Randomized Controlled Trial

Rhomboid Intercostal versus Serratus Anterior Plane Block for Analgesia After Thoracodorsal Artery Perforator Flap Following Partial Mastectomy: A Randomized Controlled Trial

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Disclaimer: This clinical trial was approved by the Institutional Review Board (IRB) at Zagazig University (ZU-IRB# 10060/ October 30, 2022) and ClinicalTrials.gov (NCT05661279, registration date December 22, 2022). The first patient in this study was enrolled on December 25, 2022.

Conflict of interest: Each author certifies that he or she, or a member of his or her immediate family, has no commercial association (i.e., consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted article.

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Background: The thoracodorsal artery perforator (TDAP) flap has been developed to improve the postoperative aesthetic and psychological states of patients who receive breast-conserving surgery (BCS); nonetheless, the TDAP flap exacerbates the pain that occurs at 2 surgical sites.

Objectives: This trial aimed to compare the efficacy of the rhomboid intercostal block (RIB) and the serratus anterior plane block (SAB) as postoperative analgesics for BCS.

Study Design: Prospective randomized controlled clinical trial.

Setting: This clinical trial was conducted at Zagazig University Hospitals.

Methods: Eighty-four patients scheduled for BCS followed by a TDAP flap were randomly divided into 3 groups (of 28 patients each). Group C received general anesthesia, and groups SAB and RIB received SAB and RIB blocks, respectively, followed by general anesthesia. The cumulative tramadol consumption within 24 hours after the operation was the primary outcome. The postoperative pain score, first-rescue analgesic time, and sensory block coverage were the secondary outcomes.

Results: The 24-hour cumulative tramadol consumption and duration of the first rescue analgesic were significantly lower and longer, respectively, in the RIB group, than in the SAB group or the control group. The VAS score was lower in the RIB group than in the SAB or control group at all measurement times, except at 24 hours postoperatively, and the values among the groups were not significantly different. Dermatomal coverage of the anterior and posterior hemithorax extended from T2-T9 in the RIB group and from T2-T10 in the anterior hemithorax only in the SAB group.

Limitations: Both block procedures were applied as single shots, and their impact on chronic postoperative pain was not assessed; the observation may therefore be drawn that a continuous local anesthetic (LA) infusion catheter could be used to extend the period of analgesia.

Conclusion: Because of its ability to block both the anterior and posterior hemithorax, the RIB, is more efficient than the SAB at controlling acute pain and reducing opioid consumption in patients undergoing BCS followed by TDAP flaps; thus, the RIB can be employed as a potential alternative in these surgeries.

Key words: Analgesia, breast-conserving surgery, partial mastectomy, regional anesthesia, rhomboid intercostal block, serratus anterior plane block, thoracodorsal artery perforator flap

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Oncoplastic intervention after breast-conserving surgery (BCS) represents one of the most common procedures that reconstructive surgeons perform daily (1). Pain after breast surgery is highly variable, but it is known to be intense during the first hours or days following surgery and can be a clinically significant problem for more than 30% of patients (2). Furthermore, this postoperative pain may progress to chronicity, known as postmastectomy pain syndrome (3).

The thoracodorsal artery perforator (TDAP) flap was initially designed by Angrigiani et al (4). Compared to the conventionally used latissimus dorsi muscle or myocutaneous (LDMC) flaps, TDAP flap procedures have the advantages of sparing muscles, reducing donor site complications, and designing thinner, aesthetically superior flaps (5). However, harvesting and repositioning the TDAP flap may increase the intensity of postoperative pain; therefore, according to several recent studies, when regional anesthesia techniques are combined with general anesthesia during breast reconstruction surgery, postoperative pain and opioid consumption are reduced, leading to early rehabilitation and a reduced length of stay for the patient (6-8). Despite its beneficial analgesic effect, a thoracic epidural block might cause hemodynamic changes, such as hypotension and decreased tidal volume (9). Paravertebral block and intercostal blocks can also provide postoperative analgesia; however, these procedures may be accompanied by such potential complications as pneumothorax and nerve injury (10,11).

The serratus anterior plane block (SAB) is a method for providing effective hemithoracic analgesia. In this technique, the analgesic effect appears to be mediated through a blockade of the lateral cutaneous branches of the intercostal nerves (12) that leaves the posterior primary rami of the thoracic intercostal nerves unblocked. Meanwhile, the rhomboid intercostal block (RIB), which was first performed in 2016 for pain relief in a patient with multiple rib fractures, may be useful in providing analgesia for both the anterior and posterior hemithorax. In the RIB, the injectate passes the midaxillary line (MAL) to the lateral cutaneous branch of the thoracic intercostal nerve and spreads medially deep to the erector spinae tissue plane and to the thoracic transverse processes, where the dorsal rami of the thoracic intercostal nerves emerge (13). However, the anterior cutaneous branches of the intercostal nerves are difficult to block with either the SAB or RIB, so they cannot provide adequate analgesia near the sternum (14).

To the authors' knowledge, the SAB and RIB have not been tested in previous research for surgeries such as the post-BCS TDAP flap. Herein, we hypothesized that the RIB could be more efficient than the SAB as an opioid-sparing analgesic because of the former procedure's extensive coverage of both the anterior and posterior hemithorax. Therefore, this trial aimed to evaluate and compare the impact of these 2 plane blocks for analgesia and postoperative opioid consumption reduction after TDAP flap reconstruction for partial reconstruction of the breast after BCS.

Methods

Study Population

This prospective randomized controlled clinical trial was conducted at Zagazig University Hospitals from December 2022 to September 2023. The trial was registered with ClinicalTrials.gov (NCT05661279) after receiving approval from the institutional review board (the Research Ethics Committee of the Faculty of Medicine, Zagazig University) with the reference number ZU-IRB#: 10060/30/10/2022.

