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**Research Article**

# Thoracic paravertebral block versus pectoral nerve block for analgesia after breast surgery

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**KEYWORDS**

Paravertebral block;
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**Abstract** *Background:* Pectoral nerve block (Pecs) is a novel interfascial plane block which can provide analgesia after breast surgery while paravertebral block (PVB) is widely used for this purpose. We evaluated the difference between the two techniques in regard to morphine consumption and analgesic efficacy after modified radical mastectomy (MRM).

*Methods:* Sixty patients undergoing elective MRM were randomly allocated into either PVB with 15–20 ml of levobupivacaine 0.25% at the level of fourth thoracic vertebra or Pecs block with 10 ml of levobupivacaine 0.25% injected inbetween pectoralis major and pectoralis minor muscle and another 20 ml levobubivacaine 0.25% inbetween pectorlis minor and serratus anterior muscle. Primary outcome measure was morphine consumption in the first 24 h while secondary outcome measures included pain scores, intraoperative fentanyl consumption as well as postoperative nausea and vomiting (PONV).

*Results:* Postoperative morphine consumed at 24 h was significantly lower in Pecs group [21 (20–25) mg] than in PVB group [28 (22–31) mg], ($p = 0.002$). Time for first request of morphine was longer in Pecs group [175 (155–220) min] than in PVB group [137.5 (115–165) min], ($p < 0.001$). Numerical rating score (NRS) at rest was lower in Pecs group compared with PVB group at 1 h, 6 h and 12 h ($p < 0.001$) but at 18 h and 24 h it was lower in PVB group compared with Pecs group ($p = 0.008$ and $< 0.001$ respectively). During movement, NRS was significantly lower at 1st hour in Pecs group ($p < 0.001$) while at 18 h and 24 h it was significantly lower in PVB group ($p < 0.001$). PONV was comparable between both groups.

*Conclusion:* Pecs block reduced postoperative morphine consumption in the first 24 and pain scores in the first 12 h in comparison with PVB after mastectomy.



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## 1. Introduction

Appropriateness of postoperative analgesic technique after breast surgery is always questionable; especially many breast surgeries are performed on the basis of day case setting. Although thoracic epidural analgesia is the gold standard technique after breast surgery [1], paravertebral block (PVB) has become a potential alternative approach [2–6]. However, both techniques may be associated with serious complications such as pneumothorax, total spinal anesthesia and inadvertent intravascular injection.

On the other hand, attributed to the recent application of ultrasound (US) in anesthetic practice, several interfascial plane blocks have been described recently. Pectoral nerve block (Pecs) is a novel interfascial plane block [7] which can provide analgesia after breast surgery. A recent study compared PVB versus combination of PVB with Pecs block in reconstructive breast surgery [8]. We hypothesized that the analgesic efficacy of Pecs block performed under US would provide a better analgesia with fewer complications in comparison with PVB. Therefore, the aim of this study is to compare postoperative morphine consumption as well as analgesic efficacy of both techniques in the first 24 h after MRM.

