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ORIGINAL ARTICLE

Investigation of the analgesic effects of rhomboid intercostal and pectoral nerve blocks in breast surgery

Gokcen Kulturoglu[1] · Savas Altinsoy[1] · Julide Ergil[1] · Derya Ozkan[1] · Yusuf Ozguner[1]

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Abstract

Purpose The objective of this study was to examine the hypothesis that the opioid consumption of patients who receive a rhomboid intercostal block (RIB) or a pectoral nerve (PECS) block after unilateral modified radical mastectomy (MRM) surgery is less than that of patients who receive local anesthetic infiltration.

Methods Eighty-one female patients aged 18–70 years who underwent unilateral MRM surgery with general anesthesia were randomly allocated to three groups. The first group received an RIB with 30 ml of 0.25% bupivacaine on completion of the surgery, and the second received a PECS block with the same volume and concentration of local anesthetic. In the third (control) group, local infiltration was applied to the wound site with 30 ml of 0.25% bupivacaine at the end of the surgery. The patients' total tramadol consumption, quality of recovery (QoR), postoperative pain scores, and sleep quality were evaluated in the first 24 h postoperatively.

Results Both the RIB (58.3 ± 22.8 mg) and PECS (68.3 ± 21.2 mg) groups had significantly lower tramadol consumption compared to the control group (92.5 ± 25.6 mg) ($p < 0.001$ and $p = 0.002$, respectively). Higher QoR scores were observed in the RIB and PECS groups than the control group at 6 h post-surgery. The lowest pain values were observed in the RIB group. The sleep quality of the patients in the RIB and PECS groups was better than that of the control group ($p < 0.001$).

Conclusion Compared to local anesthetic infiltration, the RIB and PECS blocks applied as part of multimodal analgesia in MRM surgery reduced opioid consumption in the first 24 h and improved the quality of recovery in the early period.

Keywords Rhomboid intercostal block · Pectoral nerve block · Breast surgery · Pain · Multimodal analgesia

Introduction

Pain is among the most common problems following oncological breast surgery [1]. Severe acute pain affects more than half of patients postoperatively. Unfortunately, studies have shown that acute postoperative pain is a major risk factor for the development of persistent pain, which impacts 25–60% of patients [2, 3]. The American Society of Anesthesiologists (ASA) recommends multimodal analgesic approaches for optimal postoperative acute pain management [4].

In the Procedure Specific Pain Management (PROSPECT) guidelines, regional analgesic techniques have consistently been recommended as part of a multimodal approach [5, 6]. Most recently, in the 2020 PROSPECT guidelines for oncological breast surgery, anesthesiologists are advised to consider regional anesthesia techniques, such as PECS block, paravertebral block, and local anesthetic infiltration [7]. Pectoral nerve (PECS) blocks have been presented as a utility alternative to analgesic methods such as thoracic epidural and paravertebral blocks [8, 9]. Previous studies have shown that PECS blocks are easy, safe, and effective for analgesia following breast surgery [10, 11]. While various regional anesthesia techniques, such as serratus anterior plane block and erector spinae plane block, are compared with PECS in the guidelines, the use of the rhomboid intercostal block (RIB) is not mentioned.

The RIB is a more recent analgesic technique described by Elsharkawy et al. in 2016 [12]. It is an interfascial plane block where local anesthetic is applied to between the rhomboid major and intercostal muscles and is effective between the T2 and T9 dermatomes. The RIB may have the advantage that the injection of the local anesthetic is away from

✉ Gokcen Kulturoglu
gokcenkulturoglu@hotmail.com

[1] Department of Anesthesiology and Reanimation, Etlik City Hospital, Ankara, Turkey

the surgical field and that the injected material does not interfere with the surgical dissection. However, studies and case reports showing the analgesic effectiveness of RIB after breast surgery are limited [13–16].

In this study, we aimed to test the hypothesis that opioid consumption among patients who receive an RIB or a PECS block is less than that of those who receive local anesthetic infiltration after unilateral modified radical mastectomy (MRM) surgery.

Materials and methods

Ethical statement

This single-center, prospective, randomized, single-blinded clinical trial was approved by the ethics and research committee of the University of Health Sciences Diskapi Yildirim Beyazit Training and Research Hospital (Ankara, Turkey, approval date: 02/25/2019, no: 60/13). Following receipt of approval, the study was registered at ClinicalTrials.gov (registration number: NCT03942003). Written informed consent was obtained from all the participants.