Adult female patients aged 21-60 years with a body mass index (BMI) < 35 kg/m^2 and American Society of Anesthesiologist (ASA) I or II were scheduled for elective pedicled TDAP flap placement following partial mastectomy under general anesthesia. Patients with a history of previous breast surgery or chest surgery, an allergy to the local anesthesia (LA) agent intended for use, skin lesions at the needle insertion site, psychiatric disorders, bleeding disorders, or compromised renal or hepatic functions were excluded from the trial.

Sample Size Calculation

Under the assumption that the median (range) tramadol consumption after 24 hours of video-assisted thoracoscopic surgery was 223.2 mg (144-378) in the control group, 151.3 mg (40-316) in the serratus group, and 122 mg (64-192) in the rhomboid group (15), the sample size was calculated by the OpenEpi program to be 84 patients divided into 3 equal groups (28 in each group), with a confidence level of 95% and a power of 80%.

Randomization

The patients were recruited before admission to the preoperative anesthesia clinic. The trial details were explained before written informed consent was obtained.

Each patient was assigned her own computer-generated random number. Patient assignment was performed according to this number, which was put in an envelope and opened on the day of surgery by an independent anesthetist who was not involved in further trial steps.

Eighty-four patients were randomly allocated into 3 equal groups: the C group (control group), in which surgery was performed under general anesthesia; the SAB group, in which patients received unilateral SABs with 25 mL of 0.25% bupivacaine followed by general anesthesia; and the RIB group, in which patients received unilateral RIBs with 25 mL of 0.25% bupivacaine followed by general anesthesia.

We planned to blind the operating room team by performing a sham block on patients in the control group while submitting the trial protocol and registering the trial. However, we believed that it was unethical to expose patients to the risk of a sham block without providing any benefit, so we opted to omit the sham block. Therefore, only the outcome assessors were blinded to the assignment. The outcome assessors were blinded to the assignment.

Preoperative Assessment

The preoperative visit was performed the night before surgery to evaluate each patient's medical status and drug sensitivities, describe the anesthetic plan and fasting hours (6 hours for solid and 2 hours for fluid), and discuss the trial steps.

Blood sugar levels, complete blood counts, coagulation profiles, and kidney and liver function tests were obtained from each patient. Patients were trained to use the visual analog scale (VAS), ranging from 0 (no pain) to 10 (maximum worst agonist), to assess their levels of postoperative pain.

Intraoperative

Patients were monitored with standard monitoring methods (electrocardiograms, pulse oximetry, noninvasive blood pressure monitoring, and capnography), and baseline parameters were recorded. An intravenous line was inserted before the administration of 3-5 mg of midazolam.

Performance of the SAB

The patient was placed in a supine position with her arm abducted at 90°. After sterilization and draping of the skin, the US high-frequency linear probe from Siemens Ultrasonography (Siemens Medical Solutions, USA, Inc.) was placed in a sagittal plane between the fourth and fifth ribs at the MAL. The LD, serratus anterior muscle, and external intercostal muscles were identified via ultrasonic imaging (16). A 22-gauge, 80 mm needle (Stimuplex® D, B-Braun) was inserted craniocaudally via the in-plane technique into the interfascial plane between the serratus anterior muscle and external intercostal muscles (i.e., a deep SAB was performed). After negative blood aspiration was confirmed, 1 mL of normal saline was injected for hydrodissection to verify the presence of the needle tip, after which 25 mL of 0.25% bupivacaine was injected (Fig. 1A).

Performance of the RIB

The patient was placed in the lateral decubitus position according to the selected site of surgical intervention, and the ipsilateral arm was extended to the same level as the ipsilateral chest to remove the scapula and open the space. After sterilization and draping of the skin, a linear probe from Siemens Ultrasonography (Siemens Medical Solutions USA, Inc.) was placed medial to the lower border of the scapula in an oblique sagittal plane. The rhomboid major muscle was identified underneath the trapezius muscle at the level of the T6 and T7 vertebrae, and the intercostal muscles, pleura, and lung were visualized via ultrasound (13). A 22-gauge, 80 mm needle (Stimuplex® D) was inserted craniocaudally via the in-plane technique into the interfascial plane between the rhomboid major muscle and the intercostal muscles, known as the triangle of auscultation (bounded by the lateral border of the trapezius muscle, the medial border of the scapula, and the upper border of the LD muscle). After the correct placement of the needle tip was verified by hydrodissection with 1 mL of normal saline, 25 mL of 0.25% bupivacaine was injected into the newly formed space underneath the rhomboid major muscle (Fig. 1B). All block procedures for both groups were performed by the same anesthesiologist. Both the surgeon and outcome assessors were blinded to the trial groups.

The surgeon marked the anterior axillary line (AAL), MAL, and posterior axillary line (PAL) on the patient. The perforators were located and marked with a handheld Doppler probe along the posterior axillary line.

Thirty minutes after block implementation, the sensory dermatomal block level was assessed using cold loss sensation with iced solutions.

