Original Article

Comparison of Pectoral Nerve (PECS1) Block with Combined PECS1 and Transversus Thoracis Muscle (TTM) Block in Patients Undergoing Cardiac Implantable Electronic Device Insertion – A Pilot Study

Thanigai Arasu, Ragavendran S, Nagaraja PS, Naveen G Singh, Manjunatha N, Vikram Somashekhar Basappanavar

Department of Anaesthesiology, Sri Jayadeva Institute of Cardiovascular Sciences and Research, Jayanagar, Bangalore, Karnataka, India

Abstract

Background: Pectoral nerve (PECS1) block has been used for patients undergoing cardiac implantable electronic device (CIED) insertions, however, PECS1 block alone may lead to inadequate analgesia during tunneling and pocket creation because of the highly innervated chest wall. Transversus thoracis muscle plane (TTM) block targeting the anterior branches of T2-T6 intercostal nerves can be effectively used in combination with PECS1 for patients undergoing CIED insertion. The present study hypothesized that combined PECS1 and TTM blocks would provide effective analgesia for patients undergoing CIED insertion compared to PECS1 block alone. **Materials and Methods:** Thirty adult patients between the age group of 18–85 years undergoing CIED insertion were enrolled in the study. A prospective, randomized, comparative, pilot study was conducted. A total of 30 patients were enrolled, who were randomized to either Group P: PECS1 block (n = 15) or Group PT: PECS1 and TTM blocks (n = 15). The intraoperative requirement of midazolam and local anesthetic and level of sedation by Ramsay sedation score were noted. The pain was assessed by visual analog scale (VAS) at rest and during a cough or deep breathing at 0 h, 3 h, 6 h, 12 h, and 24 h after the procedure. **Results:** VAS scores at rest were significantly lower in group PT at 0, 3, 6, and 12 h postprocedure, and during cough at 0, 6, and 12 h after the procedure ($P < 0.05$). At 24 h, VAS scores were comparable between both groups. Intraoperative midazolam consumption was higher in group P compared to group PT ($P = 0.002$). Fourteen patients in group P received local anesthetic supplementation in comparison to only one patient in group PT ($P = 0.0001$). Thirteen patients in group P received the first rescue analgesia in comparison to three patients in group PT ($P = 0.0003$). **Conclusion:** Combined PECS1 and TTM blocks provide superior analgesia, reduced net consumption of local anesthetic, sedative agents, and rescue analgesics compared to PECS1 block alone in patients undergoing CIED insertion.

Keywords: *Cardiac implantable electronic device, pectoral nerve block, transversus thoracis muscle block*

Introduction

Patients undergoing cardiac implantable electronic device (CIED) insertions have substantially increased, due to extended indications and improvement in device design with better outcomes, especially in the geriatric population. The unique challenge to the anesthesiologist during implantation of these devices are mainly operational. These patients also have compromised cardiovascular function. Hence, providing optimal sedation, adequate analgesia, and patient immobility are crucial to perform the procedure while maintaining stable hemodynamics.[1]

Placement of these devices under local anesthetic infiltration frequently leads to inadequate analgesia and frequent movement of the patient during the procedure. Anesthetic techniques such as general anesthesia (GA) and monitored anesthesia care (MAC) with sedation may be risky in debilitating patients.[2] Thoracic epidural and para-vertebral blocks (PVB) are extensively practiced for chest wall procedures. However, the thoracic epidural technique is associated with sympathectomy which may not be tolerated in geriatric population with compromised cardiovascular function. Despite the fact that PVB is associated with fewer hemodynamic alterations, there is a steep

Submitted: 31-Dec-2018
Revised: 20-May-2019
Accepted: 10-Sep-2019
Published: 07-Apr-2020

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

Access this article online
Website: www.annals.in
DOI: 10.4103/aca.ACA_255_18
Quick Response Code:

How to cite this article: Arasu T, Ragavendran S, Nagaraja PS, Singh NG, Manjunatha N, Basappanavar VS. Comparison of pectoral nerve (PECS1) block with combined PECS1 and transversus thoracis muscle (TTM) block in patients undergoing cardiac implantable electronic device insertion – A pilot study. Ann Card Anaesth 2020;23:165-9.

learning curve since they are technically challenging with the risk of accidental vascular, pleural, and neuraxial injury.[3]

Blanco *et al*., introduced the pectoral nerve block (PECS1), as an alternative analgesic technique for breast conservative surgeries.[4] Since then, various studies showed this technique to be useful in providing adequate analgesia for chest wall procedures.[5] PECS1 block targets medial and lateral pectoral nerves in the plane between the pectoralis major and pectoralis minor. It provides analgesia related to surgical disruption of pectoral muscles and related fascial structures.

