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ORIGINAL RESEARCH REGIONAL ANESTHESIA

Pectoral plane block compared to erector spinae plane block in multimodal analgesia for modified radical mastectomy patients –a prospective randomized controlled trial

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ABSTRACT

Background & Objectives: Effective perioperative analgesia is essential in patients undergoing modified radical mastectomy to reduce opioid consumption, enhance recovery, and improve patient satisfaction. Regional anesthesia techniques such as the Pectoral Plane (PECS) block and the Erector Spinae Plane (ESP) block have been evolved as promising alternatives, though their comparative efficacy remains under debate. The primary objective of this trial was to observe intra operative mean morphine consumption and mean morphine consumption in first 12 hours post operatively. The secondary objective was to assess the pain scores at 1, 6 and 12 hours post operatively

Methodology: In this prospective, randomized controlled trial, 42 patients scheduled for elective modified radical mastectomy were randomized into two groups: Group ESP and Group PECS. Standardized general anesthesia was administered in all patients. Intraoperative mean morphine consumption, postoperative mean morphine consumption at 12 hours, and pain scores at 1, 6, and 12 hours postoperatively were recorded using numerical rating scale (NRS).

Results: Group PECS provided effective postoperative analgesia compared to Group ESP. Patients in Group ESP demonstrated significantly lower mean postoperative morphine consumption and pain scores in the early postoperative period compared to Group PECS ($P < 0.05$). No major complications were observed in either group.

Conclusion: Both PECS and ESP blocks are safe and effective regional anesthesia techniques for modified radical mastectomy. However, the PECS block demonstrated superior early postoperative analgesia and reduced postoperative morphine consumption compared to ESP block.

Abbreviations: ERAS: enhanced recovery after surgery, ESP: Erector Spinae Plane, PACU: Post-Anesthesia Care Unit, PECS: Pectoral Plane, PMPS: Post-Mastectomy Pain Syndrome

Keywords: Multimodal analgesia, Pectoral plane block, Erector spine plane block, modified radical mastectomy

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1. INTRODUCTION

Breast cancer is the most common malignancy worldwide and remains a major cause of cancer-related mortality among women.[1,2] According to the World Health Organization, its incidence is rising among younger females, particularly in South Asia, where the disease presents nearly a decade earlier than in Western populations.[3,4] In Pakistan, breast cancer constitutes nearly 40% of all female malignancies, making it a critical public health concern.[5] Treatment options include surgery, chemotherapy, and radiotherapy. At our institution (Shaukat Khanum Memorial Cancer Hospital and Research Centre), over 1,000 breast surgeries are performed annually.[6]

The chest wall and breast are innervated by intercostal nerves (T2-T6), the intercostal brachial nerve (T1- T2), medial and lateral pectoral nerves (C5-T1), and the long thoracic nerve (C5-C7).[9] These nerves are often affected during surgical resection.

Post-Mastectomy Pain Syndrome (PMPS) is a chronic neuropathic pain disorder involving the chest wall, axilla, and upper arm. It is defined by the International Association for the Study of Pain (IASP) as pain persisting for more than three months following surgery.[12] Approximately two-thirds of women undergoing breast cancer surgery develop chronic pain of varying intensity.[13,14]

Multimodal analgesia-including intravenous, oral medication and regional anesthesia-is the standard of care for acute pain management.[15] Ultrasound-guided fascial plane blocks have gained popularity enhancing recovery, decrease opioid consumption, minimizing chronic pain incidence with range between 29 to 46% in all breast cancer surgeries.[12] Additionally, opioid sparing techniques may reduce cancer metastasis risk by preserving immune function because opioid inhibit cell-mediated immunity and cytokine production.[16]

There are varieties of regional blocks being used in modified radical mastectomy comprising pectoral plane blocks (PECS I and II), serratus plane block, thoracic para vertebral plane block, erector spinae plane block and inter costal nerve block. In our study we have compared pectoral plane block (PECS II) versus erector spinae plane block.

The pectoral plane blocks (PECS) consist of two types i.e PECS I and PECS II. PECS 1 involves injecting a local anesthetic between the pectoralis major and minor muscles, targeting the medial and lateral pectoral nerve. The PECS II block is an extension of PECS I. In addition to placing the local anesthetic for PECS I, it involves placing the local anesthetic between fascial plane of pectoralis minor and serratus anterior muscle. PECS II targets pectoral nerves, intercostal nerves (T2-T6), intercostobrachial nerves and the long thoracic nerve. Among PECS I and PECS II, for Modified radical mastectomy PECS II block is commonly used. This block provides effective pain relief without sympathetic block, unlike thoracic paravertebral blocks. However, complications such as intravascular injection into the pectoral branch of the thoracoacromial artery may occur but are avoidable with proper ultrasound guidance and experienced anesthetist.[17,18,19]

The Erector Spinae Plane Block (ESP) involves injecting a local anesthetic below the erector spinae muscle, offering analgesia by spreading cranially and caudally.[20] ESP block was successfully performed by Gurkan et al (2018). to patients having unilateral breast surgery.[21] It is a safe alternative to the PECS block and thoracic paravertebral block, covering a broader region of the thoracic and abdominal segments.

