Efficacy of Bilateral Pectoralis Nerve Block for Ultrafast Tracking and Postoperative Pain Management in Cardiac Surgery

Karthik Narendra Kumar, Ravikumar Nagashetty Kalyane[1], Naveen G Singh, PS Nagaraja, Madhu Krishna, Balaji Babu, Varadaraju R[1], N Sathish, N Manjunatha

Departments of Cardiac Anaesthesiology and [1]Cardiaothoracic and Vascular Surgery, Sri Jayadeva Institute of Cardiovascular Sciences and Research, Bengaluru, Karnataka, India

Abstract

Background: Good postoperative analgesia in cardiac surgical patients helps in early recovery and ambulation. An alternative to parenteral, paravertebral, and thoracic epidural analgesia can be pectoralis nerve (Pecs) block, which is novel, less invasive regional analgesic technique. **Aims:** We hypothesized that Pecs block would provide superior postoperative analgesia for patients undergoing cardiac surgery through midline sternotomy compared to parenteral analgesia. **Materials and Methods:** Forty adult patients between the age groups of 25 and 65 years undergoing coronary artery bypass grafting or valve surgeries through midline sternotomy under general anesthesia were enrolled in the study. Patients were randomly allocated into two groups with 20 in each group. Group 1 patients did not receive Pecs block, whereas Group 2 patients received bilateral Pecs block postoperatively. Patients were extubated once they fulfilled extubation criteria. Ventilator duration was recorded. Patients were interrogated for pain by visual analog scale (VAS) scoring at rest and cough. Inspiratory flow rate was assessed using incentive spirometry. **Results:** Pecs group patients required lesser duration of ventilator support ($P < 0.0001$) in comparison to control group. Pain scores at rest and cough were significantly low in Pecs group at 0, 3, 6, 12, and 18 h from extubation ($P < 0.05$). At 24 h, VAS scores were comparable between two groups. Peak inspiratory flow rates were higher in Pecs group as compared to control group at 0, 3, 6, 12, 18, and 24 h ($P < 0.05$). Thirty-four episodes of rescue analgesia were given in control group, whereas in Pecs group, there were only four episodes of rescue analgesia. **Conclusion:** Pecs block is technically simple and effective technique and can be used as part of multimodal analgesia in postoperative cardiac surgical patients for better patient comfort and outcome.

Keywords: *Cardiac surgery, fast tracking, Pecs block, sternotomy, visual analog scale*

Introduction

Surgery on the chest wall including midline sternotomy for cardiac surgery can be associated with considerable postoperative discomfort and pain.[1] Optimal dynamic pain management has become a prerequisite for early postoperative recovery.[2] Poor pain management during the early postoperative period has deleterious effects on pulmonary (atelectasis, pneumonia, and bronchial secretion stasis), cardiovascular (increased oxygen consumption and tachycardia), and musculoskeletal (muscle weakness and disuse) systems and induces stress responses and hyperglycemia.[3] In the era of fast tracking, a good postoperative analgesia in cardiac surgical patients helps in early recovery, ambulation, and early discharge from the Intensive Care Unit (ICU). Conventionally, pain in postoperative cardiac surgical patients is treated with nonsteroidal anti-inflammatory drugs and opioids with their associated side effects and delayed recovery. Effective acute pain control preserves immune function, both by suppressing the stress response and by decreasing the need for opioids. Opioids, especially morphine, inhibit both cellular and humoral immune functions.[4] Alternatively thoracic epidural and paravertebral blocks have been widely practiced and time tested with good results. Yet, not all anesthesiologists are comfortable or have the expertise in performing these deep nerve blocks due to the associated risks such as injury to the spinal cord and epidural hematoma or due to concerns related to anticoagulation. An alternative to paravertebral blockade and thoracic epidural analgesia in patients undergoing surgeries in thoracic region can be the pectoral nerve (Pecs) block involving Pecs 1 and Pecs 2 (modified

