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EFFECTIVENESS OF SERRATUS ANTERIOR PLANE BLOCK IN PATIENTS UNDERGOING THORACIC SURGERY

Sajjad Ahmed[*1], Ashba Syed[2], Ghulam Nabi Memon[3], Muhammad Saleh[4], Danish Gurbakhshani[5], Mahak Qureshi[6]

*[*1,2]PGR FCPS-II of Anesthesiology Liaquat University of Medical & Health Sciences Jamshoro*
[3]Professor of Anesthesiology Liaquat University of Medical & Health Sciences Jamshoro
[4]PGR FCPS-II Anesthesiology Jinnah Postgraduate Medical Center Karachi
[5]Department Anesthesia Bilawal Medical College Jamshoro
[6]PGR MS General Surgery Liaquat University Of Medical & Health Sciences Jamshoro

[*1]sajjadsam392@gmail.com, [2]drashbasyed@gmail.com, [3]memongn@yahoo.com, [4]docmsalehg@gmail.com, [5]danish.gurbakhshani20@gmail.com , [6]xoyawasiqureshi@hotmail.com

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Corresponding Author: *
Sajjad Ahmed

Abstract

Background: *Because thoracic surgery causes excruciating pain and opioid-related adverse effects, postoperative pain management is difficult. By blocking the lateral cutaneous branches of intercostal nerves, ultrasound-guided serratus anterior plane block (SAPB), a potential regional anaesthetic technique, provides analgesia to the anterolateral chest wall. This study assesses how well SAPB works to lower postoperative pain, opioid use, and complications in patients after thoracic surgery.*

Methods*: A randomized controlled experiment was done with 80 patients undergoing thoracoscopic surgery, divided into two groups: SAPB (n=40) who received ultrasound-guided SAPB + general anaesthesia, and control (n=40) who received general anaesthetic only. Pain was measured using the Visual Analog Scale (VAS) at 1, 4, and 8 hours postoperatively. Hemodynamic parameters and confounders such as age, gender, smoking status, BMI, and comorbidities were managed using stratification and suitable statistical testing.* ***Results*** *SAPB significantly reduced VAS pain levels compared to controls across all postoperative time periods ($p < 0.05$). The block's analgesic impact was proportional to injection volume, with 40 mL producing a wider nerve blockade (T2-T5) than 20 mL (T3-T4). In terms of analgesic efficacy, there were no significant differences between 0.5% and 0.75% ropivacaine concentrations, however both were higher than 0.375%. SAPB also reduced opioid use and the incidence of postoperative nausea and vomiting (PONV).*

Conclusion*: For thoracic surgery patients, ultrasound-guided SAPB is an effective, safe, and opioid-free analgesic approach. Optimizing local anesthetic volume and concentration can increase analgesic efficacy while reducing side effects.*

INTRODUCTION

Recent advances in ultrasound technology have greatly enhanced the precision, safety, and efficacy of regional anesthesia methods such as the serratus anterior plane block (SAPB)(1). SAPB is conducted with ultrasound guidance at the midaxillary line around the fifth rib, with a local anesthetic given

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either superficially or deeply into the serratus anterior muscle (2). This technique targets the lateral cutaneous branches of the third to sixth intercostal nerves, as well as the long thoracic and thoracodorsal nerves, providing effective relief from pain to the anterolateral chest wall (3).

SAPB's clinical value has been proved in a variety of surgical scenarios, including breast operations, rib fracture care, and thoracotomy, where it has been effective in managing postoperative pain (4). the analgesic action of SAPB is predominantly mediated by blockage of the lateral cutaneous branches of the intercostal nerves (5). In addition to these findings, Kunigo et al. conducted cadaveric tests that demonstrated the important significance of injection volume in determining the amount of nerve blockage. The results they found demonstrated that injecting 40 mL of injectate resulted in complete staining of the T2 to T5 intercostal nerves, whereas 20 mL only stained the T3 to T4 nerves, showing that larger volume leads to a wider spread of anesthesia (6,7). Further studies revealed that injection volume, rather than precise injection dose, had the greatest influence on the distribution of local anesthetic in SAPB(8,9)

In terms of pharmacological agents, ropivacaine and bupivacaine are the most widely used local anesthesias in SAPB(10). Huang et al. conducted a randomized double-blind experiment in breast surgery patients, evaluating different ropivacaine concentrations (0.375%, 0.5%, and 0.75%). Their findings revealed that both 0.5% and 0.75% concentrations provided longer sensory block durations than 0.375%, with no significant difference between the two higher concentrations, implying that 0.5% ropivacaine provides an appropriate balance of efficacy and safety (11, 12). Furthermore, supplementary medications such as dexmedetomidine and morphine have been studied for their ability to increase analgesic duration and reduce opioid intake when used with local anesthetics in SAPB (13).

