Original Article

Deep versus superficial erector spinae block for modified radical mastectomy: A randomised controlled pilot study

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ABSTRACT

Background and Aims: Forero *et al.* described two approaches of erector spinae (ES) plane block: superficial and deep to erector spinae muscle. We hypothesised that the superficial technique would not lead to optimum analgesia as the drug would have to cross one more muscle layer. We aimed to compare the techniques in terms of analgesia and sensory blockade in patients undergoing modified radical mastectomy (MRM). **Methods:** Forty American Society of Anesthesiologists (ASA) I/II female patients in age group 18–60 years undergoing unilateral MRM were included in this prospective study. Group D patients received 20 mL 0.2% ropivacaine deep to erector spinae at the T4 level. Group S patients received 20 mL 0.2% ropivacaine superficial to erector spinae. Sensory level of block, perioperative opioid consumption, and adverse effects were noted. **Results:** Twenty four hours morphine consumption was less in group D: 5.47 ± 1.1 mg and in group S was 7.66 ± 0.74 mg ($P < 0.001$). The sensory spread was more in deep group in the posterior axillary and mid axillary line. There were no reported adverse effects in either group. **Conclusion:** Injection of drug deep to ES muscle provides more cranio-caudal blockade of posterior and lateral chest wall, hence providing better analgesia following breast surgery. Injection of the drug superficial to the muscle leads to inferior analgesia.

Key words: Erector spinae block, modified radical mastectomy, postoperative pain

INTRODUCTION

Erector spinae plane (ESP) block is a simple and safe myo-fascial plane block.[1] The role of ultrasound-guided ESP block for breast surgeries has been established.[2,3] Preoperative administration of block reduces opioid consumption and opioid related adverse effects in modified radical mastectomy (MRM). A case series illustrated opioid free anaesthesia in patients scheduled for MRM.[4] The extent of analgesia provided by this block depends on the volume of drug injected, site of injection, approach of block, and pattern of spread within the myo-fascial plane. Forero *et al.* were the first to describe the block, wherein he used two approaches: Superficial and deep to erector spinae muscle.[1] The proposed mechanism was the seepage of the drug to the paravertebral space to block the ventral and dorsal rami. Our hypothesis was that giving the drug superficial to the erector spinae would not lead to optimum analgesia as the drug would have to cross one more muscle layer to block the rami. We aimed to compare both these techniques in terms of analgesia and sensory blockade in patients undergoing MRM. The primary objective was to ascertain the postoperative analgesic consumption in patients undergoing MRM after superficial technique when compared to the classical deep technique of ESP block. Secondary objectives included preoperative sensory blockade and adverse effects.

METHODS

The prospective, randomised, double-blind trial was done over a period of 10 months from February 2019 to November 2019. After taking the Institutional Ethical committee clearance (10/12/2018), clinical trial registration was done at Clinical Trial Registry India (CTRI; CTRI/2019/01/017349). The study adheres to CONSORT guidelines. Forty-four American Society of Anesthesiologists (ASA) I/II female patients between the age group 18 and 60 years, who were scheduled to undergo unilateral MRM under general anaesthesia, were screened. Out of these, 40 patients were allocated in one of the two groups.

All the patients were explained about the procedure, made familiar with numerical rating scale and patient controlled analgesia pump in the preoperative visit. Following this, an informed consent was taken from all these patients. The exclusion criteria included patients with allergy to the drugs, coagulopathy, infection at puncture site, mental disorder, communication failure, unable to discriminate cutaneous pin prick, chronic use of analgesics, and having body mass index (BMI) >30 kg/m^2. Premedication in the form of alprazolam 0.5 mg was administered orally in the morning before shifting to operating room. The enrolment for the study was done by the primary investigator. The patients were randomised into two groups of 20 each using computer-generated randomised numbers by the statistician. The random allocation sequence was kept concealed in opaque, sealed envelopes till group was assigned. Patients in Group D received 20 mL 0.2% ropivacaine deep to erector spinae at the T4 level, while patients in Group S received 20 mL 0.2% ropivacaine superficial to erector spinae at the T4 level.

The patients were shifted to preoperative holding area and monitors including noninvasive blood pressure, electrocardiography (ECG), and peripheral oxygen saturation (SPO$_2$) attached. All the blocks were performed by the second author who refrained from perioperative management or data collection. The blocks were performed with the patient in the sitting position at least 30 min before incision. A high-frequency linear probe (38 mm, 7–12 MHz frequencies) (Sonosite, Inc., Bothell, WA, USA) was placed in a transverse plane. The lateral tip of T4 transverse process was visualised as a hyperechoic structure. Trapezius, rhomboid major, and erector spinae muscles were superficial to the T4 process. Thereafter, the probe was turned 90° longitudinally.