Preoxygenation with 100% O_2 was carried out

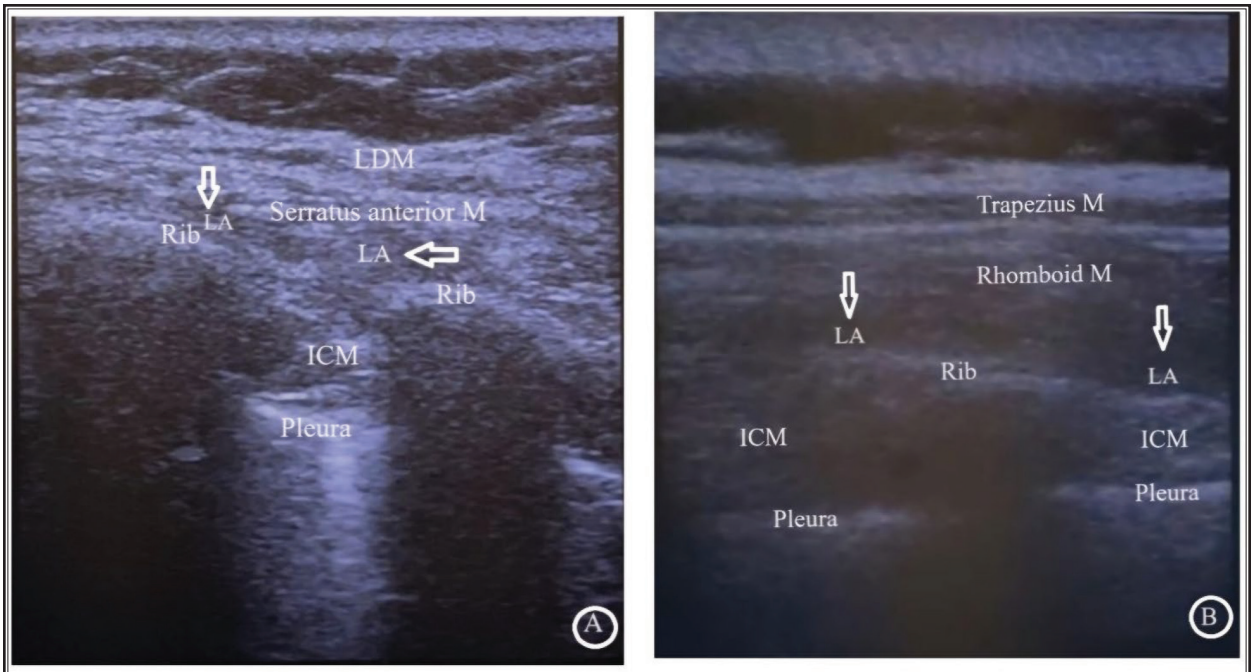


Fig. 1. *(A) Sonographic image of the deep serratus anterior plane block. (B) Sonographic image of the rhomboid intercostal block. LDM: latissimus dorsi muscle, ICM: intercostal muscle, LA: local anesthetic; white arrows show local anesthetic spread between the serratus, intercostal muscles, and ribs (A) or between the rhomboid and intercostal muscles and ribs (B).*

for 5 minutes. Anesthesia was induced using 2 mg/kg propofol and 1 µg/kg fentanyl with 0.5 mg atracurium to facilitate single-lumen endotracheal tube insertion. Anesthesia was maintained with isoflurane in oxygen and air and atracurium at 0.1 mg/kg/30 minutes, and positive pressure ventilation was adjusted to maintain the end-tidal level of carbon dioxide at 36-40 mmHg.

Hemodynamics (including heart rate [HR] and mean arterial blood pressure [MAP]), SPO_2, and $ETCO_2$ were measured intraoperatively every 5 minutes until the end of the surgery. An extra bolus dose of 1 µg/kg fentanyl was administered intraoperatively when there was a 20% or greater increase in MAP or HR from the baseline values after the exclusion of other causes.

Surgical Procedure Technique

The patient was handed to the breast surgeon for breast cancer excision, creating the post-mastectomy defect planned for the patient. Then, the amount of skin needed and the volume needed for filling and reconstructing the created defect were estimated. The flap was marked and designed according to the availability of a reliable perforator and was then harvested in either a vertical or dorsally oblique orientation (Fig. 2). An exploratory incision was usually made along the anterior border of the flap, which was kept anterior to the MAL. Dissection was performed carefully to identify the perforator, either the septocutaneous perforator in the septum between the LD and serratus anterior muscle or posteriorly to the musculocutaneous perforator through the LDM. The perforator was usually found within 2-3 cm from the lateral border of the LD muscle (beyond the PAL). Then, a premarked incision was made, and the flap was islanded and transposed to the recipient defect area. A suction drain was placed under the flap. The donor site was primarily closed (Figs. 2,3).

All patients, regardless of the group allocations, were given 1 gm of intravenous acetaminophen 30 minutes before the end of the surgery for postoperative pain management.

At the end of the procedure, 100% oxygen was administered at a fresh gas flow rate of 8 liters per minute while the halogenated agent was turned off. To reverse the residual neuromuscular block, a mixture of 0.05 mg/kg neostigmine and 0.02 mg/kg atropine was used. After smooth extubation, patients were transferred to the postoperative care unit (PACU).

Acetaminophen (15 mg/kg 4/day, maximum dose 4 gm/day) and diclofenac sodium (75 mg, administered intramuscularly twice a day) were given as postopera-

