

Analgesic efficacy of pectoral nerve block II compared to superficial serratus anterior plane block in modified radical mastectomy

Eficacia analgésica del bloqueo del nervio pectoral II en comparación con el bloqueo del plano superficial del serrato anterior en la mastectomía radical modificada

Mohamed AF Galal (MD)^{1,*} , Moustafa Kamel Riad (MD)², Alaa Mohamed Ahmed Ahmed (MSc)³, Mohamed Osman Awad Taeimah (MD)⁴

¹ Lecturer of Anesthesia, Intensive Care & Pain Management, Faculty of Medicine, Ain Shams University. Cairo, Egypt.

² Professor of Anesthesia, Intensive Care & Pain Management, Faculty of Medicine, Ain Shams University. Cairo, Egypt.

³ Assistant Lecturer of Anesthesia, Intensive Care & Pain Management, Faculty of Medicine, Ain Shams University. Cairo, Egypt.

Funding source: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflicts of interest: We declare that there were no conflicts of interest.

Fecha de recepción: 5 de enero de 2026 / Fecha de aceptación: 10 de julio de 2026

ABSTRACT

Introduction: Thoracic interfascial plane blocks represent a safe and safe regional anesthetic techniques commonly utilized in breast surgery. These blocks have demonstrated efficacy in managing acute postoperative pain following mastectomy. Nevertheless, randomized controlled trials directly comparing different interfascial plane block techniques remain limited. **Objective:** This study aimed to assess the analgesic efficacy of ultrasound-guided modified pectoral nerve (PECS II) block in comparison with the superficial serratus anterior plane block (SSAPB) for postoperative pain management in patients undergoing modified radical mastectomy (MRM). **Materials and Methods:** A total of 70 female patients scheduled for MRM under general anesthesia were enrolled in this randomized study. They were equally allocated into two groups of 35 patients each. Group I received an ultrasound-guided SSAPB using 30 mL of 0.25% bupivacaine, while Group II received an ultrasound-guided PECS II block with an equivalent total volume and concentration of bupivacaine. All blocks were administered prior to skin incision. Primary outcomes was total pethidine consumption within the first 24 postoperative hours. **Results:** The current study showed statistically significant difference between the 2 groups. Time of first rescue analgesia was significantly longer in PECS II group (7.4 ± 1.3 h) when compared to SSAPB (5.2 ± 1.6 h). Additionally, median pethidine rescue dose was significantly lower in PECS II group (30.0 ± 11.2 mg versus 57.7 ± 18.8 mg in SSAPB). **Conclusion:** This study suggests that PECS II block might provide superior postoperative analgesia compared with the SSAPB in patients undergoing MRM under general anesthesia.

Keywords: Modified radical mastectomy, oncological surgery, PECS II, pectoral nerve block type-II, postoperative pain, serratus anterior plane block.

RESUMEN

Introducción: Los bloqueos del plano interfascial torácico representan una técnica anestésica regional segura y comúnmente utilizada en

*Autor de correspondencia:

Mohamed Abdelmoneim Fouly Galal

Mohamedgalal.ap@gmail.com

*ORCID: <https://orcid.org/0009-0001-4132-6029>

ISSN: 0719-6792



cirugía de mama. Estos bloqueos han demostrado eficacia en el manejo del dolor posoperatorio agudo tras una mastectomía. Sin embargo, los ensayos controlados aleatorizados que comparan directamente diferentes técnicas de bloqueo del plano interfascial siguen siendo limitados.