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Address for correspondence:
Dr. PS Nagaraja, Department of Cardiac Anaesthesia, Sri Jayadeva Institute of Cardiovascular Sciences and Research, Bengaluru - 560 069, Karnataka, India.
E-mail: docnag10@gmail.com

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Pecs 1) interfascial blocks, which is a novel, less invasive regional analgesic technique. The ultrasound description of Pecs block was first described by Blanco *et al*.[5] for breast surgeries. Ever since its description, Pecs block has been used with good results for a wide variety of surgeries on chest wall such as radical mastectomies, breast-conserving surgeries, breast implant placement, Automated implantable cardioverter-defibrillator (AICD)/pacemaker placement, intercostal drainage tube placement, and rib fractures.[5] To perform the Pecs block, two-plane approach is used. In the first puncture, 10 ml of local anesthetic is injected between the pectoralis muscles (Pecs 1), and the second puncture gives 20 ml of local anesthetic between the pectoralis minor and the serratus anterior muscle (Pecs 2) at the level of the fourth rib. Pecs 1 block aims to block the medial and lateral pectoral nerves, whereas Pecs 2 block aims to block the anterior divisions of the thoracic intercostal nerves from T2 to T6, long thoracic nerve, and thoracodorsal nerve.

The lateral pectoral nerve most commonly arises from C5, C6, and C7 and the medial pectoral nerve from C8 and T1. The anterior divisions of the thoracic intercostal nerves from T2 to T6 lie at the back between the pleura and the posterior intercostal membrane and run in a plane between the intercostal muscles as far as the sternum. The long thoracic nerve or serratus anterior nerve arises from C5 to C7 entering the axilla behind the rest of the brachial plexus and rests on the serratus anterior muscle.[5] Since there have not been any studies on the use of Pecs block in cardiac surgical patients, the research purpose in this study was to investigate about the efficacy of ultrasound-guided Pecs block for patients undergoing cardiac surgery through midline sternotomy approach. In the present study, we hypothesized that the Pecs block would provide superior postoperative analgesia for patients undergoing cardiac surgery via midline sternotomy approach as compared with a parenteral analgesic group (control group). Our primary outcome measure was visual analog scale (VAS) pain scores, inspiratory flow rate, and ventilator hours on the first postoperative day in patients who have postoperative Pecs block compared with those managed by parenteral analgesics for postoperative analgesia.

Materials and Methods

After obtaining institutional ethics committee approval and written informed consent from the patients, 40 adult patients between the age groups of 25 and 65 years undergoing either coronary artery bypass grafting (CABG) or valve surgeries through midline sternotomy under general anesthesia were enrolled in the study. All patients received injection fentanyl 3–5 μg/kg for intraoperative analgesia. Patients with hemodynamic instability, symptoms of congestive cardiac failure, preexisting infection at the block site, allergy to local anesthetics, psychiatric illness, and patients with prolonged postoperative ventilatory course were excluded from the study. Postoperatively, once the patients were received in the postsurgical ICU, all patients received intravenous (IV) paracetamol 1 g qid and tramadol 50 mg IV BD. Patients were randomly allocated into two groups with 20 in each group using closed envelope method. The group allocation numbers were concealed in sealed opaque envelopes that were opened after enrolment of the patients. Group 1 patients did not receive Pecs block, whereas Group 2 patients received Pecs block. After confirming hemodynamic stability, satisfactory blood gasses, electrolytes, and minimal drain output, bilateral Pecs block was performed under the guidance of a linear ultrasound transducer (12 MHz). The block was performed under all aseptic precautions using a 20-gauge 5 cm needle. Injection bupivacaine 0.25% with injection dexmedetomidine 25 μg as an additive was used as a local anesthetic. The block was performed in supine position with the arm slightly abducted. The ultrasound probe was placed at the midclavicular level inferolaterally [Figure 1] to locate the axillary artery and vein and then moved laterally toward the axilla until pectoralis major, pectoralis minor, and serratus anterior muscles were identified at level of the fourth rib [Figure 2]. The needle was inserted in-plane with respect to the ultrasound probe. A volume of 20 ml of local anesthetic solution was deposited in the fascial plane between pectoralis minor and serratus anterior muscle [Video 1], followed by withdrawal of the needle to the fascial plane between pectoralis major and pectoralis minor muscle, where a volume of 10 ml was deposited [Video 2]. The block was performed similarly on the opposite side. At the end of procedure, 5 ml of 0.25% bupivacaine was infiltrated in the skin around the mediastinal drain. Care was taken not to cross the toxic dose of bupivacaine (3 mg/kg). Patients were extubated once they fulfilled the extubation criteria. Patients were interrogated for pain by VAS scoring system at rest and during cough by an intensivist blinded to the study groups at 0 h (at extubation) and thereafter at 3, 6, 12, 18, and 24 h intervals. Pain was classified into mild, moderate, and severe for analysis (mild VAS 0–4, moderate VAS 5–7, and severe VAS >8). Incentive spirometry was performed at

