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The Efficacy of Different Volumes on Ultrasound-Guided Type-I Pectoral Nerve Block for Postoperative Analgesia After Subpectoral Breast Augmentation: A Prospective, Randomized, Controlled Study

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Abstract

Background PECS type-1 block, a US-guided superficial interfacial block, provides effective analgesia after breast surgery. Aesthetic breast augmentation is one of the most common surgical procedures in plastic surgery. Subpectoral prostheses cause severe pain. The aim of this study was to investigate the effect of different volumes of the solution on the efficacy of PECS type-I block for postoperative analgesia after breast augmentation surgery.

Methods Ninety ASA status I–II female patients aged between 18 and 65 years who scheduled breast augmentation surgery under general anesthesia were included in this study. The patients were randomly divided into three groups of 30 patients each (Group 20 = 20 ml of anaesthetic solution, Group 30 = 30 ml anaesthetic solution, and Group K = Control group). Postoperative assessment was performed using the VAS score. The VAS scores were recorded postoperatively at 1, 2, 4, 8, 16 and 24 h.

Results Fentanyl consumption was statistically significantly lower in Group 20 and Group 30 compared to the Control group ($p < 0.05$). There was no statistically significant difference in fentanyl consumption between Group 20 and Group 30. The right and left VAS scores were statistically significantly lower in Groups 20 and 30 than in the Control group ($p < 0.05$). There was no statistical difference in terms of VAS scores between Group 20 and Group 30. The use of rescue analgesia was statistically lower in Groups 20 and 30.

Conclusions PECS type-1 block using 20 ml of 0.25% bupivacaine can provide effective analgesia after breast augmentation surgery.

Level of Evidence IV This journal requires that authors assign a level of evidence to each article. For a full description of these evidence-based medicine ratings, please refer to the Table of Contents or the online Instructions to Authors www.springer.com/00266.

Keywords PECS type-1 block · Breast augmentation · Postoperative analgesia

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Introduction

Aesthetic breast augmentation procedure has a significant effect on women's body appearance as well as psychological and sexual well-being. It is one of the most common surgical procedures in plastic surgery [1]. However, subpectoral prostheses cause severe pain during the postoperative period because of the surgical dissection, damage to the muscles, and expansion of breast tissues [2]. Opioids are prescribed to alleviate these problems. However,

increased opioid use causes side effects such as nausea, vomiting, sedation, and long hospital stay [3]. Alternative methods have been explored for improving patient comfort and providing effective analgesia [4].

In recent years, increasing use of ultrasound (US) in anesthesia has caused significant improvements in regional anesthesia practice. PECS type-1 block, a US-guided superficial interfacial block defined by Blanco in 2011, provides effective analgesia after breast surgery. It is easy to use and the complication rate is relatively lower [5]. Local anaesthetic solution is injected into the interfacial area between the pectoralis major muscles (PMm) and the pectoralis minor muscles (Pmm). It has been emphasized that PECS type-I block can provide effective analgesia after subpectoral prothesis surgery [5].

In the literature, there are some studies about different techniques for postoperative analgesia after breast augmentation [6–9]. There have been studies about PECS block for postoperative analgesia after reconstructive breast surgery [10–13], but studies on PECS block efficacy for breast augmentation surgery are limited [14]. Furthermore, in the literature there has been no emphasis on the concentration and volume of local anaesthetic solution.

The aim of this study was to investigate the effect of different volumes of the solution on the efficacy of PECS type-I block for postoperative analgesia after breast augmentation surgery. The primary outcome was opioid consumption at the first 24 h. Secondary outcomes were pain scores (VAS), use of rescue drug, and nausea and vomiting.

