Original Article

Comparison of fascial plane blocks (ESPB vs. TPVB) for pain relief following modified radical mastectomy

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Abstract

Background and Aims: The erector spinae plane block (ESPB) is a novel regional anesthesia technique compared to the thoracic paravertebral block (TPVB) in providing postoperative pain relief in breast surgeries. Modified radical mastectomy (MRM) is a commonly performed surgery for breast cancer. The objective of the study is to compare the efficacy of ESPB and TPVB in providing postoperative pain relief after MRM.

Material and Methods: This is a prospective randomized study conducted in a tertiary care teaching hospital. Sixty ASA I–III adult patients (age >18 years) scheduled to undergo elective unilateral MRM for breast cancer were enrolled in the study. Ultrasound-guided ESPB or TPVB with 0.25% bupivacaine was performed preoperatively on the patients randomized into two groups, namely, the ESPB and TPVB groups. All patients received patient-controlled analgesia for postoperative pain relief. Morphine consumption and Visual Analog Score (VAS) for pain were recorded at 3, 6, 12, and 24 h postoperatively.

Results: Primarily, the mean postoperative VAS scores between the two groups at 3, 6, 12, and 24 h showed no statistical significance and were comparable when matched at different time points. However, 24-h morphine consumption was significantly more in the ESPB group ($P = 0.035$). Duration of block performance also showed a significant difference, with ESPB taking less time to perform ($P < 0.001$). The mean age and body mass index (BMI) of patients and length of hospital stay in both the groups were similar.

Conclusions: Both ESPB and TPVB provided adequate analgesia in patients undergoing MRM; however, TPVB had better efficacy and opioid-sparing effect when compared to ESPB.

Keywords: Breast cancer, erector spinae plane block, modified radical mastectomy, morphine, paravertebral block, ultrasound

Introduction

One of the most prevalent cancers in women is breast cancer. The age-adjusted rate in Indian females is 25.8 per 100,000 women, and mortality is 12.7 per 100,000 women.[1] One of the main surgical methods for treating breast cancer is resection of the primary tumor and dissection of the axillary lymph nodes, which are typically done under general anesthesia supplemented with regional blocks.[2] One of the main factors contributing to the development of chronic postoperative pain is pain in the immediate postoperative period, which is severe[3] and causes delayed discharge from the post-anesthesia care unit (PACU), affects immunological and pulmonary function, and lengthens hospital stays, which, in turn, deteriorate the quality of life.[4] Therefore, strategies to alleviate this acute postoperative pain with multimodal analgesia and regional anesthetic techniques have been increasingly investigated.

Regional anesthesia constitutes many benefits including high-quality analgesia, reduction in postoperative opioid

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requirements, reduced frequency of postoperative nausea and vomiting, shorter hospital length of stay (LOS), and enhanced recovery after surgery.[5] Moreover, the use of ultrasound (USG) as a guide to regional anesthesia has enabled the development of alternatives like fascial or myofascial block to commonly utilized regional blocks.

Thoracic paravertebral block (TPVB) blocks the unilateral somatic and sympathetic nerves[5] and provides patients undergoing major breast surgery with sufficient preoperative and postoperative analgesia.[6] However, TPVB has complications like inadvertent injection or spreading into the epidural space, pneumothorax, vascular puncture, hypotension, and transient Horner's syndrome.[6]

As a safer alternative to TPVB, the erector spinae plane block (ESPB) can be used to treat thoracic neuropathic pain.[7] In ESPB, the local anesthetic (LA) is injected into the fascia between the erector spinae muscle and the vertebral transverse process, with spread to multiple paravertebral spaces,[8] causing a significant sensory block over the thoracic region. ESPB has been demonstrated to act upon both the dorsal and ventral rami, resulting in simultaneous blockage of somatic and visceral pain.[8-10]

As an alternative to traditional forms of analgesia in breast procedures, we wanted to evaluate the effectiveness of fascial plane blocks. The primary objective is to compare the analgesia provided by ESPB and TPVB in modified radical mastectomy (MRM) patients. The secondary objective is to compare the total morphine consumption in the first 24 h.

