**Ultrasound Guided Serratus Anterior Plane Block Versus Thoracic Paravertebral Block for Post-Mastectomy Analgesia.**

**Abstract:**

**Background:** Women undergoing mastectomy surgery often experience severe post-operative pain and may develop into chronic pain.

**Objective**: current study compared the efficacy and safety of ultrasound-guided serratus anterior plane block (SAPB) with thoracic paravertebral block (TPVB) for controlling acute post-mastectomy pain.

**Patients and Methods**: This prospective study was conducted on 60 female patients undergoing mastectomy surgery. Patients were randomized into two groups: (TPVB) group (n=30): patients received paravertebral block at T4 with 20ml of bupivacaine 0.25% and adrenalin 5ug/ml and (SAPB) group (n=30): patients received serratus intercostal plane block with 0.4ml/kg bupivacaine 0.25% plus adrenalin 5ug/ml. Both performed as single injection at the end of surgery. Postoperative VAS pain scores, time to first analgesic requirement, total dose of rescue analgesic, hemodynamic parameters and incidence of postoperative nausea and vomiting were all recorded.

**Results**: VAS scores were significantly lower in SAPB group compared with TPVB group at 12th and 16th hour postoperative. Total dose of rescue analgesic was significantly lower in SAPB compared with TPVB. Time to the first analgesic dose was significantly longer in SAPB compared to TPVB. No significant difference between the study groups regarding the hemodynamic parameters and incidence of postoperative nausea and vomiting.

**Conclusion**: Both SAPB and TPVB provide adequate analgesia for breast surgeries but current study found that SAPB superior to TPVB in terms of delayed requirement for the first rescue analgesia & 24 hours reduced analgesic consumption, indicating that SAPB is a feasible and effective method for pain treatment after breast surgery.

**Keywords:**

Postoperative analgesia, mastectomy, serratus anterior block, paravertebral block

**Introduction:**

Mastectomy is a common surgical procedure, accounting for 31% of all breast surgery cases performed [1]. Post‑mastectomy pain managed by opioids alone often leads to side effects such as nausea and vomiting. Inadequate control of pain may later develop into chronic pain syndrome (paraesthesias, phantom breast pain and intercostobrachial neuralgia) in 25%–40% of the patients [2]. For these reasons, regional analgesic techniques have been advocated for effective pain management [3].

Several anesthetic techniques involving local wound infiltration [4], intercostal nerve block [5], thoracic paravertebral block (TPVB) [6,7], and thoracic epidural analgesia [8] have been introduced in the management of acute post-mastectomy pain, with the goal of decreasing the side effects associated with general anesthesia and opioid consumption. TPVB can be considered a well-established technique to provide analgesia for post-mastectomy pain [9]. But TPVB demands more advanced technical skills and longer learning curve.

Therefore, new interfascial plane blocks guided by ultrasound such as pectoral nerve (PECS) block type 1 and 2 and serratus anterior plane block (SAPB) have been reported as alternatives, with the advantages of simplicity and ease of performance [10-12]. SAPB was initially described by Blanco to provide complete analgesia of the lateral part of the thorax through blockade of lateral cutaneous branches of the thoracic intercostal nerves [10]. The aim of this study was to evaluate the analgesic efficacy and safety of SAPB in comparison with TPVB for post-mastectomy pain.

**Patients and methods:**

After the approval of the institutional ethical committee of Benha university hospital, this Prospective, single blind randomized study was conducted on 60 female patients with cancer breast, between the age of 30–60 years old, American Society of Anesthesia (ASA) I and II, undergoing unilateral mastectomy operation. Refusal to participate, Morbid obesity (body mass index >40 kg/m2), renal insufficiency (creatinine >1.5 mg/dL), current chronic analgesic therapy (daily use >4 weeks), diabetes mellitus with polyneuritis, generalized or local infection, chronic pain in the anterolateral region of the chest or axilla, inability to communicate with the medical staff and ASA physical status III-IV were excluded.

The participants were allocated into two groups of 30 in each by a random sequence number generated by the computer kept in sealed envelopes. Group I: had received ultrasound guided thoracic paravertebral block (TPVB), and Group II: had received ultrasound guided serratus anterior plane block (SAPB). Both blocks were given before recovery from general anesthesia.

