

Erector Spinae Plane (ESP) Block Decreases Narcotic Requirement in Patients Undergoing Subcutaneous ICD Placement Under Sedation

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Abstract

Introduction: Providing adequate analgesia during subcutaneous ICD implantation can be a challenge. The use of regional techniques such as erector spinae plane (ESP) block can provide both analgesia and attenuate the risk of opioid use especially in high-risk patient populations. **Methods:** This was a single center, prospective study of patients undergoing SICD implantation from February 2020 to February 2022. Patients were older than 18 years of age and randomly assigned to receive ESP block or traditional wound infiltration. The primary outcome was the overall use of perioperative analgesic medications in the ESP block versus the surgical wound infiltration group. Descriptive data are reported as count, mean, or median, as appropriate. For group comparisons, Fisher's exact test was used for categorical variables; the student t-test was used for normally distributed continuous variables, and the Krustal-Wallis test was used for skewed continuous variables, as appropriate. **Results:** 24 patients were enrolled in the study. 11 patients received only wound infiltration and 13 patients received left ESP block. A significant reduction of intraoperative fentanyl use was observed in the ESP block. The overall postoperative day zero fentanyl use was also significantly decreased in the ESP group. The day to discharge was shorter in the ESP block group. **Conclusion:** This feasibility study showed that ESP block is both a safe and effective technique and demonstrated a significant decrease in intraoperative and postoperative opioid consumption that may be of clinical benefit in high risk patients. Larger studies are needed to further validate its use.

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Abstract

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Methods: This was a single center, prospective study of patients undergoing SICD implantation from February 2020 to February 2022. Patients were older than 18 years of age and randomly assigned to receive ESP block or traditional wound infiltration. The primary outcome was the overall use of perioperative analgesic medications in the ESP block versus the surgical wound infiltration group. Descriptive data are reported as count, mean, or median, as appropriate. For group comparisons, Fisher's exact test was used for categorical variables; the student t-test was used for normally distributed continuous variables, and the Krustal-Wallis test was used for skewed continuous variables, as appropriate.

Results: 24 patients were enrolled in the study. 11 patients received only wound infiltration and 13 patients received left ESP block. A significant reduction of intraoperative fentanyl use was observed in the ESP block. The overall postoperative day zero fentanyl use was also significantly decreased in the ESP group. The day to discharge was shorter in the ESP block group.

Conclusion: This feasibility study showed that ESP block is both a safe and effective technique and demonstrated a significant decrease in intraoperative and postoperative opioid consumption that may be of clinical benefit in high risk patients. Larger studies are needed to further validate its use.

Introduction

Subcutaneous implantable cardioverter-defibrillators (SICDs) are a type of cardiovascular implantable electronic device that defibrillate malignant ventricular arrhythmias. SICD can be a good alternative to a transvenous implantable cardioverter defibrillator (ICD); SICD avoids complications associated with ICDs such as cardiac perforation, lead fracture, and venous thrombosis.¹ The procedure involves the placement of the generator subcutaneously in the left lateral chest wall and tunneling of the lead across and up the left parasternal border. Since this is a densely innervated region of the chest wall; analgesia can be a challenge. Traditionally, perioperative pain management for SICD placement is dependent on wound infiltration with local anesthetics and opioids. However, wound infiltration can result in unreliable efficacy due to the need to cover a large area of the anterior chest wall, variable spread of the local anesthetic and limited duration of action. Furthermore, this patient population has multiple comorbidities resulting in higher risk for opioid-related side effects.

Regional techniques such as the erector spinae plane block (ESP) can provide good analgesia while attenuating the risk of opioids especially in this patient population. The ESP block is proposed to provide multi-dermatomal sensory block of the posterolateral and anterior thorax via anterior diffusion of local anesthetics to target the dorsal and ventral rami.² This block was chosen because it is relatively easy to perform and its sensory distribution may give coverage to both the parasternal and the inframammary tunneling sites during SICD placement.

