

Effectiveness of Erector Spinae Plane Block for Postoperative Analgesia in Modified Radical Mastectomy

Kabir MH¹, Mahabubuzzaman M², Bhowmick LK³, Islam MS⁴, Amin MR⁵, Rahim MA⁶

Abstract

Postoperative pain control in breast cancer surgery has become one of the most important goals for anesthesiologists. Several techniques have been trialed for providing postoperative analgesia after breast surgery. This randomized control study was designed to evaluate the postoperative analgesic effect of ultrasound-guided erector spinae plane (US-guided ESP) block for modified radical mastectomy surgery. To evaluate the postoperative analgesic effect of pectoral nerves block and erector spinae plane block for modified radical mastectomy surgery. This prospective, randomized, controlled trial was conducted at the Department of Anaesthesia, Analgesia, Palliative & Intensive Care Medicine in Dhaka Medical College and Hospital. A total 46 patients who were to undergo modified radical mastectomy, fulfilling selection criteria were included in the study following confirmation of the informed written consent and randomly divided into two groups- where each group include 23 Patients. Group A received ultrasound guided ESP and group B received ultrasound guided PECS block. All patients of both groups received GA after confirmation of block. All relevant information including demographic criteria, medical history, clinical evaluation during and after performance of block were collected. All patients were observed peri-operatively and data were recorded into the preformed questionnaires form. Finally, data was analyzed by SPSS version 22.0. Mean age of study population was 52.07±7.08 years with majority in age group 50-59 years. No significant difference was noted between patient's characteristics, duration of surgery and heart rate and mean arterial pressure of patient during and after operation between two groups ($p>0.05$). The mean VAS score was significantly low in ESP block as compared to the PECS block at all-time interval ($p<0.05$) except at 12 hours. Patients with ESP block had significantly late demand of 1st analgesic (12.13±2.45 hours vs 8.89±3.35 hours) ($p<0.05$) and significantly less total opioid consumption (5.17±0.57 mg vs 10.18±1.82 mg) ($p<0.05$) compared to patients with PECS block. Post-operative complication was noted significantly higher among patients with PECS block compared to ESP block. These findings from our study depict ESP block performed in patients scheduled for MRM (modified radical mastectomy) results in better pain control and less postoperative opioid consumption in the first 24 hours than PECS block.

CBMJ 2022 July: vol. 11 no. 02 P: 86-95

Keywords: Spinae plane block, pain, analgesia, breast cancer

Introduction

Among females, breast cancer is the most commonly diagnosed cancer and the leading cause of cancer death worldwide, it is about 11.6% of the total cancer patients. In 2018 it is estimated that 2.1 million newly diagnosed female breast cancer cases accounting for almost 1 in 4 cancer cases among women.¹ In Bangladesh the scenario is not different; it remains the most common cancer among women in the country. It has become a hidden burden which accounts for 69% of cancer deaths in women, with an incidence rate of about 22.5 per 100000 females.²

1. Dr. Md. Humayun Kabir, Department of Anaesthesia, Analgesia, Palliative and Intensive Care Medicine, Dhaka Medical College & Hospital, Dhaka, Bangladesh.
2. Dr. Mohammad Mahabubuzzaman, Department of Anaesthesia, Analgesia, Palliative and Intensive Care Medicine, Dhaka Medical College & Hospital, Dhaka, Bangladesh.
3. Dr. Lipon Kanti Bhowmick, Department of Anaesthesia, Analgesia, Palliative and Intensive Care Medicine, Dhaka Medical College & Hospital, Dhaka, Bangladesh.
4. Dr. Md. Saiful Islam, Department of Anaesthesia, Analgesia, Palliative and Intensive Care Medicine, Dhaka Medical College & Hospital, Dhaka, Bangladesh.
5. Dr. Md. Ruhul Amin, Department of Anaesthesia, Analgesia, Palliative and Intensive Care Medicine, Dhaka Medical College & Hospital, Dhaka, Bangladesh.
6. Dr. Md. Abdur Rahim, Department of Anaesthesia, Analgesia, Palliative and Intensive Care Medicine, Dhaka Medical College & Hospital, Dhaka, Bangladesh.

