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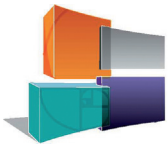

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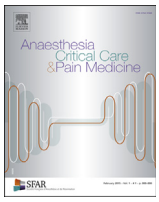

Original Article

The efficacy of ultrasound-guided type-I and type-II pectoral nerve blocks for postoperative analgesia after breast augmentation: A prospective, randomised study

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ABSTRACT

Purpose: The present study was planned to evaluate the efficacy and safety of ultrasound-guided Pecs I and II blocks for postoperative analgesia after sub-pectoral breast augmentation.
Methods: Fifty-four adult female patients undergoing breast augmentation were randomly divided into two groups: the control group (Group C, $n = 27$) who were not subjected to block treatment and Pecs group (Group P, $n = 27$) who received Pecs I (bupivacain 0.25%, 10 mL) and Pecs II (bupivacain 0.25%, 20 mL) block. Patient-controlled fentanyl analgesia was used for postoperative pain relief in both groups, and the patients were observed for the presence of any block-related complications.
Results: The 24-h fentanyl consumption was smaller in Group P [mean ± SD, 378.7 ± 54.0 μg and 115.7 ± 98.1 μg, respectively; $P < 0.001$]. VAS scores in Group P were significantly lower at the time of admission to the post-anaesthetic care unit and at 1, 2, 4, 8, 12, and 24 h ($P < 0.001$). The rates of nausea and vomiting were higher in Group C than in Group P (9 vs 2, $P = 0.018$). Hospital stay duration was shorter in Group P than in Group C (24.4 ± 1.2 h vs 27.0 ± 3.1 h, $P < 0.001$). No block-related complications were recorded.
Conclusions: Combine used of Pecs I and II blocks provide superior postoperative analgesia in patients undergoing breast augmentation and shortens hospital stay.

1. Introduction

Breast augmentation, the most common surgical procedure in aesthetic plastic surgery [1], requires effective pain management techniques to decrease postoperative pain and thereby facilitate rapid recovery. Particularly, the placement of tissue expanders under the chest wall during breast implantation may give rise to postoperative pain [2]. With the recent application of ultrasound (US) in anaesthetic practice, the pectoral nerves (Pecs) block types I and II have recently been developed as novel interfascial plane blocks which can assure analgesia after breast surgery [3,4]. This is a superficial block technique in which local anaesthesia is injected between the pectoralis major muscle (PMm) and pectoralis minor muscle (Pmm) for a Pecs I block and between Pmm and serratus anterior muscle (SAm) for a Pecs II block. The injection of local anaesthesia in the interfascial area targeted the blockage of medial and lateral pectoral nerves, long thoracic nerve (LTN), thoracodorsal nerve (TDN), and anterior divisions of the thoracic intercostal nerves from T2 to T6 [5].

In the literature, there are studies on various block methods and local anaesthetic infiltration for postoperative analgesia in breast augmentation [6–9]. However, we have not yet encountered the use of postoperative Pecs blocks in breast augmentation or other breast surgeries.

Our hypothesis was that bilateral Pecs block application would provide superior postoperative analgesia after breast augmentation compared to general anaesthesia. Our primary outcome

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measure was the comparison of fentanyl consumption during the first postoperative day between the two groups. Secondary outcomes were the postoperative visual analogue scale (VAS) pain scores, postoperative nausea and vomiting (PONV), and postanaesthetic care unit (PACU) stay, and discharge time.

2. Materials and methods

Our study was conducted at Baskent University, Konya Medical and Research Centre, after receiving ethical permission from the ethical committee of this university (KA 16/358). The study was registered in the Australian New Zealand Clinical Trials Registry (No: ACTRN 12617000687392).

Female patients aged between 20 and 64 years who underwent breast augmentation under general anaesthesia between June and October 2017 were included in the study after obtaining oral and written informed consent from them.

Patients with pre-existing infection at the block site, coagulopathy, morbid obesity (BMI $>$ 40 kg/m^2), allergy to local anaesthetics, decreased pulmonary reserve, major cardiac disorders, renal and liver dysfunction, pre-existing neurological deficits, and psychiatric illnesses were excluded, as well as those who refused to undergo the Pecs block technique and postoperative evaluation.