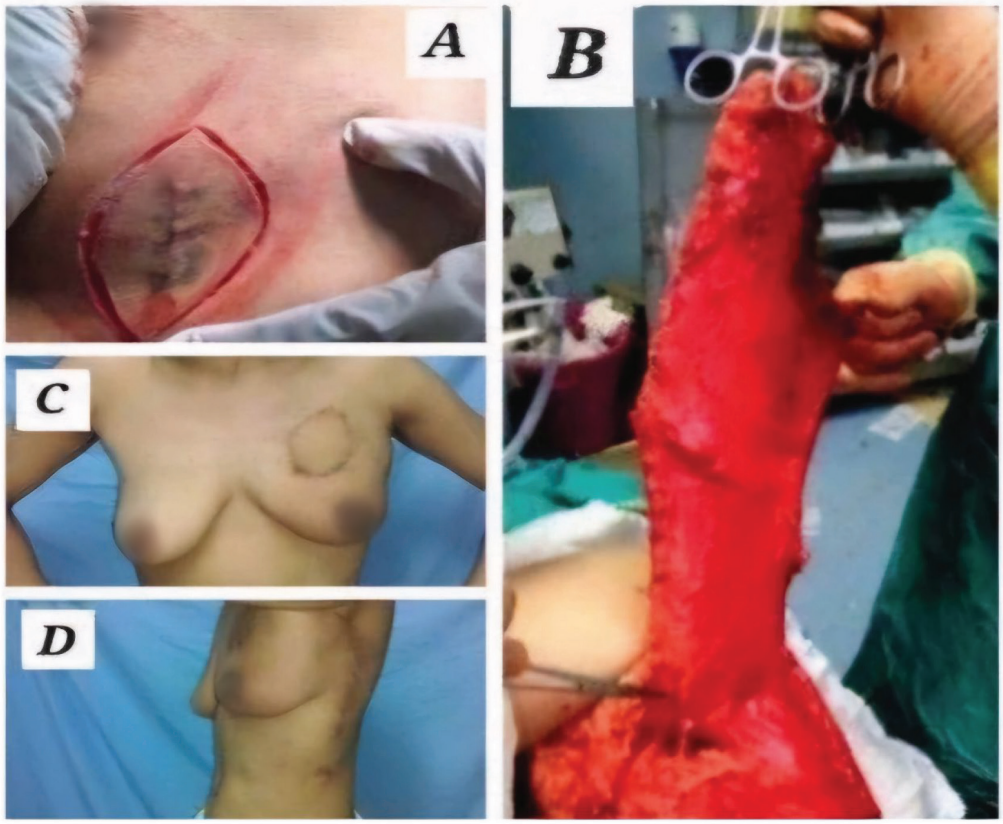
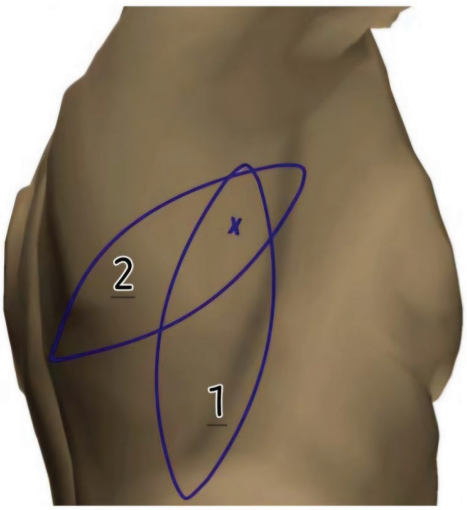


Fig. 2. *A: Tumor excision; B: thoracodorsal perforator flap harvested; C: postoperative flap reconstruction of the defect; D: scar of the flap donor site.*

tive analgesics in the ward according to a set schedule. Rescue analgesia in the form of an intravenous bolus dose of 50 mg tramadol was given if the postoperative VAS score was ≥ 3 or if the patient requested more analgesia between VAS score measurements within the first 24 postoperative hours.

Parameters for Evaluation

- Patient characteristics: age, BMI, and ASA physical status.
- Operative time (in minutes).
- Primary outcome: The total dose of rescue analgesic (tramadol) consumed in the first 24 hours postoperatively.
- Secondary outcomes:
  - The time needed to perform the technique (in minutes) was defined as the time from the placement of the ultrasound probe on the patient's skin to the end of the local anesthetic injection.



(Sinna & Qassemyar, 2011)

Fig. 3. *Illustrates the design of the two types of TDAP flaps; 1: vertical flap; 2: horizontal flap (17).*

- The VAS (18) score was assessed at rest and during movement at 30 minutes, one hour, 3 hours, 6 hours, 12 hours, and 24 hours postoperatively.
- The first rescue analgesic time (hour): This measure refers to the time of asking for the first postoperative analgesic (tramadol). The duration was calculated from the end of the operation to the patient reporting a VAS score ≥ 3.
- Intraoperative and postoperative complications included opioid-related complications such as nausea and vomiting and block-related complications such as local anesthetic toxicity and needle injury to essential organs.
- Postoperative patient satisfaction was based on a 3-point assessment scale (satisfied, neutral, or dissatisfied) and assessed at postoperative day 24.

• Covariate outcomes:
- The number of blocked dermatomes was assessed after 30 minutes of block administration using cold loss sensation with iced solutions.
- Intraoperative cumulative fentany (μg).
- HR and MAP were recorded at the baseline before the fascial planes were blocked and then immediately after the skin incision, 15, 30, 60, 90, and 120 minutes after said incision, at the end of surgery, at the PACU, and at one hour postoperatively.

Statistical Analysis

IBM SPSS Staistics 26 (IBM Corporation) was used to analyze the data. The chi-square test, Fisher's exact test, and, when appropriate, the Monte Carlo test were used to compare the categorical variables, which were defined using their absolute frequencies. The chi-square test for trend was used to compare ordinal data between 2 groups. The Shapiro-Wilk test was used to verify assumptions for use in parametric tests. Quantitative variables are expressed as means and standard deviations or medians and ranges according to the type of data. To compare quantitative data between 2 groups, an independent-sample t-test (for normally distributed data) was used. The Kruskal-Wallis test for nonnormally distributed data and one-way ANOVA for normally distributed data were used to compare quantitative data among more than 2 groups. When the difference was significant, pairwise comparisons and Fisher's least significant difference tests were used to detect differences between each pair of individual groups. The chi-square test for trend was used to test the statistical significance of block distribution between groups. The level of statistical significance was set at $P < 0.05$. A highly significant difference was indicated by $P \leq 0.001$.

