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Original Research

Pectointercostal Fascial Block (PIFB) as a Novel Technique for Postoperative Pain Management in Patients Undergoing Cardiac Surgery

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Objective: To determine the efficacy of pectointercostal fascial block in relieving postoperative pain in patients undergoing cardiac surgery.
Design: Single-blinded, prospective, randomized controlled trial.
Setting: Single-center tertiary care teaching hospital.
Participants: A total 40 participants undergoing cardiac surgery aged 18 to 80 years.
Interventions: Subjects were categorized into 2 groups of 20 each. In group 2 participants (interventional group), bilateral pectointercostal fascial block was given using ropivacaine injection 0.25% after completion of surgery, before shifting to the intensive care unit.
Measurements and Main Results: Postoperative pain was measured after extubation at 0, 3, 6, and 12 hours, using a numeric rating scale. Pain in group 2 was significantly less and lasted for a longer duration than in group 1. Fentanyl requirement was significantly higher in group 1 (1.06 ± 0.12 μ/kg) than in group 2 (0.82 ± 0.19 μ/kg).
Conclusions: Pectointercostal fascial block is an easy and efficient technique to reduce postoperative pain after cardiac surgery.

Key Words: Pectointercostal fascial block; PIFB; pain; cardiac surgery

STERNOTOMY AFTER cardiac surgery is associated with moderate- to- severe postoperative pain. Prompt measures are necessary to treat patients with postoperative pain after cardiac surgery. Incidence of pain is severe in up to 49% of patients, which increases with coughing (78%) and patient movement (62%).[1] Fear of pain inhibits cough and reduces bronchial clearance, causing decreased pulmonary function and lung infections.[2] Poorly controlled pain is associated with sympathetic nervous system activation and increased hormonal response to stress.[3] This response may contribute to multiple postoperative adverse events, including myocardial ischemia, cardiac arrhythmias, hypercoagulation, pulmonary complications, increased rate of delirium, and wound infection.[3-5]

Pectointercostal fascial block (PIFB) was first described by de la Torre in patients undergoing breast surgery.[6] This novel technique blocks the anterior cutaneous nerve, which is a branch of intercostal nerve that gives sensory supply to the skin, soft tissue, and sternum.[6,7] PIFB can be performed by placing a local anesthetic drug between the pectoralis major and external intercostal muscles. Unlike neuraxial blockade, PIFB is not associated with nerve injury, dural puncture, and epidural hematoma.[8] Several other techniques for reducing postoperative pain, such as erector spinae plane block (ESP block) and pectoral nerve blocks (PECS 1 and PECS 2), also use interfascial nerve block techniques but need special patient positioning.[8,9] PIFB has certain advantages in that it is less invasive, close to the incision line, and can be administered

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postoperatively without positioning the patient. PIFB block was successfully used to treat severe acute poststernotomy pain in patients who underwent coronary artery bypass grafting (CABG).[7] The authors' study aimed to implement this new PIFB technique in patients undergoing cardiac surgery to reduce postoperative pain.

Aim and Objective

The primary aim of this study was to evaluate the efficacy of pectointercostal fascial block in relieving postoperative pain in patients undergoing cardiac surgery. The secondary outcome of the study was to determine the effect of PIFB on requirement of fentanyl during postoperative care.

Methodology

The study was a single-blinded, prospective, randomized controlled trial. It was approved by the institute ethical committee (IECPG-313/29.05.2019) and registered at ctri.nic.in (CTRI/2019/08/020729). The study protocol was explained to the patients, and informed consent was obtained. Forty participants, aged 18 to 80 years undergoing cardiac surgery on cardiopulmonary bypass, were randomly allocated into 2 groups of 20 each: group 1 (noninterventional group) and group 2 (interventional group). Patients were allotted to either of the groups based on computer-based randomization technique on the day of surgery. Patients undergoing off-pump surgery and emergent surgeries were excluded from this study. General anesthesia was induced with intravenous fentanyl, 2 μg/kg, thiopentone 2- to- 3 mg/kg, and followed by rocuronium, 1 mg/kg, to facilitate endotracheal intubation. Anesthesia was maintained with isoflurane, intravenous fentanyl, and rocuronium bolus doses based on bispectral index. After adequate heparinization and aortocaval cannulation, full cardiopulmonary bypass was initiated. After definitive surgery and protamine reversal of heparin, activated clotting time was achieved to normal levels. Before transferring patients to an intensive care unit (ICU), group 2 subjects received PIFB.