Patients were randomly assigned by a computerised process into two groups, each including 27 patients. After their arrival at the induction room, intravenous premedication (midazolam 0.02 mg/kg) was administered to all patients. Group P received the Pecs blocks, while Group C, the control group, did not. Age, height, and American Society of Anesthesiologists (ASA) score of patients were recorded when they were taken into the operating room. Throughout the surgery, the patients were monitored using standard techniques, including electrocardiography and peripheral oxygen saturation (SpO_2) and non-invasive blood pressure (NIBP) measurements, and their data was recorded. Patients were intubated using 1–1.5 μg/kg fentanyl, 2 mg/kg propofol, and 0.6 mg/kg rocuronium for anaesthesia induction. Tidal volume was adjusted at 6–8 ml/kg. Anaesthesia was maintained by 2% sevoflurane in a 50/50 oxygen/nitrogen mixture.

2.1. Pec procedure

At the end of the surgery, Pecs blocks were applied to both breasts of only Group P patients under anaesthesia. Under aseptic conditions, blocks were first applied to one breast and later to the other. After passing to the side to which block would be applied, in order to display the block easier, a sort of towel was placed under the scapula to elevate it, and the block was applied when the arm was in parallel to the body. A high-frequency linear US probe covered with a sterile sheath (6–13 MHz, SonoSite M-Turbo, SonoSite Inc., Bothell, WA, USA) was placed longitudinally in the subclavian area where its lateral meets the coracoid process. Once the axillary artery was visible, the US probe was moved towards the caudal side of the axillary artery and then placed laterally so as to see the second rib; subsequently, it is further moved towards the caudal side to observe the third rib. When the US probe was placed laterally at an angle of 45°, PMm, Pmm, and SAm on the fourth rib were visualised. At the anterior axillary level or mid-axillary level (preferred for obtaining a better image when prosthesis volume is high), via the in-plane technique, Pecs II was first applied by injecting 20 mL of 0.25% bupivacaine in a cephalad to caudad direction, using a Stimuplex needle (Stimuplex® Ultra 360™, 30° bevel, 20 G (100 mm), B. Braun, Melsungen AG, Germany), to the fascia on SAm; then, Pecs I was applied by withdrawing the needle to the fascia between PMm and Pmm and injecting 10 mL of 0.25% bupivacaine in a medial to lateral direction. The study was conducted by three blinded anaesthesiologists. The first investigator (O.K.) only applied the blocks and was not involved in either preoperative or postoperative assessment of the patient or in anaesthesia management. The second investigator managed anaesthesia during the surgery. The third investigator evaluated postoperative pain and adverse effects.

All patients were given 4 mg of intravenous ondansetron approximately 20 min before the end of the surgery. Patients were antagonised using atropine and neostigmine in Group P after the block placement and in Group C after the breast surgery. They were extubated after reaching a sufficient tidal volume. Following extubation, they were taken to the PACU. The time spent by patients in the PACU was recorded. When the patients obtained 12 points on the Aldrete's scoring system, they were shifted to the ward.

2.2. Surgical procedure

In this study, sub-mammary incision and sub-pectoral placement were preferred for breast augmentation. While under general anaesthesia, the patients were cleaned by placing them in the supine position and their arms were arranged at right angles to the thorax. After making an initial incision, dissection was continued through the fascia of Scarpa until the pre-pectoral fascia was identified. Next, the pre-pectoral fascia was incised horizontally, and the lateral border of the PMm was elevated from the supracostal area. After further checking the pockets to ensure haemostasis, the implants were introduced via a no-touch technique. Finally, the multilayer closure was performed using absorbable sutures. Once this process was complete, the wound was dressed. A single surgeon (E.A.) performed every surgery. No patient underwent surgical drainage.

2.3. Postoperative pain management

Thirty minutes before the end of the surgery, all patients were intravenously administered 0.5 mg/kg tramadol HCl. After the surgery, 50 mg dexketoprofen was intravenously administered once every 12 h. A patient-controlled analgesia (PCA) device, which was prepared using fentanyl, was attached to the patients and was programmed to administer 10 μg/ml fentanyl (25 μg bolus dose with a 10-min lockout interval) at a 4-h limit without requiring any basal infusion. This administration continued for 24 h.

Information was provided regarding the use of both the PCA device for maintaining analgesia at PACU as well as VAS for assessing analgesia. Postoperative patient evaluation and block placement were performed by two different blinded anaesthesiologists, respectively.

