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A Prospective Randomised Study to Assess the Analgesic Efficacy of Serratus Anterior Plane (SAP) Block for Modified Radical Mastectomy Under General Anaesthesia

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Abstract

Objective: Breast cancer is the most common malignancy among women and often requires surgery for the removal of the tumour. Uncontrolled pain after breast surgeries is a common problem. Serratus anterior plane (SAP) block is a recently designed technique to block the lateral cutaneous branches of the ventral rami of thoracic intercostal nerves and may cover the area of surgical dissection for modified radical mastectomy (MRM). The primary objective of this study was to evaluate the effect of SAP block on the time to first rescue analgesic in the post-operative period in patients undergoing MRM.

Methods: A randomised, single-blind, parallel group trial was conducted in a single teaching hospital. A total of 100 patients undergoing MRM were randomised in a 1:1 ratio into 2 groups: MRM under general anaesthesia (GA) alone (group G, n=50) or GA with SAP block (group S, n=50). Blocks were performed under ultrasound guidance at the level of the 5th rib in the midaxillary line with 0.4 mL kg^{-1} of 0.375% ropivacaine.

Results: The time to request of first rescue analgesia was significantly prolonged in group S compared with group G (p=0.008). Median (interquartile range) for time to rescue analgesia in group S was 120 (60-300) min, whereas in group G, it was 60 (15-120) min. Post-operative pain scores and the number of patients requiring intra-operative additional fentanyl were significantly less in group S. No technique-related adverse events were observed.

Conclusion: SAP block improved perioperative analgesia in patients undergoing MRM.

Clinical trial registry number: CTRI/2017/11/010424. (http://ctri.nic.in/Clinicaltrials/regtrial.php?modid=1&compid=19&EncHid=45912.14862)

Keywords: Breast cancer, modified radical mastectomy, serratus anterior plane block

Introduction

Breast cancer is one of the most common malignancies among women and often requires surgery for the removal of the primary tumour. Approximately 40% of the women undergoing breast cancer surgery experience significant pain in the immediate post-operative period (1). Uncontrolled post-operative pain may hamper post-operative recovery, increase the length of hospital stay, and increase the risk of development of chronic persistent post-surgical pain (1-3).

The principles of enhanced recovery after surgery, when applied to breast surgeries, recommend the use of regional anaesthetic techniques such as paravertebral block (PVB) or thoracic epidural (TEA) in combination with general

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anaesthesia (GA) for better post-operative pain control compared with GA alone (4). These techniques although effective, may be technically challenging, and have their own set of limitations (5, 6).

Ultrasound-guided interfascial plane blocks to provide analgesia over the hemi thorax may be relatively easier and safer to perform than TEA or PVB. The serratus anterior plane (SAP) block is one such interfascial plane block that is proposed to block the lateral cutaneous branches of the ventral rami of thoracic intercostal nerves and provide analgesia of hemithorax from T2 to T9 dermatomes (7).

The SAP block was first described by Blanco et al. (7) in 2013; this block can be given by injecting the local anaesthetic between latissimus dorsi and serratus anterior (superficial plane) or between serratus anterior and intercostal muscles (deep plane). This technique has been used to provide analgesia in chest wall and thoracic surgical procedures. However, the literature regarding its efficacy as an analgesic technique in breast surgeries is limited (8-10).

We conducted this randomised controlled trial (RCT) with a hypothesis that the use of SAP block in patients undergoing modified radical mastectomy (MRM) would reduce the need of analgesics in post-operative period.

Methods

The study was approved by the Institutional Ethics Committee (ref no. IECPG/446/27.07.206, dated 30 August, 2016) and was prospectively registered with Clinical Trials Registry - India (CTRI) (registration number CTRI/2017/11/010424, dated 8 November, 2017).

