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POSTOPERATIVE PAIN RELIEF IN PATIENTS UNDERGOING UNILATERAL MODIFIED RADICAL MASTECTOMY; COMPARISON BETWEEN ULTRASOUND GUIDED ERECTOR SPINAE PLANE BLOCK VERSUS ULTRA SOUND GUIDED THORACIC PARAVERTEBRAL BLOCK

Original Research

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ABSTRACT

Background: Postoperative pain following breast cancer surgery significantly impacts patient recovery and quality of life. Effective regional anesthesia techniques, such as ultrasound-guided thoracic paravertebral block (TPVB) and erector spinae plane block (ESPB), have been utilized to optimize pain management. TPVB is considered superior due to its ability to provide a more targeted blockade of thoracic spinal nerves, potentially offering prolonged analgesia. However, comparative studies evaluating the effectiveness of these two techniques remain limited, particularly in the context of unilateral modified radical mastectomy.

Objective: To compare the efficacy of ultrasound-guided TPVB and ESPB in postoperative pain relief for patients undergoing unilateral modified radical mastectomy for breast cancer.

Methods: This randomized controlled trial was conducted in the Department of Anesthesia, Khyber Teaching Hospital, Peshawar, following ethical approval. A total of 116 female patients, aged 18–60 years, with ASA physical status I–III, were enrolled and randomized into two equal groups. Group A received ESPB, while Group B underwent TPVB, both performed under ultrasound guidance using 0.25% bupivacaine. Postoperative pain intensity was assessed using the visual analog scale (VAS) at the 12th postoperative hour. Statistical analysis was performed in SPSS version 25.0, with independent sample t-tests or Mann-Whitney U tests used for group comparisons.

Results: Group B (TPVB) exhibited significantly lower postoperative pain levels than Group A (ESPB). The mean VAS score in the TPVB group was 1.10 ± 0.89, compared to 2.14 ± 1.02 in the ESPB group ($p = 0.0001$). Stratified analysis indicated statistically significant associations between demographic factors and postoperative pain scores ($p < 0.05$).

Conclusion: TPVB provided superior postoperative pain relief compared to ESPB in patients undergoing unilateral modified radical mastectomy. Given its enhanced analgesic efficacy, TPVB should be considered the preferred regional anesthesia technique for optimizing postoperative pain management in breast cancer surgery.

Keywords: Breast cancer, modified radical mastectomy, postoperative pain, regional anesthesia, thoracic paravertebral block, ultrasound guidance, visual analog scale.

INTRODUCTION

Carcinogenesis is a multifaceted process characterized by six key hallmarks, including evasion of apoptosis, an unlimited capacity for division, enhanced angiogenesis, resistance to anti-growth signals, induction of self-generated growth signals, and the ability to metastasize. This complex process can occur in any cell, tissue, or organ, leading to a wide range of cancers. Among these, breast cancer remains one of the most frequently diagnosed malignancies and is the fifth leading cause of cancer-related mortality, with an estimated 2.3 million new cases reported globally (1,2). Surgical intervention, particularly modified radical mastectomy, is a cornerstone of breast cancer treatment. However, postoperative pain is a significant concern, affecting approximately 30% of patients, often leading to persistent pain syndromes that impact quality of life, hinder functionality, and contribute to prolonged hospital stays, emotional distress, and increased healthcare burdens (3,4). Effective pain management following breast surgery is critical to optimizing patient recovery. The advent of ultrasound technology has revolutionized regional anesthesia by improving precision and efficacy, thereby minimizing complications and enhancing postoperative analgesia (5-7). Among the various regional blocks utilized for breast surgery, the ultrasound-guided erector spinae plane block and thoracic paravertebral block have emerged as promising modalities. The erector spinae muscle group, consisting of the longissimus, spinalis, and iliocostalis muscles, extends along the vertebral column, with the erector spinae plane providing a potential anatomical space for local anesthetic deposition. This plane spans from the cranial nuchal fascia to the caudal sacrum, facilitating effective pain control through multi-segmental sensory blockade (8,9). A comparative study evaluating postoperative pain scores between these two techniques reported a mean pain score of 2.09±1.72 for the erector spinae plane block and 1.32±1.17 for the thoracic paravertebral block in patients undergoing unilateral modified radical mastectomy (10).

Despite the growing adoption of these techniques, there remains limited local data directly comparing the efficacy of the ultrasound-guided erector spinae plane block with the thoracic paravertebral block in this specific patient population. Given the increasing incidence of breast cancer diagnoses and subsequent surgical treatments, optimizing pain management strategies is paramount to enhancing recovery outcomes. Inadequate postoperative analgesia can contribute to chronic pain syndromes, impede early mobilization, and prolong hospitalization, thereby increasing both financial and emotional burdens. By addressing this gap, the present study aims to compare the mean postoperative pain scores associated with these two regional anesthesia techniques, providing evidence-based insights to refine clinical practice and improve pain management strategies for patients undergoing breast cancer surgery (11).