Objetivo: Este estudio tuvo como objetivo evaluar la eficacia analgésica del bloqueo del nervio pectoral modificado guiado por ecografía (PECS II) en comparación con el bloqueo del plano serrato superficial anterior (SSAPB) para el manejo del dolor posoperatorio en pacientes sometidas a mastectomía radical modificada (MRM). **Materiales y Métodos:** Se incluyó a un total de 70 pacientes mujeres. Se dividieron equitativamente en dos grupos de 35 pacientes cada uno. El grupo I recibió un bloqueo abdominal subcutáneo guiado por ecografía (SSAB), mientras que el grupo II recibió un bloqueo PECS II guiado por ecografía. Todos los bloqueos se realizaron antes de la incisión cutánea. El resultado principal fue el consumo total de petidina en las primeras 24 h posoperatorias. **Resultados:** El presente estudio mostró una diferencia estadísticamente significativa entre los dos grupos. El tiempo de la primera analgesia de rescate fue significativamente mayor en el grupo PECS II. Además, la dosis mediana de rescate de petidina fue significativamente menor en el grupo PECS II. **Conclusión:** Este estudio sugiere que el bloqueo PECS II podría proporcionar una analgesia posoperatoria superior en comparación con el grupo SSAPB en pacientes sometidas a MRM bajo anestesia general.

Palabras clave: Mastectomía radical modificada, cirugía oncológica, PECS II, bloqueo del nervio pectoral tipo II, dolor posoperatorio, bloqueo del plano serrato anterior.

Introduction

In modified radical mastectomy (MRM) surgery, effective pain control in the immediate postoperative period contributes to enhanced patient comfort, improved mobility, earlier ambulation, and accelerated recovery[1]. Several regional anesthesia techniques like thoracic epidural, paravertebral blocks and thoracic interfascial plane blocks have been used in breast cancer surgeries[2]. In thoracic interfascial plane blocks, needle insertion and local anesthetic (LA) injection targets a compartment between two distinct anatomical layers, thereby interrupting afferent nociceptive transmission[3]. Due to their minimally invasive nature, these techniques are considered safer alternatives to central neuraxial blocks[4]. Several thoracic interfascial plane blocks, including serratus anterior plane block (SAPB) and PECS I (interpectoral) and II (interpectoral and subpectoral) blocks, have been studied recently[5].

Anatomically, the intercostal, brachial plexus, and superficial cervical plexus nerves innervate the breast and underlying chest wall. Therefore, to achieve complete postoperative analgesia for breast cancer surgery, it is necessary to block dermatomes from C5 to T6[4]. Given the complexity of the innervation, it is unlikely that a single regional anesthetic technique can guarantee complete level of peri-operative analgesia[6].

PECS II block is an easy and reliable superficial nerve block. It is characterized by a two-plane injection technique, whereby LA is deposited between two separate fascial planes. It attempts to block the axilla, which is essential for axillary clearing, and the thoracic intercostal nerves, which are required for extensive breast excisions[7]. Comparably, serratus anterior plane block (SAPB), which can be applied superficially or deeply to serratus anterior muscle, is a safe and efficient method[8]. SAPB offers some technical advantages, including the avoiding of multiple needle insertion sites and the need for repeated changes in needle direction required during PECS II block. In addition, SAPB provides more selective blockade of the thoracic nerves when compared with PECS blocks[9].

Both of PECS II block and SAPB, block the lateral branches of the upper intercostal nerves. The present study hypothesizes that PECS II block has a higher analgesic efficacy than SAPB. Although, the pectoserratus plane block (subpectoral component of "PECS II") provides sensory coverage over the lateral aspect of the breast and axilla similar to SAPB, but the pectoral

component of PECS II (interpectoral plane block) provides additional blockade of the pectoral nerves. These nerves are linked to myofascial pain brought on by pectoral muscle disruption, which frequently happens during MRM. Because of this additional property of pain relief in PECS II, we hypothesize that PECS II block yields a higher quality of pain control than SAPB in surgical procedures involving disruption of the pectoral muscles, such as MRM. In this study, superficial serratus anterior plane block (SSAPB) approach was selected. As it was reported that SSAPB was more effective regarding anesthesia diffusion and duration of LA effect than deep SAPB (dSAPB).⁶ Given the limited number of detailed randomized studies directly comparing these two regional techniques, their analgesic efficacy was evaluated by comparing the total amount of postoperative rescue analgesics used over the first day.