Ultrasound-Guided Pectointercostal Fascial Block

With patients in the supine position, the anterior part of the chest was cleaned with betadine, 5% solution, for nerve block. A Sonosite ultrasound machine (M-Turbo model) linear high-frequency probe (L38 × 10-5 MHz) was placed 2- to- 3 cm lateral to the upper third of the sternum on the right side parallel to the sternal border. Rib shadows were identified, between the shadows from above to below: skin, subcutaneous tissue, pectoralis major muscle, intercostal muscles, and shiny pleura (Fig 1). A 22-gauge Stimuplex A block needle (B. Braun, Melsungen, Germany) was placed in the caudad- to- cephalad direction, with in-line technique in the space between the pectoralis major and external intercostal muscles (Fig. 1 and 2). Needle tip position was confirmed by hydrolocation of local anesthetic indicated by visualization of fluid spread lifting this fascial plane. After negative aspiration, 10 mL of ropivacaine injection, 0.25%% was injected into the pectointercostal space and the needle was advanced in a cephalad direction to hydrodissect the space. The same procedure was performed in the middle and lower one-third of the sternum on the right side. PIFB was performed on the contralateral side using the same technique. Maximum dose of ropivacaine injection was limited to 3 mg/kg. In both groups, a total intraoperative dose of fentanyl was given in an equal dose of 10 μg/kg. The last dose of fentanyl, 2 μg/kg, was given before transferring patients to the ICU in both groups.

Postoperative Intensive Care Unit Management and Postoperative Pain Assessment

After completion of PIFB, patients were transferred to the ICU for continued care. The study was blind to the attending nursing staff in the ICU. In both groups after arrival to the ICU, intravenous paracetamol, 1 g, and tramadol, 50 mg, were given and repeated every 6 hours as part of multimodal analgesia. After extubation, patients were evaluated for pain by an attending nurse using a numeric rating scale (NRS) at 0, 3, 6, and 12 hours during breathing of normal tidal volume and with cough. Patients complaining of pain or NRS score more than 4 in both groups were managed by intravenous fentanyl bolus as required.

Statistics

Based on a study by Kumar et al,[9] the mean postoperative pain score in the control group at baseline was 4.5 ± 2.0. Expecting 50% reduction of pain after PIFB, that is a mean of 2.25 ± 2.0, with an α error of 5% and power 90% of the study, sample size was calculated to be 17 in each group using 2-sided test. Expecting some possible dropouts and loss of follow-up, the authors included 20 patients in each group. Continuous variables were profiled as percentages, mean ± standard deviation, and median with interquartile range; whereas categorical variables were described as proportions in the groups. Differences between groups were analyzed using Student *t* test, Mann-Whitney U test, or chi-square test as applicable. As the authors compared multiple variables, Bonferroni correction was applied to reduce the risk of inflated type- y statistical error. Pain was measured as 2 variables (with and without cough); hence, p value became 0.025 (0.05/2). A p value less than 0.025 was considered significant.

Results

Fifty patients were assessed for eligibility, 7 patients did not meet inclusion criteria, and 3 patients refused to participate. There were no dropouts, deaths, and loss of follow-up in the study. A consort flow chart of the recruitment process, with randomization, is given in Figure 3. Baseline parameters were comparable between both the groups, with no statistically significant p value (Table 1). A majority of patients in both groups underwent coronary artery bypass grafting, with concurrent surgery for valvular heart disease. There was no