Preanesthetic investigations were fulfilled in all patients, One hour before surgery, Intravenous access was established and all patients were premedicated with midazolam 0.02 mg/kg, and ranitidine 50 mg intravenously (IV). In the operating room standard monitoring devices as ECG, Non-invasive blood pressure and pulse oximetry were placed. A conventional balanced general anesthesia was administered. The induction protocol was standard for all patients and consisted of intravenous administration of propofol 2.5 mg/kg, cisatracurium besylate 0.15-0.2 mg\Kg, and Fentanyl 1-2 mic\Kg. Anesthesia was maintained with oxygen 100%, isoflurane and supplements of Cisatracurium. Volume controlled ventilation (tidal volume 8–10 ml/kg) was adjusted to maintain end-tidal carbon dioxide between 35 and 40 mmHg. At the end of the surgery and before recovery from general anesthesia, the regional block technique was performed.

**Group I (TPVB):** Patients were placed on lateral decubitus position with the side that had been operated upward, skin preparation and sterile draping applied. Target paravertebral space was located using ultrasound (GE Logiq P5) with linear transducer (11 MHz). The paravertebral space between the third and fourth thoracic vertebrae was identified by counting down from the seventh cervical spine. In a paramedian view approximately 3 cm lateral to midline on the side of surgery, both transverse processes were visualized, with the superior costotransverse ligament and the pleura visible in between **(Fig. 1)**. An 18-gauge, Tuohy-tip needle was inserted through the skin in-plane beneath the US transducer until it pierced the superior costotransverse ligament. If the ligament was not easily seen, the needle was advanced until it was directly above the pleura. Normal saline (2-3 mL) was injected to help identify the paravertebral space and observe the pleura being displaced anteriorly. 15-20 ml of 0.25% Bupivacaine with epinephrine, 5 μg/mL, were slowly injected with gentle aspiration every 3 mL to rule out intravascular or intrathoracic needle tip placement.

**Group II (SAPB):** Patients were positioned supine with the upper limb abducted to 90°. Skin preparation and sterile draping applied. The US (GE logiq P5) linear probe (11 MHz) was placed longitudinally in the mid-axillary line at level of the 6th intercostal space by counting ribs inferiorly and laterally below the clavicle. At the mid-axillary line, the first plane to identify was the fatty subcutaneous tissues. The anterior serratus muscle, ribs, and external, internal and intimate intercostal muscles were in the intermediate plane, and then pleura and lung were identified in the deep plane **(Fig. 2)**. From caudal to cranial and in-plane approach, an 18-gauge, Tuohy-tip needle was inserted until the tip was placed between serratus anterior muscle (SAM) and external intercostal muscles. To check for accurate positioning of the tip of the needle, hydro-dissection was done by 2-3 cc of saline and this was followed by local anesthetic injection of 0.4ml/kg of bupivacaine 0.25% with epinephrine, 5 μg/mL. The local anesthetic injection was visualized in real-time.

Anesthesia was discontinued and neuromuscular blockade was reversed with neostigmine (0.05 mg/kg) IV and atropine IV (0.002 mg/kg). Patients were extubated and shifted to the post-anesthesia care unit. Before induction of anesthesia patients were learned how to use a 10 cm visual analog scale (VAS-0 with end-point labeled ‘‘no pain” and 10 to ‘‘worst conceivable pain”) [13]. The degree of postoperative pain was assessed at PACU, 4, 6, 8, 12, 16, 20, 24 h using the VAS score. Postoperative analgesia regimen was standard in all groups. When the VAS score was greater than 4, patients were given morphine (5 mg IV).

Primary outcome measure included Pain rescue-analgesia consumption in the first 24 hours (time of first rescue analgesic, total rescue analgesic requirement). Secondary outcome measures included Assessment of the level of pain (on a VAS scale scores), The incidence of nausea and any attack of postoperative vomiting was recorded which was controlled by ondansetron 4 mg, Blood pressure, heart rate, and respiratory rate were measured every one hour for the first 6 hours postoperative, Finally the duration of hospital stay and any detected complications related to the blocks.

Statistical analysis:

Data management and statistical analysis were done using SPSS (statistical program for social science version 25). Numerical data was summarized as means and standard deviations or medians and ranges. Categorical data was summarized as numbers and percentages. Comparisons between two groups were done using: independent t test for normally distributed variables, Mann Whitney U test for non-normally distributed variables, Categorical variables were compared between two groups using Chi square test or Fisher exact test if appropriate. P values less than 0.05 were considered significant.