Address of Correspondence:
Email: mahabubkmc@gmail.com

The principal treatment modality of breast cancer is surgery, modified radical mastectomy is often required for the patients presenting at the first and second stage of the disease. The surgery involves removal of a large amount of tissue including, entire breast is removed, including the skin, areola, nipple, and most axillary lymph nodes.³ Leading to extensive tissue injury with a great chance of postoperative pain which sometimes becomes a matter of great concern after breast surgery. Nearly half of the patient suffers chronic pain, one quarter of them described their pain as moderate to high.⁴ There are several risk factors for chronic postoperative pain, these includes younger age, invasive surgical interventions, and adjuvant radiation therapy following surgery. It is also evidenced that high pain score in the early postoperative period is an important independent risk factors for chronic postoperative pain.⁵

With the rise of breast cancer incidence the breast cancer surgery is also increasing,⁶ thus increasing the need of optimum perioperative management to reduce the surgery related morbidities. The perioperative anaesthetic management plays the vital role in this aspect specially mentioning about the post-operative pain management. Different modern pain management modalities are available in different centers around the world. The surgeries for breast cancer can be done under several varieties of regional technique such as thoracic paravertebral block, thoracic segmental epidural block, and intercostal nerve block.⁷ These techniques are used for anaesthesia and managing of their postoperative pain. But all anaesthesiologist are not familiar with those invasive techniques in breast cancer surgery. A less invasive new technique described by Blanco *et al.* is the pectoral nerve block (PECS block),

where local anesthetic is injected into the plane between the two pectoralis muscles, pectoralis major and pectoralis minor muscles (PECS-I block) and between the pectoralis minor and serratus anterior muscle at the third rib (PECS-II block).⁸ Ultrasound-guided pectoral nerve block is less invasive techniques, it allows direct visualization of peripheral nerves, the block needle and local anaesthetic distribution. So ultrasound imaging guidance pectoral nerve block (PECS block) has less chance of complication like pneumothorax, puncture vascular structures and systemic injection of local anaesthetic agents and which provides good analgesia during and after breast surgery such as total radical mastectomy.

Ultrasound-guided erector spinae plane block (ESP) was first described for the treatment of thoracic neuropathic pain, is a peri-paravertebral regional anesthesia technique that has since been reported as an effective technique for prevention of postoperative pain in various surgeries.^{4,9} In ESP block, local anesthetic is administered into the interfascial plane between the transverse process of the vertebra and the erector spinae muscles, spreading to multiple paravertebral spaces thus blocks the pain pathways of that particular region thus gives an analgesic effect.⁹

Most published articles concluded that the ESP block is an effective analgesic technique in a variety of clinical scenarios. It can be utilized successfully in the treatment of acute and chronic pain. Likewise, it has also been effective for analgesia at the cervical, thoracic, and abdominal levels. Other studies indicated that it can provide adequate analgesia in the upper or lower limbs if it is performed at the high thoracic and lumbar levels, respectively.¹⁰ Case reports have been reported that ESP block affects both the ventral

and dorsal rami and leading to blockage of both visceral and somatic pain.¹¹ The procedure has mostly been described for postoperative analgesia at the thoracic level. Additionally, it has a low rate of reported complications.¹⁰

Several other studies also reported that ESP block significantly reduces post-operative pain after modified radical mastectomy, total radical mastectomy and other breast surgeries.¹¹⁻¹³ It also reduces the requirement of conventional analgesic treatment, which possess a great value on reducing the analgesic related adverse drug reactions and also contributes to achieve a good long term outcome of pain related morbidities.^{9,11}

Both PECS and ESP block are still not very common practices in Bangladesh probably due to less evidence of its uses and consequences. As breast cancer surgery is not uncommon in this country and patients often suffer from post-operative pain after this extensive surgery which is almost entirely dependent on the opioids and non-steroidal anti-inflammatory drugs (NSAID). Those measures often fail to achieve the expected level of pain relief, eventually contribute to worsen the postoperative morbidities.

The current study was designed to compare the effectiveness of US-guided PECS block and US-guided ESP block as postoperative analgesia and to measure the conventional postoperative analgesic requirements in both groups after modified radical mastectomy.

Methods

This Prospective, randomized controlled trial was conducted Department of Anaesthesia, Analgesia, Palliative and Intensive Care Medicine, in collaboration with department of Surgery, Dhaka Medical College Hospital (DMCH), Dhaka. After having ethical clearance by Institutional Ethical Review Committee (ERC)

of DMCH, the study was carried out among Patients who underwent modified radical mastectomy due to breast cancer from September 2017 to March 2020. Patients were included as they had ASA class I&II, Breast cancer stage (I, II) and who were given informed written consent. Patients were excluded as they had known allergic to local anesthetics, bleeding diathesis or on anticoagulants, Patients having chest wall and spine deformities, Psychiatric disorders or on psychiatric medication, Breast cancer stage (III and IV) and those with infections at the site of injection.

