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Ultrasound-guided rhomboid intercostal block combined with subserratus plane block vs pectoral nerve block type-2 in analgesia for breast-conserving surgery (randomized, controlled study)

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Abstract

Introduction: The most frequent malignancy in women is the breast cancer, the rhomboid intercostal and subserratus plane (RISS) block is a novel regional approach.

Objectives: This study evaluated the analgesic efficacy of the RISS block compared to type 2 Pectoral Nerve (PECS II) block in breast cancer patients following breast-conserving surgery (BCS).

Methods: This randomized controlled trial comprised 69 women with breast cancer scheduled for unilateral BCS under general anesthesia, randomly allocated into 3 equal groups. The RISS group had unilateral RISS block using 20 mL of 0.25% bupivacaine between rhomboid major and intercostal muscles and an equal volume between external intercostal and serratus anterior muscles. The PECs Group received a PECS II block using 20 mL of 0.25% bupivacaine between pectoralis major and minor muscles and 10 mL between pectoralis major and serratus muscles. The control group did not get any blocks. The primary outcome was total postoperative morphine consumption within 24 hours. The secondary outcomes were pain score, first request for rescue analgesia, intraoperative fentanyl consumption, and hemodynamics.

Results: Requesting rescue morphine analgesia was significantly less frequent in the RISS and PECs groups compared to controls (5, 1, and 23 patients, respectively, $P < 0.001$). Similar findings were found in the need for extra intraoperative fentanyl ($P < 0.001$). Pain scores in the RISS and PECs groups were significantly lower than the control group, while RISS and PECs groups had comparable scores throughout the postoperative period. All hemodynamic readings were within the clinically acceptable ranges.

Conclusion: In patients undergoing BCS, RISS and PECs II block are comparable, safe, and effective regional analgesic alternatives.

Keywords: Analgesics, Opioids, Breast neoplasms, Postoperative pain, RISS, Nerve block, Pecs II

1. Introduction

In 2022, around 2.3 million cases of breast cancer were diagnosed, with surgery being the primary treatment method.[5] Postoperative pain is a significant concern in breast cancer surgery,[14] where nearly half of the patients suffer from moderate to severe acute pain, and 28% subsequently develop chronic pain.[27] If untreated, pain may result in slower wound healing, respiratory depression, hemodynamic problems, and stress, ultimately leading to worsened recovery outcomes. It compromises the quality of life impairing physical, psychological, and social performance.[19] Hence, it is crucial to prioritize preventing postoperative pain in these patients.

Sponsorships or competing interests that may be relevant to content are disclosed at the end of this article.

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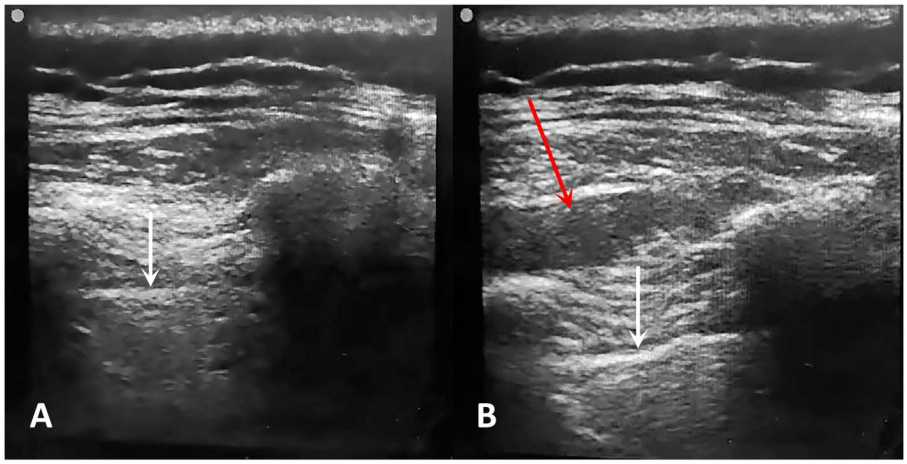

Figure 1. Rhomboid intercostal block. (A) Sonographic anatomy of the layers encountered during the rhomboid block showing the pleura (white arrow). (B) The local anesthetic injected in the plane between intercostal muscles and rhomboid muscle (red arrow).

