Glob. J. Med. Pharm. Sci.
ISSN PRINT: 2957-3610, **ISSN ONLINE**: 2957-3629
Website: https://globapc.com/
Open Access Journal

Global
Journal of Medical and
Pharmaceutical Sciences

ORIGINAL ARTICLE **OPEN ACCESS**

Comparison of Ultrasound-Guided Erector Spinae Plane Block versus Thoracic Paravertebral Block for Postoperative Analgesia in Modified Radical Mastectomy: A Prospective Randomized Controlled Trial

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Received:12-05-2023
Accepted:15-06-2023
Available online:22-06-2023

ABS TRAC T

***Background*:** Modified radical mastectomy (MRM) is associated with significant postoperative pain. Thoracic paravertebral block (TPVB) has long been considered the gold-standard regional technique for breast surgery analgesia, but it carries risks including pneumothorax, vascular injury and sympathetic blockade. The ultrasound-guided erector spinae plane block (ESPB) is a novel, technically simpler fascial plane block that has emerged as a potentially safer alternative. The present study compared the analgesic efficacy and safety of ESPB versus TPVB after MRM. ***Methods*:** In this prospective, randomized, double-blind controlled trial, 80 adult women aged 30–65 years with ASA physical status I–II undergoing elective unilateral MRM were randomly allocated to two equal groups (n = 40 each). Group E received ultrasound-guided ESPB and Group P received ultrasound-guided TPVB at the T4 level, both with 20 mL of 0.375% ropivacaine. The primary outcome was 24-hour cumulative tramadol consumption. Secondary outcomes included Numerical Rating Scale (NRS) pain scores at rest and on movement, time to first rescue analgesia, block performance time, adverse events and patient satisfaction. ***Results*:** Twenty-four-hour tramadol consumption was comparable between groups (158.4 ± 31.6 mg in ESPB versus 145.2 ± 28.4 mg in TPVB; $p = 0.054$). NRS scores at rest and on movement were similar at all time points ($p > 0.05$). Time to first rescue analgesia was 382.5 ± 68.4 minutes in ESPB and 408.6 ± 72.3 minutes in TPVB ($p = 0.10$). Block performance was significantly faster in ESPB (7.6 ± 1.8 versus 11.9 ± 2.7 minutes; $p < 0.001$). Hypotension occurred in 1 patient in ESPB versus 6 in TPVB ($p = 0.04$). No patient developed pneumothorax or local anaesthetic systemic toxicity. ***Conclusion*:** Ultrasound-guided ESPB provided postoperative analgesia comparable to TPVB after MRM, with shorter performance time and fewer haemodynamic adverse events, supporting its use as a safer, practical alternative to TPVB for postoperative analgesia in this surgical population.

Keywords: *Erector Spinae Plane Block, Thoracic Paravertebral Block, Modified Radical Mastectomy, Postoperative Analgesia, Regional Anaesthesia.*

INTRODUCTION

Breast cancer remains the most commonly diagnosed malignancy in women globally, accounting for an estimated 2.3 million new cases and 685,000 deaths in 2020 [1]. In India, breast cancer has overtaken cervical cancer as the leading cause of cancer-related morbidity and mortality among women, with a steadily rising age-standardised incidence rate [2]. Modified radical mastectomy (MRM) continues to be the most frequently performed surgical procedure for locally advanced disease, particularly in resource-limited settings where breast-conserving therapy is not always feasible.

The acute postoperative pain following MRM is moderate to severe in intensity and arises from extensive tissue dissection involving the chest wall, axilla and pectoral musculature [3]. Inadequate perioperative pain control is associated with delayed mobilisation, prolonged hospitalisation, pulmonary complications, increased opioid consumption with attendant adverse effects, and the development of chronic post-mastectomy pain syndrome, which has been reported in 25–60% of patients within the first year of surgery [4]. Effective multimodal analgesia, with regional anaesthetic techniques as a central

component, has therefore become the cornerstone of perioperative care in breast oncology.

Thoracic paravertebral block (TPVB) was first described in the surgical management of breast cancer over two decades ago and is widely regarded as the regional anaesthetic technique of reference for unilateral breast surgery [5]. A systematic review and meta-analysis of randomised controlled trials demonstrated that paravertebral blockade reduces the incidence of postoperative nausea and vomiting, lowers opioid requirements and shortens hospital stay compared with general anaesthesia alone [6]. However, TPVB is technically demanding and is associated with a non-trivial risk of complications including pneumothorax, inadvertent intravascular injection, epidural spread, sympathetic blockade with hypotension, and accidental pleural puncture. The reported failure rate, even in experienced hands, ranges from 6.1% to 10%, and these limitations are amplified when the block is performed by trainees or in centres with low procedural volume.

