Menoufia Medical Journal

PRINT ISSN: 1110-2098 - ONLINE ISSN: 2314-6788

journal hompage: www.menoufia-med-j.com



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Amira M. Elfeky

Mahmoud A. Bahram

Mahmoud A. Shamakh

Mohamed A. Balbaa

ORIGINAL STUDY

# Efficacy of Intraoperative Serratus Anterior Plane Block on Postoperative Pain Relief Following Modified Radical Mastectomy

Amira M. Elfeky [a], Mahmoud A. Bahram [a], Mohamed A. Balbaa [a], Mahmoud A. Shamakh [b,*]

[a] Department of General Surgery, Faculty of Medicine, Menoufia University, Menoufia, Egypt
[b] Department of General Surgery, Sohag General Hospital, Sohag, Egypt

**Abstract**

*Objective*: **This study aimed to assess the efficacy of intraoperative serratus anterior plane block (SAPB) in controlling postoperative pain in female patients undergoing modified radical mastectomy.**

*Background*: **Postoperative pain control poses a common challenge for patients undergoing modified radical mastectomy, often managed through opioid administration. However, muscle block techniques have gained traction to reduce opioid use. The SAPB is a thoracic regional anesthetic technique that improves postoperative analgesia.**

*Patients and methods*: **This prospective randomized study involved 50 breast cancer patients who underwent a modified radical mastectomy. They were randomly divided into two equal groups: group A received intraoperative SAPB, and group B served as the control. The primary outcome was postoperative visual analog scale; secondary outcomes included opioid and paracetamol consumption and postoperative complications.**

*Results*: **Group A exhibited significantly lower visual analog scale values within the first 12 h after surgery ($P < 0.005$), significantly delayed first postoperative analgesic dose, a significant decrease in total postoperative paracetamol and nalbuphine consumption, and a significant decrease in the incidence of postoperative nausea and vomiting compared to group B. Group A showed a nonsignificant decrease in respiratory depression and neurapraxia incidence and had a shorter hospital stay than group B.**

*Conclusion*: **SAPB is a safe and effective technique that provides substantial pain relief after breast surgery, reducing analgesic consumption, shortening hospital stays, and enhancing patient satisfaction.**

*Keywords:* Modified radical mastectomy, Postoperative analgesia, Serratus anterior plane block

## 1. Introduction

Breast cancer accounts for ~22.9% of female cancers globally and 37.7% in Egypt [1]. Surgical resection via modified radical mastectomy or conservative breast surgery remains the primary treatment modality [2].

Postoperative pain control in modified radical mastectomy patients is a prevalent concern [3]. Uncontrolled pain exacerbates the surgical stress response, impacting metabolic, endocrine, inflammatory, and immune statuses [4]. Efficient acute postoperative pain control correlates with improved postoperative outcomes, including shorter hospital stays, reduced healthcare costs, and heightened patient satisfaction [5].

Serratus anterior plane block (SAPB) is an interfascial block targeting the lateral cutaneous branches of T2−T9 intercostal nerves by injection of local anesthetic either superficial or deep to the serratus anterior muscle at the midaxillary line at the level of the fifth rib. At this location, the lateral cutaneous nerves penetrate the external intercostal and serratus anterior muscles before dividing into

Received 8 January 2024; revised 1 February 2024; accepted 19 August 2024.
Available online 18 October 2024

* Corresponding author at: Sohag 1670021, Egypt.
E-mail address: mahmoud.shamakh30@gmail.com (M.A. Shamakh).

https://doi.org/10.59204/2314-6788.3269

anterior and posterior divisions, which innervate the anterolateral chest wall. In addition, the long thoracic nerve and thoracodorsal nerve lie in the fascial plane between the serratus anterior muscle and latissimus dorsi muscle [6].

Traditionally performed preoperatively under ultrasound guidance, SAPB provides intraoperative analgesia but demands skilled anesthetists and equipment, posing risks of complications [7]. This study evaluated intraoperative SAPB efficacy in controlling postoperative pain in modified radical mastectomy patients.

## 2. Patients and methods

This prospective randomized study was completed between August 2021 and August 2022 on adult patients undergoing modified radical mastectomy at Menoufia University Hospitals. Sample size calculation was calculated with the assumption that the difference in the visual analog scale (VAS) between the two groups would be 25% according to previous studies; setting the alpha to 0.05 and beta to 20%, it was calculated that an appropriate group size would be 25 patients in each group to overcome dropouts.

