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Duration of Analgesia Following Postinduction Thoracic Paravertebral Block vs Pectoral Nerve Block for Modified Radical Mastectomy Under General Anesthesia

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Abstract: ***Background: Modified radical mastectomy (MRM) is commonly performed under general anesthesia (GA), but inadequate postoperative pain management can lead to complications and delayed recovery. Regional anesthesia techniques, such as the thoracic paravertebral block (TPVB) and pectoral nerve block (PECB), have gained popularity for providing effective analgesia. Aim: To compare effect of postinduction TPVB and PECB for MRM under GA in terms of duration of analgesia as the primary objective and severity of pain using VAS score, patient satisfaction and side effects and complication such as hypotension, bradycardia, sedation, pneumothorax vascular puncture, PONV and hematoma as secondary objectives. Methodology: This prospective, randomized intervention study was conducted in 52 female patients scheduled for MRM under GA. Patients were randomly assigned to receive either TPVB (Group 1) or PECB (Group 2) preoperatively. Both the groups received 30 ml bupivacaine 0.25% along with dexmedetomidine 1µgm/kg. Postoperatively patient was kept in HDU. VAS was measured 2 hourly for 24 hours from the time of administration of block. Result: TPVB has longer mean duration of analgesia as compared to PEC block (1763.5±24.65 vs 1670.3±28.44 minutes) but patient's satisfaction score was higher in PECB (4.32±0.47 vs 4.12±0.33; p=0.416). Though, the difference was statistically not significant. There was no significant difference between mean VAS score of both groups at all-time interval (p>0.05). Throughout the study duration VAS score remained below 3. Conclusion: From our study it was concluded that both TPVB and PEC block are equally effective for postoperative analgesia in MRM as duration of analgesia and patient satisfaction score were statistically comparable with no side effects.***

Keywords: Bupivacaine, Thoracic Paravertebral block, Pec block.

1. Introduction

Breast cancer is the second most frequent form of cancer encountered in both males and females. In 2022, there were 2.3 million women diagnosed with breast cancer and nearly 60% of breast surgery patients experience severe acute post-operative pain, nausea, vomiting, and painful restricted upper limb movements. Acute post-operative pain following modified radical mastectomy (MRM) is not only incapacitating for the patient, but is also a significant risk factor for the development of persistent chronic pain. Regional analgesia techniques like thoracic paravertebral block (TPVB), pectoral block (PECB), serratus anterior block, erector spinae block, rhomboid intercostal nerve block and local infiltration improves acute postoperative pain, reduce the incidence of post-operative nausea and vomiting, associated complications and postoperative analgesic consumption. In TPVB, local anesthetic is injected alongside the thoracic vertebral body close to where the spinal nerves emerge from the intervertebral foramen and in PECS 1 and 2 block, between the fascial plane to provide an analgesic effect by blocking nociceptive transmission from the peripheral to the central nervous system. PECB I is given between pectoralis minor and major to block medial and lateral pectoral nerves and PECB II between pectoralis minor and serratus anterior muscle to block lateral branches of intercostal nerves which innervate skin from T2 to T6. Thus, this study was conducted to compare the duration of analgesia following postinduction TPVB and PECB in patient undergoing MRM under general anaesthesia (GA).

2. Methodology

This randomized prospective single-blind interventional study was conducted between April 2023 and April 2024 in a government medical college after approval from Institutional Scientific Committee and Ethics Committee.

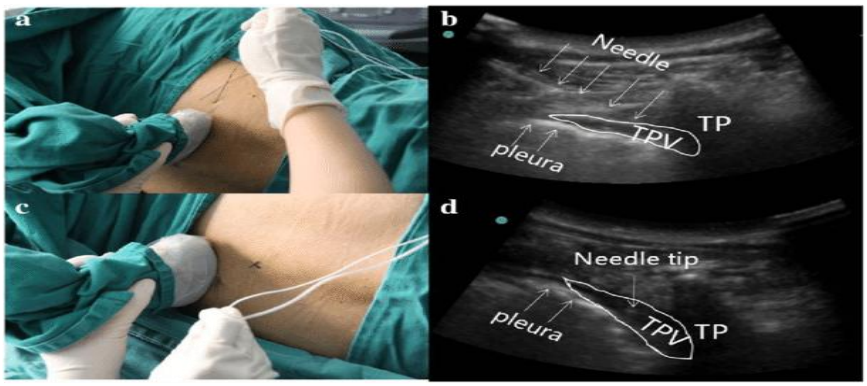
Fifty-two participants out of fifty- eight patients screened between 30 - 60 years age belonging to ASA grade II-III undergoing MRM for breast cancer under GA were included in the study. The exclusion criteria comprised local skin infections, patient's refusal, spine or chest deformity, psychiatry disorders, pregnancy, patients with allergy to study drug, patients on drug acting on alpha receptors, antipshychotics and analgesics. Eligible participants were randomly allocated into two groups using a closed envelope technique (n=26). Group 1 (TPVB) received USG guided thoracic paravertebral block at the level of 4th thoracic vertebra. Group 2 (PECB) received USG guided PEC block. Both the groups received 30ml bupivacaine 0.25% with dexmedetomidine 1µgm/kg. In PECB, 10ml was injected for PEC I and 20ml was injected for PECII.