Materials and Methods

The study received approval from the local ethics committee. Informed consent was obtained from all patients. Ninety ASA status I–II female patients aged between 18 and 65 years who scheduled breast augmentation surgery under general anesthesia were included in this study. Patients with a bleeding diathesis history, receiving anticoagulant treatment, history of allergy or sensitivity to local anaesthetics and opioids, infection at the skin of the block site, major cardiopulmonary disorders, renal or liver dysfunction, chest wall deformity, pregnancy, breast feeding were excluded from the study as well as those who refused to undergo the procedure.

The patients were randomly divided into three groups of 30 patients each (Group 20 = 20 ml of anaesthetic solution, Group 30 = 30 ml anaesthetic solution, and Group K = Control group) using a computer program before they arrived to the operation room.

General Anesthesia

In the operation room patients were monitored by electrocardiography (ECG), peripheral oxygen saturation (SpO2), and noninvasive blood pressure (NIBP). Premedication with 2 mg intravenous midazolam was administered to all patients. 2–2.5 mg/kg i.v. propofol, 1–1.5 mcg/kg i.v. fentanyl, 0.6 mg/kg i.v. rocuronium were administered to induce general anesthesia and then patients were intubated. Anesthesia was maintained with 1–2% sevoflurane in a 50/50 oxygen–air mixture and i.v. 50 mcg/h remifentanil infusion. Tidal volume at 6–8 ml/kg, frequency at 12–14/min, and end tidal at CO_2 30–35 mmHg were adjusted for ventilation. If the heart rate or mean blood pressure increased by 20% from the preoperative value, 25 mcg bolus fentanyl and 0.1 mg/kg rocuronium i.v. were administered. All patients underwent subpectoral breast augmentation with the same technique including a submammarian incision by the same surgical team.

PECS Block

PECS type-1 block was performed bilaterally to Group 20 and Group 30 at the end of the surgery before extubation. Under aseptic conditions, a high-frequency linear US probe (11–12 MHz, Vivid Q, Ge Healthcare, US) covered with a sterile sheath was placed sagittally between the lateral end of the clavicle and the acromioclavicular joint. The pectoralis major and minor muscles were visualized on the artery after visualization of the subclavian artery and vein in the first costae level (Fig. 1).

Local anaesthetic solution including 20 ml and 30 ml of 0.25% bupivacaine was administered to Group 20 and Group 30, respectively, into the interfacial space between the two muscles using in-plane technique with a 50 mm block needle (Braun 360°). The same procedure was repeated for the other breast (Figs. 2, 3).

A volume of 4 mg of ondansetron i.v. was administered to all patients 30 min before the end of the surgery. Patients were antagonized using 0.01 mg/kg atropine i.v. and 0.02 mg/kg neostigmine i.v. Patients with sufficient spontaneous respiration were extubated and then transferred to the PACU. Patients who reached 12 points on the Aldrete scoring system were shifted to the ward.

Postoperative Analgesia Management

Tramadol 0.5 mg/kg i.v. was administered to all patients 20 min before the end of the surgery. Patients were administered paracetamol 1 gr i.v. every 8 h in the postoperative period. A patient-controlled device prepared with 10 mcg/ml of fentanyl was attached to all patients with a protocol that included 10 mcg of bolus without infusion

