients undergoing modified radical mastectomy were enrolled and randomly allocated into two groups: Group P receiving ultrasound-guided PECS II block (n=40) and Group E receiving ultrasound-guided erector spinae plane (ESP) block (n=40). All patients completed the study protocol and were included in the final analysis. The demographic and perioperative characteristics were comparable between both groups (Table 1). The mean age of patients was 48.6 ± 8.7 years in the PECS II group and 49.2 ± 9.1 years in the ESP group ($p=0.76$). The mean body mass index was 25.4 ± 2.8 kg/m² and 25.7 ± 3.1 kg/m², respectively ($p=0.64$). The distribution of ASA physical status was similar between both groups, with ASA I status observed in 14 (35.0%) patients in the PECS II group and 13 (32.5%) patients in the ESP group, while ASA II status was observed in 26 (65.0%) and 27 (67.5%) patients, respectively ($p=0.81$). The mean duration of surgery was 142.5 ± 18.6 minutes in the PECS II group and 145.2 ± 20.1 minutes in the ESP group ($p=0.53$), while the mean duration of anaesthesia was 168.3 ± 22.4 minutes and 170.6 ± 24.8 minutes, respectively ($p=0.65$). No statistically significant differences were observed between the groups for any demographic or perioperative parameter, indicating comparability of baseline characteristics (Table 1). Postoperative pain assessment using the Visual Analogue Scale (VAS) demonstrated effective analgesia in both groups during the postoperative period. However, patients receiving PECS II block showed significantly lower pain scores compared with the ESP group at multiple postoperative time intervals (Table 2). The mean VAS score at 0 hour was comparable between both groups, with values of 1.2 ± 0.6 in the PECS II group and 1.4 ± 0.7 in the ESP group ($p=0.18$). At 2 hours postoperatively, the mean VAS score was significantly lower in the PECS II group compared with the ESP group (1.5 ± 0.7 vs 2.1 ± 0.9 ; $p=0.002$). Similarly, significantly lower pain scores were observed in the PECS II group at 4 hours (1.8 ± 0.8 vs 2.7 ± 1.0 ; $p<0.001$), 6 hours (2.2 ± 0.9 vs 3.1 ± 1.1 ; $p<0.001$), and 12 hours (2.8 ± 1.0 vs 3.5 ± 1.2 ; $p=0.006$) after surgery. At 24 hours, the difference in VAS scores between the two groups was not statistically significant, with scores of 3.1 ± 1.1 in the PECS II group and 3.4 ± 1.3 in the ESP group ($p=0.27$). The trend of postoperative pain scores over different time intervals demonstrated consistently lower pain intensity in the PECS II group during the early postoperative period (Figure 1). The postoperative analgesic outcomes are presented in (Table 3). The duration of analgesia was significantly longer among patients receiving PECS II block compared with ESP block (12.8 ± 2.6 hours vs 10.6 ± 2.4 hours; $p<0.001$). The time to first rescue analgesic requirement was also significantly prolonged in the PECS II group compared with the ESP group (13.1 ± 2.8 hours vs 10.9 ± 2.5 hours; $p<0.001$). The requirement for rescue analgesia during the first 24 postoperative hours was significantly lower in the PECS II group, with 25 patients (62.5%) requiring rescue analgesia compared with 34 patients (85.0%) in the ESP group ($p=0.02$). Postoperative opioid consumption was significantly reduced in the PECS II group. The mean total tramadol consumption during the first 24 postoperative hours was 82.5 ± 31.4 mg in the PECS II group compared with 112.8 ± 38.6 mg in the ESP group ($p<0.001$).