Sample size was calculated based on the pilot study with duration of analgesia (primary objective) which was 243.1 min in group 1(TPV Block) and 324.8 min in group 2(PEC Block). Assuming a 5% level of significance, 80% power, and 0.8 effect size. The minimum required sample size was 26 in each group. So, the total sample size considered for the study was 52. Confounding variables in our study was: Patient`s subjective perception to pain and Patients with neuropathy.

During the preoperative visit, the day before the surgery patient was explained about the study and briefed about visual analogue scale (VAS). On arrival to the operation theater, baseline heart rate, blood pressure and oxygen saturation were recorded. Written informed consent was reviewed, intravenous line was secured and iv fluid was started. Premedication was done with iv midazolam 0.02 mg/kg, iv glycopyrrolate 0.01 mg/kg and iv fentanyl 1.5 mcg/kg. after preoxygenation with 100% oxygen for 3 mins, induction was carried out with iv propofol 2mg/kg till loss of verbal response, iv rocuronium 0.6 mg/kg was given to facilitate tracheal intubation. After 90 seconds, laryngoscopy was performed and tracheal intubation done. General anesthesia was maintained with isoflurane, nitrous oxide in oxygen (60:40) and iv rocuronium 0.1mg/kg. Commencement of ultrasound guided block was thereafter done and study drug was administered as per the group assigned.

Technique of USG Guided Paravertebral Block

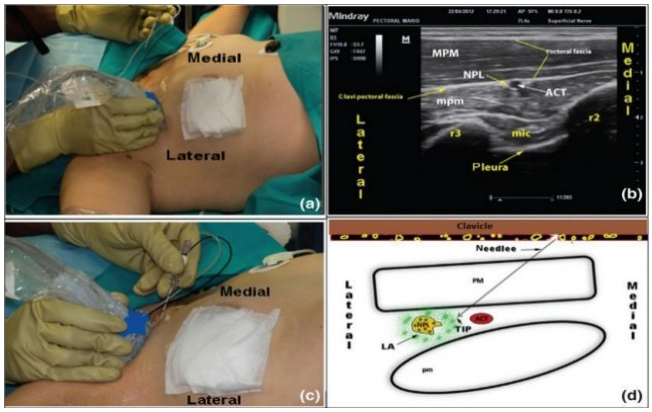
After aseptic preparation of the skin and the probe, the probe was placed on the rib at the level of 4th thoracic vertebra with the medial edge of probe in contact with the spinous process, so that the horizontal view of the rib was visualized as a hyperechoic line with posterior acoustic shadowing. The probe was then moved caudally into the intercostal space between adjacent ribs. The inferior part of transverse process was visualized as a hyperechoic convex line with posterior acoustic shadowing. The apex of thoracic paravertebral space (TPVS) was visualized as a wedge-shaped hypoechoic space surrounded by the hyperechoic line of the pleura below and the internal intercostal membrane above. The apex of TPVS was laterally continuous with the intercostal space. The internal intercostal ligament was medially continuous with the superior costotransverse membrane; these two membranes cannot be distinguished by ultrasonography. A 20-gauge Tuohy needle was inserted in a lateral-to medial direction from the outer edge of probe with the bevel facing the probe using an in-plane approach and advanced until the needle tip penetrates through the internal intercostal membrane. After a negative aspiration test for blood, study drug was injected into the TPVS slowly. The pleura was seen being pressed ventrally during local anesthetic injection.



