Original Article

Comparison of midpoint transverse process to pleura (MTP) block and erector spinae plane block (ESP) for postoperative analgesia in modified radical mastectomy patients: A double-blinded, randomized control trial

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Abstract

Background and Aims: Modified radical mastectomy (MRM) is associated with moderate severity of postoperative pain. Besides intravenous (IV) analgesics, various nerve blocks are being described for pain relief of MRM patients. We compared erector spinae plane (ESP) block with midpoint transverse process to pleura (MTP) block in these patients for postoperative analgesia.
Material and Methods: After receiving ethical committee approval from the institutional ethics committee (AIIMS, Jodhpur) and written informed consent from study participants, 66 patients who were assigned American Society of Anesthesiologists (ASA) physical status I and II, aged 18–75 years, and were scheduled to undergo MRM were enrolled and randomly allocated into two groups. Unilateral block was given before surgery at T3 or T4 level and with 15 ml of 0.5% ropivacaine in both the groups. Infusion of 0.5% ropivacaine (Neon laboratories limited, Mumbai, India) and 0.2% ropivacaine at a rate of 5 ml/h was maintained intraoperatively and postoperatively, respectively. Pain was assessed using the Visual Analogue Scale (VAS) for the next 24 hours. The total number of patients needing rescue analgesia, the total amount of rescue analgesics consumed in the next 24 hours, and patient satisfaction score were also compared between groups.
Results: Demographics and baseline vitals were comparable in the groups. On comparing VAS scores in both the groups during rest and movement at different time intervals, there was no difference in pain scores during the initial two hours. From the third hour, there was a statistically significant difference ($P < 0.001$) in pain VAS scores in both groups. The ESP group had lower VAS scores compared to the MTP group when followed for the next 24 hours. There was a statistically significant difference in patient satisfaction.
Conclusion: ESP block is more efficacious when compared to MTP block for postoperative analgesia in MRM patients.

Keywords: Erector spinae plane block, midpoint transverse process to pleura block, modified radical mastectomies, postoperative analgesia

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Introduction

Modified radical mastectomy (MRM) is associated with postoperative pain and, if this acute pain is not controlled aggressively, it can convert to chronic pain in almost 55% of cases.[1] Twenty-four percent of the patients categorize their pain as moderate to high.[2]

Opioids are most frequently used to manage postoperative pain, but several undesirable side effects, such as drowsiness, respiratory depression, nausea, vomiting, and constipation, are associated with their use. Paracetamol and NSAIDs are also used as a part of multimodal analgesia but cause side effects like gastrointestinal symptoms and have deleterious effect on renal function.[3]

Regional anesthesia is considered as the gold standard for providing postoperative analgesia.[4] Various nerve blocks like thoracic epidural analgesia, thoracic paravertebral block (TPVB), and erector spinae plane (ESP) block have been suggested for managing postoperative pain in MRM patients. The efficacy of epidural analgesia, is well established however being a central neuraxial block technique, it has many complications such as dura puncture, inadvertent high level of the blockade, and vascular puncture associated with it.

The ESP block is less invasive with an easily identifiable landmark that makes it to provide a potentiallly safe alternative to TPVB and neuraxial blocks for breast surgeries surgeries.[5,6]

Recently, a novel block was introduced by Costache *et al.*,[7] namely, the midpoint transverse process to pleura (MTP) block. It is less invasive as the position of the needle in this block is midway between the transverse process' posterior border and the pleura. Due to fenestrations present in the superior costotransverse ligament (SCTL), the drug reaches the paravertebral space.

No studies comparing the MTP block with the ESP block for postoperative analgesia in breast surgeries are present. We hypothesize that the MTP block is not inferior to the ESP block in providing postoperative analgesia to radical mastectomy patients. In order to compare the effectiveness and safety of the ESP block with the MTP block for postoperative analgesia following MRM, we designed a prospective, double-blinded, randomized trial. The primary outcome was to evaluate the Visual Analogue Scale (VAS) in the postoperative period eight hours after surgery and to assess the VAS score for the next 24 hours. Comparing the number of patients who required rescue analgesia in the following 24 hours, the total amount of rescue analgesic utilized, frequency of procedure-related problems and postoperative complications, and patient satisfaction were the secondary outcome.

