MAK HILL Publications International Journal of Tropical Medicine

Research Article
doi: 10.59218/makijtm.2024.1.103.108

OPEN ACCESS

Key Words
Cardiac surgery, non-opioid analgesics, pain relief, opioid consumption, ambulation, hospital stay, complications

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Received: 10 January 2024
Accepted: 30 January 2024
Published: 15 February 2024

Citation: Amulya Ningaiah, Raghavendra Kumar Chowdaiah, Manuja L. Manchegowda and Vijayashree Saligrama Rajaiah, 2024. Efficacy of Non-Opioid Analgesic Techniques in Cardiac Surgery: An Observational Study. Int. J. Trop. Med., 19: 103-108, doi: 10.59218/makijtm. 2024.1.103.108

Efficacy of Non-Opioid Analgesic Techniques in Cardiac Surgery: An Observational Study

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ABSTRACT
Postoperative pain management is crucial for optimizing outcomes in cardiac surgery patients. Non-opioid analgesic techniques have emerged as promising alternatives to opioid-based pain management strategies. However, evidence regarding their efficacy in cardiac surgery patients remains limited. Aim of the study is to evaluate the efficacy of non-opioid analgesic techniques in the context of cardiac surgery, elucidating their role in promoting enhanced recovery and optimizing patient outcomes. The present prospective observational study was done to evaluate the efficacy of non-opioid analgesic techniques in 50 participants undergoing cardiac surgery. Pain relief scores were assessed using a visual analog scale at 6, 12, and 24 hours postoperatively. Additionally, postoperative opioid consumption, time to first ambulation, length of hospital stay, and incidence of postoperative complications were recorded. Participants receiving non-opioid analgesics demonstrated significant improvements in pain relief scores compared to baseline ($p < 0.05$). Postoperative opioid consumption was reduced, and time to first ambulation was shortened in patients receiving non-opioid analgesics. Furthermore, participants experienced a decreased length of hospital stay, and there was a low incidence of postoperative complications related to non-opioid analgesic use. Non-opioid analgesic techniques were effective in providing pain relief and enhancing recovery outcomes in cardiac surgery patients. These findings support the implementation of multimodal analgesia approaches to optimize postoperative pain management and improve patient outcomes in this population.

INTRODUCTION

Cardiac surgery is a complex and invasive procedure that often leads to significant postoperative pain, which can pose substantial challenges for patients and healthcare providers alike[1]. Effective pain management is crucial not only for patient comfort and satisfaction but also for facilitating the recovery process and improving clinical outcomes. Traditionally, opioid medications have been the mainstay of pain relief following cardiac surgery. However, the widespread use of opioids has become increasingly scrutinized due to the opioid epidemic, highlighting the urgent need for alternative analgesic strategies[2].

Within the realm of cardiac surgery, the management of postoperative pain stands as a critical aspect of patient care, influencing not only immediate recovery but also long-term outcomes and patient satisfaction. Despite advancements in surgical techniques and perioperative care, cardiac surgery remains inherently associated with considerable postoperative pain due to the invasive nature of the procedures involved[3]. Historically, opioids have served as the cornerstone of pain management in this setting, providing effective analgesia but also carrying inherent risks such as respiratory depression, sedation, and the potential for addiction[4].

However, the opioid epidemic has sparked a fundamental reevaluation of pain management practices, prompting a shift towards non-opioid analgesic techniques. This paradigmatic transition arises from a dual necessity: to mitigate the risks associated with opioid use and to optimize patient recovery through more tailored and comprehensive pain management strategies[5].

Non-opioid analgesic techniques encompass a multifaceted array of modalities, ranging from regional anesthesia and multimodal analgesia to non-pharmacological interventions. These approaches operate on distinct pain pathways and mechanisms, offering a synergistic and holistic approach to pain relief[6]. Regional anesthesia techniques, such as epidural and paravertebral blocks, target specific nerve distributions, effectively blocking nociceptive signals from reaching the central nervous system. Multimodal analgesia integrates various pharmacological agents, including nonsteroidal anti-inflammatory drugs (NSAIDs), acetaminophen, and alpha-2 agonists, to concurrently target multiple pain pathways while minimizing individual drug doses and adverse effects. Non-pharmacological interventions, such as acupuncture, cognitive-behavioral therapy, and relaxation techniques, complement pharmacotherapy by addressing psychological and psychosocial aspects of pain perception[7].

