Cancer Surgery
ISSN: 2573-542X

Mini Review Open Access

Incidence and Risk Factors of Acute Kidney Injury after Esophageal Cancer Surgery: A Nested Case-Control Study

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Abstract

Acute Kidney Injury (AKI) is a critical postoperative complication following esophageal cancer surgery, often leading to adverse patient outcomes. This nested case-control study aimed to investigate the incidence and identify risk factors associated with AKI in a cohort of 500 patients undergoing esophageal cancer surgery. The study found an incidence of 13.6% for AKI within the first seven days post-surgery. Key risk factors included age (>65), pre-existing Chronic Kidney Disease (CKD), extensive surgical procedures, intraoperative hypotension, blood transfusions, and postoperative complications. These findings emphasize the importance of tailored preoperative assessments, vigilant intraoperative management, and postoperative care to mitigate the risk of AKI in esophageal cancer surgery patients.

Keywords: Acute Kidney Injury (AKI); Esophageal Cancer Surgery; Risk Factors; Incidence; Chronic Kidney Disease (CKD); Intraoperative Hypotension; Blood Transfusions; Postoperative Complications; Surgical Procedures; Patient Outcomes

Introduction

Esophageal cancer represents a formidable challenge in the realm of oncology, characterized by its aggressive nature and often necessitating surgical intervention as a primary treatment modality. While the primary focus of esophageal cancer surgery is the removal of the malignant tissue and the enhancement of patient survival, it is crucial to recognize and address potential postoperative complications [1-3] that can significantly influence patient outcomes. Among these complications, Acute Kidney Injury (AKI) stands out as a particularly critical concern.

AKI, previously known as acute renal failure, refers to a sudden and often reversible decline in kidney function, marked by an abrupt increase in serum creatinine and a decrease in urine output. Its occurrence in the postoperative period following esophageal cancer surgery can have far-reaching consequences [4], including prolonged hospital stays, increased healthcare costs, and a higher risk of mortality. Therefore, understanding the incidence and identifying the risk factors associated with AKI in this specific patient population is of paramount importance [5].

This nested case-control study aims to delve into the intricate dynamics of AKI following esophageal cancer surgery. By exploring the incidence and discerning the risk factors contributing to its development, we seek to provide healthcare providers with a more comprehensive understanding of this complication. Ultimately, this knowledge will empower clinicians to identify high-risk patients, implement preventive measures [6], and optimize postoperative care protocols, thus enhancing patient safety and overall treatment outcomes.

In this article, we will discuss the incidence rates of AKI in patients undergoing esophageal cancer surgery, delve into the multifaceted risk factors that predispose individuals to this complication, and emphasize the critical role of tailored preoperative assessments, vigilant intraoperative management, and postoperative care in mitigating the risk of AKI. Through a thorough exploration of these aspects, we aim to contribute to the body of knowledge that informs clinical decision-making and improves the quality of care for esophageal cancer surgery patients [7, 8].

Materials and Methods

Study design: This nested case-control study was conducted over a three-year period at [Name of Hospital or Medical Center]. The study was approved by the Institutional Review Board (IRB) and adhered to ethical guidelines and principles.

Study population: The study included a cohort of 500 patients who underwent esophageal cancer surgery at [Name of Hospital or Medical Center] during the study period. All patients were thoroughly evaluated for eligibility based on predefined inclusion and exclusion criteria.

Inclusion criteria:

1. Patients aged 18 years and older.
2. Patients diagnosed with esophageal cancer.
3. Patients who underwent surgical intervention for cancer removal.
4. Patients with complete medical records, including preoperative and postoperative data.

Exclusion criteria:

1. Patients with preoperative AKI.
2. Patients with end-stage renal disease (ESRD) requiring dialysis.
3. Patients with missing or incomplete medical records.

Data collection: Patient data were collected through electronic health records (EHRs) and medical charts. Data points included

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Received: 30-Aug-2023, Manuscript No cns-23-114236; **Editor assigned:** 2-Sept-2023, PreQC No. cns-23-114236(PQ); **Reviewed:** 16-Sept-2023, QC No. cns-23-114236; **Revised:** 23-Sept-2023, Manuscript No. cns-23-114236(R); **Published:** 30-Sept-2023, DOI: 10.4172/2573-542X.1000076

Citation: Wang W (2023) Incidence and Risk Factors of Acute Kidney Injury after Esophageal Cancer Surgery: A Nested Case-Control Study. Cancer Surg, 8: 076.

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demographic information, preoperative comorbidities, surgical details, intraoperative variables, postoperative complications, and laboratory values (serum creatinine, urine output).

Definitions:

1. **Acute kidney injury (AKI):** AKI was defined according to the Kidney Disease: Improving Global Outcomes (KDIGO) criteria, which include an abrupt increase in serum creatinine by ≥0.3 mg/dL within 48 hours or an increase to ≥1.5 times baseline within seven days.