Material and Methods

The study is a single-center, single-blinded, prospective study. It was approved by the institutional ethical committee (IEC No 160/2020) and registered at Clinical Trials Registry-India (CTRI/2022/01/039394, www.ctri.nic.in, registered 01-13-2022). All the patients who gave informed consent were enrolled (from 01-20-2022 to 08-01-2022) in the study. Adult female patients (older than 18 years) diagnosed with breast cancer ($T_{1-4}N_{0-1}M_0$) with or without post-neoadjuvant chemotherapy and scheduled for an elective unilateral MRM were screened before surgery for enrolment. All patients undergoing bilateral MRM or other reconstructive procedures, those with psychiatric illness, patients not consenting to regional anesthesia, those with previously known allergy to the LA drug, and those with local or systemic infection were excluded from the study.

All participants were randomly allocated to the ESPB and TPVB groups using a computer-generated simple randomization technique [Figure 1]. One anesthetist performed the block and conducted the surgery, while another anesthesiologist blinded to the patients' assignment to the groups did data collection. Standard monitoring (electrocardiogram, non-invasive blood pressure, pulse oximetry, temperature) was attached before induction of anesthesia, and additionally, bispectral index (BIS) monitoring was also used. The technique of balanced general anesthesia for all the patients and similar surgical techniques were employed. Patients were induced using propofol (1–2 mg/kg) and fentanyl (1.5–2.0 μg/kg). Intravenous (IV) atracurium 0.5 mg/kg was administered to facilitate supraglottic airway device (i-gel®; Intersurgical Ltd, Wokingham, UK) insertion. Sevoflurane was used to maintain the anesthesia and was titrated to a BIS value of 40–60. All patients received an injection of 1 g paracetamol IV after the procedure. All blocks were performed 15 min before induction of general anesthesia under USG guidance. A high-frequency transducer probe (13-6 MHz) was connected to the USG machine (SonoSite M-Turbo®; FUJIFILM SonoSite Inc, Bothell, WA, USA) and was placed ipsilateral to the surgical site in the sagittal plane, paramedian to the spinous process, and B-Braun Stimuplex® Ultra 360® (0.9 × 100 mm) was used for block performance. The duration of the procedure was noted. The total duration of the procedure was recorded from the start of the USG scan to deposition of the total volume of the drug in the desired plane. Postoperatively, for emergency opioid analgesia, patient-controlled analgesia (PCA) pump was given to each patient, which consisted of morphine set to deliver a 1 mg bolus dose with a 05-min lockout interval and a maximum of 04 doses per hour.

In the ESPB group, the high-frequency linear probe placed in the paramedian sagittal plane was used to identify erector spinae muscle and the transverse process of the fifth thoracic (T5)

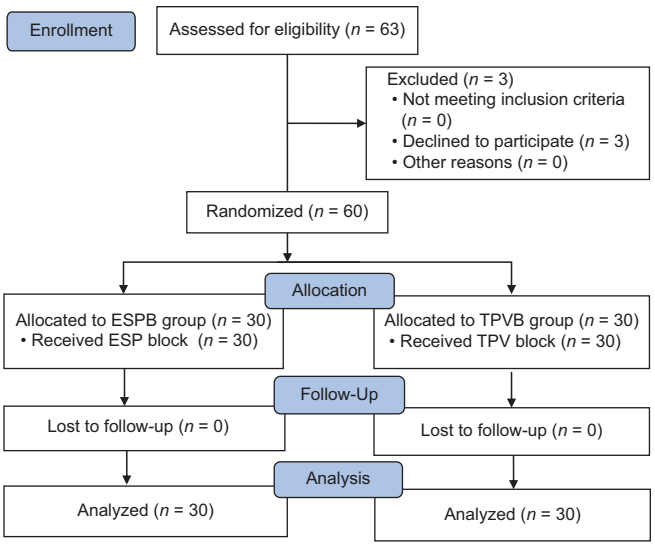

Figure 1: Consort diagram

vertebra. Deep into the muscle, 2–3 ml of 2% lignocaine was injected. The needle was then directed in the caudal direction toward the transverse process of the T5 vertebra. Hydro-dissection with 0.5–1 ml of 2% lignocaine was done to confirm the needle tip position. Following confirmation of the needle tip, a block was performed using 20 ml of 0.25% bupivacaine. The LA was observed to be distributed both caudally and cranially [Figure 2].

