Randomized Controlled Trial

Analgesic Effect of Addition of Pectointercostal Block to Serratus Anterior Plane Block in Breast Surgeries: A Randomized, Controlled Trial

Adel Ibrahim Hozien, MD[1], Amr Mohamed Helmy, MD[2], Hala Mohamed Koptan, MD[3], Yasser Esaam Elfeil, MD[4], Maha Mahmoud Soliman Yakout[1], and Hatem Bahgat Ahmed Abo Elwafa, MD[3]

From: [1]Deptartment of Anesthesia and Pain Management, Medical Research Institute, Alexandria University, Egypt; [2]Deptartment of Anesthesia and Surgical Intensive Care, Suez Canal University, Egypt; [3]Deptartment of Anesthesia and Intensive Care, Menofia University, Egypt; [4]Deptartment of Anesthesia and Surgical Intensive Care, Alexandria University, Egypt

Address Correspondence: Adel Ibrahim Hozien, MD Deptartment of Anesthesia and Pain Management, Medical Research Institute, Alexandria University, Egypt El-Horreya Avenue ElHadara, Alexandria E-mail: adelhozien@alexu.edu.eg

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Background: Ultrasound-guided serratus anterior plane block (SAPB) is an efficient perioperative analgesic modality for breast surgeries. SAPB does not block the anterior cutaneous branches of the intercostal nerves; thus, it does not provide adequate analgesia for the parasternal region and the medial side of the breast. A new parasternal block, the pectointercostal fascial plane block (PIFB) has been developed to overcome this issue.

Objectives: The study aimed to evaluate the perioperative analgesic effect of using PIFB in addition to SAPB. The primary outcome was to evaluate the postoperative pain score. The secondary outcomes were to assess perioperative opioid requirements, hemodynamic stability, and the satisfaction of the patient and surgeon.

Study Design: The current study was a prospective, double-blinded, randomized controlled study. The current study was registered at the Pan-African Clinical Trials Registry (PACTR202001789968542) and was designed after obtaining ethical institutional approval (Institutional Review Board No 00012098, Federalwide Assurance No 00018699).

Setting: The study involved 60 women between 21 and 69 years old with breast cancer who were scheduled for modified radical mastectomy or conservative breast surgeries in a university hospital.

Methods: After verbal and informed written consent, the patients were allocated to Group 1, which received SAPB, and Group 2, which received SAPB with PIFB. We assessed the Visual Analog Scale (VAS), perioperative opioid requirements, intraoperative hemodynamic stability, rescue analgesia, and complications. Patient and surgeon satisfaction were surveyed using a questionnaire where one is very dissatisfied and 5 is very satisfied.

Results: Intraoperative mean arterial blood pressure (MABP) and heart rate were significantly lower in Group 2 (SAPB+PIFB). The number of patients who needed intraoperative fentanyl was also significantly lower in Group 2 (SAPB+PIFB) (P value = 0.010). Postoperative VAS showed no significant difference in both groups. The number of patients who needed postoperative rescue morphine, time for the first rescue analgesia, first morphine dose (mg), and total opioid consumption were also comparable for both groups. Patient satisfaction and surgeon satisfaction were comparable for both groups (P values = 1.000 and 0.496, respectively).

Limitations: VAS was not recorded during movements and no follow-up was done to detect the potential effect on chronic postmastectomy pain. Moreover, after reviewing the literature, there was no efficient data about adding PIFB with different regional blocks for breast surgery.

Conclusions: The number of patients who needed intraoperative fentanyl, as well as the MABP and heart rate were significantly lower in Group 2 (SAPB+PIFB). Postoperative vital signs, VAS, postoperative analgesic requirements, and opioid consumption were comparable for both groups. Patient satisfaction was comparable for both groups, while surgeon satisfaction was higher in Group 2 (SAPB+PIFB) but statistically not significant.

Key words: Pectointercostal, fascial plane block, serratus anterior plane block, breast surgery, regional analgesia for mastectomy

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Breast cancer is the most common malignancy among women worldwide. Eighty-one percent of patients with breast cancer undergo surgery, such as mastectomy or breast-conserving surgeries as part of their treatment (1,2). Breast cancer operations often cause significant acute postoperative pain, necessitating a preoperative multimodal analgesia regimen that includes regional analgesia. Successful pain management after breast surgery is challenging and if not adequately achieved, it may increase the incidence of subsequent chronic postmastectomys pain (3,4).

