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Research Article

Deep serratus anterior plane block vs. rhomboid intercostal plane block for analgesia after breast cancer surgery: A prospective, double-blind randomized study

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ABSTRACT

Background: Ultrasound-guided interfascial plane blocks are widely used in breast cancer surgery, but direct comparisons of deep serratus anterior plane block (SAPB) and rhomboid intercostal plane block (RIPB) are limited.

Materials and Methods: Single-center, prospective, randomized, double-blind trial of 40 women (ASA I–III) undergoing oncologic breast surgery. Participants were allocated to SAPB or RIPB, both as single-shot, ultrasound-guided adjuncts to standardized multimodal analgesia. The primary outcome was 24-hour morphine consumption; secondary outcomes were pain scores (NRS at rest and with 90° arm abduction at prespecified times), time to first analgesic request, and adverse events.

Results: All randomized patients completed follow-up. Baseline features were comparable except for higher body weight in the SAPB group. The primary outcome did not differ between groups; pain scores were low throughout and showed no between-group differences. Time to first analgesic was similar (log-rank p=0.439). No block-related serious adverse events occurred.

Conclusions: Within a standardized multimodal pathway, SAPB and RIPB provided similar early analgesia with low opioid use and a reassuring safety profile. Although the study was not designed for non-inferiority, the findings support RIPB as a practical alternative to SAPB in routine breast cancer surgery. Larger, procedure-stratified studies–including quality-of-recovery and longer-term outcomes–are warranted.

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1. Introduction

Breast cancer surgery has moved from radical operations toward modified and breast-conserving techniques [1]. Postoperative pain remains a day-to-day issue for the anesthesiologist. Earlier diagnosis and the availability of alternative systemic and locoregional therapies have improved survival; the perioperative pain phase, however, demands careful, patient-specific management to support early mobilization, limit opioid exposure, and reduce the chance of pain lingering beyond the immediate recovery [2]. The breast's complex innervation, together with procedure modifications driven by tumor location, means the chosen regional technique will inevitably vary [3]. That variability, in turn, feeds the inconsistencies seen across clinical studies.

As ultrasound technology has matured and entered routine anesthesia practice, thoracic epidural and landmark-guided paravertebral techniques have given way to interfascial plane blocks [4]. The main options are pectoral nerve blocks (PECS), serratus anterior blocks (superficial and deep), the erector spinae plane block, and—

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among the more recent additions—the rhomboid intercostal plane block (RIPB) [4,5]. Compared with conventional neuraxial approaches, interfascial plane blocks offer practical advantages: a lower risk of major complications such as pneumothorax, analgesia limited to the surgical field, and relatively less sympathetic blockade. The trade-off is that coverage can be insufficient when the surgical extent widens, and block quality may drop as the field grows.

The deep serratus anterior block targets the lateral cutaneous branches of the intercostal nerves. In most breast cancer operations these branches need to be blocked, yet coverage can still be incomplete. The RIPB, originally described to block the entire hemithorax, may be insufficient parasternally. Both techniques also miss contributions from the superficial cervical plexus and branches of the brachial plexus. In the literature, deep serratus anterior plane block—hereafter SAPB—is frequently reported to reduce perioperative opioid consumption in breast cancer surgery. Throughout this manuscript, the abbreviation *SAPB* has been used to denote the deep serratus anterior plane block (DSAPB). This clarification has been added to avoid confusion with the superficial variant. For the rhomboid intercostal plane block (RIPB), the evidence base is smaller, but available reports describe similar opioid-sparing effects and acceptable analgesia. Comparative clinical studies of these two techniques are limited.

Accordingly, we conducted a prospective, double-blind, randomized trial to compare deep serratus anterior plane block (SAPB) with rhomboid intercostal plane block (RIPB) as adjuncts to a standardized multimodal analgesia regimen in breast cancer surgery. The hypothesis of this study is null, indicating no expected difference between the groups. The primary outcome was cumulative 24-hour morphine consumption; secondary outcomes included pain scores at rest and with movement at prespecified intervals, time to first analgesic request, and adverse events.

2. Materials and Methods

2.1. Study design

This prospective, randomized, double-blind study was conducted at Maltepe University Faculty of Medicine Hospital operating rooms in accordance with the Declaration of Helsinki. The protocol was approved by the Maltepe University Clinical Research Ethics Committee (decision No. 4, 01 Nov 2022). Written informed consent was obtained from all participants prior to enrollment.

2.2. Participants

Eligible patients were women aged 18 – 70 years, ASA I – III, scheduled for elective breast cancer surgery. Exclusion criteria were: neurologic/psychiatric disorders that could alter pain perception; regular use of antipsychotics or antidepressants; ASA $\geqslant$ IV; allergy to local anesthetics; coagulopathy/bleeding diathesis; or refusal to participate.

