BMC Anesthesiology

RESEARCH Open Access

Is the combination of interfascial plane blocks sufficient for awake breast cancer surgery? An observational, prospective, proof-of-concept study

Gamze Ertas[1*], Hamiyet Senol Cakmak[1], Sonmez Ocak[2], Mert Yılmaz[1], Dursun Burak Ozdemir[2] and Serkan Tulgar[1]

Abstract

Introduction Breast cancer is the most prevalent cancer among women, often necessitating surgical intervention. While surgeries like lumpectomy can be performed under local anesthesia, more extensive procedures typically require general anesthesia. Awake breast cancer surgery has emerged as an alternative due to risks associated with general anesthesia and patient preference.

Methods This prospective observational study, conducted from July 2022 to July 2023, evaluated the effectiveness of ultrasound-guided fascial plane blocks for awake breast surgery. Patients aged 18–80 years undergoing unilateral breast surgery were included, following ethical committee approval and written informed consent. Exclusion criteria were prior breast surgery, coagulopathies, infections, allergies to local anesthetics, psychiatric disorders, body mass index over 40 kg/m^2, and chest deformities. The combination of interpectoral, pecto-serratus, and deep serratus plane blocks was used as the primary anesthetic method, with a superficial parasternal block added in cases where complete cutaneous coverage was not achieved.

Results Seventeen patients were enrolled. The primary outcome, sufficient surgical anesthesia without deep sedation, was achieved in 15 patients. The combination of the aforementioned blocks proved effective, with an average surgery duration of 59.66 min, and propofol requirements averaging 1.77 mg/kg/hour. Most patients reported high satisfaction levels, and no early or late block-related complications were observed.

Conclusion The combination of fascial plane blocks is a viable option for awake breast cancer surgery, potentially eliminating the need for more invasive anesthesia techniques. Further studies are necessary to confirm these findings in larger, homogeneous patient groups.

Keywords Regional anaesthesia, Breast surgery, Nerve block, Awake surgery, Plane blocks

*Correspondence:
Gamze Ertas
gamzertas.md@hotmail.com
[1]Department of Anesthesiology and Reanimation, Samsun University Faculty of Medicine, Samsun Training and Research Hospital, Barış Bulvarı Kadıköy Mahallesi No : 199 PK : 55090 İlkadım, Samsun, Turkey
[2]Department of General Surgery, Samsun University Faculty of Medicine, Samsun Training and Research Hospital, Samsun, Turkey

Introduction

Breast cancer ranks as the most prevalent cancer type among women, with surgical intervention being a frequently employed treatment modality, albeit varying according to tumor subtype and the extent of metastasis [1]. While simple procedures such as lumpectomy can be performed under local anesthesia with sedoanalgesia, breast-conserving surgery, modified radical mastectomy, and radical mastectomy (with or without axillary lymph node dissection) are typically performed under general anesthesia [2, 3].

Sometimes clinicians encounter situations where they consider alternatives, such as awake breast cancer surgery. This assessment may be based on the risk of morbidity and mortality arising from the patient's clinical history and physical condition, or may be based on the patient's clear preference to opt out of the use of general anesthesia [4, 5]. And sometimes, this preference may also be motivated by concerns related to a pandemic like COVID-19, and the fear of transmission, thereby prompting avoidance of intubation [6, 7].

For this purpose, historically, we have observed the use of infiltrative anesthesia, tumescent anesthesia, epidural, and paravertebral blocks. However, except for the first two, these techniques are often inadequate, particularly in the upper inner and upper outer quadrants [2, 4].

The most current and logical approach to awake breast cancer surgery involves utilizing paravertebral blocks performed under ultrasound guidance, complemented by the addition of pectoral blocks to address the limitations inherent in paravertebral blocks [5]. Additionally, combinations of peri-paravertebral blocks (such as erector spinae plane block and rhomboid intercostal block) with anterolateral thoracic blocks (including superficial and deep serratus anterior plane blocks, interpectoral and pecto-serratus blocks, and pecto-intercostal blocks in the parasternal region) have also been anecdotally reported in cases of awake breast surgery [8–12].

