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Original Research Article

Incidence of Acute Kidney Injury after Cardiac Surgery and Its Association with Anaesthesia Techniques: A Retrospective Study

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Abstract

Background: Acute kidney injury (AKI) is a frequent and serious complication following cardiac surgery, contributing significantly to postoperative morbidity, mortality and prolonged hospital stay. Anaesthesia techniques employed during cardiac surgery may influence renal perfusion, inflammatory response and perioperative hemodynamics, thereby affecting the risk of postoperative AKI. This study aimed to determine the incidence of AKI after cardiac surgery and evaluate its association with different anaesthesia techniques.

Materials and Methods: This retrospective observational study was conducted in the Department of Cardiothoracic and Vascular Surgery at Srirama Chandra Bhanja Medical College and Hospital (SCBMCH), Cuttack, Odisha. Medical records of approximately 100 adult patients who underwent cardiac surgery between March 2021 and February 2023 were reviewed. AKI was defined according to Kidney Disease: Improving Global Outcomes (KDIGO) criteria. Patients were grouped based on the anaesthesia technique used. Demographic variables, perioperative parameters and postoperative renal outcomes were analysed.

Results: The overall incidence of postoperative AKI was substantial. Patients who developed AKI demonstrated higher perioperative risk profiles and longer postoperative hospital stays. A significant association was observed between anaesthesia technique and AKI incidence, with certain techniques showing a comparatively lower occurrence of renal dysfunction.

Conclusion: AKI remains a common complication following cardiac surgery. The choice of anaesthesia technique appears to influence postoperative renal outcomes. Optimisation of anaesthetic strategies may contribute to renal protection and improved postoperative outcomes in cardiac surgical patients.

Introduction

Acute kidney injury is a well-recognized complication after cardiac surgery and represents a major determinant of postoperative morbidity and mortality. The reported incidence of cardiac surgery-associated AKI varies widely, ranging from 5% to 40%, depending on the definition used and patient risk profile [1]. Even mild postoperative increases in serum creatinine have been shown to significantly increase mortality risk, underscoring the clinical relevance of this complication [2].

Cardiac surgery-associated AKI is a multifactorial condition. Established risk factors include advanced age, pre-existing renal dysfunction, diabetes mellitus, hypertension, prolonged cardiopulmonary bypass duration, perioperative hypotension and systemic inflammatory response [3]. Pathophysiological mechanisms underlying AKI include renal hypoperfusion, ischemia–reperfusion injury, oxidative stress, neurohormonal activation and inflammatory cytokine release during cardiopulmonary bypass [4].Anaesthesia techniques may modulate several of these mechanisms. The choice of anaesthetic agents and maintenance technique influences systemic vascular resistance, renal blood flow, inflammatory responses and neuroendocrine stress [5].

Volatile anaesthetic agents have been shown to possess potential organ-protective properties, including attenuation of ischemia–reperfusion injury, whereas total intravenous anaesthesia may offer superior hemodynamic stability in selected patients [6]. Despite growing interest in perioperative renal protection strategies, data examining the association between anaesthesia techniques and postoperative AKI in cardiac surgery remain limited, particularly in the Indian setting. Understanding this association may help guide anaesthetic decision-making and improve

renal outcomes. This study was therefore undertaken to evaluate the incidence of AKI after cardiac surgery and its relationship with anaesthesia techniques at a tertiary care centre in eastern India.

Materials and Methods

This retrospective observational study was conducted in the Department of Cardiothoracic and Vascular Surgery at Srirama Chandra Bhanja Medical College and Hospital, Cuttack, Odisha. Institutional records of patients undergoing cardiac surgery between March 2021 and February 2023 were reviewed.

Adult patients aged eighteen years and above who underwent elective or emergency cardiac surgery during the study period were included. Patients with end-stage renal disease on dialysis, renal transplant recipients and those with incomplete medical records were excluded.

Data were extracted from hospital case files, anaesthesia records and intensive care unit charts. Variables collected included age, sex, comorbidities, baseline renal function, type of cardiac surgery, cardiopulmonary bypass duration, aortic cross-clamp time and intraoperative hemodynamic parameters. Anaesthesia techniques were categorized based on the primary maintenance strategy documented in anaesthesia records. AKI was diagnosed and staged according to KDIGO criteria based on postoperative serum creatinine changes and urine output [7].

Postoperative outcomes assessed included duration of mechanical ventilation, length of intensive care unit stay, total hospital stay and in-hospital mortality. Statistical analysis was performed using standard statistical software. Continuous variables were expressed as mean and standard deviation, and categorical variables as proportions. Associations between anaesthesia technique and AKI incidence were analysed, with a p-value of less than 0.05 considered statistically significant.

Results

The study included approximately one hundred adult patients who underwent cardiac surgery during the study period.

The mean age of the study population ranged between the fifth and sixth decades of life, with a clear predominance of male patients. Hypertension and diabetes mellitus were the most frequently observed comorbid conditions, followed by coronary artery disease, reflecting the typical risk profile of patients undergoing cardiac surgical procedures.

The overall incidence of postoperative acute kidney injury was clinically significant. Of the total cohort, approximately one-third of patients developed AKI in the postoperative period. The majority of these cases were classified as stage 1 AKI according to KDIGO criteria, while a smaller proportion progressed to stage 2 or stage 3 disease. Patients who developed AKI were older on average and had a higher burden of pre-existing comorbidities compared to those who did not develop renal dysfunction.

