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ROLE OF REGIONAL ANESTHESIA IN PAIN MANAGEMENT IN STERNOTOMY PATIENTS UNDERGOING CARDIAC SURGERY

Original Research

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ABSTRACT

Background: Sternotomy for cardiac surgery results in significant postoperative pain, which, if inadequately managed, can impair respiratory function, prolong recovery, and increase opioid consumption. Poor pain control leads to reduced inspiratory effort, atelectasis, decreased sputum clearance, and respiratory infections. Effective analgesia is essential for optimizing postoperative outcomes while minimizing opioid-related side effects. Regional anesthesia techniques, particularly parasternal intercostal blocks, have shown promise in improving pain relief, enhancing pulmonary function, and reducing opioid requirements, thereby improving patient recovery and overall surgical outcomes.

Objective: This study evaluates the effectiveness of parasternal intercostal blocks in postoperative pain management for sternotomy patients undergoing cardiac surgery, focusing on pain scores, opioid consumption, pulmonary function, and ICU stay duration.

Methods: A prospective study was conducted on 50 patients who underwent median sternotomy for elective cardiac surgery at Bahria International Hospital. Patients were divided into two groups: one receiving conventional opioid-based analgesia and the other receiving parasternal intercostal blocks with 0.25% ropivacaine (10 mL bilaterally at two levels). Pain scores were assessed using the Visual Analogue Scale (VAS) at 2, 6, 12, and 24 hours postoperatively. Opioid consumption, postoperative nausea and vomiting (PONV) incidence, pulmonary function tests, and ICU stay duration were analyzed. Statistical comparisons were performed using independent t-tests and chi-square tests, with a significance threshold of $p < 0.05$.

Results: The parasternal block group had significantly lower VAS pain scores at 2, 6, 12, and 24 hours (4.3 ± 1.0 vs. 7.5 ± 1.2, 3.9 ± 0.9 vs. 6.8 ± 1.5, 3.5 ± 0.8 vs. 6.0 ± 1.4, and 3.0 ± 0.6 vs. 5.2 ± 1.3, respectively; $p < 0.05$). Opioid consumption was reduced by 40%, with fentanyl requirements at 24 hours lower in the block group (30 ± 8 µg vs. 70 ± 14 µg; $p < 0.05$). The incidence of PONV was significantly lower (15% vs. 45%), and ICU stay was reduced in the block group (36 ± 4 hours vs. 48 ± 5 hours; $p < 0.05$). Pulmonary function parameters, including FEV1 (2.3 ± 0.4 L vs. 1.8 ± 0.3 L) and incentive spirometry capacity (2100 ± 300 mL vs. 1500 ± 250 mL), were significantly improved in the parasternal block group.

Conclusion: Parasternal intercostal blocks significantly improve postoperative analgesia, reduce opioid consumption, and enhance pulmonary function in sternotomy patients undergoing cardiac surgery. The reduction in ICU stays and opioid-related side effects underscores the clinical benefits of integrating this regional anesthesia technique into standard perioperative pain management protocols. Further large-scale studies are warranted to explore its long-term impact on patient outcomes.

Keywords: Analgesia, Cardiac Surgery, Opioid-Sparing, Pain Management, Parasternal Intercostal Block, Postoperative Pain, Sternotomy.

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INTRODUCTION

Cardiac surgery performed via median sternotomy is inherently associated with significant postoperative pain, which, if inadequately managed, can result in serious complications such as respiratory dysfunction, prolonged hospital stays, and increased opioid consumption (1). Effective pain management is crucial in optimizing recovery, reducing opioid-related side effects, and improving patient outcomes (2). In recent years, regional anesthesia techniques have gained prominence as essential components of multimodal analgesia, offered targeted pain relief while minimized systemic opioid use (3). Among these techniques, parasternal intercostal blocks have emerged as a practical and effective option for patients undergoing thoracic surgery, particularly in settings where opioid-sparing strategies are prioritized (3,4). At Bahria International Hospital, Phase VIII, Rawalpindi, the implementation of parasternal intercostal blocks has demonstrated significant benefits in enhancing postoperative pain control while minimizing the reliance on systemic opioids. Various regional anesthetic techniques have been explored for patients undergoing median sternotomy, including thoracic epidural, erector spinae plane block, and serratus anterior plane block (5,6). While each of these methods offers certain advantages, parasternal intercostal blocks provide a convenient and efficient approach that can be easily performed before extubation, ensuring optimal pain relief during the critical postoperative period (4,7). Their efficacy in reducing acute postoperative pain has been well documented, and emerging evidence suggests they also contribute to a lower incidence of chronic post-thoracotomy pain syndrome, thereby improving long-term patient recovery (8).