In this feasibility study, we compared single shot Erector Spinae Plane (ESP) block to surgical infiltration of local anesthesia for SICD placement. The authors hypothesize that the ESP block is a safe block that will provide adequate analgesia for during the perioperative period and therefore reduce narcotic requirement in patients undergoing SICD implantation.

Methods

Study Population and Design

This was a single-center, prospective feasibility study of patients undergoing SICD implantation from Feb 2020 to Feb 2022 at our institution. Institutional Review Board approval was obtained (HS# 18-00362; GCO# 18-0776). After providing written informed consent, 24 patients (convenience sample) older than 18 years undergoing SICD placement at a single center tertiary care hospital were randomly assigned to either receiving wound filtration or ESP block. Exclusion criteria included allergy to amide local anesthetics and infection at the site of injection. All the procedures were performed with administration of IV sedation with midazolam, fentanyl, and propofol infusion and supplemental oxygen. Patients refusing the block or patients requiring general anesthesia for procedural reasons were excluded. Neither the anesthesiologists performing the block nor the patients were blinded because there was no placebo block and the blocks were performed prior to starting sedation. The anesthesiologist performing the block was different from the anesthesiologist performing the case. The anesthesiologist performing the case was present during the performance of the block and, therefore, was not blinded to the study group.

SICD Implantation Technique

For SICD device implantation, patients were placed in a supine position on the surgical table, with the left arm in an abducted position on an arm rest. There were three incisions made in total (Fig 1): left parasternal, sub-xiphoid in the midsagittal line, and inframammary along the anterior axillary line. The device was situated between the anatomic space between the serratus anterior and the latissimus dorsi muscles at the T 5-6 level. The distal tip of the electrode insertion tool was inserted at the xiphoid and tunneled laterally until the distal tip emerged in the device pocket. The electrode then was connected to the generator. The generator was fixed in the pocket with two separate sutures between the muscular fascia and the anchoring hole. The xiphoid incision site was also used to tunnel the lead cranially to reach the parasternal incision higher in the chest.

Block Technique

A left-sided ESP block at the T 5-6 level was performed under ultrasound guidance (SonoSite SNeve Ultrasound System fitted with an L38 £ 10- to 5-MHz transducer; SonoSite, Inc, Bothell, WA) with a 22 gauge, two-inch stimulating needle (Stimuplex; B. Braun Medical Inc, Bethlehem, PA) using an in-plane technique. A total of 20 mL of 0.25% bupivacaine were deposited between transverse process and erector spinae muscle (Fig 2). For the surgical infiltration group, the proceduralist injected 30 mL of 0.25% bupivacaine into the implantation and tunneling sites before incision. The patients in the ESP group did not receive any additional local anesthetics by the EP team. Patients were administered IV propofol infusion with intermittent boluses of IV midazolam and/or fentanyl as needed.

Measured Outcomes

The primary outcome was the overall use of perioperative analgesic medications in the ESP block group versus the surgical wound infiltration group. The administration of all pain medications, including opioids

and nonopioids, was documented including fentanyl, oxycodone-acetaminophen, and hydromorphone. Fentanyl use were divided into two categories, induction and intraoperative to allow for comparison of fentanyl requirements during the procedure. Induction fentanyl use is defined as fentanyl use from anesthesia start to procedure start. Intraoperative fentanyl use is any fentanyl administration after that until anesthesia stop. Secondary outcomes were visual analog pain scale (VAS) scores (0-10), intraoperative vital signs, total procedure time, total anesthesia time and length of stay in the intensive care unit. VAS scores were collected on the day of the VAS was measured.

Statistical Analysis

Descriptive data are reported as count (percent), mean (standard deviation), or median (interquartile range [IQR]), as appropriate. For group comparisons, Fisher's exact test was used for categorical variables, the student *t* -test was used for normally distributed continuous variables, and the Kruskal-Wallis test was used for skewed continuous variables, as appropriate. Statistical analysis was performed using R v4.1.1 (R Foundation, Vienna, Austria) in RStudio v1.4.1717. All tests were two-sided, and statistical significance was defined as $p < 0.05$.