Figure 1: Probe position for pectoral nerve block

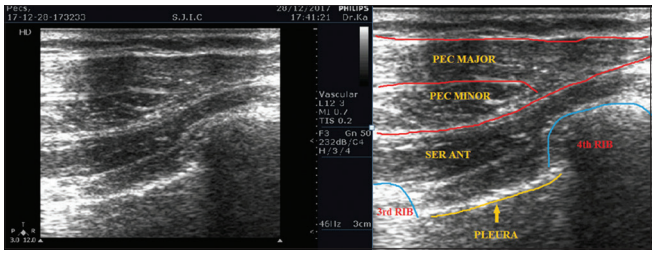

Figure 2: Sonoanatomy of pectoral nerve block

similar time intervals to assess the number of balls raised as an indicator of inspiratory flow rate (1 ball – 600 ml, 2 balls – 900 ml, and 3 balls – 1200 ml). Similar scores were assessed in the control group. Breakthrough pain was defined as VAS >4 at rest. Rescue analgesia was administered if VAS was >4 at rest or on patients demand with IV fentanyl 1 μg/kg. Second rescue analgesic planned was IV diclofenac 75 mg if VAS persistently remained >4, 30 min after the first rescue analgesia. Dynamic pain was defined as the difference in VAS scores between rest and deep breath of >2 points. The duration of ventilation was also recorded.

Statistical analysis

Statistical analysis was done using MedCalc version 12.2.1.0 (Ostend, Belgium). Data were expressed as mean ± standard deviation and analyzed using Student's unpaired *t*-test. Categorical data were analyzed using Chi-square test. $P < 0.05$ was considered statistically significant.

Results

All the forty patients completed the study protocol. Patients in both groups were comparable for demographic characteristics, including age, sex, height, and weight [Table 1]. Patients in control group included 12 CABGs, 5 mitral valve repairs (MVRs), and 3 aortic valve repairs (AVRs) while patients in Pecs group included 14 CABGs, 3 MVRs, and 3 AVRs. Patients in Pecs group (Group 2) required significantly lesser duration of ventilator support ($P < 0.0001$) in comparison to the control group (Group 1) [Figure 3]. The VAS scores at rest [Table 2a] and during cough [Table 2b] at extubation (0 h) and at 3, 6, 12, 18, and 24 h after extubation were recorded. Pain scores at rest were significantly low in patients who received Pecs block (Group 2) at 0, 3, 6, 12, and 18 h from extubation ($P < 0.05$). At 24 h, it was found that the VAS scores were comparable between the two groups and there was no statistically significant difference ($P = 0.6832$) [Figure 4]. Pain scores on cough were also low in the Pecs group (Group 2) than control (Group 1) with statistical significance at 0, 3, 6, 12, and 18 h from extubation ($P < 0.05$), though at 24 h, the VAS scores between the two groups were comparable ($P = 0.4011$) [Figure 4]. Peak inspiratory flow rates as assessed by incentive spirometry [Table 3] were higher in the Pecs group (Group 2) as compared to control group (Group 1) at 0, 3, 6, 12, 18, and 24 h from extubation ($P < 0.05$) [Figure 5]. There were a total of 34 episodes of rescue analgesia in the control group (Group 1) which included breakthrough pain, while majority of these