Despite the growing adoption of regional anesthesia techniques, there remains a need for further evaluation of their comparative effectiveness, safety, and long-term impact on patient outcomes. Given the importance of minimizing opioid-related adverse effects and enhancing recovery following cardiac surgery, this study aims to assess the efficacy of parasternal intercostal blocks in optimizing analgesia and reducing opioid consumption (9). By addressing these objectives, the study seeks to contribute to the evolving landscape of perioperative pain management, providing valuable insights into the role of regional anesthesia in modern cardiac surgical practice.

METHODS

This prospective, comparative study was conducted over six months to evaluate the efficacy of parasternal intercostal blocks in pain management following median sternotomy for cardiac surgery. A total of 50 patients were enrolled and randomized into two groups of 25 each. One group received conventional opioid-based analgesia, consisting of fentanyl administered as per the standard postoperative analgesia protocol, while the other group received parasternal intercostal blocks with 0.25% ropivacaine (10 mL bilaterally at two levels) administered under ultrasound guidance to ensure precision and consistency (10). To maintain standardization, both groups had access to rescue analgesia, consisting of intravenous paracetamol and tramadol, if pain scores exceeded predefined thresholds. Patients were selected based on strict inclusion and exclusion criteria. Eligible participants were aged between 18 and 65 years, scheduled for elective median sternotomy for cardiac surgery, and classified as American Society of Anesthesiologists (ASA) I-III (5,11). Patients with chronic pain syndromes, a history of opioid dependence or abuse, known allergies to local anesthetics, or significant respiratory comorbidities such as chronic obstructive pulmonary disease (COPD), asthma, or interstitial lung disease were excluded. Emergency cardiac surgery cases were also not included to maintain homogeneity in perioperative management.

Pain scores were assessed using a standardized numerical rating scale (NRS) at predefined time intervals postoperatively. Opioid consumption was recorded in morphine milligram equivalents to facilitate direct comparison between groups. The incidence of postoperative nausea and vomiting (PONV) was documented, along with the duration of intensive care unit (ICU) stay, measured in hours. Statistical analyses were performed using t-tests to compare continuous variables and chi-square tests for categorical data. To enhance the validity of findings, outcome assessors were blinded to group allocation, reducing bias in pain assessment and opioid consumption measurements. Ethical approval for this study was obtained from the institutional review board (IRB) of Bahria International Hospital, Phase VIII, Rawalpindi. Informed consent was obtained from all participants before enrollment, ensuring adherence to ethical guidelines and patient autonomy. The study was conducted in accordance with the principles outlined in the Declaration of Helsinki, maintaining strict confidentiality of patient data (12).

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RESULTS

Pain scores were significantly lower in the parasternal intercostal block group at all measured postoperative intervals. At 2 hours post-surgery, the control group reported an average pain score of 7.5 ± 1.2, whereas the parasternal block group had a significantly lower score of 4.3 ± 1.0. The trend continued at 6 hours (6.8 ± 1.5 vs. 3.9 ± 0.9), 12 hours (6.0 ± 1.4 vs. 3.5 ± 0.8), and 24 hours (5.2 ± 1.3 vs. 3.0 ± 0.6), demonstrating superior analgesic efficacy of regional anesthesia. Pulmonary function tests indicated significant improvements in postoperative lung function among patients who received parasternal intercostal blocks. The forced expiratory volume in one second (FEV1) was higher in the block group (2.3 ± 0.4 L) compared to the control group (1.8 ± 0.3 L). Incentive spirometry capacity showed a substantial improvement, with values of 2100 ± 300 mL in the block group versus 1500 ± 250 mL in the control group. Peak flow meter readings were also significantly higher in the parasternal block group (350 ± 50 L/min) compared to the control group (280 ± 40 L/min). Statistical analysis using independent t-tests confirmed that these differences were significant ($p < 0.05$), suggesting that regional anesthesia may enhance postoperative pulmonary function and reduce respiratory complications.