Material and Methods

After obtaining ethical committee approval (AIIMS/IEC/2018/607) and registering the study with the Clinical Trials Registry – India (CTRI/2021/06/034133), this prospective, randomized, double-blinded trial was conducted at a tertiary healthcare institute between June 2021 and July 2022. We included patients who had been assigned American Society of Anesthesiologists (ASA) physical status I–III, who were aged 18–75 years, and who were scheduled to undergo MRM. The patients who refused to give consent, had pre-existing infection at the block site, had any coagulation disorders or hemodynamic instability, had a history of psychiatric illness and pre-existing neurological deficits, had morbid obesity (BMI >40 kg/m^2), were pregnant, were posted for repeat surgery, or had any preoperative pain were excluded from the study [Figure 1]. The attending anesthesiologist examined all the patients during their preoperative visit, one day before the surgery. The patients were taught pain assessment score evaluation both at rest and when moving the arm of the operated side (abducting the arm to 90°). After receiving their written and informed consent, all eligible patients who were posted for MRM were randomized into two groups, namely, MTP and ESP.

Patients were randomly allocated into two groups in a 1:1 allocation ratio using computer-generated random numbers. A simple random sequence was generated from the computer. The group allocation numbers were concealed in sealed, opaque envelopes that were opened just before the administration of the block. Group 1 patients received MTP block, whereas Group 2 patients received ESP block at T3 or T4 unilaterally on the operative side. Both the groups received 15 ml of 0.5% ropivacaine.

In the procedure room, routine monitoring, including continuous electrocardiography (ECG), non-invasive blood pressure (NIBP), and peripheral oxygen saturation (SpO_2), were attached, and baseline vitals were recorded. All the patients received premedication with 1 mg of intravenous (IV) midazolam and 0.5 μg/kg of IV fentanyl. The patients were then placed in a sitting position, and each thoracic spine was identified and marked on the opposite side [Figure 2]. A screening ultrasound was performed using an ultrasound machine (LOGIQe, GE, China) and a high-frequency (8–15 MHz) linear transducer. The blocks were administered under all aseptic precautions, with a 22-gauge, 10-cm echogenic needle, performed by an anesthesiologist not involved in the