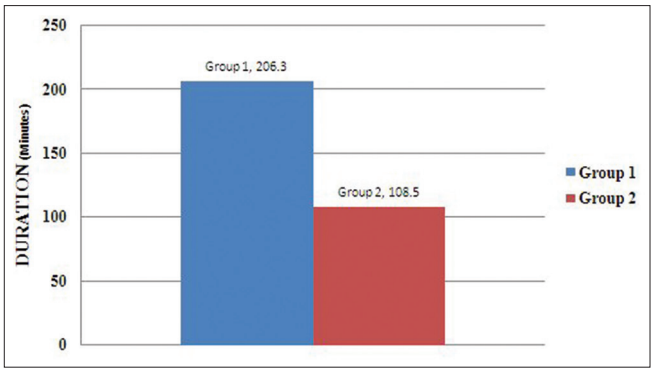

Figure 3: Ventilatory duration in minutes

Table 1: Demographic data

	Group 1	Group 2	*P*
Age (years)	53.8±9.39	53.1±10.56	0.82
Gender			
Male	13	11	0.52
Female	7	9	
Height (cm)	157.85±6.34	157.15±7.79	0.75
Weight (kg)	60.25±8.86	58.8±11.87	0.11
Ventilatory duration (min)	206.3±47.0477	108.5±24.3386	<0.0001

Values are mean±SD. SD: Standard deviation

Table 2a: Visual analog scale scores at rest

Time (h)	VAS rest		*P*
	Group 1	Group 2	
VAS-0	4.45±0.6863	1.45±1.3169	<0.0001
VAS-3	3.8±0.7678	1±0.9733	<0.0001
VAS-6	4.4±1.0463	1.15±1.04	<0.0001
VAS-12	3.6±1.2312	1.55±1.2344	<0.0001
VAS-18	3.3±1.0311	1.85±1.1367	0.0001
VAS-24	2.85±0.6708	3±1.4868	0.6832

Values are mean±SD. VAS: Visual analog scale, SD: Standard deviation

Table 2b: Visual analog scale scores with cough

Time (h)	VAS cough		*P*
	Group 1	Group 2	
VAS-0	5.15±0.8751	2.05±1.6376	<0.0001
VAS-3	4.55±0.8870	1.7±1.2607	<0.0001
VAS-6	4.75±0.7864	1.85±1.1821	<0.0001
VAS-12	4.3±0.9234	2.15±1.3870	<0.0001
VAS-18	4.1±1.0712	2.8±1.3611	0.0018
VAS-24	3.4±0.9403	3.75±1.5853	0.4011