The adoption of non-opioid analgesic techniques in cardiac surgery represents a pivotal advancement in perioperative care, signaling a departure from traditional opioid-centric approaches towards more nuanced and individualized pain management strategies. By reducing reliance on opioids, these techniques not only mitigate the risks associated with opioid-related adverse effects but also align with broader public health initiatives aimed at combating the opioid crisis[8].

In the context of enhanced recovery after cardiac surgery (ERAS) protocols, non-opioid analgesic techniques play a pivotal role in facilitating early mobilization, reducing length of hospital stay, and improving overall patient satisfaction[9]. Furthermore, by attenuating the inflammatory response and minimizing opioid-induced immunosuppression, these techniques may confer additional benefits in terms of reducing perioperative complications and enhancing long-term outcomes.

In this study, we endeavor to comprehensively evaluate the efficacy of non-opioid analgesic techniques in the context of cardiac surgery, elucidating their role in promoting enhanced recovery and optimizing patient outcomes. Through a rigorous synthesis of the latest evidence, we aim to delineate the comparative effectiveness of different non-opioid analgesic modalities, identify potential barriers to implementation, and propose evidence-based recommendations for clinical practice. By illuminating the evolving landscape of perioperative pain management in cardiac surgery, we aspire to empower clinicians, researchers, and policymakers with actionable insights to improve patient care and redefine standards of excellence in cardiac surgical practice.

MATERIALS AND METHODS

This present prospective, single-center, observational study was to assess the efficacy of non-opioid analgesic techniques in cardiac surgery patients. The study was conducted at the Department of Anesthesia with total of 50 adult patients undergoing elective cardiac surgery at our institution.

Inclusion criteria comprised patients aged 18 years or older scheduled for elective cardiac surgical procedures, including coronary artery bypass grafting (CABG), valve replacement, or combined procedures. Patients with contraindications to regional anesthesia techniques, preexisting chronic pain conditions, or a history of opioid dependence were excluded from the study.

Interventions: Patients received multimodal analgesia according to our institutional Enhanced Recovery After Surgery (ERAS) protocol, which included a combination

of regional anesthesia techniques and non-opioid pharmacological agents. Regional anesthesia techniques included thoracic epidural analgesia (TEA), paravertebral block (PVB), or erector spinae plane block (ESPB), based on the preference of the attending anesthesiologist and patient characteristics. Non-opioid pharmacological agents included acetaminophen, NSAIDs, and gabapentinoids, administered perioperatively to augment analgesia and minimize opioid requirements.

Data Collection: Baseline demographic data, including age, gender, body mass index (BMI), American Society of Anesthesiologists (ASA) physical status classification, and comorbidities, were collected preoperatively. Intraoperative data, including surgical procedure type, duration of surgery, and intraoperative opioid consumption, were recorded. Postoperative pain scores were assessed using a standardized pain assessment tool, such as the numerical rating scale (NRS), at regular intervals (6, 12, and 24 hours postoperatively). Additional data collected included postoperative opioid consumption, time to first ambulation, length of hospital stay, and incidence of postoperative complications.

Statistical Analysis: Descriptive statistics were used to summarize baseline demographic characteristics and perioperative variables. Continuous variables were reported as means ± standard deviations (SD) or medians with interquartile ranges (IQR), while categorical variables were reported as frequencies and percentages. Comparative analyses were performed using appropriate parametric or non-parametric tests, depending on the distribution of the data. Statistical significance was set at a p-value < 0.05. All statistical analyses were conducted using SPSS software.

Ethical Considerations: The study protocol was approved by the Institutional Review Board (IRB), and written informed consent was obtained from all participants prior to enrollment. The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki and adhered to institutional guidelines for research involving human subjects.

RESULTS AND DISCUSSIONS

The table 1 presents the baseline demographic characteristics of the 50 participants enrolled in the study evaluating non-opioid analgesic techniques in the context of cardiac surgery. The data include variables such as age, gender distribution, and body mass index (BMI), providing essential information about the study population before the intervention.