During pre-anaesthetic visit participants were selected according to the inclusion and exclusion criteria, they were approached to be included in the study. Following informed about the study aim, objectives and procedure and written consent was taken from each participant. History taking focusing clinical features, disease duration along with physical examination was done as per standard protocol. Patients were educated about the 10 cm visual analogue scale (VAS) during the preoperative assessment.

All patients were underwent a preoperative assessment on the day before surgery. Patients were randomly allocated into two groups, group A and group B with 23 patients in each group by computer-generated random numbers. Random group assigned was enclosed in a sealed opaque envelope to ensure concealment of allocated sequences. Sealed envelope was opened by the researcher anaesthesiologist, who performed the regional block according to randomization. Group A patients received US-guided ESP block and Group B patients received US-guided PECS block before general anaesthesia. All the patients belonging to group A and B shifted to procedure room for PECS block. After securing intravenous line in the contra lateral arm of the surgical side

and were attached to the standard monitoring. The monitors attached included non-invasive blood pressure (NIBP), electrocardiography (ECG), and peripheral oxygen saturation (SpO₂).

The patients of group A were placed in sitting position. The spine was palpated from C7 downward to T5 and point was marked to identify the T5 spinous process. After ensuring skin asepsis, the skin puncture point was infiltrated with 2 ml of 2% lignocaine by 27-gauge insulin needle then high frequency (8–12 MHz) linear probe of ultrasound machine in a sterile sheath was placed 3 cm lateral to the T5 spinous process at the side of operation. The three muscles from outward trapezius, rhomboidus major and erector spinae muscle was identified. After identification of the site of entry a 22-gauge hyperechoic sononeedle was inserted using an in-plane superior to inferior approach to place the tip into fascial plane on the deep (anterior) aspect of erector spinae muscle. The location of the needle tip was confirmed by visible fluid spread below erector spinae muscle off the bony shadow of the transverse process. A total 20 ml of 0.25% bupivacaine was injected through the needle.

The patients of group B received pectoral nerve block which was performed on the side of surgery with the patient in the supine position and the arm abducted. Infra-clavicular and axillary region were disinfected by using chlorhexidine-alcohol or povidone iodine if the patient was allergic to chlorhexidine-alcohol. The ultrasound probe was used aseptically. The ultrasound machine Sonosite M-Turbo, Bothell, Washington, USA with a high frequency linear (8–12MHz) probe were used for the block. The probe was placed obliquely under the lateral third of the clavicle. After identification of the axillary artery the probe moved distally towards the axilla to locate the

2nd, 3rd and 4th ribs, at this level the lateral border of the pectoralis major and pectoralis minor muscles were identified. The plane between the pectoralis major and pectoralis minor muscles were targeted for the block. After identification of the site of entry, the skin puncture point was infiltrated with 2 ml of 2% lignocaine by 27-gauge insulin needle. In plane technique was used for the block with a 22-gauge hyperechoic needle from the medial to lateral side. 10 ml of 0.25% bupivacaine was injected at the level of 4th rib (PECs I) then the needle was advanced deeply to reach the plane between the pectoralis minor and serratus anterior muscles and 20 ml of 0.25% bupivacaine was injected through the needle.

The patients were observed for 30 min after performing the block. The sensory level of block was assessed with pin-prick sensation every 5 min in each dermatomal distribution from T1 to T8. After confirmation of the block patients were shifted to operating room.

On arrival in operating room standard monitoring systems were attached included non-invasive blood pressure (NIBP), electrocardiography (ECG), and peripheral oxygen saturation (SpO₂). Then anaesthesia was induced with propofol 2 mg /kg and fentanyl 2 mcg/kg IV in both the groups. Tracheal intubation was facilitated by suxamethonium 2 mg/kg intravenously. Anaesthesia was maintained by halothene (0.5-0.75%) and 66% nitrous oxide in oxygen. Vecuronium 0.1 mg/kg was given as bolus and then 1mg incremental for muscle relaxation. Neostigmine 0.05 mg/kg and atropine 0.02 mg/kg were used to recover of the patients. After full regaining of muscle power patients were extubated. When the patient opened eye in responding to verbal command than transferred to the post-anaesthetic care unit (PACU).

In PACU the pain score was evaluated by VAS (VAS; 0, no pain; 10, the worst pain imaginable) was given with intravenous morphine 0.1mg/kg boluses on demand or whenever VAS pain score reached ≥ 5 in both the groups.