The primary objective of this trial was to evaluate mean morphine consumption (intraoperative and during the first 12 hours postoperatively). The secondary objective was to assess postoperative pain scores at 1, 6, and 12 hours.

2. METHODOLOGY

This prospective randomized controlled trial was conducted at the Department of Anesthesia, Shaukat Khanum Memorial Cancer Hospital and Research Centre (SKMCH&RC), Lahore. The sample size was calculated based on a previous study by Gad M. (2019) on patients undergoing modified radical mastectomy, where the mean morphine consumption in first 24 hours post operatively was reported as 16.7 ± 7.21 mg in the erector spinae plane block group (Group ESP) and 10.7 ± 3.12 mg in the pectoral plane group block (Group PECS) .[22] Using the formula for comparison of two means with unequal standard deviations, and assuming a 90% power, 95% confidence interval, and a 10% dropout rate, the required sample size was determined to be 42

patients, with 21 patients in each group. The protocol specified mean morphine consumption (intraoperative and first 12 hours postoperatively) as the primary outcome, and postoperative pain scores as secondary outcomes.

Table 1: Comparative demographic variables

Demographic variables	Group ESP (n = 21)	Group PECS (n = 21)	t-value	P-value
Age (years)	41 ± 8.673	43 ± 7.73	-0.82	0.41
BMI (kg/m^2)	28.7 ± 4.8	28.77 ± 5.8	-0.04	0.96

BMI: Body mass index; P < 0.05 considered as significant

Patients were enrolled if they had ASA physical status II or III, biopsy proven breast cancer, and were undergoing unilateral modified radical mastectomy. Exclusion criteria included patient refusal to participate, age less than 18 years, diagnosed allergy or contraindication to local anesthetic, chronic pain, obesity (BMI >35), non-cancerous or undiagnosed breast lesions, ASA IV status, and emergency surgery.

After taking approval from the Scientific Review Committee (SRC) and the Institutional Review Board (IRB), eligible patients were enrolled and written informed consent was signed. Patients were randomized into two groups using computerized randomization list. Group ESP received the erector spine plane block and Group PECS received the pectoral plane block. Data collection included demographic characteristics, duration of surgery, type of block administered, local anesthetic used (0.25% bupivacaine), total volume injected (20 mL), intraoperative and first 12-hour postoperative morphine consumption and postoperative mean pain scores at 1, 6, and 12 hours.

Standard intra operative monitoring includes blood pressure, ECG and pulse oximetry, temperature and capnography. General anesthesia was induced with propofol and atracurium, and a supraglottic airway device was inserted. After induction of anesthesia, the desired regional block (ESP or PECS) was administered by same consultant throughout the study. All patients received prophylactic intravenous ondansetron and dexamethasone to prevent nausea and vomiting. Anesthesia was maintained with sevoflurane in a 50% oxygen/air mixture targeting a MAC of 1, and ventilation was adjusted to maintain end-tidal CO_2 between 35-45 mmHg. Intraoperative rescue morphine (2 mg IV) was administered, if the heart rate or blood pressure exceeded 20% of baseline values.

At the end of surgery, sevoflurane was discontinued, and neuromuscular blockade was reversed with intravenous neostigmine and glycopyrrolate. Following removal of the supraglottic airway device, patients were transferred to the Post-Anesthesia Care Unit (PACU) for monitoring. PACU nurse assessing the pain score was blinded to the type of block.

All collected data were entered and analyzed using SPSS version 20. Variables such as age, BMI, duration of surgery, morphine consumption, pain scores and PACU discharge time were expressed as mean ± standard deviation. The mean morphine consumption, PACU discharge time and NRS pain scores were compared between groups using the independent sample t-test, with a p-value <0.05 considered statistically significant.

3. RESULTS

For this study, a total of 42 south Asian patients, who underwent modified radical mastectomy, were enrolled. Two groups of patients were created: Group ESP and Group PECS.

The mean age of patients in Group ESP was 41 ± 8.07 years, while in Group PECS it was 43 ± 7.73 years. The difference was not statistically significant (t = -0.82, P = 0.41). The mean BMI in Group ESP was 28.7 ± 4.8 kg/m² compared to 28.77 ± 5.81 kg/m² in Group PECS. No significant difference was observed (t = -0.04, P = 0.96).

