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Research Article

# EFFICACY OF THORACIC SEGMENTAL SPINAL ANESTHESIA ALONG WITH UNILATERAL ERECTOR SPINAE BLOCK IN PATIENTS UNDERGOING UNILATERAL MODIFIED RADICAL MASTECTOMY AND AXILLARY DISSECTION: A NOVEL MULTICENTRIC STUDY

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**ABSTRACT**

**Objectives:** The aim of the study was to find out the efficacy of thoracic segmental spinal anesthesia combined with unilateral erector spinae block in patients undergoing unilateral modified radical mastectomy and axillary lymph node dissection

**Methods:** This was a prospective cohort study in which 40 patients with carcinoma breast undergoing modified radical mastectomy with axillary dissection under thoracic segmental spinal anesthesia combined with unilateral erector spinae block were included on the basis of a predefined inclusion and exclusion criteria. Erector spinae plane block was given at T5 level and thoracic spinal anesthesia was then given at T5–T6 level in the same position by median or paramedian technique. Patients were assessed for severity of pain by visual analog scale score till 24 h of surgery.

**Results:** The mean age of studied cases was found to be 44.12±10.04 years. Mean weight of studied cases was 54.38±9.8 kg, whereas mean duration of surgery was found to be 98.24±16.86 min. The most common American Society of Anesthesiologists (ASA) grade to which patients belonged was found to be ASA III (55%) followed by ASA II (30%) and ASA I (15%). Eleven patients required rescue analgesia within first 24 h after surgery and mean doses of rescue analgesia in 1st 24 h after surgery was found to be 0.92±0.48. Four (10%) patients developed hypotension, whereas three (7.5%) patients had bradycardia. However, all these 7 (17.5%) had transient bradycardia or hypotension which could be managed by IV Atropine or IV mephentermine and fluid bolus.

**Conclusion:** Thoracic segmental spinal anesthesia combined with unilateral erector spinae block is an excellent option for patients undergoing modified radical mastectomy with axillary dissection.

**Keywords:** Thoracic segmental spinal, Erector spinae block, Modified radical mastectomy, Visual analog score.

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## INTRODUCTION

Breast cancer is a significant public health concern globally, with an increasing incidence and mortality rates in many countries. The incidence of breast cancer is rising due to the factors such as aging populations, changes in reproductive patterns, lifestyle changes, and improved detection and diagnosis [1]. In India, breast cancer is the most common cancer among women, with a higher incidence in urban areas than in rural areas. With advances in imaging techniques, more and more cases of carcinoma breast are being diagnosed at an early stage. In India, breast cancer is one of the most common malignancies encountered in females with a reported incidence of 25.8/100,000 women and mortality 12.7/100,000 women [2].

Approximately, 40–60% of breast surgery patients endure severe acute post-operative pain, with over 10% of patients experiencing severe pain for 6–12 months (post mastectomy pain syndrome). Intraoperative and post-operative pain is usually managed by opioids but are usually linked with adverse effects including prolonged sedation, respiratory depression, and post-operative nausea and vomiting (PONV) [3,4].

All these surgeries can be safely performed under general anesthesia (GA); however, in a small subset of patients, in whom surgical procedure under GA poses an unacceptably high risk of complications that regional anesthetic techniques may offer a safer alternative to GA [5]. The drawbacks of GA include, but not limited to, inadequate pain control due to a lack of residual analgesia, high incidence of nausea and vomiting, and increasing the length of hospitalization [6]. Increasing hospital costs have focused attention on reducing the length of hospital stay for these patients. However, the side-effects and complications of GA preclude ambulatory surgery for most patients undergoing breast surgery [7].

Subarachnoid block can be performed at any of the thoracic and lumbar spinal levels, but is considered safer if it is performed below the termination of the spinal cord to avoid iatrogenic injury to the cord itself. Thoracic segmental spinal anesthesia has been described in several groups of patients, for example, laparoscopic cholecystectomy, abdominal cancer, breast cancer surgeries, and other procedures [8].