Similarly, rescue opioid requirement was lower among patients receiving PECS II block, with 18 patients (45.0%) requiring rescue opioids compared with 29 patients (72.5%) in the ESP group ($p=0.01$). The comparison of analgesic duration, time to first rescue analgesia, and opioid consumption between both groups is shown in (Figure 2). Secondary outcomes and complications were evaluated between both groups (Table 4). Intraoperative haemodynamic parameters were comparable between both groups. The mean heart rate following surgical incision was 82.4 ± 9.8 beats/min in the PECS II group and 85.6 ± 10.2 beats/min in the ESP group ($p=0.16$), while mean arterial pressure values were 91.2 ± 8.5 mmHg and 94.1 ± 9.1 mmHg, respectively ($p=0.14$). However, intraoperative fentanyl requirement was significantly lower in the PECS II group compared with the ESP group (82.6 ± 18.5 μ g vs 96.4 ± 22.1 μ g; $p=0.003$). Patient satisfaction regarding postoperative pain control was significantly higher in the PECS II group compared with the ESP group (4.5 ± 0.6 vs 4.1 ± 0.7 ; $p=0.01$). The incidence of postoperative nausea and vomiting was comparable between the two groups, occurring in 5 patients (12.5%) in the PECS II group and 7 patients (17.5%) in the ESP group ($p=0.53$). Injection site discomfort was also similar between groups, observed in 2 patients (5.0%) in the PECS II group and 3 patients (7.5%) in the ESP group ($p=0.64$). No cases of pneumothorax or local anaesthetic systemic toxicity were observed in either group. The comparison of secondary outcomes and complications is represented in (Figure 3).

Table 1: Demographic and Perioperative Characteristics of Study Participants

Parameter	PECS II Group (n=40)	ESP Group (n=40)	p-value
Age (years), Mean $\pm$ SD	48.6 $\pm$ 8.7	49.2 $\pm$ 9.1	0.76
BMI (kg/m ²), Mean $\pm$ SD	25.4 $\pm$ 2.8	25.7 $\pm$ 3.1	0.64
ASA physical status, n (%)			
I	14 (35.0%)	13 (32.5%)	0.81
II	26 (65.0%)	27 (67.5%)	
Duration of surgery (minutes), Mean $\pm$ SD	142.5 $\pm$ 18.6	145.2 $\pm$ 20.1	0.53
Duration of anaesthesia (minutes), Mean $\pm$ SD	168.3 $\pm$ 22.4	170.6 $\pm$ 24.8	0.65

Statistical test used: Independent t-test/Chi-square test

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

Time after surgery	PECS II Group (n=40)	ESP Group (n=40)	p-value
0 hour	1.2 $\pm$ 0.6	1.4 $\pm$ 0.7	0.18
2 hours	1.5 $\pm$ 0.7	2.1 $\pm$ 0.9	0.002
4 hours	1.8 $\pm$ 0.8	2.7 $\pm$ 1.0	<0.001
6 hours	2.2 $\pm$ 0.9	3.1 $\pm$ 1.1	<0.001
12 hours	2.8 $\pm$ 1.0	3.5 $\pm$ 1.2	0.006
24 hours	3.1 $\pm$ 1.1	3.4 $\pm$ 1.3	0.27