A blunt tip, 22 gauge echogenic needle (Pajunk, sonoplexstim cannula, Geisingen, Germany; 80 mm) was inserted in plane in a caudal direction after injecting 2 cc of 2% lignocaine locally.

In group D, needle tip was kept in contact with the transverse process. We confirmed the needle tip position by injecting 0.5–1 mL of saline. It was followed by injection of 20 mL of 0.2% ropivicaine. In group S, needle tip position was kept superficial to erector spinae muscle and drug (20 mL of 0.2% ropivicaine) was injected in the fascial plane between rhomboid major and erector spinae muscle. All the patients were blinded to the block technique as the entry point for both the block procedures was the same.

The sensory level of block was assessed by a blinded observer who was not present at the time of performance of block. Pin-prick testing was done every 5 min in dermatomal distribution from T1 to T8 anteriorly in mid clavicular line (MCL), laterally in mid axillary line (MAL), posteriorly in posterior axillary line (PAL), axilla, and at medial side of upper arm.

The dermatome at which there was decreased or no sensation to pin prick stimulus compared to the other side was registered as an anaesthetised dermatome. The patient was excluded from study if the pin prick sensation did not decrease in any of these dermatomes even after 30 min. The number of anaesthetised dermatomes was recorded on a specific chart that depicted the dermatomal map.

The patient's ECG and SpO$_2$ were monitored over a period of 30 min after procedure. Any decrease in blood pressure (>20%) or vascular puncture was documented. General anaesthesia was given in a standardised manner (propofol 2 mg/kg, fentanyl 2 µg/kg, and vecuronium 0.08 mg/kg). The HR and blood pressure were recorded at baseline, after induction, after laryngeal mask airway (LMA) insertion, at skin incision, and then every 15 min until the end of surgery. Anaesthesia was maintained with sevoflurane in air and oxygen, targeted to maintain bispectral index values between 40 and 60. Intravenous ondansetron 4 mg and 8 mg of dexamethasone were given to all the patients for prophylaxis of postoperative nausea and vomiting after start of surgery. All the patients received an infusion of normal saline at a rate of 5–8 ml kg/h during surgery. If two consecutive readings showed an increase in mean arterial pressure (MAP) of 20% above baseline, intravenous fentanyl 1.0 µg/kg bolus

was given. At the end of surgery, the neuromuscular block was antagonised with neostigmine and atropine. The LMA was taken out once the patients became fully awake and breathing adequately. Intravenous paracetamol 1 gm was given before extubation and sixth hourly thereafter to all the patients.

A patient-controlled analgesia pump was attached to the patient for rescue analgesia. No background infusion was given. A lockout interval of 5 min with a maximum of 10 doses (1 mg boluses) per hour was preset. Opioid consumption in 24 h and adverse effects (hypotension, respiratory depression, shivering, nausea/vomiting and urinary retention) were documented. Rescue antiemetic ondansetron 0.1 mg kg^{-1} i.v. was given if the patient complained of nausea.

We had conducted a pilot study to see the effects in both techniques. Statistical analysis was performed using International Business Machine Statistical Package for the Social Sciences (IBM SPSS) Statistics version 20 (IBM, Armonk, New York, USA). Continuous variables are expressed as means ± standard deviation. Independent Student's *t*-test was applied to test the difference of duration of analgesia and morphine requirement between deep and superficial mode of analgesia. The level of dermatomes blocked in deep and superficial groups were expressed as median with interquartile range (Q1, Q2, and Q3) and plotted on the Box-and-Whiskers plot.

RESULTS

We did not find any significant difference in age, duration of surgery, and BMI in both the groups as shown in Table 1. The consort flow chart is shown in Figure 1.

Morphine consumption within 24 h postoperative period in group D was 5.47 ± 1.1 mg and in group S was 7.66 ± 0.74 mg. The difference was highly significant between the two groups ($P < 0.001$). The intraoperative fentanyl consumption (µg/kg) was more in group S (1.89 ± 0.435), compared to the other group: 1.1 ± 0.538 [Table 2].