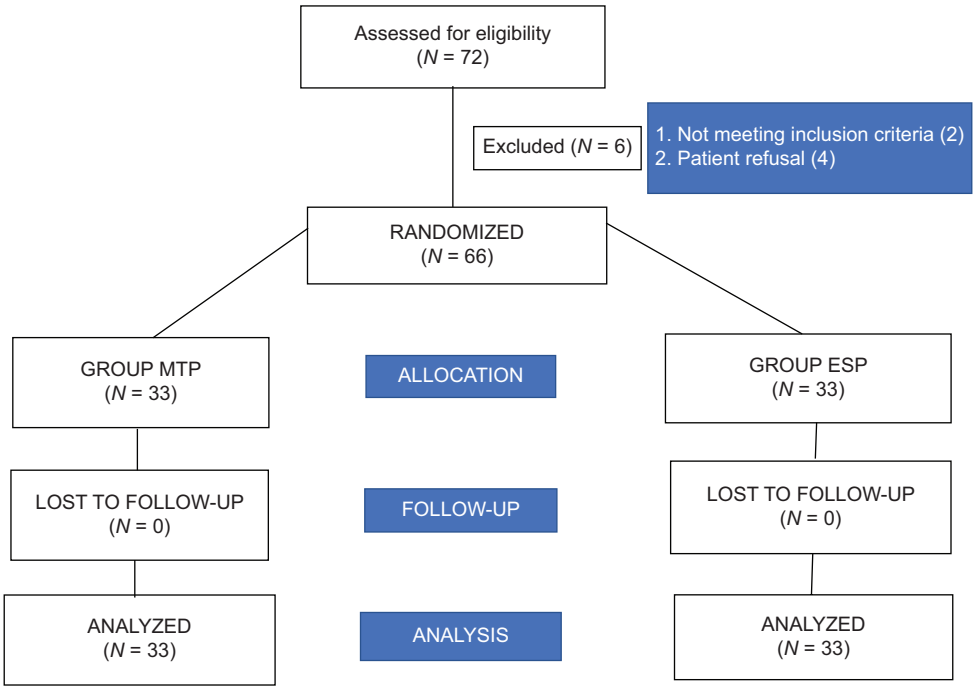

Figure 1: Consolidated Standards of Reporting Trials (CONSORT) diagram

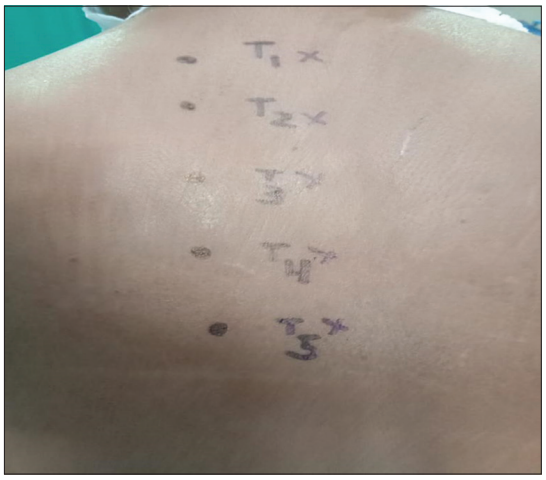

Figure 2: Surface landmark markings on the thoracic spine of a patient in sitting position

preoperative or postoperative assessment of the patient, with the anesthesia management, and data collection. The chief investigator and medical and nursing personnel were blinded. While administering both the blocks, patients were made to sit and a high-frequency linear ultrasound transducer was placed parasagittally in longitudinal orientation, 3 cm lateral to T3 or T4 spinous processes. An 8-cm, 22-gauge block needle was used for performing both the blocks.

MTP block

The needle was inserted and advanced in plane of the transducer during the parasagittal scan, aiming for the midpoint between the transverse process and pleura from cephalad to caudad. One milliliter of normal saline was given to confirm the position of the needle tip, then a total of 15 ml of 0.5% ropivacaine was administered for the block [Figure 3].

ESP block

The needle was inserted in plane of the transducer probe. It was advanced until the tip crossed the interfacial plane between the rhomboid major and erector spinae muscle and reached the transverse process. One milliliter of normal saline was used to confirm needle position and there was visible linear spread of fluid between muscles upon injection was noted, in a parasagittal scan of the muscles of the trapezius, rhomboid major, and erector spinae. A total of 15 ml of 0.5% ropivacaine was injected.

After injecting the drug, the catheter was inserted. The patients were observed for 15 minutes after performing the block for any block-related complications such as pneumothorax, postoperative nausea, and vomiting. An infusion of 0.5% ropivacaine at 5 ml/h was started intraoperatively and was converted to 0.2% ropivacaine at 5 ml/h in the postoperative period and was continued for the next 24 hours in both groups.

After arrival in the operating room, all ASA standard monitoring was attached. The patient was induced using propofol and fentanyl; rocuronium was given for muscle relaxation and the airway was secured. Intraoperative analgesia was given with fentanyl and in block infusion of 0.5% ropivacaine. The patient was extubated after the return of adequate muscle power at the end of the surgery. They

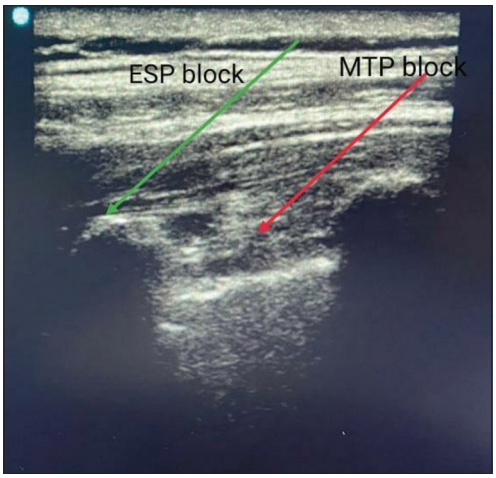

Figure 3: Ultrasound image of the insertion site of ESP block and MTP block

were then shifted to the PACU and further to the ward and monitored 24 h after surgery.