Statistical test used: Independent t-test/Mann–Whitney U test

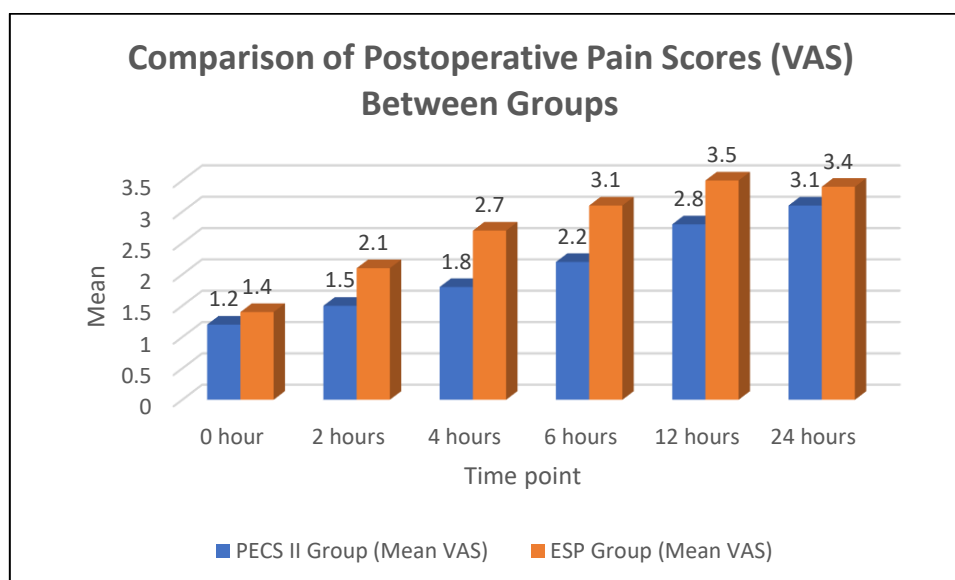


Figure 1: Comparison of Postoperative Pain Scores (VAS) Between Groups

Table 3: Comparison of Postoperative Analgesic Outcomes

Parameter	PECS II Group (n=40)	ESP Group (n=40)	p-value
Duration of analgesia (hours), Mean $\pm$ SD	12.8 $\pm$ 2.6	10.6 $\pm$ 2.4	<0.001

Time to first rescue analgesia (hours), Mean $\pm$ SD	13.1 $\pm$ 2.8	10.9 $\pm$ 2.5	<0.001
Patients requiring rescue analgesia, n (%)	25 (62.5%)	34 (85.0%)	0.02
Total tramadol consumption in 24 h (mg), Mean $\pm$ SD	82.5 $\pm$ 31.4	112.8 $\pm$ 38.6	<0.001
Rescue opioid requirement, n (%)	18 (45.0%)	29 (72.5%)	0.01