Methodology

Ethical approval for this study (FMASU MS 576/ 2021) was provided by the Ethics committee of Ain Shams University Hospital, Abbasia, Cairo, Egypt on 28/9/2021. The study was registered with Pan African Clinical Trial Registry (PACTR) with Registration Number PACTR202510755407070 in accordance with WHO and ICMJE standards.

After the approval of the hospital's ethical committee, 70 female participants scheduled for elective unilateral MRM surgery were recruited. Written informed consent was obtained from all participants.

Study population

Age 20-75 years and American Society of Anesthesiologists physical status (ASA-PS) I-II. The exclusion criteria were those who declined to participate in the study, had a LA allergy, had a locally advanced breast malignancies with skin ulcers or chest wall infiltration or had surgery lasting longer than 3 h.

Randomization and allocation concealment was performed using computer-generated random numbers put into opaque sealed envelopes which were pulled by a nurse who was unaware of the groups' allocation. Additionally, all the staff involved in data collection (in addition to patients) were blinded to the group assignment.

Patients were randomly allocated into one of two groups

(35 patients each).

1. SSAPB group underwent US-guided superficial serratus anterior plane block (30 ml was deposited. between latissimus dorsi and serratus anterior (SA) muscle).
2. PECS II block group underwent US-guided pectoral nerve block (10 ml was deposited. between PMm and Pmm and 20 ml was deposited between Pmm muscle and SA muscle).

This dosing regimen was in accordance to previous existing literature[10],[11],[12].

Perioperative management

Standard monitoring equipment was used in the operation room to record baseline measurements of heart rate (HR) and mean arterial pressure (MAP). General anesthesia was induced with intravenous fentanyl (1 µg/kg) and propofol (2 mg/kg). Endotracheal intubation was facilitated by the administration of intravenous cisatracurium (0.15 mg/kg). Mechanical ventilation was adjusted to maintain an end-tidal carbon dioxide level of approximately 35 mmHg. Prior to surgical incision, patients received intravenous paracetamol (1 g in 100 mL) and ketorolac 30 mg. Anesthesia was maintained by isoflurane 1.5-2% vapor concentration in 50% oxygen/air mixture. Supplemental fentanyl boluses (0.5 µg/kg IV) were administered if MAP and/or HR increased by 20% or more relative to baseline values. Following general anesthesia induction and securing of the endotracheal tube - while the patient was in the supine position - the authors performed either of ultrasound guided PECS II block or SSAPB according to each patient's group allocation. Technique was performed as described Blanco and their colleagues.^{7,8} Then the authors waited 20 minutes as recommended in previous literature before the surgeon can start surgical incision.² Neostigmine (0.05 mg/kg) and atropine (0.02 mg/kg) were used to reverse the muscle relaxant at the end of the surgery. After fully awake extubation, all patients were transferred to the post-anesthesia care unit (PACU). During the first 24 postoperative hours, intravenous pethidine 25 mg was administered as rescue analgesia if patients reported pain with a visual analogue scale (VAS) score of 3 or higher, with repeat dosing permitted after 15 minutes if pain persisted. Postoperative analgesia was supplemented with intravenous paracetamol (1 g in 100 mL) every 8 hours and ketorolac 30 mg every 12 hours. During the first 24 postoperative hours, intravenous pethidine 25 mg was administered as rescue analgesia if patients reported pain with a visual analogue scale (VAS) score of 3 or higher, with repeat dosing permitted after 15 minutes if pain persisted. Postoperative analgesia was supplemented with intravenous paracetamol (1 g in 100 mL) every 8 hours and ketorolac 30 mg every 12 hours.

Outcomes

The primary outcome measure was the total amount of pethidine consumed within the first 24 hours following surgery. The number of patients who needed extra intraoperative fentanyl boluses, the time it took for the initial rescue analgesia, and the visual analog scale (VAS) scores at 1, 4, 8, 12, 16, 20, and 24 hours after surgery were the secondary outcomes. LA toxicity, hemodynamic instability, respiratory depression, pares-

thesia, pneumothorax, and hematoma were among the complications that were recorded.