Results

This trial evaluated the eligibility of 93 patients who were scheduled for an elective pedicled TDAP flap after partial mastectomy under general anesthesia. The CONSORT flow diagram illustrates that 84 patients were randomly assigned to 3 equal groups of 28 patients each, with 9 patients excluded; 4 patients declined to participate, and the remaining 5 patients met one or more of the exclusion criteria (Fig. 4).

There were statistically nonsignificant differences among the studied groups in age, BMI, ASA, operative times, operative sides, and orientation of the harvesting flaps. Additionally, the time to perform the block was significantly shorter ($P < 0.001$) in the SAB group than in the RIB group (Table 1).

Regarding total tramadol consumption at 24 hours after the operation, there was a statistically significant difference among the 3 studied groups: the highest doses were in the control group, followed by the SAB group, while the lowest doses were observed in the RIB group (Table 2).

As for the first use of rescue analgesia and intraoperative fentanyl, there were significantly shorter treatment times and higher doses, respectively, in the control group, followed by the SAB group, with the RIB group experiencing the longest treatment time and lowest doses by significant margins (Table 2). However, as far as complications were concerned, there was no significant difference in the incidence of nausea and vomiting among the 3 studied groups or in LA toxicity and needle trauma between the 2 interventional groups (Table 2).

There was a highly statistically significant difference in the VAS score at rest or with movement among the 3 studied groups: the highest values at the PACU and at one, 3, 6, and 12 hours postoperatively were observed in the control group ($P \leq 0.001$), followed by the SAB group, while the RIB group had the lowest significant values at rest at one, 3, 6, and 12 hours postoperatively ($P \leq 0.001$) and with movement at 3, 6, and 12 hours postoperatively ($P \leq 0.001$); however, at 24 hours postoperatively, there was no significant difference among the 3 studied groups ($P = 0.594$ at rest, $P = 0.132$ with movement) (Fig. 5).

The patients in the SAB and RIB groups were significantly more satisfied than those in the control group, with no significant difference between the 2 interventional groups (Table 3).

There were no significant differences among the studied groups in baseline hemodynamics (HR and MAP). Later, the mean HR and MAP were significantly greater in the control group than in the SAB or RIB groups immediately after the skin incision; 15, 30, 60, 90, and 120 minutes after said incision; at the end of surgery; at the PACU; and one hour postoperatively, with no significant difference detected between the 2 interventional groups; however, the values in the SAB group were greater than those in the RIB group after 90 minutes of skin incision until the end of the measurement (Fig. 6).

There was also no statistically significant difference in the percentage of sensory block distribution between the SAB and RIB groups ($P \geq 0.999$ for T2-T8, $P = 0.42$ for T9), where most patients lost the cold sensation from T2-T9 of the anterolateral hemithorax except for the parasternal area (T10 was covered in only 10% of patients in the SAB group [$P = 0.236$]) (Fig. 7A). However, there was a highly statistically significant difference regarding the sensory block of the posterior hemithorax ($P < 0.001$); most patients in the RIB group lost the cold sensation from T2-T9 posterior to the PAL, while in the SAB group, the cold sensation was rare (Fig. 7B).

Discussion

The present trial evaluated the analgesic effect of the RIB and SAB after the TDAP flap for partial breast reconstruction following BCS and revealed less tramadol consumption within the first 24 hours postoperatively in the RIB group than in the SAB

