ORIGINAL ARTICLE

Analgesic Efficacy of Ultrasound Guided Serratus Anterior Plane Block and Pectoral Nerve Block II compared to Thoracic Epidural Block after Unilateral Modified Radical Mastectomy

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Abstract

Background: ***The gold standard surgical treatment for breast cancer is a modified radical mastectomy, which makes up 31% of all breast surgeries. In the immediate aftermath of surgery, 40-60% of patients report significant discomfort. Symptoms such as complex regional pain syndrome (causalgia) and post-mastectomy pain syndrome (PMPS) may develop after 6-12 months of this type of discomfort.***

Aim and objectives: ***Examining the effectiveness of three different blocks in managing postoperative pain after a modified radical mastectomy: thoracic epidural, ultrasound-guided PECS II, and ultrasound-guided serratus anterior plane.***

Patients and methods: ***Taking place from February 2023 through January 2025 at Al-Azhar University Hospitals, this prospective randomized double-blind clinical trial had 99 patients scheduled for unilateral modified radical mastectomy. Three groups were formed from the patients at random.***

Results: ***Time to first rescue analgesia for the pectoral nerve block (PECS) group was significantly longer in the serratus anterior plane block (SAPB) group compared to the Thoracic epidural (TEB) and PECS groups. The SAPB group drank a lot more morphine than either the TEB or PECS groups, whereas the TEB group drank much less than the PECS group. All three groups had similarly delayed block onset.***

Conclusion: ***The PECS block demonstrated superior efficacy for post-mastectomy pain management, with optimal hemodynamic stability, better pain control, a decrease in opioid usage, and a lengthened duration before the onset of rescue analgesia, while SAPB showed inferior outcomes with higher pain scores, increased opioid requirements, and poor hemodynamic control, making PECS the preferred choice for modified radical mastectomy procedures.***

Keywords: Analgesic efficacy; Thoracic epidural block; Radical mastectomy

1. Introduction

The gold standard surgical treatment for breast cancer is a modified radical mastectomy, which is why it makes up 31% of all breast surgeries. In the immediate aftermath of surgery, 40-60% of patients report significant discomfort. Complex regional pain syndrome (causalgia) and post-mastectomy pain syndrome (PMPS) can develop from this pain, which can last anywhere from six months to twelve months.[1]

Breast surgery patients often undergo ERAS, an acronym for "improved recovery following surgery and multimodal analgesia," which involves the use of multiple local or regional nerve blocks.[2]

Although transesophageal blockage (TEB) remains the method of choice for lymph node dissection after breast surgery, the issue of adequate thoracic and axillary blockage persists.[3]

Analgesia after breast augmentation procedures can be achieved with the use of a "PECS block type II" or "modified PECS's block" to obstruct the axilla (crucial for axillary clearance) and the intercostal nerves (needed for extensive excisions).[4]

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The ultrasound-guided subcutaneous angioplasty branch (SUPB) involves injecting a local anesthetic (LA) into the space between the serratus anterior and latissimus dorsi muscles. Breast and lateral thoracic wall procedures can be made more comfortable with the use of SAPB, which numbs the intercostobrachial nerve, the long thoracic nerve, the thoracodorsal nerve, and the lateral cutaneous branches of the intercostal nerves (T3–T9).[5]

The current study aims to examine the effectiveness of three different blocks in managing postoperative pain after a modified radical mastectomy: thoracic epidural, ultrasound-guided PECS II, and ultrasound-guided serratus anterior plane.

2. Patients and methods

From February 2023 to January 2025, 99 patients slated for unilateral modified radical mastectomy participated in this prospective randomized double-blind clinical study at Al-Azhar University Hospitals. The patients were randomly assigned to one of three groups: (N=33) in both sets. During a thoracic epidural block, 33 patients received a 15 mL injection of 0.25% bupivacaine between the T4 and T5 vertebrae.