## 2. Methods

After the approval of our scientific and research ethic committee (Ain-Shams University hospital), written informed consent was taken from 60 ASA physical status I–II patients (ages 36–63) scheduled for elective MRM between September 2012 and May 2013. Patients were excluded if they had a history of sensitivity to local anesthetic, bleeding disorders or receiving anticoagulant, body mass index (BMI) $\geqslant 35/kg/m^2$, spine or chest wall deformity or pregnancy. During preoperative visit; demographic data were recorded and numerical rating score (NRS; 0–10, 0 = no pain, 10 = worst pain) was explained to patients. Before surgery patients were randomly allocated according to the computer generated sequence into two equal groups. Group I (PVB = 30 patients) received a single ipsilateral PVB while the group II (Pecs = 30 patients) received US guided Pecs block preoperatively. PVB was performed with one of the investigators with the patient in sitting position at the level of 4th thoracic vertebra under complete aseptic precaution with low resistant technique with saline using an 18-G tuohy needle (Perifix, B Braun, Melsungen AG, Germany) according to Eason and Waytt' technique [9], seeking contact with the transverse process of the 4th thoracic vertebra then sliding the needle caudally for 1–1.5 cm into the paravertebral space and 15–20 ml of levobupivacaine 0.25% was injected. Pecs block was performed by another investigator while the patient in supine position with placing the ipsilateral upper limb in abduction position with a 50 mm needle (Stimuplex D, B Braun, Melsungen AG, Germany) using a linear US probe of high frequency (6–13 MHz, Sonosite, Bothell, WA, USA) after sheathing. The US probe was first placed at infraclavicular region after skin sterilization and moved laterally to locate the axillary artery and vein directly above 1st rib where pectoralis major and pectoralis minor muscles are identified at this US window. After infiltration of the skin at puncture site with 3 ml of xylocaine 2%, the needle was inserted in plane with US probe to the fascial plane between pectoralis muscles and 10 ml of levobupivacaine 0.25% was injected. Then, the US probe was moved toward axilla till serratus anterior muscle was identified above 2nd, 3rd and 4th ribs then the needle was reinserted into the fascial plane between pectoralis minor muscle and serratus anterior muscle and 20 ml of bupivacaine 0.25% was injected in increments of 5 ml after aspiration (Fig. 1). The sensory level was tested with pin prick and ice pack before induction of general anesthesia.

All patients received midazolam 1–2 mg before the induction of anesthesia and monitored with three leads electrocardiography, pulse oximetry, noninvasive blood pressure and capnography. General anesthesia was induced with fentanyl 1 μg/kg, propofol 1.5–2 mg/kg and tracheal tube was facilitated with atracurium 0.5 mg/kg. Anesthesia was maintained with isoflurane 1.5% and O2/air mixture with a fraction of 40% inspired O2. Fentanyl 25 μg in bolus doses was given intravenously if the mean blood pressure (MBP) or heart rate exceeded 20% of the preoperative value. Hypotension was defined as a decrease of more than 20% of the base line MBP and was treated with increments of 6 mg bolus doses of ephedrine iv and 250 ml of lactated ringer solution.

After recovery from anesthesia, patients were shifted to post-anesthetic care unit (PACU) for the first 2 h. Postoperative analgesia was provided with morphine. The PCA pump (Graseby 3300, Graseby Medical Ltd., Watford, UK), was programmed to deliver 1 mg morphine bolus per press with a lockout interval of 15 min and morphine consumption in the first 24 h was recorded. Pain intensity was measured using NRS (1–10) at rest and during abduction of the ipsilateral upper limb at 1, 6, 12, 18, and 24 h.

Nausea lasting more than 10 min or vomiting was treated with ondansetron 4 mg. Patient' satisfaction for postoperative analgesia was recorded according to a satisfaction score (poor = 0, fair = 1, good = 2, excellent = 3). All data were recorded with residents of anesthesia not sharing in the study. Complications related to local anesthetic drug and PVB technique like pneumothorax or epidural spread of local anesthetic as evidenced by test for sensory deficit on contralateral side were also recorded. Chest X-ray was requested for any patient in PVB group if had any difficulty of breath, desaturated or had diminished air entry at any time after the block. Primary outcome was morphine consumption in the first 24 h. Secondary outcome measures were pain intensity at rest and during movement, intraoperative fentanyl consumption, postoperative nausea and vomiting (PONV) and patient' satisfaction.

## 3. Statistical analysis

The required sample size was calculated using the IBM© SPSS© SamplePower© version 3.0.1 (IBM© Corp., Armonk, NY, USA). The primary outcome measure was the difference between the two study groups as regards the postoperative morphine consumption. A previous study [10] reported that the mean (SD) 24-h morphine consumption associated with PVB was 42.6 (11) mg. Thus, it was estimated that a sample size of 30 patients in each study group would achieve a power of 88% to detect a reduction of 20% in the mean morphine consumption associated by pectoral nerve block using a two-sided $t$ test at a significance level of 0.05.