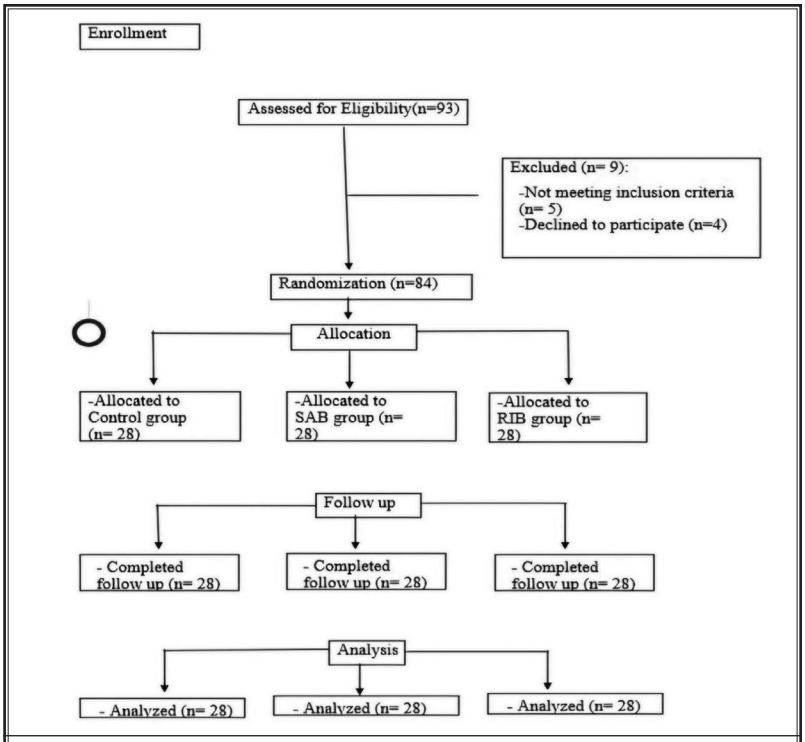


Fig. 4. *CONSORT flow diagram.*

Table 1. *Patient characteristics and operative data.*

Characteristics	Control Group (n = 28)	SAB Group (n = 28)	RIB Group (n = 28)	*P* value
Age: (years) Mean (SD)	45.82 (8.52)	48.93 (6.65)	46.68 (9.67)	[a] 0.362
BMI: (kg/m^2) Mean (SD)	24.29 (2.89)	23.86 (2.26)	24.89 (2.3)	[a] 0.302
ASA: N (%) I: II:	12 (42.9%) 16 (57.1%)	13 (46.4%) 15 (53.6%)	11 (39.3%) 17 (60.7%)	[b] 0.864
Operative side: N (%) Left Right	17 (60.7%) 11 (39.3%)	18 (64.3%) 10 (35.7%)	16 (57.1%) 12 (42.9%)	[b] 0.861[b]
Block performance time (min): Mean (SD)	------	4.79 (0.74)	6.68 (0.95)	[c] <0.001**
Flap type: N (%) Vertical Horizontal/oblique	14 (50%) 14 (50%)	12 (42.9%) 16 (57.1%)	13 (46.4%) 15 (53.6%)	[b] 0.686
Operative time: (min) Mean (SD)	169.46 (10.05)	169.75 (9.23)	172.96 (5.78)	[a] 0.242

Data are expressed as the mean (SD), number and percentage. n = total number of patients in each group. SAB: serratus anterior plane block; RIB: rhomboid intercostal block; BMI, body mass index. [a]ANOVA test, [b] chi-square test, [c] independent sample t-test. $P > 0.05$ indicates a nonsignificant difference. **$P \leq 0.001$ is highly statistically significant.

Table 2. *Analgesic data and complications among the studied groups.*

Variables	Control Group (n = 28)	SAB Group (n = 28)	RIB Group (n = 28)	*P* value	LSD
Tramadol Consumption (mg) in 24 h.: Mean (SD)	228.57 (49.87)	137.14 (37.5)	103.57 (38.32)	[a] < 0.001**	P1 = 0.001** P2 < 0.001** P3 = 0.004*
Time of first rescue analgesia (min): Mean (SD)	59.86 (9.2)	463.21 (139.05)	569.25 (118.75)	[a] < 0.001**	P1 < 0.001** P2 < 0.001** P3 < 0.001**
Intraoperative fentanyl (µg) Mean (SD)	202.89 (13.88)	142.18 (17.2)	128.57 (9.8)	[a] < 0.001**	P1 < 0.001** P2 < 0.001** P3 < 0.001**
Nausea & vomiting N (%): No: Yes:	23 (82.1%) 5 (17.9%)	27 (96.4%) 1 (3.6%)	26 (92.8%) 2 (7.1%)	[b] 0.298	
LA toxicity N (%): No: Yes:	-----	28 (100%) 0 (0%)	28 (100%) 0 (0%)	[b] 1.00	
Needle trauma N(%) No: Yes:	-----	28 (100%) 0 (0%)	28 (100%) 0 (0%)	[b] 1.00	

Data are expressed as the mean (SD), number, and percentage. n = total number of patients in each group. SAB: serratus anterior plane block; RIB: rhomboid intercostal block; LA: local anesthesia; LSD: least significant difference test. [a]ANOVA test, bchi-square test. $P > 0.05$ indicated a nonsignificant difference. *$P \leq 0.05$ is statistically significant. **$P \leq 0.001$ is statistically highly significant. P1: Control group versus SAB group. P2: Control group versus RIB group. P3: SAB group versus RIB group.

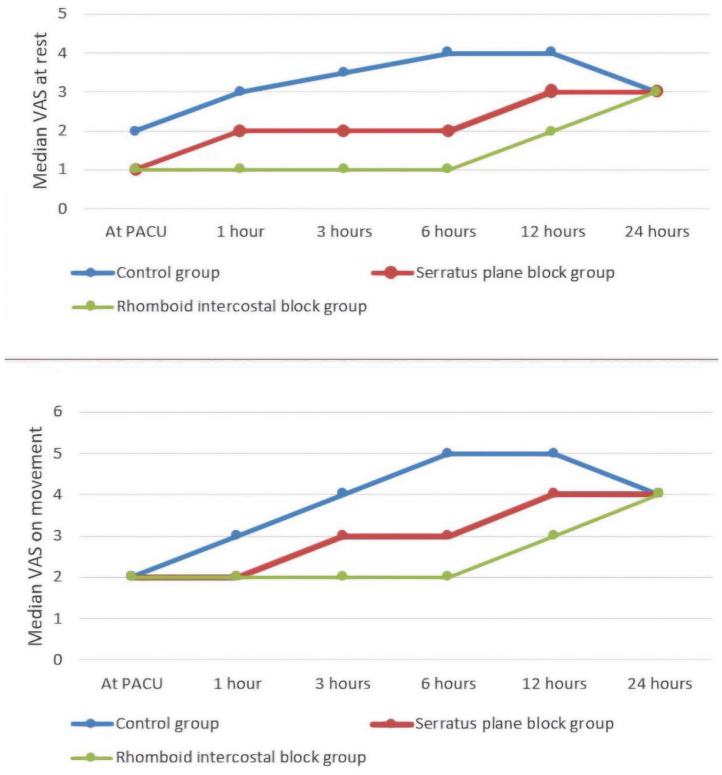


Fig. 5. *Median postoperative visual analog scale (VAS) score at rest and with movement among the studied groups. Kruskl Wallis test.*

Table 3. *Patient satisfaction among the studied groups.*

Patients' Satisfaction	Control Group (n = 28)	SAB Group (n = 28)	RIB Group (n = 28)	*P* value	LSD
Dissatisfied N (%):	20 (71.4%)	3 (10.7%)	3 (10.7%)	[a] < 0.001**	P1 < 0.001** P2 < 0.001** P3 > 0.999
Neutral N (%):	5 (17.9%)	8 (28.6%)	5 (17.9%)	[a] 0.529	
Satisfied N (%):	3 (10.7%)	17 (60.7%)	20 (71.4%)	[a] < 0.001**	P1 < 0.001** P2 < 0.001** P3 = 0.397

Data are expressed as numbers and percentages. n = total number of patients in each group. SAB, serratus anterior plane block; RIB, rhomboid intercostal block; LSD: least significant difference test. [a] Chi-square test. $P > 0.05$ indicates a nonsignificant difference. $^{**}P \leq 0.001$ is highly statistically significant. P1: Control group versus SAB group. P2: Control group versus RIB group. P3: SAB group versus RIB group.