Values are mean±SD. VAS: Visual analog scale, SD: Standard deviation

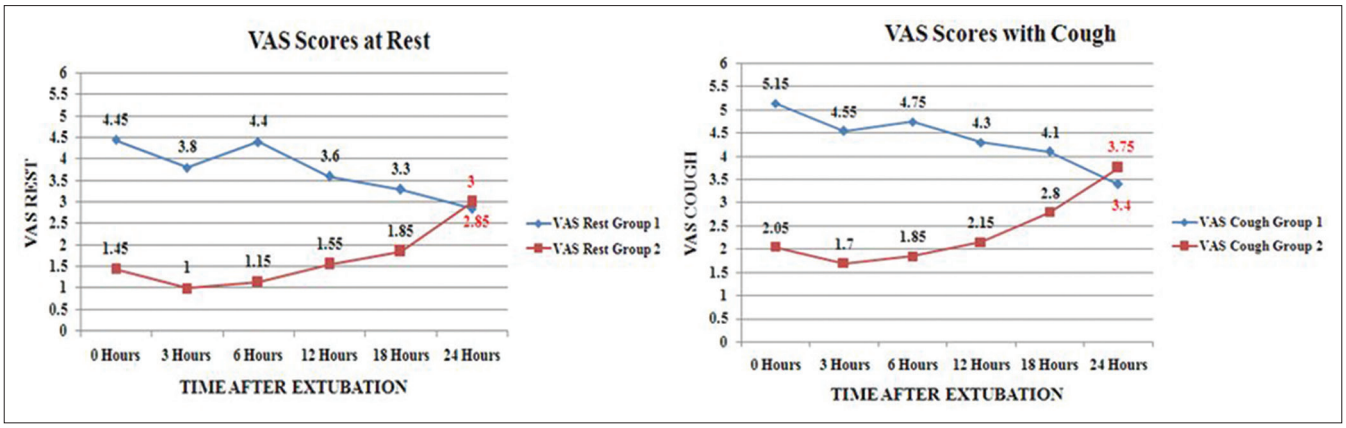

Figure 4: Visual analog scale scores with rest and cough

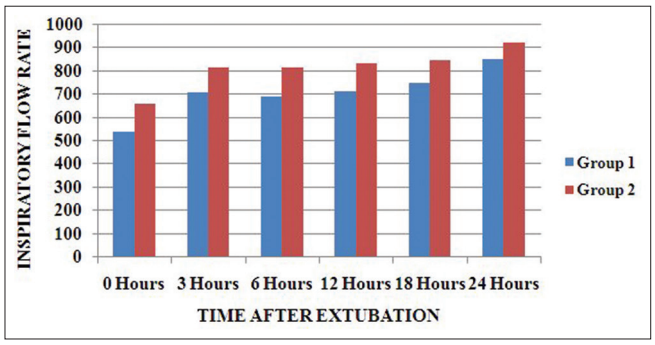

Figure 5: Incentive spirometry (inspiratory flow rate) after extubation

Table 3: Incentive spirometry (inspiratory flow rate)

Time (h)	Inspiratory flow rate		*P*
	Group 1	Group 2	
0	540±94.0325	660±127.3206	0.0016
3	705±146.8081	812.5±145.8866	0.0256
6	690±141.0487	815±134.8488	0.0068
12	712.5±160.4886	830±126.0743	0.014
18	745±146.8081	845±99.8683	0.0161
24	850±131.7893	920±69.5852	0.0424

Values are mean±SD. SD: Standard deviation

patients (91.17%) received rescue analgesia during the first 12 h, whereas in the Pecs group (Group 2), there were only 4 episodes of rescue analgesia. None of the patients in either of the groups required second rescue analgesic.

Discussion

Ever since the description of ultrasound-guided Pecs block by Blanco *et al*.,[5] the number of centers performing the Pecs block as a part of multimodal analgesia for surgeries on chest wall has been increasing rapidly. Options for effective regional anesthetic techniques are limited for patients undergoing cardiac surgery primarily because of the need for systemic heparinization during cardiopulmonary bypass and the risk of postoperative hemodynamic instability. Severe postoperative pain causes a reduction in respiratory mechanics, reduced mobility, and increases in hormonal and metabolic activity.[6,7] Deterioration in respiratory mechanics can lead to pulmonary complications and postoperative hypoxemia, which may be associated with myocardial ischemia and infarction, cerebrovascular accidents, thromboembolism, delayed wound healing, and prolonged hospital stay.[8] Although neuraxial techniques are well established in noncardiac thoracic surgery to provide superior analgesia compared with systemic opioids and reduce the incidence of postoperative pulmonary complications, they are generally avoided in cardiac surgery because of the rare but catastrophic risk of epidural hematoma. Paravertebral blockade can also be effective for chest wall analgesia, but clinicians may lack the level of expertise or resources required for its safe performance. In contrast, Pecs blockade is a relatively simple fascial plane infiltration technique that seems to be associated with an excellent safety profile.[9] These blocks have been described in the setting of breast surgery to provide chest wall analgesia. When combined with general anesthesia for breast surgery, patients who received Pecs blocks had reduced pain scores, reduced opioid consumption for up to 12 h, and improved sedation scores. Pecs blocks have also been used in patients who were poor candidates for general anesthesia as a primary anesthetic technique for the subpectoral implantation of a cardiac resynchronization therapy device. Currently, no prospective study to the best of author's knowledge has been conducted using the Pecs block in patient populations undergoing cardiac surgery through midline sternotomy. In the present study, bilateral Pecs block was used as a part of multimodal analgesia in patients undergoing midline sternotomy.