Ultrasound (US)-guided fascial plane blocks are effective novel techniques for the management of postmastectomy pain. Due to their safety and simplicity, thoracic fascial plane blocks are currently considered one of the most effective perioperative analgesic modalities. They effectively decrease opioid consumption, improve pain experience, and allow for early mobilization and discharge from the hospital (5).

The serratus anterior plane block (SAPB) affects predominantly the lateral cutaneous branches of the thoracic intercostal, intercostobrachial, thoracodorsal, and long thoracic nerves providing anterolateral and partial posterior thoracic wall analgesia (dermatomes from T2-T9) (6). The anteromedial chest wall is innervated by the anterior branches of the intercostal nerves, and SAPB is unlikely to cover this area adequately (7,8).

The US-guided pectointercostal fascial block (PIFB) is one of the blocks that target the anterior cutaneous branches of the intercostal nerves in the interfacial plane between the pectoralis major muscle and external intercostal muscle, providing analgesia to the anteromedial chest wall (9). Therefore, PIFB can supplement the SAPB to offer efficient perioperative pain control during breast cancer surgery (10). The PIFB is simpler, easier to identify, and away from the pleura when compared to other parasternal blocks (11). This study aims to compare the analgesic efficacy of the combination of SAPB and PIFB for mastectomies and breast-conservative surgeries, compared with SAPB alone.

Objectives

The current study aimed to evaluate the perioperative analgesic effect of using PIFB in addition to SAPB. The primary outcome was to evaluate the Visual Analog Scale (VAS). The secondary outcomes were to assess the perioperative opioid requirements, the intraoperative hemodynamic stability, rescue analgesia, and complications. Patient and surgeon satisfaction were surveyed using a questionnaire where one is very dissatisfied and 5 is very satisfied.

Study Design

The current study was registered at the Pan-African Clinical Trials Registry (PACTR202001789968542). It was a prospective, double-blinded, randomized, controlled study that was designed after obtaining ethical institutional approval (Institutional Review Board No 00012098, Federalwide Assurance No 00018699). Randomization was done using computerized mobilization with variable-sized blocks. A double-blinding technique was employed for both the patients and the outcome assessors.

The Department of Medical Statistics computed the minimal sample size with G*Power Version 3.1.9.2 (12). Based on their findings, adopting a power of 80% and a level of significance of 95% ($\alpha = 0.05$), the minimum needed sample size was found to be 20 patients per group (the total sample size of patients was equal to 40). To account for attrition (withdrawal) bias, the sample size was raised to 30 patients per group. (13). The recruitment period extended from May 2020 to February 2021 (Fig. 1).

Setting

After obtaining verbal and written informed consent, the study involved 60 women between 21 and 69 years old with breast cancer who were scheduled for modified radical mastectomy or conservative breast surgeries at our university hospital. Exclusion criteria included American Society of Anesthesiologists > III, bilateral breast surgeries, reconstructive surgeries, failed block, allergies to local anesthetics (LAs), soft tissue infection in the area of the procedure, neuropathy, coagulopathy, patient refusal, and any contraindications to regional anesthesia. They were randomized to receive Group 1 (SAPB) or Group 2 (SAPB+PIFB).

Methods

In the block room, each patient was attached to a multichannel monitor for full monitoring, and a 22-G cannula was inserted on the opposite side of the surgery. All

the patients received intravenous sedation with 0.03 mg/kg midazolam and 0.5 µg/kg fentanyl and were given supplemental oxygen (3L/min) through a nasal cannula after skin disinfection and sterile draping.

For SAPB, the linear transducer was placed oriented vertically in the midaxillary line at the level of the fourth and fifth ribs, where the latissimus dorsi muscle was identified, and after local skin infiltration with 2 mL of lidocaine 1%, 25 mL of 0.25% bupivacaine was injected into the fascial plane between the serratus anterior muscle and intercostal muscles and ribs.

For PIFB, the linear probe was placed parallel to the long axis of the sternum and 10 mL of 0.25% bupivacaine was injected into the fascial plane between the pectoralis major muscle and the external intercostal muscles after local skin infiltration with 2 mL of lidocaine 1%.