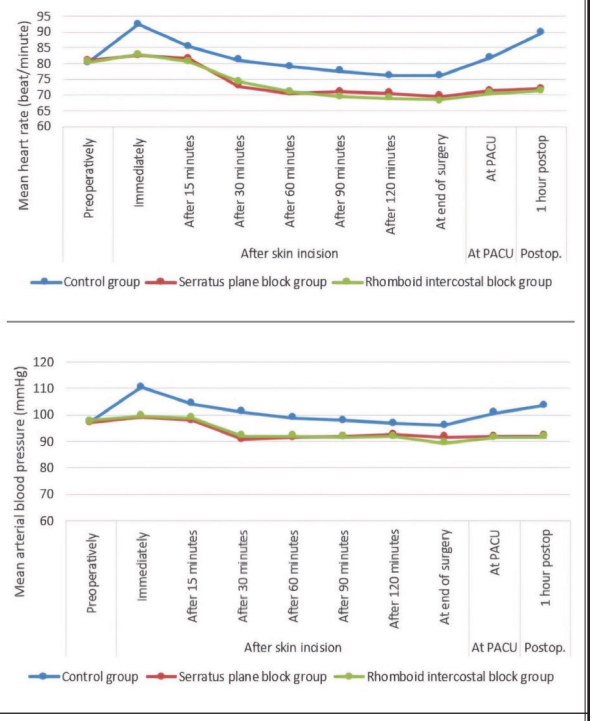


Fig. 6. *Intraoperative mean HR and arterial blood pressure among the studied groups. One-way ANOVA.*

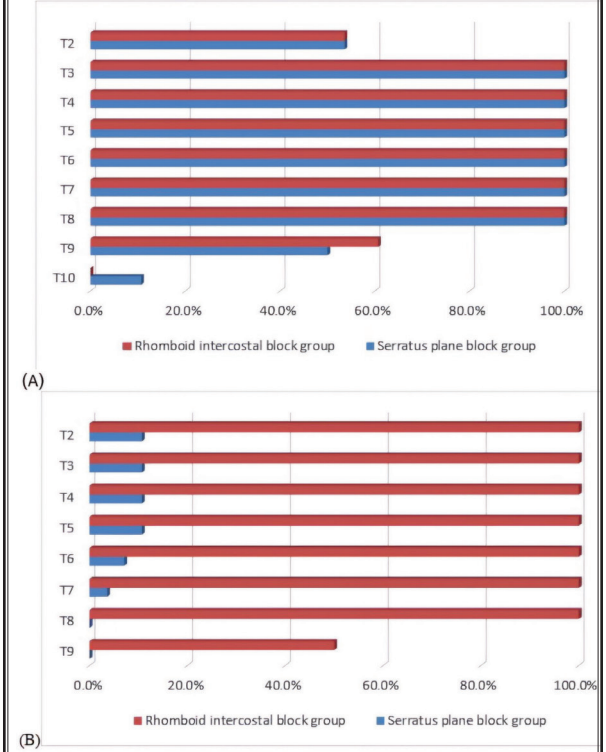


Fig. 7. *Sensory block distribution of the anterolateral hemithorax (A) and the posterior hemithorax (B) in the two intervention group.* χ^2 *chi-square test for trend.*

or control groups. Moreover, the RIB group demonstrated a longer first-rescue analgesic time and lower VAS score at rest and with movement in the PACU and within the first 12 hours postoperatively. However, no differences were found among the trial groups in opioid- or block-related complications.

This finding is consistent with that of Jiang et al (19), who reported that RIB and erector spinae plane block (ESB) were associated with better analgesic effects after modified radical mastectomy (MRM) than was SAB. In Jiang et al's (19) trial, the tramadol dosage and dynamic numeric rating scale (NRS) score within 24 hours after the operation were greater in the SAB group than in the RIB or ESB groups. Additionally, both the RIB and SPB groups had longer first pain times than did the SAB group (19). Similarly, Zhang et al (20) revealed that within 24 hours after video-assisted tho-

racic surgery), sufentanil consumption and the dynamic NRS score were greatly lower and the time to first receive analgesics was longer in the RIB and ESB groups than in the SAB group.

Chen et al (21), in their meta-analysis, concluded that a preoperative RIB was safer and more effective in managing acute pain after breast surgery and thoracoscopic surgery than was intravenous analgesia, since the RIB significantly reduced pain scores and 24-hour opioid consumption. Additionally, Altıparmak et al (22) concluded that an RIB, as a component of multimodal analgesia in patients undergoing MRM, improved the patients' quality of recovery and lowered their opioid use; however, NRS scores were similar between the RIB and control groups, and the authors attributed this finding to the effective multimodal analgesia strategy they used in both groups.

Hu et al (23) showed in their meta-analysis that a group of patients who received SABs experienced lower opioid consumption and more effective pain relief after breast surgery than did patients in the control group. However, Abdallah et al (24) found that the addition of a deep SAB to systemic analgesia did not improve analgesic outcomes (opioid consumption and VAS score) in patients who underwent ambulatory breast cancer surgery. Moreover, in their cohort analysis, Alexander et al reported that there was no significant difference in opioid consumption or pain scores between patients who underwent surgical site infiltration alone and those who underwent SABs. Furthermore, Alexander et al (25) do not recommend routine SABs for all patients undergoing simple lumpectomies if surgical site infiltration with local anesthetics is planned.