In 2016, Forero and colleagues described the erector spinae plane block (ESPB) as a novel interfascial plane technique for the management of thoracic neuropathic pain [7]. The block is performed by injecting local anaesthetic in the plane deep to the erector spinae muscle and superficial to the transverse process of the thoracic vertebra, producing extensive cranio-caudal spread that is presumed to act on the dorsal and ventral rami of the spinal nerves and on the sympathetic chain [8]. Anatomical and magnetic resonance imaging studies have confirmed that the injectate spreads across multiple vertebral levels and reaches the paravertebral space, providing a plausible mechanism for somatic and visceral analgesia of the chest wall [9].

The ESPB has gained rapid acceptance among regional anaesthetists because of several advantages: the target plane lies superficial to the transverse process, providing a clear sonographic end-point; the block is performed at a safe distance from the pleura, neuraxis and major vessels; and the technical learning curve is shorter than that of TPVB. Preliminary randomised studies have reported that ESPB significantly reduces postoperative opioid consumption and pain scores after breast surgery when compared with placebo or systemic analgesia alone [10].

Despite the growing enthusiasm for ESPB, evidence directly comparing its analgesic efficacy with the reference standard TPVB after MRM remains limited and conflicting. Some investigations have reported equivalence in pain scores and opioid sparing between the two techniques, whereas others have suggested that TPVB confers a modest advantage with respect to opioid consumption in the first 24 postoperative hours. Robust randomised controlled data, particularly from Indian populations and tertiary care teaching institutions, are scarce. There is, therefore, a clear clinical rationale for a head-to-head comparison of ultrasound-guided ESPB and TPVB performed under standardised conditions, evaluating not only analgesic efficacy but also block performance time, haemodynamic stability and the incidence of procedure-related complications.

Against this background, the present prospective randomised controlled trial was designed to compare ultrasound-guided ESPB and TPVB for postoperative analgesia following MRM, with the hypothesis that ESPB would provide analgesia comparable to TPVB while offering a more favourable safety and procedural profile.

AIMS AND OBJECTIVES

The present study aimed to compare the analgesic efficacy and safety profile of ultrasound-guided erector spinae plane block with thoracic paravertebral block in patients undergoing modified radical mastectomy under general anaesthesia. The primary objective was to compare the cumulative tramadol consumption during the first 24 hours after surgery between the two groups. The secondary objectives were to compare postoperative pain scores at rest and on movement using the Numerical Rating Scale at predefined time intervals; to compare the time to first rescue analgesia; to compare the time required to perform the block and its time to onset; to evaluate intraoperative haemodynamic parameters; to record the incidence of block-related and opioid-related adverse events; and to compare patient-reported satisfaction with postoperative analgesia between the two study groups.

MATERIALS AND METHODS

Study Design and Setting

The present prospective, randomised, double-blind, parallel-group controlled trial was conducted in the Department of Anaesthesiology of a tertiary care teaching hospital attached to J.J.M. Medical College, Davangere, over a period of 12 months. Approval was obtained from the Institutional Ethics Committee, and the trial was registered prospectively with the Clinical Trials Registry of India before enrolment commenced. Written informed consent was obtained from every participant during the preoperative anaesthetic visit.

Sample Size Calculation

The sample size was calculated based on a previously published randomised controlled study which reported a mean 24-hour tramadol consumption of approximately 168 mg (SD 35) in patients receiving ESPB after breast surgery. Considering a clinically relevant mean difference of 25 mg between groups, with α set at 0.05 (two-sided) and power at 80%, the minimum required sample was 32 patients per group. To account for attrition and protocol violations, the

sample was inflated by approximately 25%, yielding a final enrolment target of 40 patients per group, for a total of 80 participants.

The formula used for sample size estimation was:

$$n = 2 \times [(Z\alpha/2 + Z\beta)^2 \times \sigma^2] / d^2$$

Where $Z\alpha/2 = 1.96$ (for $\alpha = 0.05$), $Z\beta = 0.84$ (for power = 80%), $\sigma = 35$ mg (standard deviation of tramadol consumption), and $d = 25$ mg (minimum clinically important difference).