Total morphine consumption during the first 24 h after operation was recorded. The incidence of any adverse events like hypotension, nausea, vomiting and dizziness were recorded. Intravenous ondansetron 8 mg was given for severe nausea or vomiting.

All relevant information including demographic features, past medical history and present clinical evaluation of patient were recorded in pre designed case record form and were checked for any inconsistency. Statistical analysis was performed by using t-test in case of qualitative data and chi-square test was done for quantitative data. Then collected data were analyzed in SPSS 22. After analyses of all data $P < 0.05$ was considered statistically significant and $P < 0.001$ was considered highly statistically significant. The study was approved by the Ethical Review Committee of Dhaka Medical College, Dhaka.

Results

This study was carried among 46 patients, who were scheduled for modified radical mastectomy under general anesthesia belonging to ASA class I and ASA class II were included in this study and randomly divided into two groups with 23 patients in each group A and group B. We evaluated the postoperative analgesic effect of erector spinae plane block and pectoral nerves block for modified radical mastectomy surgery. Mean age of all patients was 52.07 ± 7.08 years with majority belonged to 50-59 years of age (52.17%). Maximum patient had ASA Class I (58.70%).

There had no statistically significant difference in any characteristics of patients between two groups as $p > 0.05$ (table-I). Average duration of surgery was 114.43 ± 11.67 minutes with no significant difference between two groups (p value 0.765) (table-I).

There had been no significant difference in average HR between two groups as $p > 0.05$ (figure-1). Figure -2 showed that there had been no significant difference in mean arterial pressure (MAP) between two groups as $p > 0.05$.

The VAS scores were significantly lower in ESP group at all-time intervals except at 12 hours. The scores were higher at these time points and this difference was statistically significant. In both group VAS score was decreased after giving rescue analgesia (table-2).

Mean VAS score was low in ES as compared to PECS block at an all-time interval. Mean value of Visual Analogue Score on 30min, 1st, 2nd, 4th, 6th, 8th, 10th, 12th, 16th and 24th hours on post-operative day was 0.43, 0.78, 1.17, 1.83, 2.22, 2.52, 5.5, 7.8, 2.17 and 1.57 in group A and 0.87, 1.52, 2.71, 3.04, 3.74, 5.48, 3.26, 5.83 and 2.39 in group B. VAS score was higher among group B at 8 hours and 16 hours. In case of group A VAS score was more at 12th hour. Up to 24 hours VAS score was significantly high in group B (table-II & figure-3).

Patients with ESP block had significantly lower opioid requirements compared to PECS block in first 24 hr. Time taking 1st analgesic demand was significantly high in ESP block group (table-III).

Patients received PECS block had developed significantly ($p < 0.05$) high post-operative complication like nausea and dizziness compared to ESP block (table-IV).

Table-I: Comparison of demographic characteristics and duration of surgery of the patients between two groups. (n=46)

| Characteristics | | Group A (n=23) | Group B (n=23) | P value |
|-------------------------------|-------------------|-------------------|-------------------|---------|
| Age (years) | 30-39 years | 2 (8.7%) | 2 (8.7%) | 0.972* |
| | 40-49 years | 6 (26.09%) | 5 (21.74%) | |
| | 50-59 years | 12 (52.17%) | 12 (52.17%) | |
| | 60 year and above | 3 (13.04%) | 4 (17.39%) | |
| | Mean±SD | 51.7±7.16 | 52.43±7.13 | |
| Weight (kg) | | 55.87±5.56 | 56.30±5.17 | 0.785** |
| Height (cm) | | 155.96±3.76 | 157.30±3.81 | 0.233** |
| ASA | Class I | 13 (56.52%) | 14 (60.87%) | 1.00* |
| | Class II | 10 (43.48%) | 9 (39.13%) | |
| Stage | I | 11 (47.83%) | 12 (52.17%) | 1.00* |
| | II | 12 (52.17%) | 11 (47.83%) | |
| Duration of surgery (minutes) | | 113.91±11.84 | 114.96±11.73 | 0.765** |

Values are expressed as Mean±SD and within parenthesis percentage (%) over column in total. *Pearson chi-squared Test (χ^2) was performed. ** Student t-test was performed.