PECS II block

In 2012, Blanco⁷ first described PECS blocks as high-volume thoracic interfascial blocks. The PECS I block is designed to anesthetize the medial and lateral pectoral nerves, whereas the PECS II block extends the area of coverage to include the long thoracic nerve in addition to the pectoral, intercostobrachial, and the third to sixth intercostal nerves[11]. The use of ultrasound guidance makes the PECS block procedure relatively simple to perform. The principal anatomical landmarks identified using ultrasound include: PMm, Pmm, SA muscle, and the cross-section of the ribs[13]. The PECS II block has a wide range of clinical applications, particularly in breast surgery, and may also be utilized for analgesia in traumatic chest injuries, pacemaker implantation, and chest tube placement[7].

A high-frequency linear US probe is positioned just below lateral third of the clavicle. The US probe is placed infero-laterally until the PMm, Pmm and SA muscles were visible through one plane at the level of the 3rd and 4th ribs. The block needle is advanced in plain view until it visualizes the interfascial line between PMm and Pmm muscles. The PMm being more superficial and the Pmm muscle being deeper and smaller. Between these muscles, the thoracoacromial artery is located. It is very important to locate as both pectoral nerves are nearby. 10 mL of LA is injected next to the pulsating artery[3]. This is PECS I block (also called: interpectoral plane block). The needle is then advanced till its tip reaches the interfascial plane between the SA and Pmm, and the patient will receive another 20 mL of LA. This is PECS II block (also called: modified PECS block)[10]. It must be noted that the PECS I block is included in the PECS II block by default, and thus, the term "PECS I + PECS II" must be avoided. Alternatively, it can be called "interpectoral plane + pectoserratus plane blocks" or (interpectoral plane + subpectoral plane block)[14].

PECS block offers several advantage; better T2-dermatomal spread (unlike paravertebral block), more liberal anticoagulant use, and dense motor and sensory nerve-blockade (unlike wound infiltration). PECS blocks are not associated with sympathetic blockade or other complications, such as hypotension, pneumothorax, or spinal cord trauma[15].

Complications are rare with the use of ultrasound. But intravascular injection into the pectoral branch of the thoracoacromial artery and puncture of the axillary fascia has been reported. These potential adverse events can be readily minimized through proper ultrasound training, and looking for the right pattern of spread of LA[7].

SSAPB

The serratus anterior plane block (SAPB) was first described by Blanco[8]. It primarily impacts the lateral cutaneous branches of the intercostal nerves, as well as the long thoracic, intercostobrachial, and thoracodorsal nerves. The LA here is injected more dorsally. As a result, SAPB block can precisely anesthetize more intercostal nerves[11]. It has been used to provide analgesia for a variety of procedures, such as breast surgery, thoracoscopy, rib fracture, and shoulder surgery[16].

Depending on the injection level, SAPB can be classified as SSAPB, dSAPB, or modified serratus anterior plane block. 1- SSAPB refers to the injection of a LA at the level of the fifth rib on the midaxillary line, between the latissimus dorsi and SA muscles[17]; 2- Deep serratus anterior block (also called serratointercostal fascial block) describes the injection of LA between the external intercostal muscle and the serratus anterior muscle at the same rib level and SSAPB anatomical line. As the serratus anterior muscle is innervated by the long thoracic nerve, which courses along its superficial surface, SSAPB may partially or completely block this nerve in addition to the lateral cutaneous branches of the intercostal nerves. In contrast, dSAPB does not affect the long thoracic nerve, thereby allowing post-operative assessment of its function[14]; 3- Modified serratus anterior block involves injection of LA between the latissimus dorsi and serratus anterior at the level of the sixth rib on the posterior axillary line. This modification - in injection site - is particularly advantageous in procedures involving latissimus dorsi flaps, as it facilitates blockade of the thoracic and thoracodorsal nerves[17].