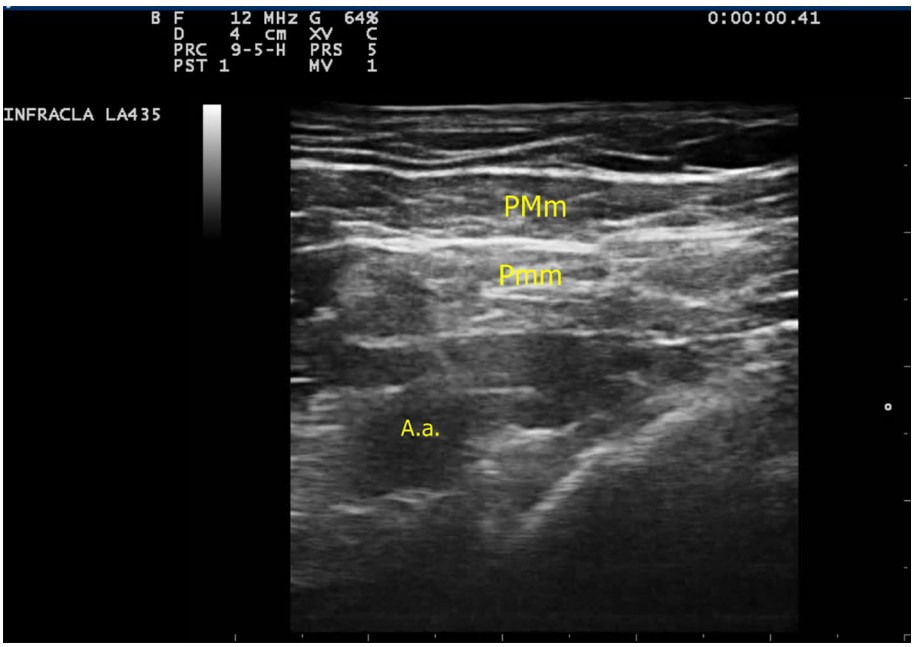

Fig. 1 Sonographic anatomy of Pecs type-1 block. A.a. indicates axillary artery

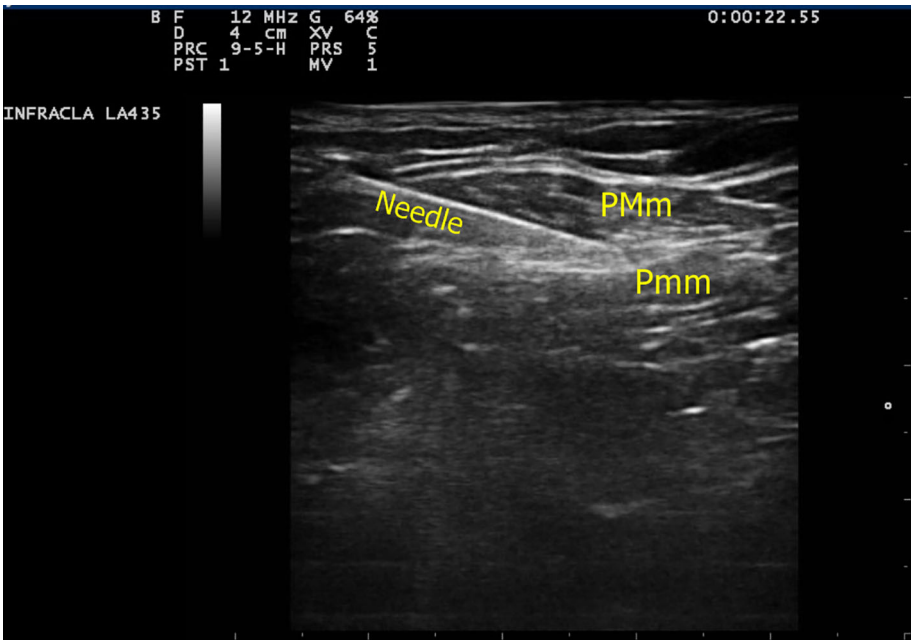

Fig. 2 Ultrasound image of needle direction between the muscles

dose, 10 min of lockout time, and a 4 h limit. Postoperative patient evaluation was performed by an anaesthesiologist blinded to the procedure.

Postoperative pain assessment was performed using the VAS score (0 = no pain, 10 = the most severe pain felt). The right side and left side VAS scores were recorded postoperatively at 1, 2, 4, 8, 16 and 24 h. If the VAS score was $\geq$ 4, 0.25 mg/kg meperidine i.v. was administered. If the patient still felt pain, another dose was administered after 15 min. The sedation level was assessed with a 4-point sedation scale (0 = awake, eyes open, 1 = sleepy but responding to verbal stimulus, 2 = sleepy and hard to evoke, and 3 = sleepy, not aroused by shaking).