Thoracic segmental spinal anesthesia in combination with same sided erector spinae plane block (ESPB) for post-operative analgesia is a novel anesthetic technique which is being used for various surgeries including breast cancer surgeries such as modified radical mastectomy [9]. In patients, where there is increased risk of complications of GA such as patients with hemodynamic instability, thoracic segmental spinal anesthesia also has an added advantage of improved quality of post-operative analgesia, lower incidence of nausea and vomiting, and shorter recovery time. However, there is a minimal risk of hypotension or bradycardia as is common with any spinal anesthesia [10]. Paresthesia can occur with any spinal technique and peripheral blocks. Furthermore, the erector spinae block provides the advantage of an excellent analgesia by covering both the visceral and somatic pain and an added benefit of a single prick for the targeted dermatomes as the drug spreads in a craniocaudal fashion. It offers advantage over the paravertebral block by eliminating the disadvantage of multiple pricks for every dermatome in a patient of breast cancer.

## METHODS

This was a prospective cohort study in which 40 patients with carcinoma breast undergoing modified radical mastectomy with axillary dissection under thoracic segmental spinal anesthesia combined with unilateral erector spinae block were included on the basis of a predefined inclusion and exclusion criteria. The study was a multicentric study and was conducted in tertiary care hospitals of Amravati, Maharashtra. All patients' pre-operative evaluation done with informed consent about thoracic spinal anesthesia in detail and was also informed about the probability of conversion to GA, if needed.

Laboratory investigations such as CBC, LFT, RFT, RBS, PT/INR, ECG, and CXR were done. After reviewing all the reports, patients were shifted to operating room. Emergency crash cart along with preparation for GA as a backup plan was kept ready.

Sample size calculation was calculated on the basis of pilot studies done for patients undergoing modified radical mastectomy under thoracic segmental spinal anesthesia. Keeping power (1-Beta error) at 80% and confidence interval (1-alpha error) at 95%, the minimum sample size required was 35 patients; therefore, we included 40 patients in this study.

Standard American Society of Anesthesiologists (ASA) monitors were attached – ECG, NIBP, SPO2, and IV access on the opposite arm taken. ESPB was given at T5 level using 20 mL 0.5% levobupivacaine (plain isobaric) on the side to be operated (using 23 g spinal needle). Thoracic spinal anesthesia was then given in the same position (sitting/lateral) by median or paramedian technique using 26 g spinal needle at T5– T6 level with Inj. levobupivacaine 0.5% (isobaric preservative free) 1.2–1.3 mL+ 3 ug dexmedetomidine (Patients with no known cardiovascular risk factors) or fentanyl (Patients with known cardiovascular risk factors) 20 ug. The incremental advancement of the needle was slow. The patient did not complain of any paresthesia during needle advancement and after observing free flow of cerebrospinal fluid (CSF) through the needle hub, drugs for spinal anesthesia were administered, and patient was made supine. The onset of action was within 5 min, complete surgical anesthesia in 10 min. The effect of the block was assessed with a pinprick, and a segmental sensory block extending from C6 to T8 was achieved without any respiratory compromise. After testing the quality of anesthesia (adequate sensory block to pin prick from the lower border of the clavicle to the inferior costal margin), the surgery was initiated. If the sensory block was inadequate after 15 min, the patient was given GA. Hemodynamic parameters, oxygen saturation, and respiratory rate were recorded on admission to the operating theater, then every 5 min till end of surgery.

Patient was able to move her legs when asked to do so. Hand grip and voluntary deep breathing was checked intermittently which was found adequate throughout and she maintained saturation of 98–99% during the surgery. Intraoperative hemodynamic were stable if intraoperative, hypotension or significant bradycardia, occurred treated with IV mephentermine or IV atropine, respectively.

Patient responded to vocal command and remained comfortable during the entire procedure. Surgery was completed in 2–2.5 h and the patient was shifted to the post-operative care unit with stable vitals. In the post-operative period, vitals were monitored, and the patient was followed up for any neurologic deficit or any other complaint till the discharge from the hospital.

If patient experienced any kind of anxiety, discomfort or pain during surgery, intravenous sedation with dexmedetomidine 0.5 ug/kg, and ketamine 1 mg/kg was given as titrated doses.

Severity of pain was assessed by visual analog scale (VAS) score at 1, 6, 12, and 24 h after surgery. Rescue analgesia was given with IV tramadol 50 mg or IV diclofenac 75 mg, or IV paracetamol 1 g if VAS score was 4 or above. Hemodynamic status and first request of analgesia was noted. Side effects such as hypotension, bradycardia, shivering, nausea, and vomiting were also noted. Patients were mobilized after 6 h; patient's satisfaction was assessed.