There are case reports on PECS with transversus thoracis muscle (TTM) block and PECS with intercostal nerve block for effective analgesia in patients undergoing modified radical mastectomy and CIED insertion, respectively.[6,7] TTM is also used in combination with parasternal block to treat the residual post-thoracotomy pain syndrome.[8] There has been limited literature on the combination of PECS1 with a TTM block for CIED insertion procedures. Hence, the present study was conducted to compare the analgesic efficacy of PECS1 block with combined PECS1 and TTM block in patients undergoing CIED insertion.

Objective of the study

To compare the analgesic efficacy of PECS1 block with combined PECS1 and TTM blocks for CIED insertion.

Materials and Methods

After the approval from the Institutional Ethics Committee and written informed consent, 30 patients (15 in each group) were enrolled in the study.

Inclusion criteria were adult patients between 18–85 years, scheduled for elective CIED insertion.

Exclusion criteria were a refusal of consent by the patient, allergy to local anesthetics, bleeding diathesis, chest wall deformities, and rib fractures.

Patients were randomized by computer-generated random table into two groups, namely, PECS1 (Group P) and combined PECS1 and TTM block group (Group PT). The subjects in both groups were explained about pain scoring based on the visual analog scale (VAS).

On the day of the procedure, intravenous access was secured. Pulse oximetry, electrocardiography, and noninvasive blood pressure monitoring were established. In both groups, the patients were premedicated with midazolam 0.5 mg intravenously. Oxygen via a simple face mask was supplemented at the rate of 6–8 L/min.

Under strict aseptic precautions, an in-plane approach using high frequency 12 MHz linear ultrasound transducer (Philips En Visor CHD, Bothell, Washington, USA 98041) was used to perform the blocks.

In group P, PECS1 block was performed after placing the transducer obliquely over the infraclavicular (pectoral) region at the level of the third rib. The skin was infiltrated locally with 2 ml of 1% lignocaine over the needle insertion site. From lateral edge of the transducer, 23G Quincke's needle was inserted deep to pectoralis major and superficial to pectoralis minor and hydro-dissection was demonstrated in the interfascial plane using injection of 3–5 ml of saline after confirming negative aspiration for blood and air [Figure 1]. A bolus dose of 0.25% bupivacaine 10 ml was administered.

Patients in group PT (PECS1 and TTM) were administered with both PECS1 and TTM blocks. Under strict aseptic precautions, the PECS1 block was performed in a similar technique to group P and a bolus dose of 0.25% bupivacaine 10 ml was administered. TTM block was performed on the same side by placing transducer horizontally lateral to the sternum at the level of third intercostal space. A 21G hypodermic needle was inserted from lateral to medial direction after skin infiltration with 2 ml of 1% lignocaine. After placing the needle tip deep to intercostal muscles and superficial to transversus thoracic muscle, hydro dissection and/or downward displacement of pleura were demonstrated using injection of 3–5 ml saline, after confirming negative aspiration for blood or air [Figure 2]. A bolus dose of 0.25% bupivacaine 10 ml was administered.

About 5 ml of 1% lignocaine was infiltrated over the skin incision site in both the groups.

During the intraoperative period, any perception of pain over the procedural site was treated with an additional 2 ml of 1% lignocaine infiltration locally by the operating cardiologist. The volume of additional lignocaine infiltration required was noted.

Level of sedation in either group was assessed with Ramsay Sedation Scale (RSS: 1-anxious, agitated, restless; 2-oriented, tranquil; 3-responds to commands; 4- brisk response to glabellar tap; 5- sluggish response to glabellar tap; 6-no response).