When writing this article, an artificial intelligence program was used to correct spelling and grammar (https://chat.openai.com).

Study design

Female patients aged between 18 and 70 years with an ASA physical status of I–II who were scheduled for unilateral MRM surgery with axillary lymph node dissection under general anesthesia were included in this study. The exclusion criteria were coagulopathy, neuropathy, chronic analgesic treatment, severe cardiopulmonary disease, severe diabetes mellitus, renal or hepatic failure, pregnancy or breastfeeding, a body mass index greater than 35 kg/m^2 or weight less than 45 kg, local site infection, non-cooperation in understanding pain scores, and local anesthetic drug allergy.

The patients were randomly allocated to one of the three groups using sequentially numbered, opaque, sealed envelopes: the RIB group ($n=27$), the PECS block group ($n=27$), and the control group with local anesthetic infiltration ($n=27$). A random ID number was assigned to each patient, and the blinded anesthesiologist used these numbers when collecting the postoperative data.

Anesthesia procedure

An intravenous (IV) line, standard monitoring (electrocardiography, pulse oximetry, noninvasive blood pressure), and bispectral index (BIS) monitoring were installed for all the patients. After premedication with 2 mg IV midazolam, IV anesthesia induction (1 mg/kg lidocaine, 2–2.5 mg/kg propofol, 1 mcg/kg fentanyl, 0.6 mg/kg rocuronium bromide) was performed. Following endotracheal intubation, anesthesia was maintained with sevoflurane in a mixture of 50% air–oxygen with 3 L/min of fresh gas flow. The sevoflurane concentration was adjusted to maintain a BIS value between 40 and 60. Intraoperatively, remifentanil infusion (0.05–0.3 mcg/kg/min, IV), ondansetron (4 mg, IV), paracetamol (1 g, IV), and tramadol (100 mg, IV) were given to each patient. Fentanyl 0.5 mcg/kg was administered intravenously if a patient's heart rate or blood pressure increased > 20% from the baseline value. The RIBs and PECS blocks were performed with ultrasound (US) guidance (Sonosite, Bothell, Washington, United States) after anesthesia induction to ensure patient blindness to the procedure. All the surgical procedures were performed by the same surgical team. Wound infiltration was used for the patients in the control group at the end of the surgery, before extubation. Neuromuscular blockade was antagonized with IV neostigmine 50 mcg/kg and atropine 10 mcg/kg. After extubation, the patients were transferred to the postanesthesia care unit (PACU) and monitored for 30 min. At the end of the 30 min, PACU nurses, who were blinded to the patient groups, conducted sensory examinations on all the patients. The nurses had been shown a short training video before undertaking the examinations. After this training, they marked the affected dermatomes on a thoracic dermatome figure. The patients with modified Aldrete scores ≥ 9 were sent to the surgical ward.

Block interventions

For the PECS block, the patient was positioned in the supine position with ipsilateral upper limb abducted 90° and a high-frequency (15–6 MHz) linear transducer placed in the sagittal plane below the clavicle. After visualizing the axillary artery and vein, the probe was moved laterally and caudally. The pectoralis major, minor, and serratus anterior muscles were identified in the same view, and 10 mL of bupivacaine 0.25% was then injected in the interfascial plane between the pectoralis major and minor muscles with a 22 G, 50 mm block needle (Echoplex, Vygon, Ecouen, France) [8]. The needle was advanced to the fascial plane between the pectoralis minor and serratus anterior muscles, and 20 mL of bupivacaine 0.25% was injected into this fascial plane as previously described [9].

The patients undergoing the RIB were placed in the lateral decubitus position with the surgical site up. The ipsilateral arm was moved across the chest to shift the scapula laterally. The linear transducer was placed in a sagittal plane over the medial border of the scapula at the level of T5 to T6. The trapezius, rhomboid major, and intercostal muscles, ribs, and pleura were visualized with

US [12]. The block needle was advanced into the interfascial plane between the rhomboid major and intercostal muscles, and 30 mL of bupivacaine 0.25% was injected into the area.

In the control group, 30 mL of bupivacaine 0.25% was used at the end of the surgical procedure to infiltrate the breast and axilla surgical incisions. Infiltration was performed under direct vision by the surgeon.