Figure 2 shows cranial and caudal spread of the local anaesthetic and resultant dermatomal blockade. In group D, in the PAL, median and upper level of spread of LA was T2. The median level of caudad spread in the same group was T6–T7, with the lower most level being T8. In MAL, median cranial spread was T3 in group D {interquartile range(IQR)<1}, while caudal
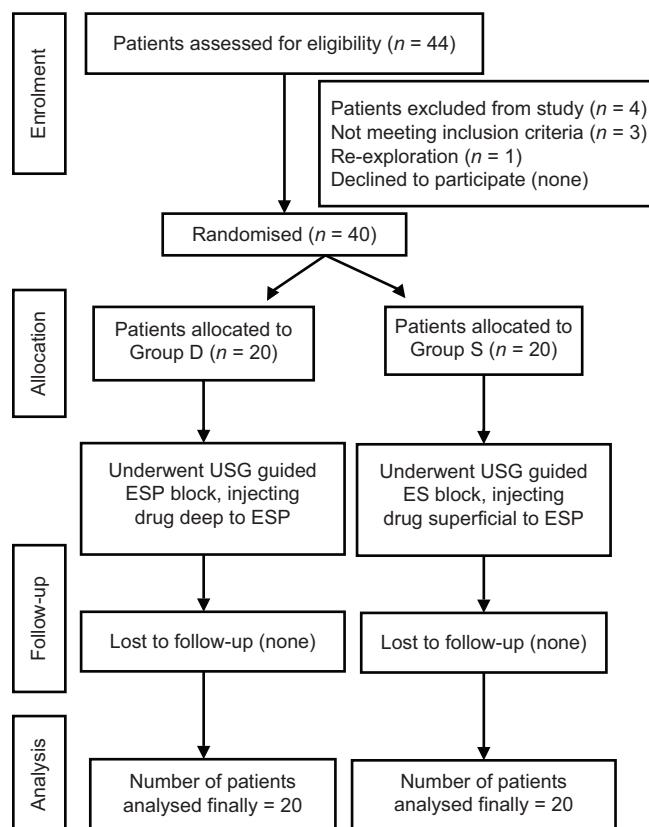

Figure 1: Consort flow chart. ESP: Erector spinae plane, USG: Ultrasonography

Table 1: Demographic data					
	Mean	**±SD**	**Mean**	**±SD**	**P***
Age (years)	47.05	10.85	44.65	10.05	0.472
Duration of surgery (h)	127.89	19.88	125.75	17.41	0.719
Weight (BMI)	21.8	1.962	22.005	2.528	0.776

SD: Standard deviation, BMI: Body mass index

Table 2: Duration of analgesia and morphine requirement				
	Group D		**Group S**	
	Mean	**±SD**	**Mean**	**±SD**	**P***
Morphine requirement (mg)	5.47	1.14	7.66	0.74	<0.001
Intraoperative fentanyl consumption (µg/kg)	1.1	0.538	1.89	0.435	<0.001

*Independent *t*-test was applied between deep and superficial mode of analgesia. SD: Standard deviation

spread was T7–T8. (IQR of 2 dermatomes: T6–T8). In MCL, median cranial spread was T3 with IQR of one dermatome and the median caudal spread was T6 with IQR of two dermatomes.

On the contrary, in group S in PAL, median cranial spread was T3 and the uppermost level achieved was T2. Caudally, the median spread was T6–T7 and the lowermost level achieved was T8. In the MAL, median spread was T3 cranially and T6 caudally. In the MCL, median spread was T3 with IQR 1 cranially and the

range of spread was T2–T4. Caudally, the median spread was T6 with IQR of 1. There were no reported adverse effects in either group. There was no statistical significant difference in the axillary blockade in both groups [Table 3].

DISCUSSION

Our study shows that the deep technique of ESP block is better than the superficial technique in terms of analgesic efficacy (less requirement of perioperative opioids). The preoperative sensory assessment showed that the spread was less extensive in the superficial group in the PAL and MAL.

The ESP block is a relatively new interfascial plane block that has gained popularity due to its ease and safety. Its use extends to various surgeries like MRM, laparotomy, hernia, pyeloplasty, etc.[5-7] Forero *et al.* were the first to describe it, wherein they used two techniques for the same block: i) Deep technique: Drug deposited deep to erector spinae muscle, ii) Superficial technique: Drug deposited superficial to erector spinae muscle at T5 level.

In the superficial technique, the first patient had sensory blockade ranging from T2 to T9 in a cephalo-caudad direction, and 3 cm lateral to the thoracic spine to the midclavicular line in an anterior–posterior direction. There was sensory blockade in axilla and medial aspect of the upper arm. Clinically, the patient had adequate pain relief.

The second patient did not exhibit any discernable sensory blockade using the same technique despite symptomatic pain relief. Thereafter, a deep technique was used and sensory blockade from T3 to T9 over the entire posterolateral aspect of the left hemithorax, extending as far anteriorly as the midclavicular line but sparing the axilla.