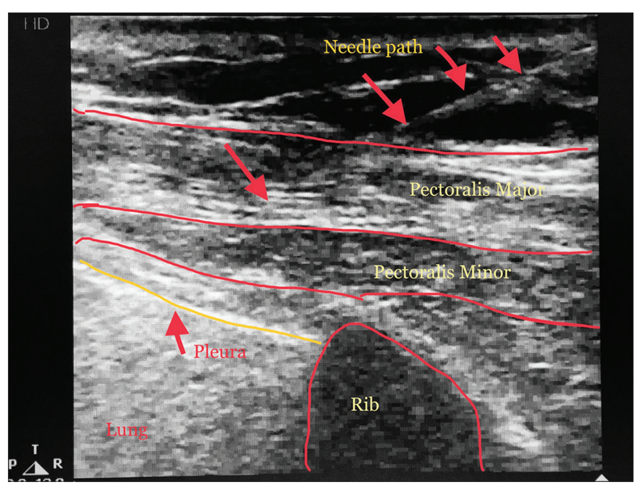

Figure 1: Sonoanatomy showing needle path while performing PECS1 block

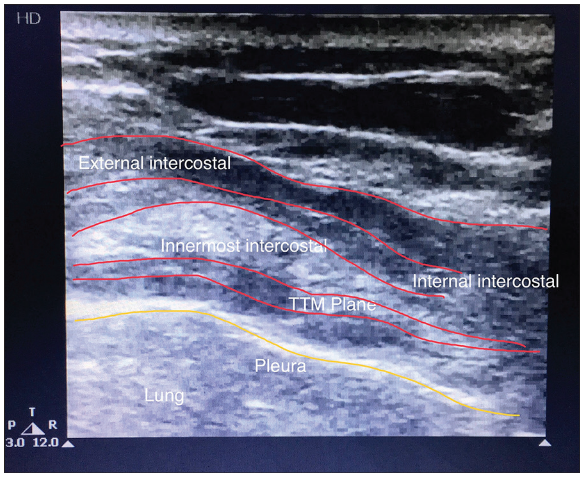

Figure 2: Sonoanatomy showing hydro dissection while performing TTM block

If RSS was 1, an additional 0.5 mg of midazolam was administered intravenously. The total dosage of supplemental midazolam was also noted.

After the surgical procedure, patients were shifted to the postoperative cardiac catheterization observation unit.

VAS score was used to assess pain postoperatively. VAS score at rest and during a cough or deep breathing were assessed after the procedure at 0 h, 3 h, 6 h, 12 h, and 24 h. The severity of pain was classified as mild (VAS 0–4), moderate (VAS 5–7), and severe (VAS 8–10).

Breakthrough pain was defined as a VAS score of 4 or more at rest or on patient's demand. IV paracetamol 15 mg/kg was administered as first rescue analgesic.

If the VAS score was persistently 4 or more after 30 min of first rescue analgesia, IV tramadol 1 mg/kg was administered slowly as second rescue analgesia.

Dynamic pain was defined as the difference in VAS score between rest and cough of >2 points.

The total consumption of first and second rescue analgesics was noted.

Statistical analysis

The normal distribution of the data was confirmed by the Shapiro-Francia test. Parametric data were expressed as mean ± SD, nonparametric data as median and range. An independent student *t*-test was used to compare continuous data between the two groups. Categorical data were assessed using Chi-square test. *P* value <0.05 was considered statistically significant. Statistical analysis was done using Medcalc software version 12.2.1.0 (Ostend, Belgium).

Results

All 30 patients completed the study protocol. Patients in both groups were comparable for demographic characteristics, including age, gender, and duration of the procedure [Table 1].

