Pectoral Nerve I and II Blocks, Single Versus Double Path, as an Effective Pain Management Strategy in Female Breast Cancer Surgery.

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Excruciating pain is a common complication following breast surgery which can be effectively treated with double path PECS I and II blocks. Sixty patients undergoing breast surgery were randomly assigned into two groups: Single-path (SP) group received a single-path pectoral nerve (PECS) I and II block, by injecting 0.25% bupivacaine 15 ml into the space between the serratus muscle and the pectoralis minor muscle, then withdrawing the needle to inject equivalent dose of bupivacaine in the plane between the pectoralis muscles. Double path group (DP) received double path block; bupivacaine 0.25% 15 ml injected into the space between pectoralis muscles through one puncture and a similar dose of bupivacaine was injected into the potential space between pectoralis minor muscle and serratus muscle through another puncture. Performance time of technique, the onset and length of the sensory block, visual analogue pain ratings (VAS), satisfaction scores, postoperative analgesic requirements and success rate were the outcomes. Single-path block had a faster performance time. Pain scores were similar at all time periods, except for 10 hours postoperatively, where double-path group had lower pain scores. In the double path block, the onset was faster and sensory block lasted longer. Double-path injection group had higher satisfaction levels. The use of double-path pectoral blocks was a beneficial approach, as it was associated with a faster onset, higher satisfaction levels, and a longer duration of analgesia.

Keywords: Pecs, breast, female, single path, double path

Introduction

Following breast surgery, over 40% of women experience excruciating pain[1]. Opioids are commonly used postoperatively to manage pain, although they can cause dose-related side effects.[2] Opioids can alter immunologic efficiency, resulting in a change in immunological state as the tumour progresses[3]. Regional anaesthesia provides better acute pain relief and lowers chronic pain incidence.[4] The Pectoral nerve block was invented by Blanco as a safer alternative.[5] The pectoral, intercostobrachial, upper six intercostal nerves and long thoracic nerves are blocked using this innovative approach. Pectoral nerve (PECS) I block is done by injecting local anaesthetics at the level of the third rib between the pectoralis minor and major.[6] In the PECS II block, local anaesthetics are administered between the pectoralis minor and the serratus anterior.[7] The aim of this prospective study was to compare the efficacy of single-path with double-path PECS I and II block in terms of pain scores, performance time, satisfaction scores, success rate, and onset of action for female patients undergoing breast cancer surgeries.

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Methods

This study was carried out at ClinicalTrials.gov after receiving ethics committee permission (FMASU R 04/ 2019) from November 2019 to July 2020. A total of 60 female patients between the ages of 35 and 50 years, with ASA physical status I and II, who were undergoing breast cancer procedures at Ain Shams university hospital were included in this prospective randomized parallel group trial. Informed consent was obtained from all patients.

Psychological issues, morbid obesity, patients undergoing bilateral surgery, patients scheduled for re-do breast surgery, patients who received radiotherapy, male patients, local anaesthetic allergy, renal insufficiency, ASA III-IV, and patients with coagulopathy were excluded.

Sample size was determined using the PASS programme (Stata Corp LLC, Texas, USA) with the type-1 error taken as 0.05 and the power as 0.8. Uppal et al. found that the single-injection PVB had a shorter median time to performance (5 minutes) than the multiple-injection group (10 minutes), with a standard deviation of 6. The mean values were taken according to Hozo et al.[8,9]. Calculated minimal sample size was 30 per group taking in consideration of a 10% dropout rate. The patients were divided into two groups using a computer-generated random number generator: a single path group (n = 30) who had PECS I and II blocks via a single injection and a double path group (n = 30) who had PECS I and II blocks via two separate injections. These blocks were performed under ultrasound guidance (S-Nerve; Sono-Site Iberica S.L, Madrid, Spain) with a linear ultrasound transducer (10–12 MHz).

Pre-anesthetic investigations were done. Before induction, midazolam 1-2 mg IV was administered to all patients. The patients were positioned supine with their elbows flexed and their shoulders abducted. An in-plane approach was used to visualize the 22G 80mm beveled tip needle.