METHODS

This randomized controlled trial was conducted in the Department of Anesthesia at Khyber Teaching Hospital, Peshawar, from August 4, 2024, to February 4, 2025, following approval from the institutional ethical review board (569/DME/KMC). The study aimed to compare the efficacy of ultrasound-guided erector spinae plane block (ESPB) and thoracic paravertebral block (TPVB) in postoperative pain management among patients undergoing unilateral modified radical mastectomy. Ethical considerations were strictly adhered to, and written informed consent was obtained from all participants prior to enrollment (12). The study population included female patients aged 18 to 60 years with American Society of Anesthesiologists (ASA) physical status I to III, confirmed breast cancer diagnosis requiring unilateral modified radical mastectomy, and normal renal and hepatic function. Exclusion criteria encompassed patients with a body mass index (BMI) below 20 or above 35, chronic opioid use, allergies to local anesthetics, contraindications to regional anesthesia, history of chronic pain disorders, or incomplete follow-up data. A total of 116 participants meeting the eligibility criteria were recruited and randomized into two equal groups using blocked randomization to ensure balance between interventions. Randomization was performed by a single anesthetist to maintain consistency and minimize bias (13).

Sample size calculation was based on prior literature reporting mean postoperative pain scores of 2.09 ± 1.72 for ESPB and 1.32 ± 1.17 for TPVB, using a power of 80% and a confidence interval of 95% (10). The WHO sample size calculator was used to determine the required sample size. Participants were allocated into Group A, receiving ESPB, or Group B, receiving TPVB. In both groups, regional blocks were performed under ultrasound guidance. For ESPB, patients were placed in an upright position, and a linear ultrasound probe was used in the sagittal plane to visualize the transverse process. A needle was advanced craniocaudally until it contacted the transverse process, and an initial test dose of 1–3 mL of 0.25% bupivacaine was injected to confirm spread, followed by the administration of 20–30 mL of the anesthetic solution to complete the block. For TPVB, a 22-gauge Tuohy needle was advanced in an out-of-plane approach

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under ultrasound guidance until it reached the paravertebral space after contacting the transverse process. Similarly, an initial test dose of 1–3 mL of 0.25% bupivacaine was injected for confirmation, followed by the administration of 20 mL for the complete block. All procedures were performed under aseptic conditions by an experienced anesthetist, and the surgical procedures were carried out by a single senior surgeon to ensure procedural uniformity (14). Standard intraoperative anesthesia monitoring, including heart rate, blood pressure, oxygen saturation, and end-tidal CO_2, was maintained for all patients. Postoperative pain assessment was conducted at the 12-hour mark using the visual analog scale (VAS), ranging from 0 (no pain) to 10 (worst possible pain). Demographic and clinical characteristics such as age, BMI, ASA status, and socioeconomic background were recorded using a structured proforma (15).

Statistical analysis was performed using SPSS version 25.0. Quantitative variables, including age, BMI, and pain scores, were expressed as mean ± standard deviation (SD) or median with interquartile range (IQR), depending on data distribution. Categorical variables, such as education status and socioeconomic class, were summarized as frequencies and percentages. Mean pain scores between groups were compared using independent sample t-tests or Mann-Whitney U tests, depending on data normality. Stratification was performed for potential confounders, including age, BMI, and socioeconomic status, to ensure robustness of results. Data were presented in tables and graphical formats for clarity (16).

RESULTS

The mean age of participants in the ESPB group was 38.78 ± 14.18 years, while in the TPVB group, it was 37.81 ± 12.48 years. The distribution of age groups revealed that 46.6% of patients in both groups were between 18 and 35 years. Among those aged 36 to 50 years, 24.1% were in the ESPB group, while 36.2% belonged to the TPVB group. Patients aged 51 to 60 years comprised 29.3% of the ESPB group and 17.2% of the TPVB group. The analysis of socioeconomic status showed that 43.1% of patients in the ESPB group and 39.7% in the TPVB group belonged to the low-income category. The middle-income group included 46.6% of ESPB patients and 39.7% of TPVB patients, while the high-income group accounted for 10.3% and 20.7% in the ESPB and TPVB groups, respectively. Education status revealed that 58.6% of patients in the ESPB group were literate compared to 44.8% in the TPVB group. Conversely, the proportion of illiterate patients was higher in the TPVB group (55.2%) than in the ESPB group (41.4%). Regarding employment, 43.1% of ESPB patients were employed, while 51.7% of TPVB patients had employment. Unemployment rates were 56.9% and 48.3% in the ESPB and TPVB groups, respectively. The distribution of residence indicated that 51.7% of ESPB patients resided in rural areas, whereas a significantly higher proportion of 74.1% of TPVB patients lived in rural settings. Urban residents comprised 48.3% of ESPB patients and 25.9% of TPVB patients.