Postoperative analgesia was assessed using VAS for pain (VAS 0 = no pain, VAS 10 = most severe pain possible). Duration at PACU was recorded right from 0 h. VAS scores during rest and movement at 0, 1, 2, 4, 8, 12 and 24 h were recorded. Active movement was defined as moving from a lying to a sitting position. When the VAS score was $\geq$40, an additional analgesic of 25 mg meperidine HCl was intravenously administered. Sedation levels were monitored using a 4-point sedation scale (0 = awake, eyes open; 1 = asleep but responding to verbal commands; 2 = asleep and difficult to rouse; and 3 = asleep, cannot be roused by shaking).

Side effects including sedation, confusion, headache, dry mouth, itching, nausea, vomiting, and need for antiemetics were recorded. Additionally, the number of times the first analgesic was required (defined as the number of times the patients required the PCA device), opioids were consumed, and meperidine was required were recorded. PONV was evaluated using a 4-point numerical scale (0 = no PONV, 1 = mild nausea, 2 = severe nausea or vomiting once, and 3 = vomiting more than once). If PONV score was $\geq$2, the

antiemetic ondansetron at 0.1 mg/kg was intravenously administered. Moreover, patients were discharged from the hospital based on the protocols followed by the surgical team, which included a pain score of <3 without morphine as well as PONV and sedation scores of 0.

2.4. Statistical analyses

The total dose of fentanyl consumed over the 24-h postoperative period was considered as the primary outcome of the study. In our preliminary study, mean ± standard deviation was 370.0 ± 261.0 μg in Group C and 97.5 ± 77.7 μg in Group P. We aimed to detect a difference of ≥200 μg in fentanyl consumption between the two groups in the 24-h postoperative period. According to Russ Lenth's Piface Java module, we calculated that 25 patients would be needed in each group based on a power of 94.35% and an alpha error of 0.05. Assuming a dropout rate of 10%, a total sample size of 54 subjects (27 per group) was therefore planned. SPSS 21.0 statistics software was used for analyses.

Appropriate parametrical or non-parametrical methods of statistical analysis were chosen for comparing Groups C and P on the basis of normality tests. Where measurements were continuous, a *t*-test for two independent samples was used for normally distributed data and a Mann–Whitney *U* test for non-normally distributed data. For analysis of time-dependent periodically repetitive measured data, a *k*-dependent Friedman test was used. Finally, for comparing categorical variables dependent on frequency tables, chi-square test was used. A *P* value of <0.05 was considered to be statistically significant.

3. Results

Eligible patients for this study were analysed in terms of the primary outcomes, and the results are presented in a Consolidated Standards of Reporting Trials (CONSORT) flow diagram (Fig. 1).

The groups were comparable with respect to age, height, weight, ASA physical status, and surgery and anaesthesia duration. The duration of analgesia was significantly prolonged in Group P than in Group C [mean ± SD, 189.8 ± 17.2 vs 173.4 ± 16.4 min; $P < 0.001$] (Table 1).

Fentanyl consumption was lower in Group P than in Group C at all time periods (0–4, 4–8, and 8–12 h). The total fentanyl consumption during the 24-h period was lower in Group P than in Group C [mean ± SD, 115.7 ± 98.1 vs 378.7 ± 54.0 μg; $P < 0.001$] (Fig. 2). Moreover, lower VAS scores at passive and active periods were observed in Group P than in Group C at all test time periods ($P < 0.001$) (Table 2). Moreover, four patients in Group P did not require any analgesic. First analgesic time, requirement for a rescue analgesic, and the difference in breast volume were not statistically significant ($P > 0.05$) (Table 3). Duration of stay in PACU was also significantly shorter in Group P than in Group C [10.1 ± 1.9 min vs 15.2 ± 1.6 min; $P < 0.001$] (Table 3). Furthermore, hospital stay was significantly shorter in Group P than in Group C [24.4 ± 1.2 h vs 27.0 ± 3.1 h; $P < 0.001$] (Table 3).

The incidence of nausea and vomiting was higher in Group C than in Group P ($n = 9$ vs $n = 2$; $P = 0.018$). For other side effects, there was no statistically significant difference between the two groups (Table 3).

