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Original Article

Anaesthesia Section

Comparison of the Efficacy of Ultrasound-guided Pectoral versus Erector Spinae Plane Blocks for Postoperative Analgesia in Patients undergoing Modified Radical Mastectomy: A Randomised Controlled Trial

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ABSTRACT

Introduction: Postmastectomy pain is more common following carcinoma breast surgery. Preventive analgesia for breast carcinoma includes administration of local infiltration or regional anaesthesia in the form of a paravertebral block, epidural, pectoral nerve block or intercostal block. Interfascial blocks, such as ultrasound guided pectoral nerve (PECS II) and Erector Spinae Plane (ESP) block have been shown to provide effective analgesia for mastectomy surgeries.

Aim: To compare the postoperative analgesic efficacy of PECSII block and ESP block following mastectomy surgeries.

Materials and Methods: The present study was a double-blinded randomised controlled study. Patients scheduled for an elective unilateral modified radical mastectomy surgery of age 18-70 years, American Society of Anaesthesiologists (ASA) physical status I-II, were enrolled in the study. Sixty patients (ASA I-II) were divided into two groups (30 in the PECS II group and 30 in the ESP group). The patients received respective blocks under ultrasound guidance after general anaesthesia. The primary outcome measured was the time of first request analgesia between groups. The secondary outcomes were postoperative Numeric Rating Scale (NRS) at eight different time-points (0.5, 1st, 2nd, 4th, 6th, 8th 12th and 24th hour) and intraoperative fentanyl requirement and haemodynamics (heart rate and mean arterial pressure). Total postoperative intravenous paracetamol consumption and rescue analgesic requirement in the first 24 hours postoperatively were noted. Statistical analysis was conducted by using Statistical Package for the Social Sciences (SPSS) version 20.0. Pearson's Chi-square test was performed to compare ratios, and categorical variables were compared using Fisher's exact test. A p-value value <0.05 was taken as statistically significant.

Results: The time of first request analgesia was prolonged and significant in ESP block (255.5±48.76 minutes) than PEC II (197.5±31.35 minutes) (p=0.000347). In the postoperative ward, NRS scores at the 30th min, first and second hour were significantly lower in ESP block than PECS II group (2.3±0.4 vs. 5.2±0.8; 3.2±0.4 vs. 4.4±0.3, 3.7±0.4 vs. 5.2±0.4); p=0.041 p=0.047, p=0.037, respectively. From the second postoperative hour to the end of the observation period, there were no significant changes in NRS scores among groups. Postoperative paracetamol consumption was significantly higher in PECS II than ESPB (1.25±0.5 grams vs 2.33±1.2 grams, p<0.043824). There was no change in intraoperative fentanyl consumption and haemodynamics between groups.

Conclusion: The ESP block had better pain control, reduced postoperative pain scores and rescue analgesia than PECS II when given as preventive analgesia in mastectomy surgeries.

Keywords: Haemodynamics, Interfascial blocks, Paracetamol, Postoperative pain, Rescue analgesia

INTRODUCTION

Patients with carcinoma breast treated with Modified Radical Mastectomy (MRM), is associated with appreciable acute postoperative pain and limited shoulder mobility. Postoperative pain is risk factor in developing chronic Postmastectomy pain [1]. About 40% of women have severe acute postoperative pain after breast cancer surgery, whereas 50% develop chronic postmastectomy pain and have a poor quality of life. Regional anaesthesia techniques provide a better pain control and have subsequently reduced the incidence of chronic pain [2]. Effective postoperative pain control decreases the surgical stress response and opioid requirement and thus preserves immune function. Opioids, especially morphine, may be responsible for high postsurgical recurrence and metastasis by inhibiting humoural and cellular immune functions [3].

The PECS block, a novel interfascial plane block technique described by Blanco R et al., in which local anaesthetic is deposited between the pectoralis major and the minor muscle (PEC1). PECS II targets the interfascial plane at the third rib between the pectoralis minor and the serratus anterior muscle [4,5]. These novel techniques attempt to block the III, IV, V, VI intercostal nerves, long thoracic, pectoral and intercostobrachial nerves. They provide analgesia to anterior thoracic wall surgeries and are very useful for axillary dissection.

The erector spinae plane block a technique described by Forero M et al., and was initially used for treatment of chronic neuropathic pain. Easy identification of sonographic target and no impeding vascular structure makes this block simple and safe to perform. Local anaesthetic injected deep to the erector spinae muscle spreads in a craniocaudal direction ascending to several levels. It also penetrates anteriorly through the intertransverse connective tissue and enters the thoracic paravertebral space where it blocks both ventral and dorsal rami of spinal nerves, rami communicans that transmit sympathetic fibres, coupled with this fact ESP block could result in both visceral and somatic analgesia [6].

