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RESEARCH

# Serratus plane block versus local infiltration anesthesia in closed tube thoracostomy insertion: cohort study

Kathryn P Menioria,[1] Dahlia Arancel[1]

[1]Department of Anesthesiology, Southern Philippines Medical Center, JP Laurel Ave, Davao City, Philippines

**Correspondence**
Kathryn P Menioria,
kpmenioria@gmail.com

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## ABSTRACT

Background. Serratus anterior plane block (SPB) is a relatively new regional anesthetic technique that provides long-lasting anesthesia, extended postoperative analgesia, and demonstrates less consumption of opioid analgesic compared to local infiltration anesthesia (LIA).

Objective. To compare the outcomes of SPB and LIA as anesthetic techniques among patients undergoing chest tube thoracostomy (CTT) insertion.

Design. Cohort study.

Setting. Department of Surgery, Southern Philippines Medical Center, from October 2017 to May 2019.

Participants. 110 male and female patients aged >18 years old undergoing CTT given either SPB or LIA.

Main outcome measures. Mean VAS during the procedure, at PACU, and 4, 8, 12, 16, 18, and 24 hours postoperatively.

Main results. Of the 110 patients undergoing CTT in this study, 55 (50%) where under SPB, and the remaining 50% where under LIA. Compared to those under LIA, patients under the SPB group had significantly lower mean VAS during the procedure (4.02 ± 1.43 vs 2.76 ± 1.35; p<0.0001), and at post-anesthesia care unit (4.25 ± 1.87 vs 3.15 ± 1.56; p=0.0010). The mean level of physician's satisfaction on the procedure was significantly higher in the SPB group than in the LIA group (3.56 ± 0.50 vs 2.96 ± 0.33; p<0.0001). The mean dose of fentanyl as supplemental anesthetic agent was significantly higher in the LIA group than those in the SPB group (1.38 ± 0.59 vs 0.95 ± 0.29; p<0.0001). Similarly, the mean dose of nalbuphine, as rescue opioid dose, was significantly higher in the LIA group than in the SPB group (2.16 ± 0.57 vs 1.53 ± 0.57; p<0.0001).

Conclusion. Patients under SPB who underwent CTT had less pain during the procedure and at the PACU, and used lower doses of the supplemental anesthetic agent (fentanyl) during the procedure, and of the rescue opioid analgesic (nalbuphine), postoperatively.

Keywords. regional anesthesia, pain score, opioid analgesia, rescue dose

## INTRODUCTION

Chest tube thoracostomy (CTT) is a life-saving procedure that promotes lung re-expansion, prevents tension pneumothorax, helps in postoperative recovery and provides symptomatic relief in certain malignancies.[1 2] Indications for CTT include symptomatic pleural effusion, pneumothorax, penetrating or severe blunt chest trauma, hemothorax, chylothorax, empyema, and chemical pleurodesis for benign and malignant conditions, among others.[3-5] However, CTT is a very painful procedure, and almost 50% of patients experience severe pain during and/or after the procedure.[6] Pain may come from the surgical incision site, from intercostal nerve injury, from the pleural incision, or from the presence and subsequent irritation caused by the drainage tubes.

The usual practice of providing anesthesia for CTT is by local infiltration anesthesia (LIA) with or without conscious sedation. A local anesthetic (usually 1% lidocaine) is administered from the skin at the level of the 6th rib and intercostal space, then into the subcutaneous tissue along the tract to the 4th or 5th intercostal space, into the intercostal muscle and the pleura. Aspiration of

### IN ESSENCE

Pain from chest tube insertion is caused by muscle spasm of the serratus anterior muscle, and blocking the long thoracic and intercostal nerves through SPB can reduce postoperative tube thoracostomy pain.

In this cohort study among 110 patients who underwent CTT insertion, the mean VAS of patients under SPB during the procedure, and at PACU, were significantly lower than those under the LIA group. The mean doses of nalbuphine and fentanyl were significantly higher among patients under LIA than those under SPB.