Side effects were recorded postoperatively. Patients with nausea or vomiting lasting longer than 10 min were administrated 4 mg ondansetron i.v.

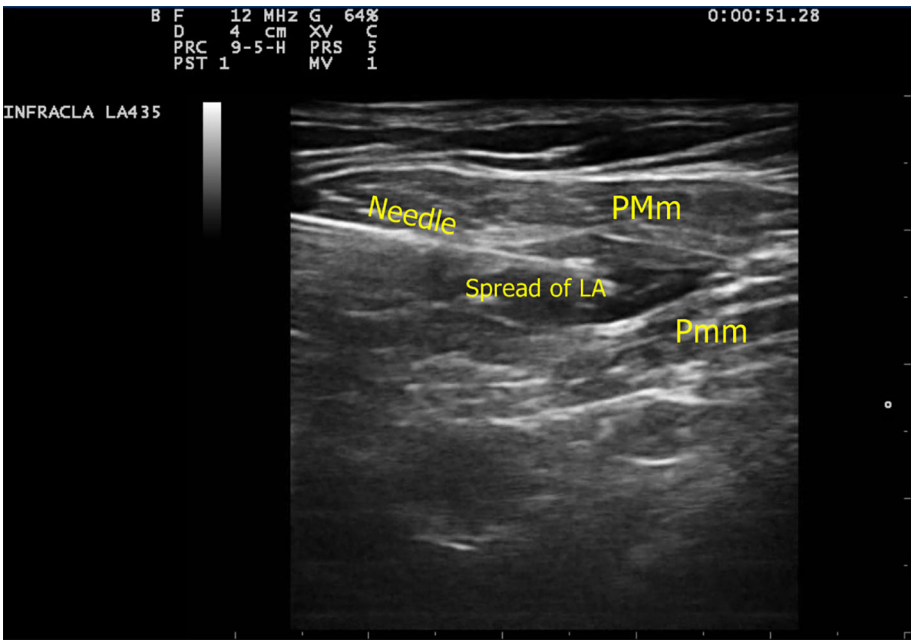

Fig. 3 Spread of local anaesthetic at the plane. LA indicates local anaesthetic

Statistical Analyses

According to the power analysis used total fentanyl consumption variable, the effect size was determined as 48.61 and the power was 0.99 in 95% confidence interval and 0.05 significance level (n_1: 30, n_2: 30, n_3: 30, x_1: 361.60 ± 59.08, x_2: 406.80 ± 105.72, x_3: 479.60 ± 38.00). This result shows that the study sample is sufficient. Statistical analysis was performed using the IBM SPSS 20.0 statistical program. The Kolmogorov–Smirnov test was used to evaluate data distributions. Pearson's χ^2 test was used to evaluate the categorical data. One-way ANOVA or Tukey's test was used to evaluate continuous variables which were normally distributed among groups. Descriptive data were expressed as mean ± SD. p value < 0.05 is considered as statistically significant.

Results

A total of 90 women undergoing breast augmentation surgery were included in this study and divided into three groups. There were no statistically significant differences between the groups in terms of age, weight, height, ASA classification, and duration of surgery ($p > 0.05$) (Table 1). The results are presented in a Consolidated Standards of Reporting Trials (CONSORT) flow diagram (Fig. 4).

Fentanyl consumption was statistically significantly lower in Group 20 and Group 30 at all time periods (1, 2, 4, 8, 16, 24) compared to the Control group ($p < 0.05$). However, there was no statistically significant difference in fentanyl consumption between Group 20 and Group 30 at all time periods (Table 2). The right and left VAS scores at all time periods (1, 2, 4, 8, 16, 24) were statistically significantly lower in Group 20 and 30 than in the Control group ($p < 0.05$). However, there was no statistical difference in terms of VAS scores between Group 20 and Group 30 at all time periods (Table 3). The use of rescue analgesia was statistically lower in Groups 20 and 30 compared to the control group; however, there was no statistically significant difference between the Groups 20 and 30 (Table 4).