Table 2: Mean duration of surgery, morphine consumption and PACU discharge time

Variables	Group ESP (n = 21)	Group PECS (n = 21)	T - value	P - value
Duration of surgery (minutes)	104 ± 23.3	112 ± 22.7	-1.13	0.27
Intraoperative morphine consumption (mg)	2.1 ± 1.7	2.8 ± 1.6	-1.38	0.18
Postoperative morphine consumption (mg)	5.75 ± 3.07	2.80 ± 1.64	3.88	0.0006
PACU discharge time (minutes)	94.20 ± 30.97	90.40 ± 30.89	0.40	0.69

PACU: Post-anesthesia care unit; P < 0.05 considered as significant

These variables were not statistically significant suggesting that in this study age and BMI did not have a significant impact on the outcomes, as shown in Table 1.

The mean duration of surgery did not differ significantly between the two groups (ESP block: 104 ± 23.3 minutes vs. PECS block: 112 ± 22.7 minutes; t = -1.13, P = 0.27).Regarding intraoperative morphine consumption, ESP Group had a mean requirement of 2.1 ± 1.7 mg, while PECS Group required slightly more, with a mean consumption of 2.8 ± 1.64 mg. This difference, however, did not reach statistical significance (t = -1.38, P=0.18), indicating that perioperative morphine usage was similar between the two groups as represented by Table 2.

Table 3: Mean pain scores at different times interval (NRS)

Time interval	Group ESP (n = 21)	Group PECS (n = 21)	t- Value	P-value
1 hour	2.60 ± 2.010	1.40 ± 0.840	2.52	0.018
6 hours	0.65 ± 0.875	0.45 ± 0.605	0.84	0.406
12 hours	0.10 ± 0.308	0.15 ± 0.366	-0.48	0.643

NRS: Numeric Rating Scale; P < 0.05 considered as significant

In contrast, a significant difference in mean post-operative morphine consumption during first 12 hours was observed between the two groups. In Group ESP, it was 5.75 ± 3.07 mg, while in Group PECS the mean morphine demand was 2.80 ± 1.64 mg. The difference in morphine consumption at 12 hours postoperative between the two groups was statistically significant t = 3.89, P < 0.001), evident as per Table 2

PACU discharge times were similar between the two groups (94.2 ± 30.9 minutes vs. 90.4 ± 30.8 minutes; t = 0.40, P = 0.69). The PACU discharge time is an important measure of how quickly patients can recover from anesthesia and the immediate post-operative period.

In Group ESP, the mean pain scores in the Post Anesthesia Care Unit (PACU) at 1, 6, and 12 hours were recorded. Statistical analysis revealed a significant difference between the two groups at 1-hour post-operative time point (t= 2.52, P = 0.018). However, at 6-hour and 12-hour time intervals, no significant differences were observed with t=0.84, P = 0.406 and t = -0.48, P = 0.643, respectively, as shown in Table 3.

4. DISCUSSION

Breast cancer is one of the most common malignancies among women globally and is a major cause of cancer-related surgical interventions. Management includes surgery, chemotherapy, radiotherapy, and hormonal therapy. Among these, surg ical resection (lumpectomy, mastectomy and axillary dissection) is fundamental but is commonly associated with significant postoperative pain. Acute Pain after breast cancer surgery is multi factorial, arising from skin incisions, muscle retraction and nerve trauma. If poorly managed, it may impair recovery, prolong hospital stay and lead to post-mastectomy pain syndrome (PMPS).

PMPS is a debilitating complication that affects quality of life. Effective peri operative pain management is crucial not only for short-term recovery but also for reducing the risk of chronic pain conditions.

Opioids are widely used for postoperative pain control. Opioid inhibit pain transmission at the spinal and supraspinal levels through μ-opioid receptor agonist. However, side effect associated with its use are nausea, vomiting, pruritus, sedation, ileus, and respiratory depression and immune modulation More concerning is the development of post operative nausea vomiting, opioid tolerance and opioid dependence making opioid sparing strategies a priority in modern anesthetic practice.

In this regard, regional nerve blocks are becoming more common as an essential component of multi-modal analgesia in pain management. Regional nerve blocks interrupt pain transmission at the peripheral level, thereby reducing the use of systemic opioid and optimize acute pain. They enhance patient comfort, improve early mobilization, facilitate respiratory function, and potentially may reduce the risk of chronic pain development syndromes as they provide site specific analgesia. Thus regional blocks promote enhanced recovery after surgery (ERAS) protocols.

Bupivacaine, a long-acting amide local anesthetic, is commonly used in these blocks. It works by blocking voltage-gated sodium channels, preventing nerve depolarization and impulse conduction.[9] While effective, bupivacaine carries a risk of dose-dependent toxicity, particularly cardiotoxicity (e.g., arrhythmias, cardiac arrest) and neurotoxicity (e.g., seizures), especially with intravascular injection or high plasma concentrations. However, use of ultrasound-guided techniques have minimized the incidence of complications and have improved precision.