Presently, although systemic opioids can cause adverse effects such as respiratory depression, sleepiness, constipation, nausea, and vomiting, they are frequently given for pain treatment after breast cancer surgery.[12] Over the past 2 decades, patients undergoing surgery for breast cancer have received several regional anesthetic techniques, with the paravertebral block (PVB) being regarded as the optimal technique for analgesia during breast surgery.[17] Nonetheless, alternative methods such as pectoral nerve block (PECS),[23] erector spinae plane block (ESPB),[15] and serratus anterior plane block (SPB)[6] have demonstrated efficacy in delivering pain relief comparable to PVB. More recently, other local techniques like rhomboid intercostal nerve block (RIB) have been implemented in breast cancer procedures.[1]

Rhomboid intercostal nerve block was introduced as a substitute for thoracic epidural analgesia.[25] In RIB, a local anesthetic is injected into the space between the intercostal and rhomboid major muscles. With 1 injection, this block provides pain relief for the front and back parts of the chest, spreading 6 to 7 segments.[2] This procedure is simply applied, with the injection site located at a distance from the operative area.[1] However, it does not block the long thoracic and pectoral nerves. These nerves need to be involved in the regional block in cases of breast-conservative surgery (BCS) due to the increasing invasiveness of partial mastectomy with reconstruction.[24]

Another recently developed approach is the rhomboid intercostal and subserratus plane block (RISS), in which a local anesthetic is given in 2 planes: deep to the serratus anterior muscle and scapula and between the rhomboid major and intercostal muscles. Rhomboid intercostal and subserratus plane block can successfully block the intercostal nerves' lateral cutaneous branches from T3 to T9, relieving pain in the chest wall in addition to blocking the long thoracic nerve.[10]

Therefore, in the current study, we aimed to assess the analgesic profile of the recent regional block ultrasound-guided RISS block in comparison to the modified PECS II block in patients with breast cancer undergoing unilateral breast conservative surgery.

2. Patients and Methods

This randomized controlled trial involved 69 female patients selected from Cairo University's National Cancer Institute's Department of Surgery. The National Cancer Institute's ethical committee approved the study (AP22304-501-048). The study was registered at clinicaltrials.gov (NCT06274814). Enrolled patients were given a thorough explanation of the study's procedure and the possible

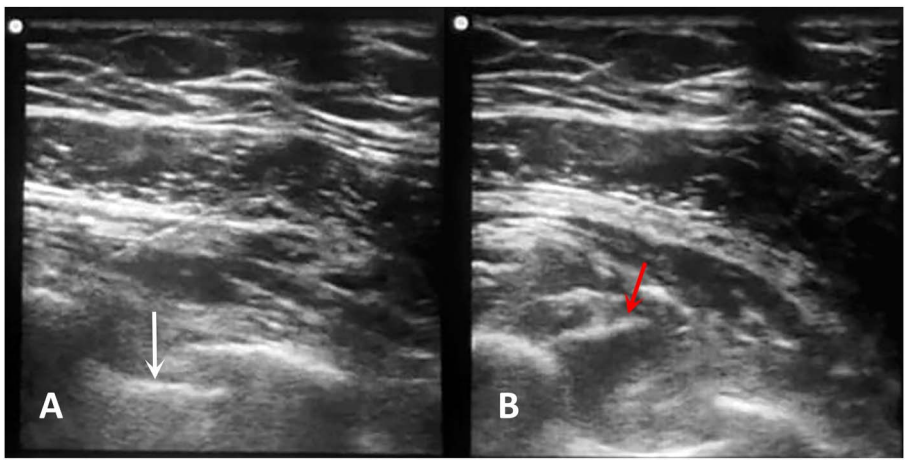

Figure 2. The subserratus block technique. (A) Sonographic anatomy of the layers encountered during the subserratus block showing the pleura (white arrow). (B) The local anesthetic injected to the plane between intercostal muscles and the serratus anterior muscle (red arrow).