In the TPVB group, the probe placed in the sagittal plane, paramedian to the T5 vertebra, was moved laterally to obtain appropriate visualization. Following the identification of the transverse process underlying the pleura, and the wedge-shaped paravertebral space, the needle was inserted in a cranial to caudal direction using an in-plane approach. After corroborating the displacement of pleura using 1 ml of LA, the block was performed by injecting 20 ml of 0.25% bupivacaine. The goal of the procedure was depression of the pleura [Figure 3].

Demographic and anthropometric data of the participants were collected. At 3, 6, 12, and 24 h after surgery, the Visual Analog Score (VAS) was used to measure pain (primary outcome). The total requirement of morphine during the 24-h postoperative period, length of hospital stay, and total time to perform the procedure were also recorded (secondary outcomes).

The sample size was calculated using G*power: Statistical Power Analyses Software.[11] The statistical test "Means: Difference between two independent means (Two Groups)" and the type of power analysis "A priori" are the parameters for G*power calculations. Power (1- β), significance level (α), and effect size are all independent variables. Input parameters consisting of an effect size of 0.78, α error probability of 0.05, power (1- β error probability) of 0.8 (1- type 2 error), and an allocation ratio of 1 were used for sample size calculation. The total sample size obtained was 54 (27 per group) with an actual power of 0.8. The sample size was then rounded off to 60 (30 per group), taking a 10% attrition rate. The null hypothesis was that there is no significant difference in the postoperative VAS score. Tests for significant differences between groups were done with the Chi-square test for categorical data, Mann–Whitney U test for continuous numerical data that were not normally distributed, and the Student's *t*-test for normally distributed categorical data. The statistical analysis was performed using "Stat" packages in R. Two-way repeated measures analysis of variance (ANOVA) was used for the analysis of dependent variables over two or more time points.

Results

A total of 64 patients were enrolled in the study, of whom three patients opted out and were excluded. Regional anesthesia was administered to 60 patients, 30 patients each in the ESPB group and TPVB group.

The mean age, body mass index (BMI), and the American Society of Anesthesiologists (ASA) physical status of patients in both groups were comparable. The ESPB group patients consumed considerably more morphine after surgery when compared to the TPVB group patients ($P = 0.035$). Also, there was a significant benefit in terms of duration to perform the block, with ESPB taking less time as against TPVB ($P < 0.001$). The mean postoperative VAS scores calculated for 3, 6, 12, and 24 h showed comparable results with no statistical significance. The results of the two-way repeated measures ANOVA revealed that there was no conspicuous interaction between group and time ($F (2.1, 61.7) = 0.81$, $P < 0.03$, $\eta p^2 = 0.46$), such that between the two groups, participants' VAS scores

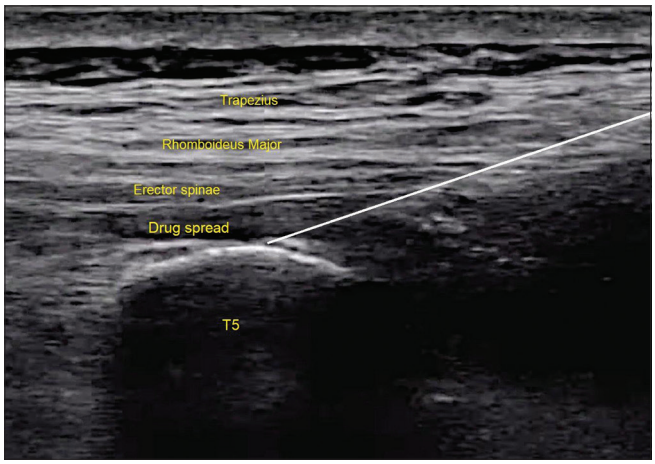

Figure 2: Ultrasound image of erector spinae plane block (ESPB)