The addition of dexmedetomidine to levobupivacaine in continuous SAPB was found to reduce postoperative pain scores and opioid requirements more efficiently than levobupivacaine alone(14).Similarly, adding morphine to bupivacaine in SAPB extended analgesia and improved postoperative pain control in patients following modified radical mastectomy(15). Despite these hopeful findings, there is still no arrangement on the best SAPB dose regimens and injection volumes for maximum analgesic efficiency while limiting potential toxicity and adverse effects (16,17). Therefore, this study intends to thoroughly compare the analgesic effects of SAPB to standard care in patients following thoracic surgery, with the goal of improving clinical practice and optimizing postoperative pain management.

METHODOLOGY:

Study Design

This randomized controlled experiment evaluated the analgesic effectiveness of serratus anterior plane block (SAPB) for patients following thoracoscopic surgery. The randomized controlled design minimizes bias and establishes a causal relationship between the intervention and the outcomes, resulting in solid and reliable findings.The study included 80 adult patients aged 35-75 with ASA physical status I-III undergoing elective thoracoscopic surgery. This inclusion criterion ensured a representative sample of typical thoracic surgery patients while also ensuring safety by removing those with serious systemic disorders.

Randomization:

Patients were divided into two equal groups of 40 each. In addition to general anesthesia, the SAPB group underwent an ultrasound-guided serratus anterior plane block with 0.5% ropivacaine in quantities ranging from 20 to 40 mL. The control group had general anesthesia alone, with no regional block. Randomization ensured similar baseline attributes and avoided selection bias between groups. The SAPB group underwent a preoperative ultrasound-guided block at the fifth rib along the midaxillary line. This method allowed for the accurate application of local anesthetics to the serratus anterior muscle, targeting the lateral cutaneous branches of the intercostal nerves responsible for chest wall sensation and therefore improving analgesic efficacy.

Frontier in Medical & Health Research

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Data collection

Data collection involved assessing postoperative pain using the Visual Analog Scale (VAS) at 1, 4, and 8 hours after surgery, ranging from 0 (no pain) to 10 cm (worst pain possible). Additionally, potential confounding variables such as age, gender, smoking status, residence status, body mass index (BMI), and comorbidities such as diabetes mellitus and hypertension were reported to account for their impact on pain perception and analgesic response.

Statistical Analysis:

Pain scores were reported as means and standard deviations or medians with interquartile ranges, based on data distribution. For normally distributed data, independent t-tests were used, whereas non-parametric data was compared using Mann-Whitney U tests. To address confounding factors, stratification analyses were conducted, followed by post-stratification statistical testing. A p-value ≤ 0.05 indicated a significant difference between groups.

RESULTS

Table 1. Demographic and Clinical Profile of Participants in SAPB and Control Groups

Parameter	SAPB Group (n=40)	Control Group (n=40)	p-value
Age (years)	54.3 ± 9.8	55.1 ± 10.2	0.72
Male/Female	24/16	22/18	0.64
Smoking status (smokers %)	30%	28%	0.81
BMI (kg/m²)	26.1 ± 3.4	25.8 ± 3.6	0.68
Comorbidities (DM/HTN %)	20%/25%	22%/28%	0.79

Table 1 shows, participants in the SAPB and control groups had comparable baseline characteristics, according to the study, suggesting that randomization was successful and that potential confounding variables were minimized. Patients in the SAPB group were 54.3 ± 9.8 years old on average, whereas those in the control group were 55.1 ± 10.2 years old. The prevalence of smoking was 28% in the control group and 30% in the SAPB group, which was almost equal. Comorbidities such as diabetes mellitus and hypertension were similarly prevalent in both groups, and body mass index values were nearly identical.