As for the analgesic effect seen in our interventional groups, this trial suggested that the RIB and SAB had a comparable intraoperative analgesic effect for patients undergoing BCS, since both procedures provided effective anterolateral hemithoracic analgesia. Our findings also seem to imply, however, that the SAB may reduce the efficiency of pain management after the TDAP flap, especially when the surgeon needs to use a horizontally or obliquely oriented flap that extends beyond the PAL, which may be remedied by using an RIB. This possibility is based on what was observed and recorded intraoperatively: the hemodynamic (HR and MAP) values were comparable between the RIB and SAB groups within the first 90 minutes of the skin incision, which coincided with the first part of the operation; however, after 90 minutes and until the end of surgery, the BCS values were not significantly greater in the SAB group than in the RIB group, which coincided with the time of flap harvesting, mainly the horizontal/oblique type. Additionally, the consumption of intraoperative fentanyl was significantly greater in the SAB group than in the RIB group. This finding was strengthened by the efficiency of the RIB and SAB in terms of the dermatomal coverage of the anterolateral hemithorax from T2-T9 in most patients in both groups. By contrast, the posterior hemithorax from T2-T9, just medial to the spinous processes, was significantly more covered in the RIB than in the SAB group.

These results are in line with an earlier trial provided by Elhouty et al (26), who showed that the RIB and SAB groups in their trial expressed significantly lower hemodynamic readings 15 minutes after the end of the thoracoscopic sympathectomy procedure than did the control group; furthermore, this decrease was more evident in the RIB group than in the SAB group. Jiang et al (19) noted that there was no significant difference in the amount of remifentanil and propofol consumed intraoperatively among the RIB, SAB, and ESB groups in their trial's population of patients undergoing MRM, but this observation could be refuted, since the trial in the present trial included another aspect of surgical interference (the TDAP flap) absent from Jiang et al's. The need for defects in dermatomal coverage may be responsible for this difference.

The dermatomal coverage seen in this trial was consistent with that witnessed by Elsharkawy et al (13) in their cadaveric trial of the RIB. Elsharkaway et al (13) concluded that dermatomal coverage stretched from T2-T9 of the anterior and posterior hemithorax and was used successfully in rib fracture patients, who experienced symptomatic relief (13). Yayik et al (27) revealed that the bilateral RIB was effective for pain management after breast reduction surgery and provided dermatomal coverage between T2-T7 of the anterior, lateral, and posterior hemithorax.

Biswas et al (28), in their cadaveric trial to evaluate the optimal injectate spread of the SAB, noted that cephalad-to-caudad spread occurred from the third to seventh rib after injection at the fifth rib in most cases, while for anterior-to-posterior spread, the dye reached the midclavicular line in more than 50% of the cases (~100%) between the MAL and AAL, irrespective of the level or plane of injection (superficial or deep SAB). Their trial also found, however, that posterior spread was limited to 20% to 27.3% of the cases between the MAL and PAL following a single injection and rarely occurred to the PAL (1/39 injection).

Ökmen and Köprücüoğlu revealed that compared to the SAB, the RIB provided a wider sensory block to the lateral and posterior thoracic wall for pain management after video-assisted thoracoscopic surgery, where the LA rarely spread to the midscapular line (15).

Notably, patients in the RIB and SAB groups in our trial were highly satisfied compared to those in the control group. Similarly, Jiang et al (19) revealed no difference among their SAB, RIB, and ESB groups in patient satisfaction. However, Zhang et al (20) reported that their patients' satisfaction scores were much greater in the RIB and ESB groups than in the SAB group.

The foregoing information makes it obvious that there is a debate regarding the efficacy of the SAB in controlling pain after breast surgery, possibly because "breast surgery," the type of surgery being performed, is too generic a term and involves different degrees of extension of the surgical procedures, making the results difficult to compare. This issue is evident in the present trial, since BCS was followed by a TDAP flap that may extend beyond the dermatomal coverage of the SAB but still within that of the RIB. Furthermore, compared to the SAB, the RIB in this surgery type has the advantage of being an easily applicable block, particularly in patients with large breasts in which the soft breast tissue is far from the ultrasonography probe and the needle, making it easier to image the appropriate anatomy and advance the needle. In addition, the RIB's injection site is distant from the surgical area, which enhances the possibility of performing the block at the end of surgery or inserting a catheter for continuous analgesia if the administration thereof is planned.

Limitations

There are several limitations to this trial. First, the sensory block evaluation was limited to the first 30 minutes of the block's performance and was not conducted in the postoperative period. Instead, the authors used the pain score and analgesic outcomes as indirect indicators of the blocks' efficacy. Second, both block procedures were applied as a single shot, and their impact on chronic postoperative pain was not assessed. Last, the trial is limited to a certain group of female patients and to a specific operation, BCS followed by a TDAP flap, and cannot be generalized to other subgroups or operations that may need other reconstructive surgeries with a larger flap, such as the whole LD flap. Therefore, future studies are needed to evaluate the impacts of the rhomboid block on these variables compared to those of other regional block techniques, such as the ESB.

Conclusion

Because of the ultrasound-guided RIB's capacity to block anterior and posterior hemithorax dermatomes with a single injection, this type of block is more efficient than SAB at controlling acute pain and reducing intraoperative and postoperative opioid consumption in patients undergoing BCS followed by TDAP flaps. Moreover, the RIB can be utilized as a potential substitute in these types of breast reconstructive procedures due to its distance from the surgical site, an additional benefit that prevents it from interfering with the surgical field, whether used pre- or post-operatively.

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