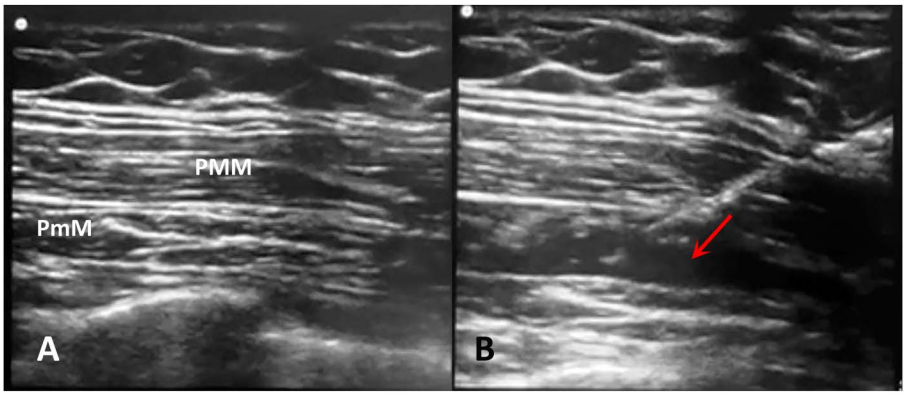

Figure 3. Type-2 pectoral nerve block. (A) Sonographic anatomy showing the pectoralis major muscle (PMM) and the pectoralis minor muscle (PmM). (B) The local anesthetic injected in the plane between PMM and PmM (red arrow).

advantages and disadvantages of the block techniques before their written informed consent was collected.

The inclusion criteria were females aged 18 to 65 with American Society of Anesthesiologists (ASA) II to III, scheduled for unilateral BCS for the treatment of breast cancer. Exclusion criteria included patients with coagulation problems body mass index (BMI) greater than 40 kg/m^2, injection site infection, history of local anesthetic allergy, chronic pain management currently being used, and history of prior breast or other chest surgery on the same side as the planned procedure.

Patients were randomly assigned to 3 groups using a computerized randomization table, each given a unique ID. The RISS group (n = 23) received a rhomboid intercostal and subserratus plane block as described by Elsharkawy et al.[10] The PECs group (n = 23) received a PECs II block as described by Blanco et al.[4] In the control group (n = 23), no block intervention was performed. After preoperative patient assessment by history taking and revision of investigations, a 20-gauge IV cannula was inserted, and midazolam 0.05 mg/kg was given for sedation. Blocks were performed in the operational room before inducing (general anesthesia) GA. Postoperative assessors were blinded to the type of block.

2.1. In group 1: rhomboid intercostal with subserratus plane block

The eligible patients were placed in the lateral decubitus position, with the superior positioning on the operative side. Using the ipsilateral arm, the scapula moved laterally by being abducted from the chest. Using the SonoSite M-turbo ultrasound machine in B mode, a high-frequency 6- to 13-MHz linear ultrasound probe was positioned medial to the medial border of the scapula in the oblique sagittal plane. The landmarks—the pleura, lung, intercostal muscles, rhomboid muscle, and trapezius muscle—were detected using ultrasound. At the level of T5–6 in the ultrasonography image, a 100-mm 21-gauge needle was placed in an aseptic manner. The interfascial plane between the rhomboid major and intercostal