Techniques Of USG Guided PEC Block

The PEC I block was performed with the patient supine and arm by the side. The coracoid process was located on ultrasound in the paramedian sagittal plane. The caudal border of the transducer was rotated laterally to allow for an in-plane needle trajectory. This rotation allowed for visualization of the pectoral branch of the thoracoacromial artery. The correct interfascial plane was confirmed by the opening of the space between the pectoralis major and pectoralis minor and then 10 ml study drug was injected. For PEC II block transducer was placed at the midclavicular line and angled inferolaterally to visualize the axillary artery, axillary vein, and second rib. The transducer was then moved laterally until the pectoralis minor muscle, and serratus anterior muscle were identified. The transducer was then moved further laterally toward the third and fourth rib. Then 20 ml of study drug was deposited in between the pectoralis minor and serratus anterior plane.

After completion of surgery reversal was done with iv glycopyrrolate 0.01mg/kg and iv neostigmine 0.05mg/kg. Trachea was extubated after thorough oral suctioning and patients were shifted to High dependency unit (HDU) for observation. HR, SBP, DBP, MAP, SpO_2, RR were recorded before induction of GA then at every 5 mins till 30 min. then at 45 min, 60 min and 120 min. VAS monitoring 2 hourly for 24 hours from the time of administration of block and recorded with a single handwritten mark placed at one point along the length of a 10 cm line that represents a continuum between the two ends of the scale- “no pain” on the left end (0 cm) of the scale and the “worst pain” on the right end of the scale (10 cm). When VAS ≥4 or when patient request for analgesic whichever was earliest then IV paracetamol 1gm was used as rescue analgesia. Duration of analgesia was considered as the time from administration of the study drug to the time to the first analgesic request by the patient. Failure of block was defined as the number of patients who had partial blocks or failed blocks (with VAS scores >8 at 0 minute). These patients were analyzed at 0 hour but excluded from further analysis because they received alternative mode of analgesia. Patient Satisfaction score was calculated using Likert’s scale ranging from 1-5 (1=very dissatisfied, 2=dissatisfied, 3=neither satisfied/dissatisfied, 4=satisfied and 5=very satisfied) at 24 hour postoperatively.



Statistical Analysis: The sample size was calculated by the mean difference in duration of analgesia in the two groups, i.e., 243.1 min in group 1(TPV Block) and 324.8 min in group 2(PEC Block) which was the primary objective of our study.

The sample size for two means (Groups):
$Z_1 - \beta = 0.84$ at 80% Power of the test. =0
N_1= Mean of the duration of analgesia in group 1
N_2 =The mean of duration of analgesia in group 2
σ_1= The standard deviation of the duration of analgesia in group 1
σ_2= The standard deviation of the duration of analgesia in group 2
r = ratio of Sample size =1

$$\mathbf{n} = \frac{\left(Z_1 - \frac{\alpha}{2} + Z_1 - \beta\right)^2 (\sigma_1^2 + \sigma_2^2)}{r(N_1 - N_2)^2}$$