Results

Twenty-four patients were enrolled in the study. Eleven patients received only wound infiltration and 13 patients received left ESP block. No patients who were approached declined participation in the study, nor were any excluded or lost to follow-up. Mean (SD) ages are 56 (11) and 57 (13) for the wound infiltration and ESP block, respectively. The percentage of male subjects were 72.7% and 84.6% in the wound infiltration and ESP block, respectively. There were no significant differences between the two groups in age, sex, BMI, ASA score, ejection fraction and comorbidities including being on anti-coagulation, a-fib, COPD, smoker, HTN, DM, CAD, pulmonary HTN, ESRD, CAD, OSA (Table 1).

A small but significant reduction of intraoperative fentanyl use was observed ($p= 0.001$) with a median of 75 [50, 100] mcg and 0 [0, 50] mcg in the wound filtration and ESP block group, respectively (Table 2). The overall postoperative day (POD) zero fentanyl use was also significantly decreased ($p=0.049$; median [IQR] of 100 [87.5, 150] mcg and 75 [50, 100] mcg of fentanyl used in the no block and block group, respectively). There was a trend of decreased POD zero oxycodone-acetaminophen (5-325mg) use, a median of 1 tab vs 0 tab, although it did not reach statistical significance ($p=0.149$). The day to discharge was shorter in the ESP block group ($p=0.038$), a median [IQR] of 1 [1, 1] day, instead of 1 [1, 2] day without the block. No NSAIDs were given due to risk of bleeding per electrophysiology team request. Other pain medication uses were not different between the two group on POD0 or POD1 and those pain medications include acetaminophen, ketamine, hydromorphone, morphine, and tramadol.

No difference was noted in vital sign changes following incision, total procedural time, total anesthesia time, or highest pain scores including immediately postop, on POD zero and POD one (Table 2). The median surgical time was 83 [73, 93.5] minutes for the wound infiltration group and 79 [73, 89] minutes in ESP block group. The median pain scores were both 0 [0, 1.5] upon arrival to PACU in the no block group and 0 [0, 0] in the ESP block group, and 5 on POD zero and POD one for both groups. The median propofol use were 66.5 [47.3, 73.7] mg in the wound infiltration group and 76.1 [53.0, 101] mg in ESP group, which was not statistically significant ($p= 0.213$). Similarly, there was no difference in the amount of midazolam administered. Length of stay in the intensive care unit also was not different between the two groups ($p = 0.116$). There was no need to induce GA in any patients. No complications, including local anesthetic toxicity, hematoma, intrathecal injection, pneumothorax or prolonged paresthesia were observed.

Discussion

This prospective study demonstrates that ESP is a safe block that is a feasible analgesic and anesthetic method for SICD placement under monitored anesthesia care (MAC). There was a small, but significant decrease in intraoperative and POD zero opioid consumption in the ESP group. While decreased narcotic use was noted on POD0, both groups had similar opioid consumption on POD1, 0 vs 1.5, wound infiltration

vs ESP block ($p=0.211$). This is most likely a reflection of the limitation of single shot ESP nerve block with plain bupivacaine. Use of catheters or liposomal bupivacaine could be studied in the future to test extension of this analgesic effect. The day to discharge was shorter in the ESP block group, possibility reflecting better pain control and faster recovery from anesthesia.

