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Analgesic Efficacy and Postoperative Outcomes of Serratus Anterior Plane Block in Patients Undergoing Coronary Artery Bypass Grafting via Median Sternotomy Approach

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ABSTRACT

Background: Pain is common at sternotomy site after cardiac surgery. Managing such pain plays an important role in patient recovery. Various side effects are related to the traditional analgesic modalities. To minimize such effects several nerve blocks have been suggested. **Objective:** The aim of our study is to evaluate the analgesic efficacy of serratus anterior plane block (SAPB) in managing acute post sternotomy pain. **Methodology:** This randomized control trial included 240 patients between age 18 to 90 undergoing coronary artery bypass grafting (CABG) via median sternotomy approach. The study was conducted at Armed Forces Institute of Cardiology/National Institute of Heart Disease Rawalpindi Pakistan, for the duration of five months from October 2024 to February 2025. Patients were divided into two groups: serratus anterior plan block (SAPB) group which received 50mg of 0.25% bupivacaine diluted in 10 ml 0.9% normal saline on both sides and a control group which did not underwent any such intervention. **Results:** Intra-op fentanyl requirement was lower in SAPB group (221.38 ± 47.11 µg) as compared to control groups (297.22 ± 77.69 µg) (p value <0.001). Post-op tramadol consumption was lower in SAPB group (109.1 ± 21.7 mg) as compared to control groups (201.3 ± 27.4 mg) (p value <0.001). Resting visual analogue score (VAS) was comparable at 6 and 48 hours but at 12 and 24 hours the SAPB group experienced a lower level of pain compared to control group. VAS during coughing was significantly lower in SAPB group as compared to control group at 6, 12 and 24 hours however this became insignificant at 48 hours. Extubation time was shorter in SAPB group than in control group (312±27 vs 377±41) (p value <0.001). **Conclusion:** SAPB reduces the intra-op dose of anesthetic agent, post-op opioid consumption and pain scores resulting in lower pulmonary complication and early recovery.

INTRODUCTION

Roughly a third of all deaths are caused by cardiovascular disease and is thus considered a principal cause of mortality worldwide. One of its treatment modalities is performing coronary artery bypass grafting (CABG). Median sternotomy is widely used incision to gain access to heart for surgery. [(1)] Pain at the site of sternotomy is the most common complain after CABG. Around 80% of patients complain of this pain which can be of varying degree specifically at the sternum. [(2)]. Poorly managed pain at site of sternotomy is extremely debilitating and can lead to chronic pain in 20-50% of patients.[(1, 3)]

Inadequate pain management after cardiac surgery can cause serious complications, including postoperative (post-op) pulmonary issues, cardiac problems like dysrhythmias and long-term complications like post sternotomy pain syndrome. Traditionally opioids have been used for pain relief in cardiac surgery but they have significant side effects such as respiratory depression, prolonged intubation time, delirium, post-operative nausea and vomiting (PONV), and ileus.[(4)] This has prompted a shift towards a multimodal pain management approach, involving various systemic and regional analgesic techniques. However, no guidelines have been specified for managing pain after cardiac surgery via median sternotomy. [(5-7)]

Semyonov et al. evaluated the effectiveness of the serratus anterior plane block (SAPB) compared to traditional pain management using intravenous opioids and NSAIDs for post-thoracotomy pain. Their findings

revealed that 43% of patients in the SAPB group and 57% in the control group reported pain, though this difference was not statistically significant. However, the SAPB group experienced significantly less intense pain, including aching, burning, shocking, shooting, pressure-like sensations, and had reduced pain in the lower and upper posterior thorax regions compared to the control group.[8]

Similarly, Aykut et al. examined the analgesic efficacy of SAPB in coronary artery bypass graft (CABG) surgery performed with median sternotomy. Their results demonstrated that patients in the SAPB group had significantly lower opioid requirements within the first 24 hours after extubation (p=0.022), along with reduced pain scores during mobilization and at rest (p=0.048, p=0.007). Similarly there was lower incidence of nausea (p=0.004), extubation time was lower (p=0.025) and there was early initiation of oral intake (p=0.030) in SAPB group, highlighting its effective role in lowering opioid consumption and improving post-op recovery.[9]

The existing literature supports SAPB as an effective method for reducing opioid use and improving post-op pain control. However, there remains a gap in research specifically focusing on the use of SAPB in patients undergoing CABG via median sternotomy. Given the complexities of pain management in this population, further investigation is needed to explore the potential advantages of SAPB in enhancing post-op outcomes. This proposed study addresses the need for improved pain management strategies in cardiac surgery, aiming to contribute to the development of more effective protocols and ultimately improve patient recovery and satisfaction.