Statistical analysis was performed with SPSS version 22. Microsoft word and excel were used to create suitable tables and graphs whenever necessary. Quantitative data were presented with the help of mean and standard deviation (SD). Qualitative data were presented with frequency and percentage tables. For quantitative data, unpaired t-test was applied and for qualitative data Chi-square test was applied.

### Inclusion criteria

The following criteria were included in the study:

1. Patients undergoing modified radical mastectomy with axillary dissection
2. Age between 18 and 70 years
3. ASA Grade I to III.

### Exclusion criteria

The following criteria were excluded from the study:

1. Patients refused thoracic spinal anesthesia
2. Thrombocytopenia or coagulopathy
3. Local site infections
4. Spinal or chest wall deformity
5. Allergic to local anesthetics
6. Patients in whom conversion to GA was required.

## RESULTS

The mean age of studied cases was found to be 44.12±10.04 years. The analysis of the patients on the basis of weight and duration of surgery showed that the mean weight of studied cases was 54.38±9.8 kg, whereas mean duration of surgery was found to be 98.24±16.86 min (Table 1).

The most common ASA grade to which patients belonged was found to be ASA III (55%) followed by ASA II (30%) and ASA I (15%) (Table 2).

The analysis of patients for severity of pain in post-operative period showed that in most of the cases, pain was tolerable. At 1 h, the mean VAS score was found to be 1.54±0.98. At 8 and 24 h after surgery, the mean VAS score was found to be 1.92±0.96 and 1.64±0.80, respectively. Eleven patients required rescue analgesia within first 24 h after surgery and mean doses of rescue analgesia in 1$^{st}$ 24 h after surgery was found to be 0.92±0.48 (Table 3).

The analysis of patients on the basis of hemodynamic parameters showed that the mean heart rate as well as systolic and diastolic blood pressures were within normal limits immediately postoperatively and till first 24 h after surgery. Similarly, mean respiratory rate and SPo2 also remained within normal limits. Four (10%) patients developed hypotension whereas 3 (7.5%) patients had bradycardia (Figs. 1-4).

The analysis of patients on the basis of adverse effects showed that out of 40 patients, 28 (70%) patients had no adverse effects during or after surgery up to 24 h. Four (10%) patients developed post-operative nausea and vomiting that could be controlled by single dose of ondansetron (4 mg intravenously). Four (10%) developed hypotension whereas 3 (7.5%) patients had significant bradycardia. One (2.5%) patient developed high cervical block (C4 level) manifesting as aphonia, desaturation, hypotension, and hypoventilation which were managed with reassurance, IV fluids, IV mephentermine IV atropine, and mask ventilation with 100% oxygen (Fig. 5).

## DISCUSSION

Segmental spinal anesthesia was described in 1909, with puncture in T2 for surgeries on the head, neck, upper limbs, and thorax, puncture between the T12 and L1 vertebrae for lower abdomen and lower limb surgeries [11]. Since the performance of the first thoracic spinal

**Table 1: Mean weight and duration of surgery in studied cases**

| Mean weight and duration of surgery | |
|---|---|
| Mean age | 44.12±10.04 years |
| Mean weight | 54.38±9.8 kg |
| Mean duration of surgery | 98.24±16.86 min |

**Table 2: ASA grades of studied cases**

| ASA grade | Number of cases | Percentage |
|---|---|---|
| Grade I | 6 | 15 |
| Grade II | 12 | 30 |
| Grade III | 22 | 22 |
| Total | | |

ASA: American Society of Anesthesiologists

**Table 3: VAS score and analgesic requirement of studied cases**

| VAS score and analgesic requirement of patients | | Cases (Group BD) |
|---|---|---|
| Mean VAS score | 1 h | 1.54±0.98 |
| | 4 h | 2.64±1.78 |
| | 8 h | 1.92±0.96 |
| | 12 h | 3.86±1.34 |
| | 18 h | 1.90±0.92 |
| | 24 h | 1.64±0.80 |
| Number of patients requiring rescue analgesia within 24 h | | 11 |
| Mean doses of rescue analgesia in 1st 24 h | | 0.92±0.48 |

VAS: Visual analog scale

anesthetic (TSA) in early 1908 by Thomas Jonnesco in Romania, many anesthetists started using it around the world as an alternative anesthetic technique for numerous surgical procedures where GA posed a higher risk to the patient [12-14].