2.3. Randomization and blinding

Patients were randomized 1:1 to receive either deep serratus anterior plane block (SAPB; Group S) or rhomboid intercostal plane block (RIPB; Group R) using a sealed opaque envelope method. Patients and postoperative assessors were blinded to allocation. The block-performing anesthesiologist could not be blinded to the technique but did not take part in postoperative assessments.

2.4. Perioperative care and general anesthesia

Standard monitoring included pulse oximetry, ECG, and noninvasive blood pressure. After 3 min preoxygenation (100% O_2), general anesthesia was induced with propofol 2–3 mg·kg^{-1}, fentanyl 1–2 μg·kg^{-1}, and rocuronium 0.6 mg·kg^{-1} for orotracheal intubation. Ventilation was set to a tidal volume of 6–8 mL·kg^{-1}, with respiratory rate adjusted to maintain end-tidal CO_2 30–35 mmHg. Anesthesia was maintained with sevoflurane ~2% in 50% O_2/air (flow 2 L·min^{-1}) and remifentanil 0.05 μg·kg^{-1}·min^{-1}. Hemodynamics (blood pressure, heart rate), end-tidal CO_2, and end-tidal sevoflurane were recorded every 10 minutes intraoperatively. Thirty minutes before the end of surgery, patients received paracetamol 1 g, tenoxicam 20 mg, and ondansetron 4 mg intravenously.

2.5. Regional block interventions

All blocks were performed before extubation by the same senior anesthesiologist (last-year resident under supervision) experienced in peripheral nerve blocks, using a linear 8–12 MHz ultrasound probe (LOGIQ e, GE Medical Systems, Jiangsu, China) and an in-plane technique with a 22G 80-mm needle (Stimuplex® Dplus, B. Braun, Germany). The local anesthetic (LA) mixture for both techniques was 40 mL total: 20 mL 0.25% bupivacaine + 10 mL 0.5% lidocaine + 10 mL saline.

Deep SAPB (Group S). With the patient supine, the linear probe was placed to identify the 2nd rib and advanced caudo-laterally to the 4th–5th rib level. The serratus anterior muscle (deep to latissimus dorsi, superficial to the ribs) was identified. The needle was inserted in-plane from the probe's supero-anterior aspect, and the LA mixture was injected between the serratus anterior muscle and the rib surface.

RIPB (Group R). With the lateral decubitus position (block side up), the upper arm was crossed over the chest to retract the scapula laterally. The probe was placed along the medial border of the scapula at approximately T5–T6. Skin, subcutaneous tissue, trapezius, rhomboid, intercostal muscles, rib, pleura, and lung were identified. The LA mixture was deposited between the rhomboid major muscle and the 5th rib.

After block completion, atropine 0.02 mg·kg^{-1} and neostigmine 0.04 mg·kg^{-1} were administered for neuromuscular reversal, and patients were extubated once adequate spontaneous breathing was confirmed.

2.6. Postoperative analgesia protocol

All patients received morphine patient-controlled analgesia (PCA) (Eitan Q Core Sapphire™ Multi-Therapy Infusion System). Morphine was prepared at 1 mg·mL^{-1}; the PCA was programmed with no basal infusion, 1 mg bolus, 20-minute lockout, and a maximum of 4 mg per 2 hours. Paracetamol 1 g was administered every 8 hours. For NRS $\geqslant$ 4, diclofenac sodium 75 mg was given as rescue analgesia.

2.7. Outcomes and follow-up

Pain intensity was assessed using the Numerical Rating Scale (NRS, 0–10; 0 = no pain, 10 = worst pain imaginable) at 20 and 40 minutes, 1, 3, 6, 12, 18, and 24 hours postoperatively. At the same time points, the number of PCA bolus attempts and cumulative morphine dose were recorded. The primary outcome was 24-hour morphine consumption. Secondary outcomes included NRS scores over time, number of PCA demands, time to first analgesic request, and adverse events/complications. Recorded complications were pneumothorax, nausea, vomiting, pruritus, and local anesthetic systemic toxicity (LAST).

2.8. Statistical analysis and sample size

The target sample size was 40 patients (n=20 per group), calculated to detect a between-group difference in postoperative opioid requirement with 80% power at a two-sided α=0.05.

Data were analyzed using IBM SPSS Statistics v22 (IBM SPSS, Türkiye). Normality was assessed with the Shapiro–Wilks test. Descriptive statistics are presented as mean ± SD or median [quartiles] for continuous variables and counts (%) for categorical variables. Independent-samples t-test was used for normally distributed continuous data; Mann–Whitney U for non-normal data. Chi-square or Fisher's Freeman–Halton tests were applied to categorical comparisons. Time to first analgesic was analyzed by Kaplan–Meier with the log-rank test. All tests were two-sided with α=0.05.