Inclusion Criteria

Adult women aged 30 to 65 years, of American Society of Anesthesiologists (ASA) physical status I or II, with body mass index between 18 and 30 kg/m², scheduled for elective unilateral modified radical mastectomy with axillary lymph node dissection under general anaesthesia, and who provided written informed consent, were considered eligible for inclusion.

Exclusion Criteria

Patients were excluded if they had patient refusal, allergy to amide local anaesthetics, uncorrected coagulopathy or therapeutic anticoagulation, localised infection at the proposed block site, pre-existing chronic pain or chronic opioid use, significant cardiac, hepatic or renal dysfunction, spinal deformity, pregnancy or lactation, psychiatric illness or inability to comprehend the Numerical Rating Scale.

Randomisation and Blinding

A computer-generated random number sequence with a 1:1 allocation ratio was used. Allocation concealment was ensured by sequentially numbered, opaque, sealed envelopes prepared by an investigator not otherwise involved in the study. The block was performed by a single anaesthesiologist with previous experience of more than fifty blocks of each type. The patients, the surgical team, the anaesthesiologist managing intraoperative care and the outcome assessor recording postoperative data remained blinded to group allocation throughout the study period.

Preoperative Preparation

All patients underwent a standard preoperative evaluation including history, clinical examination and routine investigations. The Numerical Rating Scale (NRS), ranging from 0 (no pain) to 10 (worst imaginable pain), was explained to every patient on the evening before surgery. Patients fasted for eight hours and received tablet alprazolam 0.25 mg and tablet ranitidine 150 mg orally on the night before and the morning of surgery.

Block Procedure

On arrival in the operating theatre, standard ASA monitoring (electrocardiography, non-invasive blood pressure and pulse oximetry) was applied. An 18-gauge intravenous cannula was secured and Ringer's lactate infusion was commenced. Both blocks were performed in the sitting position with full asepsis using a high-frequency linear ultrasound probe (6–13 MHz) and a 22-gauge, 80 mm echogenic block needle.

In the ESPB group (Group E), the spinous process of the fourth thoracic vertebra (T4) was identified by counting from the C7 spinous process. The probe was placed in a parasagittal orientation 3 cm lateral to the midline at the T4 level, and the trapezius, rhomboid major and erector spinae muscles were identified overlying the hyperechoic shadow of the transverse process. The needle was advanced in-plane in a cranio-caudal direction until its tip lay deep to the erector spinae muscle and contacted the transverse process. After negative aspiration and confirmation of correct plane spread by hydrodissection with 1–2 mL of normal saline, 20 mL of 0.375% ropivacaine was injected.

In the TPVB group (Group P), the probe was placed in a transverse orientation lateral to the spinous process of T4 to identify the transverse processes, parietal pleura and superior costotransverse ligament forming the paravertebral space. The needle was advanced in-plane from lateral to medial until its tip pierced the superior costotransverse ligament and entered the paravertebral space, with downward displacement of the pleura on injection. After negative aspiration, 20 mL of 0.375% ropivacaine was deposited.

The time taken to perform the block, defined as the interval from skin contact of the probe to needle withdrawal, was recorded. Block onset was assessed at five-minute intervals by loss of cold sensation to ice at the dermatomes from T2 to T6. A block was considered successful if cold sensation was abolished in at least three contiguous dermatomes within 30 minutes.

Anaesthetic Management

Fifteen minutes after block performance, general anaesthesia was induced with intravenous fentanyl 2 µg/kg, propofol 2 mg/kg and vecuronium 0.1 mg/kg, and the trachea was intubated. Anaesthesia was maintained with isoflurane 1.0–1.2% in a 50:50 oxygen-air mixture, with controlled mechanical ventilation to maintain end-tidal carbon dioxide between 30 and 35 mm Hg. Intraoperative analgesia consisted of intravenous paracetamol 1 g infused over 15 minutes. An intraoperative increase in heart rate or mean arterial pressure of more than 20% from baseline was treated with intravenous fentanyl 0.5 µg/kg, and the cumulative dose was recorded. At the end of surgery, neuromuscular blockade was reversed with neostigmine 0.05 mg/kg and glycopyrrolate 0.01 mg/kg, and the trachea was extubated.