All the procedures were performed under sterile conditions. The bupivacaine was injected slowly with aspiration every 5 mL. The intralipid solutions were prepared in the operating room and PACU to mitigate local anesthesia complications.

Analgesia protocol and outcome measures

All the patients received a 1 g dose of IV paracetamol every 8 h and IV tramadol via a patient-controlled analgesia (PCA) device (bolus 20 mg, lockout time 20 min, without infusion, maximum dose limited to 400 mg) for 24 h. The patients' postoperative pain scores were recorded by an anesthetist blinded to the study in the PACU (T0) and 1 h (T1), 4 h (T4), 6 h (T6), 12 h (T12), and 24 h (T24) following surgery. The numerical rating scale (NRS), which ranges from 0 (no pain) to 10 (unbearable pain), was used to assess pain and guide the pain treatment. If the NRS was recorded as 4 or greater with the routine analgesia protocol, dexketoprofen (50 mg/kg) IV was administered as a rescue analgesic in the PACU and ward.

The primary outcome measure of the study was the evaluation of the total postoperative tramadol consumption in the first 24 h following surgery. Secondary endpoints included the measure of the quality of recovery (QoR), postoperative NRS scores, and sleep quality of the patients. The quality of functional postoperative recovery after MRM was assessed using the Turkish version of the global QoR-40 score [17]. The QoR-40 is a questionnaire that consists of 40 items with five subheadings: physical comfort ($n=12$), emotional state ($n=9$), patient support ($n=7$), pain ($n=7$), and physical independence ($n=5$). Each question is scored on a five-point Likert scale. The total score ranges from 40 (very poor) to 200 (excellent). The QoR-40 was administered 1 day before surgery in the outpatient clinic of the anesthesiology department (t1), at 6 h post-surgery (t2), and before discharge from the hospital on the first postoperative day (t3). Quality of sleep was measured using an 11-point Likert scale, where 0 = unsatisfied, 5 = neutral, and 10 = satisfied) [18]. At the 24th hour postoperatively, the patients were asked to respond 'yes' or 'no' to questions regarding the side effects of nausea and vomiting.

Sample size and statistical analyses

We performed a sample size calculation using G*Power version 3.1.9.4 based on the pilot data obtained from the mean opioid consumption. In the preliminary study, the postoperative tramadol consumption (mean ± SD) was 56 ± 26.1 mg in the RIB group, 60 ± 20 mg in the PECS group, and 80 ± 31.6 mg in the control group. An ANOVA (fixed effects, omnibus, one-way) test was used with an α-error of 0.05, 80% power, and a 0.38 effect size for the three groups. The total sample size was 72 patients. Due to concerns about possible unexpected losses, the number of patients was increased by 10–15% to a total of 81 patients.

The Statistical Package for the Social Sciences (SPSS, version 22.0, Chicago, IL, USA) was used for the analysis. The numerical values were expressed as the mean ± standard deviation or median (interquartile range, IQR). The Shapiro–Wilk test was used to check normality. One-way ANOVA was used for the continuous variables with a normal distribution. The Kruskal–Wallis test was used for the continuous variables without a normal distribution. $p<0.05$ was considered statistically significant. Bonferroni correction was used to compare the groups, and the adjusted significance value was used for pairwise comparisons.

Results

Eighty-one patients were enrolled in the study from 1 June 2019 to May 2021. Two patients declined to participate in the study, and three patients did not meet the inclusion criteria. Four of the 76 recovered patients were excluded from the analysis for the following reasons: reoperation, block failure, or postoperative severe anxiety. Finally, 72 patients were included in the analysis (Fig. 1).

The demographic variables and duration of surgery (time between first incision and last dressing applied) were similar for all three groups (Table 1).

In the sensory examination conducted in the PACU, sensory block was detected in the T2–T8 dermatomes of the patients who received RIB and between the T1 and T5 dermatomes in the PECS group patients. One patient who received a PECS block exhibited no dermatomal involvement, and she was excluded from the study.

The primary outcome of this study indicated that tramadol consumption was lowest in the RIB group (58.3 ± 22.8 mg). The mean tramadol consumption in the PECS group and the control group was 68.3 ± 21.2 mg and 92.5 ± 25.6 mg, respectively (Table 2). There was no significant difference between the RIB and PECS block groups ($p=0.42$). However, both the RIB and PECS groups had significantly lower tramadol consumption compared to the control group ($p<0.001$ and $p=0.002$, respectively).