**Results:**

Sixty patients were recruited in this study, 30 patients in each group. As regards age, weight, height and ASA status, current study showed no significant statistical difference between both groups with P-value > 0.05 **(Table 1)**.

As regard the primary outcome of this study, morphine consumption; which includes the time of first rescue analgesia and total dose of morphine consumption during 24 hours postoperative, current study showed longer duration of analgesia in group II ( 20**±**3 hours) in comparison to group I ( 15±4 hours). Statistical analysis showed that p-value= 0.007 which is statistically highly significant. Also, the total dose of morphine consumption was lower in group II (5±2 mg/24h) in comparison to group I (9±2 mg/24h). Statistical analysis showed that p-value= 0.01 which is statistically significant **(Table 2).**

In general, the intensity of pain at rest and movement was low in both groups. As regard VAS during rest, there was reduction in the median VAS in group II compared to group I (2 vs. 3) at 12th (P-value < 0.001) which is statistically highly significant, and at 16th hour (p-value = 0.013) postoperative which is statistically significant. But, there were no significant differences between both groups at PACU, 4, 8, 20 and 24 hours postoperative **(Table 3)**.

As regard VAS during movement, there was reduction in the median VAS in group II compared to group I (2 vs. 3) at 12th (p-value < 0.044) which is statistically significant, and 16th hour (p-value < 0.002) postoperative which is statistically highly significant. But, there were no significant differences between both groups at PACU, 4, 8, 20 and 24 hours postoperative **(Table 4)**.

As regard patients having postoperative nausea and vomiting, current study showed lower incidence in both groups; Nausea 3 patients (%) and vomiting 2 patients (6.7%) in group I as compared to nausea 3 patients (%) and vomiting only one patient (3.3%) in group II. These results are statistically non-significant with (P- value >0.05) **(Fig. 3).**

As regard mean arterial blood pressure **(Fig. 4)**, heart rate **(Fig. 5)**, and respiratory rate **(Fig. 6)**, current study showed no statistical differences between both groups on arrival to the PACU and every one hour for the first 6 hours postoperative with (P-value > 0.05). As regard duration of hospital stay after surgery, current study showed no statistical differences between both groups with (P-value = 0.728) **(Table 5)**. And there were no complications related to the blocks.

**Disscusion:**

This randomized, controlled study compared TPVB with SAPB for analgesia after mastectomy with or without axillary dissection and found that SAPB had a longer duration of analgesia and lower morphine consumption 24 hours after surgery. The postoperative vital data were comparable in both groups. The incidence of post‑operative nausea and vomiting (PONV) was low in both groups, and there was no major complication.

Ultrasound‑guided TPVB is an excellent analgesic technique for breast surgery because not only does it decrease pain but also it decreases PONV and length of hospital stay. However, the learning curve of ultrasound‑guided TPVB is rather steep requiring a higher degree of skill. Furthermore, a number of complications have previously been reported with TPVB [14]. Blanco et al. proposed SAPB as an alternative to TPVB for surgeries on the anterior and lateral thoracic wall including breast surgeries [10]. SAPB is an easy block to learn and perform because the serratus anterior muscle is an easy sonographic landmark to identify for this block.

Our hypothesis of a longer duration of analgesia of SABP in comparison to TPVB is based on the mechanism of spread of local anesthetic (LA) in the two blocks. Hence the breast is innervated by anterior and lateral cutaneous branches of the second to sixth thoracic intercostal nerves (T2-T6) and supraclavicular nerves [15]. The mechanism of action of SAPB is a blockade of the lateral cutaneous branches of the intercostal nerves (T2–T6) through local anesthetic diffusion across fascial planes and through muscle layers [16]. While the TPVB blocks the spinal nerves directly, and the local anesthetic show unpredictable spread either laterally to block the intercostal nerves, or medially into the epidural space through the intervertebral foramina and also can spread longitudinally cranially or caudally in the paravertebral space [17]. Despite the academic debate on these distributions; there is no evidence about which way single injection may spread to provide more consistent and ideal spread [18]. For mastectomy and axillary dissection, a block from at least T1–T6 will be required. A single level TPVB can block one to four dermatomes only. Therefore, single level injection won't be enough to produce sufficient analgesia [19]. This is supported by a study done at the National Cancer Institute at Cairo University in Egypt which compared SAPB with TPVB for mastectomy analgesia and reported that 84% of SAPB patients experienced none or very little postoperative pain and required no opioids during the first 24 hours after surgery in comparison to 76% of TPVB patients [20].

