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ORIGINAL RESEARCH REGIONAL ANESTHESIA

Serratus anterior plane block for postoperative analgesia in modified radical mastectomy

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ABSTRACT

Introduction: Serratus Anterior Plane (SAP) block can be used as part of multimodal analgesia, reducing the need for additional analgesia for 24 h postoperatively. The SAP block (SAPB) is easy to apply with a safe technique and low side effects. This study analyzes serratus anterior plane block as postoperative analgesia in Modified Radical Mastectomy (MRM) surgery by assessing the level of pain, side effects, and complications.

Methods: This study was a double-blind randomized control trial (RCT) conducted on patients scheduled to undergo MRM, at Dr. Kariadi Hospital Semarang during August-October 2022. A total of 44 patients were enrolled, and divided into two groups; 22 patients in each group. The treatment group received SAPB and was compared with the control group of morphine 0.1 mg/kg, in terms of the numeric pain rating scale, at 4, 8, 12, and 24 h postoperatively, time and number of analgesic rescue doses, the incidence of PONV and pruritus within 24 h postoperatively. Independent T-test, Mann-Whitney, Chi-square, and Fischer tests were performed to analyze the data. $P < 0.05$ was considered significant.

Results: The mean NRS at 4, 12, and 24 h postoperatively was lower in the SAPB group than in the control group (2.73 ± 0.77 vs. 3.23 ± 0.53; 1.77 ± 0.61 vs. 2.32 ± 0.48, and 1.45 ± 0.59 vs. 2.09 ± 0.61). The difference was statistically significant, e.g., $P = 0.017$, $P = 0.003$, and $P = 0.001$, respectively. Time to the first request of rescue analgesia was prolonged in the SAPB group than in the control group (398.86 ± 140.6 vs. 100.91 ± 10.3; $P = 0.000$). The mean rescue analgesic dose in the SAPB group was lower than in the control group (3.59 ± 1.56 vs. 8.55 ± 2.4; $P = 0.000$). The control group showed a higher incidence of PONV (68.2% vs. 18.2%, $P = 0.01$). There was no significant difference in the groups regarding the frequency of pruritus ($P = 0.073$).

Conclusion: Serratus anterior plane block reduced pain significantly up to 24 h postoperatively compared to the control group. The patients in this group needed rescue analgesia after longer duration and needed lower doses of rescue analgesia. There was lower frequency of PONV than the control group.

Abbreviations: MRM - Modified Radical Mastectomy; PONV – Postoperative Nausea and Vomiting; PMPS - Post-Mastectomy Pain Syndrome; PVB – Para Vertebral Block; SAP - Serratus Anterior Plane; VAS - Visual Analog Scale

Key words: Serratus Anterior Plane Block; Breast Cancer; Modified Radical Mastectomy

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1. INTRODUCTION

Breast cancer is the most common type of cancer in women and is the second leading cause of cancer death after lung cancer. In 2017 in the United States, it was estimated that there were around 252,710 new cases of invasive breast cancer, 63,410 new cases of carcinoma in situ, and about 40,610 women would die from breast cancer.[1,2] In 2018, breast cancer was the second highest prevalent cancer in Indonesia (after cervical cancer) with a prevalence of 0.5%. There is a tendency of increased incidence of breast cancer from year to year, where the incidence reaches 26 per 100,000 women.[3]

Modified radical mastectomy (MRM) is a type of mastectomy surgery that removes the entire breast tissue, pectoralis minor muscle, and axillary lymph nodes. One of the problems with MRM is a high postoperative pain score with an estimated visual analog scale (VAS) score of 5 due to an incision in the intercostobrachial nerve (cutaneous branch of T1-T2) during axillary dissection.[4] This pain can develop into post-mastectomy pain syndrome (PMPS), which significantly interferes with the quality of life.[5]

Intravenous opioids are the drugs of choice for pain treatment. Morphine is considered the gold standard of analgesics, but administration of morphine often causes side effects of nausea, vomiting, itching, and sedation.[5-7] Death rates from opioid overdose increased by 15.6%, of which 21-29% of patients abused opioids prescribed for pain management in the United States. Therefore, alternative postoperative pain management methods may play a role in the opioid epidemic.[6]

The serratus anterior plane (SAP) block is a safe and easy alternative to regional analgesics compared to other techniques performed by providing anterolateral analgesia to the chest wall.[5-7] Previous studies of SAPB have reported benefits in reducing intraoperative and postoperative opioid requirements. Many studies have shown that there is no difference in the degree of pain relief between SAPB, epidural block, and intercostal nerve block; and SAP having lower complications than para vertebral blocks (PVB).[8-11]

The SAPB is easier to apply, is a safe technique and has mild side effects. We studied the efficacy of SAPB regarding postoperative analgesia in patients undergoing modified radical mastectomy surgery at Dr. Kariadi Semarang Hospital, and observed the comparative side effects and complications.