According to the location of breast cancer and the presence of axillary involvement, the orientation of surgical incision varies. We hypothesized that different breast cancer surgeries could be performed under awake or mild sedation using only ultrasound-guided fascial plane blocks, without the need for paravertebral, peri-paravertebral, or neuraxial techniques. We designed an observational, prospective study with the acceptance that the combination of interpectoral, pecto-serratus, and deep serratus plane blocks (with the addition of parasternal blocks if the incision extends parasternally) could serve as an alternative to paravertebral block combinations for such surgeries. The aim of this proof-of-concept study is to investigate the effectiveness of the aforementioned combination of interfascial plane blocks for awake breast surgery.

Methodology

Study protocol

This prospective observational proof-of-concept study was conducted at a tertiary care hospital between July 2022 and July 2023, following approval from the local ethics committee (Ondokuz Mayıs University Clinical Research Ethical Committee, OMUKAEK:2022/144) and prospective registration on clinicaltrial.gov (NCT05427292). Throughout this research project, we adhered to the principles outlined in the Declaration of Helsinki, 2013.

Patients aged 18–80 years undergoing unilateral breast surgery with ASA physical class I-III were included in the study. Throughout the study, awake breast surgery technique under the block combination we investigated was offered as an alternative to general anesthesia, regardless of their comorbidities. Written informed consent was obtained from all patients for participation in the study and the procedures to be performed.

Our exclusion criteria were determined to play an important role in defining our study sample. Those who have had previous breast surgery other than excisional biopsy, those with coagulopathy, those with bleeding disorders, those with a history of local infection at the injection site, those with a history of local anesthetic allergy, those with psychiatric diseases such as depression, mania, schizophrenia, or those using antipsychotic drugs for more than 4 weeks. It was planned to exclude from the study users, patients with a body mass index (BMI) exceeding 40 kg/m^2, and patients with chest deformities such as pectus excavatum and pectus carinatum.

Ultrasound guided regional anesthesia

Patients who consented to participate in the study were transferred to the regional anesthesia performance room 45 min prior to the surgical procedure. Sedoanalgesia was induced using intravenous 1 mg midazolam and 7.5 mg ketamine. Prior to block administration, comprehensive discussions were conducted with the surgical team regarding the tumor's localization, the medial and lateral extension of the surgical incision, and the presence of axillary dissection. All blocks were executed in the prone position, under optimal antiseptic conditions, and by the consistent anesthesia team (ST).

A high-frequency ultrasound transducer (10–18 MHz, Esaote MyLabTM30Gold) was employed for combination administration in the majority of patients. In instances where optimal imaging was not attainable (e.g., in morbidly obese patients for deep serratus blocks), a low-frequency (3–5 MHz) transducer was utilized. The blocks were performed using a sonovisible peripheral nerve block needle (Vygon Echoplex, 85 mm, 21 G, Ecouen, France). Saline was not used for hydrodissection. In all block performances, bupivacaine, which is most

commonly used in fascial plane blocks in our country, was used.

The block combination was applied in the same sequence to all patients. A linear transducer was positioned superomedially and inferolaterally under the clavicle. It was then slided to visualize the third and fourth ribs. Structures including the superficial to deep layers such as pectoralis major, pectoralis minor, serratus anterior muscles, ribs, intercostal muscles, and pleura were identified. The thoracoacromial artery was recognized between the pectoral muscles and confirmed with Doppler to avoid intra-arterial injection. The needle was advanced using an in-plane technique, and initially, 20 mL of local anesthetic (LA) was deposited between the pectoralis minor and serratus anterior muscles (pecto-serratus block). Subsequently, the needle was withdrawn, and 10 mL of LA was injected between the pectoral muscles (interpectoral block). The transducer was then advanced to the midaxillary line. The serratus anterior muscle, latissimus dorsi muscle, fourth rib, intercostal muscles, and pleura were visualized. The needle was advanced to the deep interfascial plane of the serratus anterior muscle, and 20 mL of LA was deposited, completing the combination. If the surgical incision was reported to extend to the sternum, a superficial parasternal-intercostal block was added at the level of the fourth costal cartilage with 10 mL of LA. The LA concentration was maintained between 0.20% and 0.25%. Maximum doses were determined for each patient, and care was taken not to exceed the dose of 2.5 mg/kg for bupivacaine.