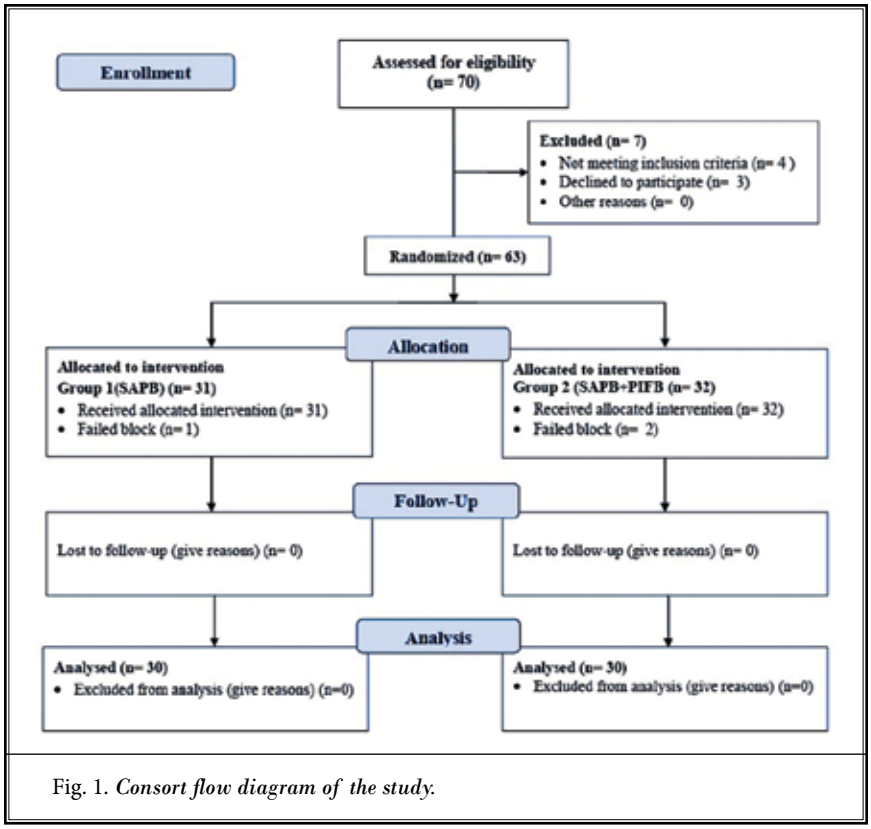

Fig. 1. *Consort flow diagram of the study.*

In both groups, the sensory block level assessment was tested every 5 minutes up to 20 minutes after receiving the block by loss of cold sensation to a piece of ice; the successful block was approved when the block covered T2-T6 dermatomal level. The failed block was not included in the analysis.

General anesthesia was induced with 1.5 µg/kg fentanyl and 1.5-2.5 mg/kg propofol. Neuromuscular block was achieved with atracurium 0.5 mg/kg. Anesthesia was maintained with 1% to 1.5% isoflurane in 50% oxygen. Additional rescue boluses of 50 µg fentanyl were administered if the heart rate or mean blood pressure increased by > 20% of the patient's baseline measured upon arrival to the operation room. All the patients received 1 g of paracetamol infusion intraoperatively and 30 mg of intravenous ketorolac, both of which were given routinely every 8 hours postoperatively. If the patient complained of pain and their VAS exceeded 4, the attending anesthesiologist was consulted, and repeated boluses of 1 mg morphine were given as rescue analgesia at any point in the first 24 hours. Granisetron 1 mg was given if the patient suffered nausea and vomiting.

Measurement

The patient's demographic data, surgery type, side, and duration were recorded. Baseline and intraoperative mean arterial blood pressure (MABP) (mmHg), heart rate (beats/min), number of patients who needed fentanyl intraoperatively, and fentanyl dose (µg) were recorded. The patient's vital signs were monitored in the ward every 4 hours for the first 24 postoperative hours. The postoperative pain was assessed using the VAS (VAS = 1-10, 0 = no pain, and 10 = the worst possible pain), starting from 30 minutes to one hour and then every 4 hours. The time for the first rescue analgesia, first morphine dose (mg), total opioid consumption, and opioid or LA-related side effects were evaluated. Patient and surgeon satisfaction were surveyed using a questionnaire where 1 = very dissatisfied, 2 = dissatisfied, 3 = neutral, 4 = satisfied, and 5 = very satisfied.