The study included adult female patients (≥18 years old) diagnosed with breast cancer, and modified radical mastectomy was indicated. Patients with a history of bleeding dyscrasias or allergy to one of the study medications or patients with locally advanced breast malignancies with skin ulceration or infiltration of the chest wall were excluded from the study.

After Institutional Ethical Committee approval was obtained, all 50 patients signed a written informed consent before enrolling in the study. They were randomly divided by closed-envelope method into two equal groups: group A included 25 patients who received a SAPB, and group B included 25 patients who did not receive the serratus anterior block as a control group.

All the included patients were evaluated by proper history, physical examination, routine laboratory, and radiological investigations. Patients were instructed to fast for 6 h before the operation.

On the day of the operation, patients were transferred to the operating theater. Then general anesthesia was induced by propofol 1.5–2 mg/kg i.v. and followed by administration of intravenous fentanyl 2 μg/kg for intraoperative analgesia. After completing the surgery of modified radical mastectomy and before closure, an injection of 5 ml (2 ml 0.25% bupivacaine + 2 ml lidocaine 2% + 1 ml saline) was performed in the fascia between latissimus dorsi and serratus anterior muscles at the level of fifth intercostal space at midaxillary line for SAPB group. Closure was then performed after the insertion of suction drains.

After the operation, all patients were transferred to the postanesthesia care unit and then to the internal ward unless there was a reason for admission to the ICU. A VAS was used to rate the postoperative pain levels [8]. The patient was instructed to place a mark on a line of ten cm in length indicating their level of pain, where 0 = no pain and 10 = severe pain. Pain severity was measured at 2, 4, 8, 12, and 24 h after the end of surgery of modified radical mastectomy.

If the patient reported a VAS of more than 3, paracetamol 1 g infusion over 20 min was given, and if the pain persisted after 20 min, Nalbuphine was given in bolus doses, each 4 mg/bolus. Paracetamol was repeated in the same dose every 6 h according to VAS.

### 2.1. Statistical analysis

SPSS for Windows, version 25, 2017 (Statistical Package for the Social Sciences; IBM Corporation, Armonk, New York, USA) was used for statistical analysis of the collected data. For the assessment of quantitative data, the Shapiro–Wilk test was used for normality testing. For normally distributed data, it was presented at the mean and SD and compared using the $\chi^2$ test. Abnormally distributed data was described as median and interquartile range. Then, it was it was compared using the Whitney test. For all of the mentioned tests, $P$ value less than 0.05 was considered statistically significant.

## 3. Results

The mean age of the included cases was 46.60 ± 3.62 and 47.20 ± 3.20 years in groups A and B, respectively ($P$ = 0.283). The mean BMI was 29.90 ± 5.45 and 30.51 ± 4.54 kg/m$^2$ in the same groups, respectively ($P$ = 0.64). There was no significant difference between the two groups regarding the previous both demographic variables, as illustrated in Table 1.

Regarding the postoperative VAS, group A demonstrated significantly lower values than group

*Table 1. Demographic characteristics of the studied groups.*

| Items | Groups (mean ± SD) | | $Z$ value | $P$ value |
|---|---|---|---|---|
| | Group A ($n$ = 25) | Group B ($n$ = 25) | | |
| Age (year) | 43.60 ± 3.62 | 47.20 ± 3.20 | 1.270 | 0.283 |
| BMI | 29.90 ± 5.45 | 30.51 ± 4.54 | 0.47 | 0.64 |

B within the initial 8 h following surgery ($P = 0.000$). Twelve hours after surgery, group A maintained significantly lower values compared to group B ($P = 0.02$). Although group A exhibited decreased values compared to group B at the 24-h mark, this difference was not statistically significant ($P = 0.10$), as illustrated in Table 2.

As illustrated in Table 3, the first analgesic request was significantly delayed in group A, while administration of paracetamol and nalbuphine doses also showed a significant decrease in the same group ($P = 0.0001$) compared to group B.

Regarding postoperative nausea and vomiting (PONV), there was a statistically significant decrease in the incidence of PONV in group A compared to group B ($P = 0.003$). In addition, there was no significant difference between the two groups in the incidence of respiratory depression ($P = 0.37$). There was no significant difference between the two groups in the incidence of neurapraxia ($P = 0.37$). The length of hospital stay was found to be nonsignificantly shorter in patients who administered SAPB compared to those who received general anesthesia alone ($P = 0.8$), as illustrated in Table 4.