After completion of procedures under ultrasound guidance, the presence of cutaneous blockade was evaluated in the surgical field using a pinprick test. If adequate anesthesia was confirmed, the patient was transferred to the operating room.

Perioperative sedation and analgesia regimen

Upon admission to the operating room, patients received a bolus of 1 mcg/kg fentanyl intravenously and an infusion of propofol at a dose of 1 mg/kg/hour was initiated. During the perioperative period, propofol infusion was adjusted between 0.5 and 4 mg/kg based on the pain reported by the patient and haemodynamic parameters. In cases where patients still experienced severe pain secondary to surgical manipulations, boluses of ketamine at 7.5 mg were administered. If the propofol dose exceeded 4 mg/kg, a decision was made to transition to general anesthesia. Thirty minutes before the end of surgery, 1 gram of paracetamol and 50 mg of dexketoprofen were administered, and a schedule was set for the repeat administration of paracetamol every 8 h and dexketoprofen every 12 h.

Outcome measurements

The primary outcome of the study was sufficient surgical anesthesia. After confirming the sensory block in the surgical area with the pin-prick test after the block combinations, successful completion of the surgical procedure 'without the need for deep sedoanalgesia' was considered 'sufficient surgical anesthesia' [3, 5]. Deep sedoanalgesia was defined as patients requiring propofol over 4 mg/kg/h. This threshold was determined based on the drug's prescribing information as provided in the product leaflet available in our country, where this dose is indicated as the upper limit for sedation. Additionally, we anticipated potential airway issues at doses above 4 mg/kg/hour and thus deemed it appropriate to continue anesthesia with a laryngeal mask.

Secondary outcomes of the study were Pain scores on the Numerical Rating Scale (NRS), Quality of Recovery 15 scale, analgesic consumption, modified Wilson Sedation Scale, quality of anesthesia, postoperative morphine consumption as a rescue analgesic and scaling of working conditions. NRS is a segmented numerical version of the visual analog scale (VAS), where participants choose an integer between 0 and 10 to best reflect the intensity of their pain. This 11-point numerical scale ranges from '0,' representing no pain (e.g., "no pain"), to '10,' representing the worst imaginable pain (e.g., "worst pain imaginable" or "worst pain conceivable"). NRS values and additional analgesic requirements were recorded at postoperative 1, 3, 6, 12, and 24 h.

The patient's perception of anesthesia quality was evaluated at 24 h using the Postoperative Quality of Recovery 15 in Turkish scale (QoR15) questionnaire [13].

Patients were assessed at 5-minute intervals during the intraoperative period using the 4-point Modified Wilson Sedation Scale (1. Oriented, may have eyes closed but responds to name; 2. Drowsy, may have eyes closed but can be aroused by name; 3. Responsive to mild physical stimulation (earlobe); 4. Unresponsive to mild physical stimulation).

When the patients came to the postoperative recovery room at the end of the surgery, their perception of anesthesia quality was evaluated using a 5-point Likert scale (5.Extremely satisfied, 4.Satisfied, 3.Neither satisfied nor dissatisfied, 2.Unsatisfactory, 1.Very dissatisfied). Additionally, early or late block-related complications were noted.

The scaling of the working conditions was assessed by the practitioner performing the procedure at the end of the surgery, using one of the following options: No different from general anesthesia, Slightly challenging/sufficient, or Extremely challenging/insufficient.