There was no significant difference between the groups with respect to hazards ratio, SpO_2, and mean arterial pressure during the perioperative period. No block-related complications, such as

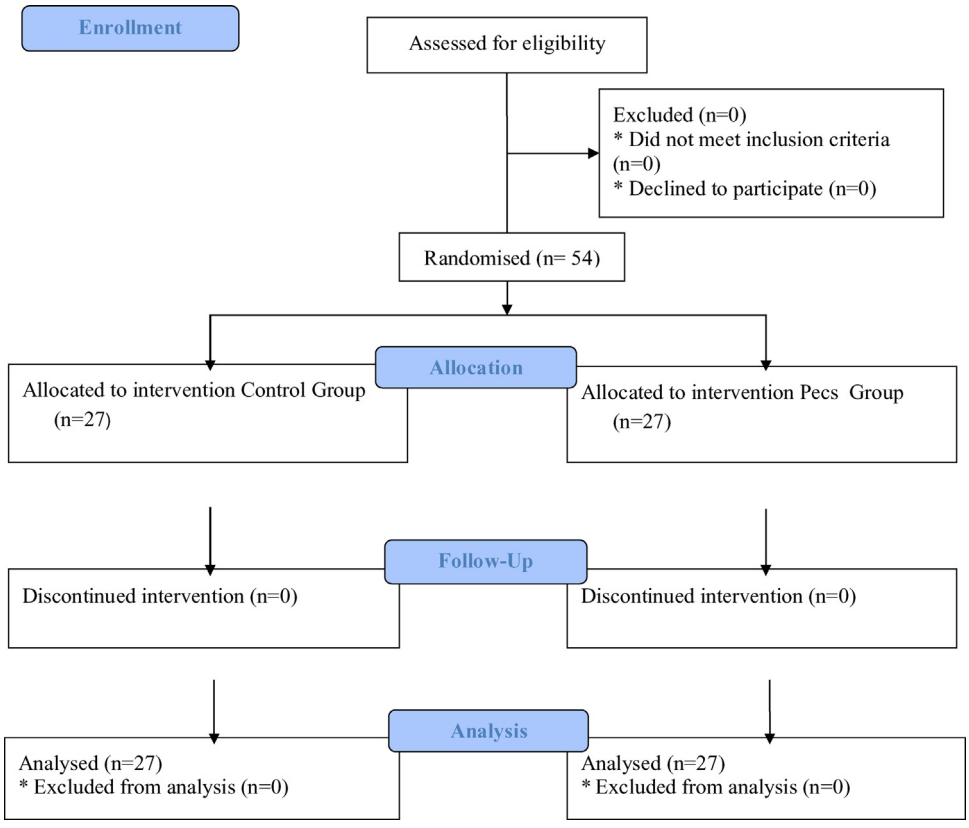

Fig. 1. Consolidated Standards of Reporting Trials (CONSORT) flow diagram of study.

pneumothorax, vascular puncture, and local anaesthetic toxicity were observed.

4. Discussion

In this study, we demonstrated that the combined application of bilateral US-guided Pecs I and Pecs II blocks after sub-pectoral breast augmentation provided lower VAS scores and reduces opioid need during the postoperative period in Group P as opposed to Group C. We also observed that Group P experienced lower incidence of PONV as an opioid-related side effect as well as shorter PACU and hospital stay than Group C, because opioid requirement was needed earlier and higher in Group C.

Various regional techniques can be employed for effective management of postoperative pain following bilateral breast augmentation. These techniques include, but are not limited to, systemic opioid use, intercostal, thoracic paravertebral, thoracic epidural and Pecs blocks [6,8,10]. Using systemic opioids alone has been reported to be insufficient for blockade of nociceptive neurons and preventing central sensitisation induced by cytokines and prostaglandins following tissue injury. This may be due to massive stimulation of peripheral afferent fibres following the insertion of breast prosthesis into the retromuscular pocket and the partial separation of sternal and costal origins of PMm [10–12]. Bilateral multilevel intercostal blocks, indeed, have been associated with the risk of pneumothorax, local anaesthetic toxicity, vascular puncture, abscess and neuritis as well as lack of blocking nerves from brachial and cervical plexuses [6,7]. Despite their advantages regarding efficient analgesia, short hospital and PACU stay and patient satisfaction, thoracic epidural blocks have the risk of more serious complications such as serious haemodynamic deterioration and possible neurologic complications such as dural and spinal cord puncture [13–15], whereas thoracic paravertebral block has been associated with vascular, neuronal, and pleural puncture, cardiac depression, epidural or intrathecal dissemination [7,16].