Table 1: Demographic variables

	Group P (*n*=15)	Group PT (*n*=15)	*P*
Age (years) [Mean±SD]	67.8±15.08	67.13±14.08	0.9
Gender			
Male	7	7	1.0
Female	8	8	
Height (cm) (Mean ±SD)	164.90±6.85	167.57±4.97	0.090
Weight (kg) (Mean ±SD)	57.80±9.25	57.00±9.64	0.744
Duration of procedure (min) [Mean±SD]	72.66±7.98	68.66±8.33	0.1

SD: Standard Deviation, min: Minutes, cm: Centimetre, kg: Kilogram

Table 2a: VAS score at rest

Time	VAS score at rest		*P*
	Group P (*n*=15)	Group PT (*n*=15)	
VAS-0 (mean±SD)	2.6±1.59	1.0±0.92	0.002*
VAS-3 (median±IQR)	3 (2 to 3)	1 (1 to 2)	0.006*
VAS-6 (mean±SD)	3.66±0.28	2.2±1.01	0.0008*
VAS-12 (mean±SD)	5.0±0.43	2.8±0.29	0.0003*
VAS-24 (mean±SD)	3.4±1.18	3.0±0.37	0.22

SD: Standard deviation, IQR: Interquartile range, VAS: Visual analog scale. *Statistically significant

Table 2b: VAS score during deep breathing or cough

Time	VAS score during deep breathing or cough		*P*
	Group P (*n*=15)	Group PT (*n*=15)	
VAS-0	2.66±1.54	1.2±1.14	0.006*
VAS-3	2.86±0.74	2.2±1.61	0.15
VAS-6	4.0±1.41	2.7±1.09	0.01*
VAS-12	5.53±1.99	3.13±1.35	0.0006*
VAS-24	3.4±1.18	3.2±0.41	0.54

Values are Mean±SD, SD: Standard deviation, VAS: Visual analog scale. *Statistically significant

VAS score at rest [Table 2a] and during deep breathing or cough [Table 2b] were recorded at 0 h, 3 h, 6 h, 12 h, and 24 h after completion of the procedure. VAS scores at rest were significantly lower in group PT patients at 0 h, 3 h, 6 h, and 12 h ($P < 0.05$). At 24 h, VAS scores at rest were comparable between the two groups ($P = 0.22$). Pain scores during deep breathing or cough were also significantly low at 0 h, 6 h, and 12 h in group PT than group P ($P < 0.05$). At 24 h, VAS scores during cough were comparable between the two groups ($P = 0.54$).

The number of patient that required first rescue analgesia was significantly high in group P as compared to group PT (13 in group P vs 3 in group PT, $P = 0.0003$) [Table 3a]. Total consumption of first rescue analgesia was significantly higher in group P (1400.0 ± 910.25) than the group PT (266.66 ± 593.61) ($P = 0.0004$) [Table 3b].

Second rescue analgesia was administered in four patients in group P as compared to only one patient in group PT (P = 0.14). Total requirement of second rescue analgesia was comparable between two groups (group P 13.33 ± 22.88 mg vs 3.33 ± 12.90 mg in group PT) (P = 0.15) [Table 3b].

Local anaesthetic supplementation was administered to 14 patients in group P as compared to only one patient in group PT (P = 0.0001) [Table 3a]. Total requirement of additional local anaesthetic was significantly higher in group P (2.53 ± 1.35) as compared to group PT (0.66 ± 2.58) (P = 0.01) [Table 3b].

Total requirement of midazolam was significantly higher in group P (0.46 ± 0.44) as compared to group PT (0.06 ± 0.17). (P = 0.002) [Table 3b].

Ramsay sedation score at 5 min was significantly lower in group P (1.4 ± 0.5) as compared to group PT (2.4 ± 1.06) (P = 0.001). At 30 and 60 min, it was higher in group P as compared to group PT (P < 0.05) [Table 3c].

Discussion

Pain and patient discomfort following interventional electrophysiological procedures are vastly underestimated. Although routine local infiltration at the procedural site provides analgesia, it frequently interrupts the procedure and the effect is short-lasting. Any undertreated pain will lead to emotional stress which in turn results in negative immune-modulating effects and cognitive dysfunction postoperatively.[9] Bode *et al*. highlighted the high prevalence (60%) of postprocedural pain in the first 24 h following cardiac device surgical procedures.[10]

Bollman *et al*. showed that 86% of patients who underwent subpectoral ICD implantation under conscious sedation had a mean VAS score of 34 ± 20 at 24 h after the procedure.[11] Chronic shoulder pain and disability were described in 54% of patients for more than 3 years after ICD implantation.[12]

These findings enlighten the fact that properly structured multimodal analgesia is needed to address these issues. In the paradigm of enhanced recovery after surgery (ERAS), site-specific regional anesthesia is evolving as an adjunct to opioid-sparing strategies.