A total of 100 American Society of Anesthesiologists (ASA) physical status I and II female patients aged 18 to 65 years undergoing MRM were recruited (Figure 1). Patients with an infection at the site of SAP block, severe chest wall deformity, body mass index of ≥30 kg m^{-2}, a history suggestive of coagulopathy, or those receiving any anticoagulants were excluded from the study.

Main Points:

- SAP block is a newly described technique of analgesia for breast surgeries.
- This RCT evaluated the effect of SAP block on time to request of first rescue analgesia in patients undergoing MRM.
- The time to request of first rescue analgesia was significantly prolonged in patients who received SAP block.

All the recruited patients underwent a routine pre-anaesthetic checkup and were explained about the study protocol. Written informed consent was obtained from all the patients. Patients were randomly allocated in 1 of the 2 groups using computer-generated random number table in a 1:1 ratio and randomised group concealed in serially numbered opaque envelopes. The envelopes were opened by an operation theatre nurse not involved in the study. The 2 groups included were as follows:

- Group G: MRM under GA alone.
- Group S: MRM under GA along with ultrasound-guided SAP block using single injection technique.

All patients were transferred to the pre-operative holding area. An intravenous line was secured and electrocardiograms (ECGs), non-invasive blood pressure (NIBP), and pulse oximeter (SPO_2) were attached, and baseline parameters, heart rate (HR), NIBP, and SPO_2 were noted.

The blocks were performed by a single anaesthetist who had experience of more than 40 ultrasound-guided SAP blocks. The patients were placed in a supine position with the arm abducted to 90°. Under all aseptic precautions, a linear high-frequency ultrasound (USG) probe (SonoSite*Micromaxx*, Inc., Bothell, WA, USA, C6oe/6-13 MHz) was placed over the midclavicular region of the thoracic cage in a sagittal plane. The ribs were counted inferiorly and laterally until the 5th rib was identified in midaxillary line, and puncture site was marked (Figure 2a and b). The puncture site was infiltrated subcutaneously with 2 mL of 2% lignocaine. A 22 G echogenic blunt tipped needle (Stimuplex A,