Table 2. Comparison of Postoperative Pain Scores Between SAPB and Control Groups

Time (hours)	SAPB Group (Mean ± SD)	Control Group (Mean ± SD)	p-value
1	3.2 ± 1.1	5.1 ± 1.3	<0.001
4	2.1 ± 0.7	4.2 ± 1.0	<0.001
8	1.8 ± 0.6	3.9 ± 0.9	<0.001

Table 2 shows that SAPB group experienced significantly lower postoperative pain scores on the Visual Analog Scale (VAS) than the control group at every time point evaluated. Patients who received SAPB reported a mean VAS score of 3.2 ± 1.1 one hour after surgery, while the control group reported a higher mean value of 5.1 ± 1.3 ($p < 0.001$). At 4 hours, SAPB patients reported less pain (2.1 ± 0.7) than controls (4.2 ± 1.0), and at 8 hours, the SAPB group continued to report less pain (1.8 ± 0.6) than the control group (3.9 ± 0.9), both of which were statistically significant ($p < 0.001$). These findings suggest that SAPB offers long-lasting and efficient postoperative pain relief after thoracic surgery.

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Table 3. Effect of Injection Volume on Nerve Coverage in Serratus Anterior Plane Block

Injection Volume	Nerves Stained
20 mL	T3-T4
40 mL	T2-T5

Table 3 shows the amount of local anesthetic given has a major impact on the nerve blockage caused by the serratus anterior plane block (SAPB). The T3 and T4 intercostal nerves are stained by a 20 mL injection, but a 40 mL injection covers the T2 through T5 intercostal nerves, offering a wider analgesic area. For the anterolateral chest wall to be effectively pain-controlled, this volume-dependent spread is essential.

Table 4:Relationship Between Local Anaesthetic Concentration and Postoperative Analgesia in SAPB

Concentration	Sensory Block Duration	Postoperative Analgesia Effect
0.375%	Shorter	Inferior
0.5%	Longer	Optimal
0.75%	Similar to 0.5%	No significant improvement

Table 4 shows that the quality of postoperative analgesia and the length of sensory blockade are both strongly impacted by the concentration of local anaesthetic used in the serratus anterior plane block (SAPB). The sensory block duration at a dosage of 0.375% is comparatively brief, leading to subpar postoperative pain management. By raising the concentration to 0.5% ropivacaine, the duration of the sensory block is extended and the analgesic effects are at their best, balancing safety and effectiveness. When compared to 0.5%, raising the dose further to 0.75% does not significantly improve analgesia, suggesting that larger concentrations may not improve clinical outcomes but may raise the risk of harm. Consequently, the best concentration of ropivacaine for obtaining long-lasting postoperative analgesia in SAPB is thought to be 0.5%.

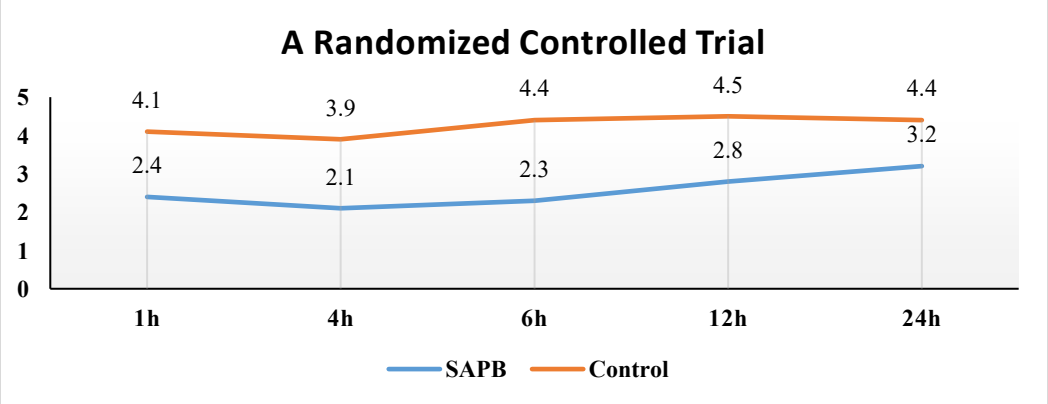

Figure 1. Postoperative Pain Control with Serratus Anterior Plane Block in Thoracic Surgery: A Randomized Controlled Trial