Statistical Analysis

The IBM SPSS Software Program Version 20.0 (IBM Corporation, Armonk, NY) was used to examine the data provided to the computer. Categorical data has been displayed as percentages and numbers. When > 20% of the cells had an assumed count of < 5, the

Monte Carlo correction test was used instead of the chi-square test to compare the 2 groups. The Shapiro-Wilk test was used to determine the normality of continuous data. Range (minimum and maximum), median, mean, and SD were used to convey quantitative data. In the case of regularly distributed quantitative data, 2 groups have been compared using the Student's t test. In contrast, the Mann-Whitney U test was employed to compare 2 groups for quantitative variables that were not regularly distributed. The significance of the obtained results was judged at the 5% level.

Results

Both groups were comparable in age, weight, surgery type, side, and duration (*P* values = 0.570, 0.842, 0.584, 0.795, and 0.082, respectively) (Table 1).

Intraoperative MABP and heart rate were significantly lower in Group 2 (SAPB+PIFB) (Figs. 2 and 3). The number of patients who needed intraoperative fentanyl was significantly lower in Group 2 (SAPB+PIFB) (*P* value = 0.010) (Table 2).

Postoperative VAS (Table 3) showed no significant difference in both groups. The number of patients who required postoperative rescue morphine, time for the first rescue analgesia, first morphine dose, and total morphine consumption (mg) were comparable for both groups (*P* values = 0.184, 0.109, 0.305, and 0.872, respectively) (Table 2). Postoperative vital signs were comparable in both groups. Patient satisfaction was comparable for both groups, while surgeon satisfaction was higher in Group 2 (SAPB+PIFB) but statistically not significant (*P* values = 1.000 and 0.496, respectively) (Table 4). There were no reported complications or major side effects related to the opioids or LAs.

Discussion

In addition to causing pain, immunosuppression, and angiogenesis, the surgical stress response contributes directly to tumor survival, recurrence, and most importantly, the development of chronic postsurgical pain (14). Although no conclusive data to support or refute that using regional anesthesia would reduce cancer recurrence, it is associated with lower levels of inflammation and a better immune response reducing angiogenesis (15).

The results of the current study showed that there was a significant reduction in the number of patients who required intraoperative opioids (fentanyl), as well as significantly better hemodynamic stability in Group 2 (SABP+PIFB) than in Group 1 (SAPB) alone. This reflects the complex innervation of the breast, which arises from the lateral and anterior cutaneous branches of the second to sixth intercostal nerves in addition to the intermediate supraclavicular nerve in the upper part. From the brachial plexus arise the lateral C5-C7 and the medial C8-T1 pectoral nerves, the long thoracic nerve C5-C7, and the thoracodorsal nerve C6-C8. Whereas, the inner aspect of the upper arm is innervated by the intercostobrachial nerve (16).

In 2013, Blanco et al (17) introduced SAPB, describ-

Table 1. *Comparison between the 2 studied groups according to patient and surgery characteristics.*

	Group 1 (SAPB) (n = 30)	Group 2 (SAPB+ PIFB) (n = 30)	Test of Significance	*P*
Surgery Side				
Right	13 (43.3%)	14 (46.7%)	$\chi^2 = 0.067$	0.795
Left	17 (56.7%)	16 (53.3%)		
Surgery Type				
Conservative breast surgery	19 (63.3%)	21 (70.0%)	$\chi^2 = 0.300$	0.584
Modified radical mastectomy	11 (36.7%)	9 (30.0%)		
Age (y)				
Mean ± SD	47.60 ± 10.84	49.33 ± 12.60	t = 0.571	0.570
Weight (kg)				
Mean ± SD	73.73 ± 8.33	73.27 ± 9.64	t = 0.201	0.842
Surgery Duration (min)				
Mean ± SD	68 ± 16.5	77 ± 22.5	t = 1.769	0.082

SAPB: serratus anterior plane block; PIFB: pectointercostal fascial plane block; t: Student t test; χ^2: chi-square test; *P*: *P* value for comparing the 2 studied groups