MATERIAL AND METHODS

This randomized control trial was conducted at Armed Forces Institute of Cardiology/National Institute of Heart Disease, Rawalpindi Pakistan, for the duration of five months from October 2024 to February 2025. After getting written informed consent from all subjects and approval from ethical committee, Patients of either gender with age between 18 years to 90 years undergoing elective on pump CABG via median sternotomy were included in the study.

Patients with redo or emergency surgery, concurrent valvular disease/surgery, intraoperative (intra-op) and post-op complications (use of IABP, on table CPR, reopening, open chest), chronic opioid users, pregnant patients, and patients with contraindication to regional blocks (like infection at site of block) were not included in the study.

Patients were assigned randomly into two groups on 1:1 using computer-based lottery method i.e. SAPB group and Control group after preoxygenation patients were anesthetized using propofol, atracurium and fentanyl. After intubation, arterial line and central venous line was passed. Sevoflurane and remifentanil infusion were used for anesthesia maintenance.

Patients in SAPB group received 50mg of 0.25% bupivacaine diluted in 10ml of normal saline given on both sides via ultrasound guided technique while the control group did not. At the anterior axillary line and over the 6th rib and intercoastal space, the linear probe of ultrasound was placed. The structures were visualized after which the needle was advanced under the serratus anterior muscle. To ensure the delivery of anesthetic agent at the proper site, 2 ml of 0.9% normal saline was used for hydro dissection. Once in the right plane 10 ml of diluted bupivacaine was injected.

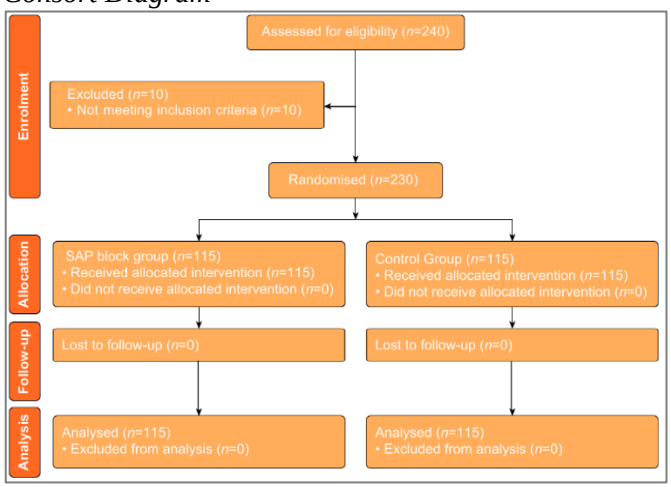
After the block was injected, the surgical procedure commenced. The internal thoracic artery was harvested in all cases. Roller pump cardiopulmonary bypass (CPB) was used. The target flow was kept between 2.2–2.4 L./min/m2. After decannulation, protamine was used for heparin reversal. The patients were smoothly weaned off CPB. After securing hemostasis and passing mediastinal and pleural drains, the sternum was closed using 5G metal wires.

Before shifting the patient to intensive care unit (ICU),1 gram of acetaminophen and 1mg/kg of tramadol was administered to all patients.1 gram acetaminophen was administered every 6 hours for the first 24 hours and then 8 hourly until discharge. Pain scores were recorded VAS and if it exceeded 4 then tramadol was administered as 1mg/kg.

Data collection Performa was used to document the basic demographics of patients including age, BMI, gender and comorbid. Procedure duration, CPB time, cross clamp time (X-clamp time) and extubation time was noted. Post-op VAS score was noted at rest and while cough at 6, 12, 24 and 48 hours. Pre and post op respiratory function were assessed using tri-ball spirometer where lifting 1 ball was labeled as poor effort, 2 balls as good and all 3 balls as best effort. Intra and post-op opioid consumption and total ICU stays were also noted. Intra-op complication like hypotension and bradycardia and post-op complication like PONV and delirium were also noted.