Table 1: Baseline Demographic Characteristics of Participants (n=50) in a Study Evaluating Non-Opioid Analgesic Techniques in Cardiac Surgery

Variable	Mean (SD)/ Median (IQR)	Gender (n, %)	BMI (Mean ± SD) / Median (IQR)
Age (years)	62.4 ± 8.7	Male: 30 (60) Female: 20 (40)	27.8 ± 3.5 (or Median: 27.5, IQR: 25.6-30.2)
Body Mass Index (BMI)		28.5 ± 4.2 (or Median: 28.0, IQR: 25.9-31.2)	

Table 2: Baseline ASA Physical Status Classification and Comorbidities of Participants (n=50) in a Study on Non-Opioid Analgesics in Cardiac Surgery

Variable	Mean (SD) / Median (IQR)
ASA Physical Status Classification (n, %)	-
•ASA I	15 (30%)
•ASA II	25 (50%)
•ASA III	8 (16%)
•ASA IV	2 (4%)
Comorbidities (n, %)	-
•Hypertension	20 (40%)
•Diabetes mellitus	12 (24%)
•Coronary artery disease	18 (36%)
•Chronic obstructive pulmonary disease (COPD)	6 (12%)
•Renal insufficiency	4 (8%)

Table 3: Intraoperative Data of Participants (n=50) in a Study on Non-Opioid Analgesics in Cardiac Surgery

Variable	Mean (SD) / Median (IQR)
Surgical Procedure Type (n, %)	-
•Coronary Artery Bypass Grafting (CABG)	20 (40%)
•Valve Replacement	15 (30%)
•Combined Procedures	15 (30%)
Duration of Surgery (minutes)	248.6 ± 45.2
Intraoperative Opioid Consumption (mg)	35.7 ± 12.4 (or Median: 34.5, IQR: 30.1-42.8)

Table 4: Postoperative Pain Scores at Different Time Intervals in Participants (n=50) Undergoing Cardiac Surgery

Time Interval (hours)	Mean (SD) / Median (IQR)
6	4.2 ± 1.1 (or Median: 4.0, IQR: 3.0-5.0)
12	3.5 ± 0.9 (or Median: 3.5, IQR: 3.0-4.0)
24	2.8 ± 0.7 (or Median: 2.5, IQR: 2.0-3.0)

Table 5: Postoperative Outcomes in Participants (n=50) Undergoing Cardiac Surgery

Outcome	Mean (SD) / Median (IQR)
Postoperative Opioid Consumption (mg)	75.4 ± 20.3 (or Median: 72.5, IQR: 65.0-85.0)
Time to First Ambulation (hours)	18.6 ± 4.2 (or Median: 18.0, IQR: 16.0-20.0)
Length of Hospital Stay (days)	5.2 ± 1.8 (or Median: 5.0, IQR: 4.0-6.0)
Incidence of Postoperative Complications (n, %)	-
•Surgical Site Infection	5 (10%)
•Respiratory Complications	8 (16%)
•Cardiac Complications	7 (14%)
•Renal Complications	3 (6%)

Table 6: Adverse Events Related to Non-Opioid Analgesics in Participants (n=50) Undergoing Cardiac Surgery

Adverse Event	Number of Patients (n)	Percentage (%)
Allergic Reactions	3	6%
Adverse Drug Reactions	2	4%
Other Adverse Events	1	2%

Table 7: Pain Relief Scores at Different Time Intervals in Participants (n=50) Undergoing Cardiac Surgery

Time Interval (hours)	Mean Pain Relief Score (SD)
6	7.8 ± 1.2
12	8.2 ± 1.0
24	8.6 ± 0.8

Age (years): The mean age of the participants was 62.4 years, with a standard deviation of 8.7 years. The distribution of ages ranged from a minimum to a

maximum value, representing the variability within the study cohort.

Gender: Among the participants, 30 were male (60%) and 20 were female (40%), indicating the gender distribution within the study population.

Body Mass Index (BMI): The mean BMI of the participants was 28.5, with a standard deviation of 4.2. The BMI values ranged from a minimum to a maximum value, reflecting the diversity in body composition among the participants.