The incidence of vomiting was higher in the control group than in the other groups, but there was no statistical difference between Groups 20 and 30. Complications related to PECS block type-1 (pneumothorax, hematoma, local anaesthetic toxicity, etc.) were not observed during the study period (Table 4).

Discussion

This prospective randomized controlled study showed that performing PECS type-1 block alone resulted in lower VAS scores after subpectoral breast augmentation and decreased opioid consumption. There was no difference between Group 20 and Group 30 in terms of VAS scores and opioid consumption. In addition, the incidence of vomiting was lower in PECS type-1 block groups.

Various techniques can be performed for postoperative analgesia management after bilateral breast augmentation surgery. These techniques are not limited and include use of opioid as well as thoracic paravertebral, thoracic epidural, intercostal, and PECS blocks [6, 8, 9, 14].

Table 1 Demographic data of the Control group, Group 20, and Group 30

	Control group (n = 30)	Group 20 ml (n = 30)	Group 30 ml (n = 30)	p value
Age (years)	38.17 ± 7.56	37.2711.15	38.67 ± 6.21	0.814[α]
Weight (kg)	73.90 ± 8.88	68.97 ± 16.00	74.27 ± 9.43	0.162[α]
Height (cm)	164.63 ± 7.62	163.50 ± 4.82	165.70 ± 6.55	0.420[α]
ASA (I/II)	20/10	25/5	21/9	0.303[β]
Duration of surgery (min)	152.66 ± 5.58	153.96 ± 5.50	156.06 ± 7.04	0.098[α]
Operative procedures (1/2)	16/14	15/15	18/12	0.731[β]

Values are expressed as mean ± standard deviation or only number

ASA American Society of Anesthesiologists

1, reduction mammoplasty; 2, augmentation mammoplasty

[α]$p > 0.05$, one-way ANOVA between groups; [β]$p > 0.05$, Chi-squared test between groups