SICD insertion is a very stimulating procedure; general anesthesia (GA) with ETT may provide ideal surgical condition. However, in high-risk, cardiac-compromised patients who are undergoing SICD placement, avoiding GA can minimize hemodynamic instability and facilitate quick recovery. Monitored anesthesia care (MAC) is often safer for these high-risk patients. Nonetheless, deep sedation is often needed due to the stimulating nature of the procedure including parasternal tunnel and device insertion between muscle layers. The possibility of oversedation and transitioning to GA without a secured airway can in turn lead to increased mortality and morbidity.^{6,7,8}

Previously, the authors have completed a study showing transversus thoracis plane (TTP) and serratus anterior plane (SAP) blocks as a safe and feasible analgesic adjunct for SICD.⁹ There was significant reduction in intraoperative fentanyl use, with a median of 45mcg vs 90mcg. Zhang et al. also showed TTP and SAP blocks significantly reduced intraoperative dexmedetomidine and remifentanyl use in patients undergoing SICD placement.¹⁰ Postoperatively, sufentanil use in the block group was half of the local infiltration group; ketorolac use in the block group was a quarter of the local infiltration group.¹⁰

These studies demonstrated an important role for truncal blocks to reduce intraoperative and postoperative pain medication use while performing SICD implantation safely under moderate sedation. However, there are higher risks of pneumothorax and internal mammary artery puncture with the TTP block due to anatomical proximity of the fascia plane to the pleura and internal mammary artery.¹¹ For a patient who has had an internal mammary coronary arterial bypass, the fascial plane injectate may not spread adequately to result in coverage of multiple dermatomes.¹¹ On the other hand, ESP is a single trunk block that has the potential to cover the entire anterior thorax except for the sternum.² This could provide analgesia for all incisional and tunneling sites (Fig 1). The transverse process provides a safe landing zone for the needle tip to lower the risk of pneumothorax in case the needle tip cannot be well-visualized during the block.² ESP is a relatively easy block to perform with a steep learning curve. To the authors' best knowledge, there has been no prospective studies comparing pain medication requirements between patients who received wound infiltration and ESP block for SICD placement under sedation. One retrospective chart review case series by Koller et al. showed that children who received parasternal and ESP blocks before extubation after SICD placement had reduced narcotic requirement compared to the wound infiltration group.¹²

ESP blocks have been used successfully in many thoracic and cardiac surgeries. Studies have shown promising results. In video-assisted thoracic surgery, Ciftci et al. showed decreased total fentanyl consumption in the ESP group (176mcg vs 717mcg) compared to the control group and significantly lower pain scores (passive and active) in the ESP group, especially in the first 8 hours, via a prospective randomized study of 60 patients.¹³ Multiple studies showed decreased opioid use and speedier recovery in cardiac surgery patients who received ESP blocks.^{14,15} Krishna et al. showed bilateral single shot ESP blocks reduced the mechanical ventilation time from 102 minutes to 63 minutes. Total opioid use was 231 mcg to 935mcg. Most importantly, the time to ambulation was cut in half, from 62 hours to 36 hours. ICU stay was 42 hours instead of 70 hours.¹⁴ Macaire et al. utilized bilateral ESP catheters in open cardiac surgery and demonstrated decreased total morphine consumption, PONV, time to first mobilization, and pain scores at rest one month after surgery.¹⁵

Although these patients can also receive paravertebral or epidural blocks for intraoperative and postoperative pain control with the possibility of dense analgesia precluding GA or deep sedation, the loss of sympathetic tone can result in profound hypotension and bradycardia. Many of the patients requiring SICD have compromised cardiovascular systems and may develop hemodynamic instability, especially when combined with sedation. Furthermore, many patients are on anticoagulation; due to concerns for epidural hematoma, paravertebral and epidural blocks would require the patient to hold anticoagulation ahead of time, which may not always be feasible.^{16,17} These factors have contributed to the limited use of such techniques in cardiac

procedures. Novel truncal blocks, such as ESP at the T4 level can provide analgesia to the T1 to T7 thorax by local anesthetic spreading cranial-caudally and towards the paravertebral space.