Tsai *et al*. observed that thoracic paravertebral block with sedation provided good analgesia in a 51-year-old male scheduled for removal of infected ICD and laser lead extraction.[13] But it has inherent risks associated with it in anticoagulated patients and demands more technical expertise. In contrast, truncal plane blocks are relatively easy to perform and provide excellent analgesia with a good safety profile.[14]

Fujiwara *et al*. administered PECS with intercostal nerve block for cardiac resynchronization therapy (CRT-D) implantation and found it to be an effective analgesic technique.[7] However, intercostal nerve block has to be administered at multiple sites causing discomfort to the patient. In contrast, the TTM block targets anterior branch of T2-T6 intercostal nerves, hence a single injection for TTM block is usually suffice.

Ali Hassn *et al*. administered ultrasound-guided PECS block using dexmedetomidine and bupivacaine in patients with chronic postmastectomy pain. They noted that lower VAS scores in the first 24 h after surgery, reduced chronic pain on follow up, and better patient satisfaction.[15]

Since PECS block doesn't provide adequate analgesia for procedures extending to the internal mammary area, Ueshima *et al.* conducted a study on patients undergoing mastectomy under GA wherein PECS block alone was compared with combined PECS and TTM block. They found lower VAS scores both at rest and during movement in combined PECS and TTM block groups.[16]

In the present study, the VAS score at rest was significantly lower in patients who received combined PECS1 and TTM blocks (group PT) at 0, 3, 6, and 12 h (P < 0.05). VAS scores during deep breathing or cough were also lower in the combined PECS1 and TTM blocks group (group PT) compared to PECS1 block alone (group P) with statistical significance at 0, 6, and 12 h (P < 0.05).

This was reflected by a five-fold increase in the use of first rescue analgesia in the PECS group as compared to combined

Table 3a: Number of patients requiring analgesia

	Group P (n=15)	Group PT (n=15)	P
Local anaesthetic supplementation	14	1	0.0001*
First rescue analgesia	13	3	0.0003*
Second rescue analgesia	4	1	0.14

*Statistically significant

Table 3b: Total consumption of sedation/rescue analgesia

	Total consumption of sedation/ rescue Analgesia		P
	Group P (n=15)	Group PT (n=15)	
Intraoperative midazolam (mg)	0.46±0.44	0.06±0.17	0.002*
Intraoperative local anaesthetic (ml)	2.53±1.35	0.66±2.58	0.01*
First rescue analgesia (mg)	1400.0±910.25	266.66±593.61	0.0004*
Second rescue analgesia (mg)	13.33±22.88	3.33±12.90	0.15

Values are Mean±SD. SD: Standard deviation. Mg: Milligrams, ml: Millilitres. P =< 0.05 is statistically significant

Table 3c: Ramsay sedation score

Time	Ramsay Sedation Score		P
	Group P (n=15)	Group PT (n=15)	
5 min	1.4±0.5	2.4±1.06	0.001*
30 min	3.46±1.12	2.46±1.06	0.01*
60 min	3.2±1.08	2.4±0.63	0.01*

*Statistically significant

PECS and TTM blocks. Thirteen patients in group P received first rescue analgesia compared to three patients in group PT, with most of the patients requiring at around the twelfth hour.

Elamaym *et al.* compared combined GA and PECS plus TTM blocks with GA alone in patients undergoing radical mastectomy and showed better analgesia and reduced opioid consumption intraoperatively in the PECS plus TTM blocks group (285.6 ± 76.2 vs 345.3 ± 120.9) (*P* = 0.006).[6]

In the present study, 14 patients in group P received local anaesthetic supplementation compared to only one patient in group PT [*P* = 0.0001] and the net consumption of local anaesthetic also reduced in group PT [0.66 ± 2.58] versus group *P* [2.53 ± 1.35], (*P* = 0.01). Both were statistically significant.

Total consumption of midazolam was higher in group P (0.46 ± 0.44) than group PT (0.06 ± 0.17), which is statistically significant (*P* = 0.002).

None of the patients in either group had complications related to the block procedures such as pneumothorax, local anesthetic systemic toxicity, hematoma, and so on.