Few studies have compared the effects of PECS and ESP block for postoperative analgesia in patients who underwent radical mastectomy [7]. In the present study, the intraoperative haemodynamics and analgesic requirement in addition to postoperative analgesic requirement was analysed.

The aim of the study was to compare the effects of ultrasound-guided modified (PECS II) block and ESP block on postoperative analgesic efficacy. The primary outcome measured was the time of first request analgesia between groups. The secondary outcomes were postoperative NRS at eight different time-points (0.5, 1st, 2nd, 4th, 6th, 8th, 12th and 24th hour), intraoperative fentanyl requirement and haemodynamics (heart rate and mean arterial pressure), total intravenous paracetamol consumption and rescue analgesic requirement in the first 24 hours postoperatively.

MATERIALS AND METHODS

The double-blinded randomised controlled study was conducted at a tertiary care institute from December 2018 to December 2021. After approval of the Institutional Ethical Committee (IEC) (8/154/IEC/PP/2018) the trial was registered in Clinical trial Registry India REF/2018/08/021202.

Sample size calculation: A pilot study, with 10 participants in each group (PEC II and ESP), showed that the duration of analgesia (mean±standard deviation) of ESP (255.5±48.76) was 30% higher than PEC II (197.5±31.35). Based on this finding, the estimated sample size, with 80% power of the study and type I error of 0.05, was 27 patients in each group. Allowing for dropout of 10%, a total 30 patients in each group were recruited.

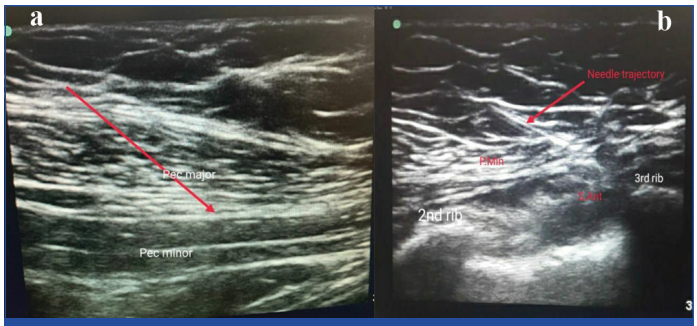
Inclusion criteria: A total of 62 female patients, who were undergoing MRM under general anaesthesia of ASA grade 2 or 3 in the age group of 18-70 years were included.

Exclusion criteria: Patients with pre-existing block site infection, coagulopathy, morbid obesity (BMI >40 kgm^2), allergy to local anaesthetics, decreased pulmonary reserve, were excluded from the study.

Study Procedure

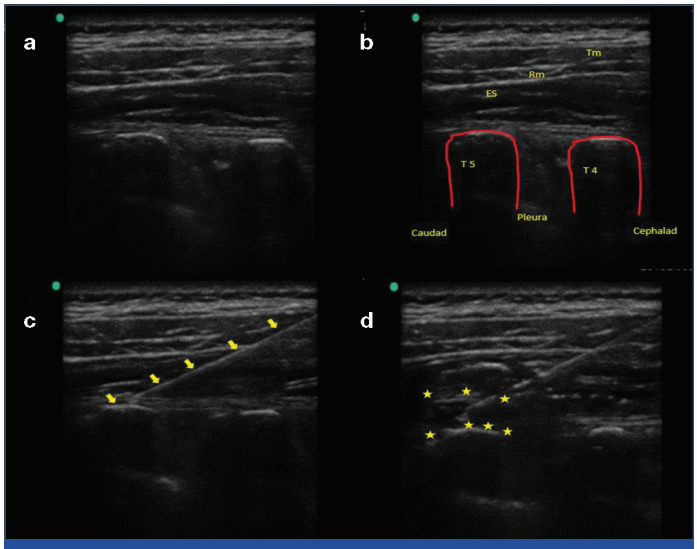
All patients were kept fasting overnight, and premedicated with diazepam 5 mg and famotidine 40 mg orally the night before surgery. Using random sequence number generated by the computer, the participants were allocated into two groups of 30 each (PECS II and ESP). The participants opened the sealed envelopes on the day of surgery before induction, and received either PECS II or ESP as per the envelope. Both the theatre anaesthesiologist and participants were blinded to the type of block. Two experienced anaesthesiologists performed the blocks were blinded to the data collection. A dedicated pain nurse performed follow-up of patients and data collection. All patients were connected to mandatory monitors, and general anaesthesia was administered as per institute protocol. Patients were premedicated with the injection of fentanyl 2 µg/kg i.v. followed by propofol 2 mg/kg-1 i.v. vecuronium 0.1 mg/kg i.v. for tracheal intubation. Anaesthesia was maintained with oxygen and nitrous oxide isoflurane with controlled ventilation by a circle system. After securing the endotracheal tube and switching to the anaesthesia ventilator, the patients in each group received their respective blocks.