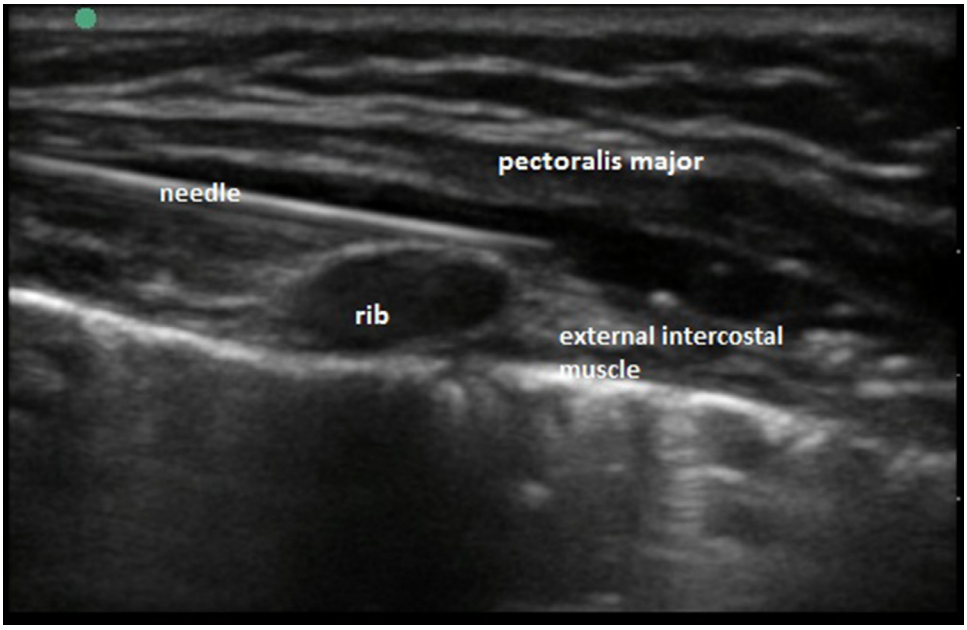

Fig 1. Ultrasound image showing needle placed between the pectoralis major and external intercostal muscle plane. Image also shows the rib shadow and underlying shiny pleura.

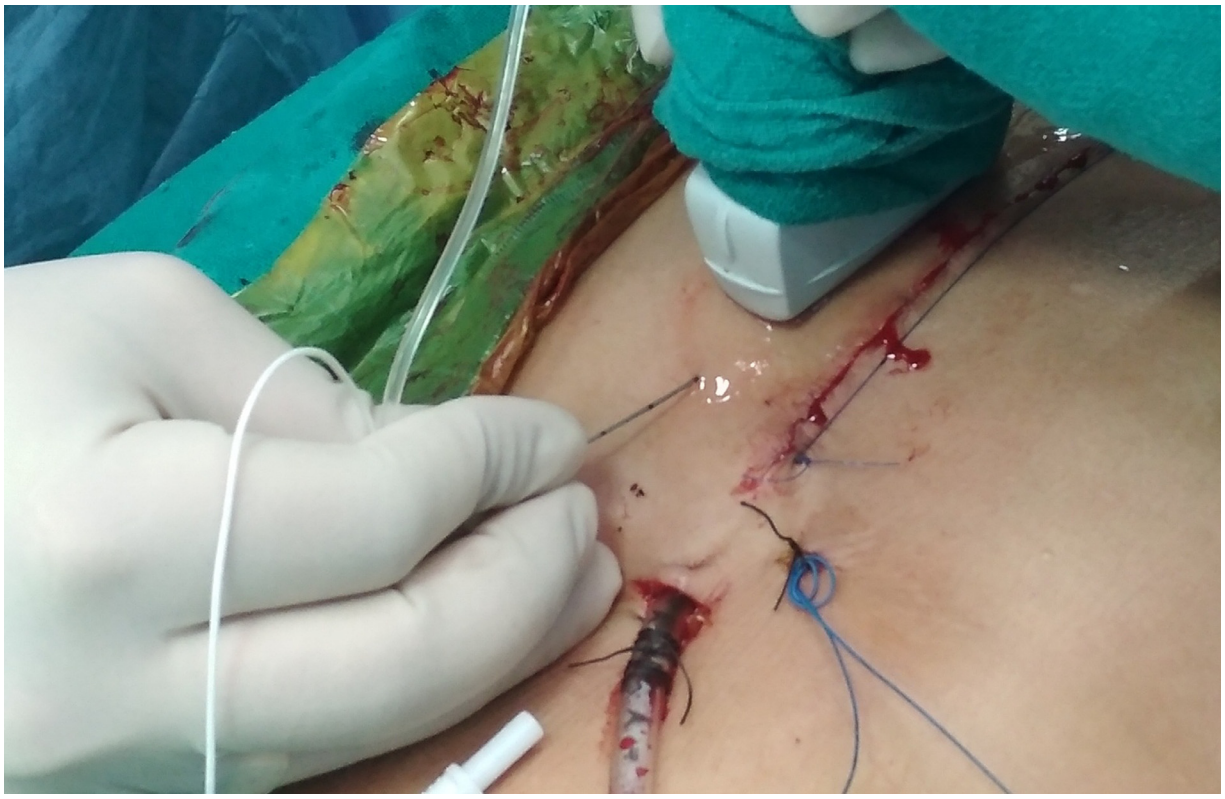

Fig 2. Image showing placement of ultrasound probe 2- to- 3 cm lateral to the sternal border. The needle is entered in a cephalad direction with in-line technique.

statistically significant difference in duration of postoperative mechanical ventilation.