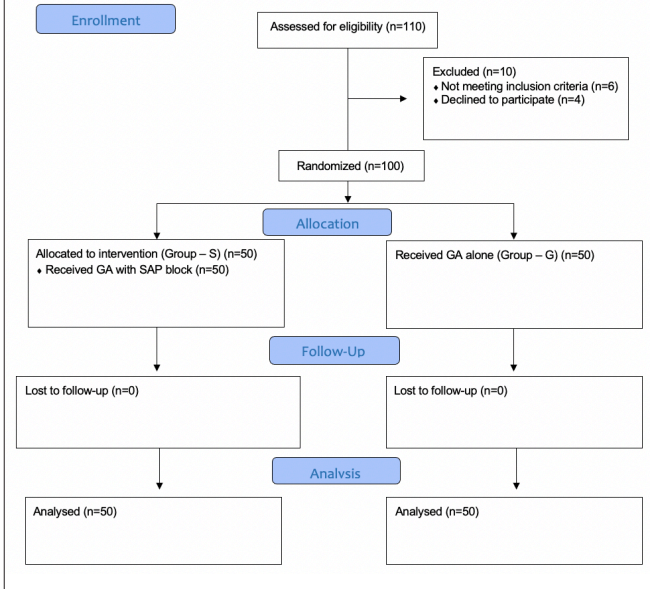

Figure 1. CONSORT diagram showing the flow of patients in the trial

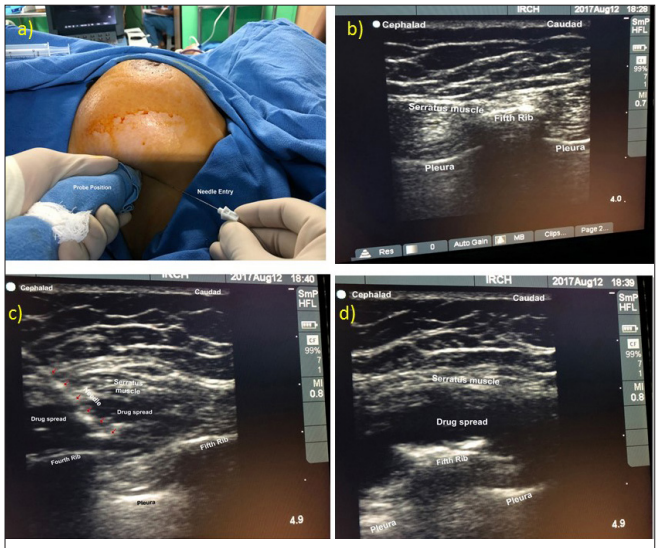

Figure 2. Images showing steps of SAP block performed

22G × 2˝, B. Braun Melsungen AG, Germany) was inserted in-plane with the ultrasound probe and guided between the serratus anterior muscle and the external intercostal muscle (Figure 2c). Thereafter 0.4 mL kg^{-1} of 0.375% Ropivacaine (maximum volume of 30 mL) was injected after aspiration to exclude intravascular needle placement. Drug spread in the desired plane was confirmed by ultrasound (Figure 2d). After 15 min of the block, the patients were shifted to the operating room. Patients in group G were not given the block but were retained in the pre-operative holding area for about an equal duration of time.

In the operating room, ECG, NIBP, and SPO_2 were reattached. In both the groups, and GA was induced with intravenous fentanyl (2 µg kg^{-1}) followed by propofol (1-2 mg kg^{-1}) and vecuronium (0.1 mg kg^{-1}). After 3 min of bag and mask ventilation, appropriate size I-gel was inserted (size depending on weight of the patient). Anaesthesia was maintained with 1 minimum alveolar concentration desflurane in oxygen and air. Ventilation was maintained using volume-controlled mode to achieve an $EtCO_2$ of 35-45 mm Hg.

Intravenous (IV) paracetamol (15 mg kg^{-1}) was administered before the start of the surgery and repeated after every 6 hours for the first 24 hours. All patients received IV dexamethasone 8 mg for post-operative nausea and vomiting prophylaxis. Intra-operative HR, systolic blood pressure (SBP), diastolic blood pressure, mean arterial pressure (MAP) and ECG was monitored after every 5 min. Intra-operative vecuronium boluses were administered as required. Fentanyl (0.5 µg kg^{-1}) was given if there was an increase in HR or SBP by more than 20% of the baseline values, and the total intra-operative fentanyl consumption was recorded. All the intra-operative and post-operative observations and analgesic administration was done by an anaesthesiologist who was unaware of the group allotment and intra-operative management.

At the end of surgery, residual neuromuscular block was reversed with neostigmine (50 µg kg^{-1}) and glycopyrrolate (10 µg kg^{-1}), and I- gel was removed once spontaneous ventilation resumed. All patients were transferred to the post-anaesthetic care unit for further monitoring, observation, pain assessment, and rescue analgesia. In the post-operative period, the Numeric Rating Score (NRS) for pain at rest and on movement (90^0 abduction of ipsilateral arm), at time 0, 1, 2, 6, 12, and 24 hours after extubation was assessed by an independent observer not involved in administering the block or the intra-operative management of the patients. If NRS was ≥4, then rescue analgesia with IV diclofenac 1.5 mg kg^{-1} (rounded off to nearest 50 mg or 75 mg) in 100 mL of normal saline was administered. Thereafter diclofenac was given after every 8 hours.

The primary objective of our study was comparison of time to first rescue analgesic (defined as the time starting after extubation until the need of rescue analgesia) in the post-operative period between the 2 groups. The secondary objectives were to compare the intra-operative fentanyl requirement and post-operative pain scores between the 2 groups. Post-operative complications such as nausea and vomiting were also recorded. Technique-related complications if any, such as pleural puncture, pneumothorax, or local anaesthetic toxicity, were noted.