The serratus anterior plane block (SAPB) technique offers several advantages. First, it eliminates the need for multiple needle insertion points and changes in needle orientation required in PECS II block. Second, it provides more selective targeting of the thoracic nerves compared with PECS II block. Third, axillary analgesia is improved over PECS II block by injecting the anesthetic drug just above the lateral cutaneous nerve's outflow through the midaxillary line[8],[9],[18].

However, adverse effects have been reported during mastectomy procedures. In particular, SSAPB has been associated with disruption of the axillary fascia, which may interfere with surgical dissection and operative performance[19].

Sample size

Kaur et al.[19], reported an effect size of 0.73-0.78 comparing pain score of shoulder and static pain between the two studied groups. A sample size of at least 31 cases per group (at least 62 cases in the two groups) achieves 0.8 power to detect an effect size of 0.73 using independent two samples t-test with level of confidence of 0.05. A 10% increase in the sample size to compensate for the loss of follow-up and so the final sample size would be 35 per group.

Statistical analysis

All data will be recorded, analyzed and statistically compared between both groups to identify any significant differences between them. Recorded data were analyzed using the statistical package for social sciences, version 23.0 (SPSS Inc., Chicago, Illinois, USA). The quantitative data were presented as mean $\pm$ standard deviation and range. The p-value was considered significant as the following: P-value < 0.05 was considered significant, P-value < 0.001 was considered as highly significant, P-value > 0.05 was considered insignificant.

Results

Seventy patients were recruited as per inclusion and exclusion criteria during the study period. All patients completed the study and were included in the final analysis. There was no statistically significant difference noted in the demographic data in both groups.

A statistically significant difference was found in the requirement for opioid analgesic medications between the two study groups as follows. Intraoperatively, the number of patients who received fentanyl incremental dose was higher in SSAPB (42.9%) versus PECS II block (20%). Postoperatively, the number of patients who needed rescue analgesic dose was higher in SSAPB (37.1%) versus PECS II block (14.3%). Additionally, SSAPB group patients had higher postoperative VAS score when compared to PECS II group patients, from the 30th minute till the 12th postoperative hour from PACU arrival. There was no significant difference in VAS scores between the 2 groups at 16 h, 20 h and 24 h after surgery. The mean time to the first request of analgesic given was lower in SSAPB (5.2 ± 1.6 h) when compared to PECS II group patients (7.4 ± 1.3 h) (Table 1). The mean dose of postoperative pethidine during the 1st 24 hours was higher in SSAPB (57.7 ± 18.8 mg) when compared to PECS II group patients (30.0 ± 11.2 mg) (Table 2). Finally, no recorded side effects.

Discussion

Among patients undergoing breast cancer surgery, the

Table 1. Time to 1st rescue analgesia (hours) in cases required rescue analgesia among the studied groups

Measures	SSAPB	PECS II	[^] p-value
Mean $\pm$ SD	5.2 $\pm$ 1.6	7.4 $\pm$ 1.3	0.013*

[^]Independent t-test, SD: Standard deviation.

PECS II: Modified pectoral nerves, SSAPB: superficial serratus anterior plane block.

Table 2. Total pethidine dose (mg) in cases required rescue analgesia among the studied groups

Measures	SSAPB	PECS II	[^] p-value
Mean $\pm$ SD	57.7 $\pm$ 18.8	30.0 $\pm$ 11.2	0.007*

[^]Independent t-test, SD: Standard deviation.

PECS II: Modified pectoral nerves, SSAPB: superficial serratus anterior plane block.

incidence of severe pain in the immediate postoperative period has been reported to be approximately 60%. The use of preventive analgesia within a multimodal analgesic strategy aims to suppress sustained nociceptive neuronal activity, thereby reducing the risk of chronic pain development as well as associated morbidity and mortality[19]. To date, clinical trials have reported significant perioperative analgesic benefits associated with either of PECS II block[1],[18],[20],[21],[22],[23] or with SSAPB[12],[24] in MRM when compared to control group. However, owing to the limited number of randomized studies directly comparing PECS II block and SSAPB, the present work sought to evaluate and compare their efficacy with respect to the duration and quality of analgesia.