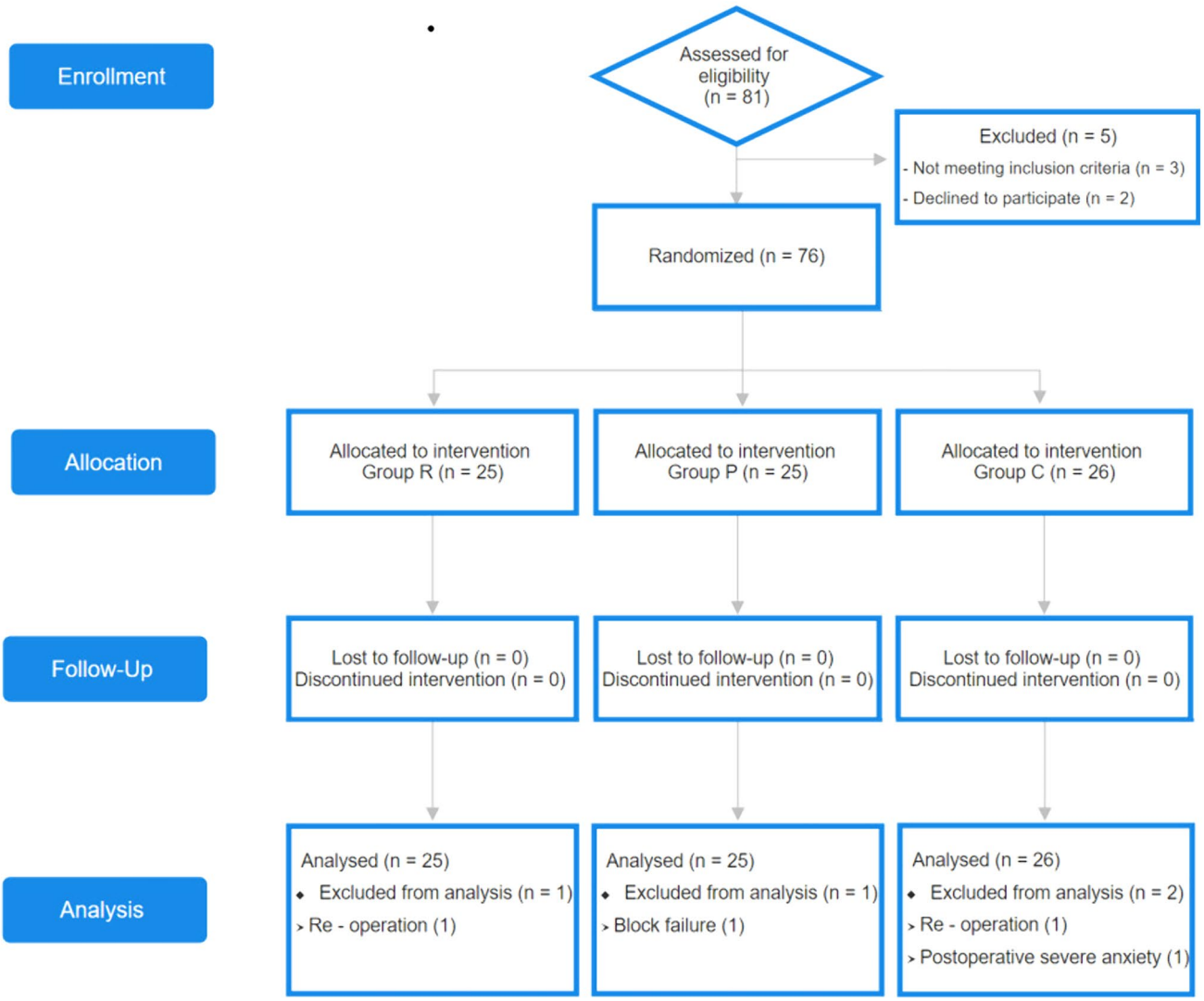

Fig. 1 Patient flow in the study

Table 1 Patient characteristics

	RIB group ($n=24$)	PECS group ($n=24$)	Control group ($n=24$)	p value*
Age, year (mean ± SD)	53 ± 9.4	51.9 ± 8.5	52.6 ± 8.5	0.913
BMI, kg/m^2 (mean ± SD)	28.1 ± 6.1	28 ± 5.4	29.5 ± 10.5	0.731
ASA I/II, n (%)	4/20 (16.6/83.3)	5/19 (20.8/79.1)	6/18 (25/75)	0.777
Duration of surgery, min (mean ± SD)	96.4 ± 17.9	100.4 ± 12.3	101.2 ± 12.6	0.475