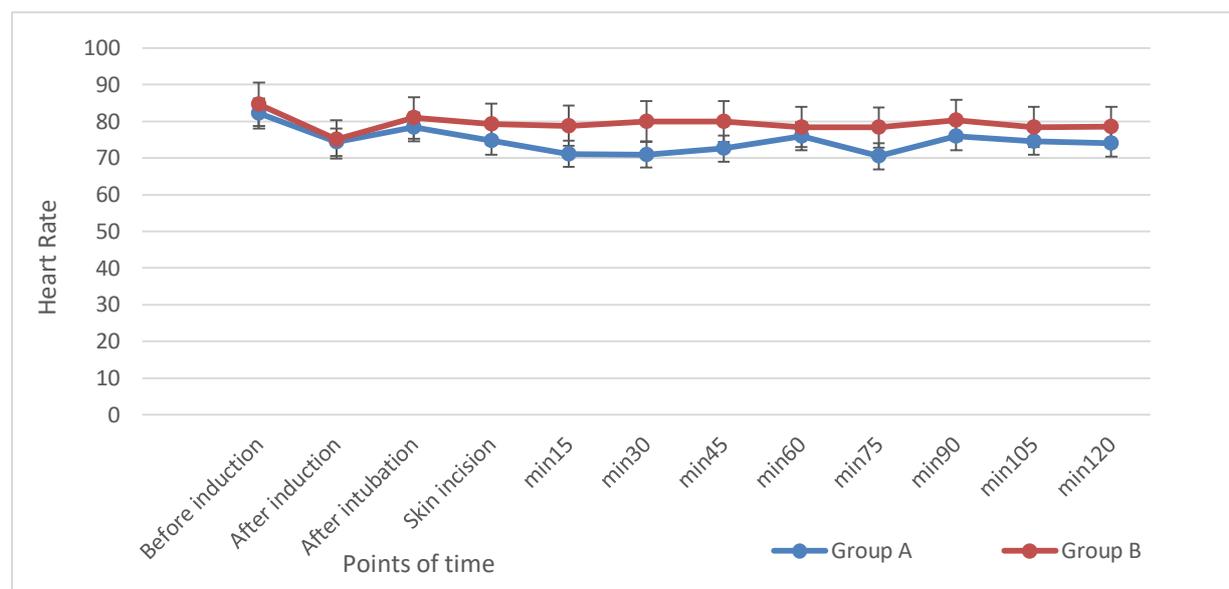
Figure-1: Heart rate of the patients.

Figure-2: Mean arterial pressure of the patients.

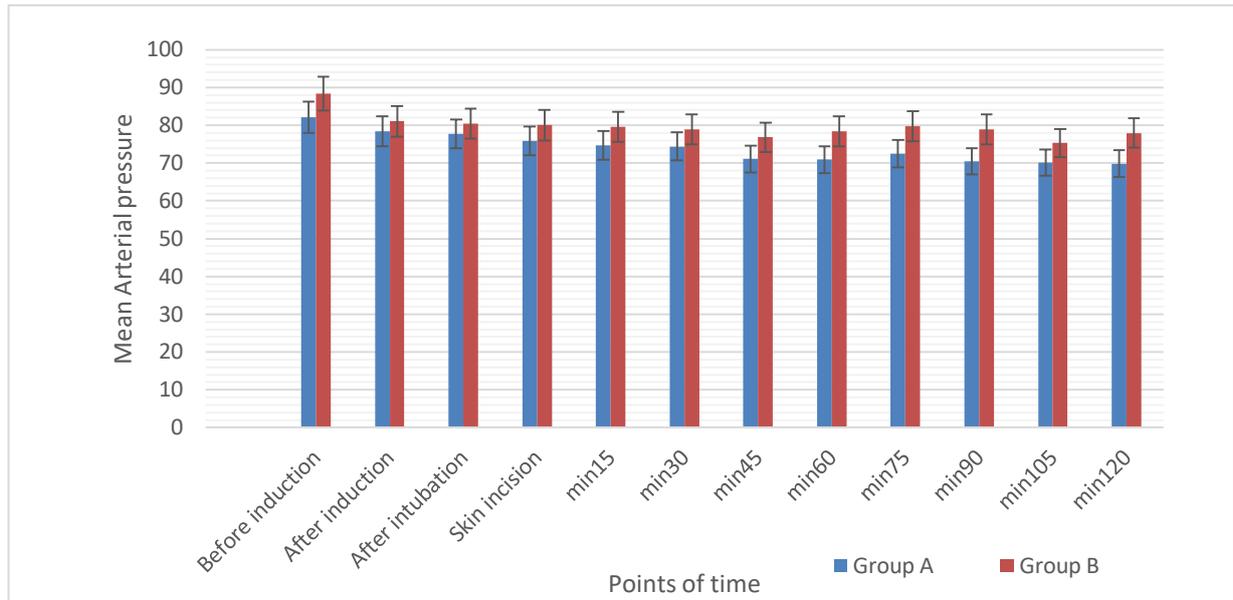


Table-II: VAS score of the patients. (n=46)