Table 1 Demographic data, surgical types, and administered blocks

Descriptive characteristics of patients	
	All Patients
Age (years)	69.70 ± 11.51
Length (cm)	157.83 ± 16.15
Weight (kg)	70.94 ± 10.14
ASA class (n)	
I	1
II	4
III	11
IV	1
Types of Surgery	
MRM + AD	8
BCS + AD	3
BCS + SLN	2
Mastectomy	1
BCS	3
Block Combinations	
SAP + PcS+İP	11
SAP + PcS+İP + PS	4
Failure/GA	2

MRM: Modified Radical Mastectomy AD: axillary dissection BCS: breast conserving surgery SLN: sentinel lymph node SAP: Serratus anterior plane block PcS: pecto-serratus block PS: parasternal block İP: interpectoral block GA: general anesthesia

Table 2 Perioperative outcome measures

Perioperative outcome measures*	
Surgical time (min)	60 (57.5–67.5)
Propofol dose mg/kg/h	1.88 (1.29–2.90)
Number of ketamine bolus**	
0	5
1	2
2	4
3	2
4	2
Maximum sedation score**	
1 (oriented)	3
2 (drowsy)	6
3 (responsive to mild physical stimulation)	6
4 (unresponsive to mild physical stimulation)	0
Quality of the operating conditions	
2 (indistinguishable from general anesthesia)	7
1 (slightly challenging/ adequate)	8
0 (extremely challenging/inadequate)	0
Patient Satisfaction**	
5 (Extremely satisfied)	8
4 (Satisfied)	7
QoR-15 score	137 (134-141.5)

Values are number of patient or median (IQR [range]) * Patients with general anesthesia/failure were excluded from evaluation. **: presented as number of patients. QoR: Quality of Recovery.

Statistics

In this prospective observational study, a one-year duration was determined, and patients who consented to participate during this period were included in the study. Therefore, no sample size calculation was performed.

Data analysis was conducted using SPSS for Windows, Version 16.0 (SPSS Inc, Chicago, USA). Continuous variables were presented as mean ± standard deviation or median (25th–75th percentiles), while categorical assessments were presented as patient numbers. Normal distribution was assessed using the Kolmogorov-Smirnov test. The t-test was applied for continuous variables with equal variance, whereas the Mann-Whitney U test was used for non-normally distributed data. Ratios and categorical data were compared using the Chi-square and Fisher's exact tests. Statistical significance was set at $p < 0.05$.

Results

Seventeen patients provided consent to participate in the study. The block combinations were successfully administered to all patients, and the hydrodissection effect of the local anesthetic in the interfascial plane was confirmed sonographically. Demographic data, surgical types, and administered blocks for all patients are provided in Table 1. No complications related to the applied regional anesthesia techniques were observed, and the duration of blocks is presented in Table 1.

The primary outcome, defined as "sufficient surgical anesthesia," was achieved in 15 out of 17 patients with the combination block at the interfascial plane, resulting in uncomplicated completion of breast cancer surgery. In addition, a parasternal block was also performed on four of these fifteen patients. In one patient, pin-prick evaluation revealed insufficient cutaneous block in and around the nipple, and general anesthesia was used for the surgical procedure. In another patient, although a cutaneous block was confirmed in the surgical field, general anesthesia was initiated due to exceeding the planned propofol infusion threshold dose of 4 mg/kg/hour. A total volume of 60 mL was administered in block applications, with this volume being 70 mL only in those with additional parasternal blocks, and the dose of bupivacaine did not exceed 2.5 mg/kg in any case. No early or late complications related to the block were observed.