This study was conducted on a sample of 99 patients underwent modified radical mastectomy divided into three equal groups: Group (1): received TEB with an injection of a single shot of 15 ml of 0.25% bupivacaine between T4 and T5 vertebrae, Group (2): received ultrasound-guided SAPB with an injection of 30 ml bupivacaine 0.25% and Group (3): received ultrasound-guided PECS II with an injection of 20 ml bupivacaine 0.25% of pectoral-minor above the Serratus anterior muscle.

Sample size:

The primary outcome of pain management, as measured by the difference in VAS scores gathered from previous research, was used to calculate the sample size.[6] The G Power program version 3.1.9.4 was used to determine the sample size according to the following: 2-tailed, α error=0.05, effect size of 0.774. The test's power is 80.0%. The initial calculation for each group's sample size was 28 instances; however, after adding 15% to account for potential dropouts, the final sample size was 33 cases.

The following were administered to all participants:

Take a patient's vitals, including their age, sex, the length and medication of any co-occurring medical conditions (such as high blood pressure, diabetes, chronic liver disease, chronic kidney illness, or heart disease), as well as their weight, BMI, and ASA classification.

During the clinical examination, it is important to measure vital signs such as systolic and diastolic blood pressure, heart rate, and peripheral oxygen saturation.

These characteristics were recorded at the commencement of the operation, throughout anesthesia, endotracheal intubation, extubation, and the recovery unit, as well as every hour during the operation.

We judged the patient to have hypotension if their SAP was less than 80 mm Hg, their MAP was less than 60 mm Hg, or both were less than 25% of their baseline level. If the MAP was more than 25% of the baseline level, the patient was deemed to have hypertension.

If the heart rate was more than 25% of the baseline, it was classified as tachycardia, and if it was less than 45 beats/min, it was deemed bradycardia.

A cuff was used to monitor the patient's blood pressure during intubation, anesthesia, and the procedure; this was done manually following extubation.

All participants were required to complete written informed consent forms.

Before general anesthesia was induced, all patients were premedicated with intravenous midazolam at a dosage of 0.02 mg/kg and administered a regional block in accordance with the technique used by each group.

General anesthesia:

The intravenous induction of general anaesthesia was accomplished with the use of rocuronium 0.5 mg/kg, propofol 2 mg/kg, and fentanyl 2 µg/kg. The anaesthesia was sustained by administering rocuronium 0.1 mg/kg as required (PRN) under the guidance of a nerve stimulator, along with breathed sevoflurane 2-3% in oxygen/air (FiO2=0.5). End tidal CO2 levels were maintained at 30 and 35 mmHg in patients by mechanical ventilation. After the airway reflexes were fully restored, the patients were given atropine (0.02 mg/kg) and neostigmine (0.05 mg/kg) to relieve any residual neuromuscular obstruction after extubation. Upon completion of the procedure and every eight hours thereafter, an intravenous anaesthetic dose of one gramme is administered.

Thoracic epidural block:

Position:

The individual supported herself with a pillow and a step stool. To alleviate lumbar lordosis, the patient was told to arch forward like a ferocious cat. Having the patient sit up straight, bend at the waist and hips, and ease their shoulders forward, we prepared them for the procedure.

Identification of Epidural space: Methods such

as nerve stimulation, ultrasonography-guided, or lack of resistance to air or preservative-free normal saline were used to identify the space. Anesthesia level: At the thoracic level, which is located in the midline between the vertebrae T4-5

Serratus anterior plane block: The patients were positioned in a lateral decubitus position, with their arms abducted and the operative side facing up.

Pectoralis nerve block II: The patient must be in a supine position with their arm either at a right angle to their body or resting next to them while the Pecs II block is administered.

Measured outcome:

Block onset and time: the duration between anesthesia induction and the duration of the block. Systolic, diastolic, and mean blood pressure and heart rate were recorded intraoperatively at 30th, 60th, 120th minutes, postoperatively at 2th, 4th, 8th, 10th, 14th, 18th, 20th, and 24th hours. Doses of postoperative opioids are required within 24 hours. Visual analogue scale(VAS) were recorded at 1st, 2nd, 4th, 8th, 10th, 14th , 18th, 20th and 24th hours.