BMI body mass index, *SD* standard deviation, *min* minute

*one-way ANOVA

There were no significant differences in the total QoR-40 scores between the three groups at the baseline (t1) and the 24th hour (t3) (Table 2). However, at 6 h postoperatively (t2), the total scores were lower than the baseline values for all the groups. When comparing the groups, higher scores were observed for the PECS and RIB groups than the control group at 6 h ($p<0.016$). When the QoR-40 score subtypes were analyzed, we found that this difference mainly applied to pain ($p=0.034$), physical comfort ($p=0.005$), and emotional status ($p=0.002$).

The postoperative NRS scores at rest and movement are presented in Table 2. The lowest NRS values were observed

Table 2 Primary and secondary outcomes

	RIB group ($n=24$)	PECS group ($n=24$)	Control group ($n=24$)	p value[t]
Tramadol consumption (mg), mean ± SD	58.3 ± 22.8*	68.3 ± 21.2*	92.5 ± 25.6	< 0.001[µ]
Quality of recovery—40 scores, mean ± SD				
t1	181.3 ± 8.61	180.7 ± 7.3	178.4 ± 7.1	0.418
t2	173.3 ± 5.3*	173.3 ± 6.5*	165.9 ± 4.7	< 0.001[µ]
t3	183 ± 8.8	184.5 ± 8.2	179.3 ± 7.1	0.085
Numerical rating scale scores at rest, median (IQR)				
PACU	2 (1–2)*	3 (2–3.5)	3 (2–4)	0.011[µ]
1st hour	2 (1–3)*	3 (2–4)	3 (2–4)	0.018[µ]
4th hour	2 (1–2)*	3 (2–3)	3 (2–3.5)	0.016[µ]
6th hour	2 (2–3)*	3 (2.5–4)	3 (3–4)	0.006[µ]
12th hour	2 (1.5–2)	2 (2–3)	2 (2–3)	0.36
24th hour	2 (1–2)	2 (1–2)	2 (1–2)	0.363
Numerical rating scale scores at movement, median (IQR)				
PACU	3 (2–3)*	3 (2–4)	3 (3–4)	0.04[µ]
1st hour	2 (1.5–3)*	3.5 (3–4)	3.5 (3–4)	0.002[µ]
4th hour	2 (2–3)*	4 (3–4)	3.5 (3–4)	0.001[µ]
6th hour	3 (2–3)*	4 (3–5)	4 (3–5)	0.048[µ]
12th hour	3 (2–3)	3 (2–3)	3 (3–3)	0.898
24th hour	2 (1–2)	2 (1–2)	2 (1–2)	0.061
Sleep quality, median (IQR)	8 (7–8)*	6.5 (5–8)*	3.5 (2–5)	< 0.001[µ]
Nausea/vomiting, n (%)	2 (8.3)/0	2 (8.3)/0	6 (25)/0	0.195[#]

IQR interquartile range, *PACU* postanesthesia care unit; [t] Kruskal–Wallis test, [µ]$P<0.05$, Kruskal–Wallis; *adjusted $P<0.05$ with Bonferroni correction (Pairwise comparisons with Group C) and [#]Fisher's Exact Test

in the RIB group. The RIB group had significantly low values at rest and movement in the PACU and at hours 1, 4, and 6 compared to the control group ($p<0.05$). The patients' sleep quality scores on the first postoperative night are presented in Table 2.

No complications related to the RIB, PECS block, and local anesthetic were observed at any time during the study period.

Discussion

In this study, multimodal analgesia management was applied for pain control in patients following MRM surgery. The results showed that the tramadol consumption in the first 24 h among the patients who received the RIB or the PECS block was lower than that of the control group patients, who were treated with local infiltration. Both the RIB and the PECS block were observed to improve the QoR of the patients at the 6th hour and to enhance their quality of sleep on the first postoperative night. Lower pain scores were detected in the pain assessments of the RIB group during the first 6 h.