The difference in NRS for pain was measured using the Mann-Whitney U test (Tables 2 and 3). No statistically significant difference was observed between the 2 groups at NRS 0 and 3 hours. Median values of NRS at 6 hours (1 [0-2]) and 12 hours (1 [0-4]) were significantly lower in group 2. Cough NRS scores were in the mild range at 0, 3, and 6 hours in both the groups, with significantly less pain experienced in group 2 (Fig 4). Patients in group 1 experienced moderate pain at 12 hours; with cough and NRS score statistically higher than in group 2 (Table 3). Rescue fentanyl used in group 1 (1.06 ±

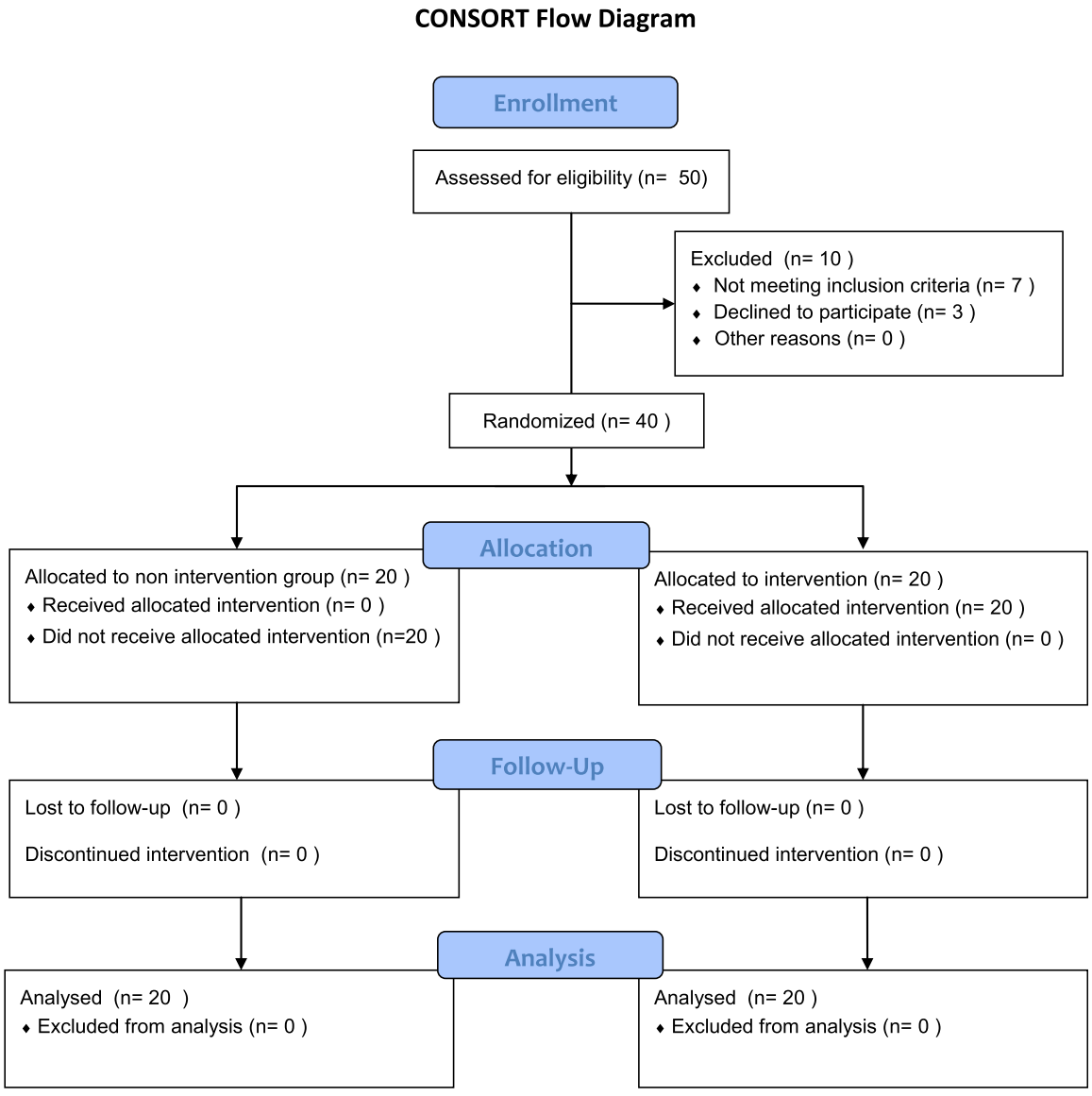

Fig 3. Consort flow diagram showing recruitment process.