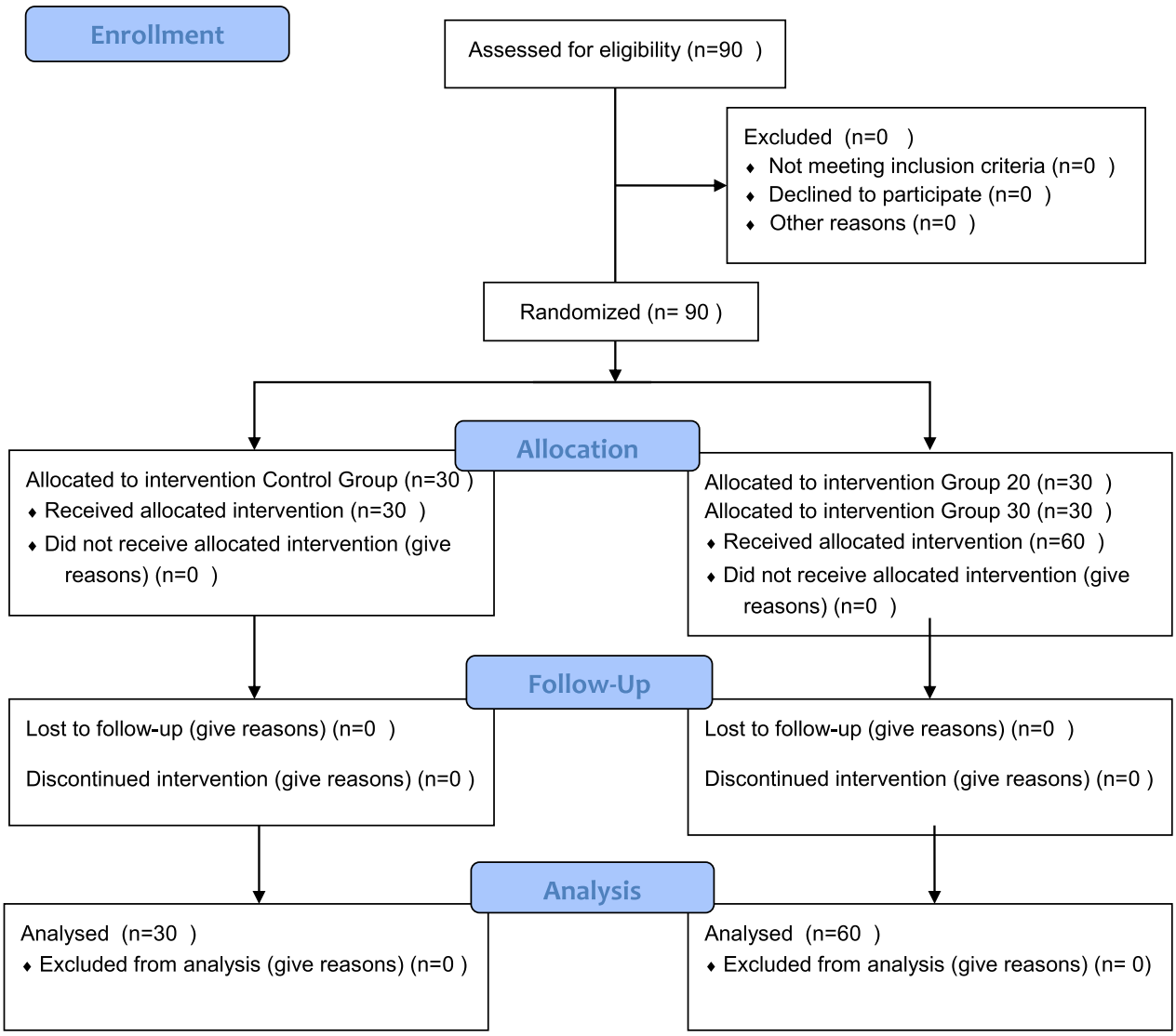

Fig. 4 Consolidated standards of reporting trials (CONSORT) flow diagram of study

Table 2 Comparison of fentanyl consumption (mcg) between Control group, Group 20 and Group 30

Postoperation hour	Control group (n = 30)	Group 20 (n = 30)	Group 30 (n = 30)	p value
1	108.66 ± 30.48	54.00 ± 24.71$^{\alpha}$	50.00 ± 18.75$^{\alpha}$	< 0.001
2	144.00 ± 36.16	81.33 ± 34.0$^{\alpha}$	79.66 ± 34.68$^{\alpha}$	< 0.001
4	168.00 ± 42.21	115.33 ± 47.75$^{\alpha}$	111.00 ± 58.27$^{\alpha}$	< 0.001
8	200.00 ± 45.78	150.66 ± 66.79$^{\alpha}$	136.33 ± 76.67$^{\alpha}$	0.001
16	224.66 ± 48.33	1776.66 ± 80.87$^{\alpha}$	163.00 ± 92.14$^{\alpha}$	0.006
24	257.33 ± 51.65	201.33 ± 96.26$^{\alpha}$	182.33 ± 111.15$^{\alpha}$	0.005

Values are expressed as mean ± standard deviation

$^{\alpha}p < 0.05$, one-way ANOVA compared with Control group

Table 3 The comparison of right and left sides VAS values between Control group, Group 20 ml and Group 30 ml