Statistical analysis was done on a personal computer using IBM© SPSS© Statistics (IBM© Corp., Armonk, NY) version

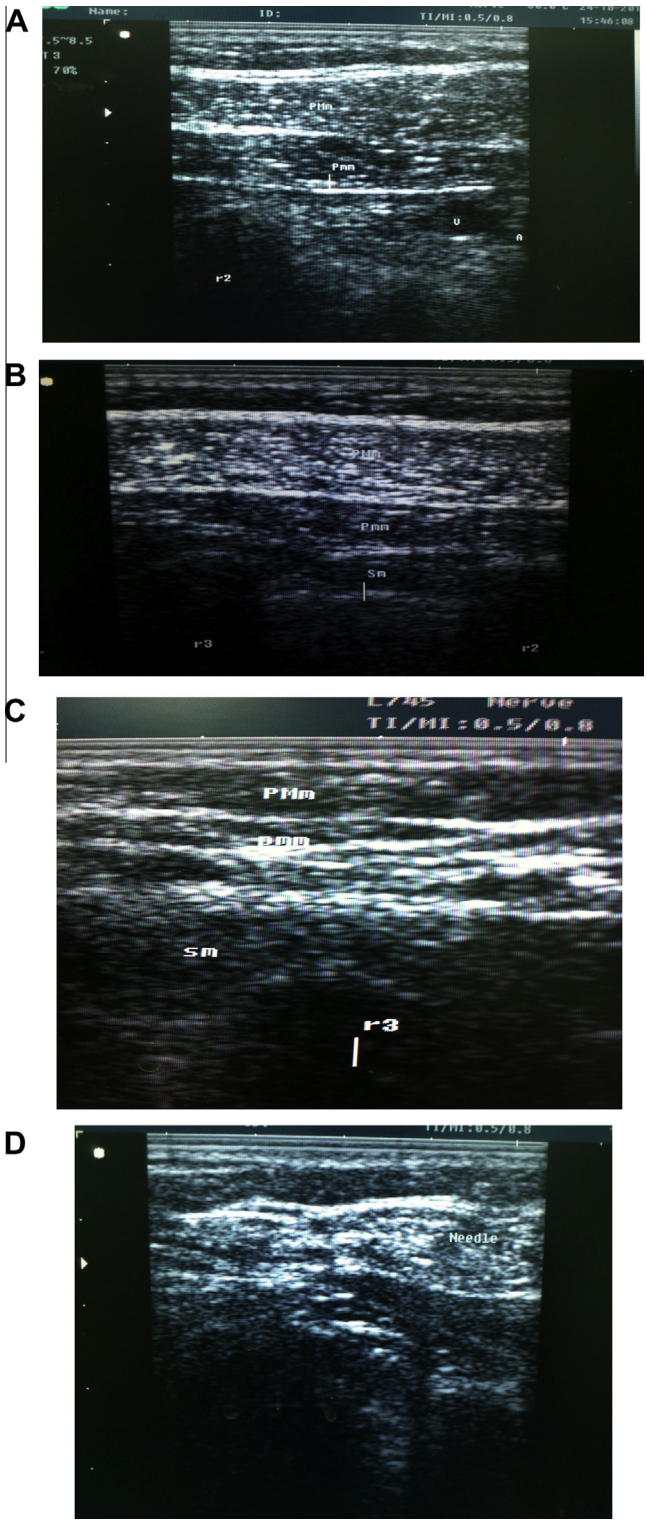


**Figure 1** Ultrsound scanning of Pecs blocks I and II, figures A and B respectively. Local anesthetic was injected in the plane between PMm and Pmm, Pecs block I (figure C) and inbetween Pmm and sm, Pecs block II (figure D). The needle is seen in the fascial plane between Pmm and sm, figure D. PMm = Pectoralis major muscle, Pmm = Pectoralis minor muscle, sm = serratus muscle, A = axillary artery, V = axillary vein, r2 = rib2, r3 = rib3.

21. Normality of numerical data distribution was tested using the Shapiro–Wilk test. Normally distributed numerical data were presented as mean and standard deviation and intergroup differences were compared using the independent-sample Student's $t$ test. Non-normally distributed numerical data were presented as median and interquartile range and intergroup differences were compared non-parametrically using the Mann–Whitney $U$ test. Categorical data were presented as number and percentage and differences between the two groups were compared using the Pearson chi square test (for nominal data) or the chi square test for trends (for ordinal data).