The average duration of surgeries completed under regional anesthesia was found to be 59.66 ± 12.60 minutes. When evaluated according to surgical types, 8 patients underwent breast-conserving surgery, while 7 patients underwent modified radical mastectomy, with axillary clearance performed in 11 of these cases. The mean propofol requirement during the perioperative period was 1.77 ± 0.85 mg/kg/hour (min-max: 0.5–3.20 mg/kg/h). The data of the patient who underwent

general anesthesia is considered 'unsuccessful' and therefore is excluded from this average.

The number of patients who did not require additional ketamine bolus in addition to propofol infusion was 5, while in others, it was administered an average of 1.6 times. When considering the deepest sedoanalgesia levels measured during the entire surgery, the sedation score of 3 patients was 1 (oriented), the score of 6 patients was 2 (drowsy), and the score of 6 patients was 3 (responsive to mild physical stimulation). No patient was evaluated at score 4 (unresponsive to mild physical stimulation), which we consider as deep sedation during the surgery. When evaluating patients' perception of anesthesia quality, 8 patients reported being 'extremely satisfied,' and 7 patients reported being 'satisfied.' The average QoR-15 score was 134.46±11.38. According to the surgeon's assessments, 7 cases were deemed 'indistinguishable from general anesthesia,' while 8 patients were assessed as 'slightly challenging/adequate.

In the first 24 h postoperatively, the patients' NRS scores at rest did not exceed 4, and there was no need for rescue analgesia with opioids in addition to the scheduled analgesia.

Discussion

This observational study demonstrated that in the majority of cases, the combination of interfascial plane blocks was sufficient as the primary anesthetic method, eliminating the need for deeper blocks. In 15 of 17 cases, procedures were completed successfully using combinations of interfascial blocks without the need for deep sedation, and there was significant variation in the types of surgeries performed.

The complex innervation of the breast, the various types of breast cancer surgeries, and the potential incision lines for these procedures, as well as the diversity of deep tissue manipulations, are all critical factors that need thorough evaluation before planning and recommending awake breast cancer surgery to a patient [9, 14]. This evaluation should take into account the involvement of interpectoral, axillary, and parasternal lymph nodes, the extent of fascial plane dissections, and the presence of procedures such as lymph node dissection or scraping [3, 4, 7].

The lateral and anterior cutaneous branches of the 3rd to 6th intercostal nerves, along with the terminal branches of the supraclavicular nerve originating from the brachial plexus, play active roles in the cutaneous innervation of breast tissue [15]. Additionally, the intercostobrachial nerve is significant in the cutaneous innervation of the axillary region [4]. A comprehensive regional anesthesia technique capable of achieving complete cutaneous blockade of the breast by targeting all relevant nerves has yet to be developed [3]. Thoracic epidural and paravertebral blocks are currently the most effective techniques for extensive cutaneous anesthesia. However, even these methods fall short of blocking the supraclavicular nerve, thus failing to provide a truly comprehensive blockade [15].

In awake breast surgical procedures, the patient's discomfort is not limited to the skin incision alone. The use of electrocautery can induce unpleasant sensations such as electric shocks and muscle twitches. Consequently, cutaneous blockade alone is insufficient for awake surgery, as it fails to address these additional sources of discomfort [4]. Due to these and similar reasons, it is critically important to block the motor innervation of muscles such as the pectoral muscles and serratus anterior. Blocking the lateral and medial pectoral nerves can be beneficial in this regard [7]. However, many clinicians might consider this approach to be hypothetical. For this purpose, various regional anesthesia techniques such as interpectoral, pecto-serratus plane blocks have been developed [16]. These techniques target nerves that cannot be effectively blocked by paravertebral or epidural methods.

Initially, paravertebral techniques were used in awake breast surgeries, which are quite invasive and require deep sedation as they do not provide complete anesthesia on their own. Pawa et al. [5] combined paravertebral blocks with pectoral blocks and demonstrated that this technique could effectively anesthetize the area, allowing the surgical procedure to be successfully completed with minimal sedative use. Similarly, Gürkan et al. [9] added interpectoral and serratus anterior blocks to thoracic paravertebral blocks, enabling awake breast surgery with reduced sedative requirements. However, they reported that patients experienced pain during skin incisions. In the literature, we can find anecdotal reports of similar combinations being used [3–5, 9, 17].