Statistical analysis

A previous study reported the time to first rescue analgesic [visual analogue scale (VAS) of ≥4] as 131.33±21.36 min in the control group in patients undergoing elective breast surgeries (11). We assumed that the SAP block would increase the time to first rescue analgesic by 30%. Considering a superiority margin of 20%, with 90% power and 5% significance, 45 patients were required in each group. However, we included 50 patients in each group to account for dropouts (total of 100 patients).

The data analysis was performed by the IBM Statistical Package for the Social Sciences software (IBM Corp., Armonk, NY, USA). For continuous demographic data, unpaired Student *t*-test was applied to compare between the 2 groups. For hemodynamic parameters, we applied the linear mixed model, taking the first order autoregressive variance structure to compare between the groups and within the group mean values. The normality of time to first rescue analgesic was tested by Shapiro-Wilk test and was found to be right skewed; thus non-parametric Mann-Whitney U test was performed to compare the time to first rescue analgesia between the 2 groups. Kaplan-Meier survival analysis with log-rank test was applied to compare the survival distribution (time to rescue

analgesic) between the 2 groups. Chi-square test was applied for comparing the proportion of those requiring rescue analgesics between the groups. A p value of <0.05 was considered to be significant.

Results

The Consolidated Standards of Reporting Trials flow diagram for this study is shown in Figure 1. The demographic profile was comparable (p>0.05) (Table 1). The median [interquartile range (IQR)] time to first rescue analgesia was significantly prolonged in group S compared with group G; 120 (60-300) min vs 60 (15-120) min), p=0.008 (Figure 3).

The log-rank test showed a significant difference (p=0.005) between the 2 groups for time to first rescue analgesia. The probability of a patient being pain-free (NRS<4) was significantly higher in group S than in group G (Figure 4). The number of patients requiring rescue analgesia were 30% (15/50) in group S as compared with 54% (27/50) in group G (p=0.015).

Post-operative pain scores at rest and on movement were significantly less in group S until 6 hours post-operatively (Table 2). Intra-operative hemodynamic variables (MAP, pulse rate)

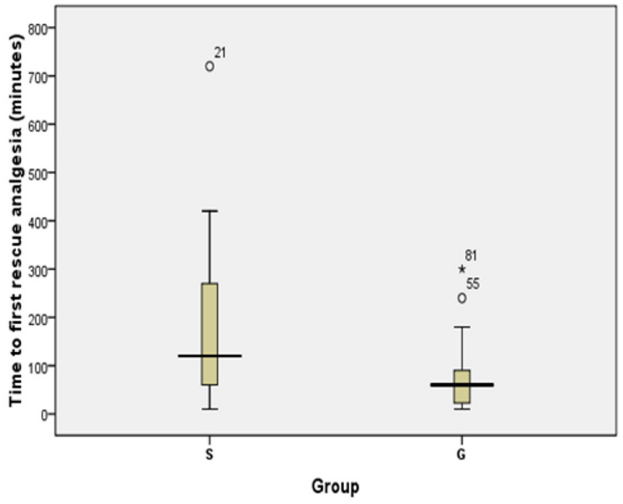

Figure 3. A Box-and-Whisker plot of time to first rescue analgesic (minutes) in each group .The middle line in each box represents the median value, the outer margin of the box represent the interquartile range. The circle and asterix represent outliers. Median (IQR), Group S: 120 (60-300) min; Group G: 60 (15-120) min