USG guided PEC II block technique: Patients in group PECS II group were positioned supine with the arm abducted to 90°. A linear array probe of high-frequency (Sonosite M Turbo) was placed on the midclavicular level [7]. The coracoid process was located on ultrasound in the paramedian sagittal plane. With the transducer at the midclavicular level and angled infernolaterally, the axillary artery and vein and the second rib were identified. The transducer was then moved laterally until the third and fourth rib (the pectoralis minor and serratus anterior) were identified. Needling was done using 22 G 9 cm Quincke spinal needle in-plane, cephalad to caudad direction. Local anaesthetic was injected at two interfascial planes. The first injection was made between the pectoralis major and minor muscles, with 10 mL of 0.25% ropivacaine and, the interfacial plane between the pectoralis major and pectoralis minor opens up after correct placement of drug. The second injection was made between the pectoralis minor, and serratus anterior 15 mL of 0.25% ropivacaine was injected. The local anaesthetic was injected after aspiration in 5 cc increments [Table/Fig-1a,b].



[Table/Fig-1]: PECS II block (a) PECS 1 (b) PECS 11.
Red arrow Needle trajectory
Pec. Major-Pectoralis major, P. Min-pectoralis minor

USG guided ESP block technique: The patients in ESP group were placed in the right or left lateral with operating side non dependent after taking utmost care of endotracheal tube during positioning. ESP was performed at the T5 level, using a 38 mm high-frequency linear probe (model: M Turbo, Fujifilm sonosite. inc USA). The inferior angle of the scapula was taken as an anatomical reference of T7. The spinous process of T5 was first identified with the probe in longitudinal orientation at the midline. By moving the probe about 3 cm laterally, trapezius, rhomboid major, and erector spinae muscles were identified. The transverse process was visualised as flat, squared-off acoustic shadows [Table/Fig-2a,b] deeper to the erector spinae muscle plane. After identifying the T5 transverse process, 23 gauge spinal needle (Becton Dickinson. India) was inserted using an in-plane cephalo-caudad approach to contact the bony shadow of the transverse process with a tip placed deep to the fascial plane of erector spinae muscle [Table/Fig-2c]. The correct location of the tip was further confirmed by hydro localisation using normal saline and observing for fluid lifting the erector spinae muscle off the transverse process following which 25 mL of 0.25% ropivacaine in aliquots was injected [Table/Fig-2c]. After performance of the block the patients were positioned supine for surgery.



[Table/Fig-2]: Erector spinae block (a) squared Transverse process, (b) T4, T5 transverse process, (c) needle trajectory (arrow), (d) local anaesthetic lifting off erector spinae from transverse process (*).

The HR and blood pressure were recorded before induction, postinduction, after tracheal intubation, at skin incision, and then every 10 min until the end of surgery. If mean arterial pressure exceeded >25% of baseline fentanyl 1.0 µg/kg i.v. bolus was given. If pain was not controlled with paracetamol Inj. morphine 0.1 mg/kg i.v. was given as rescue analgesic. The patients were monitored for

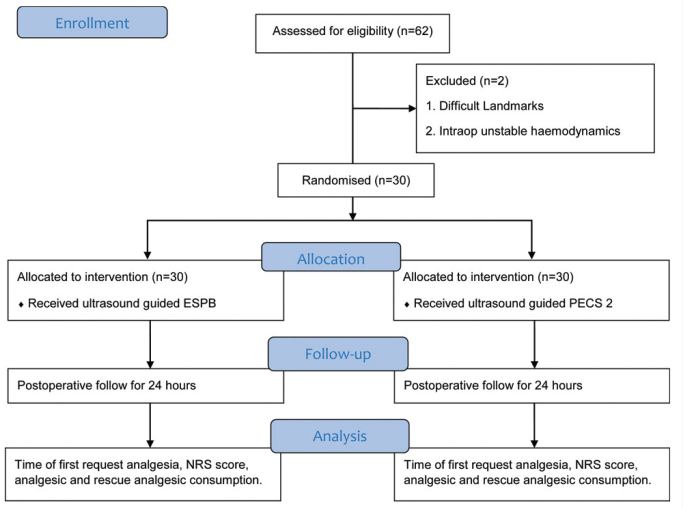
24 hours after surgery in the Postoperative Recovery Unit (PACU) for the following parameters. The duration of analgesia (time to first rescue analgesia after administration of block), total intravenous paracetamol consumption and rescue analgesic in 24 hours after surgery. Numeric rating scale 0-10; (0=no pain and 10=worst pain) was used for assessing postoperative pain [8]. Pain score was recorded at 0.5, 1, 2, 4, 6, 8, 12 and 24 hours after surgery by a pain nurse and analgesic was titrated according to score.