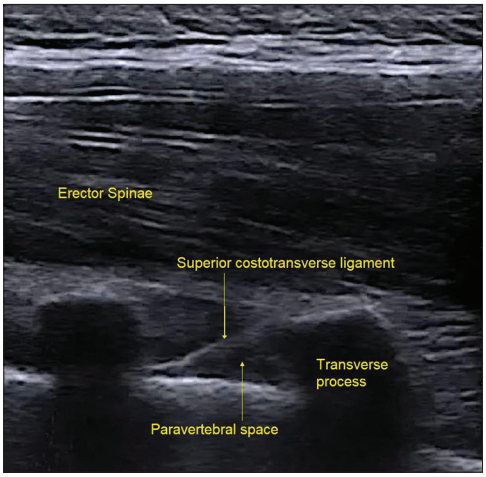

Figure 3: Ultrasound image of paravertebral space

were comparable when matched at different time points. The mean duration of surgery and LOS were also similar in both the groups [Table 1 and Figure 4]. There were no procedure-related complications that occurred during the performance of the blocks.

Discussion

Patients undergoing breast surgery are greatly distressed by the postoperative pain that results from their surgery for breast cancer, and this has been shown to deteriorate their quality of life.[12,13] Regional anesthesia has revolutionized the field of pain management, resulting in reduced use of drugs like opioids. Consequently, their adverse effects like postoperative nausea vomiting, pulmonary complications, and requirement for PACU stay have also decreased. In addition, the use of regional anesthesia potentially attenuates the neuroendocrine response and decelerates disease progression.[14] The popularization of USG-guided nerve blocks improved the efficacy safety and ease of performing blocks. TPVB, thoracic epidural anesthesia, USG-guided fascial plane blocks such as serratus plane blocks, pectoral nerve blocks, and ESPB are used as effective analgesic techniques for various thoracic surgeries. ESPB currently has its application in breast surgery, rib fracture, lumbosacral spine surgery, surgeries of the abdomen, refractory thoracic neuropathic pain, and chronic shoulder pain. ESPB aims to avoid the pleura and neuraxial structures, thus making it a less-invasive, less-demanding, and safer alternative. We, therefore, performed the study to compare it with the more conventional TPVB.

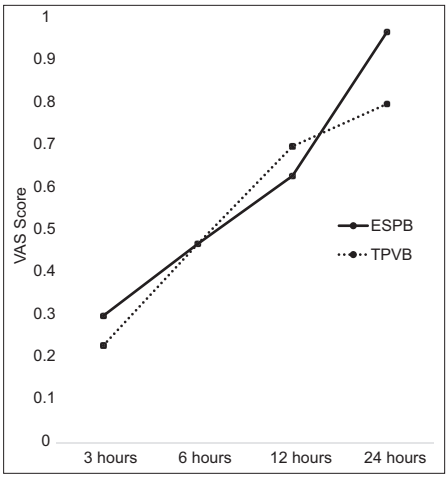

Figure 4: Postoperative Visual Analog Score (VAS). ESPB = erector spinae plane block, TPVB = thoracic paravertebral block, Mann–Whitney U test*

Moustafa *et al.*,[15] in their study, compared the success rates of USG-guided ESPB versus TPVB among anesthesia residents in MRM. A 100% success rate was observed in the ESPB group as opposed to 77.8% in the TPVB group. Also, the ESPB group required much less time to complete the block, suggesting that ESPB is an easier block to perform when compared to TPVB. Moreover, USG guidance improves the accuracy and reduces the rate of complications. Testimony to this is the fact that there were no negative incidents while the blocks were being performed.

Gürkan *et al.*,[16] in a double-blinded, prospective, randomized controlled study, found no difference in the postoperative analgesic effects (24-h morphine consumption) of ESPB and TPVB with a control group in breast surgeries. Numeric Rating Scale (NRS) ratings showed a statistically significant difference between TPVB and the control groups postoperatively. However, neither ESPB and control nor ESPB and TPVB showed a discernible difference. However, in our investigation, there was a significant difference in the total amount of morphine consumed at 24 h, with larger consumption noted in the ESPB group.