Effective pain management, during and after chest tube insertion, is imperative in order to lessen postoperative outcomes, decrease patient discomfort, and enhance the surgeon's level of satisfaction in doing the procedure.

air or fluid indicates that the needle has entered the pleural space. The remainder of the anesthetic is then infused into the pleural space.[7-9] Local infiltration is generally safe but has a limited duration of action.[10]

The emerging approach for intraoperative and postoperative pain management of patients who undergo CTT is by fascial plane block (e.g., serratus anterior plane block [SPB]). Initially used to provide analgesia during breast surgery, SPB was found to be effective for rib fracture pain and in cases requiring chest tube placement for anterior and lateral chest wall trauma.[11] SPB has shown to be a relatively long-lasting regional anesthesia thus improving pain scores and enhancing incentive spirometry volumes.[11 12]

With several CTT procedures done in this institution's operating theater per day, a good intraoperative anesthesia that also provides an extended postoperative analgesia is required in order to effectively manage pain associated with chest tube insertion. Insufficient analgesia leads to extended hospital stay and therefore increased healthcare costs. Local anesthetic infiltration, which has been the current method of pain control for CTT in this institution, has demonstrated to be inadequate in inducing anesthesia and has limited duration of analgesia, causing great discomfort on the patient and inconvenience on the surgeon. We did this study to compare the outcomes of SPB and LIA as anesthetic techniques among patients undergoing CTT insertion.

## METHODOLOGY

### Study design and setting

We did a cohort study on patients undergoing CTT given either SPB or LIA at Southern Philippines Medical Center's Department of Surgery from October 2017 to May 2019. The department admits around 1,200 patients for CTT annually. During the duration of the study, SPB started to be used as frequently as LIA among patients who underwent CTT.

### Participants

Patients 18 years old and above, with American Society of Anesthesiology (ASA) score of I-IV, and scheduled for CTT insertion were included in the study. Patients with a Glascow Coma Scale of <10, history of local anesthetic allergy, infection near the insertion site, or deranged bleeding parameters were excluded from the study.

To determine the minimum sample size for this study, we assumed that the mean pain score of patients undergoing chest tube insertion is 3.7 ± 5.6.13 Calculation was done in order for the study to detect a 3-point difference in the mean pain scores between two groups of patients receiving different anesthetic techniques for the chest tube insertion procedure as statistically significant. In a test for difference between two independent means carried out at 95% level of confidence, a total sample size of at least 55 patients per group will have 80% power of rejecting the null hypothesis if the alternative holds.

### Data collection

We reviewed the medical records of patients included in the study to collect data on their age, sex, anesthetic technique used for CTT insertion (SPB vs LIA), duration of procedure, and pain scores during the procedure, at PACU, and 24 hours postoperatively. We also collected data on rescue medications given to the patients and level of satisfaction of physicians in doing the procedure.

The main outcome measures for this study were the postoperative mean visual analogue scale (VAS) scores at PACU, and 4, 8, 12, 16, 18, and 24 hours postoperatively. Pain assessment by PACU and ward nurses using a scale of 0-10 (0=no pain to 10=breakthrough pain). The mean duration of procedure and the level of physician's satisfaction in the ease of doing the procedure—using a Likert scale—were also documented. Giving of fentanyl as supplemental anesthetic agent intraoperatively, including the dose given, were recorded. We also determined the proportion of patients given nalbuphine as postoperative rescue opioid dose, and the mean cumulative postoperative rescue opioid dose per group among those who received nalbuphine. We also noted the presence of complications due to the anesthetic agents used in both groups—i.e., lightheadedness, dizziness, difficulty in focusing, tinnitus, confusion, circumoral numbness, seizures, hypotension, dysrhythmia, and cardiac arrest.

### Statistical analysis

We summarized continuous variables as means and standard deviations, and compared means using t-test. We summarized categorical variables as frequencies and percentages, and compared proportions using chi-square test or

**Table 1** Baseline characteristics of patients

| Characteristics | SPB (n=55) | LIA (n=55) | p-value |
|---|---|---|---|
| Mean age ± SD, *years* | 46 (25.41) | 4 (23.53) | 1.0000* |
| Had any surgical procedure, *frequency (%)* | 46 (25.41) | 4 (23.53) | 1.0000* |
| Male | 4 (2.20) | 0 (0.00) | 1.0000* |
| Female | 7 (3.85) | 0 (0.00) | 1.0000* |

Fisher's exact test. We used Epi Info™ 7.2.1 for all our statistical tests.