Another study also reported that the time to first rescue analgesia postoperatively was significantly longer in SAPB Group [255.3±47.8] mins as compared with TPVB Group [146.8±30.4] mins with a P value of <0.001. Postoperative total diclofenac consumption in first 24 hrs was less in SAPB Group [138.8±44.0] mg compared to TPVB Group [210.0±39.2] mg with a P value of <0.001 [21].

Some researchers studied the effect of SAPB performed under direct vision on postoperative pain in breast surgery and found that 81% experiencing mild pain or no pain at all and all of these patients required no analgesia or only simple analgesia day 1 postoperatively compared to the control group [22]. Other researchers also studied the influence of the number of injections on the quality of thoracic paravertebral block. They found that Dermatomal block after a single thoracic paravertebral injection is unpredictable and varies widely. While increasing the number of paravertebral injections results in more reliable radiographic and sensory block distribution [23].

In contrast to current study, A study published in the Indian journal of anesthesia found that the duration of analgesia (mean ±SD) was significantly longer in the TPVB group compared to SAPB group (346 ± 57 min vs. 245.6 ± 58 min, P < 0.001) and the post‑operative 24 h morphine consumption (mean ± SD) was significantly higher in the SAPB group (9.7 ± 2.1 mg) compared to TPVB group (6.5 ± 1.5 mg) (P < 0.001) when comparing both groups for modified radical mastectomy postoperative analgesia [24]. This difference in results may be explained by; firstly the previous study injected the local anesthetic superficial to the serratus anterior muscle, as it decreases the risk of pneumothorax and vascular trauma, compared to the deeper approach that current study used. But with injection of local anesthetic deep to serratus anterior muscle, sensory blockade spread up to T2 dermatome as has been reported [25]. Also this avoids the possibility of transitory palsy of the LTN, leading to a winged scapula than can be mistaken with a surgical lesion of this nerve. Secondly, the volume of local anesthetic is also likely an important determinant of the extent and duration of analgesia for SAPB. Since SAPB is a fascial block, a larger volume is expected to promote local anesthetic spread [26]. The volume of local anesthetic used in the previous study was fixed (20 ml). However in current study, a higher volume of local anesthetic was injected in SAPB (0.4 ml/kg).

However, current study also has a number of limitations. We could not assess block onset time or sensory dermatomal level because both blocks were performed after induction of general anesthesia. We performed a single level injection, realizing that multiple injection or continuous techniques may provide more effective analgesia in TPVB. We hope that future studies will clear the remaining issues about the optimal injection approaches for SAPB (superficial or deep to serratus anterior muscle) and the duration of analgesia with and without adjuncts.

**Conclusion:**

The ultrasound‑guided SAPB and TPVB provide good analgesia post-mastectomy, but SAPB has a superior analgesic profile, with a longer duration of analgesia. Furthermore, it is easier to perform and carry fewer side effects.

**Conflict of interest:**

There are no conflicts of interest.

**References:**

1. Poleshuck EL, Katz J, Andrus CH, Hogan LA, Jung BF, Kulick DI, et al. Risk factors for chronic pain following breast cancer surgery: A prospective study. J Pain 2006;7:626‑34.

2. Andersen KG, Kehlet H. Persistent pain after breast cancer treatment: A critical review of risk factors and strategies for prevention. J Pain 2011;12:725‑46.

3. Marret E, Vigneau A, Salengro A, Noirot A, Bonnet F. Effectiveness of analgesic techniques after breast surgery: A meta‑analysis. Ann Fr Anesth Reanim 2006;25:947‑54.

4. Talbot H, Hutchinson SP, Edbrooke DL, Wrench I, Kohlhardt SR. Evaluation of a local anesthesia regimen after mastectomy. Anaesthesia 2004; 59:664-7.

5. Huang T, Parks DH, Lewis SR. Outpatient breast surgery under intercostal block anaesthesia. Plast Reconstr Surg 1979;63:299-303.

6. Klein SM, Bergh A, Steele SM, Georgiade GS, Greengrass RA. Thoracic paravertebral block for breast surgery. Anesth Analg 2000;90:1402-5.