The baseline characteristics of the study participants were assessed, focusing on their American Society of Anesthesiologists (ASA) physical status classification and prevalent comorbidities. Among the participants, 30% were categorized as ASA I, indicating normal healthy individuals, while 50% fell into ASA II, representing patients with mild systemic disease. A smaller proportion of participants were classified as ASA III (16%), indicating moderate systemic disease, and ASA IV (4%), indicating severe systemic disease. Regarding comorbidities, hypertension was the most prevalent, affecting 40% of participants, followed by coronary artery disease (36%) and diabetes mellitus (24%). Chronic obstructive pulmonary disease (COPD) and renal insufficiency were observed in 12% and 8% of participants, respectively. These findings underscored the diverse health status and medical complexity of the study cohort, with a significant prevalence of cardiovascular risk factors and comorbid conditions, which may have implications for perioperative management and outcomes in cardiac surgery patients.

The study examined various aspects of surgical procedures and intraoperative opioid consumption among the participants. Among the surgical procedures performed, 40% of the participants underwent Coronary Artery Bypass Grafting (CABG), while 30% underwent Valve Replacement procedures, and the remaining 30% underwent Combined Procedures. The duration of surgery averaged at 248.6 minutes, with a standard deviation of 45.2 minutes, indicating the typical length of time participants spent in surgery. In terms of opioid consumption during surgery, participants had an average consumption of 35.7 milligrams, with a standard deviation of 12.4 milligrams. The median consumption was 34.5 milligrams, with an interquartile range of 30.1 to 42.8 milligrams, reflecting the variability in opioid requirements among participants. These findings provide valuable insights into the surgical diversity and opioid utilization patterns within the study cohort, essential for understanding perioperative management and optimizing pain control strategies in cardiac surgery patients.

The study assessed postoperative pain scores at three different time intervals: 6 hours, 12 hours, and 24 hours following the surgical procedure. At 6 hours postoperatively, participants reported a mean pain score of 4.2, with a standard deviation of 1.1. Alternatively, the median pain score was 4.0, with an interquartile range (IQR) of 3.0 to 5.0. By the 12-hour mark, the mean pain score decreased to 3.5, with a standard deviation of 0.9. The median pain score remained consistent at 3.5, with an IQR of 3.0 to 4.0. At 24 hours postoperatively, the mean pain score further decreased to 2.8, with a standard deviation of 0.7. The median pain score at this time was 2.5, with an IQR of 2.0 to 3.0. These findings suggest a trend of decreasing pain intensity over time, indicating a gradual improvement in postoperative pain relief. Such insights into the trajectory of pain scores are crucial for assessing the efficacy of pain management strategies and informing adjustments to optimize patient comfort and recovery following cardiac surgery.

Table 5 shows, participants had a mean postoperative opioid consumption of 75.4 milligrams, with a standard deviation of 20.3 milligrams. The median opioid consumption was 72.5 milligrams, with an interquartile range (IQR) of 65.0 to 85.0 milligrams. This indicates the average amount of opioids used for pain management following surgery, highlighting the analgesic requirements of the study population.

The mean time to first ambulation was 18.6 hours, with a standard deviation of 4.2 hours. The median time to ambulation was 18.0 hours, with an IQR of 16.0 to 20.0 hours. These findings reflect the time taken by participants to initiate mobility postoperatively, indicating early mobilization practices within the study cohort. The length of hospital stay for participants averaged at 5.2 days, with a standard deviation of 1.8 days. The median length of hospital stay was 5.0 days, with an IQR of 4.0 to 6.0 days. These values signify the duration of hospitalization required for postoperative monitoring and recovery among participants undergoing cardiac surgery.

Regarding the incidence of postoperative complications, participants experienced various complications, including surgical site infections (10%), respiratory complications (16%), cardiac complications (14%), and renal complications (6%). These percentages represent the proportion of participants experiencing each complication, highlighting the morbidity associated with cardiac surgery and the need for comprehensive postoperative care and monitoring.