Administrative design:

All participants were asked to sign a written informed consent form. The Institutional Review Board (IRB) at Al-Azhar University's Faculty of Medicine provided ethical clearance. The security of the data was ensured.

Statistical Analysis

Statistical experts at IBM© in Chicago, IL, USA, analysed the data using SPSS v27. The use of Shapiro-Wilk and histograms allowed for the evaluation of data normality. We analysed quantitative parametric data given as means and standard deviations using analysis of variance (ANOVA) with a Tukey post hoc test. A Kruskal-Wallis test with modified Bonferroni correction was used to compare quantitative non-parametric data sets. The quality parameters were analysed using Chi-square, with data displayed as percentages and frequencies. A two-tailed P-value below 0.05 was considered statistically significant.

3. Results

In this study, 116 participants were evaluated for eligibility; eleven participants did not satisfy the requirements, and six patients declined participation. The remaining participants were randomly assigned to three equal groups, each consisting of 33 persons. Each assigned patient was monitored and subjected to statistical analysis.

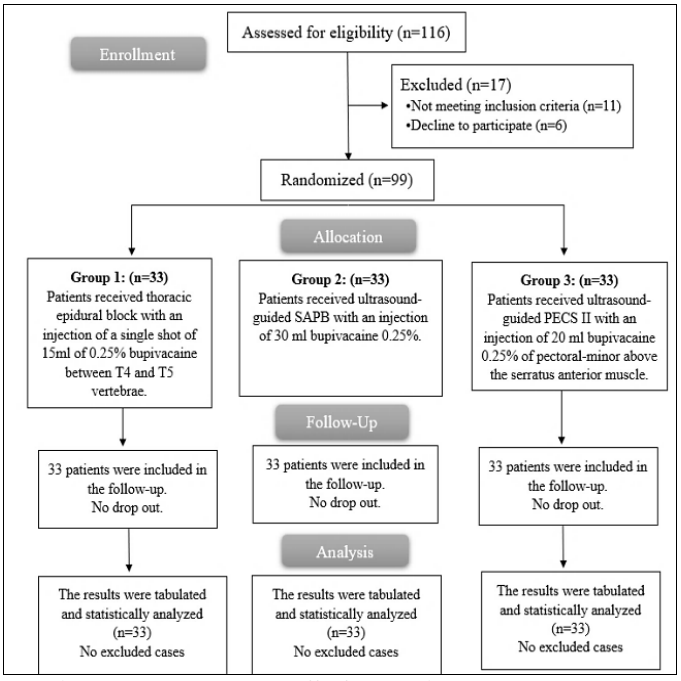

Figure 1. enrolled patients' CONSORT flowchart.

Table 1. The demographic information of the groups under study.

		GROUP-1 (N=33)	GROUP-2 (N=33)	GROUP-3 (N=33)	P-VALUE
AGE(YEARS)	Mean±SD	49.7±8.29	50.2±7.05	47.2±6.8	0.216
	Range	37-64	39-61	38-59	
WEIGHT(KG)	Mean±SD	66.8±5.43	64.4±5.31	63.97±5.06	0.063
	Range	59-80	55-77	57-76	
HEIGHT(CM)	Mean±SD	170.39±5.29	168.45±5.4	167.21±5.68	0.063
	Range	159-179	161-177	159=76	
BMI(KG/M^2)	Mean±SD	23.02±1.35	22.7±1.62	22.9±1.73	0.730
	Range	20.2-25	19.3-24.9	18.9-24.8	
ASA PHYSICAL STATUS	I	15(45.45%)	20(60.61%)	18(54.55%)	0.462
	II	18(54.55%)	13(39.39%)	15(45.45%)	
DURATION OF SURGERY (MIN)	Mean±SD	95.3±20.88	98.2±17.31	94.7±23.22	0.765
	Range	65-130	70-125	60-130	

BMI:Body mass index, ASA:American society of anesthesiologists.

The three groups exhibited minimal differences regarding age, height, weight, BMI, ASA physical state, and duration of operation.