Table 1: Comparison between two groups

Parameter	ESPB (n=30)	TPVB (n=30)	t/Chi-square*	P
Age (years)	49.93±13.45	52.94±13.45	1.69	0.12
BMI (kg/m^2)	26.89±3.80	26.01±2.82	1.69	0.13
ASA				
I	13	10	0.77*	0.68
II	12	13		
III	5	7		
Duration of surgery (h)	146.5±22.17	149.33±24.98	1.69	0.32
24-h morphine consumption (mg)	6.30±2.53	5.13±3.63	1.69	0.035
Length of stay in hospital (days)	1.1±0.37	1.1±0.30	1.69	0.16
Duration of block performance (s)	256.47±40.95	382.7±48.13	1.69	<0.001
Postoperative VAS score			z	
3 h	0.3±0.65	0.23±0.62	0.62	0.54
6 h	0.47±0.50	0.47±0.57	0.14	0.89
12 h	0.63±0.56	0.7±0.59	0.4	0.69
24 h	0.97±0.61	0.8±0.61	1.05	0.29

*BMI=Body mass index, ESPB=Erector spinae plane block, TPVB=Thoracic paravertebral block, VAS=Visual Analog Score. *Chi square test*

In both trials comparing ESPB and TPVB, there were no significant variations in the pain scores at all time intervals. In non-mastectomy breast surgery, pain scores, opioid consumption, and median morphine equivalents were shown to be more in subjects who received ESPB in contrast to those who received TPVB.[4] Swisher *et al*. concluded that TPVB conferred better analgesia and reduced the requirement of opioids following non-mastectomy breast surgery. This study was the first published report stating that TPVB was superior when compared to ESPB in terms of intraoperative and postoperative morphine requirements and pain scores after non-mastectomy breast surgery. However, this study excluded mastectomies including non-cancer reconstructive procedures and used a higher concentration (0.5% ropivacaine) of LA. Further, they gave two injections at T2 and T4 levels for TPVB and a single injection at T3 or T4 in ESPB, depending on whether axillary dissection was done or not. In our study, with the use of the equivalent concentration and volume of LA in patients with comparable anthropometric profiles, postoperative morphine consumption was found to be more in the ESPB group when compared to the TPVB group. We propose that potential explanations for greater morphine consumption in the ESPB group include the absence of LA expansion to the paravertebral area, sparing of the ventral rami, and the formation of dorsal rami in ESPB.[17] However, the VAS scores were monitored at fixed intervals and LOS were comparable in both the groups. The fact that a patient's perception of a substantial change in pain may rely on the baseline degree of pain may help to explain the similar VAS scores in both the groups.[18] In patients with mild baseline pain, both effective and less-effective methods will relieve pain and appear to be equally effective. Also, patients tend to overrate their pain levels when previous pain scores were not shown to them.[18]

Pneumothorax, hypotension, bradycardia, epidural or intrathecal spread, vascular puncture, nerve damage, and Horner's syndrome are known complications of TPVB. However, with the use of USG guidance, the risk of complications has been reduced markedly. Throughout the course of our trial, there were no difficulties or negative side effects associated with the procedure.

The limitation of the study is that it is a single-center study with a small sample size. Furthermore, we had evaluated neither the block's efficacy before surgery nor the basal pain threshold of the patients. The investigators were aware of the randomization, even though the individuals were unaware of the treatment group assignment. Another limitation is that surgeries like mastectomies, reconstructive surgeries, and so on were not included in our study. Also, the outcomes of this study are only relevant to the particular LA type, concentration, and volume used. Different surgical procedures (e.g. mastectomy), block techniques, administration approaches, and use of additives may alter the results.

Conclusions

When ESPB was administered, patients with similar demographics displayed considerable differences in the amount of postoperative morphine consumed in contradistinction to TPVB. When the VAS scores, LOS and complications rate were compared, no significant difference was observed between the two groups. Thus, even though both ESPB and TPVB provided adequate analgesia in patients undergoing MRM, TPVB showed better efficacy and opioid-sparing effect than ESPB. Nevertheless, a multicenter study with a larger sample size could provide more meaningful clinical outcomes and guide as to which modality of pain relief is better in breast surgeries.

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Nil.

Conflicts of interest
There are no conflicts of interest.

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