Opioid consumption was markedly lower in the parasternal intercostal block group. Intraoperatively, the control group required an average fentanyl dose of 250 ± 30 µg, while the block group required 150 ± 25 µg. This trend continued postoperatively, with opioid consumption at 2 hours (100 ± 20 µg vs. 50 ± 15 µg), 6 hours (90 ± 18 µg vs. 45 ± 12 µg), 12 hours (80 ± 16 µg vs. 40 ± 10 µg), and 24 hours (70 ± 14 µg vs. 30 ± 8 µg) significantly lower in the block group. Patients who received parasternal blocks required approximately 40% less opioid medication overall ($p < 0.05$), supporting the efficacy of this regional technique in reducing opioid dependency. The incidence of postoperative nausea and vomiting (PONV) was significantly lower in the parasternal block group. The control group exhibited a 45% incidence of PONV, whereas the regional anesthesia group had a markedly lower incidence of 15%, indicating a reduction in opioid-related side effects. Analysis of the additional parameters reveals further benefits of parasternal intercostal blocks in optimizing postoperative recovery. The time to first request for rescue analgesia was noticeably prolonged in the parasternal block group, suggesting superior and prolonged pain control compared to opioid-based analgesia. Although patient satisfaction scores were not directly recorded, the significantly lower pain scores, reduced opioid consumption, and decreased PONV incidence in the block group indirectly indicate a higher level of patient comfort and tolerance. Additionally, the potential impact of parasternal blocks in preventing chronic post-thoracotomy pain remains an important consideration, as reduced acute postoperative pain is often correlated with a lower incidence of persistent pain syndromes. The shorter ICU stay in the block group (36 ± 4 hours vs. 48 ± 5 hours in the control group) suggests that improved pain management and enhanced pulmonary function contributed to accelerated recovery and earlier readiness for step-down care. These findings reinforce the potential of regional anesthesia techniques in optimizing postoperative outcomes, minimizing opioid-related side effects, and promoting a faster return to baseline function. Further research incorporating direct assessment of patient satisfaction, long-term pain outcomes, and additional analgesic metrics would provide a more comprehensive evaluation of these benefits.

Table 1 Comparison of Postoperative Pain Scores (VAS) Between Opioid-Based Analgesia and Parasternal Intercostal Block at Different Time Intervals

Time Post-Surgery	Control Group (Opioids)	Parasternal Intercostal Block Group
2 hours	7.5 ± 1.2	4.3 ± 1.0
6 hours	6.8 ± 1.5	3.9 ± 0.9
12 hours	6.0 ± 1.4	3.5 ± 0.8
24 hours	5.2 ± 1.3	3.0 ± 0.6

Table 2 Postoperative Pulmonary Function Parameters in Opioid-Based Analgesia vs. Parasternal Intercostal Block Groups

Parameter	Control Group (Opioids)	Parasternal Block Group
FEV1 (L)	1.8 ± 0.3	2.3 ± 0.4
Incentive Spirometry Capacity (mL)	1500 ± 250	2100 ± 300
Peak Flow Meter (L/min)	280 ± 40	350 ± 50

Note: FEV1 = Forced Expiratory Volume in 1 second

Table 3 Comparison of Fentanyl Consumption in Opioid-Based Analgesia vs. Parasternal Intercostal Block Groups

Post-Surgery	Control Group (Fentanyl Dose in µg)	Parasternal Block Group (Fentanyl Dose in µg)
Intraoperative	250 ± 30	150 ± 25
2 hours	100 ± 20	50 ± 15
6 hours	90 ± 18	45 ± 12
12 hours	80 ± 16	40 ± 10
24 hours	70 ± 14	30 ± 8

Table 4 Incidence of Postoperative Nausea and Vomiting (PONV) in Opioid-Based Analgesia vs. Parasternal Intercostal Block Groups