VAS	Control group (n = 30)	Group 20 ml (n = 30)	Group 30 ml (n = 30)	p value
Right, at 1 h	6.00 ± 1.36	4.43 ± 1.71$^{\alpha}$	4.10 ± 1.74$^{\alpha}$	< 0.001
Right, at 2 h	5.43 ± 1.22	3.67 ± 1.62$^{\alpha}$	3.23 ± 2.22$^{\alpha}$	< 0.001
Right, at 4 h	5.00 ± 1.11	3.03 ± 1.42$^{\alpha}$	2.30 ± 1.62$^{\alpha}$	< 0.001
Right, at 8 h	4.63 ± 0.99	2.37 ± 1.12$^{\alpha}$	1.70 ± 1.29$^{\alpha}$	< 0.001
Right, at 16 h	3.80 ± 0.99	2.07 ± 1.23$^{\alpha}$	1.43 ± 1.00$^{\alpha}$	< 0.001
Right, at 24 h	2.97 ± 0.66	1.40 ± 0.72$^{\alpha}$	0.93 ± 0.785$^{\alpha}$	< 0.001
Left, at 1 h	5.67 ± 1.53	4.23 ± 1.22$^{\alpha}$	4.33 ± 1.88$^{\alpha}$	0.001
Left, at 2 h	5.43 ± 1.22	3.63 ± 1.45$^{\alpha}$	3.47 ± 2.19$^{\alpha}$	< 0.001
Left, at 4 h	5.00 ± 1.11	3.13 ± 1.54$^{\alpha}$	2.47 ± 1.90$^{\alpha}$	< 0.001
Left, at 8 h	4.63 ± 0.99	2.50 ± 1.33$^{\alpha}$	1.77 ± 1.38$^{\alpha}$	< 0.001
Left, at 16 h	3.70 ± 0.91	1.97 ± 1.12$^{\alpha}$	1.50 ± 1.22$^{\alpha}$	< 0.001
Left, at 24 h	3.27 ± 0.82	1.37 ± 0.85$^{\alpha}$	0.93 ± 0.86$^{\alpha}$	< 0.001

Values are expressed as mean ± standard deviation

VAS visual analog scale

$^{\alpha}p < 0.05$, one-way ANOVA compared with Control group

Table 4 Comparison of the adverse events and rescue drug use

	Control group (n = 30)	Group 20 ml (n = 30)	Group 30 ml (n = 30)	p value
Nausea (yes/no)	14/16	5/25$^{\alpha}$	4/26$^{\alpha}$	0.005
Vomiting (yes/no)	12/18	2/27$^{\alpha}$	3/27$^{\alpha}$	0.001
Rescue drug (yes/no)	30/0	19/11$^{\alpha}$	15/15$^{\alpha}$	< 0.001
Pneumothorax	0	0	0	1
Haematoma	0	0	0	1
Local aesthetic toxicity	0	0	0	1

Values are expressed as mean

$^{\alpha}p > 0.05$, Chi-squared test compared with Control group

Opioids are frequently preferred, but they have side effects such as sedation, dizziness, nausea, vomiting, addiction, tolerance, and respiratory depression (opioid-related side effects) and do not affect the underlying pathological process of pain and inflammation [15, 16]. Intercostal nerve blocks require multiple injections and can cause complications such as pneumothorax, intravascular injection, pain in the injection area, and abscess [17]. Thoracic epidural analgesia is the gold standard for breast surgery, and paravertebral block is as effective as thoracic epidural analgesia [10]; however, both techniques can cause serious complications such as spinal cord injury, dural puncture, total spinal anesthesia, and pneumothorax [18]. PECS block was defined by Blanco in 2011 after the