RIB has been reported to provide analgesia for the anterior and posterior chest wall [12]. In a meta-analysis published in 2022, RIB was found to be effective and reliable for acute pain management after thoracoscopic procedures and breast surgeries [19]. However, only two studies on breast surgery were evaluated in the meta-analysis. In the first study, a group that received the RIB was compared with a group that did not receive this block [16], while in the second study, patients treated with the RIB or PECS block were compared to a group that did not receive these blocks [15]. Although different opioid types were used, both studies found that the RIB reduced postoperative opioid consumption compared to the non-block groups. In this study, the RIB and the PROSPECT-recommended PECS block were compared with local anesthetic infiltration at the surgical site. As far as we could determine, no study has previously compared the RIB and local anesthetic infiltration for breast surgery. However, in a recent study, the RIB and local anesthetic infiltration were compared for postoperative pain management in thoracoscopic surgery, and it was found that the RIB significantly reduced postoperative opioid consumption compared to the infiltration anesthesia [20]. In this study, we observed that the opioid consumption in the first 24 h postoperatively in the RIB and PECS groups was significantly lower compared to the group that underwent infiltrative anesthesia. There was no significant difference in terms of opioid consumption between the group that received the RIB

and the PECS group. However, the sample size in our study may not be sufficient to generalize the RIB and the PECS block as analgesically equivalent following MRM surgery.

In our study, the RIB effectively reduced the patients' NRS pain scores during both rest and movement in the first 6 h postoperatively compared to the patients in the control group. However, the pain scores at hours 12 and 24 were similar for these two groups. No significant differences in pain scores were observed during either rest or movement between the patients who received the PECS block and the control group within the first 24 h. This could be related to the application of our multimodal analgesia regimen, the local anesthetic infiltration administered to the control group, and the decrease in acute pain between 12 and 24 h following breast surgery. Although defined as the control group, local anesthetic infiltration is also an effective analgesic modality [21]. It has been reported that local anesthetic infiltration can provide analgesia for up to 24 h [22]. In a study that compared the RIB (20 mL of 0.25% bupivacaine) and local anesthetic infiltration (17 mL of 0.25% bupivacaine) after thoracoscopic surgery, the patients were followed with tramadol PCA during the first 24 h [20]. No differences in the pain scores were observed between the groups after the first 6 h. In a study that compared the PECS block (30 mL of 0.2 ropivacaine) and local anesthesia infiltration for postoperative pain after breast implant surgery, no differences in pain scores were noted in the first 12 h; however, the patients who received local anesthesia infiltration had lower pain scores in the evaluation at 24 h [23]. In addition to interventions (RIB, PECS block and local anesthesia infiltration) all the patients in our study received a basic analgesic regimen that included a fixed dose of paracetamol (4×1 g). The first dose was administered intraoperatively, the second dose was administered within a 6–8 h interval, and the third and fourth doses were administered within a 12–24 h interval. The fact that patients received all three doses of paracetamol after the 6th hour may have also influenced our results.

QoR-40 is an effective, simple, reliable, and objective measure developed to assess postoperative recovery quality [24, 25]. In our study, the QoR-40 values were examined preoperatively and at 6 and 24 h postoperatively, with the lowest total values obtained at the 6-h measurement. Although the values were lower compared to the baseline, the fact that both block-administered groups showed better QoR-40 scores compared to the control group is significant. In a study, researchers investigated the effectiveness of the RIB in breast cancer surgeries and examined the 24-h QoR-40 values. They observed that the RIB group had higher scores compared to the control group for which no interventions were performed [16]. In our study, we applied local anesthetic infiltration to the control group, which could explain the reason we did not detect a difference in the 24-h QoR-40 measurements between the control group and the other groups. Barrington and colleagues assessed two groups of patients who underwent PECS block and infiltration analgesia using a recovery quality scale known as QoR-15, which is similar to QoR-40, at 24 h after breast surgery. The results of their study showed no significant differences between the two groups [26].