*Table 2. Basal and follow-up visual analog scale score in the studied groups.*

| Items | Groups (mean ± SD) | | Z value | P value |
|---|---|---|---|---|
| | Group A ($n = 25$) | Group B ($n = 25$) | | |
| Postoperative | | | | |
| PACU | 0.44 ± 0.50 | 7.08 ± 1.07 | 25.79 | 0.000* |
| 2 h | 1.04 ± 0.78 | 6.32 ± 0.98 | 20.69 | 0.000* |
| 4 h | 2.28 ± 0.73 | 5.48 ± 0.91 | 13.44 | 0.000* |
| 8 h | 3.24 ± 0.59 | 5.32 ± 0.94 | 8.28 | 0.000* |
| 12 h | 3.92 ± 0.59 | 5.08 ± 0.86 | 3.43 | 0.02 |
| 24 h | 4.40 ± 0.95 | 4.88 ± 0.86 | 1.96 | 0.10 |

PACU, postanesthesia care unit.
*Significant ($P < 0.05$).

## 4. Discussion

Acute or chronic postoperative pain and shoulder dysfunction are the most common complications after breast surgery [9]. Uncontrolled acute perioperative pain is an independent risk factor for postmastectomy pain syndrome [10]. Thus, proper management of postmastectomy pain improves patient experience after surgery and decreases the incidence of chronic postoperative pain [11].

Postoperative analgesia after modified radical mastectomy can be achieved by the administration of opioids and regional anesthesia like thoracic epidural block, intercostal blocks, or paravertebral block [12]. Alternatively, SAPB, a thoracic regional anesthetic technique, is commonly used for postoperative analgesia of the thoracic region [13]. Anatomically, SAPB was performed in the superficial plane. This is considered safer than other regional anesthetic techniques [14].

Blanco *et al.* [15] identified superficial and deep spaces for injections in SAPB, with wider dermatome distribution in superficial SAPB. Bhoi *et al.* [14] found lower pain levels in the superficial SAPB group compared to the deep group, potentially attributed to long thoracic nerve and thoracodorsal nerve blockade in superficial SAPB.

SAPB is a relatively easy procedure that carries minimal complications with a high success rate when performed by an anesthesiologist skilled in USG blocks like pneumothorax, nerve injury, vascular puncture, infection, and local anesthetic toxicity [16]. In our technique, as the infiltration is done under vision after dissection and identification of the

*Table 3. Postoperative analgesic requirements in the studied groups.*

| Items | Groups (mean ± SD) | | Z value | P value |
|---|---|---|---|---|
| | Group A ($n = 25$) | Group B ($n = 25$) | | |
| First analgesic request (h) | 10.10 ± 0.54 | 0.67 ± 0.33 | 6.245 | 0.0001* |
| Total nalbuphine consumption (mg) | 11.70 ± 1.03 | 22.20 ± 4.43 | 6.100 | 0.0001* |
| Total paracetamol consumption (mg) | 670.00 ± 300 | 1340.00 ± 380.106 | 6.079 | 0.0001* |

*Significant ($P < 0.05$).

*Table 4. Postoperative complications in the studied groups.*

| Items | Group A ($n = 25$) | Group B ($n = 25$) | Z value | P value | Significance |
|---|---|---|---|---|---|
| Nausea and vomiting | 0.08 ± 0.27 | 0.4 ± 0.5 | 3.36 | 0.003* | S |
| Respiratory depression | 0 ± 0 | 0.04 ± 0.2 | 1.00 | 0.37 | NS |
| Neurapraxia | 0.04 ± 0.2 | 0 ± 0 | 1.00 | 0.327 | NS |
| Hospital stay (h) | 24.08 ± 0.7 | 27.04 ± 2.3 | 6.02 | 0.8 | NS |

* Significant ($P < 0.05$).

structures, these complications can be avoided. Advantages of SAPB over paravertebral block and epidural analgesia are; it is safe even in patients with coagulation abnormalities, low coast and enhance transefer from postanasthesia care unit [17].

This study was conducted at Menoufia University Hospital, aiming to assess the efficacy of intraoperative SAPB in controlling postoperative pain in female patients undergoing modified radical mastectomy. As regards general patient criteria, there was no significant difference between the two groups ($P > 0.05$), which confirms our findings and ensures unbiased results.