Postoperative Follow-Up

All patients were observed in the post-

anaesthesia care unit for two hours and subsequently on the surgical ward. Pain at rest and on ipsilateral arm abduction was assessed using the NRS at 0, 2, 4, 6, 12, 18 and 24 hours after extubation by an investigator blinded to group allocation. All patients received intravenous paracetamol 1 g eight-hourly as part of standard multimodal analgesia. Rescue analgesia with intravenous tramadol 1 mg/kg was administered when the NRS score was four or greater, and the time to first rescue dose and total tramadol consumption over 24 hours were recorded. Episodes of hypotension (defined as a fall in mean arterial pressure of more than 20% from baseline), bradycardia, nausea, vomiting, pruritus and any block-related complications including pneumothorax, local anaesthetic systemic toxicity and persistent paraesthesia were documented. Patient satisfaction with analgesia was rated on a four-point Likert scale (1 = poor, 2 = fair, 3 = good, 4 = excellent) at 24 hours.

Statistical Analysis

Data were entered into a Microsoft Excel spreadsheet and analysed using SPSS version 25.0 (IBM Corporation, Armonk, NY, USA). The Shapiro-Wilk test was used to check normality of continuous variables. Normally distributed continuous data were presented as mean ± standard deviation and compared between groups using the two-tailed independent samples Student's t-test; non-normally distributed data were summarised as median (interquartile range) and compared using the Mann-Whitney U test. Categorical variables were expressed as frequencies and percentages and compared using the Chi-square test or Fisher's exact test as appropriate. Repeated measurements of pain scores were analysed using repeated-measures analysis of variance. A two-tailed p-value less than 0.05 was considered statistically significant.

RESULTS

A total of 92 patients were assessed for eligibility, of whom 80 fulfilled the inclusion criteria and completed the study protocol. Forty patients were allocated to each group, and there were no dropouts or protocol violations during the follow-up period. The two groups were comparable with respect to age, body mass index, ASA physical status distribution, side of surgery, baseline haemodynamic parameters and duration of surgery, with no statistically significant differences (Table 1).

The block performance characteristics differed significantly between the two techniques. The mean time required to perform the block was substantially shorter in the ESPB group than in the TPVB group (7.6 ± 1.8 minutes versus 11.9 ± 2.7 minutes, $p < 0.001$). The time to onset of sensory blockade in at least three contiguous dermatomes was marginally longer for ESPB (15.8 ± 3.2 versus 13.4 ± 2.9 minutes, $p = 0.001$), although the proportion of successful blocks at 30 minutes was similar (95.0% versus 97.5%, $p = 0.56$). The number of needle passes required was greater in the TPVB group (median 2 versus 1, $p = 0.003$) (Table 2; Figure 4).

Regarding postoperative pain, the NRS scores at rest were comparable between the groups at every assessment point during the first 24 hours, with mean scores ranging between 1.0 and 2.4 in both groups ($p > 0.05$ at all time points). NRS scores during ipsilateral arm abduction were also statistically similar at 0, 2, 4, 6, 12, 18 and 24 hours ($p > 0.05$) (Tables 3 and 4; Figures 1 and 2).

The primary outcome, cumulative 24-hour tramadol consumption, did not differ significantly between the groups. Patients in the ESPB group required a mean of 158.4 ± 31.6 mg of tramadol, while those in the TPVB group required 145.2 ± 28.4 mg (mean difference 13.2 mg, 95% CI –0.2 to 26.6, $p = 0.054$). The mean time to first rescue analgesia was 382.5 ± 68.4 minutes in the ESPB group and 408.6 ± 72.3 minutes in the TPVB group ($p = 0.10$) (Table 5; Figure 3). The intraoperative fentanyl requirement was similar between groups (142.6 ± 28.4 µg in ESPB versus 132.8 ± 26.7 µg in TPVB, $p = 0.12$).

The two techniques differed in the incidence of haemodynamic adverse events. Hypotension was recorded in 1 of 40 (2.5%) patients in the ESPB group and 6 of 40 (15.0%) patients in the TPVB group ($p = 0.04$). Bradycardia occurred in two patients in the TPVB group and none in the ESPB group ($p = 0.49$). No patient developed pneumothorax, local anaesthetic systemic toxicity or persistent paraesthesia. The frequency of postoperative nausea and vomiting was numerically lower in the ESPB group (10.0% versus 22.5%, $p = 0.13$) but did not reach statistical significance. Patient satisfaction scores rated as 'good' or 'excellent' were 90.0% in the ESPB group and 92.5% in the TPVB group ($p = 0.69$) (Table 6).