The use of local anesthetic infiltration with sedation is safe and effective in most patients and is still the preferred method of management in many centers.¹⁸ Even though an ESP block is relatively safe and easy to perform, there is still risk of pneumothorax and unintended epidural or intrathecal injection and it may not reliably block the parasternal incision and tunneling site. However, the benefit of decreasing even a small amount of opioid use intraoperatively and postoperatively can be beneficial in certain patient populations, such as the morbidly obese and patients with significant cardiac and pulmonary comorbidities, and the addition of an ESP block may provide larger benefits than in the average patient.¹⁹ While many hospitals are experiencing nursing shortages in the post-covid world, the ability to discharge patients early and safely with non-opioid pain management will benefit the entire healthcare system.

The use of ESP block did not increase the overall anesthesia time likely because it is a relatively easy to perform block and it is one injection whereas local infiltration requires injection of the entire tunneling sites which is large area. Furthermore, even under moderate sedation, patients likely move more due to the stimulation of the local injection in very densely innervated parasternal and inframammary sites. This often can prolong the procedural time, and hence the overall anesthesia time.

Recent studies have shown that even small reduction in intraoperative opioid use can have a significant decrease in postoperative complications, particularly in high-risk patients,^{20,21} although large studies are needed to determine this effect. The limitations of this study include the anesthesia provider and patient were not blinded to the block; these could have been sources of bias. Furthermore, the study population was small and a well powered study with a larger number of patients would be needed to determine outcomes and validate the use of this block as a standard of care for SICD placements. Additionally, larger volume and/or higher concentration of bupivacaine may potentially provide a denser block and prolong the analgesic effect. Some recent have shown that 0.375% and 0.5% bupivacaine compared to 0.25% and 30cc of volume compared to 20cc may provide better pain control.²²⁻²⁴

Conclusion

This feasibility study confirmed that ESP block is a safe and effective technique under MAC sedation in a multimodal analgesic regimen for SICD implantation and demonstrated a small but significant decrease in intraoperative and postoperative opioid consumption that may be of clinical importance in high-risk patients. Larger studies are needed to further investigate and validate the utility and more importantly the characteristics (ie. volume and concentration) of ESP blocks as a standard for SICD implantation.

Conflict of Interest

None.

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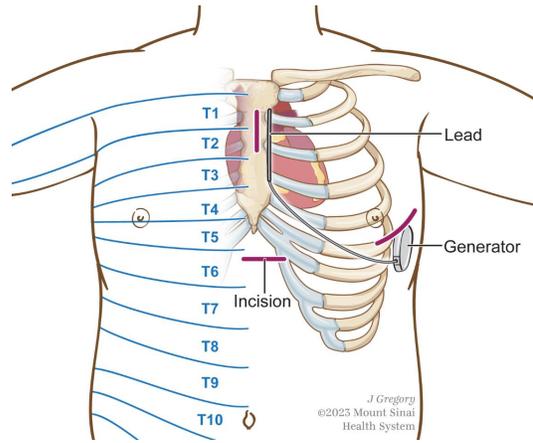
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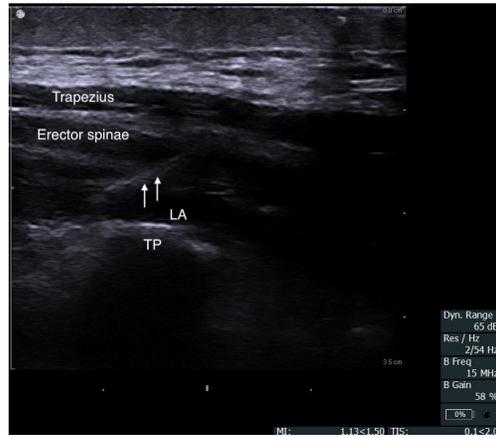
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Figure Legends:

Figure 1. Dermatomal levels of incisions, tunneling site and device.

Figure 2. Erector Spinae Plane Block at T4 level using In-plane Approach Visualizing Local Anesthetic Spread Between Transverse Process (TP) and Erector Spinae Muscle





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