Statistical test used: Independent t-test and Chi-square test

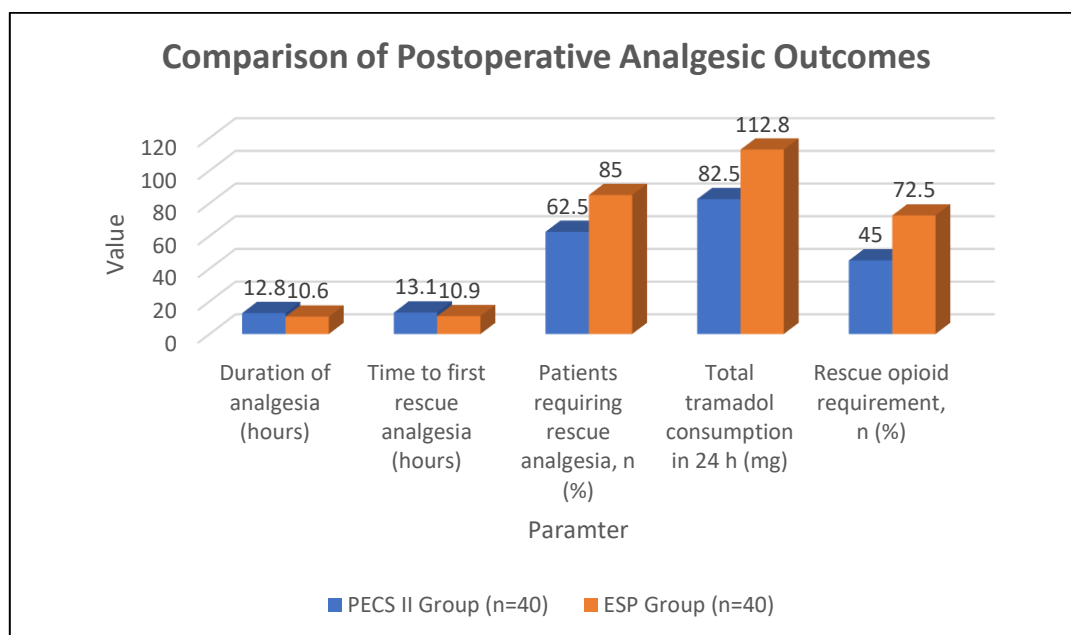


Figure 2: Comparison of Postoperative Analgesic Outcomes

Table 4: Comparison of Secondary Outcomes and Complications

Parameter	PECS II Group (n=40)	ESP Group (n=40)	p-value
Intraoperative fentanyl requirement (μ g), Mean $\pm$ SD	82.6 $\pm$ 18.5	96.4 $\pm$ 22.1	0.003
Heart rate after incision (beats/min), Mean $\pm$ SD	82.4 $\pm$ 9.8	85.6 $\pm$ 10.2	0.16
MAP after incision (mmHg), Mean $\pm$ SD	91.2 $\pm$ 8.5	94.1 $\pm$ 9.1	0.14
Patient satisfaction score, Mean $\pm$ SD	4.5 $\pm$ 0.6	4.1 $\pm$ 0.7	0.01
Postoperative nausea/vomiting, n (%)	5 (12.5%)	7 (17.5%)	0.53
Injection site discomfort, n (%)	2 (5.0%)	3 (7.5%)	0.64
Pneumothorax, n (%)	0	0	—
Local anaesthetic toxicity, n (%)	0	0	—