| VAS score | Group A (n=23) | Group B (n=23) | P value |
|-----------|----------------|----------------|----------|
| Min 30 | 0.43±0.59 | 0.87±0.69 | 0.027** |
| Hour 1 | 0.78±0.6 | 1.52±0.73 | 0.001** |
| Hour 2 | 1.17±0.72 | 2.17±0.89 | <0.001** |
| Hour 4 | 1.83±1.03 | 3.02±1.30 | <0.001** |
| Hour 6 | 2.22±1.76 | 3.74±1.39 | <0.001** |
| Hour 8 | 2.52±1.53 | 5.48±1.78 | 0.001** |
| Hour 12 | 5.78±0.95 | 3.26±0.81 | 0.003** |
| Hour 16 | 2.17±0.58 | 5.83±1.30 | 0.001** |
| Hour 24 | 1.57±0.84 | 2.39±0.72 | 0.001** |

Values are expressed as Mean ±SD. ** Student t-test was performed to compare the mean VAS score of both groups.

Figure 3: Trends in VAS score of patients.

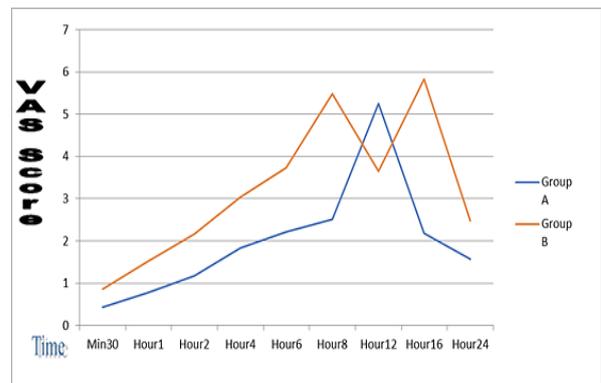


Table-III: Assessment of analgesic requirements of the patients. (n=46)

| Variables | Group A (n=23) | Group B (n=23) | P value |
|---|----------------|----------------|----------|
| 1 st analgesic demand (hour) | 12.13±2.45 | 8.89±3.35 | <0.001** |
| Total opioid consumption (mg) | 5.71±0.57 | 11.18±1.82 | <0.001** |

Values are expressed as Mean±SD and within parenthesis percentage (%) over column in total. ** Student t-test was performed

Table-IV: Complication of the patients. (n=46)

| Complication | Group A (n=23) | Group B (n=23) | P value |
|--------------|-------------------|-------------------|---------|
| Nausea | 3 (13.04%) | 10 (43.48%) | 0.047* |
| Vomiting | 1 (4.35%) | 3 (13.04%) | 0.608* |
| Hypotension | 1 (4.35%) | 3 (13.04%) | 0.608* |
| Dizziness | 2 (8.70%) | 9 (39.43%) | 0.035* |

Discussion

Breast cancer is the most common malignancy of women all over the world. Unfortunately, two-thirds of women who undergo breast cancer surgery are reported to develop chronic pain in the postoperative period.¹⁴ Achieving adequate perioperative analgesia can be challenging in patients undergoing breast cancer surgeries. These patients experience significant postoperative pain. Regional anaesthetic techniques like thoracic epidural and paravertebral blocks were considered gold standard analgesic techniques to date.¹⁵ These techniques may be associated with problems like pneumothorax, vascular puncture, nerve damage etc.⁷ As an alternative to these blocks, some newer techniques have been designed with better safety profile and comparable pain relief. Pectoral nerve block (PECS) is an inter-fascial block technique, in which the drug is deposited into the inter-fascial plane between the pectoralis major and minor/pectoralis minor and serratus anterior muscles.⁸ Ultrasound-guided erector spinae plane (US-ESP) block is a novel analgesic technique in which local anaesthetic drug is injected superficial or deep to erector spinae muscle. This block has been used in various surgeries including radical mastectomy.¹⁶ There have been fewer studies comparing both of these