Single path PECS I and II block:

The probe was positioned below the outer third of the clavicle, revealing the pectoralis major and minor muscles as well as the thoraco-acromial artery. It was then moved infero-laterally over the fourth rib, revealing the pectoralis major and minor muscles. The ultrasound (US) probe was then moved towards the anterior axillary line till pectoralis minor and serratus anterior muscles were identified at the level of 4th rib and thoraco-acromial artery. Skin was infiltrated with 1% lidocaine. The needle was inserted in plane, 15mL of 0.25% bupivacaine was injected after negative aspiration into the potential space between pectoralis minor muscle and serratus muscle. Then it was withdrawn to inject another 15 ml of 0.25% bupivacaine in the fascial plane between pectoralis muscles.

Double path PECS I and II block:

The ultrasound probe was placed below the outer third of the clavicle, revealing the pectoralis major and minor muscles as well as the thoraco-acromial artery. The probe was then moved inferolaterally to locate the fourth rib, where the pectoralis major and minor muscles were visible. The skin was infiltrated with 1% lidocaine, then the needle was inserted in plane and 15mL of 0.25% bupivacaine was injected into the potential space between pectoralis muscles. For the second puncture, the ultrasound probe was moved towards the anterior axillary line until the pectoralis minor and serratus anterior muscles were identified at the level of 4th rib and the thoraco-acromial artery. The needle was inserted in plane and a similar dose of 0.25% bupivacaine was placed into the potential space between pectoralis minor muscle and serratus muscle (PECS II).

All blocks were done by a single experienced operator. A pin prick test was used to determine the sensory level of the block.

Following the block, fentanyl (1 microgram/kg), propofol, and cisatracurium were administered to induce general anaesthesia. Anesthesia was maintained with 100% oxygen, isoflurane, and cisatracurium supplements. End-tidal carbon dioxide was kept between 35 and 40 mmHg. Inadequate analgesia was defined as more than 20% rise in mean blood pressure and/or heart rate following skin incision and during surgical operation, that was controlled with 1 μg/kg fentanyl. At the completion of the surgical procedure, neuromuscular blockade was antagonized with neostigmine (0.05 mg/kg) IV and atropine IV (0.03 mg/kg). Patients were extubated and moved to the post-anesthesia care unit. Performance time, the time duration from insertion of the first needle till removal of the needle after the last injection duration was the primary outcome.

Visual analogue scores (VAS) were measured immediately after recovery (0 hour), then 2, 4, 10, and 24 hours later. 0 = “no pain” and 10 = “worst imagined pain” on a visual analogue scale (VAS).

If the VAS score was more than 4, IV morphine increments of 0.1 mg/kg and ketorolac 30 mg 8 hourly were given. The onset of the sensory block, duration of the sensory block (interval between onset of block and the first request for postoperative opioid analgesic), sensory dermatomal spread (evaluated by pinprick sensation at mid-clavicular line 30 minutes after performance of the block) and the degree of sensory block (graded as follows: grade 0 = strong sensation; grade 1= dull sensation or analgesia; grade 2 = no sensation or anesthesia), and patients' satisfaction scores (0 = complete dissatisfaction, 10 = most satisfaction) were recorded. The rate of success (number of patients who did not receive supplemental doses of intraoperative opioid analgesic during the surgical procedure after the onset of the block), complications such as pneumothorax, hematoma formation, vascular puncture, paraesthesia, and local anaesthetic toxicity, overall dose of postoperative morphine and ketorolac required were also recorded. All postoperative outcome measures were evaluated by an investigator who was blinded to group allocation and the nature of the study. Non-parametric and parametric data were tested using the Mann-Whitney U test and the Independent T-test. The categorical data was compared using the Chi-square test.

Results

Sixty patients were enrolled with 30 in one group. Both groups of patients had similar demographics and surgical data (Table 1). In both groups, the success rate was similar.

Pain scores of both study groups after extubation, 2,4 and 24 hours postoperatively were comparable. However, the VAS of the double-path group was significantly lower 10 hours postoperatively. (P<0.001) (Table 2).