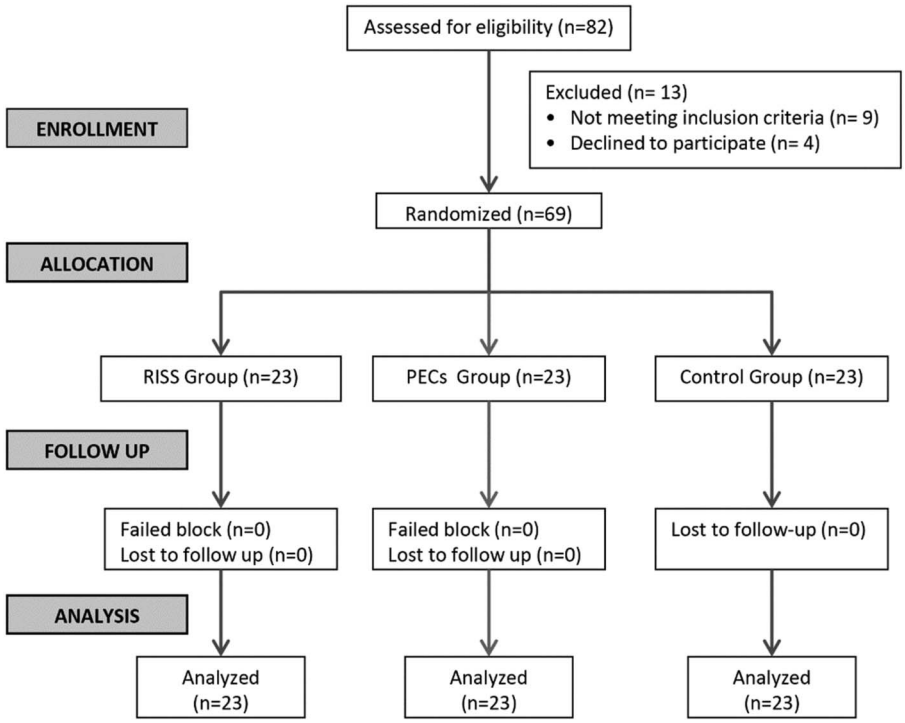

Figure 4. CONSORT flowchart of the included patients.

Table 1

Baseline characteristics in the 3 studied groups.

	RISS group (n = 23)	PECs group (n = 23)	Control group (n = 23)	*P*
Age (y)	49.7 ± 9.7	50.9 ± 7	52.1 ± 6.9	0.598
BMI (kg/m^2)	29.9 ± 4.6	28.7 ± 5.6	30.9 ± 5.4	0.346
ASA class (II/III)	15/8	13/10	12/11	0.659
Heart rate (bpm)	77 ± 8	80 ± 11	84 ± 11	0.073
MAP (mm Hg)	91 ± 7	91 ± 6	94 ± 7	0.230
SPO_2 (%)	98 ± 1	98 ± 1	98 ± 1	0.463

Data are presented as mean ± SD.

ASA, American Society of Anesthesiologists; BMI, body mass index; MAP, mean arterial pressure; SPO_2, oxygen saturation.

muscles was utilized to inject 20 mL of 0.25% bupivacaine as a single dosage. The extent of the local anesthetic solution beneath the rhomboid muscle was observed using ultrasonography (**Fig. 1**). After that, the ultrasonic probe was moved laterally and caudally to locate the tissue plane for the subserratus block at the T8–9 level between the external intercostal muscles and the serratus anterior. A second injection of 20 mL of 0.25% bupivacaine was given after the needle was moved from its original location. For this investigation, all block procedures were performed by the same anesthesiologist who had previously performed RIB and RISS blocks in over 30 cases (**Fig. 2**).

2.2. In group 2: type-2 pectoral nerve block

In group 2: type-2 pectoral nerve block was done by applying 30 mL of 0.25% bupivacaine (20 mL separates the pectoralis major and minor muscles while 10 mL separates the serratus and pectoralis major muscles) (**Fig. 3**).