The present study demonstrated that the PECS II block may provide superior postoperative analgesia compared with SSAPB, as reflected by a longer time to first rescue analgesia and reduced postoperative analgesic requirements during the first 24 hours after surgery.

These findings are supported by the work of Kubodera and colleagues[25], who, in a retrospective observational study, suggested that PECS II block may be more effective than SSAPB for postoperative pain control. In their analysis, 55% of patients in the PECS II group reported no pain two months following surgery, compared with only 19% of patients in the serratus anterior plane block group. Furthermore, patients who received PECS II block exhibited lower median numerical rating scale (NRS) pain scores during the first 24 postoperative hours. Although not statistically significant, but postoperative analgesic consumption during the same period was also lower in the PECS II group.

In agreement with the findings of the present study, Fujii and colleagues[26] reported that the PECS II block was more effective than SSAPB in reducing the incidence of chronic post-mastectomy pain at six months (10% versus 33%). Additionally, PECS II block was associated with lower median morphine consumption during the first 24 postoperative hours compared with SSAPB (4 mg versus 6 mg).

In contrast to our results, Amir and colleagues[9] compared the postoperative analgesic efficacy of SSAPB and PECS II block in patients undergoing MRM and concluded that SSAPB provided superior analgesic quality and longer duration. In their study, patients receiving SSAPB required their first rescue analgesic dose significantly later, at a mean of 1,280 minutes postoperatively, compared with 826 minutes in the PECS II group. Moreover, total analgesic consumption over the first 24 postoperative hours was substantially lower in the SSAPB group than in the PECS II group. The discrepancy between their findings and ours may be attributed to the smaller volume of LA administered into the pectoserratus plane during the PECS II block. This anatomical plane is intended to anesthetize the long thoracic nerve, as well as the pectoral, intercostobrachial, and third through sixth intercostal nerves[11]. Although no studies have established a fixed-dose regimen for PECS II block, it is plausible that relatively larger volumes of LA are necessary to achieve optimal clinical efficacy. Notably, most studies evaluating PECS II block have employed volumes of approximately 10 mL in the interpectoral plane and 20 mL in the pectoserratus or subpectoral plane[27].

Conclusion

The current study showed that ultrasound-guided PECS II block provided superior postoperative analgesia when compared with the superficial serratus anterior plane block. This was evidenced by a longer time to first rescue analgesia and a lower total postoperative opioid requirement. Further studies with larger sample sizes, inclusion of control groups, and the addition of parasternal intercostal plane block supplementation are warranted to validate and expand upon these results.

Availability of data and material: The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Acknowledgments: We have no affiliations with or involvement in any organization.

On behalf of all the contributors I will act and correspond with the journal from this point onward at all stages of refereeing and publication, also post-publication. All authors have contributed intellectually to the manuscript and the manuscript has been read and approved by all the authors. All authors contributed to the study conception and design. All authors read and approved the final manuscript. The contents have not been published elsewhere and the paper is not being submitted elsewhere. We adhere to bioethical principles (see <http://www.icmje.org/>).

Ethics approval and consent to participate: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Ethical approval for this study ((FMASU MS 576/ 2021)) was provided by the Ethics committee of Ain Shams University hospital, Abbasia, Cairo, Egypt on 28/9/2021