In our combination, we hypothesized that the area blocked by the paravertebral block could be extended with a deep serratus anterior block and, if necessary, a parasternal block. Additionally, by incorporating pecto-serratus and interpectoral blocks, we aimed to achieve both muscular and cutaneous anesthesia, thus providing complete anesthesia. Our proof-of-concept study demonstrated the efficacy of this combined approach.

The innervation of the nipple-areola complex is contentious, with indications that the upper portion of the breast may derive its innervation partially from the supraclavicular nerves [18]. Although it is known that the innervation of the nipple is provided by the anterior and lateral cutaneous branches of the intercostal nerves, there is a debate about which intercostal nerves are involved in this innervation and the course they take through the breast parenchyma. However, it is clear that even with our combination, we could not block the

terminal branches of the supraclavicular nerves extending superior to the nipple. This might explain the failed block observed in one of our patients.

Interfascial plane blocks do not guarantee nerve blockade as selective nerve/plexus blocks do, because the spread of local anesthetic in the interfascial plane is variable depending on several factors. The spread of the local anesthetic in the interfascial plane is unpredictable due to reasons such as fascial adhesions, adjacent masses, and individual anatomical differences [19, 20]. Several factors influence the spread and success of the interfascial plane block. The epimysial fascia in the pectoral region is thinner, and the muscles adhere more tightly to the fascia. Therefore, it may be more challenging for the local anesthetic to remain within the fascial plane when administered here. Age, comorbidities, and trauma can cause variations in fascial thickness, thereby affecting block success [21]. Similarly, surgical incisions and manipulations may not always proceed as initially planned. Considering these situations and limitations, it may be more logical to complement the potential failures of interfascial plane blocks with other fascial plane blocks, as we have done.

It is also very important to understand that when performing anesthesia with interfascial plane blocks, the sensation of pain or discomfort due to the use of electrocautery cannot be eliminated. Furthermore, even if complete cutaneous blockade is achieved, patients may still express discomfort, necessitating the mandatory application of conscious sedation, which should not be overlooked.

In this study, we could have used other techniques such as erector spinae plane block, superficial serratus plane block, and rhomboid intercostal plane block as part of the combinations. Further studies can be conducted on these techniques. However, we applied interfascial plane blocks that are closer to the target.

In these and similar combinations, the most feared aspect for clinicians should be the potential toxicity resulting from the use of high amounts of local anesthetics. Although we adjusted the concentrations to stay within the normal dose range, we must remain vigilant. The change of local anesthetic levels in the blood over time and their safe levels have been demonstrated in techniques such as plane blocks, erector spinae plane block and thoracoabdominal nerve blocks [22, 23]. Although deep blocks, such as paravertebral blocks, will still be required for anesthesia management in surgeries involving thoracic penetration, fascial plane blocks can be effectively used in procedures that do not enter the chest cavity, such as breast surgery [24, 25]. However, such combinations have not been studied and should be investigated.

However, our study has some limitations. The first and most significant limitation is the lack of standardization in the types of surgeries performed on the patients included in the study. The number of patients who met the inclusion criteria and agreed to participate was quite small. Awake breast cancer surgery should not be generalized and routinely applied; rather, it should be considered as an alternative to general anesthesia in high-risk patients. Another limitation is that in some cases, we had to add a parasternal block to our triple block combination. This could have been standardized from the beginning. However, we deemed it appropriate to add parasternal block only in mandatory situations to avoid excessive local anesthetic load.

In addition to presenting an alternative option, we hope that our study raises awareness about 'awake breast cancer surgery.' Neither the patients nor the surgical team were aware of this option until we initiated the study. There is a need for this and similar studies to bring to mind awake breast cancer surgery as an anesthesia technique with the potential to become widespread, especially in high-risk patients.