It was observed that the rest and dynamic pain as assessed by the difference in VAS scores during deep breathing or cough was less in patients who received Pecs block (Group 2) when compared to control group (Group 1). Patients in Pecs group (Group 2) had significantly lesser VAS scores both at rest and during cough postoperatively up to nearly 18 h in comparison to the control group (Group 2), thus indicating that the bilateral Pecs block can be efficiently used for postoperative pain management in patients undergoing cardiac surgery through

midline sternotomy. Since the patients who received Pecs block had superior analgesia when compared to the control group, these patients could be fast-tracked and extubated with ease, thus requiring a significantly lesser duration of ventilator support (108.5 ± 24.34 min) in comparison to the control group (206.3 ± 47.05) with a $P < 0.0001$. This suggests that the patients in the Pecs group had a superior comfort profile than the control group.

Bashandy and Abbas[9] studied the use of Pecs block in patients undergoing modified radical mastectomy (MRM) for breast cancer and demonstrated lower pain scores in patients who received Pecs block than in the controls. They also demonstrated lesser perioperative opioid use, including intraoperative fentanyl as well as postoperative morphine in the Pecs group compared with that in the control group in the first 12 h.

Kulhari *et al*.[10] compared the efficacy of Pecs block versus thoracic paravertebral block for postoperative analgesia after radical mastectomy and found that Pecs block was an effective and safe technique, which provided better pain relief compared to the thoracic paravertebral block and it also reduced the consumption of postoperative opioid consumption.

ELdeen[11] compared ultrasound-guided Pecs blockade with thoracic spinal blockade for conservative breast surgery in cancer breast and concluded that Pecs block was technically simple and easy to learn with few contraindications, provides hemodynamic stability, and has a low complication rate and it is, therefore, a safe and effective technique in performing intraoperative anesthesia and controlling postoperative pain after unilateral conservative breast surgery.

Ali Hassn *et al*.[12] in their study on ultrasound-guided Pecs block with the use of dexmedetomidine and bupivacaine for controlling chronic pain after MRM observed and concluded that reduced VAS scores were seen at the first 24 h postoperatively, with significant reduction in total postoperative analgesia and delayed rescue analgesia in the bupivacaine-dexmedetomidine group in relation to the control group. This marked reduction in the severity of postoperative pain correlated with reduced chronic pain on follow-up and better patient satisfaction, good sleep, and reduced analgesic requirement, which improved quality of life.

Wahba and Kamal[13] studied thoracic paravertebral block versus Pecs block for analgesia after breast surgery and 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 paravertebral block. Moreover, intraoperative fentanyl consumption was significantly lower in patients of Pecs group in comparison with paravertebral group.

Similar to the above studies, the present study demonstrated a reduced postoperative analgesic and opioid requirement in the Pecs group in comparison to the control group.

The present study demonstrated that the VAS scores at rest were significantly lower (VAS ≤4) postoperatively in Pecs group when compared to the control group. This was reflected in the use of rescue analgesia in the Pecs group who received rescue analgesia on only 4 occasions in 24 h, whereas the control group received rescue analgesia on 34 occasions in the 24 h postoperative period.

Since the patients in the Pecs group had significantly lesser postoperative pain even during cough which facilitated expulsion of secretions, patients in this group had better pulmonary rehabilitation reflected by significantly higher inspiratory flow rate on incentive spirometry in comparison to the control group. It can also be inferred from the above observation that since patients in the Pecs group had better pain relief, they required lesser opioids in the postoperative period which, in turn, helped in earlier rehabilitation.

Small sample size was the limitation of the study.

Conclusion

Pecs block is technically simple, safe, and very effective technique and can be used as a part of multimodal analgesia in postoperative cardiac surgical patients for better patient comfort and satisfaction and also helps in superior pulmonary rehabilitation, thus assisting in better outcome.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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