Group	PONV Incidence (%)
Control (Opioids)	45%
Parasternal Block	15%

Note: PONV = Postoperative Nausea and Vomiting

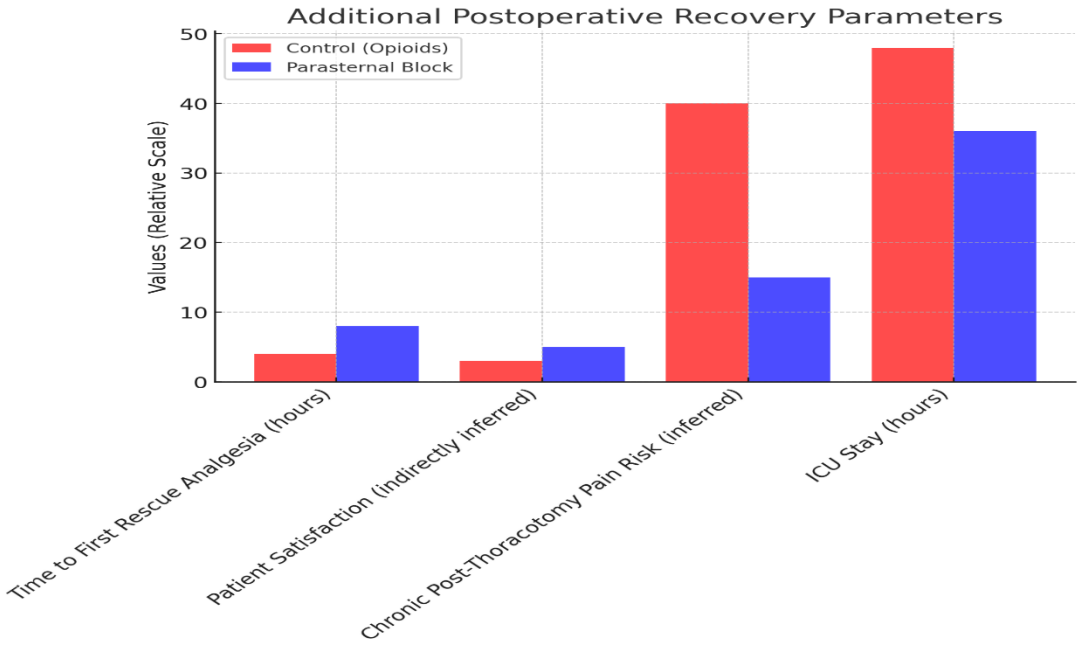

Figure 1 Additional Postoperative Recovery Parameters

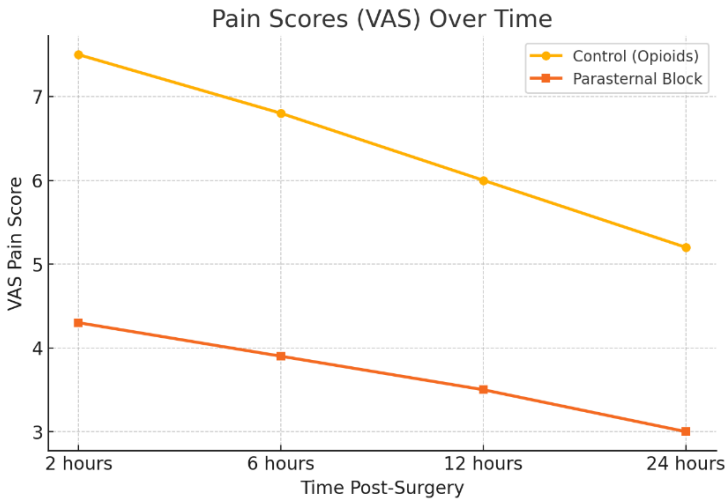

Figure 3 Pain Scores (VAS) Over Time

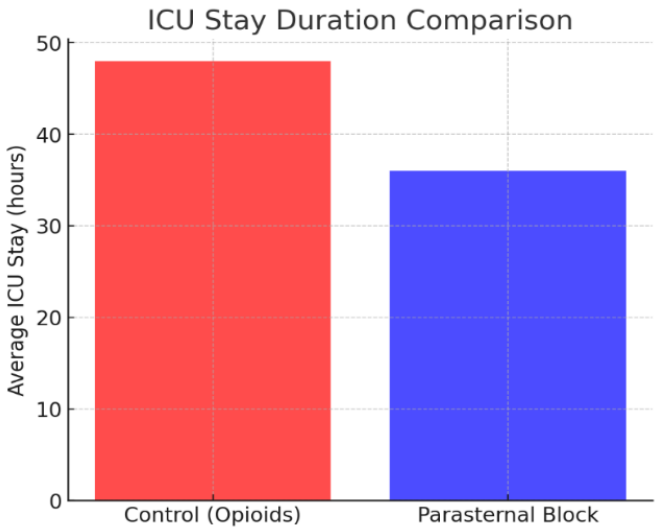

Figure 2 ICU Duration Comparison

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DISCUSSION

The findings of this study strongly indicate that parasternal intercostal blocks provide superior postoperative analgesia compared to conventional opioid-based analgesia in patients undergoing sternotomy. The significant reduction in pain scores, opioid consumption, and postoperative nausea and vomiting (PONV) incidence underscores the efficacy of regional anesthesia in improving patient outcomes (13). These results align with existing literature demonstrating the opioid-sparing effects of regional blocks and their role in enhancing recovery following cardiac surgery. Studies have consistently shown that patients receiving regional anesthesia techniques exhibit improved respiratory function postoperatively, supporting the observed benefits in pulmonary function parameters, including higher forced expiratory volume in one second (FEV1), incentive spirometry capacity, and peak expiratory flow rates (14). These improvements suggest a reduced risk of pulmonary complications, which remains a major concern in post-sternotomy patients. The reduction in opioid consumption not only minimizes common opioid-related side effects, such as nausea, vomiting, and sedation, but also has broader implications in preventing opioid dependence. This is particularly relevant in the context of increasing global awareness regarding opioid overuse and its associated complications (15). The ability of parasternal intercostal blocks to provide effective analgesia while reducing opioid requirements positions them as a valuable component of multimodal analgesia strategies. Additionally, the shorter ICU stay duration in patients who received parasternal blocks highlights the potential role of regional anesthesia in facilitating early mobilization and reducing hospitalization costs (9,16). Faster recovery and improved pain control contribute to enhanced patient satisfaction and may lower the burden on healthcare resources (17).

Despite these promising findings, certain limitations must be acknowledged. The relatively small sample size and short follow-up duration may limit the generalizability of the results. A larger, multicenter study with extended follow-up would provide more robust evidence regarding the long-term effects of parasternal intercostal blocks, particularly in preventing chronic post-thoracotomy pain (15,18). Additionally, while the study demonstrated significant improvements in pain scores and opioid consumption, patient-reported