Pectoral nerve block1 versus modified pectoral nerve block2 for postoperative pain relief in patients undergoing modified radical mastectomy: a randomized clinical trial†

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Abstract

Background. Pectoral nerve block1 (PEC1) given between pectoralis major and minor, and modified pectoral nerve block2 (mPEC2) performed between pectoralis minor and serratus anterior, can provide continuous analgesia after modified radical mastectomy (MRM) when catheters are placed before skin closure. This study was designed to compare PEC1 and mPEC2 block for providing postoperative pain relief after MRM.

Methods. Sixty-two physically fit patients undergoing MRM were assigned into two groups (Group PEC1, n=31 and Group mPEC2, n=31). Before wound closure, epidural catheter was placed in the group designated muscle plane and 30ml of 0.25% bupivacaine was injected through the catheter after wound closure. Bupivacaine 15ml of 0.25% top up was given on patient’s demand or whenever visual analogue scale (VAS) score was >4. Time for first analgesia (TFA), number of top ups and VAS was recorded at 0.5, 6, 12, 18, 24 h after surgery. Sensory blockade was assessed 30 min after extubation.

Results. Analgesia was significantly prolonged in group mPEC2 [mean(SD)] 313.45(43.05) vs 258.87(34.71) min in group PEC1, P<0.001. Total pain experienced over 24 h was significantly less in group mPEC2 [mean(SD)] 258.87(34.71) min in group PEC1, P<0.001. Consequently, top up requirements were significantly reduced in group mPEC2 than in group PEC1 [median(range)] 3(2-4) vs 4(3-5) respectively, P<0.001. Lateral pectoral (77.42% and 35.48%) and thoracodorsal nerves (93.55% and 48.39%) had higher incidence of sensory block in group mPEC2 than group PEC1, P<0.001.

Conclusions. mPEC2 provides better postoperative analgesia than PEC1 when catheters are placed under direct vision after MRM.

Key words: analgesia; modified radical mastectomy; nerve block; postoperative period; regional anaesthesia; surgery
Patients undergoing modified radical mastectomy (MRM) under general anaesthesia consume 6 to 48 mg of morphine,1 2 putting them at a risk of developing opioid induced side-effects.3

Methods

This double blinded, randomized, clinical trial was conducted after obtaining approval from the institutional ethical committee (Reg No. ECR/62/Inst/VBE/2013) dated 26/05/2015, and CTRI registration CTRU/2017/02/007811 [CTRI registration was applied after obtaining approval from the institutional ethical committee (Reg No. ECR/62/Inst/WB/2013) dated 26/05/2015, and CTRI registration CTRI/2017/02/007811]. Sealed opaque envelopes that were opened after enrollment of the patients. The catheter was placed between pectoralis major and minor in Group PEC1 and between pectoralis minor and serratus anterior in Group mPEC2 before wound closure under direct vision by the operating surgeon (Fig. 2).

In the operating room, 18-gauge i.v. cannula was cited on the opposite side and baseline ECG, heart rate (HR), non-invasive blood pressure (NIBP), and peripheral oxygen saturation (SpO2) were recorded using a multiparameter monitor. General anaesthesia was induced with i.v. fentanyl 1 μg/kg-1 followed by propofol 1.5–2 mg kg-1 i.v. until loss of verbal response. Tracheal intubation was facilitated with atracurium 0.5 mg kg-1 and anaesthesia was maintained with isoflurane (minimal alveolar concentration 1–1.3) and 66% nitrous oxide in 33% oxygen through a circle system. Patient’s lungs were ventilated with positive pressure ventilation to maintain end-tidal carbon dioxide between 4.0 and 4.5 kPa. ECG, NIBP, SpO2, end tidal carbon dioxide and nasopharyngeal temperature were continuously monitored and recorded throughout surgery. All patients received a continuous infusion of ringer lactate solution at the rate of 5–8 ml kg-1 h-1 during surgery. Fentanyl 25 μg was given i.v. if mean bp or heart rate exceeded 20% of the preoperative value. Any incidence of hypotension (mean arterial pressure <65 mm Hg) was treated with rapid infusion of 200 ml ringer lactate and, if required, injection mephentermine was given in 3 mg i.v. boluses. Bradycardia (HR < 50 beats min-1) was treated with i.v. atropine (0.6 mg). All the patients received ondansetron 0.1 mg kg-1 i.v. over 20 min before completion of surgery. At the end of surgery before wound closure, a perforation was made with 18 gauge Tuohy needle (B. Braun, Germany: Perifix; one 401 filter set) just below clavicle and an epidural catheter was passed through it. The surgeon placed the catheter with the tip directed towards axilla, either between pectoralis major and minor muscle (Group PEC1), or between pectoralis minor and serratus anterior (Group mPEC2). Once the skin closure was completed, 30 ml of 0.25% bupivacaine was injected through the catheter under complete aseptic conditions and surgical drains were kept clamped for 15 min before making the injection. Residual neuromuscular block was antagonized with the mixture of neostigmine (0.5 mg) and glycopyrrrolate (0.4 mg) i.v. and tracheal extubation was performed when the patient was fully awake.