STATISTICAL ANALYSIS

The statistical analysis was conducted by using SPSS version 20.0. Mean, median, standard deviation, were used for descriptive variables and the t-test was used to compare parametric variables with normal distribution between the two groups. Mann-Whitney U test was used to compare parametric variables without normal distribution. Pearson's Chi-square test was performed to compare ratios, and categorical variables were compared using Fisher's exact test. Continuous variables such as blood pressure and heart rate are expressed as mean±SD or median with interquartile range as wherever required. A p-value <0.05 was accepted as statistically significant.

RESULTS

[Table/Fig-3] shows the CONSORT diagram of the patients enrolled on the study. One patient in PECS II group block could not be administered because of difficulty in identifying the landmarks. Another patient in ESPB group had excessive intraoperative bleeding with unstable haemodynamics, so she was excluded. Finally, 30 patients in each group completed the trial. Demographic details are shown in [Table/Fig-4].



[Table/Fig-3]: CONSORT diagram.

Parameters	ESP group (n=30) (mean±SD)	PECSII group (n=30) (mean±SD)	p-value
Age (years)	48.64±14.54	47.30±16.45	0.72
Weight (Kg)	55.61±9.70	54.45±11.20	0.282
Height (cms)	159±10.65	158±12.45	0.542
Duration of surgery (Minutes)	88.6±25.55	89.45±28.65	0.82

[Table/Fig-4]: Demographic data.
Data are expressed as mean±SD

The primary outcome was the time of first request analgesia, which was significantly longer in ESP (255.5±48.76 minutes) than PEC II (197.5±31.35 minutes) (p=0.000347). In the intraoperative period, there was no difference between the groups for fentanyl requirement. Postoperative paracetamol consumption (1.25±0.5 grams vs 2.33±1.2 grams, p<0.04382) was high in PECS II than ESP group. Five patients (16%) in ESPB group and 13 in PECS II (43%) were supplemented with rescue analgesic Inj.morphine 0.1 mg/kg intravenously. Six patients in the PECS II group, and four in the ESPB group had postoperative vomiting (p=0.927). [Table/Fig-5] and intraoperative haemodynamics such as heart rate and mean arterial pressure [Table/Fig-6]. NRS score at 30th min, first and second hour was significant statistically between ESPB and PECS II. There was no difference after second-hour group for NRS at any point of time [Table/Fig-7].

Analgesic requirement		ESP (n=30) mean±SD	PECS II (n=30) mean±SD	p-value
*Intraoperative fentanyl (micrograms)		100±45	100±50	0.6423
*Postop paracetamol (grams)		1.25±0.5	2.33±1.2	0.043824
Postop rescue analgesic	Yes	5 (16.7%)	13 (43.3%)	0.0321
	No	25 (83.3%)	17 (56.7%)	

[Table/Fig-5]: Analgesic requirements between groups.
*Intra op fentanyl and postop paracetamol consumption expressed as mean±SD

Time interval	Heart rate (Mean±SD)			Mean arterial pressure (Mean±SD)		
	ESPB	PECS II	p-value	ESPB	PECS II	p-value
Baseline	88.65±11.72	86.18±9.71	0.864	93.51±5.84	94.87±6.88	0.361
Preinduction	86.32±14.51	87.32±11.65	0.739	91.56±8.81	93.45±7.21	0.400
Postinduction	75.45±11.54	76.68±15.66	0.654	78.51±6.21	77.92±9.32	0.286
Post intubation	93.75±13.61	94.55±14.67	0.542	80.75±5.54	80.66±8.81	0.452
10 Min	78.37±10.05	77.56±12.45	0.654	75.50±6.75	78.31±8.91	0.095
20 Min	76.53±7.84	77.54±11.32	0.732	73.53±6.39	76.09±6.03	0.194
30 Min	73.61±11.23	72.81±9.80	0.644	72.95±5.65	72.16±8.21	0.411
40 Min	74.50±5.15	77.31±11.91	0.432	74.72±8.02	74.88±8.59	0.092
50 Min	72.23±6.39	73.09±5.83	0.634	78.75±3.54	79.61±5.81	0.521
60 Min	71.95±8.68	75.16±9.44	0.411	75.50±7.75	77.31±9.91	0.092
70 Min	72.72±10.02	73.63±11.59	0.092	74.51±6.91	74.09±8.31	0.194
80 Min	74.85±3.54	75.61±4.81	0.422	71.85±5.65	72.16±8.21	0.611
90 Min	73.42±8.77	74.51±4.55	0.571	74.72±8.02	74.88±8.59	0.082