Statistical test used: Independent t-test/Chi-square test

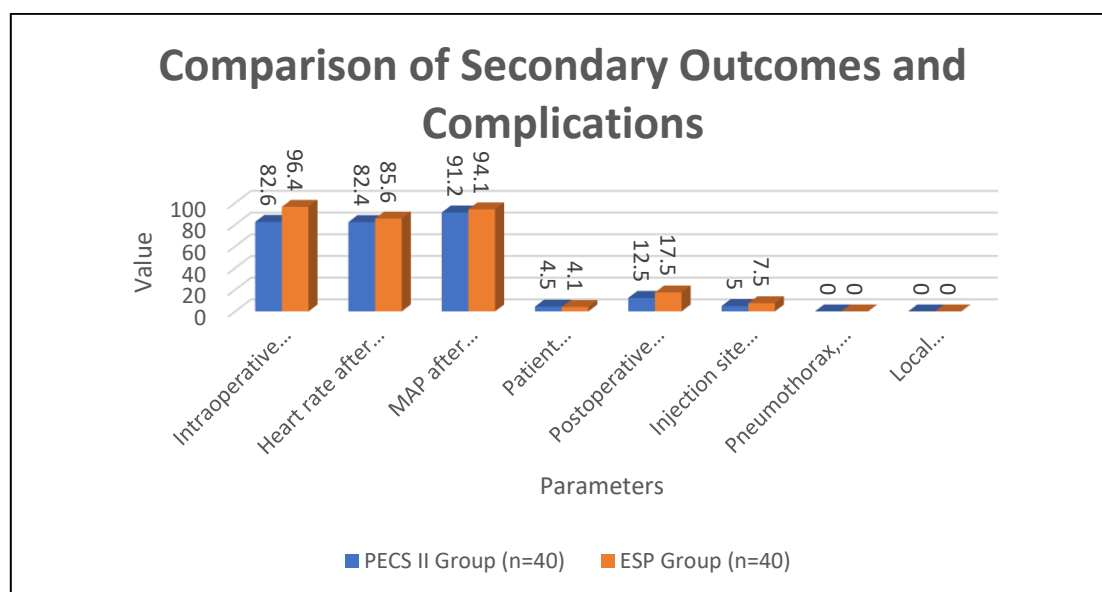


Figure 3: Comparison of Secondary Outcomes and Complications

DISCUSSION

The present randomized comparative study evaluated the analgesic efficacy of ultrasound-guided PECS II block versus erector spinae plane (ESP) block in 80 patients undergoing modified radical mastectomy. Both techniques provided effective postoperative analgesia; however, PECS II block demonstrated superior analgesic efficacy with lower postoperative pain scores, prolonged duration of analgesia, and reduced opioid consumption. The duration of analgesia was significantly longer in the PECS II group compared with the ESP group (12.8 ± 2.6 hours vs 10.6 ± 2.4 hours; $p < 0.001$), with lower 24-hour tramadol consumption (82.5 ± 31.4 mg vs 112.8 ± 38.6 mg; $p < 0.001$). ESP block has gained popularity as an effective regional analgesic technique for breast surgery due to its technical simplicity, broad sensory coverage, and favourable safety profile. Singh and Chowdhary (2018) [13] reported that ESP block provided effective postoperative analgesia following modified radical mastectomy, with reduced pain scores and rescue analgesic requirement. Similarly, Altıparmak et al. (2019) [14] demonstrated that ESP block significantly decreased postoperative pain and opioid consumption after mastectomy and highlighted the influence of local anaesthetic concentration on block efficacy. In our study, ESP block provided satisfactory analgesia; however, postoperative pain scores were higher compared with PECS II block at 2 hours (2.1 ± 0.9 vs 1.5 ± 0.7), 4 hours (2.7 ± 1.0 vs 1.8 ± 0.8), 6 hours (3.1 ± 1.1 vs 2.2 ± 0.9), and 12 hours (3.5 ± 1.2 vs 2.8 ± 1.0). The difference may be related to variations in local anaesthetic spread and anatomical coverage of nerves involved in breast and axillary sensation. PECS II block provides blockade of the medial and lateral pectoral nerves, thoracic intercostal nerve branches, long thoracic nerve, and thoracodorsal nerve, providing effective analgesia for both breast and axillary regions. This targeted coverage may explain its superior analgesic effect in MRM. Altıparmak et al. (2019) [14] compared modified PECS block and ESP block after radical mastectomy and reported that both techniques reduced postoperative opioid requirement; however, PECS-based blockade provided better analgesic outcomes. Consistent with their findings, our study demonstrated prolonged analgesia with PECS II block (12.8 ± 2.6 hours vs 10.6 ± 2.4 hours; $p < 0.001$), reduced rescue analgesic requirement (62.5% vs 85%; $p = 0.02$), and lower opioid consumption compared with ESP block. Goswami et al. (2017) [15] compared PECS I and modified PECS II blocks in patients undergoing modified radical mastectomy and reported superior analgesic efficacy with PECS II due to improved coverage of lateral thoracic and axillary sensory pathways. Our findings further support the role of PECS II as an effective opioid-sparing technique in breast surgery. The effectiveness of ESP block depends on the extent of local anaesthetic spread along the erector spinae fascial plane and its paravertebral extension. Choi et al. (2019) [16] demonstrated that injectate volume influences paravertebral spread during ESP block, which may contribute to variability in clinical analgesic outcomes. In our study, comparatively higher pain scores and opioid requirements in the ESP group may be explained by variable anterior spread and inconsistent blockade of ventral rami supplying the breast. Regional blocks reduce nociceptive transmission and decrease perioperative opioid requirements. In the present study, intraoperative fentanyl requirement was significantly lower in the PECS II group compared with the ESP group (82.6 ± 18.5 μ g vs 96.4 ± 22.1 μ g; $p = 0.003$), indicating better intraoperative analgesic coverage. Gurkan et al. (2018) [10] also reported reduced postoperative opioid consumption following ESP block in breast surgery patients, supporting its role as an effective opioid-sparing technique. Edinoff et al. (2021) [8] highlighted the safety and feasibility of ultrasound-guided interfascial plane blocks as alternatives to conventional neuraxial techniques. No major complications such as pneumothorax, vascular injury, neurological deficit, or local anaesthetic systemic toxicity occurred in either group in our study. Minor adverse events were comparable, confirming the safety of both techniques.

CONCLUSION

Ultrasound-guided PECS II and erector spinae plane blocks both provide effective postoperative analgesia in patients undergoing modified radical mastectomy. PECS II block demonstrated superior analgesic efficacy with prolonged duration of analgesia, reduced opioid consumption, and lower postoperative pain scores compared with ESP block. PECS II block may be considered a preferable opioid-sparing regional analgesic technique for enhanced recovery after breast cancer surgery.