In the postoperative recovery room pain intensity was measured with VAS score at 0.5 h, six, 12, 18, 24 h postoperatively. At 30 min, postoperatively sensory block was assessed for lateral pectoral, median pectoral, intercostals, thoracodorsal and long thoracic nerves with pin prick method in their area of distribution, barring the area of surgical incision. Time for first analgesic top up (primary outcome measure of the study) was noted when the VAS score was > 4 or if the patient demanded analgesia. Each top up comprised of 15 ml of 0.25% bupivacaine and the number of top ups required in 24 h were noted in all patients. If the pain relief was inadequate after a top up dose (VAS score > 4), rescue analgesia was performed.
analgesia with 100 mg of i.v. tramadol was provided. All data was recorded by an investigator who was blinded to the group allocation and was not involved or present during surgery.

**Statistical analysis**

Sample size for the study was calculated on the basis of time to first rescue analgesia as the primary outcome measure. It is estimated that 31 subjects will be required per group in order to detect a difference of 33 mins in this parameter with 80% power and 5% probability of Type I Error. This calculation assumed a SD of 46 mins on the basis of an initial pilot study in 10 subjects (5 in each group) and two-sided testing. As the only intervention was placement of catheter in group designated muscle plane, no dropouts were anticipated in the study and therefore no adjustment to sample size was made. Statistical analysis was carried out by entering raw data into MS Excel and analysed using IBM SPSS® statistical package version 20 (SPSS Inc.,
Chicago, IL, USA). Patient characteristics and clinical data from the two groups were compared using two-tailed Student’s t-tests. Intergroup differences between VAS over time recorded throughout the 24-h period were analysed by Friedman’s Test, as the VAS for Group mPEC2 was not normally distributed, and Mann-Whitney U-test was performed to determine the significance for area under the curve, *P*<0.001. Median bupivacaine top up doses were analysed using Mann-Whitney U-test and sensory block was analysed by using Fisher’s exact test. *P*<0.05 was considered statistically significant for all tests.

**Results**

The physical characteristics and the duration of surgery were comparable in both the groups. Baseline mean arterial pressure and intraoperative mean fentanyl requirements were similar in both the groups. (Table 1).

Satisfactory pain relief (mean VAS score<2.5) was observed in both the groups throughout the study period. However, a comparison of total pain experienced over 24 h (area under the VAS pain vs time curve) was significantly lower in group mPEC2 (mean 9.77, SD 6.93) when compared with group PEC1 (mean 24.19, SD 10.81), *P*<0.0001 (Fig. 3). Similarly, VAS pain score in group mPEC2 was significantly less at 6, 12, 18 and 24 h postoperatively when compared with group PEC, *P*<0.05 (Fig. 3). Duration of analgesia was significantly prolonged in group mPEC2 (mean 313.45, SD 43.05 min) when compared with group PEC1 (mean 258.87 SD 34.71 min), *P*<0.001. Consequently, significantly lesser number of top up doses of bupivacaine were received in group mPEC2 (median 3, range 2–4) when compared with group PEC1 (median 4, range 3–5), *P*<0.001. None of the patients in both the groups required any rescue analgesic dose or had any complications.

Sensory block of lateral pectoral and thoracodorsal nerves was more frequently demonstrated in group mPEC2 (77.42% and 93.55%) when compared with group PEC1 (35.48% and 48.39%), *P*<0.01 (Table 2).

**Discussion**

We have demonstrated that both PEC1 and mPEC2 provide a good quality of postoperative pain relief, when catheters are placed under direct vision before wound closure in patients undergoing MRM. However, mPEC2 provided significantly better quality and long duration of pain relief than PEC1. When regional blocks are not used, postoperative morphine consumption can range anywhere between 6–48 mg during the first 24 h after MRM. The annual audit (2014–2015) of our institution revealed mean morphine consumption of 20.5 mg during first 24 h postoperatively, in patients undergoing MRM when regional blocks were not used during or after general anaesthesia for providing postoperative pain relief.

PEC1 block is performed between pectoralis major and minor muscle resulting in blockade of lateral pectoral nerve (C5-7) and medial pectoral nerve (C8-T1), hence it is more useful in superficial

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**Table 1** Patient characteristics and baseline parameters in both the groups. Values expressed as mean (SD) for the number of patients in each group. *Age expressed as mean (range) for the number of patients in each group.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Group PEC1 (n=31)</th>
<th>Group mPEC2 (n=31)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr)*</td>
<td>48.9 (38–60)</td>
<td>49.8 (38–62)</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>157.35 (6.625)</td>
<td>157.97 (6.45)</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>60.45 (6.14)</td>
<td>60.19 (6.52)</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>24.44 (2.52)</td>
<td>24.19 (2.99)</td>
</tr>
<tr>
<td>Duration of surgery (min)</td>
<td>119.1 (9.15)</td>
<td>121.9 (8.31)</td>
</tr>
<tr>
<td>Baseline mean arterial pressure (mm Hg)</td>
<td>93.35 (6.16)</td>
<td>96 (9.15)</td>
</tr>
<tr>
<td>Intraoperative fentanyl consumption (µg)</td>
<td>34.68 (12.38)</td>
<td>32.62 (11.54)</td>
</tr>
</tbody>
</table>