3. Results

A total of 40 patients were enrolled and randomized to the SAPB (n=20) or RIPB (n=20) group; all completed follow-up and were included in the analyses. Baseline characteristics were similar between groups with the exception of higher body weight in SAPB (Table 1). Cumulative 24-hour morphine consumption was low and did not differ between groups, and time-point analyses showed no significant differences (Table 2). Pain scores were likewise low in both groups, with no between-group differences at any scheduled time point (Tables 3 and 4). Time to first analgesic request did not differ significantly between techniques on Kaplan–Meier analysis (log-rank p=0.439). No block-related serious adverse events occurred; postoperative nausea/vomiting occurred in 6/40 (15%) and only one patient (2.5%) required rescue diclofenac.

Table 1. Baseline characteristics (mean ± SD or n (%)).

Variable	SAPB (n=20)	RIPB (n=20)	p-value
Age (years)	53.9 ± 14.0	50.9 ± 13.2	0.483
Height (cm)	162.0 ± 6.0	159.5 ± 5.3	0.161
Weight (kg)	69.8 ± 11.7	62.3 ± 8.7	0.027
BMI (kg·m^{-2})	26.7 ± 4.9	24.5 ± 3.4	0.113
Surgical duration (min)	140.8 ± 43.7	124.5 ± 23.2	0.150
ASA I / II / III	6 / 11 / 3	6 / 14 / 0	0.186
Axillary dissection, n (%)	14 (48.3%)	15 (51.7%)	0.723

Table 2. Morphine consumption by time point (median [IQR]).

Time	SAPB	RIPB	p-value
1 h	1 [0–1]	1 [0–1]	0.968
3 h	1 [0–1.75]	1 [0–1.75]	0.738
6 h	1 [1–2]	1 [0–2]	0.414
9 h	1.5 [1–2]	1 [0–2]	0.314
12 h	2 [1–3.75]	1.5 [0–2]	0.201
18 h	2 [1–4]	2 [0–3]	0.183
24 h	2 [1–4.75]	2 [0–3]	0.192
Total 0–24 h (mean; median)	3.05; 2	1.75; 2	NS

Table 3. NRS at rest (median [IQR]).

Time	SAPB	RIPB	p-value
1 h	1.5 [0–2]	1 [0–2]	0.862
3 h	0.5 [0–1]	1 [0–2]	0.383
6 h	0 [0–1]	0 [0–1]	0.947
12 h	0 [0–1]	0 [0–0]	0.445
18 h	0 [0–1]	0 [0–0]	0.478
24 h	0 [0–0]	0 [0–0]	0.841

Table 4. NRS with 90° arm abduction (median [IQR]).

Time	SAPB	RIPB	p-value
1 h	2 [1–3]	2 [0.25–3]	0.989
3 h	1 [0.25–2]	1 [0–2.75]	0.925
6 h	1 [0–1.75]	1 [0–1]	0.461
12 h	0.5 [0–2]	0 [0–1]	0.383
18 h	0 [0–1]	0 [0–1]	0.820
24 h	0 [0–1]	0 [0–1]	0.718

4. Discussion

In this randomized, double-blind trial, adding either deep serratus anterior plane block (SAPB) or rhomboid intercostal plane block (RIPB) to a standardized multimodal regimen yielded comparable early analgesia and opioid sparing after breast cancer surgery. Pain trajectories overlapped, time to first analgesic did not differ, and no block-related serious adverse events were observed. Within this protocol, SAPB and RIPB appear broadly interchangeable as adjuncts.

Deep serratus anterior plane block (SAPB) is already known as one of the most opioid-sparing options for breast cancer surgery, with many studies supporting its effectiveness [6]. In our randomized study—although not designed as a formal non-inferiority trial—rhomboid intercostal plane block (RIPB) performed at least as well as SAPB within the same multimodal pathway [7]. Pain scores and morphine use moved in parallel, and we saw no safety signal that would argue against RIPB as a practical alternative. Although direct comparisons between SAPB and RIPB are still limited, some meta-analyses have reported a signal in favor of RIPB [7]. That said, these syntheses mostly weight pain scores and opioid consumption, while quality-of-recovery (QoR) and functional endpoints remain underrepresented. We also did not assess QoR in this trial, which is a limitation. Future studies should include validated QoR scales (e.g., QoR-15/40), sleep and shoulder function, readiness for discharge, and longer-term outcomes such as persistent postoperative pain and return to usual activity.