## RESULTS

A total of 110 patients, 55 for SPB group and 55 for LIA group, were included in the analysis for this study. The baseline characteristics of the patients per anesthetic technique group are shown in Table 1. The two groups were comparable in terms of mean age and sex distribution.

Table 2 shows the comparative pain scores, recorded as mean VAS scores, of patients during the procedure, at PACU, and every four hours postoperatively until the 24th hour. The mean VAS scores of patients in the SPB group were significantly lower than those in the LIA group during the procedure (2.76 ± 1.35 vs 4.02 ± 1.4, p<0.0001) and at PACU (3.15 ± 1.56 vs 4.25 ± 1.87, p=0.0010). The mean VAS scores from the 4th to the 24th hour postoperatively were comparable between the two groups. The mean durations of procedure were likewise comparable. The mean level of physicians' satisfaction on the procedure in the SPB group (3.56 ± 0.50) was significantly higher than that in the LIA group (2.96 ± 0.33; p<0.0001).

The use of supplemental anesthetic agent (fentanyl) during the procedure and rescue opioid analgesic (nalbuphine) for patients who underwent CTT is shown in table 3. At least one dose of fentanyl was given to 54/55 (98.18%) of the patients in the LIA group, and only 51/55 (92/73%) of the patients in the SPB group. However this is not significantly different between the two groups (p=0.3633). The mean dose of fentanyl given among those under LIA (1.38 ± 0.59mg) is significantly higher than those under SPB (0.95 ± 0.30mg; p<0.0001). All patients in both groups were given at least one dose of nalbuphine. The mean dose of nalbuphine given was significantly higher among patients under LIA (2.16 ± 0.57mg) than among those under SPB (1.53 ± 0.57mg; p<0.0001). No patient in either group developed any complications during the study.

## DISCUSSION

### Key results

In this study, the mean VAS of patients under SPB during the procedure, and at PACU,

**Table 2** Comparison of outcomes

| Outcomes | SPB (n=55) | LIA (n=55) | p-value |
|---|---|---|---|
| Mean VAS ± SD, *years* | 46 (25.41) | 4 (23.53) | 1.0000* |
| During procedure | 46 (25.41) | 4 (23.53) | 1.0000* |
| at PACU | 4 (2.20) | 0 (0.00) | 1.0000* |
| 4 hours postoperatively | 7 (3.85) | 0 (0.00) | 1.0000* |
| 8 hours postoperatively | 46 (25.41) | 4 (23.53) | 1.0000* |
| 12 hours postoperatively | 4 (2.20) | 0 (0.00) | 1.0000* |
| 16 hours postoperatively | 7 (3.85) | 0 (0.00) | 1.0000* |
| 20 hours postoperatively | 46 (25.41) | 4 (23.53) | 1.0000* |
| 24 hours postoperatively | 4 (2.20) | 0 (0.00) | 1.0000* |
| Mean duration of procedure ± SD, *minutes* | 7 (3.85) | 0 (0.00) | 1.0000* |
| Mean level of physician's satisfaction ± SD | 7 (3.85) | 0 (0.00) | 1.0000* |

*significant @ p<0.05

**Table 3** Comparison of supplemental anesthetic agents, and rescue opioid dose given to patients

| Outcomes | SPB (n=55) | LIA (n=55) | p-value |
|---|---|---|---|
| Number of patients given fentanyl, *frequency (%)* | 46 (25.41) | 4 (23.53) | 1.0000* |
| Mean dose of fentanyl given ± SD, mg | 46 (25.41) | 4 (23.53) | 1.0000* |
| Number of patients given rescue dose, *frequency (%)* | 4 (2.20) | 0 (0.00) | 1.0000* |
| Mean dose of nalbuphine given ± SD, mg | 7 (3.85) | 0 (0.00) | 1.0000* |

* significant @ p<0.05
† Fisher's exact test

were significantly lower than those under the LIA group. Postoperatively, the mean VAS scores, between the two groups, from the 4th to the 24th hour were comparable. This is also the same with the mean durations of procedure. However, the mean level of physician's satisfaction on the procedure was significantly higher in the SPB group than in the LIA group. Although the proportion of patients given fentanyl during the procedure, and nalbuphine postoperatively, were comparable between the two groups, the mean doses of nalbuphine and fentanyl were significantly higher among patients under LIA than those under SPB.