Shorter onset time of the block was recorded in double-path group in comparison with single-path group [11.73 ± 1.60, 19.27 ± 2.32 respectively] (Table 3). A longer duration of the block was recorded in double-path group [19.07 ± 1.53] (Table 3).

***Table 1**: Demographic data (BMI: body mass index; ASA: American Association of Anaesthesiologists)*

	Single path	Double path	P- value
Age (years)	42.70±5.48	43.60±4.75	0.500
BMI (kg/m2)	24.97±1.81	25.53±2.21	0.282
ASA			
ASA I	18(60.0%)	16(53.3%)	0.602
ASA II	12(40.0%)	14(46.7%)	
Duration of surgery (minutes)	111.87±1.14	112.03±7.21	0.901
Simple mastectomy	12(40.0%)	10(33.3%)	0.592
Mastectomy with axillary lymph node clearance	18(60.0%)	20(66.7%)	0.592
Success rate	29(96.7%)	26(86.7%)	0.161

Except for Age, BMI, surgical duration which were shown as Mean±SD, all data are reported as percentage

***Table 2:** Visual analogue scores.*

VAS (cm)	Single path	Double path	P- value
Immediately after extubation (0 hour)	1 (1-2)	1 (1-2)	1.000
2 h postoperative	2 (1-2)	1 (1-2)	0.797
4 h postoperative	2 (2-3)	2 (1-3)	0.084
10 h postoperative	5 (4-5)	2 (2-3)	<0.001
24 h postoperative	2 (2-3)	2 (2-3)	0.277

All data were shown as median h: hours

Table 3*: The onset time and duration of the block.*

		Single path	Double path	P-value
Onset time(min)	Mean±SD	19.27 ± 2.32	11.73 ± 1.60	<0.001
	Range	16 – 22	10 – 14	
Duration of the block (h)	Mean±SD	11.50 ± 0.51	19.07 ± 1.53	<0.001
	Range	11 – 12	17 – 21	

All data were shown as Mean±SD h: hours; min: minutes

Table 4: *The incidence of postoperative adverse events, satisfaction scores, level of block, time of performance and end-tidal isoflurane concentration.*

	Single path	Double path	p- value
Paresthesia	1(%)	0(0%)	0.313
Pneumothorax	0(%)	0(0%)	1.000
Local anesthetic toxicity	1(3.3%)	1(3.3%)	1.000
Hematoma formation	2(0.0%)	1(3.3%)	0.554
Vascular puncture	1(10.0%)	0(13.3%)	0.313
Satisfaction scores; Median (IQR)	5 (5 – 6)	9 (9 – 9)	<0.001
Time of performance (min); mean±SD	5.43±0.50	10.93±0.74	<0.001
Upper level of block (T2 dermatomal spread)	2(6.7%)	2(6.7%)	1.000
Lower level of block (T6 dermatomal spread)	6(20.0%)	6(20.0%)	1.000

Except for the time of performance, which was reported as mean SD, and the satisfaction score, which was presented as median, all data are presented as percentages. (IQR); h: hour

Table 5*: Postoperative morphine and ketorolac consumption.*

	Single path	**Double path**	**p-value**
24 h postoperative morphine (mg)	13.56± 0.85	7.95±1.20	<0.001
24 h postoperative ketorolac (mg)	106.63 ±28.71	44.07±9.2	<0.001

All data are shown as Mean±SD

The time it took to complete a single-path block (5.43±0.50) was significantly less (P<0.001) (Table 4). The double-path injection group had higher satisfaction levels, P <0.001(Table 4). Two patients in each of the study groups missed T2 dermatomal spread (Table 4) while 6 patients in both groups missed T6 dermatomal spread (Table 4). Despite not exceeding the safe dose of local anesthetic and intermittent aspiration, one patient from each group developed convulsions during recovery from anesthesia without any arrhythmia or deterioration of the vital signs which was treated with intravenous intralipid 20% 1.5 ml/kg over 1 minute then the patients dramatically recovered and were sent to high dependency unit for monitoring (Table 4). The double-path group had a significantly lower postoperative morphine intake [7.95±1.20 mg] and a significantly lower postoperative ketorolac intake [44.07±9.2 mg]; P <0.001 (Table 5).