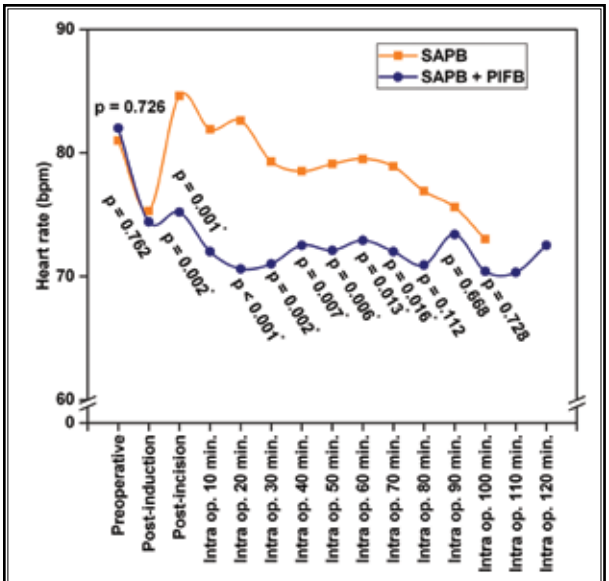

Fig. 2. *Comparison between the 2 studied groups according to intraoperative heart rate (beats/min).*

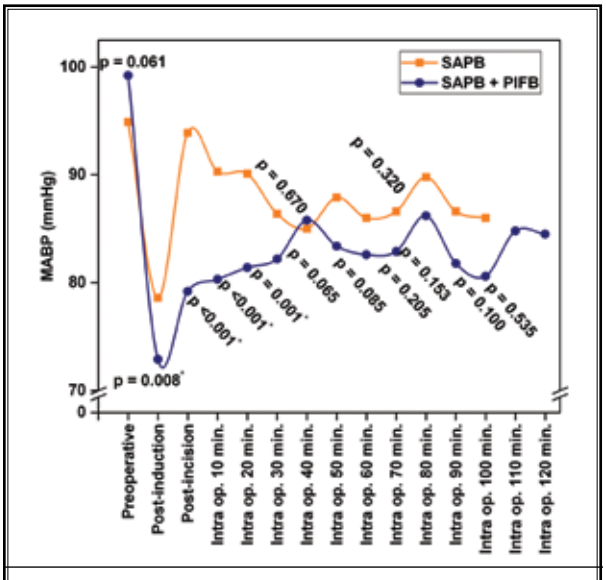

Fig. 3. *Comparison between the 2 studied groups according to intraoperative MABP (mmHg).*
MABP, mean arterial blood pressure.

Table 2. *Comparison between the 2 studied groups according to analgesic requirements.*

	Group 1 (SAPB) (n = 30)	Group 2 (SAPB+PIFB) (n = 30)	Test of Significance	*P*
Rescue Intraoperative Analgesia				
Number of patients	19 (63.3%)	9 (30.0%)	$\chi^2 = 6.696$*	0.010*
Fentanyl (ug) Median (Min-Max)	100 (50-150)	50 (50-100)	U = 61.500	0.243
Rescue Postoperative Analgesia				
Number of patients	14 (46.7%)	9 (30.0%)	$\chi^2 = 1.763$	0.184
Morphine first dose (mg) Median (Min-Max)	2 (2-3)	3 (2-3)	U = 46.0	0.305
When (h) Median (Min-Max)	7.5 (4-18)	10 (7-16)	U = 37.500	0.109
Total Morphine Consumption (mg)				
Mean ± SD	3.4 ± 1.34	3.3 ± 1.41	t = 0.163	0.872

SAPB: serratus anterior plane block; PIFB: pectointercostal fascial plane block; SD: standard deviation; t: Student t test; U: Mann-Whitney test; χ^2: chi-square test; *P*: *P* value for comparing the 2 studied groups
*Statistically significant at $P \leq 0.05$

ing it as a progression from his previous work on pectoralis (PECS) blocks I in 2011 and PECS II in 2012. And since then, there have been multiple trials on SAPB to assess its efficacy.

Mayes J et al (18) in an anatomical evaluation of SAPB, suggested that the spread of dye through the subserratus plane means anesthetizing the lateral cutaneous branches of intercostal nerves and supporting their clinical experience that SAPB anesthetizes the axillary region, as well as the superficial structures of the lateral thorax.