Table 1: Demographic and baseline clinical characteristics of the study groups

Variable	ESPB Group (n=40)	TPVB Group (n=40)	p-value
Age (years), mean ± SD	48.6 ± 8.4	50.2 ± 9.1	0.42
BMI (kg/m²), mean ± SD	24.8 ± 2.6	25.3 ± 2.9	0.42
ASA I, n (%)	22 (55.0)	19 (47.5)	0.50
ASA II, n (%)	18 (45.0)	21 (52.5)	—
Side of surgery (right), n (%)	23 (57.5)	21 (52.5)	0.65
Baseline heart rate (bpm), mean ± SD	78.4 ± 9.2	80.1 ± 8.7	0.40

Baseline MAP (mm Hg), mean ± SD	92.6 ± 8.1	94.2 ± 7.8	0.37
Duration of surgery (min), mean ± SD	138.4 ± 22.6	142.8 ± 24.1	0.40

ASA, American Society of Anesthesiologists; BMI, body mass index; MAP, mean arterial pressure; SD, standard deviation. p < 0.05 considered significant.

Table 2: Block performance characteristics in the two study groups

Parameter	ESPB Group (n=40)	TPVB Group (n=40)	p-value
Block performance time (min), mean ± SD	7.6 ± 1.8	11.9 ± 2.7	<0.001*
Time to sensory onset (min), mean ± SD	15.8 ± 3.2	13.4 ± 2.9	0.001*
Number of needle passes, median (IQR)	1 (1–2)	2 (1–3)	0.003*
Successful block at 30 min, n (%)	38 (95.0)	39 (97.5)	0.56
Dermatomal spread (levels), median (IQR)	4 (3–5)	4 (3–5)	0.78

*IQR, interquartile range; SD, standard deviation. *Statistically significant (p < 0.05).*

Table 3: Postoperative Numerical Rating Scale (NRS) pain scores at rest

Time point (h)	ESPB Group, mean ± SD	TPVB Group, mean ± SD	p-value
0	1.2 ± 0.8	1.0 ± 0.7	0.24
2	1.6 ± 0.9	1.4 ± 0.8	0.30
4	1.8 ± 0.9	1.7 ± 0.9	0.62
6	2.2 ± 1.0	2.0 ± 0.9	0.35
12	2.4 ± 1.1	2.2 ± 1.0	0.40
18	2.3 ± 1.0	2.1 ± 0.9	0.34
24	2.0 ± 0.9	1.9 ± 0.8	0.60

NRS, Numerical Rating Scale (0 = no pain, 10 = worst imaginable pain); SD, standard deviation.

Table 4: Postoperative Numerical Rating Scale (NRS) pain scores during ipsilateral arm abduction

Time point (h)	ESPB Group, mean ± SD	TPVB Group, mean ± SD	p-value
0	1.6 ± 0.9	1.4 ± 0.8	0.30
2	2.4 ± 1.0	2.2 ± 0.9	0.34
4	2.8 ± 1.1	2.6 ± 1.0	0.40
6	3.2 ± 1.2	3.0 ± 1.1	0.44
12	3.4 ± 1.2	3.2 ± 1.1	0.44
18	3.2 ± 1.1	3.1 ± 1.0	0.67
24	2.9 ± 1.0	2.8 ± 0.9	0.65

NRS, Numerical Rating Scale; SD, standard deviation

Table 5: Rescue analgesia requirement and 24-hour opioid consumption

Variable	ESPB Group (n=40)	TPVB Group (n=40)	p-value
Patients requiring rescue analgesia, n (%)	36 (90.0)	32 (80.0)	0.21
Time to first rescue (min), mean ± SD	382.5 ± 68.4	408.6 ± 72.3	0.10
Number of rescue doses, median (IQR)	2 (1–3)	2 (1–2)	0.18
24-h tramadol consumption (mg), mean ± SD	158.4 ± 31.6	145.2 ± 28.4	0.054
Intraoperative fentanyl (µg), mean ± SD	142.6 ± 28.4	132.8 ± 26.7	0.12

IQR, interquartile range; SD, standard deviation.