All $P$ values are two-sided. $P < 0.05$ is considered statistically significant.

## 4. Results

A total of 60 patients undergoing breast surgery were included in the study and no patient was excluded. The two groups were comparable with respect to age, sex, BMI, ASA physical status, surgical procedures and surgical time ($p > 0.05$), as shown in Table 1. Intraoperative fentanyl consumption was significantly lower in Pecs group [105 (95–110) µg] compared with PVB group [127.5 (110–145) µg] as shown in Table 1; ($p < 0.001$).

The time for the first request for morphine was significantly longer in the Pecs group [175 (155–220) min] than in the PVB group [137.5 (115–165) min], ($p < 0.001$) as shown in Table 2 and Fig. 2. Morphine consumption at 24 h was significantly lower in Pecs group [21 (20–25) mg] in comparison with PVB group [28 (22–31) mg], ($p = 0.002$) as shown in Table 2 and Fig. 3. NRS at rest was significantly lower at rest in Pecs group than in PVB group at 1 h, 6 h, and 12 h; ($p < 0.001$) but at 18 h and 24 h it was lower in PVB group compared with Pecs group ($p = 0.008$ and $< 0.001$ respectively) as shown in Table 2 and Fig. 4. Meanwhile during movement; NRS was significantly lower at 1st hour in Pecs group ($p < 0.001$) while at 18 h and 24 h it was significantly lower in PVB group ($p < 0.001$) as shown in Table 2 and Fig. 5. Incidence of PONV and patients' satisfaction for postoperative analgesia were comparable between the two groups ($p > 0.05$) as shown in Table 3. Only one patient in PVB group developed hypotension (MBP decreased 38.5% of its basal value) and responded to ephedrine 12 mg and 250 ml lactated ringer solution and was recorded to have contralateral sensory deficit. No local anesthetic toxicity was recorded.

## 5. Discussion

This prospective randomized study showed that Pecs block performed in patients before MRM resulted in less postoperative morphine consumption in the first 24 h with lower intensity of pain in the first 12 h in comparison with PVB. Moreover, intraoperative fentanyl consumption was significantly lower in patients of Pecs group in comparison with PVB group. However; pain intensity was lower in the 2nd 12 h in patients who received PVB. Patients' satisfaction was almost comparable between both techniques in respect to postoperative analgesia.

Several forms of regional techniques like local anesthetic infiltration [11], intercostals nerve block [12], epidural block [1], and PVB have been used for management of pain after breast surgery.

**Table 1** Patient characteristics and operative data.

| Variable | PVB group ($n$ = 30) | Pecs group ($n$ = 30) | $P$ value |
|---|---|---|---|
| Age (yr) | 49.9 (6.9) | 49.9 (6.7) | 1.0 |
| BMI (kg/m$^2$) | 30.2 (2.3) | 30.2 (2.2) | 0.825 |
| ASA I/II | 20/10 | 18/12 | 0.592 |
| Surgical time (min) | 109.633 (17.0) | 108.4 (17) | 0.780 |
| Intraoperative fentanyl consumption (μg) | 127.5 (110.0–145.0) | 105 (95.0–110.0) | < 0.001* |

Data are presented as mean (SD), ratio, number (%) or median (interquartile range).
* $P < 0.05$ is considered significant between the two groups.