Postoperative pain was assessed using the VAS (with lowest, 0, indicating no pain and highest score, 10, indicating worst imaginable pain) at every hour till the 4th hour, then at the 8th, 12th, 16th, 20th, and 24th hour. Rescue analgesia consisting of IV paracetamol (1 g) was given if a VAS score ≥4 was recorded at rest. If the score did not decrease after 30 minutes, then IV tramadol (2 mg/kg) was administered and was considered as block failure. The total number of patients who needed rescue analgesia and the total amount of analgesics used in 24 hours postoperatively were recorded. Procedure-related and postoperative complications such as hypotension, respiratory depression, postoperative nausea and vomiting (PONV), shivering, headache, dizziness, constipation, urinary retention, pruritus, failure rate, and patient satisfaction level were also recorded. The patient's satisfaction levels were also assessed using a numerical satisfaction score (4 = excellent, 3 = good, 2 = fair, 1 = poor) 24 hours after surgery.

Sample size

This study was conducted as a non-inferiority trial. We assumed that the MTP block was as good as the ESP block in terms of analgesic efficacy. The primary end point was pain measured on the VAS at eight hours postoperatively. The non-inferiority limit was 2. The standard deviation was anticipated to be 2.5 by assuming a one-sided type 1 error rate of 2.5% and 95% power, and the actual mean difference between treatments was zero. The sample size was calculated as 33 patients in each group.

Statistical analysis

Data was analyzed using the IBM SPSS Statistics software version 22 (IBM SPSS Advanced Statistics, Chicago, IL, USA). The results of the categorical measurements were presented as numbers or ratios, and the results of quantitative variables were presented as mean (SD). The Chi-squared test was used for comparing qualitative data. After checking the normality of the data, the unpaired student's *t* test was used for comparing quantitative data between the two groups across different time points. The difference was considered significant if *P* was <0.05.

Results

The demographic profile of the participants was similar in both groups [Table 1].

On comparing VAS scores by applying an unpaired *t* test in both the groups during rest and movement at different time intervals, no difference in pain scores was noted during the initial two hours. From the third hour, there was a statistically significant difference in pain VAS scores in both groups, with lower VAS scores noted in the ESP group compared to that in the MTP group when followed for the next 24 hours [Table 2].

On comparing the VAS (rest and movement) in both the groups over the specific time points, the *P*- value came out to be statistically significant ($P < 0.001$) [Figure 4].

Eight patients in MTP and three in the ESP group needed rescue analgesia in the next 24 hours. Mean dose of PCM in the ESP group and MTP group was 0.03 ± 0.17 g and 1.73 ± 3.67 g, respectively, with a *P*- value <0.01.

There was a statistically significant difference in patient satisfaction scores between the two groups [Table 3].

Discussion

The current study was a non-inferiority trial that compared the postoperative analgesic efficacy of MTP and ESP block in MRM patients. We found that ESP is a better alternative than MTP for managing postoperative analgesia. The breast is innervated by intercostal nerves and supraclavicular nerves.[8] Most patients experience severe pain in the immediate postoperative period after MRM, which leads to delayed discharge from the hospital. Although many drugs, including opioids, are used for postoperative pain, regional anesthesia is considered the gold standard for postoperative analgesia.

To the best of our knowledge, this is the first double-blinded, prospective, randomized clinical trial that has compared ESP and MTP blocks in terms of VAS scores during rest and movement postoperatively in MRM surgeries. Both ESP and

Table 1: Distribution of demographic variables, duration of surgery, and block performance time in two groups

Variables	MTP group	ESP group	*P*
Age in years (mean±SD)	48.33±15.13	49.7±10.6	0.673
Height in cm (mean±SD	154.5±5.5	155±4.0	0.145
Weight in kg (mean±SD)	59.98±10.7	55.75±8.1	0.117
ASA† grade	16/17	22/11	
Duration of surgery (minutes; mean±SD)	157.76±29.24	157.7±24.79	0.993
Block performance time (minutes; mean±SD)	11.97±4.4	13.88±5.6	0.129

