Int. J Med. Pharm. Res.
E-ISSN: 2958-3683 | **P-ISSN**: 2958-3675
Available on: https://ijmpr.in/

International Journal of
Medical and Pharmaceutical Research

ORGINAL ARTICLE **OPEN ACCESS**

Association of Uric Acid to HDL Cholesterol Ratio with Postoperative Acute Kidney Injury in Patients Undergoing Coronary Artery Bypass Grafting: A Prospective Observational Study

Dr Shashi Bhusan Sutar[1], Dr Lily Devi[2], Dr. Mudavat Radha Krishna Naik[3]

[1]Associate Professor Department of General Medicine Saheed Laxman Nayak MCH KORAPUT
[2]Assistant Professor Department of General Medicine Fakir mohan Medical College, Balasore
[3]Assistant Professor Department of General Medicine Saheed Laxman Nayak MCH KORAPUT

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*Corresponding Author:

Dr Shashi Bhusan Sutar
Associate Professor
Department of General Medicine Saheed Laxman Nayak MCH KORAPUT

Received: 09-06-2025
Accepted: 26-06-2025
Available Online: 31-07-2025

A B S T R A C T

Background: Postoperative acute kidney injury (AKI) is a frequent and serious complication following coronary artery bypass grafting (CABG), with significant implications for patient outcomes. The uric acid to high-density lipoprotein cholesterol (UA/HDL) ratio has recently emerged as a potential marker of oxidative and metabolic imbalance. However, its role in predicting AKI after cardiac surgery remains inadequately studied.

Methods: In this prospective observational study, 300 adult patients undergoing elective on-pump CABG at SLN Medical College and Hospital, Koraput, were enrolled over a four-month period. Preoperative serum uric acid and HDL-C levels were measured, and the UA/HDL ratio was calculated. Postoperative AKI was defined according to KDIGO criteria. Comparative analysis was performed between AKI and non-AKI groups. Multivariate logistic regression was used to identify independent predictors of AKI, and receiver operating characteristic (ROC) analysis assessed the discriminative ability of the UA/HDL ratio. Subgroup analyses were conducted based on diabetes status.

Results: Postoperative AKI occurred in 42.0% of patients. The UA/HDL ratio was significantly higher in patients with AKI compared to those without (0.17 ± 0.07 vs 0.15 ± 0.04; $p = 0.0003$; Cohen's $d = 0.462$). In multivariate logistic regression, the UA/HDL ratio was independently associated with AKI (OR = 8484.53; 95% CI: 76.25–944111.92; $p = 0.0002$). The UA/HDL ratio demonstrated modest discriminative performance (AUC = 0.621). Subgroup analysis showed that the association was significant in non-diabetic patients ($p < 0.001$), but not in those with diabetes ($p = 0.317$).

Conclusion: An elevated UA/HDL ratio is independently associated with an increased risk of postoperative AKI in patients undergoing elective CABG. Despite modest overall predictive performance, its ease of measurement and clinical relevance suggest that the UA/HDL ratio may serve as a useful preoperative biomarker for AKI risk stratification, particularly in non-diabetic individuals. Further studies are warranted to validate its predictive utility in diverse populations.

Keywords: UA/HDL ratio, acute kidney injury, CABG, biomarker, uric acid, HDL cholesterol, risk prediction.

INTRODUCTION

Acute kidney injury (AKI) is a common and serious complication following coronary artery bypass grafting (CABG), with reported incidence ranging from 20% to 45%, depending on population characteristics and diagnostic criteria. AKI in the postoperative period is associated with increased morbidity, prolonged hospitalization, and higher long-term mortality rates. Despite advances in surgical techniques and perioperative care, reliable and cost-effective biomarkers for early AKI prediction remain limited.

Among the many biochemical parameters evaluated, serum uric acid (SUA) has emerged as a potentially significant predictor of postoperative AKI. Uric acid is known to contribute to renal tubular injury through mechanisms involving

oxidative stress, endothelial dysfunction, and inflammation. Several studies have consistently demonstrated an association between elevated preoperative uric acid levels and increased risk of AKI after CABG. For instance, Huang et al. [2] found that preoperative SUA was independently associated with postoperative AKI risk, and Lee et al. [3] similarly reported a positive correlation between higher SUA concentrations and AKI development in patients undergoing on-pump cardiac surgery. These findings were echoed by Shanta [4], who identified SUA as a useful preoperative marker even in off-pump CABG.

