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Analgesic Requirements and Incidence of Neuropathic Pain after Erector Spinae Plane Block in Different Patient Positions: A Retrospective Comparative Study.

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ABSTRACT:

Background: Multimodal analgesia that includes pharmacotherapy and regional anesthetic techniques such as erector spinae plane block (ESPB), is recommended for the management of post-mastectomy pain

Methods: A retrospective analysis of 75 patients' records who had modified unilateral radical mastectomy where the initial anesthetic plan was ESPB with general anesthesia were reviewed. According to the patient's position during the ESPB, they were assigned into three groups: Group I (sitting position), Group II (lateral decubitus), and Group III (prone position). The endpoints were the dermatomal sensory block, the visual analog scale (VAS) for pain, the time to the first request for postoperative analgesia, opioid consumption, neuropathic pain & complications, and anesthesiologist satisfaction.

Results: More sensory block coverage was detected in the mid-axillary and mid-clavicular lines in group I compared with groups II and III (p-value < 0.001). The VAS for pain did not differ significantly among the studied groups over 16 hours postoperatively. However, it decreased significantly in group I compared to the other groups at 20 and 24 hours postoperatively. The percentage of patients who requested morphine analgesia, the time for the first request of rescue opioid, and the total dose of analgesic requirements were comparable. There was insignificant variation regarding the anesthesiologist's satisfaction with the ease of the block and the incidence of neuropathic pain.

Conclusion: ESPB in the sitting position resulted in more dermatomal sensory block and prolonged analgesia. However, compared to the prone or lateral positions, it did not significantly reduce analgesic requirement or the development of neuropathic pain after mastectomy.

Keywords: Erector spinae plane block, Patient position during the block, Dermatomal sensory block, VAS, Modified radical mastectomy.

INTRODUCTION

Globally, breast cancer ranks as the fifth leading cause of death. (1) Postoperative pain is a mix of nociceptive and neuropathic pain that if not handled appropriately, can evolve into chronic pain and negatively affect daily life activities. (2) Multimodal perioperative analgesia is highly recommended for the control of post-mastectomy pain, including drugs such as non-steroidal anti-inflammatory drugs, gabapentin, opioids, lidocaine-based IV infusions, and regional analgesia. (3, 4)

Novel interventions such as ultrasound-guided fascial plane blocks have proven to be beneficial in alleviating pain following mastectomy. Currently, one of the best perioperative analgesic modalities is thoracic fascial plane blocks because of their simplicity and safety. They enable early mobilization and hospital discharge, effectively reduce the need for opioids, and decrease the progression to chronic neuropathic pain. (5)

Forero et al. (6) initially described the erector spinae plane block (ESPB) as an effective intervention for thoracic nociceptive and neuropathic pain in 2016. The efficacy of local anesthetic (LA) block is influenced by its diffusion to nearby target nerves and compartmental distribution. According to preliminary clinical results, the ESPB injectate is anticipated to block somatic and visceral pain by spreading to both rami of the spinal neurons. (7, 8)

Cadaveric studies using methylene blue and computed tomography to examine the spread of the LA revealed its differential caudal dissemination through the interfacial planes. (6) Other imaging investigations revealed dispersion in the craniocaudal direction. (7) The extent of LA dissemination in live patients is considered more significant than documented in cadavers

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because of the propulsive power of the muscle tone. According to a recent review of pooled ESPB publications, the ESPB is a safe and effective option for multiple types of thoracic, abdominal, and extremity surgeries. (9) The extent of the dissemination in published trials is unknown due to variations in approach and volume of anesthetic delivered. Numerous factors affect ESPB, such as LA volume, unilateral or bilateral block, block level, and patient position. It can be administered in the lateral, prone, or sitting positions.

Methods and Materials:

After institutional ethical committee approval (IORG0008812, IRB00010526_ E/C.S/N.R17/2023), we conducted a retrospective review of 102 patient's medical records at Medical Research Institute Hospital between January 2022 and January 2023 (Figure 1). The Helsinki Declaration's ethical guidelines were adhered to during the study. The number of participants was determined according to the recommendation of the statistical department. The PASS Version 20 Program was used to detect the differences in the dermatomal sensory block between ESPB in different positions, taking into consideration a 95% confidence level and 80% power. The minimum hypothesized sample size of 75 eligible patients (25 per group) was required (10)

The present study included data from 75 female patient records, ASA II and III, aged 34 to 69, and had a unilateral modified radical mastectomy. Patients who received standard general anesthesia (GA) and ultrasound-guided ipsilateral successful erector spinae plane block in different patient positions (sitting, prone, or lateral) using 30 ml of bupivacaine 0.25% at the transverse process (TP) of the fourth thoracic vertebra and who had followed up for one month to detect neuropathic pain signs and symptoms were all included in the study.