In a study conducted by Bouman EA and colleagues, paravertebral block and local anesthesia infiltration for major oncological breast surgeries were compared. The authors reported that while there were no differences in the pain scores in the first 24 h, the opioid consumption was higher in the local anesthesia infiltration group [27]. In another study, following radical mastectomy surgery, while there was no difference in the NRS pain scores within the first 3 h between two different intervention groups, the amounts of opioids consumed during this period significantly differed from each other [28]. These findings suggest that patients may require varying doses of analgesics despite similar NRS scores assessed at designated time frame. In our study, while NRS scores were similar in both the PECS and local anesthetic infiltration groups at all time points (T0, T1, T4, T6, T12, T24), the total opioid consumption differed between the groups. The patients in the control group may have pressed the PCA button more frequently due to higher analgesic demand. This situation in the control group may lead to lower scores on the QoR at the 6th hour and a lower quality of sleep due to interruptions in sleep duration.

Our study had certain limitations. First, we were unable to record the hourly opioid consumption of the patients. Second, some patients received neoadjuvant chemotherapy before MRM surgery. However, we did not query the medications these patients took or any symptoms of nausea and/or vomiting experienced during the preoperative period. Third, while we demonstrated the analgesic superiority of the PECS block and the RIB compared to local anesthetic infiltration, a larger sample size is needed to determine analgesic equivalence or superiority between the PECS block and the RIB following MRM surgery.

In conclusion, the RIB and the PECS block applied as part of the multimodal analgesia in the MRM surgery in this study reduced our patients' opioid consumption in the first 24 h postoperatively and improved their QoR in early postoperative period compared to local anesthetic infiltration.

Data availability The data that support the findings of this study are available on request from the corresponding author, (GK). The data are not publicly available due to our participants' informed consent forms.

References

1. Vadivelu N, Schreck M, Lopez J, Kodumudi G, Narayan D. Pain after mastectomy and breast reconstruction. Am Surg. 2008;74(4):285–96.