2. METHODOLOGY

This study was a double-blind randomized control trial (RCT) and employed patients, ages 18-59 y, ASA class I or II, undergoing modified radical mastectomy (MRM) surgery performed in August-October 2022 at Dr. Kariadi Hospital Semarang. A total of 44 patients were enrolled, and divided into two groups; 22 patients in each group. Informed consent was obtained from each subject before conducting the study. The SAPB treatment group was given 20 ml of isobaric bupivacaine 0.25% injection in the serratus anterior plane using an ultrasound-guided technique postoperatively. The control group received initial dose of morphine 0.1 mg/kg intravenous followed by maintenance dose of 20 µg/kg/h continuous infusion as postoperative analgesia.
. Both groups were induced with propofol 2 mg/kg and rocuronium 0.6 mg/kg. Anesthesia was maintained with sevoflurane 1 MAC in oxygen-air, intravenous paracetamol 1 g and ketorolac 30 mg intravenously. The patients were taught about the use of numerical rating scale (NRS) during pre-anesthesia visits. Patients with opioid allergies were excluded from this study.

Data collected in this study were NRS at 4, 8, 12, and 24 h postoperatively, time to first analgesic request, the number of analgesic rescue doses required, and the incidence of PONV and pruritus within 24 h postoperatively. Independent T-test, Mann-Whitney U test, Chi-square, and Fischer tests were performed to analyze the data. The data were considered statistically significant if $P < 0.05$. All analyses were carried out with SPSS version 26 for Windows.

Formal permission was obtained from the Kariadi Hospital Institutional Review Board. Ethical clearance was obtained from RSUP Dr. Kariadi Hospital Semarang, Indonesia, ethics clearance committee (Ethical Clearance No.: 843/EC/KEPK-RSDK/2021). The study was registered with https://www.irct.ir/ under trial ID 71858.

Table 1: Demographic data of the patients

Variables	SAP Block Group		Control Group		p-value
	Mean ± SD	Median (Min-Max)	Mean ± SD	Median (Min-Max)	
Age (y)	47.91 ± 10.46	50 (18-59)	47.68 ± 9.19	49.5 (30-59)	0.939 [T]
Weight (kg)	58.96 ± 13.36	59.5 (33-85)	61.45 ± 8.91	59 (48-80)	0.408 [T]
Height (cm)	154.55 ± 4.79	152.5 (145-163)	159.36 ± 4.46	160 (150-168)	0.001[T*]
IMT (kg/m^2)	24.86 ± 5.74	24.4 (14.7-37.8)	24.12 ± 2.55	24.05 (18.4-28.3)	0.585 [T]
Surgery duration (min)	125.68 ± 10.03	120 (110-150)	121.82 ± 7.79	120 (105-140)	0.265 [M]

**Significant; [M] - Mann Whitney test; [T] - Independent T-Test*

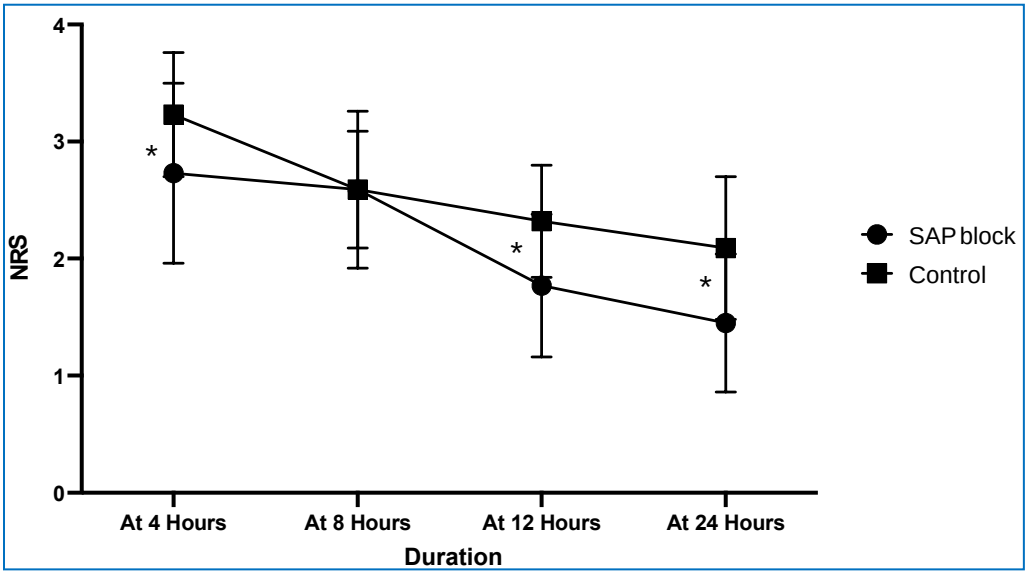

Figure 1: NRS graph in SAP and Control groups for 24 h (*Significant)

3.3. Rescue analgesic use

The mean time to the first use of rescue analgesics in the SAPB group was longer than that of the control group,

and the mean total dose of rescue analgesics in the SAPB group was less than that of the control group.