†ASA=American Society of Anesthesiologists, SD=Standard deviation. Student's t test and chi-squared test applied. P<0.05 is significant

Table 2: Comparison of VAS scores at rest and at movement between the two groups

Time (hours)	VAS* at rest (mean±SD)			VAS* at movement (mean±SD)		
	MTP group	ESP group	*P*	MTP group	ESP group	*P*
1	1.21±0.992	1.0±1.19	0.437	2.03±1.3	2.0±1.4	0.92
2	1.3±0.951	0.7±0.951	0.012	2.09±1.1	1.52±1.20	0.05
3	1.42±0.969	0.42±0.663	<0.001	2.0±1.19	0.82±0.917	<0.001
4	1.33±1.10	0.36±0.603	<0.001	1.88±1.2	0.64±0.822	<0.001
8	1.27±1.06	0.24±0.502	<0.001	1.79±1.2	0.42±0.751	<0.001
12	1.12±1.11	0.15±0.442	<0.001	1.52±1.34	0.22±0.553	<0.001
16	0.85±1.00	0.12±0.485	<0.001	1.33±1.13	0.18±0.465	<0.001
20	0.76±1.03	0.03±0.174	<0.001	1.18±1.18	0.09±0.292	<0.001
24	0.64±0.99	0.03±0.174	<0.001	1.0±1.22	0.09±0.292	<0.001

VAS=Visual analogue scale, values represent statistical significance. Student's t-test was applied. P<0.05 was considered significant

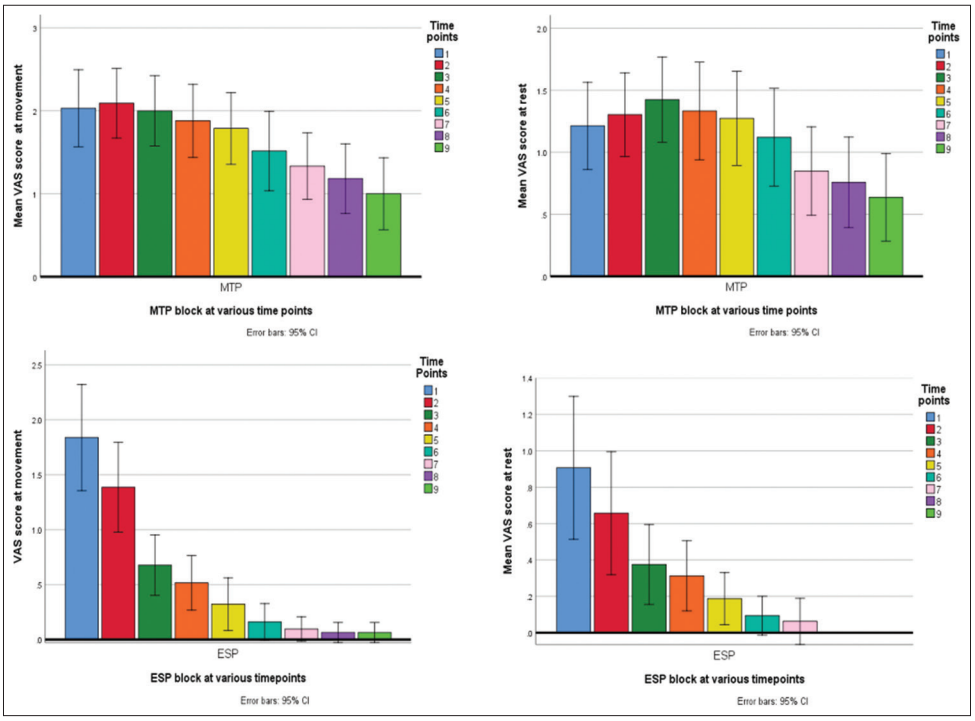

Figure 4: Bar diagram showing VAS scores at various time points in MTP and ESP blocks

MTP blocks are relatively newer techniques that have been used for providing postoperative analgesia.