blocks in these surgeries, but none in the Bangladeshi population.¹⁷

The mean age of all patients was 52.07±7.08 years with the majority belonged to 50-59 years of age (52.17%). The maximum patient had ASA class I (58.70%) with no statistical significance between groups (p>0.05). The average duration of surgery was 114.43±11.67 minutes which was also not significantly different between two Groups (p value 0.765). There had a statistically significant difference in VAS score after 30 minutes, 1, 2, 4, 6, 8,10, 12, 16 and 24 hours of surgery as p value <0.05. The mean VAS score was low in ESP block as compared to the PECS block at an all-time interval except at 12 hours which was statistically significant. Besides, patients with ESP block had significantly lower analgesic requirements with post-operative rescue analgesic needed (p value 0.047), 1st analgesic demand (12.13±2.45 vs. 8.89±3.35 hour, p value <0.001) and total opioid consumption (5.17±0.57 vs. 11.18±1.82 mg, p value 0.002). Furthermore, complications like nausea and dizziness were significantly high (p value 0.029) in PECS block in compared to ESP block.

ESP block has been used for postoperative analgesia of several painful conditions since 2016. In these studies, the researchers used different concentrations of bupivacaine, ropivacaine, and lidocaine during block procedures.^{9,18-20} Similarly, two other studies evaluated the effect of ESP block by using 20ml of 0.25% bupivacaine. These studies reported that ESP block provided effective postoperative analgesia after unilateral mastectomy surgery.^{21,22} We evaluated the effect of ESP block using the same volume and observed similar effect.

A randomized control trial done by Gürkan *et al.* on analgesic effect of single shot US-guided ESP for breast surgery showed a similar effect like our study.²⁰ They observed a decrease in postoperative morphine consumption by 65% which was statistically significant, thus establishing its role for analgesia and postoperative opioid sparing effect. Nair *et al.* published efficacy of this block in a similar surgery on a case series of five patients.²³

They also had a very encouraging result of no requirement of opioid in any of their patient for rescue postoperative analgesia. Most of case reports/ series has used this block for perioperative analgesia but Kimachi *et al.*²⁴ used US-guided ESP for complete surgical anaesthesia for a right-sided mastectomy and axillary dissection in a patient with high cardiovascular risk. They not only accomplished complete surgical anaesthesia but also less requirement of postoperative analgesic.

These findings from our study depict ESP block performed in patients scheduled for MRM (modified radical mastectomy) results in better pain control and less postoperative opioid consumption in the first 24 hours. Hence it is a superior block than PECS in patients scheduled for MRM surgeries.

Erector spinae plane block can be used for postoperative analgesia in modified radical mastectomy.

Conclusion

ESP block gives more prolongation of analgesia than that of PECS block and also reduced opioid consumption in first 24 hours in modified redical mastectomy.

Limitations

This study had some limitations as follows:

1. The present study was conducted among the patient with stage I and stage II but what will be the effect if the patient has stage III and stage IV.
2. As short time follow up was observed for first 24 hours so we were unaware about development of chronic post-surgical pain.
3. The volume of local anaesthetic is different in two blocks.

References

1. Bray F, Ferlay J, Soerjomataram I, Siegel RL, Torre LA, Jemal A. *Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries.* *CA Cancer J Clin.* 2018 Nov;68(6):394-424.
2. Uddin AF, Khan ZJ, Islam J, Mahmud A. *Cancer care scenario in Bangladesh.* *South Asian J Cancer.* 2013 Apr;2(2):102-4.
3. Freeman MD, Gopman JM, Salzberg CA. *The evolution of mastectomy surgical technique: from mutilation to medicine.* *Gland Surg.* 2018 Jun;7(3):308-315.
4. Altıparmak B, Korkmaz Toker M, Uysal Aİ, Gümüş Demirbilek S. *Comparison of the efficacy of erector spinae plane block performed with different concentrations of bupivacaine on postoperative analgesia after mastectomy surgery: ramdomized, prospective, double blinded trial.* *BMC Anesthesiol.* 2019 Mar 4;19(1):31.
5. Bruce J, Thornton AJ, Powell R, Johnston M, Wells M, Heys SD, Thompson AM, Smith CW, Chambers AW, Scott NW; Recovery Study Group. *Psychological, surgical, and sociodemographic predictors of pain outcomes after breast cancer surgery: a population-based cohort study.* *Pain.* 2014 Feb;155(2):232-243.
6. DeSantis C, Ma J, Bryan L, Jemal A. *Breast cancer statistics, 2013.* *CA Cancer J Clin.* 2014 Jan-Feb;64(1):52-62.
7. Schnabel A, Reichl SU, Kranke P, Pogatzki-Zahn EM, Zahn PK. *Efficacy and safety of paravertebral blocks in breast surgery: a meta-analysis of randomized controlled trials.* *Br J Anaesth.* 2010 Dec;105(6):842-52.