$$= \frac{(1.96 + 0.84)^2 (1172.6^2 + 73.95^2)}{1(243.1 - 324.8)^2}$$

$$= \frac{7.84 * 1380495.363}{4436078.4}$$

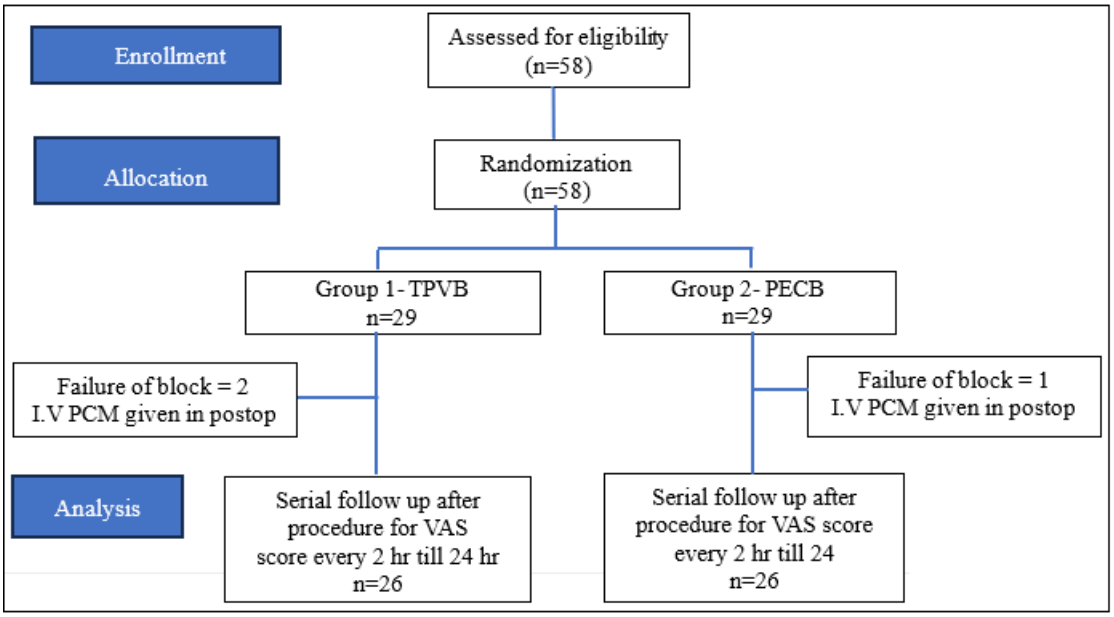
$$= 2.34$$

The sample size was calculated using G*power software v.3.1.9.7. statistical test for the difference between two independent means (two groups) was used. Assuming a 5% level of significance,80% power, and 0.8 effect size. The minimum required sample size was 26 in each group. So, the total sample size considered for the study was 52

3. Result

A total of 58 patients were screened and enrolled in the study, but three patients from each group were excluded from the study because of block failure (2 patients in TPV group and 1 patient in PEC group) and mistakenly I.V paracetamol was given by staff nurse as a routine (1 patient in TPVB and 2 patients in PECB group). Overall, the data of 26 patients in each group were analyzed. (Consort Diagram1)

Consort Diagram



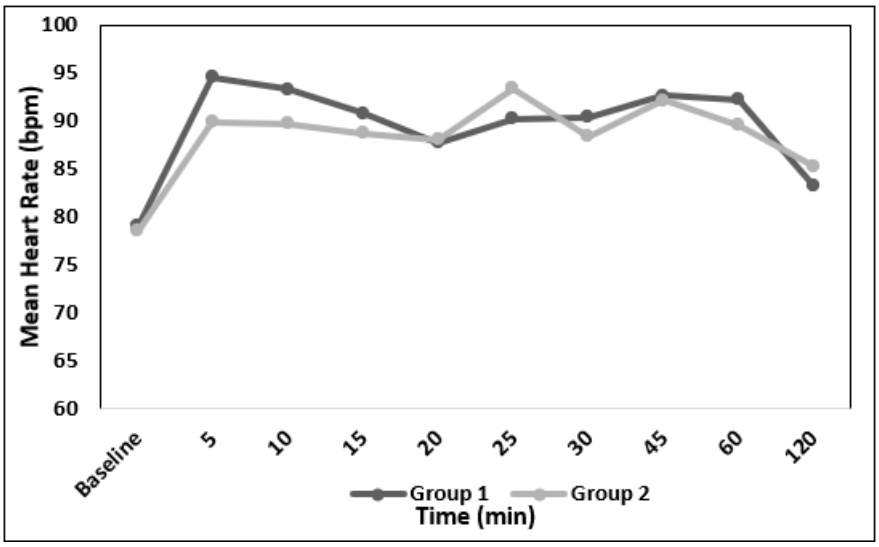
- The primary outcome variable of our study is duration of analgesia was considered as the time from administration of the study drug to the time to the first analgesic request by the patient.
- Secondary outcome variables are PSS at the 2,4,6,8 and 24 hours postoperatively and side effects such as hypotension, sedation, bradycardia, pneumothorax, hematoma, nerve injury and hypoxia.

The Demographic profile, ASA grade and Duration of Surgery in both the groups were comparable (Table 1)