Limitations

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

REFERENCES

1. Shipton EA. The transition of acute postoperative pain to chronic pain: Part 1 – Risk factors for the development of postoperative acute persistent pain. *Trends Anaesth Crit Care*. 2014;4(2-3):67-70.
2. Malik KM, Imani F, Beckerly R, Chovatiya R. Risk of opioid use disorder from exposure to opioids in the perioperative period: a systematic review. *Anesth Pain Med*. 2020;10(1):e101339.
3. Schnabel A, Reichl SU, Kranke P, Pogatzki-Zahn EM, Zahn PK. Efficacy and safety of paravertebral blocks in breast surgery: a meta-analysis of randomized controlled trials. *Br J Anaesth*. 2010;105(6):842-852.
4. Blanco R, Fajardo M, Parras Maldonado T. Ultrasound description of Pecs II (modified Pecs I): a novel approach to breast surgery. *Rev Esp Anestesiol Reanim*. 2012;59(9):470-475.
5. Bashandy GM, Abbas DN. Pectoral nerves I and II blocks in multimodal analgesia for breast cancer surgery: a randomized clinical trial. *Reg Anesth Pain Med*. 2015;40(1):68-74.

6. Thomas M, Philip FA, Mathew AP, Jagathnath Krishna KM. Intraoperative pectoral nerve block (Pec) for breast cancer surgery: a randomized controlled trial. *J Anaesthesiol Clin Pharmacol*. 2018;34(3):318-323.
7. Forero M, Adhikary SD, Lopez H, Tsui C, Chin KJ. The erector spinae plane block: a novel analgesic technique in thoracic neuropathic pain. *Reg Anesth Pain Med*. 2016;41(5):621-627.
8. Edinoff AN, Girma B, Trettin KA, Horton CC, Kaye AJ, Cornett EM, et al. Novel regional nerve blocks in clinical practice: evolving techniques for pain management. *Anesth Pain Med*. 2021;11(4):e118278.
9. Altıparmak B, Korkmaz Tokar M, Uysal AI, Turan M, Gumus Demirbilek S. Comparison of the effects of modified pectoral nerve block and erector spinae plane block on postoperative opioid consumption and pain scores of patients after radical mastectomy surgery: a prospective, randomized, controlled trial. *J Clin Anesth*. 2019;54:61-65.
10. Gurkan Y, Aksu C, Kus A, Yorukoglu UH, Kilic CT. Ultrasound-guided erector spinae plane block reduces postoperative opioid consumption following breast surgery: a randomized controlled study. *J Clin Anesth*. 2018;50:65-68.
11. Comparison of PECS II and erector spinae plane block for postoperative analgesia following modified radical mastectomy: Bayesian network meta-analysis.
12. Erector spinae plane block versus PECS block type II for breast surgery: a randomized controlled trial.
13. Singh S, Chowdhary NK. Erector spinae plane block an effective block for post-operative analgesia in modified radical mastectomy. *Indian J Anaesth*. 2018;62(2):148-150.
14. Altıparmak B, Korkmaz Tokar M, Uysal AI, Gumus Demirbilek S. Comparison of the efficacy of erector spinae plane block performed with different concentrations of bupivacaine on postoperative analgesia after mastectomy surgery: randomized, prospective, double-blinded trial. *BMC Anesthesiol*. 2019;19(1):31.
15. Goswami S, Kundra P, Bhattacharyya J. Pectoral nerve block 1 versus modified pectoral nerve block 2 for postoperative pain relief in patients undergoing modified radical mastectomy: a randomized clinical trial. *Br J Anaesth*. 2017;119(4):830-835.
16. Choi YJ, Kwon HJ, O J, Cho TH, Won JY, Yang HM, et al. Influence of injectate volume on paravertebral spread in erector spinae plane block: an endoscopic and anatomical evaluation. *PLoS One*. 2019;14(10):e0224487.