Table 1
Baseline parameters.

	Group 1	Group 2	p Value
Age	46.25 ± 14.47	51.25 ± 15.86	0.30*
Sex			
Male	13 (65%)	7 (35%)	0.748†
Female	11 (55%)	9 (45%)	
Diagnosis			
Coronary artery disease	9 (45%)	11 (55%)	0.762†
Valvular heart disease	7 (35%)	7 (35%)	
Others	4 (20%)	2 (10%)	
Duration of mechanical ventilation, h	6.3 ± 1.49	6.4 ± 1.35	0.82*
Rescue fentanyl, μg/kg	1.06 ± 0.12	0.82 ± 0.19	0.001*
Time to place PIFB, min		6 ± 1.02*	

Abbreviation: PIFB, pectointercostal fascial block.
* Student *t* test.
† Fisher exact test.

Table 2
NRS scores during normal tidal volume breath.

	Group 1 Median (min-max)	Group 2 Median (min-max)	p Value*
NRS 0	0.5 (0-2)	0 (0-1)	0.058
NRS 3	1 (0-3)	0 (0-2)	0.092
NRS 6	2 (1-3)	1 (0-2)	0.001
NRS 12	3.5 (2-5)	1 (0-4)	0.001

Abbreviation: NRS, numeric rating scale.
* Mann-Whitney U test.

Table 3
NRS scores with cough.

	Group 1 Median (min-max)	Group 2 Median (min-max)	p Value*
Cough NRS 0	1 (1-2)	0 (0-1)	0.001
Cough NRS 3	3 (1-5)	1 (0-2)	0.001
Cough NRS 6	3 (2-5)	1 (1-3)	0.001
Cough NRS 12	4 (2-7)	3 (1-4)	0.001

Abbreviation: NRS, numeric rating scale.
* Mann-Whitney U test.

0.12 μ/kg) was greater than in group 2 (0.82 ± 0.19 μ/kg) and was statistically significant ($p < 0.001$). Mean duration to perform PIFB bilaterally was 6 ± 1.02 minutes.

Discussion

The authors' study demonstrated advantage of PIFB over opioid usage in reducing postoperative pain after cardiac surgery. Patients who received PIFB experienced less pain for a longer postoperative period, along with less fentanyl requirement.

Since the description of PIFB in breast surgery by de la Torre, this technique has been gaining popularity in chest wall surgeries and trauma.[6] PIFB blocks the anterior cutaneous branch of intercostal nerves, emerging at the lateral sternal border at multiple levels using fascial spread of local anesthetic. Neuraxial techniques in cardiac surgery were adopted less than a decade ago because fears of permanent neurologic deficits were expressed.[10] Perioperative use, of antiplatelet agents and intraoperative heparin are a matter of concern in the setting of neuraxial blocks. So recently, fascial plane blocks have been used frequently to provide postoperative analgesia in cardiac surgery patients. Fascial plane block is considered a "minimally invasive" regional technique that is qualitatively equivalent to neuraxial blocks.[11] PIFB is considered a component of thoracic fascial plane blocks, including transverse thoracic block, PECS block, and parasternal block.[12] Other interfascial plane block techniques explained recently are ESP block and serratus anterior plane block.[13,14]

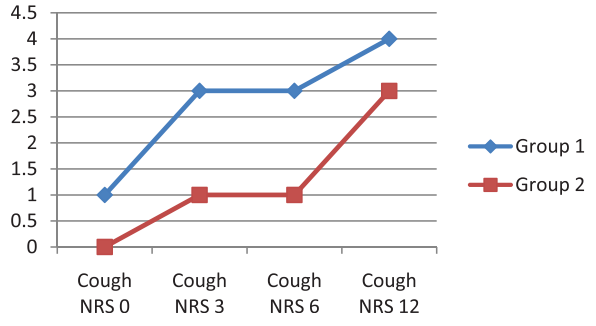

Fig 4. Pictogram depicting cough numeric rating scale pain score comparison between both groups. Group 1 patients had a higher pain score than group 2 patients in the postoperative period.