2. Wang K, Yee C, Tam S, Drost L, Chan S, Zaki P, Rico V, Ariello K, Dasios M, Lam H, DeAngelis C, Chow E. Prevalence of pain in patients with breast cancer post-treatment: a systematic review. Breast. 2018;42:113–27.
3. Andersen KG, Kehlet H. Persistent pain after breast cancer treatment: a critical review of risk factors and strategies for prevention. J Pain. 2011;12(7):725–46.
4. American Society of Anesthesiologists Task Force on Acute Pain Management. Practice guidelines for acute pain management in the perioperative setting: an updated report by the American society of anesthesiologists task force on acute pain management. Anesthesiology. 2012;116(2):248–73.
5. Joshi GP, Schug SA, Kehlet H. Procedure-specific pain management and outcome strategies. Best Pract Res Clin Anaesthesiol. 2014;28(2):191–201.
6. Lee B, Schug SA, Joshi GP, Kehlet H, PROSPECT Working Group. Procedure-specific pain management (PROSPECT)—an update. Best Pract Res Clin Anaesthesiol. 2018;32(2):101–11.
7. Jacobs A, Lemoine A, Joshi GP, Van de Velde M, Bonnet F, PROSPECT Working Group collaborators#. PROSPECT guideline for oncological breast surgery: a systematic review and procedure-specific postoperative pain management recommendations. Anaesthesia. 2020;75(5):664–73.
8. Blanco R. The 'pecs block': a novel technique for providing analgesia after breast surgery. Anaesthesia. 2011;66(9):847–8.
9. Blanco R, Fajardo M, Parras MT. Ultrasound description of Pecs II (modified Pecs I): a novel approach to breast surgery. Rev Esp Anestesiol Reanim. 2012;59(9):470–5.
10. Versyck B, van Geffen GJ, Chin KJ. Analgesic efficacy of the Pecs II block: a systematic review and meta-analysis. Anaesthesia. 2019;74(5):663–73.
11. Grape S, Jaunin E, El-Boghdadly K, Chan V, Albrecht E. Analgesic efficacy of PECS and serratus plane blocks after breast surgery: a systematic review, meta-analysis and trial sequential analysis. J Clin Anesth. 2020;63: 109744.
12. Elsharkawy H, Saifullah T, Kolli S, Drake R. Rhomboid intercostal block. Anaesthesia. 2016;71(7):856–7.
13. Tulgar S, Selvi O, Thomas DT, Manukyan M, Özer Z. Rhomboid intercostal block in a modified radical mastectomy and axillary curettage patient; a new indication for novel interfascial block. J Clin Anesth. 2019;54:158–9.
14. Gürkan Y, Manici M, Salgın B, Dilege E, Ağcaoğlu O, Tatar S, Erçelen Ö. Bilateral rhomboid block may provide complete pain relief following bilateral breast surgery. J Clin Anesth. 2021;68:110064.
15. Ciftci B, Ekinci M, Basim P, Celik EC, Tukac IC, Zenciroglu M, Atalay YO. Comparison of ultrasound-guided type-ii pectoral nerve block and rhomboid intercostal block for pain management following breast cancer surgery: a randomized. Controlled Trial Pain Pract. 2021;21(6):638–45.
16. Altıparmak B, Korkmaz Toker M, Uysal AI, Dere Ö, Uğur B. Evaluation of ultrasound-guided rhomboid intercostal nerve block for postoperative analgesia in breast cancer surgery: a prospective, randomized controlled trial. Reg Anesth Pain Med. 2020;45(4):277–82.
17. Karaman S, Arici S, Dogru S, Karaman T, Tapar H, Kaya Z, Suren M, Gurler BM. Validation of the Turkish version of the quality of recovery-40 questionnaire. Health Qual Life Outcomes. 2014;12:8.
18. Yun S, Jo Y, Sim S, Jeong K, Oh C, Kim B, Lee WY, Park S, Kim YH, Ko Y, Chung W, Hong B. Comparison of continuous and single interscalene block for quality of recovery score following arthroscopic rotator cuff repair. J Orthop Surg (Hong Kong). 2021;29(1):23094990211000144.
19. Chen R, Su S, Shu H. Efficacy and safety of rhomboid intercostal block for analgesia in breast surgery and thoracoscopic surgery: a meta-analysis. BMC Anesth. 2022;22(1):101 (**BMC Anesthesiol. 2022;22(1):71**).
20. Toulan HF, Abdelrazik RA. Effects of rhomboid intercostal plane block for postoperative analgesia after thoracoscopic surgery compared with local anesthetic infiltration. Egyptian J Anaesth. 2022;38(1):179–84.
21. Lu TJ, Chen JH, Hsu HM, Wu CT, Yu JC. Efficiency of infiltration with bupivacain after modified radical mastectomy. Acta Chir Belg. 2011;111(6):360–3.
22. Stamenkovic DM, Bezmarevic M, Bojic S, Unic-Stojanovic D, Stojkovic D, Slavkovic DZ, Bancevic V, Maric N, Karanikolas M. Updates on wound infiltration use for postoperative pain management: a narrative review. J Clin Med. 2021;10(20):4659.
23. Moris V, Sanchez A, Guilloteau A, Guillier D, Heranney J, Zwetyenga N, Kerfant N. Pectoral plane block versus local anesthetic infiltration in breast implant augmentation surgery: a retrospective study. Plast Reconstr Surg. 2022;150(2):319e–28e.
24. Myles PS, Weitkamp B, Jones K, Melick J, Hensen S. Validity and reliability of a postoperative quality of recovery score: the QoR-40. Br J Anaesth. 2000;84(1):11–5.
25. Gornall BF, Myles PS, Smith CL, Burke JA, Leslie K, Pereira MJ, Bost JE, Kluivers KB, Nilsson UG, Tanaka Y, Forbes A. Measurement of quality of recovery using the QoR-40: a quantitative systematic review. Br J Anaesth. 2013;111(2):161–9.
26. Barrington MJ, Seah GJ, Gotmaker R, Lim D, Byrne K. Quality of recovery after breast surgery: a multicenter randomized clinical trial comparing pectoral nerves interfascial plane (pectoral nerves ii) block with surgical infiltration. Anesth Analg. 2020;130(6):1559–67.
27. Bouman EA, Theunissen M, Kessels AG, Keymeulen KB, Joosten EA, Marcus MA, Buhre WF, Gramke HF. Continuous paravertebral block for postoperative pain compared to general anaesthesia and wound infiltration for major oncological breast surgery. Springerplus. 2014;3:517.
28. Cesur S, Aksu C, Güler SA, Kuş A. Modified pectoral nerve block versus bi-level erector spinae plane block for postoperative analgesia after radical mastectomy surgery: a prospective, randomized, controlled trial. Korean J Anesthesiol. 2023;76(4):317–25.