**Table 2** Postoperative pain scores and analgesic consumption.

| Variable | PVB group ($n$ = 30) | Pecs group ($n$ = 30) | $P$ value |
|---|---|---|---|
| Time to first analgesic (min) | 137.5 (115.0–165.0) | 175 (155.0–220.0) | < 0.001* |
| 24-h Morphine consumption (mg) | 28 (22.0–31.0) | 21 (20.0–25.0) | 0.002* |
| NRS at rest at 1 h | 4 (3.0–5.0) | 3 (2.0–3.0) | < 0.001* |
| NRS at rest at 6 h | 3 (3.0–5.0) | 2.5 (2.0–3.0) | < 0.001* |
| NRS at rest at 12 h | 4 (3.0–4.0) | 2 (2.0–3.0) | < 0.001* |
| NRS at rest at 18 h | 3 (2.0–4.0) | 4 (3.0–4.0) | 0.008* |
| NRS at rest at 24 h | 3 (2.0–3.0) | 4 (4.0–5.0) | < 0.001* |
| NRS on movement at 1 h | 6 (5.0–7.0) | 4 (4.0–5.0) | < 0.001* |
| NRS on movement at 6 h | 5 (4.0–6.0) | 5 (4.0–5.0) | 0.352 |
| NRS on movement at 12 h | 4 (3.0–5.0) | 4 (3.0–4.0) | 0.398 |
| NRS on movement at 18 h | 3 (3.0–4.0) | 5 (4.0–5.0) | < 0.001* |
| NRS on movement at 24 h | 3 (2.0–4.0) | 5 (5.0–6.0) | < 0.001* |

Data are presented as median (interquartile range).
* $P < 0.05$ is considered significant between the two groups.

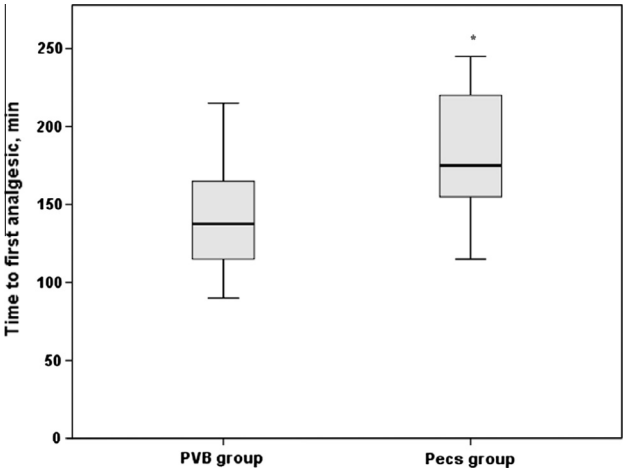


**Figure 2** Box plot showing time to first analgesic request in the two study groups. * $P < 0.001$ versus PVB group.

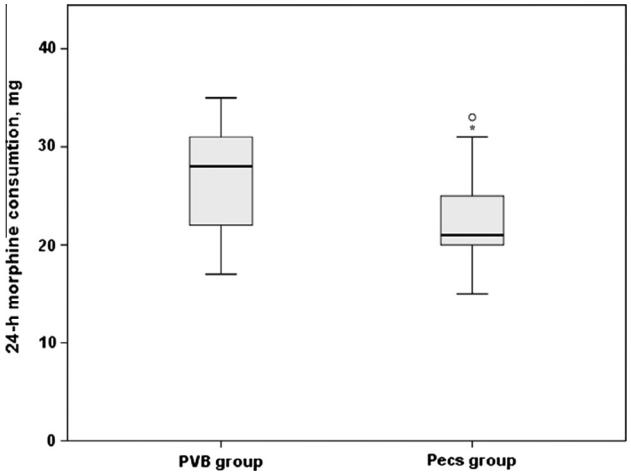


**Figure 3** Box plot showing 24-h morphine consumption in the two study groups. Circles represent outliers. * $P = 0.002$ versus PVB group.

Based on the expert's opinion, many authors have adopted PVB as the technique of choice for relief of pain after breast surgery [2–6] but this block may be not suitable in all breast surgeries. This technique provides ipsilateral dermatomal blockade without block of contralateral sympathetic chain [13]. Moreover, PVB does not block medial and lateral pectoral nerves well as long thoracic and thoracodorsal nerves. Therefore, during breast surgeries involving axillary dissection, lack of adequate analgesia is definitely coexisting.

Comparison between single injection versus multiple injections techniques has not been described before. Eason and Wyatt [9] reported that at least four intercostal spaces could be anesthetized by a single injection of 15 ml of 0.375% bupivacaine. However; Coveney et al. [14] reported that inadequacy of block after multiple injections was 15% while Pusch et al. [15] reported that the inadequacy of block was 19% after single injection during axillary dissection.