Imbelloni *et al.* investigated anatomy of the thoracic spinal by magnetic resonance imaging (MRI) in 50 patients. The space between the dura mater and spinal cord in the thoracic region measured with MRI was 5.19 mm at T2, 7.75 mm at T5, and 5.88 mm at T10. The angle of entry between T5 and T6 (almost 50°) elongated the distance from the tip of the needle to the posterior surface of the cord. MRI confirmed that the spinal cord and the cauda equina were touching the dura mater posteriorly in the lumbar region and anteriorly in the thoracic region. This position increases the distance to a point that allows needle advancement without touching the cord, such as in the case of accidental perforation of the dura mater during the administration of spinal anesthesia [8].

A study of 300 patients undergoing thoracic spinal puncture reported a 6.6% incidence of paresthesia without neurological sequelae almost half the incidence (12%) with lumbar puncture. This can be an explanation for the low incidence of neurologic complications [8,15].

Modified radical mastectomy is common surgical procedures performed in breast cancer among women. In patients having cardiovascular morbidity, regional anesthetic techniques are preferred over GA. Thoracic segmental spinal anesthesia combined with unilateral erector spinae block is an alternative to GA in patients undergoing modified radical mastectomy [16].

Conventionally, trained anesthesiologists often afraid to perform spinal anesthesia above the termination of the spinal cord due to fear of injuring the spinal cord from the needle tip. TSA offers a feasible alternative in patients who are at high risk of perioperative morbidity and mortality under GA, with particular reference to older patients who have reduced physiological reserve and multiple comorbidities [17]. Spinal anesthesia has several advantages compared with GA like better intraoperative and post-operative pain control [18], earlier recovery of gastrointestinal function [19], less PONV, earlier ambulation and discharge from hospital [20], a lower incidence of deep vein thrombosis lower surgical site infection rates [21], reduced need for blood transfusions, and reduced costs [22].

There are a number of advantages of thoracic segmental spinal anesthesia. The most obvious advantage is that there is no blockade of the lower extremities, that is, little caudal spread. This means that a significantly larger portion of the body experiences no venal dilation and may offer a compensatory buffer to adverse changes in blood pressure intraoperatively. This is one of the major risks identified in surgery. Furthermore, the dose of the spinal anesthesia drug is exceedingly low, given the highly specific block to only certain nerve functions along a section of the cord [23]. The degree of muscle relaxation achievable without central or peripheral respiratory or circulatory depression is superior to that with GA. In addition, the danger of cardiac arrest is much diminished [24].

Neuraxial anesthesia can inhibit the neuroendocrine stress response, and patients who receive regional analgesia have lower opioid requirements. It can reduce opioid requirements after breast surgery. Opioids may themselves inhibit cell-mediated immunity and host anti-tumor defenses. Because it negatively affects patients' daily lives, methods to prevent and reduce chronic pain and its severity should be developed. The segmental thoracic spinal showed some advantages over GA for the treatment of breast cancer [25].

In a study, segmental spinal anesthesia performed for laparoscopic cholecystectomy at T10 level in 20 patients was evaluated where upper sensory block level obtained was T2–T4 with minimal hemodynamic changes and no respiratory complications. The amount of CSF in the thoracic spinal segment is comparatively less as in lumbar and cervical segment and the thoracic nerve roots are thinner as compared to the lower or upper ones, there is lesser dilution of the anesthetic drug and the dose required per segment is much less [26]. The nerve roots are easily blocked due to their smaller diameter. Both these factors contributing to a good block with lesser amounts of LA used. One of the studies comparing conventional doses of hyperbaric bupivacaine at lumbar level with half the dose in the thoracic injection, highlighted the onset time to reach T-3 level is reduced with the latter. With the thoracic injection, the incidence of hypotension was less, and capability to move themselves to the transport trolley (stretcher) was an added advantage as the duration of motor and sensory block was significantly shorter with the smaller dose and thoracic approach. Patients offered that this technique must be assessed very carefully managed by anesthetists with considerable experience. There is no single esthetic technique which fits all patient for all surgery, but what is described here is an option to expand the concept of regional anesthesia by performing spinal anesthesia in the thoracic region with high patient satisfaction and of proven safety which offers greater advantages in certain high-risk patients [27].