Exclusion criteria:

Bilateral breast cancer, morbidly obese patients (BMI ≥ 40 kg/m²), chronic opioid use, patients with incomplete file data, or missed follow-up (one month postoperative) were all excluded from the study

According to the patient position during the ESPB, they were divided into three groups:

Group 1: (sitting position) 25 patients received preoperative ESPB in the sitting position.

Group 2: (lateral position) 25 patients received preoperative ESPB in the lateral decubitus, with the operative site at the top.

Group 3: (prone position) 25 patients received preoperative ESPB in the prone position

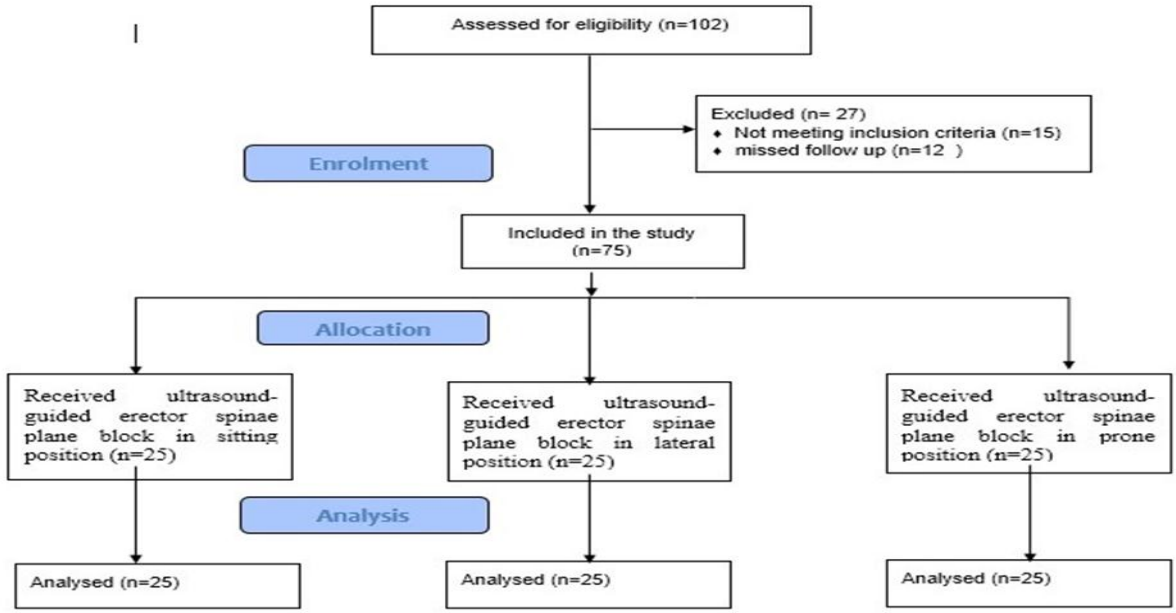

Figure 1: consort flow chart

We collected the following data from each patient file **(Measurements):**

1. Dermatomal sensory loss after ESPB at midclavicular and midaxillary lines using an ice cube or pinprick and this parameter was our primary endpoint.
2. VAS measurements for pain intensity in the first 24 hours. According to the analgesic protocol. If the VAS was ≥ four, the patient received repeated increments of 2 mg morphine.
3. Time to first request for analgesia.
4. Opioid consumption during the first postoperative day.
5. Anesthesiologists' satisfaction with the ease of the block is measured using Likert scale, with five being very satisfied and one being very dissatisfied.
6. Complications (such as Incidence of nausea and vomiting, local anesthetic toxicity, and pneumothorax).
7. Signs and symptoms of neuropathic pain measured by the Deuleur Neuropathique 4 (DN4) scale (11) and

documented in patient files were used to rate the incidence of development of neuropathic pain one month postoperatively. The DN4 questionnaire evaluates ten items. Questions 1 through 7 can be answered by interviewing patients, but questions 8 through 10 require patient examinations. The DN4 score is the cumulative count of these ten elements present in each patient. A score of 4/10 is the cut-off point for diagnosing neuropathic pain.