References

1. Noorain Z, Waqar SH, Shah SA, et al. Comparison of postoperative pain with and without pectoral block in patients undergoing modified radical mastectomy. *Journal of Ayub Medical College Abbottabad*. 2024 Feb 5;36(1):25-8. doi: 10.55519/jamc-01-12588. PMID: 39585253.
2. Makkar JK, Dahiya D, Jain D, et al. Effect of balanced anaesthesia with and without modified pectoralis nerve block on postoperative analgesia after breast surgeries: A randomised controlled trial. *Indian Journal of Anaesthesia*. 2021 Sep 1;65(Suppl 3):S110-4. doi: 10.4103/ija.ija_125_21. PMID: 34703055.
3. Castello Branco de Sousa PC, Alves Bersot CD, Pereira LF, et al. Evaluation of Pectoral Nerve Blocks Type II (PEC II) for Augmentation Mammoplasty: Prospective, Randomized, and Double-Blind Study. *Surgeries*. 2024 Nov 5;5(4):1010-22. doi: 10.3390/surgeries5040081.
4. Singariya G, Pahuja H, Kamal M, et al. Analgesic efficacy of ultrasound-guided erector spinae block and pectoral nerve block in patients undergoing modified radical mastectomy: A randomized control trial. *In The Indian Anaesthetists Forum* 2021 Jul 1 (Vol.