The fact that SAPB only blocks the lateral cutaneous branches of intercostal nerves, and thus fails to block the medial aspect of the breast, promoted the idea that a combination of fascial blocks could provide a clue for analgesia of the whole breast (19). PIFB was

Table 3. *Comparison between the 2 studied groups according to VAS.*

VAS	Group 1 (SAPB) (n = 30)	Group 2 (SAPB+PIFB) (n = 30)	U	*P*
30 min				
Median (Min-Max)	0.5 (0-2)	0.5 (0-2)	450.0	1.000
1 h				
Median (Min-Max)	1 (0-2)	1 (0-2)	418.50	0.609
4 h				
Median (Min-Max)	1 (0-4)	1 (0-2)	402.0	0.409
8 h				
Median (Min-Max)	1 (1-4)	1 (1-5)	402.50	0.422
12 h				
Median (Min-Max)	1 (1-2)	1 (0-4)	424.0	0.664
16 h				
Median (Min-Max)	2 (1-4)	1 (0-4)	387.50	0.302
20 h				
Median (Min-Max)	1 (1-2)	1 (0-2)	440.0	0.859
24 h				
Median (Min-Max)	1 (1-2)	1 (0-2)	365.50	0.117

VAS: Visual Analog Scale; SAPB: serratus anterior plane block; PIFB: pectointercostal fascial plane block; U: Mann-Whitney test; *P*: *P* value for comparing the 2 studied groups

Table 4. *Comparison between the 2 studied groups according to patient and surgeon satisfaction.*

Satisfaction	Group 1 (SAPB) (n = 30)	Group 2 (SAPB+PIFB) (n = 30)	χ^2	MCP
Patient				
3	1 (3.3%)	1 (3.3%)	1.194	1.000
4	1 (3.3%)	0 (0.0%)		
5	28 (93.3%)	29 (96.7%)		
Surgeon				
2	2 (6.7%)	0 (0.0%)	2.843	0.496
3	4 (13.3%)	2 (6.7%)		
4	1 (3.3%)	1 (3.3%)		
5	23 (76.7%)	27 (90.0%)		

SAPB: serratus anterior plane block; PIFB: pectointercostal fascial plane block; χ^2: chi-square test; MC: Monte Carlo; *P*: *P* value for comparing the 2 studied groups

introduced by de la Torre et al (11) by injecting the LA between the pectoralis major muscle and the external intercostal muscle in the interfacial plane where the anterior cutaneous branch of the intercostal nerve emerges from the lateral aspect of the sternum.

Thus, combining SAPB and PIFB provided superior intraoperative analgesic properties than SAPB alone. Whereas, the number of patients who needed postoperative rescue morphine, time for the first rescue analgesia, first morphine dose (mg), total opioid consumption, and VAS did not show significant statistical differences between the 2 groups, which can be explained by the progressive and gradual distribution of LA to the anterior hemithorax due to the anatomical continuity of the fascial plane to the midclavicular line (20).

In our study, surgeon satisfaction with the surgical field was higher, but statistically insignificant in Group 2 (SAPB+PIFB).

In contrast to the problems faced by Bakshi et al (21) after PECS block, the use of electrocautery may be restricted by the potential of the LA to disseminate along the fascial planes, which was clarified by the longer time elapsed from the initiation of the block until the start of the surgery, as well as the proximity of the block site to the surgery field. This is unlikely to be an issue with SAPB and PIFB.

The clinical significance of the addition of PIFB to SAPB was evident intraoperatively in the current study in the form of a significant reduction in the number of patients who required top-up fentanyl and the reduction in intraoperative heart rate and MABP with better surgical field and surgeon satisfaction. However, there were no significant postoperative changes in VAS and opioid requirements between the 2 groups, setting the need for a large multicenter study to evaluate the efficacy of the addition of PIFB to reduce postoperative opioids. Moreover, we may suggest increasing the volume of LA to 20-30 mL or adopting multiple injections (2 or 3 injections at T2, T4, and T6 parasternal lines) to increase the efficacy of PIFB (22-25).

Limitations

This study was limited by the potential for a varied impact of breast mass location on postoperative pain, as well as the lack of VAS recording during movements. Furthermore, no follow-up was conducted to detect the potential effect on chronic postmastectomy pain. After reviewing the literature, no efficient data were found regarding the addition of PIFB with different regional blocks for breast surgery.

Conclusions

The number of patients who needed intraop-

erative fentanyl, MABP, and heart rate were all significantly lower in the Group 2 (SAPB+PIFB). Postoperative vital signs, VAS scores, postoperative analgesic requirements, and opioid consumption were comparable for both groups. Patient satisfaction was comparable and statistically not significant for both groups, while surgeon satisfaction was higher in Group 2 (SAPB+PIFB) but statistically not significant.

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