Conclusion

This prospective observational proof-of-concept study, has demonstrated that the combination of deep serratus plane block, interpectoral block, and pecto-serratus block at appropriate and safe doses/volumes, along with low to moderate sedative support, can complete awake breast cancer surgery procedures. This combination can be considered as an alternative anesthesia technique. Comprehensive prospective studies in homogeneous groups are needed to assess efficacy and reliability.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12871-024-02725-0.

Supplementary Material 1

Supplementary Material 2

Author contributions

S.T and GE contributed to the concept of the study. MY, HC and GE contributed to the data collection. ST contributed to the data analysis. Surgery of the cases was performed by DO and SO. All authors read and approved the final manuscript.

Funding

No funding.

Data availability

The datasets used and/or analysed during the current study available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The study received approval from the Local Ethics Committee (Samsun Ondokuz Mayıs University - Clinical Research Ethics Committee: 2022/144), and was registered on clinicaltrials.org (NCT05427292, Registration date: 13.06.2022). The research, conducted in the Department of Anesthesiology at Samsun University Training and Research Hospital, spanned from July 2022 to July 2024. The study's adherence to the principles of the Declaration of Helsinki was ensured, and written informed consent was obtained from all participants. The CONSORT checklist for the study is available in Fig. 1.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Received: 7 July 2024 / Accepted: 10 September 2024
Published online: 20 September 2024