3. RESULTS

3.1. Demographic characteristics

A total of 44 patients were enrolled, consisting of 22 patients for each group. There was no difference between age, weight, BMI, and duration of surgery in the two groups. There was a difference between the body length in the two groups, where the mean body length in the SAPB group was shorter than the control group.

3.2. Comparison of NRS scores

There was a significant difference in NRS scores in the SAPB and control groups, where the mean NRS at 4-, 12-, and 24-h postoperative MRM was lower in the SAPB group compared to the control group. There was no difference in NRS at 8 h postoperative MRM in the two equal groups (p = 0.717).

3.4. Complications

The postoperative PONV was higher in the control group than in the SAPB group. There was no significant difference in pruritus (P = 0.073).

4. DISCUSSION

In terms of demographic characteristics, this study recruited a homogeneous patient population. Significant differences were only found in height, but age, weight, and BMI were equivalent in both groups. Height did not affect the difference in dose or effect of the two treatments. Meanwhile, over 60 y of age, there are changes in sensory processes and pain perception due to a decrease in nerve fiber density, degeneration of sensory fibers, and a reduction in nerve conduction speed that will decrease the response to pain compared to young people. Body mass index determines the severity of pain, as obese patients have a lower pain threshold, this is because visceral fat tissue increases the release of pro-

Table 2: Comparison of NRS scores in SAPB vs. Control Group

Hours	SAP Block Group		Control Group		p-value
	Mean ± SD	Median (Min-Max)	Mean ± SD	Median (Min-Max)	
At 4	2.73 ± 0.77	3 (2-4)	3.23 ± 0.53	3 (2-4)	0.017 M*
At 8	2.59 ± 0.67	3 (1-3)	2.59 ± 0.5	3 (2-3)	0.717 M
At 12	1.77 ± 0.61	2 (1-3)	2.32 ± 0.48	2 (2-3)	0.003 M*
At 24	1.45 ± 0.59	1 (1-3)	2.09 ± 0.61	2 (1-3)	0.001M*

**Significant; M - Mann Whitney test;*

Table 3: Comparison of rescue analgesic use in SAPB vs. Control groups on NRS

Parameter	SAPB Group		Control Group		p-value
	Mean ± SD	Median (Min-Max)	Mean ± SD	Median (Min-Max)	
First dose duration	398.86 ± 140.61	360 (240-720)	100.91 ± 10.3	100 (90-120)	0.000 M*
Total Dose	3.59 ± 1.56	2 (1-8)	8.55 ± 2.4	8 (5-13)	0.000T*

**P = significant, M Mann-Whitney Independent T-test*

inflammatory mediators resulting in a high pain response compared to non-obese patients.[12]

SAPB patients showed significantly lower NRS scores compared to the control group at 4-, 12-, and 24-h postoperatively (P = 0.017, P = 0.003, and P = 0.001), respectively. These results were consistent with the study of Hernandez et al., showing that the pain scores of patients receiving SAPB may decrease from a median of 7 to 3 after block onset (0.5-8 h).[13] No further pain scores were reviewed, as the duration of analgesia varies depending on whether the patient is receiving a single injection block or an indwelling catheter. However, SAPBs effectively reduce pain scores from 0.5 to 4 h after local anesthetic injection.[13] Bakeer et al. in their study compared the benefits of SAPB and showed that it was associated with significantly lower VAS scores during movement of the shoulder or during all assessment times when they were compared with the control group (P < 0.001).[14] In another study, low NRS values were associated with the analgesic effect produced by the SAPB lasting up to 12 h postoperatively.[15] Semyonov et al. showed that patients undergoing SAPB had significantly lower pain levels after thoracic surgery compared to patients in the standard pain control group.[16]

The mean NRS at 8 h in the SAPB group and control group showed no significant difference with P = 0.717, this result was because the SAPB effect had run out, and when the NRS assessment was performed during the eighth hour, the patient had sought extra rescue analgesics, leading to reduced pain. The duration of the analgesia effect of the SAPB is consistent with the literature, where both patients had a minimum NRS and only started to rise 12 h after surgery or 14 h after the block was performed. The duration of this effect is also influenced by other multimodal analgesics.[5,16] In our study, a similar approach was used: giving oral paracetamol 1 g and oral ibuprofen 400 mg every 8 h in both groups.