Our study results showed no difference in VAS scores ($P < 0.05$) between the two groups in the postoperative period for the first two hours. From the third hour onwards till the 1st 24 hours, the ESP group had lower VAS scores than the MTP group. Since the same dose of local anesthetic drug (15 ml of 0.5% ropivacaine) was used in both of these groups, it can be interpreted that the ESP block is better than the MTP block for postoperative analgesia in MRM surgeries during rest and movement. The probable reason for this may

Table 3: Comparison of patient satisfaction scores between the two groups

Satisfaction Score	MTP group	ESP group	*P*
	3† (3–4)	4† (4–4)	<0.001

†*Median score was 3 in the MTP group and 4 in the ESP group; P<0.001*

be that the drug in the ESP block was given directly, just below the erector spinae muscles, where the nerves traverse an area just outside the PVB; however, in the MTP block, the drug is given in the muscle with the expectation that it will travel through the fenestrated costotransverse ligament to reach into the paravertebral space. The spread of the drug may not be uniform in the MTP block and can lead to inferior analgesia when compared to ESP. Patient satisfaction score was also compared in both groups, and it was lower in the MTP group when compared to the ESP group. This suggests that patients given the ESP block were more satisfied since they experienced more pain relief than patients who were given the MTP block.

The erector spinae complex includes muscles located in the lumbar, thoracic, and cervical regions. Thus, this plane covers multiple dermatomes and allows the wide cranial-caudal spread of the local anesthetic drug. Forero *et al.*[5] described the successful application of the ESP block in two cases of severe neuropathic pain and concluded that the ESP block produced an extensive multi-dermatomal sensory block. The ESP block has shown promise as a secure and straightforward method for thoracic analgesia in both acute postsurgical or posttraumatic pain and chronic neuropathic pain. Hamilton and Manickam[9] reported a case of a patient with multiple unilateral rib fractures who was successfully treated with ESP block by utilizing a continuous catheter approach. Bonvicini *et al.*[10] mentioned using a bilateral ESP block in breast cancer surgery patients sharing their prior experience of the bilateral ESP blocks for providing adequate analgesia in the postoperative time.

The sonoanatomy of the ESP block is apparent and straightforward; it is quick and uncomplicated to administer, and patients typically tolerate it well.[11] The ESP block may be an effective substitute for the paravertebral block, epidural analgesia, and other myofascial thoracic wall blocks after breast cancer surgery.

In MTP blocks, the drug is deposited superficially to the superior costotransverse ligament, resulting in a variable spread in the paravertebral space and the ESP.[4,5] This uneven spread in the MTP block, compared to the wide cranial-caudal spread of local anesthetic drug in the ESP block, might be the reason for its lower efficacy in relieving pain as compared to the ESP block.[12,13]

Eskin *et al.*[14] compared the ESP block with the MTP block at the T12/L1 level for postoperative analgesia in lumbar spinal surgery and concluded that the ESP block was more effective than the MTP block in terms of postoperative VAS score.

Kaur *et al.*[15] mentioned that the MTP block could be successfully used in chest trauma patients for pain relief. Another case report by Pedoto *et al.*[16] cited the successful use of the MTP block in minimally invasive thoracic non-cardiac surgery. Being superficial, the MTP block can be easily performed in obese patients.[17]

There were no significant complications in any of the groups. The mean of rescue analgesia was significantly lower in the ESP group compared to the MTP group. This may be because of better analgesia in the ESP block compared to the MTP block. The patients were more comfortable in the ESP group, probably due to the better spread of the drug in the ESP block to the paravertebral space, causing more effective analgesia.

The first limitation of our study was that we performed postoperative pain assessment for up to 24 hours. However, patients may perceive pain for up to 48 to 72 hours during these surgeries. The second limitation was that the distribution of block and success was not assessed immediately after administering the block. The third limitation is that of small sample size in our study, a trial with a larger sample size is needed to further examine these results as it is the first study comparing ESP and MTP blocks in MRM surgeries.

Conclusions

Both ESP and MTP blocks are safe and effective techniques for providing postoperative analgesia in MRM surgeries. The ESP block seems to be superior in providing postoperative analgesia compared to the MTP block in MRM surgeries.

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Conflicts of interest
There are no conflicts of interest.

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