Based on a case report by Victor and his colleagues,[7] PIFB was successfully used to treat a postoperative CABG patient with retractable pain not responding to opioids and other analgesics. PIFB, also called "subpectoral interfascial plane block," was used successfully to treat pain of sternal fractures using a catheter-based technique.[15] This can be used as a model to achieve better results treating postoperative pain in cardiac surgery. Unlike the intercostal nerve block technique that requires multiple bilateral injections, with risk of pleural and intercostal nerve injury, PIFB is easy to perform under ultrasound guidance. Along with anterior cutaneous nerve block, local spread of drug also helps in effective pain control of sternotomy and helps lessen systemic absorption. The internal mammary artery (IMA) has perforating branches traversing the pectointercostal space where PIFB is placed. Patients undergoing coronary artery bypass grafting, with internal mammary artery harvesting, experience more pain than other patients undergoing sternotomy.[16] PIFB being placed closer to the IMA dissection site added better postoperative pain relief and recovery. In the authors' study, opioid requirement and NRS score were significantly less in the interventional group, suggesting better pain control. NRS scores were low and insignificant between both the groups during 0 and 3 hours of

extubation during normal breathing. This can be partially explained by intravenous paracetamol and tramadol given at 6 hourly intervals coinciding with the extubation time. However, NRS scores with cough were significantly higher in the noninterventional group during initial hours of extubation. The authors have administered ropivacaine for PIFB, as it exhibits longer duration of action and less cardiotoxicity.[17]

PIFB has multiple uses, such as sole anesthesia technique in breast surgery, perioperative pain control in cardiac surgery, and analgesia for rib and sternal fracture.[18,19] PIFB has been successfully used to wean from mechanical ventilation in patients with retractable pain at the endothoracic drainage site.[18] Catheter-based technique can be introduced in PIFB for prolonged perioperative pain control.[18,19] Similar to PIFB, Eljezi et al. used continuous bilateral sternal infusion of ropivacaine with catheters placed at the lateral sternal border.[20] They observed lower movement-evoked pain and morphine consumption than the placebo group even though pulmonary function remain unaffected. Regional anesthesia techniques confer better hemodynamic stability, perioperative analgesia, attenuation of surgical stress response, early extubation, improved pulmonary function, and decreased cognitive dysfunction.[21]

Minimally invasive cardiac surgery, using fascial plane blocks as a sole anesthetic technique, can be the best regimen an anesthesiologist can provide for the patient. PIFB, in comparison to other fascial plane blocks, has certain advantages and disadvantages. Under ultrasound guidance, PIFB is easy to administer and close to the incision site, which helps in effective analgesia but requires multiple injection sites. In the authors' study, total duration to place PIFB bilaterally was acceptable (6 ± 1.02 minutes). PIFB is placed in the supine position so it can also be administered in the ICU after patient extubation. However, other fascial plane blocks, such as ESP block, target intercostal nerve roots and require a single injection site bilaterally with lesser drug volume, but require special patient positioning to perform the block.[13,22] In the authors' observation, a special mention of disadvantage with PIFB was insertion of abdominal muscles high above the incision site. Patients in this study did not develop any complications related to PIFB, such as hematoma, wound infection, prolonged paresthesias, and iatrogenic pneumothorax.

The authors' study had certain limitations, such as patients undergoing CABG required additional analgesics for pain at the venous graft incision in the lower limb and thoracotomy pain for pleural drain placement. Sense of pain is related to many individual variables, so its comparison between the individuals and groups is a difficult task due to many confounding factors. However, benefits of PIFB outweigh the risk of opioid analgesics, and PIFB can be considered in all types of cardiac surgical procedures. With superior results of PIFB compared with opioid analgesia in adult patients, the probability of using this block in the pediatric population undergoing cardiac surgery may be considered in the future.

Conclusion

With recent advances in cardiac anesthesia techniques, PIFB adds to fascial plane blocks that deliver promising results in sternotomy pain. Ultrasound-guided PIFB is a minor easy intervention with fairly low-risk fascial plane block modality in cardiac surgery to reduce postoperative pain.

Acknowledgments

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Conflict of Interest

The authors declare no conflict of interest.

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