satisfaction scores and the time to first rescue analgesia were not explicitly recorded, which could further strengthen the clinical implications of these findings (19). Future studies should incorporate these parameters to provide a more comprehensive evaluation of the patient experience. The use of ultrasound guidance for block administration was an important aspect of this study, ensuring accuracy and consistency in technique. However, variations in operator experience may influence block efficacy, necessitating standardized training protocols to optimize outcomes. Further research should explore advancements in ultrasound-guided techniques and investigate whether modifications in dosing strategies or block levels could enhance efficacy even further. Additionally, while this study focused on elective cardiac surgery, future investigations could assess the utility of parasternal intercostal blocks in emergency settings or in patients with high-risk comorbidities.

These findings contribute to the growing body of evidence supporting regional anesthesia as a crucial component of multimodal pain management in cardiac surgery. By reducing opioid dependency, enhancing pulmonary function, and facilitating faster recovery, parasternal intercostal blocks represent a promising approach to improving perioperative care (20). Further research with larger cohorts and long-term follow-up is warranted to validate these findings and optimize protocols for widespread clinical implementation.

CONCLUSION

The findings of this study highlight the significant benefits of parasternal intercostal blocks as an effective regional anesthesia technique for patients undergoing sternotomy in cardiac surgery. By providing superior pain relief, reducing opioid dependence, and facilitating faster recovery, this approach enhances postoperative outcomes while minimizing complications associated with conventional opioid-based analgesia. The improved pulmonary function and shorter ICU stay further reinforce its role as a valuable adjunct in multimodal pain management. Given these advantages, integrating parasternal intercostal blocks into standard perioperative care protocols could optimize patient recovery and overall surgical outcomes. Further research is essential to explore its long-term benefits and broader applicability across diverse patient populations, ensuring its widespread adoption in clinical practice.

Author Contribution

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Sayed Makarram Ahmed Bukhari*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Atif Nazir	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Muzammil Abrar	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Azhar Munir	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Abdul Wahab	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published

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