2.3. General anesthesia

All patients underwent standard monitoring techniques, including peripheral O_2 saturation assessments, noninvasive blood pressure monitoring, and electrocardiography. The rate of infusion of isotonic saline was 15 mL/kg/h. Preoxygenation was used for 3 minutes to establish anesthesia, and then fentanyl (1 μg/kg), propofol (1–2 mg/kg), and atracurium (0.5 mg/kg) were injected intravenously. The end-tidal CO_2 level was kept between 35 and 40 mm Hg by positive-pressure breathing using an endotracheal tube. About 2% sevoflurane and 50% oxygen were used to maintain anesthesia. Atracurium (0.1 mg/kg) was also given every 20 minutes. Adjusting the anesthetic dosage kept blood pressure within 20% of the baseline value. In case the patient's blood pressure raised by 20% or more from the baseline, intravenous fentanyl (0.5 μg/kg) was administered. Ephedrine (0.1 mg/kg) was given if the blood pressure dropped by more than 20% from the initial reading. Atropine (0.01 mg/kg) was given if the heart rate dropped below 50 bpm. Neostigmine and atropine were used to counteract the effects of atracurium after the surgery. When the patient met the requirements for extubation after the surgery, an endotracheal tube was removed. After that, the patient was admitted to the Post-Anesthesia Care Unit (PACU).

Heart rate (HR) and mean arterial blood pressure (MAP) were recorded immediately upon induction and every 15 minutes during the operation. It was also noted how much fentanyl was consumed during surgery. The Bispectral index (BIS) was employed to assess the depth of anesthesia. A reading of 40 to 60 indicates adequate general anesthesia for surgery.

Postoperative data were documented, including pain visual analogue sacale (VAS) score, HR, and MAP at 0, 3, 6, 9, and 24 hours, the duration until the first rescue analgesia were recorded, as well as the frequency and total dosage of the prescribed medication during 24 hours, recovery time (the time needed to be fully conscious and able to obey commands), and side effects (nausea, vomiting, hematoma, hypotension, bradycardia). If the VAS was 4 or more, rescue analgesia was administered with 30 mg of ketorolac, a nonsteroidal anti-inflammatory analgesic. If the VAS was at least 6, morphine 3 mg was given.

The primary outcome measure was the total quantity of morphine given in the first 24 hours after surgery. The secondary outcomes were the postoperative pain VAS score, the timing of the first rescue analgesia, the amount of fentanyl used intraoperatively, the intraoperative HR and MAP, and the adverse events (nausea, vomiting, hematoma, hypotension, and bradycardia).

Table 2

Recovery time and analgesic profile of the 3 studied groups.

	RISS group (n = 23)	PECs group (n = 23)	Control group (n = 23)	*P*
Recovery time (min)	12.0 ± 2.1	11.7 ± 1.8	21.2 ± 2.7	<0.001
No. of patients needing extra-fentanyl intraoperatively	3 (13.0%)	1 (4.3%)	23 (100%)	<0.001
No. of patients requesting postoperative rescue analgesia	5 (21.7%)	1 (4.3%)	23 (100%)	<0.001
VAS score				
Immediate	1 (0–2)[a]	1 (0–2)[a]	7 (4–7)[b]	<0.001
After 3 h	1 (0–3)[a]	1 (0–2)[a]	6 (4–7)[b]	<0.001
After 6 h	1 (0–7)[a]	1 (0–3)[a]	4 (4–7)[b]	<0.001
After 9 h	1 (0–4)[a]	1 (0–2)[a]	5 (4–7)[b]	<0.001
After 24 h	0 (0–4)[a]	1 (0–4)[a]	5 (4–5)[b]	<0.001

Data are presented as mean ± SD, median (range), or number (%). Groups with different superscript letters are significantly different.

VAS, visual analogue score.

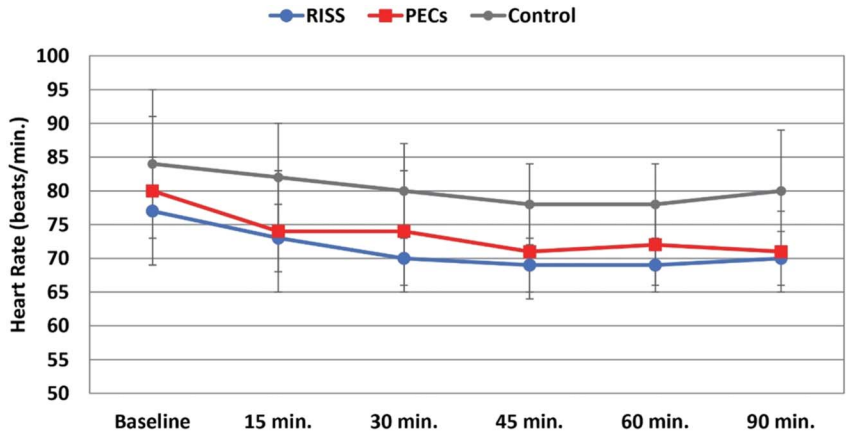

Figure 5. Intraoperative changes in the (HR) in the 3 groups. HR, heart rate.