Limitations

We did not follow up with the patients after discharge to assess chronic pain.

Probably a larger sample size would have revealed any complications associated with these blocks.

Conclusion

Combined PECS1 and TTM blocks can provide superior analgesia, reduced net consumption of local anesthetic, sedative agents, and rescue analgesics compared to PECS1 block alone in patients undergoing CIED insertion.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Looi KL, Lee AS, Cole K, Agarwal S, Heck PM, Begley DA, *et al*. Consious sedation and analgesia use in cardiac device implantation. Int J Cardiol 2013;168:561-3.
2. Gross WL. Non-Operating Room Anesthesia. In. Miller RD, editor. Miller's Anesthesia. 8th ed. Philadelphia, PA: Churchill Livingstone/ Elsevier; 2015. p. 2646-73.
3. Nair AS, Sahoo RK, Ganapathy M, Muduniri R. Ultrasound guided blocks for surgeries/procedure involving chest wall (Pecs 1,2 and serratus plane block). Anaesth Pain Intensive Care 2015;19:348-51.
4. Blanco R. The Pecs block: A novel technique for providing analgesia after breast surgery. Anaesthesia 2011;66:847-8.
5. Versyck B, Van Houwe P, Van Geffen GJ, Van de Valde M, Slappendal R. A qualitative syatematic review of the pectoral nerves block type I and II. Acta Anaesth Belg 2017;68:49-62.
6. Abo Elamayam MA, Oshita K, Taguchi S, Kato T, Hamada H, Abdelmageed N, *et al*. The analgesic efficacy of pectoral nerve and transversus thoracic muscle plane block in radical mastectomy. MEJ Anesth 2018;25:89-94.
7. Fujiwara A, Komasawa N, Minami T. Pectoral nerves (PECS) and intercostal nerve block for cardiac resynchro nization therapy device implantation. Springerplus 2014;3:409.
8. Piraccini E, Biondi G, Byrne H, Calli M, Bellantonio D, Musetti G, *et al*. Ultrasound guided transversus thoracic plane block, parasternal block and fascial planes hydrodissection for internal mammary post thoracotomy pain syndrome. Eur J Pain 2018;22:1673-77.
9. Page GG, Blakely WP, Ben-Eliyahu S. Evidence that postoperative pain is a mediator of the tumour-promoting effects of surgery in rats. Pain 2011;90:191-9.
10. Bode K, Breithardt OA, Kreuzhuber M, Mende M, Sommer P, Richter S, *et al*. Patient discomfort following catheter ablation and rhythm device surgery. Eurospace 2015;17:1129-35.
11. Bollmann A, Marx A, Sathavorn C, Mera F, DeLurgio D, Walter PF, *et al*. Patient discomfort following pectoral defibrillator implanation using conscious sedation. Pacing Clin Electrophysiol 1999;22:212-5.
12. Celikyurt U, Agacdiken A, Bozyel S, Argan O, Sade I, Vural A, *et al*. Assessment of shoulder pain and shoulder disability in patients with implantable cardioverter-defibrillator. J Interv Card Electrophysiol 2012;36:91-4.
13. Tsai T, Diaz CR, Deschner B, Thomas K, Wasnick JD. Thoracic paravertebral block for implantable cardioverter-defibrillator and laser lead extraction. J Clin Anesth 2008;20:379-82.
14. Abdallah FW, MacLean D, Madjdpour C, Cil T, Bhatia A, Brull R. Pectoralis and serratus fascial plane blocks each provide early analgesic benefits following ambulatory breast cancer surgery: A retrospective propensity-matched cohort study. Anesth Analg 2017;125:294-302.
15. Ali Hassn A, Zanfaly H, Biomy T, Pre-emptive analgesia of ultrasound-guided pectoral nerve block II with dexmedetomidine –bubivacaine for controlling chronic pain after modified radical mastectomy. Res Opin Anesth Intensive Care 2016;3:6-13.
16. Ueshima H, Otake H. Addition id transverses thoracic muscle plane block to pectoral nerves block provides more effective perioperative pain relief than pectoral nerves block alone for breast cancer surgery. Br J Anaesth 2017;118:439-43.