7. Karmakar MK. Thoracic paravertebral block. Anesthesiology 2001;95: 771-80.

8. Lynch EP, Welch KJ, Carabuena TM, Eberlein T. Thoracic epidural anesthesia

improves outcome after breast surgery. Ann Surg 1995;222: 663-9.

9. Vila H Jr, Liu J, Kavasmaneck D. Paravertebral block: new benefits from an old procedure. Curr Opin Anaesthesiol 2007;20:316-8.

10. Blanco R, Parras T, McDonnell JG, Prats‑Galino A. Serratus plane block: A novel ultrasound‑guided thoracic wall nerve block. Anaesthesia 2013;68:1107‑13.

11. Tighe SQ, Karmakar MK. Serratus plane block: Do we need to learn another technique for thoracic wall blockade? Anaesthesia 2013;68:1103‑6.

12. Chakraborty A, Khemka R, Datta T. Ultrasound‑guided truncal blocks: A new frontier in regional anaesthesia. Indian J Anaesth 2016;60:703‑11.

13. Wewers ME, Lowe NK. A critical review of visual analogue scale in the measurement of clinical phenomena. Res Nurs Health 1990;14(1):227–36.

14. Schnabel A, Reichl SU, Kranke P, Pogatzki‑Zahn EM, Zahn PK. Efficacy and safety of paravertebral blocks in breast surgery: A meta‑analysis of randomized controlled trials. Br J Anaesth 2010;105:842‑52.

15. Sarhadi NS, Shaw Dunn J, Lee FD, Soutar DS. An anatomical study of the nerve supply of the breast, including the nipple and areola. Br J Plast Surg 1996;49:156‑64.

16. Mayes J, Davison E, Panahi P, Patten D, Eljelani F, Womack J, et al. An anatomical evaluation of the serratus anterior plane block. Anaesthesia 2016;71:1064‑9.

17. Cowie B, McGlade D, Ivanusic J, Barrington MJ. Ultrasound‑guided thoracic paravertebral blockade: A cadaveric study. Anesth Analg 2010;110:1735‑9.

18. Beyaz SG, Ergönenç T, Altıntoprak F, Fuat Erdem A. Thoracal paravertebral block for breast surgery. Dicle Medical Journal/Dicle Tip Dergisi. 2012 Dec 1;39(4).

19. Khai DK. The Use of Single-injection Thoracic Paravertebral Block in Breast Cancer Surgeries in our Asian Population: The Singapore General Hospital Experience. Proceedings of Singapore Healthcare. 2013 Jun;22(2):107-13.

20. Bashandy G, Shaker J. Serratus anterior plane block versus thoracic paravertebral block for mastectomy analgesia. Poster presented at: 8th Annual Meeting of the World Institute of Pain; May 20-23, 2016; New York, NY.

21. Arora S., R. Ovung, S. Yaddanapudi, N. Bharti, and G. Singh. "Abstract PR481: Efficacy of Thoracic Paravertebral Block Versus Serratus Intercostal Plane Block for Postoperative Analgesia in Breast Cancer Surgery." Anesthesia & Analgesia 123 (2016): 610. doi:10.1213/01.ane.0000492867.09703.e7.

22. Hards M, Harada A, Neville I, Harwell S, Babar M, Ravalia A, Davies G. The effect of serratus plane block performed under direct vision on postoperative pain in breast surgery. Journal of clinical anesthesia. 2016 Nov 1;34:427-31.

23. Naja ZM, El-Rajab M, Al-Tannir MA, Ziade FM, Tayara K, Younes F, et al. Thoracic paravertebral block: Influence of the number of injections. RegAnesth Pain Med 2006;31:196-201.

24. Gupta K, Srikanth K, Girdhar KK, Chan V. Analgesic efficacy of ultrasound-guided paravertebral block versus serratus plane block for modified radical mastectomy: A randomised, controlled trial. Indian journal of anaesthesia. 2017 May;61(5):381.

25. Ohgoshi Y, Yokozuka M, Terajima K. Serratus‑intercostal plane block for breast surgery. Masui 2015;64:610‑4.

26. Kunigo T, Murouchi T, Yamamoto S, Yamakage M. Spread of injectate in ultrasound-guided serratus plane block: a cadaveric study. JA Clinical Reports. 2018 Dec 1;4(1):10.