Postoperative pain assessment at the 12th hour demonstrated a statistically significant difference between the two groups. The ESPB group had a mean pain score of 2.14 ± 1.02, while the TPVB group exhibited a lower mean score of 1.10 ± 0.89 ($p = 0.0001$). Stratified analysis of demographic factors, including age, BMI, and ASA classification, revealed statistically significant associations with postoperative VAS scores in both groups ($p < 0.05$). These results indicate that while both ESPB and TPVB are effective regional anesthesia techniques for postoperative pain control, TPVB provided superior pain relief in the immediate postoperative period.

Table 1: Descriptive statistics

Groups		Age (Years)	Height (Kg)	Weight (Kg)	BMI (Kg/m^2)
Group A (ESPB)	Mean	38.78	1.6810	70.55	24.98
	N	58	58	58	58
	Std. Deviation	14.18	.01851	3.130	1.30
Group B (TPVB)	Mean	37.81	1.6807	70.71	25.05
	N	58	58	58	58
	Std. Deviation	12.48	.01927	3.454	1.45

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Table 2: Demographics

Demographics		Groups			
		Group A (ESPB)		Group B (TPVB)	
		N	%	N	%
Age distribution (Years)	18 to 35	27	46.6%	27	46.6%
	36 to 50	14	24.1%	21	36.2%
	51 to 60	17	29.3%	10	17.2%
Socioeconomic status	Low	25	43.1%	23	39.7%
	Middle	27	46.6%	23	39.7%
	High	6	10.3%	12	20.7%
Education status	Literate	34	58.6%	26	44.8%
	Illiterate	24	41.4%	32	55.2%
Employment status	Employed	25	43.1%	30	51.7%
	Unemployed	33	56.9%	28	48.3%
Residence area	Rural	30	51.7%	43	74.1%
	Urban	28	48.3%	15	25.9%

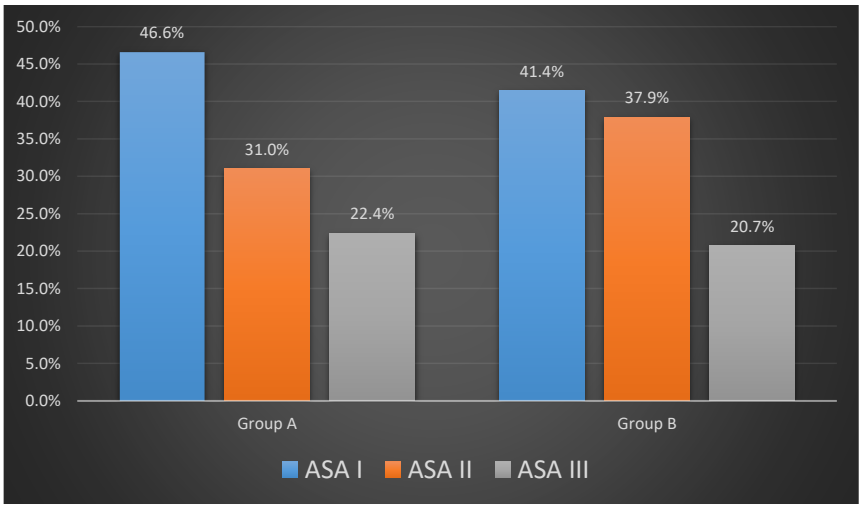

Figure: ASA class distribution

Table 3: Comparison of Postoperative pain score at 12th hour

Postoperative pain score at 12th hour	Groups	N	Mean	Std. Deviation	P value
	Group A (ESPB)	58	2.14	1.017	0.0001
	Group B (TPVB)	58	1.10	.892	