Among the fascial plane blocks, both the Erector Spinae Plane block (ESP) and the Pectoral Plane block (PECS) have been used for analgesia in breast surgery. The ESP

block involves injection deep to the erector spinae muscle, allowing for longitudinal spread of anesthetic and potential indirect blockade of both dorsal and ventral rami of thoracic spinal nerves. Although technically easy and safe, its effectiveness in anterior chest wall surgery may be limited due to variable anterior spread and possible complication such as pneumothorax.

In contrast, the PECS block, particularly the PECS II technique is more anatomically targeted for breast surgery. It anesthetizes the medial and lateral pectoral nerves, long thoracic nerve, thoracodorsal nerve, intercostobrachial nerve, and anterior branches of intercostal nerves. This results in effective coverage of the pectoralis major and minor muscles, axilla, and lateral chest wall, which are the primary pain-generating areas during and after breast surgery.

This study compared the analgesic efficacy of the erector spinae plane block and the pectoral plane block in patients undergoing modified radical mastectomies. Data suggested that, the PECS block showed superior analgesic efficacy compared to the ESP block, with notably lower postoperative morphine requirement postoperatively. The extensive blockade of the anterior thoracic wall nerves by PECS block results in enhanced analgesic efficacy observed in patients, particularly in surgeries involving the anterior chest wall and pectoral region. In contrast, the ESP block primarily targets the dorsal rami of spinal nerves and have limited spread to the anterior thoracic wall and therefore, providing relatively less effective analgesia.

The significant difference in morphine consumption between the ESP and PECS block groups in our study is consistent with the findings of Altiparmak et al. (2018).[2] He suggested that the ESP block is less effective in controlling post-operative pain compared to the PECS block. The higher opioid consumption in the ESP group ($P = 0.001$) further corroborates this finding. The increased opioid usage in the ESP group may indicate a need for alternative analgesic strategies or adjuncts to enhance pain control following procedures involving this block. These results suggest that while both techniques offer some level of post-operative pain relief, the PECS block may be more effective in minimizing the need for opioid analgesia, potentially contributing to a lower risk of opioid-related side effects.

The data suggest that pain levels in the PACU were significantly lower in Group PECS compared to Group ESP at the 1 hour post-operatively. However, at 6 and 12 hours post operatively pain scores in both groups were comparable, with no statistically significant differences observed. These findings may indicate that the initial pain relief provided by PECS block in Group P was more effective in the immediate post-operative period, but both groups achieved similar levels of pain control over time. The findings of this study contrast with those of Altiparmak et al.(2018) and Gad et al. (2019). who reported a statistically significant difference in pain scores at all time intervals post operatively.[2,22]

In line with the findings of Najeeb et al. (2019) our study demonstrates that the use of the Pectoral Plane block (PEC) significantly reduces post-operative pain in patients undergoing breast surgery.[8] Najeeb et al. (2019) reported significantly lower pain scores in patients who received the PECS block compared to the control group, with a P-value of 0.001, indicating a robust analgesic effect.

Additionally, a randomized controlled trial comparing the erector spinae plane block to the modified pectoral plane block in patients undergoing mastectomies revealed higher pain scores at multiple time intervals and high morphine requirement postoperative in the ESP block group, suggesting that the ESP block may be less effective at providing sustained post-operative pain relief compared to the modified PECS block.[22] This further reinforces the notion that PECS block are more effective at managing pain and offers safer, superior analgesia.

5. LIMITATIONS

This study has several limitations. Single center study, the short 12-hour follow-up despite prior studies using a 24-hour endpoint, restricts comparability and assessment of sustained analgesic effects. Despite these constraints, the study provides preliminary evidence that the PECS II block offers superior early postoperative analgesia compared with the ESP block following modified radical mastectomy.

6. CONCLUSION

The two groups were similar in demographic characteristics, duration of surgery, intraoperative morphine use, and PACU discharge time, confirming baseline comparability. The significant differences observed were postoperative mean morphine consumption and reduced pain scores during the immediate postoperative time period which were significantly lower in the PECS block group compared with the ESP block group. These findings suggest that the PECS block provides more effective postoperative analgesia without affecting intraoperative parameters or delaying recovery, and may therefore be considered a preferable regional technique in this surgical setting.

7. Data availability

The numerical data generated during this research is available with the authors.

8. Conflict of interest

All authors declare that there was no conflict of interest.

9. Funding

The study utilized the hospital resources only, and no external or industry funding was involved.

10. Authors' contribution

MF: Idea; study design; data collection

AA, HBK: Literature review, manuscript writing

HUR: Literature review, data collection

ADA: Literature review, proof reading

SRM: study design; Literature review, proof reading

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