8. Demographic data (Age, BMI) and duration of surgery.

Statistical analysis:

The data was analyzed using IBM SPSS software, version 20.0 (Armonk, NY: IBM Corp). Numbers and percentages were used to represent the qualitative results. Quantitative data were expressed using the interquartile range (IQR), mean, standard deviation, and median. The significance level for the results was determined at 5%.

Statistical tests;

1. Chi-square test: For categorical variables.
2. Monte Carlo correction for chi-square: if more than 20% of the cells have a count of less than five.
3. F-test (ANOVA) for normally distributed quantitative data and the Post Hoc test (Tukey) for pairwise comparisons. ANOVA with repeated measures was used to compare between more than two periods, and a post-hoc test (adjusted Bonferroni) was used for pairwise comparisons.
4. Kruskal Wallis test for abnormally distributed quantitative data to compare between more than two studied groups and Post Hoc (Dunn's multiple comparisons test) for pairwise comparisons. Friedman test is used to compare between more than two periods, and the Post Hoc Test (Dunn's) is used for pairwise comparisons.

Results

Seventy-five patients' records were reviewed (Figure 2). The mean dermatomal sensory block in the mid-axillary and mid-clavicular lines was (9.96 ± 0.93 and 7.84 ± 0.80, respectively) in group I (7.68 ± 0.95 and 6.12 ± 0.88, respectively) in group II and (8.12 ± 0.78 and 6.60 ± 0.82 respectively) in group III. The dermatomal sensory block at the mid-axillary and mid-clavicular lines in the sitting position was significantly more than in the lateral and prone positions, with an insignificant difference between the prone and lateral positions (Table I). There were insignificant variations in VAS between the studied groups in the postoperative period from arrival to the PACU until 16 hours postoperatively. At 20 and 24 hours, the VAS showed significantly lower scores in patients in group 1 versus groups 2 and 3 (Figure 2).

Table (I):Comparing the studied groups regarding the mid-clavicular and mid-axillary dermatomal sensory block.

Dermatomal sensory block	Group I (Sitting) (n = 25)	Group II (Lateral) (n = 25)	Group III (Prone) (n = 25)	F	p
At Mid-clavicular line					
Mean ± SD.	7.84 ± 0.80	6.12 ± 0.88	6.60 ± 0.82	28.358*	<0.001*
	p_1<0.001*, p_2<0.001*, p_3=0.111				
At Mid-axillary line					
Mean ± SD.	9.96 ± 0.93	7.68 ± 0.95	8.12 ± 0.78	38.186*	<0.001*
	p_1<0.001*,p_2<0.001*,p_3=0.193				

SD: **Standard deviation**

F: **F for One-way ANOVA test and a Post Hoc Test (Tukey) for** pairwise comparison between two groups.

p: p-value for comparison among **groups.**

p_1: p-value for comparing the **Sitting** vs. **lateral groups.**

p_2: p-value for comparing the **Sitting** vs. **prone groups.**

p_3: p-value for comparing **Lateral** vs. **prone groups.**

*: Statistically significant at $p \leq 0.05$

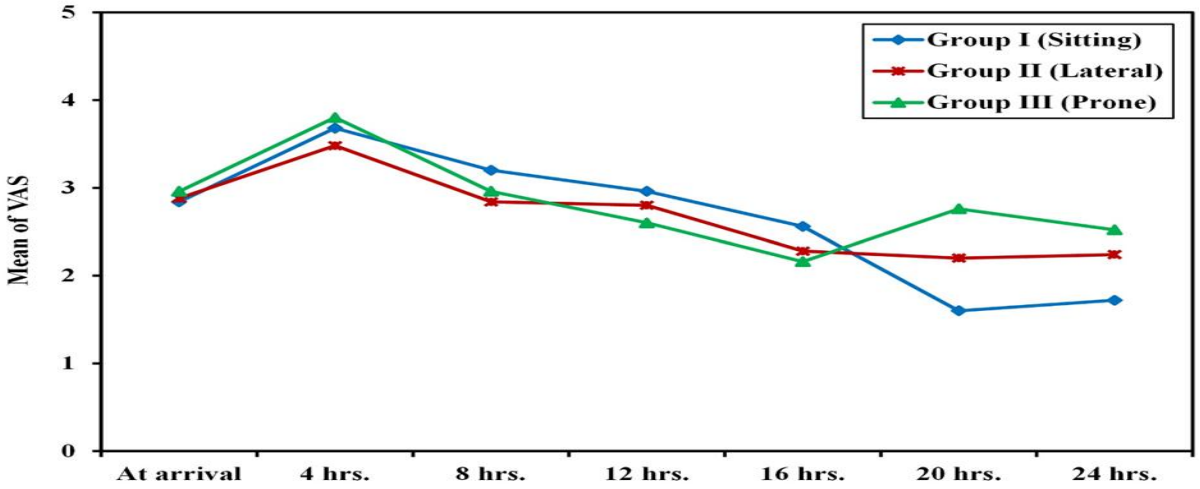

Figure 2: comparing the changes in the visual analog scale (VAS) for pain among the groups.