2.4. Sample size estimation

The sample size was calculated based on 2 studies. The first study in patients subjected to BCS reported a reduction of opioid requirements from 77.0 ± 41.9 μg in the control group to 43.8 ± 28.5 μg in patients who received PECS II block.[20] In patients undergoing video-assisted thoracoscopic surgery, the second study showed a reduction of sufentanil consumption to 51.9 ± 2.2 after RISS compared to 73.5 ± 8.2 in the control group.[8] Based on the above findings, the effect size was found to be 0.439. It accounts for the variations in the group means of opioid consumption at 24 hours after the surgery in PECS II, RISS vs the control group (43.8 μg, 51.9 μg, and 73.5 μg, respectively). To be more conservative, the highest standard deviation was used = 28.5. With a level of significance = 0.05 and a power of test 0.9, then 69 patients were sufficient to reject the null hypothesis that the means of the 3 study groups are not different. G-Power version 3.1.9.2 was used for calculating sample size.

2.5. Statistical analysis

IBM SPSS Statistics version 23 (IBM Corp., Armonk, NY) was used for statistical analysis. When applicable, the mean and standard deviation or the median and range were used to express numerical data. Frequency and percentage were used to express qualitative data. The relationship between qualitative variables was investigated using the χ^2 test, often known as Fisher exact test. When it came to quantitative data, the ANOVA test was used to compare the 3 groups, followed by the Wilcoxon signed-ranks test and the post-hoc "Schefe test" for pairwise comparisons or the Friedman test. Every test had 2 tails. A *P*-value less than 0.05 was deemed noteworthy.

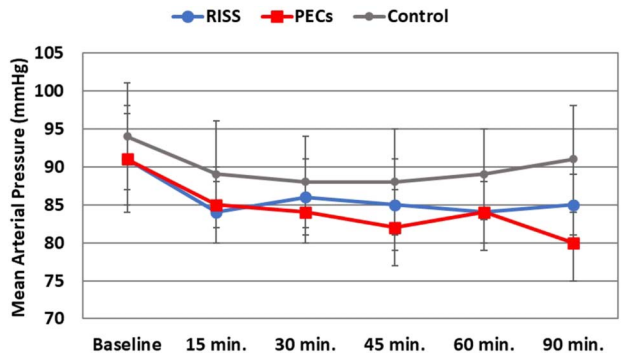

Figure 6. Intraoperative changes in the (MAP) in the 3 groups. MAP, mean arterial pressure.

3. Results

A review of 82 patients' eligibility was conducted. Nine individuals had their criteria not met, and 4 patients declined to be included in the study. Three groups of 23 patients each were randomly assigned, and for the remaining patients, statistical analysis and follow-up were conducted (**Fig. 4**).

Age, BMI, ASA class, and baseline hemodynamics did not significantly differ among the 3 groups (**Table 1**).

Requesting rescue morphine analgesia was significantly less frequent in the RISS and PECs groups compared to controls (5, 1, and 23 patients, respectively, $P < 0.001$). One patient in the PECs group received ketorolac after 24 hours. One patient in the RISS group received a single morphine injection of 3 mg, and the other 4 patients received ketorolac injections (**Table 2**). The median time to request rescue analgesia in the RISS group was 9 hours (range: 6–24 hours). The median morphine consumption in the control group was 6 mg (range: 3–9 mg).

Recovery time was significantly shorter in the RISS (12.0 ± 2.1) and PECs (11.7 ± 1.8) groups compared to the control group (12.0 ± 2.1) ($P < 0.001$, for the 2 comparisons), while the RISS and PECs groups had comparable recovery times ($P = 0.843$) (**Table 2**).