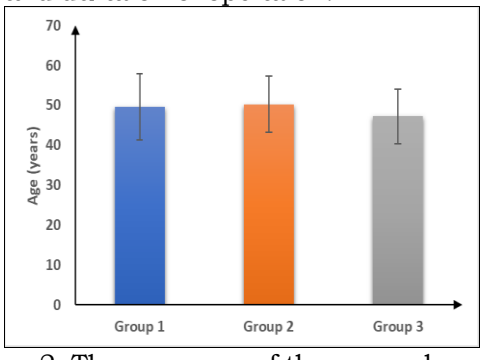

Figure 2. The age range of the research groups

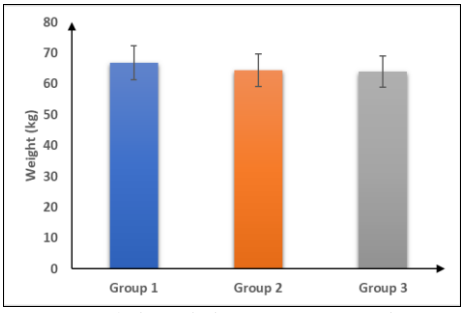

Figure 3. Weight of the groups under study.

Table 2. Heart rates of the research groups during surgery

	GROUP-1 (N=33)	GROUP-2 (N=33)	GROUP-3 (N=33)	P-VALUE	POST HOC
BASELINE	81.79±9.02	78.42±9.31	80.58±9.09	0.322	
30MIN	63.61±11.88	70.67±12.85	77.48±9.4	<0.001*	P1=0.037* P2<0.001* P3=0.046*
60MIN	63.3±8.78	70.15±12.04	75.68±9.22	<0.001*	P1=0.02* P2<0.001* P3=0.08
120MIN	65.2±8.67	68.2±8.26	69.33±8.26	0.715	
END OF SURGERY	74.94±8.93	75.27±9.59	77.58±9.16	0.453	

*:Significantly different as P-value≤0.05. P1:P value between group-1 and group-2,

P2: P-value between group1 and group3, P3:P value between group-2 and group3.

The three groups' intraoperative heart rates at baseline, 120 minutes, and the completion of operation did not differ significantly. Groups 2 and 3 had considerably greater intraoperative heart rates than group 1, Group 3's heart rate was markedly elevated compared to that of Group 2 (P value<0.05) at 30 minutes.

Groups 2 and 3 had considerably greater intraoperative heart rates than group 1 (P-value<0.05), although group 2 and group 3 did not differ significantly at 60 minutes.

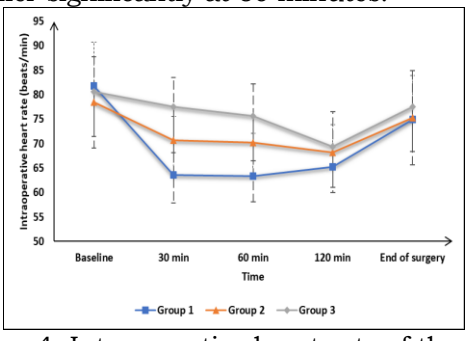

Figure 4. Intraoperative heart rate of the groups under study.

Table 3. Intraoperative SBP of the groups under study.

	GROUP-1 (N=33)	GROUP-2 (N=33)	GROUP-3 (N=33)	P-VALUE	POST HOC
BASELINE	115.73±5.34	117.12±3.63	118.45±5.88	0.095	
30MIN	100.45±14.39	107.45±12.43	115.42±5.92	<0.001*	P1=0.04* P2<0.001* P3=0.016*
60MIN	101.12±9.54	108.36±8.52	110.77±8.13	<0.001*	P1=0.003* P2<0.001* P3=0.517
120MIN	101.8±9.12	106.8±4.49	108.33±6.47	0.309	
END OF SURGERY	113.58±5.27	114.06±3.63	115.61±6.06	0.244	

Systolic blood pressure, or SBP, is significant when the P-value is less than 0.05. P1:P value between groups 1 and 2, P2: P-value comparing groups 1 and 3. P3: P-value comparing groups two and three.