The percentage of patients who asked for rescue opioid analgesia, the median duration for the first request of rescue opioids, and the total dose of opioid requirement were not statistically significant among the three groups (p-values = 0.903, 0.633, and 0.627, respectively) (Table II).

Table (II): Comparing the three studied groups according to the first rescue analgesia and opioids requirements

	Group I (Sitting) (n = 25)	**Group II (Lateral) (n = 25)**	**Group III (Prone) (n = 25)**	**Test of sig.**	**p**
	No. (%)	**No. (%)**	**No. (%)**		
First rescue analgesia of morphine					
Number of patients					
No	3 (12%)	4 (16%)	2 (8%)	χ^2=	^{MC}p=
Yes	**22 (88%)**	**21 (84.0%)**	**23 (92%)**	0.814	0.903
Time for first rescue analgesia of morphine (hour)					
Median (Min. – Max.)	4.0 (0.0 – 12.0)	4.0 (0.0 – 12.0)	4.0 (0.0 – 8.0)	H=0.916	0.633
Total Amount of morphine(mg)					
Mean ± SD.	2.48 ± 1.33	2.32 ± 1.49	2.64 ± 1.25	H=	0.627
Median (Min. – Max.)	2.0 (0.0 – 4.0)	2.0 (0.0 – 6.0)	2.0 (0.0 – 4.0)	0.933	

SD: **Standard deviation** H: H for **Kruskal Wallis test**
χ^2: **Chi-square test** MC: **Monte Carlo**
p: p-value for comparing **the three studied groups**

The anesthesiologist satisfaction with the ease of the block varied insignificantly among the groups (p-value = 0.176). The incidence of neuropathic pain in the three groups after one month showed an insignificant statistical difference (p-values = 0.924) (Table IV). Regarding postoperative complications, we reported a comparable frequency of nausea and vomiting in the three groups (p-values = 0.803 and 0.866) (Table III). The Age, body mass Index and surgical time were insignificant (Table IV).

Table (III**): Comparison between the three studied groups according to anesthesiologist's satisfaction with the ease of the block, the incidence of complications, and the neuropathic pain.**

	Group I (Sitting) (n = 25)	**Group II (Lateral) (n = 25)**	**Group III (Prone) (n = 25)**	**Test**	**p**
	No. (%)	**No. (%)**	**No. (%)**		
Anesthesiologist's satisfaction with the ease of the block					
Mean ± SD.	3.60 ± 0.50	3.36 ± 0.49	3.32 ± 0.69	F=1.779	0.176
Postoperative complications					
Nausea	7 (28%)	5 (20%)	6 (24%)	χ^2=0.439	0.803
Vomiting	2 (8%)	1 (4%)	3 (12%)	χ^2=1.118	^{MC} p = 0.866
DN4 questionnaire for neuropathic pain ≥4					
No	20 (80 %)	20 (80%)	19 (76%)	χ^2=	0.924
Yes	5 (20%)	5 (20%)	6 (24%)	0.159	

SD: **Standard deviation** χ^2 :Chi-square test
MC: Monte Carlo F: for One-way ANOVA test
p: p-value for comparing between the three studied groups

Table (IV**):Comparing the demographic data and duration of surgery of the three studied groups.**

	Group I (Sitting) (n = 25)	Group II (Lateral) (n = 25)	Group III (Prone) (n = 25)	F	p
Demographic data					
Age (years)					
Mean ± SD.	52.80 ± 10.35	53.92 ± 10.79	57.52 ± 8.22	1.567	0.216
BMI (kg/m^2)					
Mean ± SD.	37.24 ± 1.76	36.40 ± 1.55	37.0 ± 1.85	1.570	0.215
Duration of surgery (min.)					
Mean ± SD.	98.16 ± 5.94	97.64 ± 7.11	99.24 ± 6.25	0.400	0.672