All patients in the control group required extra doses of fentanyl during the intraoperative period compared to few patients (3 patients in RESS and 1 patient in PECS) ($P < 0.001$) (**Table 2**).

Through the 24 postoperative hours, the VAS scores in the RISS and PECs groups were significantly lower than the control group. There was no significant difference between the RISS and PECs groups in the VAS scores in all readings of the post-operative period (**Table 2**).

Heart rate and mean arterial blood pressure showed trivial changes in the 3 groups during the intraoperative period. However, all readings were within the clinically acceptable ranges (**Figs. 5 and 6**). During the postoperative period, the HR and MAP were clinically stable with intergroup differences of the HR after 3, 6, 9, and 24 hours, and intergroup differences of the MAP on arrival to the PACU and after 3 hours (**Table 3**). Postoperative nausea and vomiting scores were significantly higher in the control group than in the RISS and PECs groups ($P < 0.001$).

Table 3

Heart rate and mean arterial pressure during the postoperative period in the 3 studied groups.

	RISS group (n = 23)	PECs group (n = 23)	Control group (n = 23)	P
Heart rate (bpm)				
Immediate	96 ± 5	95 ± 6	92 ± 7	0.107
After 3 h	92 ± 5[a]	84 ± 6[b]	90 ± 7[a]	<0.001
After 6 h	88 ± 8[a]	81 ± 6[b]	85 ± 7[ab]	0.013
After 9 h	81 ± 6[ab]	77 ± 6[a]	85 ± 9[b]	0.003
After 24 h	77 ± 6[a]	73 ± 7[a]	92 ± 13[b]	<0.001
MAP (mm Hg)				
Immediate	85 ± 4[a]	80 ± 5[b]	91 ± 7[c]	<0.001
After 3 h	84 ± 5[a]	91 ± 6[b]	87 ± 6[ab]	0.002
After 6 h	88 ± 7	89 ± 5	87 ± 7	0.655
After 9 h	91 ± 6	87 ± 5	87 ± 7	0.069
After 24 h	89 ± 5	90 ± 6	88 ± 6	0.458

Data are presented as mean ± SD. Groups with different superscript letters are significantly different.
MAP, mean arterial pressure.

Postoperative nausea and vomiting score 1 was more common in the RISS group compared to the PECs group (**Table 4**).

4. Discussion

This is the first randomized clinical trial comparing the analgesic efficacy of PECs and RISS blocks after BCS. The results of this study demonstrated that both regional blocks showed comparable effects in reducing the need for intraoperative fentanyl and postoperative morphine within 24 hours after BCS. Ultrasound-guided RISS and PECs blocks can efficiently relieve pain in the first postoperative 24 hours after BCS with no significant intergroup difference.

Rhomboid intercostal nerve block was first presented in 2016 as an analgesic method for both the front and back of the chest. A cadaveric study showed the dye spreading in the tissue plane from T2 to T9 levels involving the lateral branches of the intercostal nerves, posterior primary rami, and the clavipectoral fascia within the axilla. The inferior insertion of the serratus is stained up to T9, while the serratus anterior is stained up to T2.[11]

Few studies tested the analgesic effect of RIB in females subjected to breast surgery. Altıparmak et al.[1] compared the RIB with a control group that received no regional blocks in patients undergoing modified radical mastectomy (MRM). The authors demonstrated significantly reduced postoperative morphine consumption in the RIB group than the control group. Nonetheless, they did not find any decrease in postoperative pain intensity or intraoperative fentanyl consumption.[1] One year later, Jiang et al.[18] compared RIB with ESPB and SPB after MRM. Rhomboid intercostal nerve block was found to be as effective as ESP in reducing postoperative pain and opioid consumption. The 2 techniques were superior to SAB. Similar to the previous study, the consumption of intraoperative anesthesia was the same.