At baseline, 120 minutes, and the completion of operation, there was no discernible variation in intraoperative SBP. Group 2 and Group 3 had significantly higher intraoperative SBP than Group 1 and Group 3 had considerably higher intraoperative SBP than Group 2 (P-value<0.05) at 30 minutes. Groups 2 and 3 had considerably greater intraoperative SBP than group 1 (P-value<0.05), but group 2 and group 3 did not differ significantly at 60 minutes.

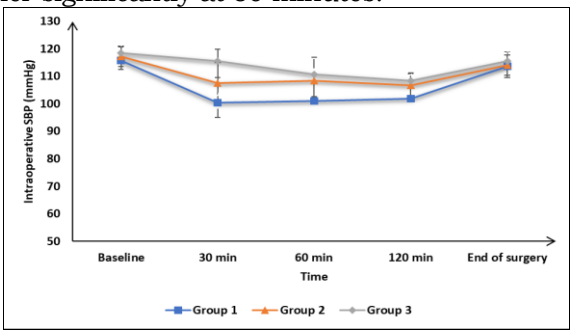

Figure 5. Intraoperative SBP of the groups under study.

Table 4. Onset of block, time to first rescue analgesia and total dose of morphine consumption of the groups under study

		GROUP-1 (N=33)	GROUP-2 (N=33)	GROUP-3 (N=33)	P-VALUE	
ONSET OF BLOCK(MIN)	Mean±SD	7.8±1.62	8.5±2.02	8.9±1.97	0.075	
	Range	6-10	5-11	7-13		
TIME TO FIRST RESCUE ANALGESIA(H)	Mean±SD	5.2±0.73	4.1±0.97	7.5±1.15	<0.001*	P1<0.001* P2 <0.001* P3<0.001*
	Range	4-6	2-5	6-9		
TOTAL DOSE OF MORPHINE CONSUMPTION(MG)	Mean±SD	16.4±3.37	19.1±2.92	14.4±3.25	<0.001*	P1=0.002* P2 =0.036* P3<0.001*
	Range	10-20	15-25	10-20		

*: P-value ≤0.05 indicates a significant separation. P1: P-value comparing groups 1 and 2,

P2: P-value comparing groups 1 and 3; P3: P-value comparing groups 2 and 3.

There was no discernible difference in the three groups' block onset times. Group 1 had a substantially longer time to initial rescue analgesia than group 2, and group 3 had a significantly longer time to initial rescue analgesia than both groups (P-value<0.001). Group 3's morphine intake was significantly lower than that of groups 1 and 2, although group 1's was significantly lower than group 2's (P-value<0.05).

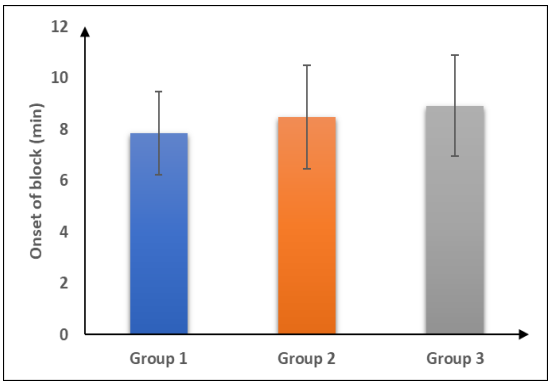

Figure 6. Onset of block of the groups under study.

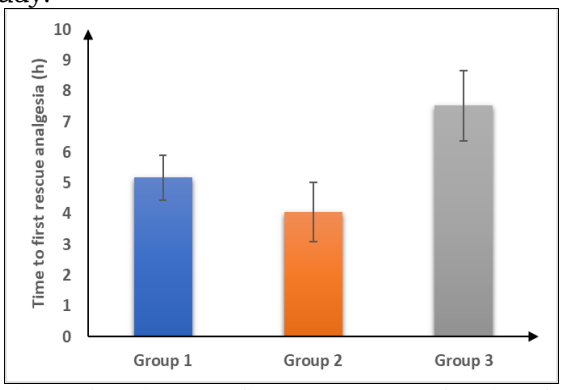

Figure 7. Time to first rescue analgesia of the groups under study.