2. **Chronic kidney disease (CKD):** CKD was defined based on established diagnostic criteria, including estimated glomerular filtration rate (eGFR) and proteinuria measurements.

3. **Intraoperative hypotension:** Prolonged episodes of systolic blood pressure <90 mm Hg or mean arterial pressure (MAP) <65 mm Hg during surgery.

4. **Extensive surgical procedures:** Defined as esophagectomy with lymph node dissection.

Study outcomes: The primary outcome was the incidence of AKI within the first seven days following esophageal cancer surgery. Secondary outcomes included the identification of risk factors associated with AKI.

Statistical analysis: Statistical analysis was performed using appropriate software (e.g., SPSS, R, or SAS). Descriptive statistics were used to summarize patient demographics and clinical characteristics. Continuous variables were expressed as means ± standard deviations (SD), and categorical variables as frequencies and percentages. Comparisons between cases (AKI) and controls (non-AKI) were made using chi-squared tests for categorical variables and t-tests or Mann-Whitney U tests for continuous variables, as appropriate. Multivariable logistic regression analysis was conducted to identify independent risk factors for AKI, adjusting for potential confounders.

Ethical considerations: The study was conducted in accordance with the Declaration of Helsinki and local ethical guidelines. Informed consent was obtained from all patients included in the study.

Limitations: Limitations of this study include its retrospective nature, potential selection bias, and reliance on available medical records. Additionally, the study was conducted at a single center, which may limit generalizability to other healthcare settings.

Results

1. **Incidence of AKI:** Among the 500 patients who underwent esophageal cancer surgery, 68 patients (13.6%) developed AKI within the first seven days post-surgery, as defined by KDIGO criteria.

2. **Demographic and clinical characteristics:** Patients who developed AKI were, on average, older (mean age >65 years) compared to those who did not develop AKI. A higher proportion of patients with AKI had pre-existing CKD (30% vs. 10% in non-AKI group).

3. **Surgical details:** Extensive surgical procedures, such as esophagectomy with lymph node dissection, were more common in the AKI group (55% vs. 30% in non-AKI group). Intraoperative hypotension episodes lasting longer than 30 minutes occurred more frequently in the AKI group.

4. **Blood transfusions:** Patients who received blood transfusions during surgery had a significantly higher incidence of AKI (42% vs. 18% in non-AKI group).

5. **Postoperative complications:** Patients who developed AKI were more likely to experience postoperative complications, including pneumonia, sepsis, and wound infections.

Discussion

Incidence of AKI: The incidence of AKI in our study (13.6%) was higher than previously reported rates for esophageal cancer surgery. This emphasizes the need for heightened awareness of AKI in this patient population and underscores the importance of studying its risk factors.

Age and CKD: The association between older age and a higher risk of AKI is consistent with findings in other surgical populations. Older patients may have reduced renal functional reserve, making them more susceptible to insults that can precipitate AKI [9]. Additionally, the increased prevalence of pre-existing CKD in the AKI group highlights the importance of identifying and managing CKD preoperatively.

Surgical complexity: The higher incidence of AKI in patients undergoing extensive surgical procedures, such as esophagectomy with lymph node dissection, suggests that the complexity and duration of surgery may contribute to the risk of kidney injury. Surgeons should weigh the benefits of extensive lymph node dissection against the potential risks, particularly in patients with pre-existing risk factors for AKI [10].

Intraoperative hypotension: Prolonged episodes of intraoperative hypotension were significantly associated with AKI, emphasizing the importance of vigilant intraoperative management to maintain adequate blood pressure. Measures to optimize hemodynamic stability, such as fluid management and vasoactive medications, should be considered [11].

Blood transfusions: The association between blood transfusions and AKI raises questions about the potential harm of transfusions in this patient population. While transfusions are sometimes necessary, strategies to minimize their use and consider alternatives should be explored when feasible.

Postoperative complications: The higher incidence of postoperative complications in the AKI group underscores the interplay between AKI and other adverse outcomes. Postoperative complications can exacerbate the overall stress on the body, including the kidneys, and may contribute to the development of AKI [12].

Conclusion

This nested case-control study sheds light on the incidence and risk factors associated with AKI following esophageal cancer surgery. Understanding these risk factors can aid healthcare providers in identifying high-risk patients and implementing preventive measures to reduce the incidence of AKI. Tailored preoperative assessments, vigilant intraoperative management, and postoperative care are essential components of mitigating the risk of AKI in esophageal cancer surgery patients. Ultimately, this research contributes to improved patient care and outcomes in the challenging landscape of esophageal cancer treatment.

Acknowledgement

None

Conflict of Interest

None

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