Thereafter, Elsarkawy et al.[10] extended their option of RIB for chest wall analgesia to the newer block RISS based on the concept of continuity of the chest wall fascial system. They augmented RIB with a caudally oriented injection of the local anesthesia (LA) deeper to the serratus muscle. Rhomboid intercostal and subserratus plane block selectively targets the lateral cutaneous branches of the thoracic intercostal nerves' ventral rami. The spread occurs medially to the dorsal rami of the intercostal nerves between T3 and T9 beneath the erector spinae and above the thoracic transverse processes.[10] In a case series of 21 patients who underwent abdominal surgery, RISS block was shown to provide effective postoperative analgesia.[9]

Longo et al.[21] described the utilization of the RISS block in nonintubated patients during video-assisted thoracoscopic surgery (VATS). Up to 4 hours postoperatively, the patients were pain-free and did not need extra pain medicines. A case report of RISS use in an intubated patient undergoing VATS lobectomy reported well-controlled postoperative pain for 8 hours. A paracetamol injection was required after 12 hours, but no opioids were used.[22] Similar findings were reported by Deng et al.,[8] who found that both RIB and RISS block significantly reduced opioid needs within 24 hours after VATS, but RISS was superior.

In the current study, we compared the novel RISS block technique with an extensively studied regional block in cases of breast surgery, the modified PECs block. Pectoral nerve block targets the long thoracic nerves, together with the intercostal nerves, and medial and lateral pectoral nerves, by LA injection into the plane between the serratus anterior and pectoralis minor muscles, and between the 2 pectoralis muscles.[7]

Several studies have utilized the PECs II block for breast surgery. Compared to thoracic paravertebral blockade, the PECS II block provided a comparable decrease in pain intensity and opioid consumption usage.[13,16,26] On the other hand, PECS block was superior to systemic analgesia in the reduction of pain and opioid use.[23,28] In patients undergoing BCS, PECS block moderately reduces opioid consumption, prolongs analgesic duration, and lowers postoperative pain when compared to systemic analgesics. However, it is not yet recommended by any professional anesthesia society.[3]

We found RISS to provide a comparable effect to the more standard regional block for breast surgery, the PECs II block. It yielded adequate pain reduction and refraining from opioid usage. This comparable analgesic profile can be attributed to

Table 4

Postoperative nausea and vomiting scores in the 3 studied groups.

	RISS group (n = 23)	PECs group (n = 23)	Control group (n = 23)	P
PONV score				<0.001
0	9 (39.1%)	15 (65.2%)	3 (13.0%)	
1	14 (60.9%)	8 (34.8%)	6 (26.1%)	
2	0 (0.0%)	0 (0.0%)	14 (60.9%)	

PONV, postoperative nausea and vomiting.

blocking the lateral cutaneous branches of the intercostal nerves between T3 and T8 levels covering the surgical area effectively. Rhomboid intercostal and subserratus plane block has the advantage of the distant injection site relative to the surgical incision. The efficacy of RISS in the more extensive procedure in breast cancer surgery, the MRM, needs to be investigated to reach a clue about the equality of the 2 procedures.

The primary limitation of the present research is the small sample size, yet the fact that it is the initial study to contrast the new RISS method with the traditional PECs II block could be a valid rationale.

5. Conclusion

In patients undergoing breast conservative surgery, RISS and PECs II block are safe and effective regional analgesic alternatives. The 2 blocks had comparable efficacy regarding the reduction of postoperative pain intensity and opioid consumption during the first 24 hours after surgery. The 2 techniques were hemodynamically stable and decreased significant postoperative nausea and vomiting. The 2 techniques were technically feasible with no failures in all cases.

Disclosures

The authors have no conflict of interest to declare.

Acknowledgments

Ethics approval and consent to participate: All patient guardians provided written informed permission after the study was approved by the National Cancer Institute (NCI)—Cairo University's ethical committee (AP22304-501-048) and registered on clinicaltrials.gov (NCT06274814). Each participant received information on the purpose and advantages of the study, and data were gathered anonymously.

Consent for publication: Not applicable.

Availability of data and materials: The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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