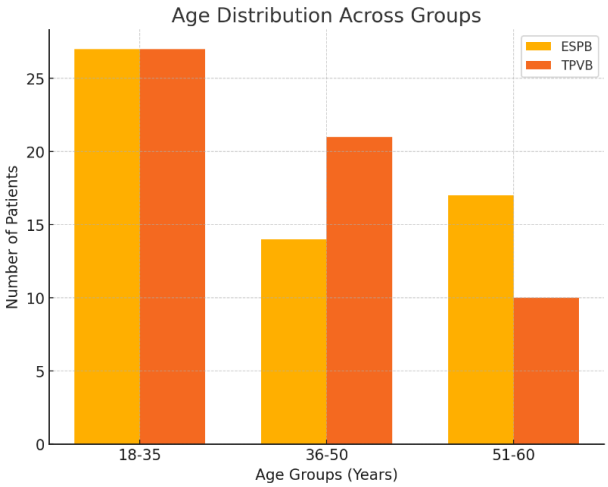

Figure 2 Age Distribution Across Group

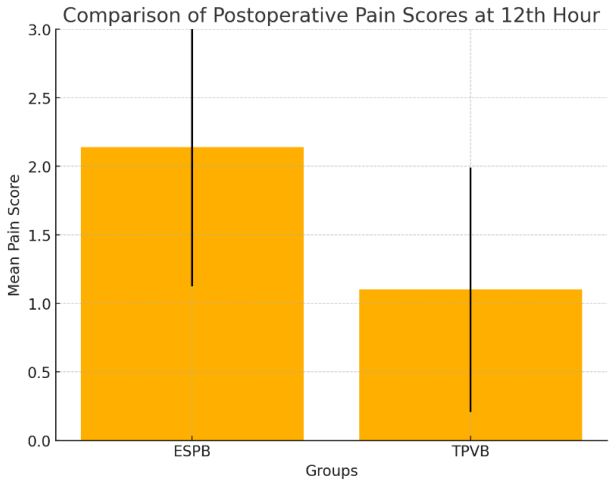

Figure 1 Comparison of Postoperative Pain Scores at 12th Hour

DISCUSSION

The findings of this study demonstrated that patients who received thoracic paravertebral block (TPVB) experienced significantly lower postoperative pain scores at the 12th hour compared to those who received an erector spinae plane block (ESPB), highlighting the superior analgesic effect of TPVB in the immediate postoperative period. These results align with previous studies, which have shown that TPVB provides enhanced pain relief, reduces opioid consumption, and prolongs the duration before additional analgesia is required. The effectiveness of TPVB in reducing postoperative pain can be attributed to its ability to provide a more targeted and extensive blockade of thoracic spinal nerves, which may result in superior sensory blockade compared to ESPB (17,18). Existing literature has consistently reported that TPVB reduces the need for postoperative opioid analgesia. Studies have indicated that patients undergoing ESPB often require higher doses of opioids for pain control compared to those receiving TPVB. Findings from randomized controlled trials have shown that morphine consumption in the first 24 hours postoperatively is significantly lower in the TPVB group, further supporting the superior analgesic properties of this technique. Additionally, the time to first analgesic request has been observed to be longer in patients who received TPVB, indicating prolonged pain relief in comparison to ESPB. These findings suggest that TPVB may contribute to better postoperative recovery by minimizing opioid-related adverse effects such as nausea, vomiting, and respiratory depression (19-21).

While some studies have reported comparable pain relief when ESPB and TPVB are administered continuously through catheter infusion, the current study focused on single-shot techniques, which revealed a clear advantage of TPVB in the early postoperative period. This distinction is critical in clinical settings where catheter-based techniques may not be feasible due to logistical or patient-related factors. The findings of this study reinforce the growing body of evidence supporting the use of TPVB as a preferred regional anesthesia technique for patients undergoing unilateral modified radical mastectomy (22-24). Despite the strengths of this study, certain limitations must be acknowledged. The study focused exclusively on single-shot techniques, which limits the ability to generalize findings to continuous infusion methods. Additionally, factors such as intraoperative opioid administration and variability in patient pain perception could have influenced postoperative pain scores. Future research should explore the long-term benefits of both techniques, particularly in the context of chronic post-mastectomy pain syndromes. Comparative analyses of additional parameters, such as hemodynamic stability, postoperative nausea and vomiting, and cost-effectiveness, could further enhance the understanding of these techniques in clinical practice (25,26).

The findings of this study provide valuable clinical insight into optimizing postoperative analgesia for breast cancer surgeries. By demonstrating that TPVB offers superior pain relief in the immediate postoperative period, these results contribute to evidence-based decision-making in anesthesia management. Further research exploring the combination of regional anesthesia techniques with multimodal analgesic strategies may provide additional improvements in postoperative pain management while minimizing opioid dependence (27,28).

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CONCLUSION

This study establishes that ultrasound-guided thoracic paravertebral block provides more effective postoperative pain relief than erector spinae plane block in patients undergoing unilateral modified radical mastectomy. The findings highlight its superior analgesic efficacy, making it a more suitable option for managing postoperative pain in breast cancer surgery. Given its ability to offer prolonged pain control, TPVB should be considered a preferred regional anesthesia technique to enhance patient recovery, reduce reliance on opioids, and improve overall postoperative outcomes.

AUTHOR CONTRIBUTIONS

Author	Contribution
Syeda Sadia Muaziz*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Muhammad Javed Khan	Critical Review Has given Final Approval of the version to be published
Neelam Noreen	Manuscript Review
Syed Hassan Iftikhar	Manuscript Review

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