Table 5. Postoperative MAP of the groups under study.

	GROUP-1 (N=33)	GROUP-2 (N=33)	GROUP-3 (N=33)	P-VALUE	POST HOC
2-H	89.36±4.14	95.27±6.21	87.88±3.71	<0.001*	P1<0.001* P2=0.425 P3 <0.001*
4-H	95.36±8.74	102.52±12.2	88.06±4.49	<0.001*	P1= 0.005* P2=0.004* P3<0.001*
8-H	98.3±9.77	102.33±10.82	90.91±10.99	<0.001*	P1=0.271 P2=0.015* P3<0.001*
10-H	102.27±10.08	105±12.78	95.15±9.96	0.001*	P1=0.575 P2= 0.027* P3< 0.001*
14-H	99.09±9.36	101.27±10.59	97.18±10.99	0.2787	
18-H	101.45±8.83	103.52±12.62	99.12±11.9	0.28745	
20-H	100.24±10.07	104±10.17	98.97±10.67	0.12494	
24-H	99.39±8.5	101.82±11.19	97.12±9.89	0.16281	

MAP: Mean arterial pressure, *: P-value ≤0.05 indicates a significant difference. P1: P-value comparing groups 1 and 2, P2: P-value comparing groups 1 and 3, P3: P-value comparing groups 2 and 3.

The three groups' postoperative MAPs at 14, 18, 20, and 24 hours did not differ significantly. At two hours, there was not a significant distinction among groups 1 and 3, and postoperative MAP was considerably lower in groups 1 and 3 than in group 2 (P-value<0.05). Group 1 had considerably lower postoperative MAP than Group 2 (P-value<0.05) at 4 hours, while Group 3 had significantly lower MAP than Groups 1 and 2. At 8 and 10 hours, there was no appreciable difference between groups 1 and 2, and postoperative MAP was considerably lower in group 3 than in groups 1 and 2 (P-value<0.05).

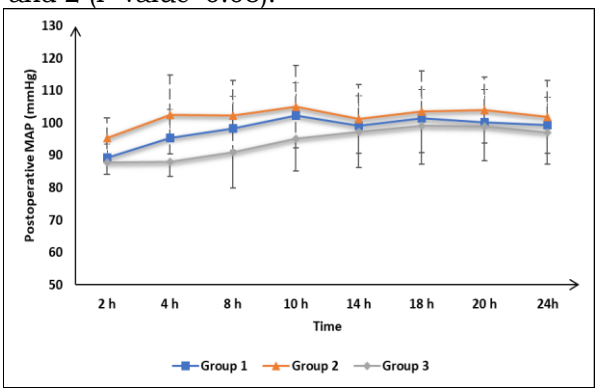

Figure 8. Postoperative MAP of the groups under study.

Table 6. Complications of the groups under study.

	GROUP-1 (N=33)	GROUP-2 (N=33)	GROUP-3 (N=33)	P-VALUE
HYPOTENSION	10(30.3%)	6(18.18%)	1(3.03%)	0.013*
BRADYCARDIA	8(24.24%)	5(15.15%)	0(0%)	0.013*
PONV	5(15.15%)	7(21.21%)	3(9.09%)	0.390

*:Significantly different as P-value≤0.05. PONV: Group 3 had significantly less bradycardia and hypotension than groups 1 and 2 (P-value=0.013). PONV did not significantly differ across the three groups.

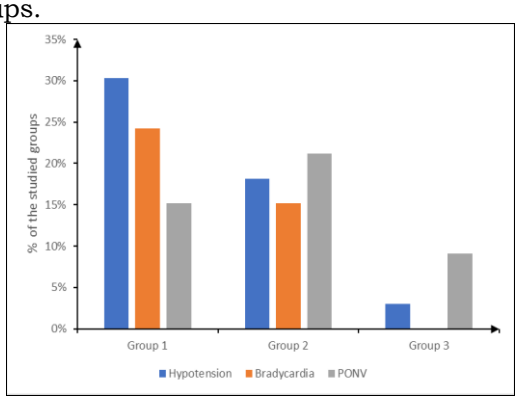

Figure 9. Complications of the groups under study.