A straightforward reason for our similar results is the shared plane anatomy. The rhomboid–intercostal plane (RIPB) deep to the rhomboid major is contiguous anteriorly with the plane deep to the serratus anterior used for deep SAPB [8]. Injectate in either space can travel along the lateral thoracic wall and bathe the lateral cutaneous branches of T2–T7 intercostal nerves (including their anterior divisions that supply the breast envelope) [9]. With scapular retraction in RIPB, spread often runs anterolaterally beneath serratus—functionally resembling a two-level/deep SAPB effect across one or two interspaces [10]. In other words, both techniques end up targeting the same nerve set in the same fascial continuum, so it is not surprising that early pain scores and opioid use tracked each other. (The caveat remains parasternal coverage, where neither technique reliably reaches the anterior cutaneous branches without an adjunct.) As recently highlighted by Fusco et al. [11], interfascial plane blocks (FPBs) are significantly volume-dependent, with injectate volume being a key determinant of the spread and efficacy. Accordingly, we opted for a 40 mL volume in our study to maximise craniocaudal diffusion and dermatomal coverage, and suggest that in future comparative analyses of plane blocks the volume variable should always be accounted for.

The axillary region receives sensory innervation mainly from the intercostobrachial (T2) and partially from the long thoracic and thoracodorsal nerves. Although the anatomical spread of SAPB may theoretically provide broader coverage toward the axillary area than RIPB, this difference did not appear to influence our findings [9]. In our study, the proportion of patients who underwent axillary dissection was similar between the groups (48% vs. 51%), and no difference in postoperative analgesic outcomes was observed. The deep fascial plane beneath the serratus anterior was preferred in this study because it lies closer to the lateral cutaneous branches of the intercostal nerves, which are responsible for the anterolateral thoracic wall sensation [10]. Local anesthetic injected in this plane tends to spread more uniformly along the thoracic wall and provides more reliable analgesia for lateral chest incisions. In contrast, the superficial plane, located between the latissimus dorsi and serratus anterior muscles, may produce variable spread, and combined injections can increase procedure time and local anesthetic volume without proven additional benefit.

Several limitations merit mention. Our sample size was modest (n=40), which narrows precision and does not support a formal non-inferiority claim or robust subgroup analyses. Surgical procedures were not fully homogeneous (a spectrum of oncologic breast operations with/without axillary dissection); although the proportion undergoing axillary dissection was similar between groups, variation in field extent and tissue trauma can meaningfully affect pain trajectories and block requirements. This was a single-center study with a single operator and a fixed local anesthetic mixture delivered as single-shot blocks, which may limit generalizability to other settings or catheter strategies. Outcomes were confined to the first 24 hours and did not include quality-of-recovery measures or longer-term endpoints (e.g., sleep, shoulder function, persistent postoperative pain). Baseline weight differed between groups and could confound pharmacokinetics; we did not adjust outcomes for weight beyond randomization. These constraints should temper interpretation and motivate larger, procedure-stratified trials with standardized ERAS pathways, QoR endpoints, and consideration of catheter or layered plane techniques. Another limitation of this study is the fixed injectate volume of 40 mL. Although this volume was selected to achieve adequate craniocaudal spread and consistent anterolateral thoracic coverage while maintaining safety through dilution, different volumes (e.g., 30–40 mL) reported in the literature may influence the extent of block spread and analgesic effect. The last limitation is that all blocks were performed by a single experienced operator. While this ensured procedural consistency, it may limit the generalizability of the findings to settings with varying levels of operator expertise.

5. Conclusions

Both SAPB and RIPB provided good early pain control after breast cancer surgery. Opioid use was low in both groups, and we saw no block-related serious events. Although the trial was not designed to prove non-inferiority, the results looked clinically similar for pain scores, opioid use, and time to first analgesic. In everyday practice, RIPB seems a reasonable alternative to SAPB; the choice can follow surgical field access, patient anatomy, and operator experience. Larger studies with quality-of-recovery measures and longer follow-up would help confirm these findings.

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Conflict of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this manuscript.

Data Availability

The datasets created and/or analyzed during the current study are not publicly available, but are available from the corresponding author upon reasonable request.

Ethics Approval and Consent to Participate

This study was approved by the ethics committee of Maltepe University Clinical Research Ethics Committee (decision No. 4, 01 Nov 2022). Written informed consent was obtained from the participants. All methods were performed in accordance with relevant guidelines and regulations.

Author Contributions

Doğukan Kilit: *conceptualization, methodology, software, validation, formal analysis, investigation, resources, data curation, writing – original draft, writing – review & editing,*
Zeliha Özer: *writing – original draft, writing – review & editing.*

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