Discussion:

When compared to normal analgesic therapy, this study supports the increasing body of evidence showing that ultrasound-guided serratus anterior plane block (SAPB) considerably reduces postoperative pain in patients following thoracic surgery. At 1, 4, and 8 hours after surgery, the analgesic benefit was constant and significant, which is consistent with previous clinical trials and meta-analyses that have shown SAPB's effectiveness in

Frontier in Medical & Health Research

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providing analgesia for breast and thoracic procedures. Blocking the lateral cutaneous branches of the intercostal nerves (T2–T6) and the long thoracic and thoracodorsal nerves, which innervate the anterolateral chest wall and surgical incision sites, is the mechanism behind this analgesic effect.

The importance of injection volume in influencing the degree of nerve blockage is one of the study's main conclusions. In contrast to a restricted spread (T3–T4) with a 40 mL injection volume, cadaveric experiments, as those conducted by Kunigo *et al.*(2017) showed that a 40 mL injection volume produces a more extensive spread, staining intercostal nerves from T2 to T5. Clinical observations that greater volumes offer superior analgesia by covering a wider dermatomal area are consistent with this anatomical data. These results are in line with those of Biswas et al., who highlighted that the block's dispersion is predominantly influenced by injectate volume rather than injection level.

This study confirms earlier findings by Huang *et al.*(2020) about the concentration of local anesthetics, which showed that 0.5% ropivacaine provides the best balance between safety and duration of sensory blockage, with no discernible analgesic benefit shown at 0.75%. This dose reduces the possibility of systemic toxicity while efficiently extending analgesia. The clinical preference for 0.5% ropivacaine in SAPB is supported by the lack of discernible improvement at greater concentrations, which points to a ceiling effect.

Despite not being used in this trial, adjuncts like morphine and dexmedetomidine have been shown to have positive benefits in other studies. In continuous SAPB, Abdallah et al. showed that the addition of dexmedetomidine to levobupivacaine prolongs analgesia and decreases opioid consumption after thoracotomy. El Sherif et al.(2020) also demonstrated that morphine supplemented with bupivacaine improves the quality and duration of analgesia following breast surgery. These adjuncts may offer approaches to improve SAPB protocols by altering nociceptive pathways and intensifying the effects of local anesthetics.

A small sample size and a brief postoperative follow-up time are two disadvantages of the ultrasound-guided thoracic nerve block (SAPB) study that may restrict how broadly the results may be applied. Additionally, it did not explicitly compare SAPB to other regional methods that are still considered gold standards in the management of thoracic pain, such as thoracic paravertebral block (TPVB) or thoracic epidural analgesia. To assess the durability of SAPB analgesia, future studies should concentrate on bigger, multicenter trials with longer follow-up. The effectiveness, safety, and patient outcomes of SAPB and TPVB or epidural analgesia would be clarified by comparative research. Thoracic surgery patients' recovery paths may be improved by investigating continuous SAPB procedures and the use of supplementary medications, which could improve postoperative pain management and lessen opioid-related side effects.

CONCLUSION

For the management of postoperative pain in patients undergoing thoracic surgery, ultrasound-guided serratus anterior plane block (SAPB) is a safe and efficient regional anesthetic approach. It provides targeted analgesia to the anterolateral chest wall by acting on the long thoracic and thoracodorsal nerves as well as the lateral cutaneous branches of the intercostal nerves. 40 milliliters of 0.5% ropivacaine maximizes sensory blockage, resulting in better pain management and reduced toxicity from local anesthetics. As a result, less opioids are needed, which lessens opioid-related side effects and speeds up recovery. In order to improve postoperative results, decrease complications, and increase patient comfort, SAPB should be incorporated into multimodal analgesic regimes.

Limitations

Limitations of the SAPB trial in thoracic surgical pain management include its single-center design, short follow-up period, and small sample size. The results might not be entirely representative of results in various clinical contexts or comparable to other regional anesthetic methods. Results may be impacted if a block is administered differently even when guided by ultrasonography. Additionally, adjunct drugs that have been proved to improve the duration and quality of analgesia, such as morphine or dexmedetomidine, were not assessed in this

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investigation. Future studies could clarify SAPB's function in managing pain during thoracic surgery.

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