We used a dose of 20 mL at the level of T4 based on a study done by Gurkan Y, *et al.* They gave ESP (deep technique) block for MRM, which reduced the opioid consumption significantly.[8] The morphine consumption reduced from 16.6 ± 6.92 to 5.76 ± 3.8 mg in the ESP group compared to the control group. Our results are also comparable as the 24-h morphine consumption was 5.47 ± 1.14 mg in the deep group.

Other studies have used local anaesthetic ranging from 20 to 30 ml. Cassai *et al.* stated that the volume needed to cover one dermatome ranged from 2.5 to 6.6 mL, with a median value of 3.4 ml.[9] In our study, the spread ranged from 3 to 6 dermatomes with a volume of 20 ml.

Our clinical findings were corroboratory to the cadaveric evidence found earlier by various authors. A cadaveric study done by Forero *et al.* showed that drug deposited deep to ESP muscle acts on both the ventral and dorsal rami of the spinal nerve roots. When it is deposited superficial to the muscle, the dye stains only the dorsal rami. According to Chin KJ, *et al.,* the drug diffuses to the paravertebral space and acts at both the dorsal and ventral rami of the thoracic spinal nerves. It also affects the rami communicans that supply the sympathetic chain.[10] This has also been stated in various other studies.[1,11,12] Similarly, in our study, the sensory blockade was more in deep technique, which could be explained by the same

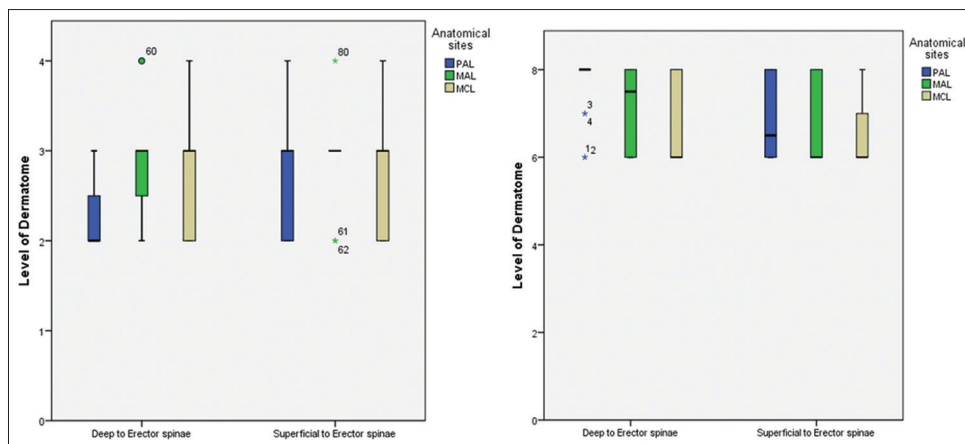| Table 3: Axillary blockade			
	Grp ID: Deep	Grp S: Sup	*P*
Axillary blockade	5	2	0.211

Chi-square test

Figure 2: Box-and-Whiskers plot of cranial and caudal spread of local anaesthetic relative to anatomical sites

mechanism. In the deep group, there would have been more seepage of drug in the paravertebral space, while in the superficial group, the muscle might act as a barrier to the spread.

In a cadaveric study done by Ivanusic *et al.*, the spread of the dye in the deep technique did not involve the ventral rami or the paravertebral space. The spread of the dye was both superficial and deep to the ESP muscle, and the dorsal rami were stained either close to the costotransverse foramen or involving its more distal branches. They further added that their cadaveric study did not correlate with the various clinical reports. They attributed this variation to the difference in tissue tension and intrathoracic pressure in living and cadaver.[13]

There are various studies that have established the role of ESP in mastectomy patients. All of these have used deep technique. Erector spinae block is considered to be a good alternative to paravertebral block in terms of safety as it is away from the spinal canal. Also, the superficial nature of the block makes it easy to administer. We did not encounter any adverse effects in any of the patients.

The target of ESP block for mastectomy patients is to block the ventral rami of the spinal cord. Depositing the drug deep to ESP muscle enables the drug to seep in the paravertebral space contrary to what would be seen in superficial block. Hence, deep technique is better in terms of analgesia and is the standard technique in mastectomy patients.

Our study had some limitations. We did not confirm our spread using radiological techniques: Fluoroscopy/CT after dye injection. Our main aim was to study the effects of both the techniques on analgesic consumption in patients scheduled for MRM.

CONCLUSION

Injection of drugs deep to erector spinae muscle provides more cranio-caudal blockade of posterior and lateral chest wall than superficial group. The quality of analgesia following breast surgery is better on injecting the drug deep to erector spinae muscle.

Conflicts of interest
There are no conflicts of interest.

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