Pecs block is an interfascial plane block used for anaesthetising breast region by blocking median and lateral pectoral nerves originating from cervical and brachial plexuses, LTN, TDN, and thoracic intercostal nerves from T2 to T6 between the PMm and Pmm as well as between the Pmm and Sam [5,17]. Blanco described Pecs blocks as Pecs I between PMm and Pmm targeting the lateral pectoral nerve and Pecs II between Pmm and Sam to ensure better analgesia for more extended lateral dissection (such as tissue expander insertion) and axillary dissection [3,4]. The main advantages of the block are being a rather superficial block and the better visualisation of pleura by ultrasonography to avoid pneumothorax as well as a good postoperative analgesia. However, there still exists the risk of intravascular injection to the cephalic vein, thoraco-acromial artery or haematoma or winged scapula [16,18] whereas we did not observe such complications in the current study.

Pérez et al. claimed that if Pecs II block was applied on SAm in case of LTN paralysis, winged scapula syndrome might be encountered. They also described the single-needle injection method wherein Pecs II was applied first followed by Pecs I, following withdrawal of the needle [19]. We also applied blocks using the in-plane technique, which involved the single-needle injection method. We first injected on SAm (Pecs II); then, by

Table 1
Demographic characteristic of study patients.

	Group C ($n=27$)	Group P ($n=27$)	P
Age, yr	35.11 ± 6.1	35.26 ± 7.5	0,937[a]
Weight, kg	63.89 ± 10.7	63.07 ± 12.0	0.544[a]
BMI, kg m^{-2}	23.18 ± 3.1	22.84 ± 3.7	0.721[a]
ASA status (I:II)	21/6	19/8	0.535[b]
Duration of surgery, min	168.89 ± 16.4	165.74 ± 17.6	0.500[a]
Duration of anaesthesia, min	173.44 ± 16.4	189.81 ± 17.2	0.001[a,*]

Values are presented as number or mean ± standard deviation. ASA = American Society of Anesthesiologists.
[a] Independent sample t test.
[b] Chi-square test.
[*] $P < 0.05$ is statistically significant.

Table 2
Comparison of VAS scores at postoperative time points.

	Group C	Group P	P
At rest			
At PACU	4.70 ± 1.1	1.70 ± 1.9	<0.001[a,*]
1 h	4.78 ± 0.9	1.00 ± 1.2	<0.001[b,*]
2 h	5.11 ± 1.0	1.26 ± 1.3	<0.001[b,*]
4 h	4.44 ± 1.0	1.37 ± 1.4	<0.001[a,*]
8 h	3.81 ± 1.0	1.00 ± 1.4	<0.001[a,*]
12 h	3.33 ± 0.8	0.33 ± 0.6	<0.001[a,*]
24 h	2.33 ± 0.8	0.07 ± 0.4	<0.001[a,*]
During active movement			
At PACU	6.19 ± 0.9	2.07 ± 2.2	<0.001[a,*]
1 h	5.81 ± 0.8	1.44 ± 1.5	<0.001[a,*]
2 h	5.89 ± 1.1	2.33 ± 1.5	<0.001[b,*]
4 h	5.96 ± 1.3	2.04 ± 1.7	<0.001[b,*]
8 h	4.67 ± 1.2	1.22 ± 1.5	<0.001[b,*]
12 h	4.00 ± 1.1	0.44 ± 0.6	<0.001[a,*]
24 h	3.33 ± 1.0	0.08 ± 0.4	<0.001[a,*]

Values are mean ± standard deviation. PACU = post anaesthesia care unit.
[a] Independent sample the Mann–Whitney U test.
[b] Independent sample t test.
[*] $P < 0.05$ is statistically significant.