Figure 1

Consort Diagram



RESULTS

A total of 240 patients were included in the study, 120 in SAPB group and 120 in control group. In SAPB group the block failed in 2 cases while reopening was done 3 cases. Also reopening was done in 3 cases of control group and IABP was passed to 2 patients after shifting to ICU. There was no significant difference between ICU stay in both groups. Extubation time was shorter in SAPB than in control group (312±27 vs 377±41) with a p value of <0.001. Basic Demographic data of both group in documented in table 1.

The mean intra-op fentanyl requirement was lower in SAPB group (221.38 ± 47.11 µg) as compared to control groups (297.22 ± 77.69 µg) with a p value <0.001. SAPB group consumed lower dose of post-op tramadol (109.1 ± 21.7 mg) as compared to control groups (201.3 ± 27.4 mg) with a p value <0.001

VAS at rest was comparable at 6 ad 48 hours but at 12 and 24 hours the SAPB group experienced a lower level of pain compared to control group. VAS during coughing was significantly lower in SAPB group as compared to control group at 6, 12 and 24 hours however this became insignificant at 48 hours. (Table 2)

Comparison of pre- and post-op (24 hours) respiratory function using tri-ball spirometer showed better respiratory efforts in SAPB group. (Table 3)

In control group 10 patients suffered intra-op hypotension (8%) while only 3 (2%) patients in SAP group (p-value 0.232). In control group 8 patients suffered intra-op bradycardia (7%). In SAPB group only 7 (6%) suffered intra-op bradycardia (p-value 0.411). PONV was relatively higher in control group 13 (11%) than in SAPB group 8 (7%) with a p value of 0.12. (Table 4) Only one patient in SAPB group suffered from pneumothorax. Delirium was documented in only 3 patients in control group.

Table 1

Comparison of demographic data

Parameter	SAPB group n=115	Control group n=115
Age (year)	56.2±9.6	52.9±10.2
Weight (kg)	76.9±11.2	72.1±9.9
Height (cm)	172.4±7.2	171.5±6.9
Gender		
Male	75 (65%)	70 (60%)
Female	40 (35%)	45 (40%)
Hypertension	37 (32%)	29 (25%)
Diabetes	23 (20%)	28 (24%)
Duration of surgery (min)	282.7±31.2	276±42.6
CPB time(min)	121±7	116±8
X- Clamp time(min)	76±11	81±9
ICU stay (hours)	27.9±3.2	28.2±3.5
Extubation time(min)	312±27	377±41

Table 2

Comparison of VAS at Rest

Time	SAPB group n=115	Control group n=115	P value
6 Hours	2(1-2.5)	2(1.5-3)	0.213
12 hours	2(1-3)	4(3-5)	<0.001
24 hours	2(1-2.25)	3(3-3.5)	<0.001
48 hours	2(1-2.25)	2(2-3)	0.422
Comparison of VAS during cough			
Time	SAPB group n=115	Control group n=115	P value
6 Hours	3(2-4)	5(5-6)	<0.001
12 hours	3.5(2.5-4)	5.5(5-6)	<0.001
24 hours	3(2.25-3)	4(3-4)	<0.001
48 hours	2(1-2)	2(1.5-2)	0.221

Table 3

Comparison of Respiratory efforts

Time	SAPB group n=115	Control group n=115	P value
Baseline	Best effort (3-balls)	Best effort (3-balls)	-
24 hours	Good to best effort	Poor to good effort	<0.001

Table 4

Comparison of Complications

Time	SAPB group n=115	Control group n=115	P value
Intra-op hypotension	3 (2%)	10 (8%)	0.232
Intra-op Bradycardia	7 (6%)	8 (7%)	0.411
PONV	8 (7%)	13 (11%)	0.12

DISCUSSION

This study was a single-center feasibility trial suggesting that the SAPB block is effective in alleviating pain at the surgical site following CABG, whether at rest and during coughing. SAPB leads to better pulmonary functions, reduced opioid consumption, lower occurrence of opioid related side effects and early recovery after CABG.