*Fig 3 Mean VAS (SEM) over time in both the groups. VAS=Visual Analogue Scale, SEM=Standard error of mean. Area under curve for Group mPEC2 [9.77 (6.93)] [mean(SEM)]. Area under curve for Group PEC1 [24.19 (10.81)] [mean(SEM)]. *P*<0.05.
breast surgery such as breast augmentation. On the other hand PEC2 block is more complete and blocks most of the nerve supply of the breast (pectoral, intercostobrachial, third to sixth intercostals, and the long thoracic and thoracodorsal nerves) and is therefore more suitable for major cancer surgery of the breast involving axillary dissection. As an additional separate injection was not made between pectoralis major and minor muscles as in PEC2 block, the technique was termed as modified PEC2 (mPEC2) block.

In all the previous clinical trials, pectoralis blocks were given preoperatively under ultra-sonographic guidance and as a single shot technique. Hence putting a catheter preoperatively in the mentioned plane would have been cumbersome and a hindrance in the operating field. In the current study, pectoralis nerve blocks (PEC1 and mPEC2) were performed under direct vision after completion of surgery with an epidural catheter placed between two muscle planes. Hence, the benefit of these blocks could be extended into the postoperative period. However, anatomical compartments are breached after surgery and the injected drug does not confine itself to a particular interfascial compartment. Hence the spread of drug would be different from the conventional technique given with the fascial plane intact. Some proportion of the injected drug will have the tendency to gravitate down into the axilla and block the nerves in the planes below.

Both PEC1 and mPEC2 blocks clinically provided satisfactory analgesia (VAS score was never >2.5 and none of the group required any rescue analgesic). Sensory block of lateral pectoral and thoracodorsal nerve was more frequently observed in patients belonging to group mPEC2, consequently these patients had better quality and longer duration of analgesia when compared with group PEC1. Sparing of lateral pectoral and thoracodorsal nerve in PEC1 block was also observed in the pilot study conducted to determine the sample size for the current study. After obtaining the informed consent from patients recruited for the pilot study, a drug mixture (1.5% methylene blue mixed with 30ml of the 0.25% bupivacaine) was injected in the two groups in the respective muscle planes after wound closure, to observe the spread and stain pattern of the drug and dye mixture. Stay sutures were applied and after waiting for 10 min, sutures were removed to note dye spread and structures stained. In PEC1 block patients, the dye and LA mixture did not trickle down to the axilla as space between pectoralis major and minor muscle is large enough to contain major volume of injected drug mixture (Fig. 4). As a result, the lateral pectoral nerve is likely to be spared as it exists in different plane and the

<table>
<thead>
<tr>
<th>Nerves</th>
<th>Group PEC1 (n=31)</th>
<th>Group mPEC2 (n=31)</th>
<th>P value</th>
</tr>
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<tbody>
<tr>
<td>Lateral pectoral nerve</td>
<td>35.48</td>
<td>77.42*</td>
<td>0.002</td>
</tr>
<tr>
<td>Medial pectoral nerve</td>
<td>96.77</td>
<td>90.32</td>
<td>0.301</td>
</tr>
<tr>
<td>Intercostal nerves (III-VI)</td>
<td>100</td>
<td>100</td>
<td>1.000</td>
</tr>
<tr>
<td>Long thoracic nerve</td>
<td>93.55</td>
<td>100.0</td>
<td>0.151</td>
</tr>
<tr>
<td>Thoracodorsal nerve</td>
<td>48.39</td>
<td>93.55*</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Table 2 Percentage of patients having sensory block in both the groups. *P<0.05
drug is unable to reach the nerve despite the disruption of intercostobrachial nerve is severed during surgery and leads to sensory loss of the supplied area.

Catheter dislodgement if not fixed to any underlying structure and blood collection might hamper the action and spread of local anaesthetics. The port sides of the drains and epidural catheters are different, hence each time the local anaesthetics were infiltrated, the surgical drains needed to be clamped for 15 min in order to give time for the local anaesthetics to act. Having a catheter in close vicinity of operated site raises a remote chance of infection. However, none of these potential complications were observed in the current study.

To conclude, mPEC2 provides better quality and duration of postoperative analgesia than PEC1 when catheters are placed under direct vision after MRM. However, both PEC1 and mPEC2 blocks provide good quality of continuous analgesia.

**Authors’ contributions**

Study design/planning: S.G., P.K., J.B.

Study conduct: S.G., J.B.

Data analysis: P.K., J.B.

Writing paper: S.G., P.K.

Revising paper: all authors

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**Declaration of interest**

None declared.

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**References**