SD: Standard deviation F: for One-way ANOVA test
p: p-value for comparing the three studied groups

Discussion:

The dermatomal sensory block at the mid-axillary and mid-clavicular lines in the sitting position was significantly more than in the lateral and prone positions after ESPB, with an insignificant difference between the prone and lateral positions. This may be explained by the augmented cephalocaudal spread of local anesthetic due to the effect of gravity in the sitting position, with the added impact of the cephalocaudal direction of injection force and the propulsive force of the muscle tone. The mean dermatomal block was 6-9 segments in the different positions, with more blocked dermatomes at the mid-axillary line than at the mid-clavicular line. In accordance with our findings, Selvi et al. (12) examined the ESPB at T9 in 50 patients. They reported that successful sensory block was achieved in 67% of the dorsolateral quadrants, 58% of the dorsomedial quadrants, 69% of the ventrolateral quadrants, and 55% of the ventromedial quadrants.

The efficacy of ESPB for breast surgery was investigated and approved (cutaneous sensory loss in 5-8 segments) in several previous studies. (13-18) Barrios and his colleagues (19) reported that 20 mL of 0.5 % plain bupivacaine injection at the mid-thoracic level produced a nine-dermatomal sensory loss 60 minutes after performing ESPB. Hamilton and Manickam (20) reported a loss of cold sensation from T1 to T9, in which ESPB was performed at T5 with a bolus of 20 ml of 0.25% Levobupivacaine, followed by a further 15 ml of 0.25% Levobupivacaine injected through a catheter. The large volume of LA and the delayed assessment time after the block were among the factors determining the level of dermatomal sensory block.

The current analysis showed insignificant variations in VAS for pain between the groups until 16 hours postoperatively. At 20 and 24 hours, the VAS showed significantly lower scores in patients in the sitting position compared to the lateral and prone positions. This may be attributed to LA's more extensive cephalocaudal spread and prolonged analgesic coverage in the sitting position. However, in patients who requested rescue analgesia, the median duration for the first request of rescue analgesia and total morphine consumption were comparable in the three groups.

A meta-analysis involving 679 patients by Zhang et al. (21) concluded that ultrasound-guided ESPB reduced pain intensity and reduced morphine consumption within the first 24 hours after breast cancer surgery. Another meta-analysis involving 861 patients was conducted by Leong and his assistants (22) and revealed that ESPB decreased pain levels and opioid consumption for up to 24 hours following breast surgery when compared to GA alone, and its efficacy was comparable with paravertebral block.

Hamed MA and his colleagues (23) studied the ESPB on 140 participants scheduled for elective CS versus intrathecal morphine (ITM). The mean time to the first analgesic request was 4.93 hours in the ITM group and 12 hours in the ESPB group. The total opioid consumption in the first 24 hours was significantly lower in the ESPB group. Wahdan et al. (24) studied the ESPB group compared to the control group in elective lumbar spine surgeries. In the ESPB group, the total amount of morphine consumed was significantly decreased, and the time to the first analgesic request was delayed considerably in patients who underwent lobectomy (25) with video-assisted thoracic surgery and received ESPB Versus standard anesthesia with opioid use. The ESPB group had a significantly lower total dose of morphine during the first 24 postoperative hours.

According to the records, most anesthesiologists were satisfied with the ease of the block regardless of the patient's position. ESPB in different patient positions resulted in a comparable incidence of nausea and vomiting. The incidence of neuropathic pain one month after surgery was comparable among groups. wagih et al.(26) reported comparable incidence and intensity of neuropathic pain after mastectomy at one week and after one month postoperatively in patients who received ESPB compared to the serratus anterior plane block. The erector spinae block effectively numbs the dorsal rami of the spinal neurons that innervate the posterior thorax and breast area. It has the potential to alleviate acute and, consequently, reduce the likelihood of developing chronic neuropathic pain after breast surgery by effectively blocking pain signals and improving patient outcomes and satisfaction. The use of ESPB in the management of chronic pain has recently expanded for various neuropathic pain conditions, such as post-herpetic neuralgia and metastatic rib pathologies. (6, 27-29)

Conclusion

According to the analysis of the collected data, ESPB in the three patient positions resulted in effective perioperative analgesia. However, ESPB in the sitting position resulted in

more dermatomal sensory block and more prolonged analgesia. The analgesic requirements, the incidence of neuropathic pain one month after surgery, and complications after ESPB were comparable in the three patient positions.

Declaration of interest:

The authors report no conflict of interest

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