Singh *et al.* conducted a study to evaluate the post-operative analgesic effect of ultrasound-guided erector spinae plane (US-guided ESP) block for modified radical mastectomy (MRM) surgery [16]. The study found that post-operative morphine consumption was found to be significantly less in patients receiving US-guided ESP block compared to control group (1.95±2.01 mg required in ESP group vs. 9.3±2.36 mg required in control group, p=0.01). All the patients in control group required supplemental morphine postoperatively compared to only two patients requiring that in US-guided ESP block group (p<0.01). On the basis of these findings, the authors concluded that US-guided ESP block when given before MRM surgery provided effective post-operative analgesia. Similar findings were also reported by the authors such as Mazy *et al.* [28] and Premachandra *et al.* [29]. Out of 40 patients, 28 (70%) patients had no adverse effects during or after surgery up

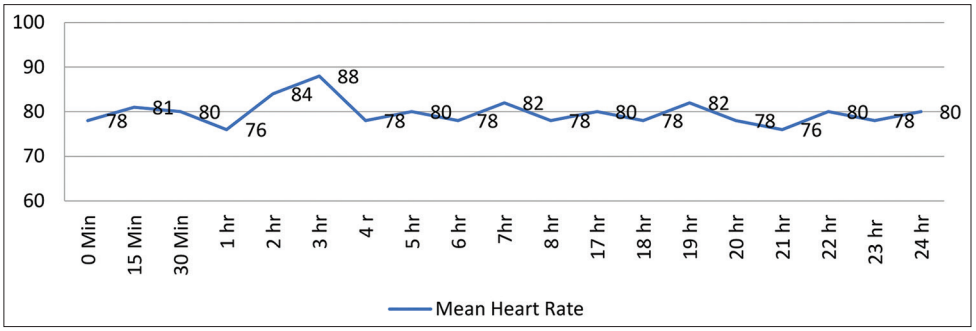


**Fig. 1: Mean heart rate in studied cases up to 24 h postoperatively**

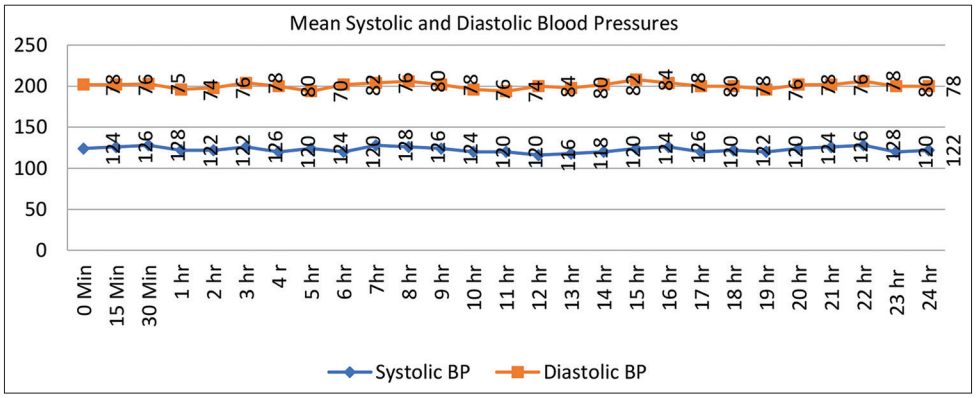


**Fig. 2: Mean blood pressure in studied cases up to 24 h postoperatively**

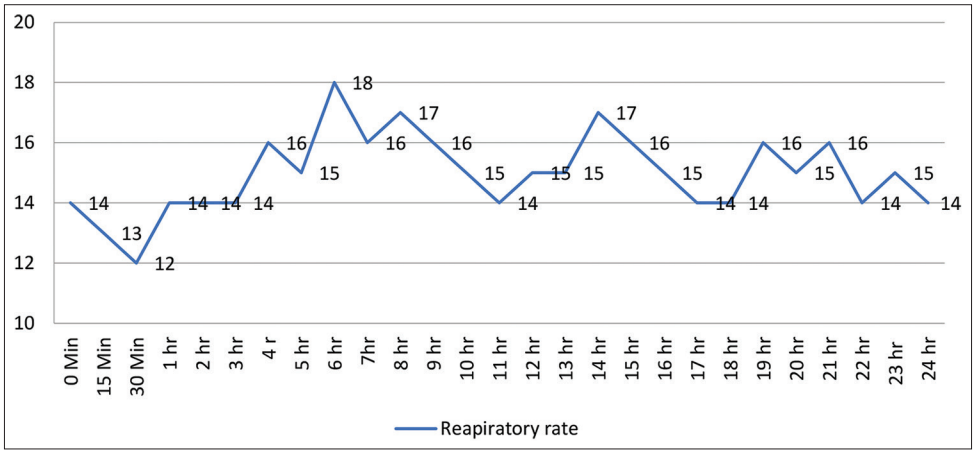


**Fig. 3: Mean respiratory rate in studied cases up to 24 h postoperatively**

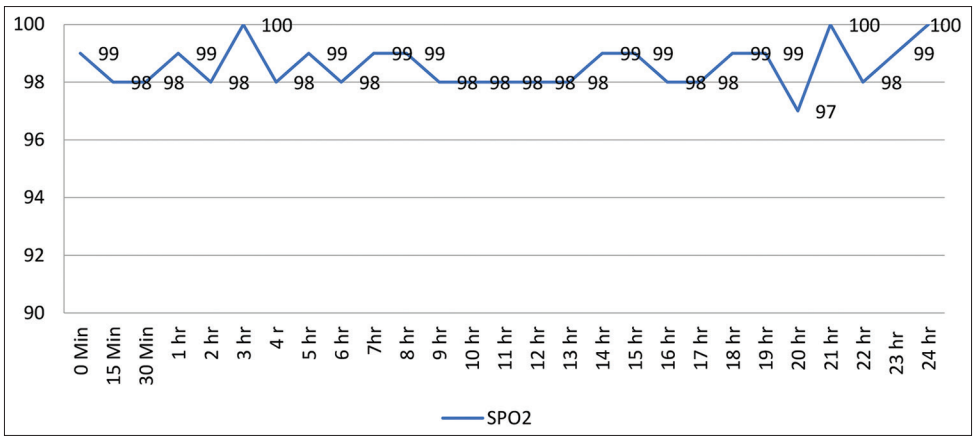


**Fig. 4: Mean SPO2 values in studied cases up to 24 h postoperatively**

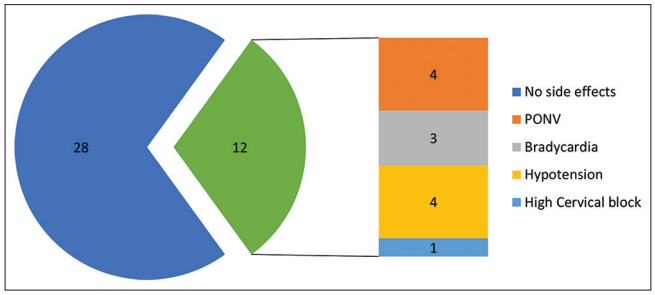


**Fig. 5: Adverse effects in studied cases**

to 24 h. Four (10%) patients developed post-operative nausea and 4 (10%) developed hypotension whereas 3 (7.5%) patients had bradycardia. Mahmoud *et al.