References

1. Filip CI, Cătană A, Kutasi E, et al. Breast Cancer screening and prophylactic mastectomy for high-risk women in Romania. Med [Internet]. 2024;60(4). https://doi.org/10.3390/medicina60040570.
2. Costa F, Strumia A, Remore LM, et al. Breast surgery analgesia: another perspective for PROSPECT guidelines. Anaesthesia. 2020;75(10):1404–5. https://doi.org/10.1111/anae.15161.
3. Hamilton DL, Pawa A. Anaesthesia for awake breast surgery. BJA Educ. 2022;22(12):452–5.
4. Woodham V, Duraisamy K, Pawa A. Anesthesia during awake breast surgery: additional questions. Reg Anesth Pain Med. 2018;43(8):890.
5. Pawa A, Wight J, Onwochei DN, Vargulescu R, Reed I, Chrisman L, Pushpanathan E, Kothari A, El-Boghdadly K. Combined thoracic paravertebral and pectoral nerve blocks for breast surgery under sedation: a prospective observational case series. Anaesthesia. 2018;73(4):438–43.
6. Buonomo OC, Vinci D, De Carolis G, Pellicciaro M, Petracca F, Sadri A, Buonomo C, Dauri M, Vanni G. Role of breast-conserving surgery on the National Health System Economy from and to SARS-COVID-19 era. Front Surg. 2021;8:705174.
7. Vanni G, Costanzo G, Pellicciaro M, Materazzo M, Buonomo C, Federico T, Giacobbi E, Servadei F, Anemona L, Noce A, Dauri M, Buonomo OC. Awake Breast Surgery: A Systematic Review. In Vivo. 2023 Jul-Aug;37(4):1412–22.
8. Santonastaso DP, DE Chiara A, Bagaphou CT, Cittadini A, Marsigli F, Russo E, Agnoletti V. Erector Spinae plane block associated to serratus anterior plane block for awake radical mastectomy in a patient with extreme obesity. Minerva Anestesiol. 2021;87(6):734–6.
9. Gürkan Y, Kalyoncu İ, Şimşek D, Manici M. Multiple thoracic wall blocks for awake breast surgery: a Case Report. Turk J Anaesthesiol Reanim. 2023;51(6):510–2.
10. Pirri C, Torre DE, Behr AU, De Caro R, Stecco C. Ultrasound-Guided Interpectoral and Pectoserratus Plane Blocks in Breast Surgery: An Alternative Option to General Anaesthesia in an Elderly Woman with a Complex Medical History. Life [Internet]. 2022;12(12). https://doi.org/10.3390/life12122080
11. Pedrosa FP, Cravo H. Serratus Anterior Plane Block for Awake breast surgery: a Case Report. Pract. 2020;14(14):e01354.
12. Tulgar S, Kiziltunç B, Thomas DT, Manukyan MN, Ozer Z. The combination of modified pectoral nerves block and rhomboid intercostal block provides surgical anesthesia in breast surgery. J Clin Anesth. 2019;58:44.
13. Selvi O, Azizoğlu M, Temel G, Tulgar S, Chitneni A, Çınar EN, Özer Z, Gürkan Y. Translation and validation of the Turkish version of the quality of postoperative recovery score QoR-15: a Multi-centred Cohort Study. Turk J Anaesthesiol Reanim. 2022;50(6):443–8.
14. Tulgar S, Selvi O, Thomas DT, Deveci U, Ozer Z. A novel approach to blockage of pectoral nerves: Ultrasound guided modified Clavipectoral Fascial Plane Block (PECs-Zero). J Clin Anesth. 2019;59:49–50.
15. FitzGerald S, Odor PM, Barron A, Pawa A. Breast surgery and regional anaesthesia. Best Pract Res Clin Anaesthesiol. 2019;33(1):95–110.
16. Chin KJ. Thoracic wall blocks: from paravertebral to retrolaminar to serratus to erector spinae and back again - a review of evidence. Best Pract Res Clin Anaesthesiol. 2019;33(1):67–77.
17. Marrone F, Fusco PF, Paventi S, Tomei M, Failli S, Fabbri F, Pullano C. Combined thoracic erector spinae plane and inter-transverse plane blocks for awake breast surgery. Anaesth Rep. 2024;12(1):e12294.
18. 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(3):156–64.
19. Selvi O, Tulgar S, Serifsoy TE, Lance R, Thomas DT, Gürkan Y. Quadrant and Dermatomal Analysis of Sensorial Block in Ultrasound- guided Erector Spinae Plane Block. Eurasian J Med. 2022;54(2):121–6.
20. Fusco P, Pascarella G, Stecco C, Blanco R, Forero M, Pawa A, Tulgar S, Strumia A, Remore LM, DE Cassai A, Colantonio LB, Del Buono R, Fattorini F, Sepolvere G, Tedesco M, Petroni GM, Ciaschi W, Crassiti M, Costa F. Factors to consider for fascial plane blocks' success in acute and chronic pain management. Minerva Anestesiol. 2024;90(1–2):87–97.
21. Black ND, Stecco C, Chan VWS. Fascial Plane blocks: more questions than answers? Anesth Analg. 2021;132(3):899–905.
22. Maximos S, Vaillancourt-Jean É, Mouksassi S, De Cassai A, Ayoub S, Ruel M, Desroches J, Hétu PO, Moore A, Williams S. Peak plasma concentration of total and free bupivacaine after erector spinae plane and pectointercostal fascial plane blocks. Can J Anaesth. 2022;69(9):1151–9.
23. Aikawa K, Uchinami Y, Morimoto Y. Chronological changes in plasma levobupivacaine concentrations after bilateral modified thoracoabdominal nerve block through perichondrial approach. J Anesth. 2023;37(4):641–4.
24. Alagoz A, Findik G, Sazak H, Demiroz SM, Baldemir R, Ulger G, Zengin M. Non-intubated video-assisted thoracoscopic surgery under combination of erector spinae plane block and thoracic paravertebral block. BMC Anesthesiol. 2022;22(1):99.
25. Bagaphou TC, Santonastaso DP, Cerotto V, Carli L, Cordellini M, Chiotti V, Martinelli S, Fusco P, Gori F. Combined PECs II block with parasternal block for awake radical mastectomy. Minerva Anestesiol. 2022;88(12):1078–9.

Publisher's note