- 22, No. 2, pp. 129-135). Medknow.
5. Maniker RB, Johnson RL, Tran DQ. Interfacial plane blocks for breast surgery: which surgery to block, and which block to choose?. *Anesthesia & Analgesia*. 2020 Jun 1;130(6):1556-8. doi: 10.1213/ane.0000000000004413. PMID: 32384345.
6. Cavallo C, Romanelli A, Gammaldi R. Deep serratus anterior plane block and superficial parasternal block for awake mastectomy in a high-risk patient. *Anaesthesia, Pain & Intensive Care*. 2024 May 30;28(3):577-81. doi: 10.35975/apic.v28i3.2480.
7. Blanco R, Fajardo M, Maldonado TP. Ultrasound description of Pecs II (modified Pecs I): a novel approach to breast surgery. *Revista española de anestesiología y reanimación*. 2012 Nov 1;59(9):470-5. doi: 10.1016/j.redar.2012.07.003. PMID: 22939099.
8. Blanco R, Parras T, McDonnell JG, et al. Serratus plane block: a novel ultrasound-guided thoracic wall nerve block. *Anaesthesia*. 2013 Nov;68(11):1107-13. doi: 10.1111/anae.12344. PMID: 23923989.
9. Amir SH, Sheikh K, Ali QE, et al. A Comparative Study of Ultrasound-Guided Serratus Anterior Plane Block with Pectoral Nerve Block Type II in Breast Surgeries. *Indian Journal of Pain*. 2022 Jan 1;36(1):37-42. doi: 10.4103/ijpn.ijpn_71_21.
10. Alasrag AS, Elkeblawy AM, Abo Elyazid MM, et al. Analgesic efficacy of ultrasound-guided PECS II and transeversus thoracic plane blocks compared to serratus anterior plane block for modified radical mastectomy: A randomized prospective study. *Egyptian Journal of Anaesthesia*. 2023 Dec 31;39(1):218-25. doi: 10.1080/11101849.2023.2182991.
11. Alshawadfy A, Al-Touny SA. Comparing the quality of analgesia with ultrasound-guided pectoral nerve block and serratus anterior plane block II in patients undergoing modified radical mastectomy: a randomised clinical trial. *Anaesthesiology Intensive Therapy*. 2023 Jan 1;55(1):52-9. doi: 10.5114/ait.2023.126218. PMID: 37306272.
12. El-Tohamy SA, Elhossieny KM, Galal El-Deen AM, et al. Ultrasound-Guided Serratus Plane Block for perioperative Analgesia in Modified Radical Mastectomy: A Randomized Controlled Trial. *Zagazig University Medical Journal*. 2025 Sep 15. doi: 10.21608/zumj.2025.414146.4110.
13. Shankarraman D, Jegadish B, Reddy A et al. Breast Surgeries in Select High-Risk Patients under Pec Block. *Breast Global Journal*. 2024 Jan 1;2(1):16-20. doi: 10.4103/bgj.bgj_15_24.
14. Sethuraman RM. Regional Anesthesia Techniques for Breast Cancer Surgeries-A Narrative Review. *Indian Journal of Surgical Oncology*. 2025 Feb;16(1):127-33. doi: 10.1007/s13193-024-02043-4. PMID: 40114888.
15. Jindal R, Meena S, Bhati S, et al. Postoperative analgesic efficacy of intraoperative pectoral nerve block for modified radical mastectomy: a double-blind prospective randomised interventional study. *Indian Journal of Surgical Oncology*. 2023 Mar;14(1):215-21. doi: 10.1007/s13193-022-01680-x. PMID: 36891452.
16. Tan KW, Masri SN, Musthafa QA, et al. Analgesic efficacy of the superficial versus deep serratus plane blocks for mastectomy with axillary clearance: A randomized controlled trial. *Medicine*. 2022 Sep 2;101(35):e30515. doi: 10.1097/md.00000000000030515. PMID: 36107598.
17. Chai B, Wang Q, Du J, et al. Research progress on serratus anterior plane block in breast surgery: a narrative review. *Pain and Therapy*. 2023 Apr;12(2):323-37. doi: 10.1007/s40122-022-00456-z. PMID: 36484891.
18. Sharma S, Tiwari S, Sharma K, et al. Randomized controlled trial comparing the efficacy of pectoral nerve block with general anesthesia alone in patients undergoing unilateral mastectomy. *Indian Journal of Surgical Oncology*. 2021 Mar;12(1):158-63. doi: 10.1007/s13193-020-01269-2. PMID: 33814847.
19. Kaur U, Shamshery C, Agarwal A, et al. Evaluation of postoperative pain in patients undergoing modified radical mastectomy with pectoralis or serratus-intercostal fascial plane blocks. *Korean Journal of Anesthesiology*. 2020 Oct 1;73(5):425-33. doi: 10.4097/kja.20159. PMID: 32987492.
20. Assaf G, Gholmieh L, Al Nawwar R, et al. Effectiveness of the medial approach to PECS block in modified radical mastectomy: a retrospective study. *Anaesthesia, Pain & Intensive Care*. 2024 Apr 17;28(2):237-42.
21. Alam GF, Farhana K, Nimmi NP, et al. Effectiveness of Pectoral Nerve Blocks (PEC II) for Post Operative Pain Management in Breast Surgery. *Bangladesh Journal of Pain*. 2022 Jul 1;2(1):10-6. doi: 10.62848/bjpain.v2i1.3780.
22. Riaz A, Saleem M, Mahmood K et al. Effectiveness of ultrasound-guided modified pectoral nerve block (PECS II) for post-operative pain relief after modified radical mastectomy (MRM). *Pakistan Armed Forces Medical Journal*. 2021 Jun 1;71(3):1011-4. doi: 10.51253/pafmj.v71i3.4086.
23. Serce GI, Tulubas EK. Comparison of ultrasonography-guided pectoral nerve block with patient-controlled analgesia for breast surgery patients. *The European Research Journal*. 2021;7(2):136-41. doi: 10.18621/eurj.584619.
24. Chai B, Yu H, Qian Y, et al. Comparison of postoperative pain in 70 women with breast cancer following general anesthesia for mastectomy with and without serratus anterior plane nerve block. *Medical Science Monitor: International Medical Journal of Experimental and Clinical Research*. 2022 Feb 7;28:e934064-1. doi: 10.12659/msm.934064. PMID: 35125493.
25. Kubodera K, Fujii T, Akane A et al. Efficacy of pectoral nerve block type-2 (Pecs II block) versus serratus plane block for postoperative analgesia in breast cancer surgery: a retrospective study. *Nagoya Journal of Medical Science*. 2020 Feb;82(1):93.
26. Fujii T, Shibata Y, Akane A, et al. A randomised controlled trial of pectoral nerve-2 (PECS 2) block vs. serratus plane block for chronic pain after mastectomy. *Anaesthesia*. 2019 Dec;74(12):1558-62. doi: 10.1111/anae.14769. PMID: 31273773.
27. Anam K, Mochamat M. A PECS II Block as Post Operative Analgesia After Modified Radical Mastectomy. *Solo Journal of Anesthesia, Pain and Critical Care (SOJA)*;4(2):92-105.