[Table/Fig-6]: Intraoperative haemodynamics.
Min: Minutes. Data expressed as mean±SD

Timeline	PECS II	ESPB	p-value
30 min	5.2±0.8	2.3±0.4	0.041
1 hr.	4.4±0.3	3.2±0.4	0.047
2 hr.	5.2±0.4	3.7±0.8	0.037
4 hr.	4.5±0.3	4±0.5	0.781
6 hr.	4.3±0.4	4.4±0.4	0.921
8 hr.	5.8±0.5	5.5±0.5	0.911
12 hr.	4.4±0.3	4.6±0.6	0.867
24 hr.	3.5±0.4	3.3±0.5	0.921

[Table/Fig-7]: Numeric rating scale outcome.
Hr: Hour

DISCUSSION

Paravertebral block and thoracic epidural were the best possible choice for postoperative pain following mastectomies. The paravertebral block is known for serious complications like pneumothorax [9,10]. Many clinicians hesitate to perform this block as it is an advanced technique. It has been said that facial plane blocks may signal a 'paradigm shift' by displacing the thoracic paravertebral block [11]. ESP and PECS II has the potential to live up to that due to its ever-increasing indications since its first report by Blanco R et al., and Forero M et al., [4,6]. The primary outcome in present study was the time of first request analgesia, which was significantly longer is ESPB than PEC II. The major advantage of ESP block is its ability to gain access to paravertebral space indirectly without the potential risk of needle-pleura interaction and the subsequent possibility of pneumothorax [12]. The ESP block is a fascial plane block whereby local anaesthesia is injected deeper

into ES muscle and superficial to transverse process [13]. ESP block achieves extensive dermatomal spread and the predominant site of action is said to be on the dorsal and ventral rami of spinal nerves.

Coverage of multiple dermatomes is possible due to the extension of this plane along the entire length of the thoracolumbar spine and is partly helped by the 'barrier' produced by the intercostal muscles [14]. Moreover, additional intercostal spread and epidural spread of injectate noticed in cadaveric studies [15,16].

"Modified PECS block" or "PECS block type II" blocks the pectoral nerves, the intercostobrachial, III-IV-V-VI intercostals and the long thoracic nerve. Kikuchi M et al., in his cadaveric study proved that the dye spread after PECS I and II blocks reached the surface of the serratus anterior muscle and extended to the mid-axillary line [17]. The extensive dermatomal spread in ESP block, when compared to PEC II, might be the reason for significance in first request analgesia between groups [18].

Analyses between groups showed a statistically significant difference between ESP and PECS II in NRS score at 30th min, first and second hour. No difference after second-hour group for NRS in any time. Postoperative paracetamol consumption was high PECS 2 than ESP group.

Kulhari S et al., found that postoperative analgesia following the PECS II block was superior to Thoracic Paravertebral Block (TPVB) in patients undergoing MRM [19]. The present study hypothesise that there is mobilisation of local anaesthetic from tissue plane during surgical incision in PECS II block, which is a known problem with any regional technique near the operative field, thus causing a difference in NRS score, paracetamol and rescue analgesic consumption. Haemodynamic parameters, intraoperative fentanyl needed and the incidence of postoperative complications recorded no significant difference between the two groups. This finding was concordant with a study done by Gad M et al., [20].

Limitation(s)

The density and dermatomal mapping of the block was not done as the patients were in general anaesthesia. Patients were not followed-up to quantify the postmastectomy pain syndrome. Future cadaveric studies with different drug volumes are needed to assess the dermatomal spread of the local anaesthetic.

CONCLUSION(S)

Easily recognisable sonoanatomy with a clear endpoint and absence of vital structures in the needle trajectory make ESP block simple and safe. ESP block has better pain control, reduced postoperative pain scores and rescue analgesia than PECS II when given as preventive analgesia in mastectomy surgeries.

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