In this study, group A expressed significantly lower postoperative VAS values compared to group B during the early 12 h after surgery ($P < 0.001$).

The analgesic effect produced by SAPB may last up to 12 h postoperatively. Semyonov and colleagues found that patients who were operated on with SAPB had significantly lower pain levels after thoracic surgery compared to patients in the control group [18].

Furthermore, Datu and Prasetyadhi's study found significantly lower mean pain scores at 6, 12, and 24 h in the test group compared to controls [19]. Similarly, Fajardo *et al.* [20] conducted serratus-intercostal plane block injections in 115 patients over 3 years, favoring this technique due to local anesthetic placement into the fascial plane between serratus anterior muscle and EIM.

Arora *et al.* [21] reported that the duration of analgesia was 255.3 ± 47.8 min in the SAPB group, aligning with previous reports. Rahimzadeh *et al.* [12] reported the time to first rescue analgesia as 323.5 ± 49.7 min after SAPB in patients undergoing breast cancer surgery.

In the current study, there was a significant decrease in postoperative nalbuphine and paracetamol consumption in group A ($P < 0.001$). Nalbuphine doses had mean values of 11.70 ± 1.03 and 22.0 ± 4.43 mg, while paracetamol doses had mean values of 67.08 ± 3.35 and 134.08 ± 9.53 mg in group A and group B, respectively.

Shokri and Kasem found no significant difference in VAS scores at 2, 18, and 24 h postoperative between the study groups, yet clinically, serratus-intercostal plane block alongside general anesthesia offers better postoperative pain control with minimal adverse effects compared with local infiltration, indicating that SAPB is a feasible and effective method for enhancing postoperative pain management after breast surgery [22].

Reducing opioid usage in oncological surgeries, apart from averting complications, may benefit oncological outcomes as opioids possess immune modulatory effects in addition to their analgesic effects [23].

Common opioid side effects include dizziness, PONV, constipation, and respiratory depression, which arises from mu-opioid receptor activation in brainstem respiratory neurons [24]. Moreover, the meta-analysis revealed a significantly lower PONV incidence in patients treated with SAPB, potentially attributed to reduced postoperative opioid consumption. Effective PONV prevention aids postoperative recovery and shortens patient discharge times [25].

The incidence of nausea and vomiting markedly decreased in group A compared to group B (8 vs. 40%, respectively – $P = 0.003$) in our study. Semyonov *et al.* [16] also noted lower postoperative vomiting scores with SAPB (4.2 vs. 12%, with $P < 0.01$). Likewise, Aroraa *et al.* [26] reported that there was a significant decrease in the incidence of PONV in the SAPB group versus the thoracic paravertebral block group (2 vs. 8, respectively – $P < 0.028$).

In the present study, there was no significant difference between both groups regarding the incidence of RD, neurapraxia, and length of hospital stay.

Local anesthesia can induce neurapraxia through different mechanisms, including vasoconstriction causing nerve ischemia, chemical nerve injury, nerve compression from high surrounding pressures during local anesthesia administration, neurotmesis due to needle perforation, and inflammatory complications [27].

This study had several limitations. First of all, it was a single-center study that included a relatively small sample size. In addition, we followed up with the patients for only 24 h after surgery. Also, the surgical injection technique should have been compared to the pre-incision USG block to elucidate which will offer better pain control and intraoperative hemodynamic control.

### *4.1. Conclusion*

Based on the findings of this study, it is evident that intraoperative SAPB is a safe and effective technique that offers effective pain relief after breast cancer surgery. It results in decreased analgesic consumption, shorter hospital stays, and increased patient satisfaction.

## Ethical considerations

Study protocol and written consent were submitted to the ethical committee of Menoufia University

for approval prior participation of eligible patients. All data was collected by a single physician and kept secured in an encrypted computer file.

## Funding

Authors themselves and Menoufia University. We obtained written consent from each patient after explaining aims and benefits of this study.

## Authors' contributions

Mahmoud A. Shamakh made substantial contributions to the conception and shared with the design of the work; Mahmoud A. Bahram, Mohamed A. Balbaa, Amira M. Elfeky made substantial contributions to the conception, design of the work; the acquisition, analysis, interpretation of data, and had drafted the work and substantively revised it. All authors have read and approved the manuscript.

## Conflicts of interest

There are no conflicts of interest.

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