Takimoto et al. and Camacho et al. showed that block success confirmed by the loss of cold sensation above the axilla occurred 15 min after the SAPB was performed. After the first block, the patient reported pain decreased from 10 to 6 on the NRS. Patients who were given the SAPB in their study did not require interventional pain management since the last SAPB was performed.[17,18]

Table 4: Comparative frequency of complications

Complication	SAPB Group	Control Group	p-value
PONV	4 (18.2)	15 (68.2)	0.01C *
Pruritus	0 (0)	3 (13.6)	0.073 F

**Significant, CChi-square F Fischer-exact test. Data presented as n (%)*

The study's results for the required time for rescue analgesia parameter found that the mean time needed for rescue analgesics in the SAPB group was longer than the control group (398.86 ± 140 .61 vs. 100.9 ± 10.3 min; P = 0.00). These results are consistent with a previous study by Bakeer et al. The SAPB group

was associated with a delay in the first administration of postoperative rescue analgesic, e.g., 337.5 ± 40.6 min compared to the control group.[12] Yuwei et al. showed that the time to pain onset after surgery was 19 ± 5 h with SAPB, while 16 ± 5 h with paravertebral block and 12 ± 5 h with general anesthesia.[19]

Regarding the total rescue analgesic consumed, the SAPB group was lower than the control group (3.59 ± 1.56 vs. 8.55 ± 2.4, P = 0.00). This decreased need for rescue analgesics is consistent with the study of Bakeer et al., that patients in the SAPB group rarely required morphine during the first 24 h, compared to the control group (P < 0.001).[14] In the SAPB group, the demand for morphine dose was 2 mg, while the average dose consumed in the control group was 7 mg (range: 2-12) (P < 0.001).[12] Semyonov et al. showed that the total morphine and tramadol required for pain relief during the first few postoperative hours was significantly lower in patients undergoing SAPB.[16] Chen et al. showed that the SAPB provided a superior analgesic effect, where pain scores and opioid consumption were significantly lower in the postoperative period.[20]

In this study, the incidence of nausea and vomiting in the treatment group was 18.2%, and in the control group was 68.2%. Pruritus was not found in the treatment group, while in the control group, it was found in 13.6% of the patients. This indicates that patients who received SAPBs had fewer side effects. These results align with the study of Bakeer et al. [14] Khalil et al. stated that SAPB provided minimal side effects and maintained stable blood pressure.[21] In the Yuwei et al. study, anesthesia with either block was associated with significantly less intraoperative propofol and sufentanil, decreased postoperative rescue analgesia, and less postoperative nausea and vomiting compared to general anesthesia alone.[19] Other side effects were also not found in the study from Baker. No cases of pneumothorax, local anesthetic toxicity, or opioid side effects such as respiratory depression, pruritus, or urinary retention were recorded. All patients from the SAPB group were satisfied (score 2) with postoperative analgesia.[14]

5. LIMITATIONS

This study has several weaknesses. First, the NRS score, which is less relevant to assess the pain scale because it is evaluated after the use of rescue analgesics so that it will reduce pain in both groups. In addition, there might be differences in the educational status of the research respondents, so there can be bias when assessing the pain scale because it is subjective. Education influences increasing the incidence of pain. Lower education levels might lead to higher levels of anxiety, mood disorders such as depression, and difficulties in understanding the explanations of medical personnel in education that increase the incidence of postoperative pain. Assessment of the incidence of PONV and postoperative pruritus was also biased because the control group received significantly more opioids than the SAPB group.

6. CONCLUSION

In conclusion, SAP block reduced pain significantly in 4 hours postoperatively, longer duration and lower doses of rescue analgesia, and less PONV compared to the control group. Thus, SAP Block is effective as an alternative to postoperative analgesia in MRM surgery. Further research is needed to confirm and strengthen the results of this study, either by using a multicenter study or assessing other variables that may cause bias.

7. Data availability

The numerical data generated during this research is available with the authors.

8. Acknowledgement

We gratefully thank Faculty of Medicine, Diponegoro University, Jawa Tengah 50275, Indonesia.

9. Conflict of interest

The study utilized the hospital resources only, and no external or industry funding was involved.

10. Authors' contribution

MC, JA: Concept, manuscript editing, and supervision

TP: Literature search, manuscript editing, and statistical analysis

CHM, WI: Literature search, conduction of the study work, and statistical analysis

SAW: Manuscript editing, conduction of the study work, and supervision

TEN: Literature search, Manuscript editing, supervision

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