Table 6: Adverse events and patient satisfaction in the two study groups

Variable	ESPB Group (n=40)	TPVB Group (n=40)	p-value
Hypotension, n (%)	1 (2.5)	6 (15.0)	0.04*
Bradycardia, n (%)	0 (0.0)	2 (5.0)	0.49
Nausea / vomiting, n (%)	4 (10.0)	9 (22.5)	0.13
Pruritus, n (%)	1 (2.5)	2 (5.0)	1.00
Pneumothorax, n (%)	0 (0.0)	0 (0.0)	—
Local anaesthetic toxicity, n (%)	0 (0.0)	0 (0.0)	—
Satisfaction (good/excellent), n (%)	36 (90.0)	37 (92.5)	0.69

**Statistically significant (p < 0.05).*

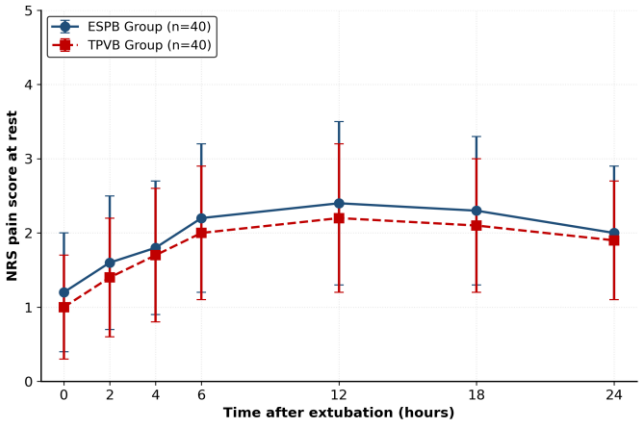

Figure 1: Postoperative Numerical Rating Scale (NRS) pain scores at rest over 24 hours. Values are presented as mean ± standard deviation. No statistically significant difference was observed between the ESPB and TPVB groups at any time point (p > 0.05)

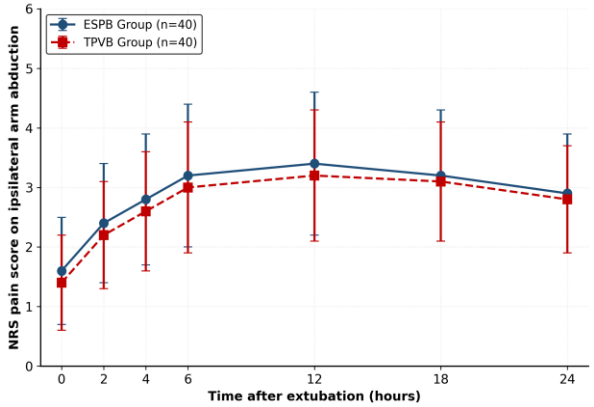

Figure 2: Postoperative Numerical Rating Scale (NRS) pain scores on ipsilateral arm abduction over 24 hours. Values are presented as mean ± standard deviation. Pain scores were comparable between the two groups at all time points (p > 0.05)

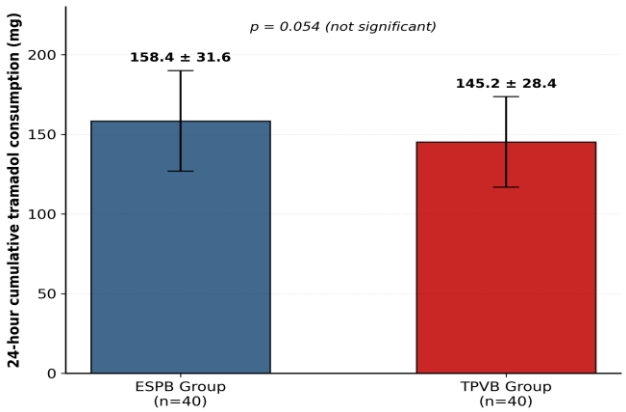

Figure 3: Cumulative 24-hour tramadol consumption in the two study groups. Bars represent mean ± standard deviation. The difference between the groups approached but did not achieve statistical significance (p = 0.054)

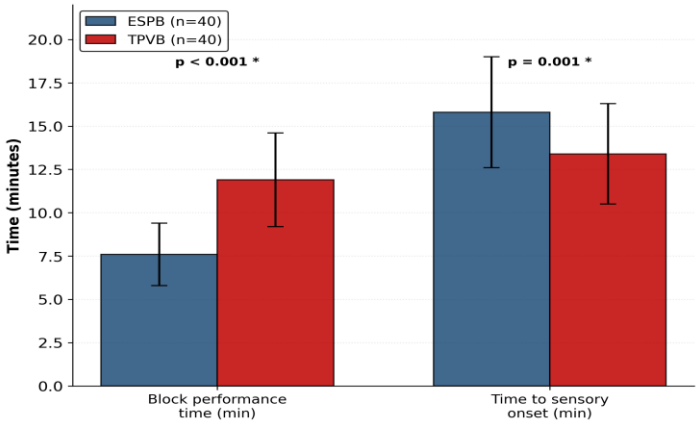

Figure 4: Block performance characteristics. Block performance time was significantly shorter in the ESPB group, while time to sensory onset was modestly shorter in the TPVB group. *Statistically significant (p < 0.05)

DISCUSSION

The present prospective randomised controlled trial demonstrated that ultrasound-guided ESPB provided postoperative analgesia comparable to TPVB after modified radical mastectomy, with no statistically significant differences in 24-hour tramadol consumption, NRS pain scores at rest or on movement, or time to first rescue analgesia. ESPB additionally offered a shorter block performance time and a significantly lower incidence of hypotension, supporting its role as a safer and more practical alternative to the established reference technique.