4. Discussion

One of the most common surgical treatments is a mastectomy; nevertheless, between 25% and 60% of patients who have undergone breast cancer operations report ongoing difficulty after the procedure.[7] By enhancing the effectiveness of acute pain management, regional anesthesia decreased chronic pain.[8]

Supporting our study, Abdelmoniem et al.,[9], 50 female patients scheduled for a modified radical mastectomy were split into two equal groups for the study: PECS and TEB. They found that the

PECS group had a significantly higher intraoperative heart rate than the TEB group, but that the PECS group had a significantly higher postoperative heart rate than the TEB group. This difference may have been caused by the different PECS block injection site and dosages of bupivacaine injections; the patients they treated received a 0.25% injection of 10 ml bupivacaine at the fascial plane next to the pectoral major and minor muscles.

During 30 and 60 minutes, respectively, the intraoperative systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure (MAP) in the PECS group were much higher than in the TEB group, and at 30 minutes, the PECS group was much higher than SAPB. Compared to the TEB and PECS groups, the SAPB group had significantly greater SBP and DBP immediately following surgery. However, by two hours post-op, there was no substantial variance between the two groups.

Abdelzaam et al.,[10] observed that the SAPB group's postoperative MAP was noticeably higher than the TEB group's.

This agreed with Abdel-Mo`men et al.,[11] who showed that the PECS group's intraoperative MAP was noticeably greater than the TEB group's. However, there was no discernible difference in the postoperative MAP between the PECS and TEB groups.

In this context, Abdel Rahman et al.,[12] demonstrated that the two groups' post-operative mean arterial blood pressures differed significantly.

Also, Khalil et al.,[13] For this prospective randomized observer-blind controlled trial, forty patients who underwent thoracotomy under general anesthesia were split evenly into two groups: Preoperative thoracic epidural catheters were inserted in Group (SAPB) and activated before extubation according to the same dosage schedule as Group (TEB). 30 ml of 0.25% levobupivacaine was injected before extubation in Group (SAPB), followed by 5 ml/hr of 0.125% levobupivacaine. Their results demonstrated that the postoperative MAP for the SAPB group was significantly higher than that of the TEB group. Still, postoperative heart rates did not fluctuate much across the SAPB and TEB groups, and neither group's heart rates varied significantly throughout the day. This difference in results could be explained by the fact that the anesthetics used in their study were different from ours in terms of type, dosage, and concentration.

In the same context, Abdel Rahman et al.,[12] found that the SAPB group required far fewer opioids overall and required much less time to reach the point of initial rescue analgesia compared to the control group.

In the same line, Abdel-Mo`men et al.,[11] demonstrated that the PECS group's delay to the first rescue analgesia was substantially longer than the TEB group's. Additionally, compared to the TEB group, the PECS group consumed much fewer opioids overall.

According to the current study's findings, there was no discernible difference between the three groups' PONV and patient satisfaction. The PECS group had much lower hypotension than both the TEB and SAPB groups, whereas the differences between the two groups were negligible. Bradycardia was not substantially different between the TEB and SAPB groups; however, it was significantly lower in the PECS group compared to both groups.

This agreed with Alshawadfy et al.,[14] When comparing the satisfaction scores and PONV of the SAPB and PECS groups, they found no statistically significant distinction.

Limitations:

The study was conducted at a single facility, had a small sample size, and did not compare the three methods in various surgical procedures or with various anaesthetic types, dosages, and concentrations.

4. Conclusion

The PECS block demonstrated superior efficacy for post-mastectomy pain management, with optimal hemodynamic stability, better pain control, lower use of opioids, and a longer delay to first rescue analgesia, while SAPB showed inferior outcomes with higher pain scores, increased opioid requirements, and poor hemodynamic control, making PECS the preferred choice for modified radical mastectomy procedures.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

Authorship

All authors have a substantial contribution to the article

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Conflicts of interest

There are no conflicts of interest.

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