Discussion

The findings of this investigation revealed that single-path PECS I-II blocks had significantly low performance times. Pain score was similar at all time periods, except for 10 hours postoperatively, in which pain score was lower in the double-path group. In double path block, the onset time was shorter. The blockade in the double path group lasted a longer duration, and it gave a higher level of satisfaction. The double-path group had low postoperative morphine and ketorolac consumptions.

Patients undergoing shoulder surgery who received single-injection or triple-injection interscalene blocks were studied by Wang and colleagues [10], and they revealed shorter performance time in the single injection group and a shorter time of onset and longer duration of blockade with the triple injection group.In each cadaver, Cowie et al. [11] used an ultrasound-guided approach to inject 20 mL of contrast dye at T6-7 on one side and a double-injection procedure of 10 mL at T3-4 and T7-8 on the contralateral side. They mentioned that a double-injection strategy reached more thoracic dermatomes than a single-injection technique due to much larger segmental intercostal dispersion[11].

Uppal et al.[8] investigated the efficacy of single injection versus multiple injection paravertebral block (PVB) in female patients after unilateral mastectomy and discovered that single injection block took considerably less time to be conducted than multiple injection approach. Kaya et al.[12] studied the analgesic efficacy of PVB with single or multiple injection techniques in patients undergoing video-assisted thoracoscopy and they found that performance time was 17.9 ± 3.0 minutes in multiple- injection and 6.8 ± 1.9 minutes in single-injection group and this agreed with our findings which showed that the performance time in double path block was longer than that of single path block. Roy et al.[13] compared single-injection and double-injection supraclavicular block in patients undergoing hand and elbow surgeries; they reported that the performance time in single-injection group (179 ± 104 seconds) was less than double injection group (275 ± 137 secs), ($P < 0.01$). Choudhary[14] examined single and double-point injection approaches of ultrasound-guided supraclavicular block in patients having forearm operations, finding that the double injection group had a higher success rate, a faster onset, and a longer block duration. In terms of the start and extent of supraclavicular blocks, Sayed and his colleagues found no significant difference between single and double injection approaches[15]. Several studies comparing different nerve block procedures found that multiple injection method results in a faster start time and a higher success rate than a single injection of local anaesthetic [16].

Bakshi and his colleagues, experienced problems during surgical dissection and electrocautery use because of fluid filled spaces following PECS block performance. However, this problem was not reported in any of our surgical procedures probably because of the time gap we allowed before the commencement of the surgery causing better local anaesthetic absorption.[17]

PECS II block combined with general anesthesia provides effective analgesia for mastectomy and axillary clearance, because long thoracic and thoracodorsal nerves in addition intercostobrachial nerve, lateral branches of intercostal nerves III, IV, V, VI and pectoral nerves are all blocked while PECS I block anesthetise only the medial and lateral pectoral nerves [18]. A limited number of case reports showed local anaesthetic toxicity especially when combined with general anesthesia without the need for intravascular insertion and with a low dose[19]. The authors speculated that the cause could be patients' low tolerance for LA, or that the toxicity threshold varies depending on circumstances like hypercarbia, other medications, or hypothermia.[20] Also, a case report experienced by Dhir et al. [21] showed that local anesthesia toxicity can occur inspite of the use of safe doses of local anesthetic, frequent aspirations and absence of intravascular placement.

Versyck et al. [22] conducted a clinical study to see if pectoral nerve block was effective for patients undergoing mastectomy with sentinel node or axillary node dissection. They found that pain scores and postoperative opioid demand were low

with PECS block in the first 24 hours after surgery when compared to the saline group.

Although, early management with lipid therapy at the first sign of neurologic or cardiovascular symptoms of local anesthetic toxicity may result in overtreatment of the vast majority of patients but they will be safe from experiencing risks of severe toxicity and on the other hand, the risks of treatment are often well tolerated[23].

Conclusion

Ultrasound-guided double-path PECS I and II blocks appeared to be the preferred technique over single-path PECS I and II blocks because it has a faster onset time, a similar success rate, higher satisfaction levels and longer sensory block duration.

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