Moreover, spread of local anesthetics from paravertebral space into the epidural space is not uncommon. For instance, Cowie et al. [16] reported spreading of the dye in 40% of

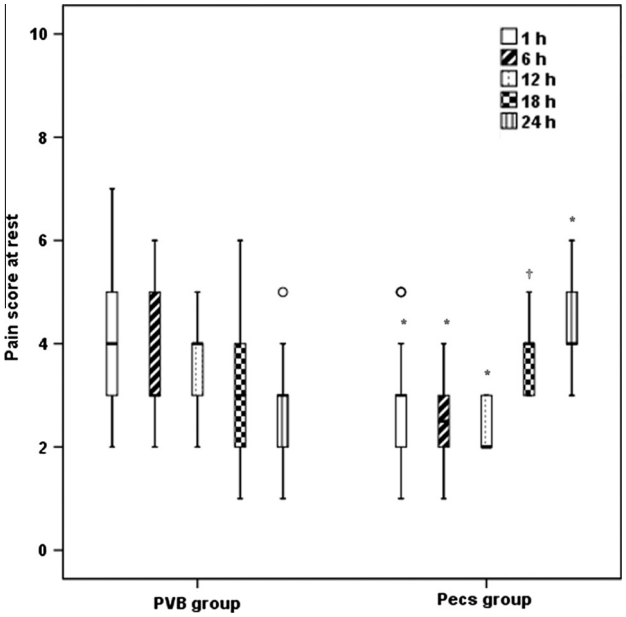


**Figure 4** Box plot showing postoperative pain scores at rest in the two study groups. Circles represent outliers. $^{*}P < 0.001$ and $^{\dagger}P = 0.008$ versus PVB group.

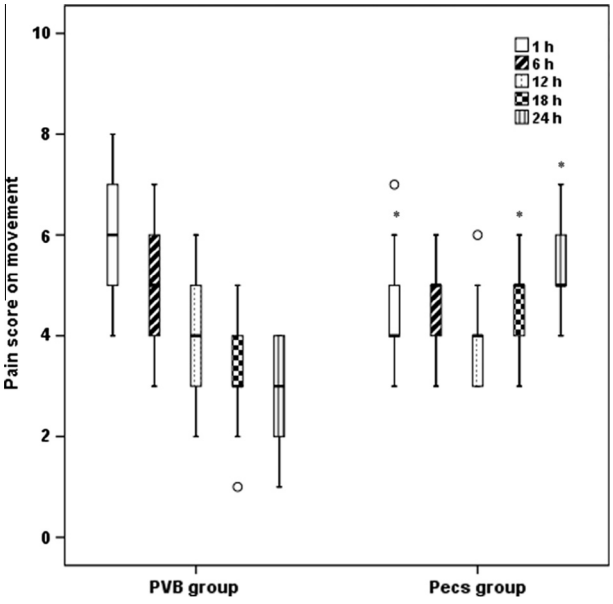


**Figure 5** Box plot showing postoperative pain scores on movement in the two study groups. Circles represent outliers. $^{*}P < 0.001$ versus PVB group.

cadavers after injection. This finding was also reported by Purcell-Jones et al. [17] who showed that up to 70% of volume of injectant spreaded into the epidural space. This spread of local anesthetics is due communication between the two spaces through intervertebral foramina [18].

Therefore based on published data, the fact that PVB may transform into epidural block or even total spinal anesthesia [19] should be considered. Lönnqvist et al. [20] reported that the frequency of complications was as follows: hypotension (4.6%); vascular puncture (3.8%); pleural puncture (1.1%) and pneumothorax (0.5%) after performing PVB in 367 patients. Therefore, performing this technique may not suit many of breast surgeries that are performed as day case surgery. This reflects the extreme desire for a safer and simple analgesic technique.