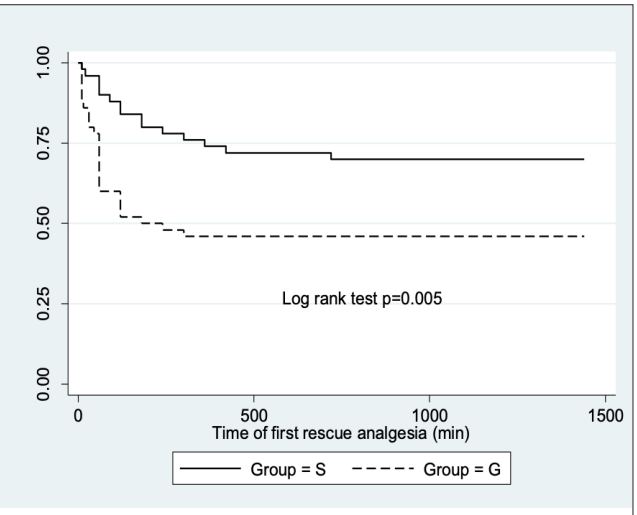

Figure 4. Kaplan Meier curve showing the pain free period (NRS <4) in both groups

Table 1. Showing the comparison between demographic parameters, duration of surgery, and ASA physical status in the 2 groups

Parameter	Group G (n=50)	Group S (n=50)	p
Age (y)	47.18±9.48	46.98±10.55	0.921
Weight (kg)	58±11.89	57.46±9.30	0.563
Height (m)	1.54±0.67	1.52±0.56	0.246
BMI	24.83±3.94	24.81±4.43	0.981
Duration of surgery (min)	111.50±13.14	111.10±17.15	0.896
ASA physical status (1:2)	34:16	33:17	0.832

BMI: body mass index; ASA: American Society for Anesthesiologists.

Table 2. Post-operative numeric rating scores for pain

Time (h)	Group G (n=50)		Group S (n=50)		p	
	At rest	On movement	At rest	On movement	At rest	On movement
0	2 (0-3)	2.5 (2-3)	0 (0-1)	1 (0-2)	<0.001	<0.001
1	2 (2-3)	3 (2-3)	2 (1-2)	2 (2-3)	<0.001	<0.001
2	2 (2-3)	3 (2-3)	2 (2-2)	2 (2-3)	0.002	<0.001
6	2 (2-3)	3 (2-3)	2 (2-2)	2 (2-3)	0.010	0.001
12	2 (2-2)	3 (2-3)	2 (2-2)	2 (2-3)	0.636	0.040
24	2 (2-2)	3 (2-3)	2 (2-2)	3 (2-3)	0.171	0.416

Data are expressed as median (interquartile range).

were comparable in both the groups. With regard to opioid use, it was observed that 12% (6/50) patients in group S needed additional doses of fentanyl in the intra-operative period as compared with 28% (14/50) in group G (p=0.046).

The incidence of nausea and vomiting was similar in both groups (3 patients in group S and 4 patients in group G). No adverse effects, such as pleural puncture, pneumothorax, or local anaesthetic toxicity, were observed in any patient in either group.

Discussion

We observed from this RCT that the supplementation of SAP block in patients undergoing MRM under GA improves post-operative analgesia significantly, delaying the need of first rescue analgesic drug as compared with patients who do not receive SAP block.

Anterior chest wall and breast are innervated by the pectoral nerves supplying the pectoralis major and minor muscles, anterior and lateral cutaneous branches of ventral rami of T2 to T6 spinal nerves, branches of supraclavicular nerve, long thoracic nerve, and thoracodorsal nerve supplying serratus anterior and latissimus dorsi muscles (12). Regional anaesthesia techniques provide effective analgesia, attenuate surgical stress response, and decrease opioid use. This, coupled with the direct protective effect of regional block using local anaesthetic (LA) on cancer cell migration may prevent tumour recurrence (13).

SAP block was first described by Blanco et al. (7) in 2013; various approaches for SAP block (deep and superficial approach) have been described in the literature (14-16). We chose the deep approach because it has been shown to be equally efficacious to the superficial approach (17), and we found it easier to practice.