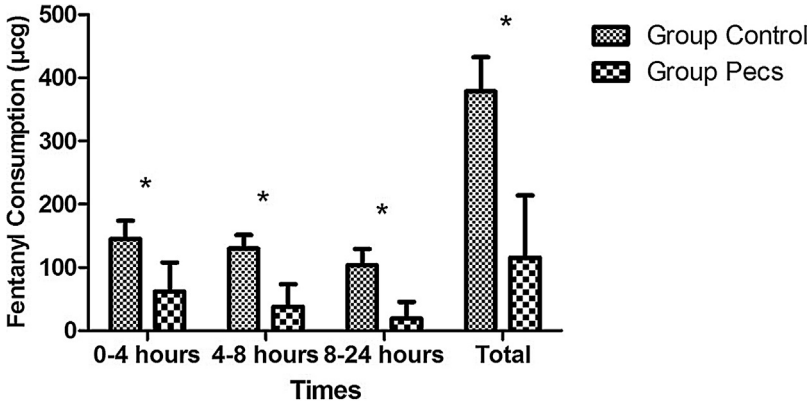

Fig. 2. Fentanyl consumption of groups at postoperative time points. *$P < 0.05$ between groups.

Table 3
Comparison of the first analgesic time, rescue analgesic, breast volume, PACU and hospital stay between groups and incidence of adverse events.

	Group C (*n*: 27)	Group P (*n*: 27)	*P*
The first analgesic time	79.63 ± 31.04	89.13 ± 49.26	0.429[a]
Rescue analgesic	19/8	12/15	0.054[b]
Breast volume (cc)	444.44 ± 233.0	481.48 ± 216.2	0.548[a]
PACU stay (min)	15.15 ± 1.6	10.11 ± 1.9	<0.001[a,*]
Hospital stay (h)	27.03 ± 3.1	24.37 ± 1.2	<0.001[c,*]
Sedation	0	0	1[b]
Nausea/vomiting	9	2	0.018[b,*]
Pruritus	0	0	1[b]
Urinary retention	0	0	1[b]
Pneumothorax	0	0	1[b]
Haematoma	0	0	1[b]
Local anesthetic toxicity	0	0	1[b]

Values are presented as number or mean ± standard deviation. PACU = post anaesthesia care unit.
[a] Independent sample *t* test.
[b] Chi-square test.
[c] Independent sample the Mann–Whitney *U* test.
[*] $P < 0.05$ is statistically significant.

withdrawing the needle, injection was administered to the interfascial area between PMm and Pmm (Pecs I). Also, we did not encounter winged scapula syndrome in any of our patients after applying the Pecs II block on SAm.

Several studies reported the use of Pec I and II blocks preoperatively for various breast surgeries such as radical mastectomy and modified ones for breast cancer [20–24]. These studies have shown the efficacy of Pecs blocks regarding postoperative analgesia by showing decreased VAS scores and reduced need for opioid consumption in the postoperative period [22–24], however, the effect of Pecs blocks on PONV was controversial [22,23]. To our knowledge, our study is the first prospective randomised study that involves the combined application of Pecs I and Pecs II blocks to both breasts following sub-muscular breast augmentation. The decrease in VAS scores, opioid consumption and PONV incidence at 24 h postoperatively as well as no requirement for analgesia in four patients following Pecs blocks in our study also proved that the utilisation of this block at the end of the surgery still provided benefit in terms of postoperative pain management. The postoperative application of Pecs blocks under anaesthesia might have prolonged the duration of blockade.

In our study, we applied bilateral Pecs I block into the interfascial area between PMm and Pmm and Pecs II block into the interfascial area between Pmm and SAm with 10 mL and 20 mL of 0.25% bupivacaine, respectively, with a single-needle injection technique. Due to the risk of toxic reactions, we chose a diluted concentration of bupivacaine while still considering total and maximum dose of local anaesthetic [25] and no bupivacaine-related reaction was observed in any of the patients.

There are several limitations of this study. The main limitation was not using a placebo in Group C. Further, dermatome examination of both breasts after block application was not conducted, because wounds were most easily dressed while patients were still under anaesthesia. In addition, if the blocks had been applied preoperatively, opioid requirements might have been lower during surgery and there could have been faster recovery during the postoperative period. Finally, the pain was only evaluated during the first 24 h, and chronic pain was not monitored for long-term results.

As a conclusion, we suggest that the postoperative application of bilateral US-guided Pecs I and II blocks provide sufficient analgesia after breast augmentation, and has thus become increasingly popular for aesthetic surgical procedures.

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Disclosure of interest

The authors declare that they have no competing interest.

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Study design: O.K., H.U.P., E.A., R.D., O.Y.C., A.A.
Patient recruitment: H.U.P., E.A., R.D.
Administration of block: O.K.
Data collection: O.K., H.U.P., R.D.
Data analysis: O.K., O.Y.C., A.A.
Writing up of the first draft of the paper: O.K.

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