**Table 3** Postoperative complications and overall patient satisfaction.

| Variable | PVB group ($n$ = 30) | Pecs group ($n$ = 30) | $P$ value |
|---|---|---|---|
| Incidence of PONV | 17 (56.7%) | 16 (53.3%) | 0.795 |
| Patient satisfaction | | | 0.863 |
| Poor | 0 | 0 | |
| Fair | 9 (30%) | 9 (30%) | |
| Good | 14 (46.7%) | 13 (43.3) | |
| Excellent | 7 (23.3%) | 8 (26.7%) | |

Data are presented as number (%).

Attributed to the aid of US and understanding of the neural supply of the anterior chest wall and breast, the gate for Pecs block was opened; a novel interfascial plane block recently described by Blanco [7]. Based on anatomical structure, this block was initially performed as Pecs I block then it was modified as Pecs II block to suit the extent of surgery. For instance, during breast expander and prosthesis insertion, Pecs I block is enough since the pectoralis major muscle is mainly affected. Meanwhile, Pecs II block favors mastectomy and axillary clearance, since long thoracic and thoracodorsal nerves are involved [7].

The neural supply includes three distinguished groups: lateral pectoral nerve (C5-7) lying between pectoralis major muscle and pectoralis minor muscle and medial pectoral nerve (C8-1) running under pectoralis minor muscle and both supply that muscles; spinal nerves (T2-6) running in plane between intercostal muscles and constitute lateral and anterior branches to supply chest wall and long thoracic nerve (C5-7) and thoracodorsal nerve (C6-8) which supply serratus anterior and latissimus dorsi muscle respectively.

In fact, wound infiltration and field block with local anesthetic were described after breast surgery but with varying results [11,21,22]. Therefore; deposition of local anesthetic drugs under real time US into the fascial planes of above described group of muscles is easy and would be accurate to provide better results.

In the present study, meanwhile overall morphine consumption was less in patients of Pecs group in the 1st 24 with lower pain scores in the 1st 12 h, and pain intensity was higher in the next 12 h in comparison with PVB group probably because of effacing effect of local anesthetic. However, Sidiropoulou et al. [10] reported that pain intensity was lower at 16 h and 24 h after local infiltration but with continuous ropivacaine infusion in comparison with PVB but morphine consumption was almost comparable. The current study was designed to compare the outcome between the two groups after single injection which is more suitable in day case surgery otherwise we would have put a catheter. In fact, cases enrolled in the study were not day case but data collected for duration of Pecs are seldom while that of PVB after single injection lasts up to 23 h [23].

Another recent study [8] reported that pain scores were significantly lower when pectoral nerve block was combined with PVB. However, in the trial of Sopena-Zubiria et al. [8], patients enrolled in the study had minor breast surgery; subpectoral implants. The main shortage of adequacy of PVB is unmasked during axillary dissection. In presence of axillary dissection, PVB was reported to have inadequate block [14,15]. Therefore; Pecs block may be more efficient after surgery with axillary dissection.

Keeping in consideration that the frequency of PONV after breast surgery under general anesthesia is relatively high [24], the lower incidence of PONV in Pecs group in comparison with PVB group in the current study is another advantage. Perhaps, the use of propofol [25] and avoidance of nitrous oxide [26] have some effects but lower morphine consumption in Pecs group may play another role.

Only one patient in PVB group was recorded to have bilateral blockade and hypotension which presumably due to epidural spread of local anesthetic, otherwise no complications were recorded. Therefore, Pecs block is considered to be a technique that almost devoid of predicted complication.

There are two limitations in this study. First, being non-double blinded study carries risk of some bias. However, this was too difficult to avoid because of understanding of the medical staff of the nature of this study. Second, it may be argued that we did not insert a catheter to prolong the analgesic effect of local anesthetic but in the study design it was intended not to put a catheter to avoid patient discomfort and complication like epidural migration or pleural puncture in PVB group.

In conclusion, Pecs is a potential analgesic technique alternative to PVB after breast surgery. It provided less morphine consumption and lower pain scores with a greater analgesic effect in comparison with PVB. Further studies are needed to evaluate its efficacy as a sole anesthetic technique.

## 6. Conflict of interest

None declared.

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