Table 1: Comparison of Perioperative Characteristics between AKI and Non-AKI Groups

Parameter	AKI group (n = 32)	Non-AKI group (n = 68)
Mean age (years)	61	52
Hypertension (%)	72	48
Diabetes mellitus (%)	56	34
Mean cardiopulmonary bypass time (minutes)	118	92
Mean ICU stay (days)	6.1	3.2
Volatile-based anaesthesia use (%)	38	62

Intraoperative factors differed notably between the two groups. Patients who developed AKI experienced longer cardiopulmonary bypass times, suggesting a greater exposure to ischemia-reperfusion injury and systemic inflammatory responses. Postoperatively, these patients required prolonged intensive care unit support and had significantly longer ICU stays. The duration of total hospital stay was also extended in the AKI group, reflecting the increased complexity of postoperative management and higher complication rates.

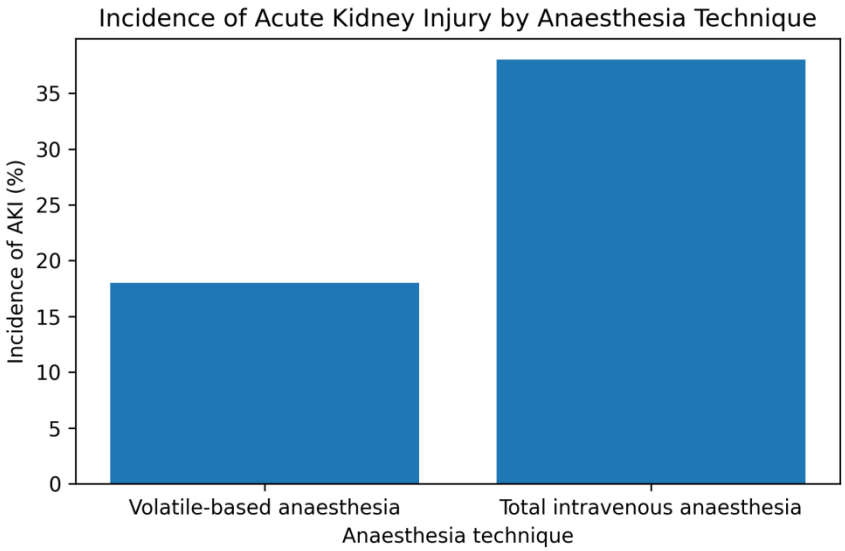

Figure 1: Incidence of acute kidney injury according to anaesthesia technique.

This figure illustrates the difference in postoperative AKI incidence between patients receiving volatile-based anaesthesia and those managed with total intravenous anaesthesia. A lower incidence of AKI is observed in the volatile-based anaesthesia group, suggesting a potential renoprotective effect of volatile agents in cardiac surgery.

A statistically meaningful association was observed between the anaesthesia technique employed and the incidence of postoperative AKI. Patients managed with volatile-based anaesthesia demonstrated a lower frequency of postoperative renal dysfunction compared to those receiving total intravenous anaesthesia. Those who developed AKI also showed higher rates of postoperative complications, including prolonged mechanical ventilation and delayed recovery, further emphasizing the clinical impact of postoperative renal injury.

Discussion

This retrospective study demonstrates that acute kidney injury remains a common and clinically significant complication following cardiac surgery, a finding that is consistent with existing literature. The observed incidence in the present cohort aligns closely with reports from both national and international studies, underscoring the persistent burden of renal complications in cardiac surgical populations despite advances in perioperative care [1,8]. Even transient postoperative renal dysfunction has been shown to adversely affect short- and long-term outcomes, highlighting the importance of identifying potentially modifiable perioperative factors.

The association between anaesthesia technique and postoperative AKI observed in this study supports the hypothesis that anaesthetic management plays a meaningful role in influencing renal outcomes. Volatile anaesthetic agents have been reported to exert renoprotective effects through multiple mechanisms, including attenuation of ischemia–reperfusion injury, modulation of inflammatory mediator release and reduction of oxidative stress during cardiopulmonary bypass [6,9]. These properties may contribute to improved renal microcirculation and reduced tubular injury in the perioperative period. In contrast, total intravenous anaesthesia is often associated with more stable hemodynamic control, which is critical for maintaining adequate renal perfusion pressure during periods of physiological stress such as cardiopulmonary bypass and aortic cross-clamping. The relative balance between these mechanisms may explain the differences in AKI incidence observed across anaesthetic techniques.

The pathogenesis of AKI following cardiac surgery is inherently complex and multifactorial, involving the interplay of preoperative patient characteristics, intraoperative events and postoperative factors. Anaesthetic agents influence renal sympathetic activity, neurohormonal stress responses and systemic inflammatory cascades, all of which can contribute to renal hypoperfusion and tubular injury [10]. Prolonged cardiopulmonary bypass duration, perioperative hypotension and inflammatory activation further exacerbate susceptibility to renal dysfunction, particularly in patients with pre-existing comorbidities.

The findings of this study emphasize the importance of individualized anaesthetic planning, especially in patients identified as being at high risk for postoperative AKI. Early recognition of susceptible individuals, combined with careful selection of anaesthetic techniques and meticulous

intraoperative hemodynamic management, may help mitigate renal injury and improve postoperative outcomes. While the retrospective design and reliance on medical records represent inherent limitations, and the relatively modest sample size may limit broader generalizability, the study provides valuable real-world data from a tertiary care centre in eastern India.

Importantly, it highlights the need for well-designed prospective studies to further elucidate the renal effects of different anaesthetic strategies and to develop evidence-based protocols aimed at reducing the incidence of cardiac surgery–associated acute kidney injury.

Conclusion

Acute kidney injury remains a frequent and clinically significant complication following cardiac surgery. This study demonstrates an association between anaesthesia techniques and postoperative AKI incidence.

Careful selection and optimization of anaesthetic strategies may contribute to improved renal outcomes and reduced postoperative morbidity. Further prospective studies are required to establish causality and define optimal anaesthetic approaches for renal protection in cardiac surgery.

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