## Strengths and limitations

We were able to demonstrate that patients experience lesser pain under SPB during and right after the procedure compared to those under LIA. Surgeons also showed higher satisfaction while doing the procedure under SPB. Lower doses of both supplemental agent and rescue opioid analgesic were used under SPB. However, we did not include indications for doing CTT in this study.

## Interpretation

The approach for the management of intraoperative and postoperative pain for chest wall surgeries (breast surgeries and chest drainage procedures) involves a multimodal approach. Multimodal analgesia, i.e. a combination of regional anesthesia and an opioid analgesic, serves to optimize pain control during the perioperative period of thoracic surgery, and also minimizes dosages and reduces reliance on a single agent.[14] SPB is an ultrasound-guided thoracic regional anesthetic technique that is relatively simple to perform and is associated with fewer side effects.[12] Other regional anesthetic techniques such as intercostal nerve block and thoracic paravertebral block may cause pneumothorax or transient Horner's syndrome and other neurological side effects, hence, SPB may serve as a better alternative.[10]

SPB has been shown to be effective on surgical procedures performed on the anterolateral chest wall such as chest drain insertion and cosmetic and reconstructive breast surgery. It has demonstrated a relatively long-lasting regional anesthesia and analgesia at the level of T2-29.[12 15] In a recent case series demonstrating the analgesic effect of SPB for tube thoracostomy pain, rib fracture pain, and acute herpes zoster pain, SPB has shown significant pain relief in elderly patients.[16] This was similar to the results of our study which showed that SPB demonstrated significant pain relief to patients undergoing CTT. In another study, SPB has provided long-lasting paresthesia in breast surgery patients.[12]

Comparing the effects of SPB and LIA for postoperative analgesia after thoracoscopic surgery, SPB has shown to be superior to LIA in terms of patient pain scores and opioid consumption—using sufentanil and/or tramadol—postoperatively,[17] similar to the results of our study where patients under SPB showed lower mean VAS scores during the procedure, and at the PACU and consumed lower doses of nalbuphine postoperatively compared with LIA. In another study comparing the efficacy of serratus intercostal plane block and local wound infiltration on postoperative analgesia after breast surgery, SPB has resulted in significant analgesia, required less doses of rescue analgesic (i.e., pethidine), and demonstrated less incidence of postoperative vomiting.[18]

Most patients complain about postoperative pain on the site adjacent to where the chest tube is inserted. The chest tube traverses the serratus anterior and intercostal muscles and triggers painful muscle spasm of the serratus anterior muscle.[19] Blocking

the long thoracic nerve, as well as the cutaneous branch of the intercostal nerve, which is effectively done by SPB, could reduce postoperative pain after thoracoscopic surgery.[19 20] The long thoracic nerve is not blocked sufficiently by LIA, hence making SPB superior to LIA.[17]

### Generalizability

The results of this study are applicable to most patients for CTT since the demographic and clinical characteristics of our patients are similar to those of usual patients scheduled for the procedure.

## CONCLUSION

The mean VAS during the procedure and at PACU for patients under SPB were significantly lower than those under LIA. However, mean VAS scores from the 4th to 24th hour postoperatively were comparable between the two groups. The mean level of physician's satisfaction on the procedure was significantly higher in the SPB group than in the LIA group. The mean dose of fentanyl as supplemental anesthetic agent, and the mean dose of nalbuphine as rescue opioid analgesic, was significantly lower among patients under SPB than those under LIA.

**Contributors**
KPM and DA both had substantial contributions to the study design, and to the acquisition, analysis and interpretation of data. KPM and DA wrote the original draft and subsequent revisions, and both authors reviewed, edited, and approved the final version of the manuscript. KPM and DA both agreed to be accountable for all aspects of the work.

**Ethics approval**
This study was reviewed and approved by the Department of Health XI Cluster Ethics Review Committee (DOH XI CERC reference P17082301).

**Reporting guideline used**
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