use of ultrasound was suggested and a better understanding of neural support of the anterior chest wall and breast tissue [5]. The PECS block is a new interfacial plane block, and two applications of PECS block, type 1 and type 2, have been defined. The advantages of the block are that it is superficial and that it is possible to have a better visualization of the pleural and vascular structures with use of ultrasound; thus it can avoid complications unlike pneumothorax and vascular injury. The neural supply of the chest wall includes three groups [10]: the first group is the medial pectoral nerve located under the pectoralis minor, and the lateral pectoral nerve (C5–7) underlying between the pectoralis major and the minor (C8–1). These two nerves innervate both pectoralis major and pectoralis minor muscles. The pectoral nerves defined as motor nerves, but it was recommended that they also have proprioceptive and nociceptive fibers like the other motor nerves [12]. The second group is the spinal nerves (T2–6) present between the intercostal muscles and forming the lateral and anterior branches supporting the chest wall. Thoracic nerve roots are divided into dorsal and ventral branches after leaving through the intervertebral foramen. Dorsal branches provide muscle and sensory innervation of the paravertebral area. The ventral branches move towards the ribs to the lateral site and are named intercostal nerves. The lateral cutaneous branch of the intercostal nerve provides innervation of the skin and muscles of the lateral chest wall. The anterior cutaneous branch penetrates the PMm and provides innervation of the medial site of the breast [19, 20]. The third group is the long thoracic nerve (C5–7) and the thoracodorsal nerve; the former innervates the serratus anterior and the latter innervates the latissimus dorsi muscle. Intercostal nerve block does not provide effective analgesia after subpectoral implants due to the pain being transported via the thoracoacromial trunk compared to the intercostal nerves [21]. It has been reported that PECS type-1 block could be effective since the pectoralis major muscles involved in breast augmentation surgeries used sub pectoral prosthesis [5]. The Pecs block is a combination of motor and sensory nerve blocks [12]. It has been emphasized that type-2 block should be performed for mastectomy and axillary dissection surgeries [5]. Therefore, we performed only type-1 block in our study.

Studies have evaluated the effectiveness of PECS type-1 and type-2 blocks for postoperative analgesia management after breast surgery [10–14]. They reported that administration of a PECS block is effective by reducing VAS scores and opioid consumption for postoperative analgesia. Bashandy et al. [12] and Morioka et al. [13] reported that administration of PECS block did not affect the incidence of postoperative nausea and vomiting; however, in our study, we saw that the PECS block groups had lower incidences of vomiting due to reduced use of opioid. To the best of our knowledge, our study is the first to compare the different drug volumes for performing PECS type-1 block alone for postoperative analgesia management after breast augmentation surgery using subpectoral prosthesis.

Karaca et al. [14] reported that the postoperative VAS scores and opioid consumption were lower in the block group in their study evaluating the efficacy of combined PECS type-1 and 2 blocks on postoperative analgesia management for patients undergoing breast augmentation surgery using prothesis. They administered 10 ml of 0.25% bupivacaine 10 for PECS type-1 and 20 ml PECS type-2 groups, and a total of 30 ml volume was used. In our study, we aimed to compare the different volumes of local anaesthetics by performing only PECS type-1 block; thus, we administrated 20 ml of 0.25% bupivacaine for one group and 30 ml for another. We found that the PECS type-1 block using 20 ml was efficient for postoperative analgesic management after breast augmentation surgery. Therefore, for these types of surgeries, it can be said that performing a PECS type-2 block is not necessary. We administrated bupivacaine in a dilute concentration because of the risk of toxicity [22, 23], and our opinion is that the block using a low volume of bupivacaine will be effective.

Cros et al. [24] reported that PECS type-1 block was not effective in the management of postoperative analgesia in their study. Patients underwent mastectomy and axillary lymph node dissection as a surgical procedure. When compared with the results obtained in our study, PECS type-1 block is effective for postoperative analgesia after breast augmentation surgery.

There are some limitations of this study. Firstly, we administered two different volumes in our study. Large-scale studies with lower volumes can be performed. Secondly, we performed the block before extubation at the end of surgery. The block could be performed pre-emptively before the surgical procedure. Lastly, the sample size was determined according to the postoperative opioid consumption, which was the primary aim of the study. Further studies with a larger sample size may be needed.

Conclusion

We conclude that PECS type-1 block using 20 ml of 0.25% bupivacaine can provide effective analgesia after breast augmentation surgery.

Compliance with Ethical Standards

Conflict of interest The authors report no conflicts of interest.

Ethical Approval The study received approval from the local ethics committee.

Informed Consent Informed consent was obtained from all patients.

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