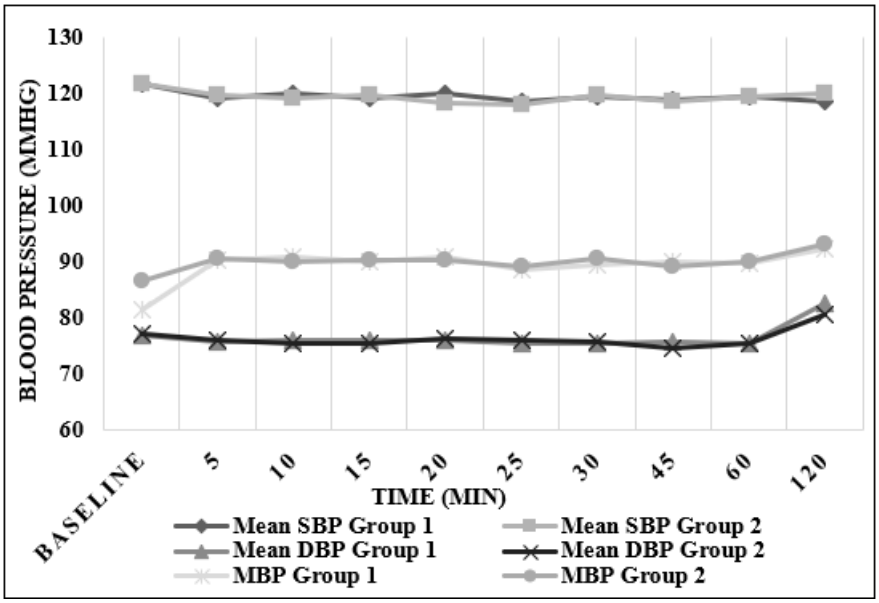
Table 1: Demographic Profile

Parameters	Group 1	Group 2	p value
Age (years)	45.2 ± 9.02	47.0 ± 9.65	0.546
Weight (kg)	52.0±8.10	51.8±6.34	0.25
Height (meter)	1.5±0.08	1.5±0.07	0.57
BMI (kg/m²)	22.8±4.13	21.8±3.77	0.24

Hemodynamic parameters such as heart rate, systolic blood pressure, diastolic blood pressure and mean arterial pressure in both the groups were comparable (Graph 1 and Graph 2)

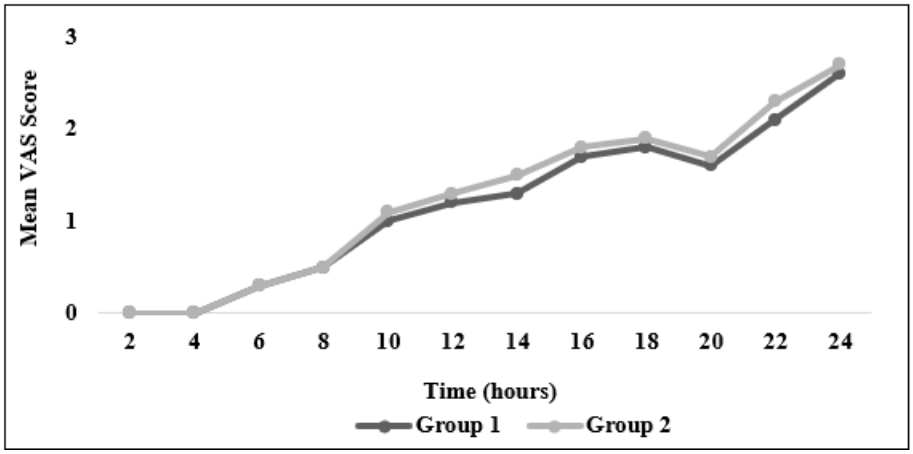


Graph 1: Mean Heart Rate (bpm)



Graph 2: Mean SBP, DBP and MBP

Graph 3 show the mean VAS score of the patients of group 1 and group 2 at 2hr,4hr,6hr, 8hr, 10hr, 12hr, 14hr, 16hr, 18hr, 20hr, 22hr and 24 hr postoperatively. There was no significant difference between mean VAS score of both group 1 and group 2 at all time interval ($p>0.05$)



Graph 3: Mean VAS Score

Table 2 shows Mean Patient Satisfaction Score and Mean duration of Analgesia in both the groups and the difference of which was statistically not significant (p >0.05).

Table 2: Mean Patient Satisfaction Score and Mean duration of Analgesia

Parameter	Group 1 (mean± SD)	Group 2 (mean± SD)	p value
Patient Satisfaction Score	4.30±0.47	4.12±0.33	0.416
Duration of analgesia	1763.5±24.65 min	1670.3±28.44 min	0.252

4. Discussion

In our study it was seen that mean duration of analgesia for PVB block (1763.5±24.65) was higher as compared to PEC block (1670.3±28.44) minutes but was not statistically significant (p = 0.252). While both techniques were effective, the difference in mean PSS was comparable (p >0.05). None of the group shows incidence of side effects and complications due to block and drugs such as bradycardia, hypotension, sedation, pneumothorax, PONV and vascular puncture in either group.