* conducted a study to analyze feasibility of segmental spinal anesthesia for breast surgeries [13]. The authors reported that out of 25 studied cases none of the patients required intraoperative analgesics or conversion to GA. Twenty-three patients were totally satisfied, whereas the two patients who developed nausea with hypotension event reported average satisfaction. No patients developed post-dural puncture headache, post-operative nausea or vomiting. Similar side effects were reported by the authors such as Elakany and Abdelhamid [30]. Our novel study emphasized the use of higher concentration of levobupivacaine 0.5% (isobaric) for the ESPB block which provided excellent post-operative analgesia and for a prolonged duration until 12 h. Furthermore, since the dose used for segmental spinal was below 1.5 mL, the total dose and volume did not exceed the toxic limits and there was no single incident of local anesthetic systemic toxicity in our study.

## CONCLUSION

Thoracic segmental spinal anesthesia combined with unilateral erector spinae block is an adequate option for modified radical mastectomy. Among its advantages are the quality of post-operative analgesia, lower incidence of nausea and vomiting, and shorter recovery time, with the consequent early hospital discharge. It can be used successfully and safely for breast surgeries by experienced anesthesiologists with patient and surgeon satisfaction. Cardiorespiratory stability is maintained, though there are remote chances of hypotension or bradycardia as is common with any spinal anesthesia. Further, randomized control trials need be done in a large cohort to establish its full usefulness and safety.

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## AUTHORS' CONTRIBUTIONS

ND - Concept and design of the study; interpreted the results, prepared first draft of manuscript and critical revision of the manuscript; KA - Statistically analyzed and interpreted; reviewed the literature and manuscript preparation; RH - Design of the study, statistically analyzed and interpreted, preparation of manuscript and revision of the manuscript; NP - Concept and coordination of the overall study.

## COMPETING INTERESTS

None.

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