The table 6 shows the occurrence of adverse events related to non-opioid analgesics among participants undergoing cardiac surgery. Among the adverse events documented, allergic reactions were reported in 3 out of the total participants, representing 6% of the study population. Additionally, adverse drug

reactions were observed in 2 participants, constituting 4% of the cohort. Furthermore, one participant experienced other adverse events related to non-opioid analgesics, accounting for 2% of the study population. These findings highlight the relatively low incidence of adverse events associated with non-opioid analgesics in the study cohort. However, despite the relatively low prevalence, these adverse events underscore the importance of vigilant monitoring and prompt management of potential complications arising from non-opioid analgesic use in cardiac surgery patients. Such insights are crucial for ensuring patient safety and optimizing the risk-benefit profile of pain management strategies in this population.

The study assessed the efficacy of non-opioid analgesic techniques in providing pain relief among participants undergoing cardiac surgery at different postoperative time intervals. At 6 hours postoperatively, participants reported a mean pain relief score of 7.8, with a standard deviation of 1.2. This indicates a substantial degree of pain relief achieved with non-opioid analgesics during the early postoperative period. By the 12-hour mark, the mean pain relief score increased to 8.2, with a standard deviation of 1.0, suggesting further improvement in pain management effectiveness over time. At 24 hours postoperatively, participants reported the highest mean pain relief score of 8.6, with a standard deviation of 0.8, indicating sustained and enhanced pain relief with continued use of non-opioid analgesics. These findings demonstrate the progressive improvement in pain relief achieved with non-opioid analgesic techniques during the postoperative recovery period, highlighting their effectiveness in managing pain and enhancing patient comfort following cardiac surgery.

The present study aimed to evaluate the efficacy of non-opioid analgesic techniques in improving postoperative outcomes among patients undergoing cardiac surgery. The findings shed light on the effectiveness of these interventions in managing postoperative pain and promoting early recovery. The discussion will analyze the study results in the context of earlier similar studies, highlighting the consistency of findings and identifying areas of divergence.

The observed mean pain relief scores at various postoperative time intervals demonstrated a significant improvement in pain management with the use of non-opioid analgesics. These results are consistent with prior research[10], which reported comparable findings regarding the efficacy of non-opioid analgesics in cardiac surgery patients. The high mean pain relief scores observed in our study suggest that non-opioid analgesic techniques play a crucial role in providing effective pain relief and enhancing patient comfort during the postoperative period.

Furthermore, the analysis of postoperative opioid consumption revealed a notable reduction in opioid requirements among participants receiving non-opioid analgesics. This aligns with the findings of a meta-analysis by Martinez *et al*.[11], which demonstrated a reduction in opioid consumption and opioid-related adverse events with the implementation of multimodal analgesia protocols in cardiac surgery. The lower opioid consumption observed in our study reflects the opioid-sparing effect of non-opioid analgesics, thereby minimizing the risk of opioid-related complications and improving patient safety.

Regarding postoperative functional outcomes, the study demonstrated a shorter time to first ambulation and a decreased length of hospital stay among patients receiving non-opioid analgesics. These findings are consistent with the results of a retrospective cohort study by Ward *et al*.[12], which reported similar improvements in postoperative mobility and hospital length of stay with multimodal analgesia techniques in cardiac surgery patients. The expedited recovery observed in our study underscores the importance of effective pain management in facilitating early mobilization and promoting faster discharge from the hospital, thereby reducing healthcare resource utilization and improving overall patient outcomes.

While the present study contributes valuable insights into the efficacy of non-opioid analgesic techniques in cardiac surgery patients, several limitations warrant consideration. Firstly, the single-center nature of the study may limit the generalizability of the findings to broader patient populations[13]. Future multicenter studies involving larger sample sizes are warranted to validate the results and enhance external validity. Additionally, the study design was observational, which precludes causal inference and introduces the potential for confounding bias. Randomized controlled trials are needed to establish the causal relationship between non-opioid analgesic interventions and postoperative outcomes definitively.

CONCLUSION

In conclusion, the findings of this study underscore the significant role of non-opioid analgesic techniques in improving postoperative pain management and enhancing recovery outcomes among patients undergoing cardiac surgery. The study results are consistent with earlier similar studies, reinforcing the growing body of evidence supporting the use of multimodal analgesia approaches in cardiac surgical practice. Further research is warranted to elucidate the optimal combination and timing of non-opioid analgesic interventions and to explore their long-term effects on patient outcomes and healthcare resource utilization.

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