In a recent study by Yao et al. (16), SAP block was shown to enhance pain relief and quality of recovery after breast cancer surgery. In contrast to our study, the authors had a smaller sample size of 72 patients (36 in each group) and assessed for 40-item quality of recovery as their primary outcome. In line with our results, this study also shows SAP block to be effective in reducing post-operative pain. However, this study included all types of breast surgeries from partial mastectomies to mastectomy with axillary clearance, whereas we included a homogeneous surgical population undergoing MRM. Yao et al. (16) gave a fixed volume of drug (25 mL of 0.5% ropivacaine to all patients, whereas we gave volume based on the total body weight (0.4 mL kg^{-1}). In addition, Yao et al. (16) gave physiological saline to the control group, whereas we refrained from giving a sham block due to ethical concerns.

In studies analysing duration of analgesia with SAP block by Abdallah et al. (14) and Gupta et al. (15), wide variation in duration of the analgesia has been reported (43-240 min). We found the median time to rescue analgesia as 120 min (IQR: 60-300). These wide variations in duration of block or time to rescue analgesia may be explained by the use of different plane of drug deposition, varying concentration, volume and type of LA used, and varying pain threshold of patients.

The intensity of pain was reduced in the SAP group, as shown by the significant reduction in post-operative NRS scores for pain. Post-operative pain scores were significantly reduced at rest and on movement till 6 hours post-operatively (Table 2). In addition, the intra-operative fentanyl consumption was reduced in the SAP group. The findings of this study are similar to those of previous studies that have shown a reduction in intra-operative opioid requirements and post-operative VAS scores after SAP block (14-16).

Similar to previous studies on SAP block (17) in which the drug was deposited in the deep plane, that is, between the serratus anterior muscle and the external intercostal, we found no technique-related adverse effects such as pleural puncture or pneumothorax. Thus, our results reinforce the safety of this block; moreover, drug deposition under ultrasound vision safeguards against the displacement of the needle tip and accidental pleural puncture.

The limitations in our study include the absence of patient blinding as the block was given before the induction of GA as part of our institutional practice. However, the observer was blinded for the block administration and was not allowed to check the records or confirm from the patient for the same. We decided against giving a sham block for patient blinding because of ethical concerns (18). In addition, the dermatomal effect of the LA to confirm for the success of the block could not be achieved owing to the limited time between the block and the induction of GA, but we visualised the spread of the drug in the desired interfascial plane with ultrasound at the time of performing the block. As all the blocks were performed by a single anaesthetist and the spread of drug in the desired plane was visualised under ultrasound, we have assumed the blocks to be successful. Finally, a more objective assessment of post-operative pain would have been assessing post-operative opioid requirement using patient-controlled analgesia. However, owing to limited resources and economical constraints, we could not use patient-controlled analgesia pumps in all patients.

To get more objective and accurate results in the future, future studies should ensure patient blinding by performing the intervention or block after the induction of GA and using patient-controlled analgesia technique to calculate and accurately compare post-operative analgesia.

Conclusion

The administration of SAP block in patients undergoing MRM under GA delays the need for first analgesic rescue. It improves post-operative pain scores and decreases intra-operative analgesic requirements without any added adverse events.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of All India Institute of Medical Sciences, New Delhi (ref no. IECPG/446/27.07.206, dated 30 August, 2016).

Informed Consent: Written informed consent was obtained from all patients who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – S.B., S.M., N.G., R.G., S,B.; Design – S.B., S.M., N.G., R.G., S.B.; Supervision – S.M., N.G., R.G., S.B.; Resources – S.B., S.M., N.G., R.G., S.T., S.B.; Materials – S.B., S.M., R.G., N.G., S.B.; Data Collection and/or Processing – S.B., S.M., S.V., R.K., N.G., R.G.; Analysis and/or Interpretation – S.B., S.M., R.K., N.G., R.G.; Literature Search – S.B., S.M., S.V.; Writing Manuscript – S.B., S.M., S.V., N.G., R.G.; Critical Review – S.M., N.G., R.G.; Other – S.B., N.G., S.V.