These findings are concordant with the seminal randomised clinical trial by Swisher and colleagues, who compared single-injection ESPB with TPVB in 100 patients undergoing breast surgery and reported equivalent opioid consumption and pain scores in the first 24 postoperative hours [11]. Likewise, Gürkan and co-workers, in a three-arm trial comparing ESPB, TPVB and intravenous morphine following breast surgery, found that the two regional techniques were similar in opioid-sparing effect and clearly superior to systemic analgesia alone [12]. The trend towards a slightly higher opioid requirement in the ESPB group observed in the present study, although not statistically significant, mirrors the directionality reported in these earlier investigations.

Several other comparative studies have evaluated ESPB against alternative regional techniques in breast surgery. Altıparmak *et al*., compared modified pectoral nerve block with ESPB in radical mastectomy and noted comparable analgesic efficacy with both techniques [13]. Sinha *et al*., in an Indian randomised trial comparing pectoral nerve blocks with ESPB, similarly reported equivalent analgesia between the two approaches [14]. Singh and Kumar, also in an Indian setting, demonstrated that ESPB significantly reduced postoperative opioid consumption and prolonged the

time to first rescue analgesia compared with systemic analgesia after MRM [15]. The cumulative weight of this evidence supports the clinical utility of ESPB as part of a multimodal analgesic regimen in breast surgery.

In contrast, a small minority of studies has reported a modest advantage for TPVB. Karmakar's foundational work on the anatomy and physiology of TPVB described the unilateral somatic and sympathetic blockade achieved by direct deposition of local anaesthetic in the paravertebral space, which has been postulated to confer slightly more reliable dermatomal coverage [16]. This may explain the trend towards lower opioid consumption in the TPVB group in the present cohort. Hetta and Rezk, in a randomised trial comparing pectoralis-serratus interfascial plane block with TPVB for unilateral radical mastectomy, observed that TPVB delayed the need for rescue analgesia, although both techniques were considered acceptable [17]. Naja *et al*., similarly demonstrated that nerve-stimulator-guided paravertebral block reduced opioid requirement and improved postoperative analgesia compared with general anaesthesia alone in breast surgery [18].

The shorter procedural time for ESPB in this trial, averaging less than eight minutes compared with nearly twelve minutes for TPVB, is consistent with prior reports and reflects the relatively superficial and easily identifiable sonographic landmarks of the erector spinae plane. Cadaveric and magnetic resonance imaging investigations by Adhikary, Ivanusic and others have shown that local anaesthetic deposited deep to the erector spinae muscle reaches the paravertebral and epidural spaces through diffusion across the costotransverse foramina, providing an anatomical basis for the analgesia observed clinically [19]. The lower incidence of hypotension and the absence of pneumothorax in the ESPB group in the present study reflect the avoidance of pleural and sympathetic chain proximity inherent to the TPVB technique.

The strengths of the present trial include its randomised double-blind design, standardised perioperative protocol, identical local anaesthetic dose and volume in both groups, and prospective registration. Several limitations should, however, be acknowledged. The single-centre nature of the study and the relatively modest sample size limit external generalisability. The follow-up was restricted to 24 hours, precluding inferences about chronic post-mastectomy pain, which is an outcome of substantial clinical relevance. The blocks were performed by a highly experienced anaesthesiologist, which may not reflect performance characteristics in the hands of less experienced operators. Finally, the study was not powered to detect rare complications such as pneumothorax, and a much larger sample would be required to draw definitive conclusions about safety.

CONCLUSION

In adult women undergoing elective modified radical mastectomy, ultrasound-guided erector spinae plane block provided postoperative analgesia of efficacy comparable to that of thoracic paravertebral block, with similar 24-hour opioid consumption, pain scores and time to first rescue analgesia. ESPB was associated with a significantly shorter block performance time, a lower incidence of hypotension and a comparable safety profile overall. These findings support the use of ESPB as a practical, effective and safer alternative to TPVB for postoperative analgesia after modified radical mastectomy, particularly in settings where rapid block performance and avoidance of pleural and neuraxial proximity are desirable. Further multicentre trials with longer follow-up are warranted to evaluate the impact of ESPB on the development of chronic post-mastectomy pain.