8. Blanco R, Fajardo M, Parras Maldonado T. *Ultrasound description of Pecs II (modified Pecs I): a novel approach to breast surgery. Rev Esp Anesthesiol Reanim.* 2012 Nov;59(9):470-5.
9. Tulgar S, Kapakli MS, Senturk O, Selvi O, Serifsoy TE, Ozer Z. *Evaluation of ultrasound-guided erector spinae plane block for postoperative analgesia in laparoscopic cholecystectomy: A prospective, randomized, controlled clinical trial. J Clin Anesth.* 2018 Sep;49:101-106.
10. Kot P, Rodriguez P, Granell M, Cano B, Rovira L, Morales J, Broseta A, Andrés J. *The erector spinae plane block: a narrative review. Korean J Anesthesiol.* 2019 Jun;72(3):209-220.
11. Swati S, Kumar GA. 'Ultrasound-guided erector spinae plane block for postoperative analgesia in modified radical mastectomy: A randomised control study', *Indian J Anaesth.* 2019 October; 4:200-4.
12. Orozco E, Serrano RE, Rueda-Rojas VP. *Erector spinae plane (ESP) block for postoperative analgesia in total radical mastectomy: case report. Colomb. J. Anesthesiol. [Internet].* 2018 Dec. 1 [cited 2022 Aug. 1];46(Supplement):66-8.
13. Aksu C, Kuş A, Yörükoğlu HU, Tor Kılıç C, Gürkan Y. *Analgesic effect of the bi-level injection erector spinae plane block after breast surgery: A randomized controlled trial. Agri.* 2019 Jul;31(3):132-137.
14. Macdonald L, Bruce J, Scott NW, Smith WC, Chambers WA. *Long-term follow-up of breast cancer survivors with post-mastectomy pain syndrome. Br J Cancer.* 2005 Jan 31;92(2):225-30.
15. Sinha C, Kumar A, Kumar A, Prasad C, Singh PK, Priya D. *Pectoral nerve versus erector spinae block for breast surgeries: A randomised controlled trial. Indian J Anaesth.* 2019 Aug;63(8):617-622.
16. Forero M, Adhikary SD, Lopez H, Tsui C, Chin KJ. *The Erector Spinae Plane Block: A Novel Analgesic Technique in Thoracic Neuropathic Pain. Reg Anesth Pain Med.* 2016 Sep-Oct;41(5):621-7.
17. Bashandy GM, Abbas DN. *Pectoral nerves I and II blocks in multimodal analgesia for breast cancer surgery: a randomized clinical trial. Reg Anesth Pain Med.* 2015 Jan-Feb;40(1):68-74.
18. Hamilton DL, Manickam B. *Erector spinae plane block for pain relief in rib fractures. Br J Anaesth.* 2017 Mar 1;118(3):474-475.
19. Chin KJ, Malhas L, Perlas A. *The Erector Spinae Plane Block Provides Visceral Abdominal Analgesia in Bariatric Surgery: A Report of 3 Cases. Reg Anesth Pain Med.* 2017 May/Jun;42(3):372-376.
20. Gürkan Y, Aksu C, Kuş A, Yörükoğlu UH, Kılıç CT. *Ultrasound guided erector spinae plane block reduces postoperative opioid consumption following breast surgery: A randomized controlled study. J Clin Anesth.* 2018 Nov;50:65-68.
21. Chin KJ, Adhikary S, Sarwani N, Forero M. *The analgesic efficacy of pre-operative bilateral erector spinae plane (ESP) blocks in patients having ventral hernia repair. Anaesthesia.* 2017 Apr;72(4):452-460.
22. Veiga M, Costa D, Brazão I. *Erector spinae plane block for radical mastectomy: A new indication? Rev Esp Anesthesiol Reanim (Engl Ed).* 2018 Feb;65(2):112-115.
23. Nair AS, Seelam S, Naik V, Rayani BK. *Opioid-free mastectomy in combination with ultrasound-guided erector spinae block: A series of five cases. Indian J Anaesth.* 2018 Aug;62(8):632-634.
24. Kimachi PP, Martins EG, Peng P, Forero M. *The Erector Spinae Plane Block Provides Complete Surgical Anesthesia in Breast Surgery: A Case Report. A A Pract.* 2018 Oct 1;11(7):186-188.