Limiting the stress response to surgery leads to reduction of perioperative complications. Enhanced Recovery after Surgery (ERAS) protocols serve this purpose and are used in many disciplines including cardiac surgery. An important component of ERAS is to minimize to opioids consumption for managing pain and reduction in their side events. It was observed in a recent study that SAPB applied for analgesia resulted in better pain control, pulmonary function and early and better mobility in patients undergoing CABG which results in early recovery and reduction in complications. Effective pain control reduces the chances of systemic inflammation and lowers the chances of early complication like atelectasis leading to pulmonary infections and late complications like persistent post-op pain. Thus, shifting focus towards opioid sparing regional analgesic modalities should be encouraged.[7, 10]

CABG patients are treated with anticoagulant which leads to a limitation in use of such modalities due to the risk of developing local hematomas during intervention but using these modalities under ultra sound guidance can lower such risks and there use in combination with multimodal analgesic strategies can provide effective analgesia to CABG patients. The administration of

anesthetic agent in SAPB to block the lateral cutaneous branches of the intercostal nerves offers pain relief to the anterolateral region of the chest wall [3, 11]. The fascial plane where anesthetic agent is injected during SAPB is poorly vascularized. So, the chances of toxicity to local anesthetic agent are lower and thus comparatively a larger dose can be injected safely[12]. Another limitation of SAPB owing to its superficial nature is that it is less effective when it comes to managing visceral pleural pain. [13] Some researchers suggest that post-thoracotomy pain in cardiac surgery can be reasonably managed with SAPB.[14]

In our study, patients treated with SAPB experienced much less pain especially during cough and had lower dynamic VAS as compared to control group. This led to a lower requirement of opioid analgesics in SAPB group. Another study reported similar findings where that SAPB provided a better analgesia resulting in a lower post-op VAS score. [15] Similar findings were reported in cases such as open thoracotomy, video-assisted thoracoscopy (VATs) and minimal invasive thoracic surgery with lower pain score in favor of SAPB group[16, 17]

Our study also found that patient in SAPB group required significantly lower dosage of intra-op anesthetic agents compared to control group. Dost et al, reported similar finding where the patients in SAPB group much lesser dosage of anesthetic agents during the procedure compared to control group. Similarly, the need of post-op opioid analgesic was significantly lower in SAPB group of our study than in control group which is in line with the finding of Emine et al.[18]

Furthermore, rate of intra-op complications was relatively although not significantly high in control group like hypotension and bradycardia. Similarly, post-op complication like PONV and delirium were reported higher in control group of our study. This can be due to lower requirement of intra-op anesthetic and post op opioid analgesics in SAPB group. Similar findings were reported by Hassan et al and other studies.[10, 19, 20]

Patients in SAPB of our study showed better post op respiratory efforts when assessed with tri ball spirometer as compared to control group owing to better analgesic cover due to the effects of block. Better respiratory efforts lead to reduction in complication like atelectasis and respiratory tract infections. This effect of SAPB was also elaborated by Devarajan et al.[21]

Gautam et al demonstrated a decrease in extubation time of patient treated with SAPB after landing in ICU compared to control group. Patients in SAPB group of our study had significantly lower duration of mechanical ventilation with a difference of almost one hour (312±27 vs. 377±41 min). This effect was may be due to the lower opioid consumption and thus lower sedative effect. Also, SAPB provided a better analgesic profile resulting in the reduced pain during inspiration and movement.[22] ICU stay of patients in our study was comparable between both group of our study.

In our study SAPB administration failed in 2 cases due to procedural anxiety. Since CABG and SAPB are performed in supine and there was no need of a specific positioning in patient, SAPB was administered under general anesthesia to tackle the issue of procedural anxiety. Also administering SAPB before incision provided added preemptive analgesic effect. Failure to administer SAPB due to procedural anxiety has also been reported in other studies. [23]

Few limitations were encountered in our study. This study aimed to assess the immediate post op analgesic efficacy of a single dose of SAPB while long term effect of this intervention was not explored. Further studies are need with longer follow up of patients and insertion of catheter for prolonged post op pain control.

CONCLUSION

Keeping in view all the outcomes, we conclude that SAPB can be effectively be used in cardiac surgery patients to lower pain scores, opioid demand and incidence of opioid related side effects, respiratory complications and shorten extubation time, which ultimately helps lower overall morbidities as well as overall care costs.

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