REFERENCES

1. Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, Bray F. Global cancer statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA: a cancer journal for clinicians. 2021 May;71(3):209-49.
2. Mathur P, Sathishkumar K, Chaturvedi M, Das P, Sudarshan KL, Santhappan S, Nallasamy V, John A, Narasimhan S, Roselind FS, Icmr-Ncdir-Ncrp Investigator Group. Cancer statistics, 2020: report from national cancer registry programme, India. JCO global oncology. 2020 Jul;6:1063-75.
3. Tasmuth T, von Smitten K, Hietanen P, Kataja M, Kalso E. Pain and other symptoms after different treatment modalities of breast cancer. Ann Oncol. 1995;6(5):453–9.
4. Wang L, Guyatt GH, Kennedy SA, Romerosa B, Kwon HY, Kaushal A, Chang Y, Craigie S, de Almeida CP, Couban RJ, Parascandalo SR. Predictors of persistent pain after breast cancer surgery: a systematic review and meta-analysis of observational studies. Cmaj. 2016 Oct 4;188(14):E352-61.
5. Coveney E, Weltz CR, Greengrass R, Iglehart JD, Leight GS, Steele SM, Lyerly HK. Use of paravertebral block anesthesia in the surgical management of breast cancer: experience in 156 cases. Annals of surgery. 1998 Apr 1;227(4):496-501.
6. 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):842–52.
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):621–7.
8. Chin KJ, Adhikary S, Sarwani N, Forero M. The analgesic efficacy of pre-operative bilateral erector

spinae plane (ESP) blocks in patients having ventral hernia repair. Anaesthesia. 2017;72(4):452–60.
9. Adhikary SD, Bernard S, Lopez H, Chin KJ. Erector spinae plane block versus retrolaminar block: a magnetic resonance imaging and anatomical study. Reg Anesth Pain Med. 2018;43(7):756–62.
10. Gürkan Y, Aksu C, Kuş A, Yörükoğlu UH, Kılıç CT. Ultrasound guided erector spinae plane block reduces postoperative opioid consumption following breast surgery: a randomized controlled study. J Clin Anesth. 2018;50:65–8.
11. Swisher MW, Wallace AM, Sztain JF, Said ET, Khatibi B, Abanobi M, Finneran IV JJ, Gabriel RA, Abramson W, Blair SL, Hosseini A. Erector spinae plane versus paravertebral nerve blocks for postoperative analgesia after breast surgery: a randomized clinical trial. Regional Anesthesia & Pain Medicine. 2020 Apr 1;45(4):260-6.
12. Gürkan Y, Aksu C, Kuş A, Yörükoğlu UH. Erector spinae plane block and thoracic paravertebral block for breast surgery compared to IV-morphine: a randomized controlled trial. J Clin Anesth. 2020;59:84–8.
13. Altıparmak B, Korkmaz Toker M, Uysal Aİ, Turan M, Gümüş 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: a randomized controlled study. J Clin Anesth. 2019;54:61–5.
14. Sinha C, Kumar A, Kumar A, Prasad C, Sharma S, Pal R. Pectoral nerve versus erector spinae block for breast surgeries: a randomised controlled trial. Indian J Anaesth. 2019;63(8):617–22.
15. Singh S, Kumar G. Ultrasound-guided erector spinae plane block for postoperative analgesia in modified radical mastectomy: a randomised control study. Indian J Anaesth. 2019;63(3):200–4.
16. Karmakar MK. Thoracic paravertebral block. Anesthesiology. 2001;95(3):771–80.
17. Hetta DF, Rezk KM. Pectoralis-serratus interfascial plane block vs thoracic paravertebral block for unilateral radical mastectomy with axillary evacuation. J Clin Anesth. 2016;34:91–7.
18. Naja MZ, Ziade MF, Lönnqvist PA. Nerve-stimulator guided paravertebral blockade vs. general anaesthesia for breast surgery: a prospective randomized trial. Eur J Anaesthesiol. 2003;20(11):897–903.
19. Ivanusic J, Konishi Y, Barrington MJ. A cadaveric study investigating the mechanism of action of erector spinae blockade. Reg Anesth Pain Med. 2018;43(6):567–71.