We aimed to compare the effectiveness of paravertebral block (PVB) and pectoral nerve block (PEC) using a combination of bupivacaine and dexmedetomidine for postoperative pain relief in patients undergoing Modified Radical Mastectomy (MRM) under general anesthesia. Effective management of acute postoperative pain is crucial, as inadequate control can lead not only to immediate discomfort but also to long-term issues such as chronic pain syndromes. Conditions like paresthesia, phantom breast pain, and intercostobrachial neuralgia are particularly prevalent, affecting 25%–40% of patients following breast surgery.

This aligns with Mazy et al., who also reported prolonged analgesia in both TPVB and STSA groups, though their duration was shorter than ours due to their method of administering the study drug in two divided doses at T2 and T4 levels, whereas we administered the drug at a single T4 level.

Similarly, Mahran et al. noted a delayed need for the first dose of analgesic, as they used a 22-gauge peripheral catheter and administered 5 mL/hour of 0.125% levobupivacaine along with a 20 mL bolus of 0.25% levobupivacaine. In contrast, our study used a single dose of 30 mL of 0.25% bupivacaine combined with dexmedetomidine. Wahba SS et al. and Kulhari et al. observed a longer duration of analgesia with TPVB compared to PEC, potentially due to their administration of TPVB in the sitting position, while our study used the lateral decubitus position, potentially influencing drug spread. Additionally, the volume and type of anesthetic used varied, with Wahba SS et al. utilizing 20 mL of levobupivacaine and Kulhari et al. using 30 mL of bupivacaine for PEC and 15–20 mL for TPVB.

Mohamed SA et al. also reported prolonged analgesia, though shorter than in our study, likely due to their administration of 20 mL of 0.25% bupivacaine paravertebrally, divided between T1–T6 levels, unlike our single 30 mL injection at T4. Mahdy EW et al. (PEC) and Mahran E et al. (TPVB) also observed extended analgesia durations, albeit shorter than ours, as they used 25 mL of 0.25% plain bupivacaine, whereas we added 1 µg of dexmedetomidine to 30 mL of 0.25% bupivacaine. Studies by Wahba SS et al., Mohamed SA et al., and Kulhari S et al. showed shorter analgesia durations compared to our findings, likely due to the use of plain local anesthetics instead of the addition of dexmedetomidine as an adjuvant. Similarly, Amin SRM et al. found prolonged analgesia in TPVB with plain bupivacaine (20 ± 3 hours), but still less than our study due to our use of dexmedetomidine. Regarding surgical duration, Tripathy S et al. reported a shorter mean duration than our study. Consistent with studies by Wahba SS et al., Tripathy S et al., and Mazy A et al., we also observed high patient satisfaction scores in both groups. This reflects the effective pain management achieved by the prolonged analgesic effect of the bupivacaine and dexmedetomidine combination, highlighting the importance of prioritizing patient comfort and preferences in selecting analgesic techniques.

VAS scores in our study were also in line with those reported by Mohamed SA et al., who observed VAS scores of 2–3 at rest (VAS.R) in the TPVB group (0.25% 20 mL bupivacaine + 1 µg/kg dexmedetomidine) over 48 hours. However, Elewa AM et al. reported a higher median VAS score (6 [IQR 5–7]) at 8, 12, and 24 hours in the PVB group, likely due to their use of plain bupivacaine (0.25% 30 mL) without dexmedetomidine, underscoring the advantage of the adjuvant in our study.The safety profile of both PVB and PEC techniques was also favorable in our study, with no significant side effects or complications, including hypotension, bradycardia, sedation, postoperative nausea and vomiting (PONV), vascular puncture, or pneumothorax. This reinforces the safety of combining bupivacaine with dexmedetomidine for these blocks.

However, our study has some limitations that must be acknowledged. The small sample size (n=26) limits the generalizability of our findings to broader populations. Additionally, subjective measures such as VAS scores, responses to the ODI questionnaire, and patient satisfaction scores introduce variability due to individual interpretation. Future research should address these limitations by including larger and more diverse samples, extending follow-up periods, and focusing on patient-centered functional and satisfaction outcomes to strengthen the evidence base and enhance the applicability of results.

5. Conclusion

Paravertebral and pectoral nerve block with dexmedetomidine as an adjuvant to bupivacaine provide comparable duration of analgesia, patient satisfaction and pain severity without any side effects and complications in patients undergoing Modified Radical Mastectomy. Thus, either PVB or PEC block can be chosen based on the clinical context, patient preference, and the anesthesiologist's expertise.

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Conflicts of interest: None

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