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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. [Crossref]
2. Shapiro FE. Anesthesia for outpatient cosmetic surgery. Curr Opin Anaesthesiol 2008; 21: 704-10. [Crossref]
3. Gärtner R, Jensen MB, Nielsen J, Ewertz M, Kroman N, Kehlet H. Prevalence of and factors associated with persistent pain following breast cancer surgery. JAMA 2009; 302: 1985-92. [Crossref]
4. Arsalani-Zadeh R, ElFadl D, Yassin N, MacFie J. Evidence-based review of enhancing postoperative recovery after breast surgery. Br J Surg 2011; 98: 181-96. [Crossref]
5. Lynch EP, Welch KJ, Carabuena JM, Eberlein TJ. Thoracic epidural anesthesia improves outcome after breast surgery. Ann Surg 1995; 222 :663-9. [Crossref]
6. Naja Z, Lönnqvist PA. Somatic paravertebral nerve blockade. Incidence of failed block and complications. Anaesthesia 2001; 56: 1184-8. [Crossref]
7. 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. [Crossref]
8. Bhoi D, Pushparajan HK, Talawar P, Kumar A, Baidya DK. Serratus anterior plane block for breast surgery in a morbidly obese patient. J Clin Anesth 2016; 33: 500-1. [Crossref]
9. Hards M, Harada A, Neville I, Harwell S, Babar M, Ravalia A, et al. The effect of serratus plane block performed under direct vision on postoperative pain in breast surgery. J Clin Anesth 2016; 34: 427-31. [Crossref]
10. Biswas A, Luginbuehl I, Szabo E, Caldeira-Kulbakas M, Crawford MW, Everett T. Use of Serratus Plane Block for Repair of Coarctation of Aorta: A Report of 3 Cases. Reg Anesth Pain Med 2018; 43: 641-3. [Crossref]
11. Das S, Bhattacharya P, Mandal MC, Mukhopadhyay S, Basu SR, Mandol BK. Multiple-injection thoracic paravertebral block as an alternative to general anaesthesia for elective breast surgeries: A randomised controlled trial. Indian J Anaesth 2012; 56: 27-33. [Crossref]
12. Blanco R, Fajardo M, Parras Maldonado T. Ultrasound description of Pecs II (modified Pecs I): a novel approach to breast surgery. Rev Esp Anestesiol Reanim 2012; 59: 470-5. [Crossref]
13. Sekandarzad MW, van Zundert AAJ, Lirk PB, Doornebal CW, Hollmann MW. Perioperative Anesthesia Care and Tumor Progression. Anesth Analg 2017; 124: 1697-708. [Crossref]
14. Abdallah FW, MacLean D, Madjdpour C, Cil T, Bhatia A, Brull R. Pectoralis and Serratus Fascial Plane Blocks Each Provide Early Analgesic Benefits Following Ambulatory Breast Cancer Surgery: A Retrospective Propensity-Matched Cohort Study. Anesth Analg 2017; 125: 294-302. [Crossref]
15. 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 J Anaesth 2017; 61: 381-6. [Crossref]
16. Yao Y, Li J, Hu H, Xu T, Chen Y. Ultrasound-guided serratus plane block enhances pain relief and quality of recovery after breast cancer surgery: A randomised controlled trial. Eur J Anaesthesiol 2019; 36: 436-41. [Crossref]
17. Abdallah FW, Cil T, MacLean D, Madjdpour C, Escallon J, Semple J, et al. Too Deep or Not Too Deep?: A Propensity-Matched Comparison of the Analgesic Effects of a Superficial Versus Deep Serratus Fascial Plane Block for Ambulatory Breast Cancer Surgery. Reg Anesth Pain Med 2018; 43: 480-7. [Crossref]
18. Miller FG, Kaptchuk TJ. Sham procedures and the ethics of clinical trials. J R Soc Med 2004; 97: 576-8. [Crossref]