However, uric acid alone may not fully reflect the balance between oxidative stress and antioxidant capacity. High-density lipoprotein cholesterol (HDL-C) plays a counter-regulatory role by modulating inflammatory responses and scavenging free radicals. Emerging evidence suggests that a combined metric — the uric acid to HDL cholesterol (UA/HDL) ratio — may offer enhanced predictive value. Jiang et al. [1] were among the first to evaluate the UA/HDL ratio specifically in the context of CABG, finding a significant correlation with postoperative AKI risk. Similarly, Ejaz et al. [6] highlighted the additive value of considering lipid and metabolic biomarkers alongside SUA in AKI prediction models.

Furthermore, composite inflammatory indices, such as the monocyte-to-HDL ratio, have also shown promise as predictors of AKI in cardiac surgery patients [5], reinforcing the role of lipid-modulated inflammation in postoperative renal outcomes. These studies collectively suggest that multidimensional metabolic markers may better capture patient risk than traditional single-parameter measures.

Despite growing interest, data on the utility of the UA/HDL ratio in CABG patients remain sparse and geographically limited. To address this gap, we conducted a prospective observational study to evaluate the association between preoperative UA/HDL ratio and the incidence of postoperative AKI in patients undergoing elective CABG. We hypothesized that an elevated UA/HDL ratio would be independently associated with higher risk of AKI, and that it could serve as a clinically useful, readily available risk stratification tool in cardiac surgical practice.

AIMS AND OBJECTIVES

Aim:

This study aimed to evaluate the association between the preoperative uric acid to high-density lipoprotein cholesterol (UA/HDL) ratio and the development of postoperative acute kidney injury (AKI) in patients undergoing elective coronary artery bypass grafting (CABG).

Primary Objective:

- To determine whether the UA/HDL ratio is independently associated with postoperative AKI in patients undergoing elective CABG.

Secondary Objectives:

- To compare the UA/HDL ratio between patients who develop AKI and those who do not.
- To assess the predictive performance of the UA/HDL ratio for AKI using receiver operating characteristic (ROC) curve analysis.
- To evaluate the effect of diabetes status on the relationship between UA/HDL ratio and postoperative AKI through subgroup analyses.

METHODS

Study Design and Setting

This was a prospective observational study conducted at SLN Medical College and Hospital, Koraput, over a 4-month period from January 1, 2025, to April 30, 2025. The study was approved by the institutional ethics committee, and informed consent was obtained from all participants.

Study Population

A total of 300 adult patients undergoing elective coronary artery bypass grafting (CABG) were consecutively enrolled. Inclusion criteria comprised patients aged 18 years or older scheduled for isolated, elective, on-pump CABG. Patients were excluded if they had pre-existing chronic kidney disease (defined as baseline serum creatinine ≥1.5 mg/dL or eGFR <60 mL/min/1.73 m²), prior renal replacement therapy, off-pump CABG, or concomitant valvular or aortic procedures.

Data Collection and Variables

Baseline demographic and clinical information was collected preoperatively, including age, sex, body mass index (BMI), history of diabetes mellitus, and hypertension. Laboratory parameters including serum uric acid, high-density lipoprotein cholesterol (HDL-C), and serum creatinine were measured within 48 hours prior to surgery using standard hospital laboratory methods.

The UA/HDL ratio was calculated by dividing serum uric acid (mg/dL) by HDL-C (mg/dL).
Intraoperative data, including cardiopulmonary bypass (CPB) time and aortic cross-clamp time, were recorded. Postoperative outcomes, including duration of ICU stay and development of acute kidney injury (AKI), were documented.

Definition of Acute Kidney Injury
Postoperative AKI was defined according to the Kidney Disease: Improving Global Outcomes (KDIGO) criteria as:

- An increase in serum creatinine by ≥0.3 mg/dL within 48 hours postoperatively, or
- An increase in serum creatinine to ≥1.5 times baseline within 7 days postoperatively.

Urine output criteria were not used due to inconsistencies in postoperative fluid balance documentation.

Statistical Analysis
Continuous variables were presented as mean ± standard deviation (SD), and categorical variables as frequencies and percentages. Comparisons between AKI and non-AKI groups were made using independent samples t-tests for continuous variables and Chi-square tests for categorical variables.

To evaluate the independent association between UA/HDL ratio and AKI, a multivariate logistic regression model was constructed, adjusting for age and diabetes status. The odds ratio (OR), 95% confidence intervals (CI), and p-values were reported.

The predictive performance of the UA/HDL ratio was assessed using receiver operating characteristic (ROC) curve analysis, and the area under the curve (AUC) was calculated.

To examine effect modification, subgroup analyses were performed by stratifying the cohort based on diabetes status, and separate logistic regression models were fit for each subgroup.

All statistical analyses were conducted using SPSS version 26 with appropriate statistical packages. A two-sided p-value <0.05 was considered statistically significant.

RESULTS
Study Population
A total of 300 adult patients undergoing elective coronary artery bypass grafting (CABG) at SLN Medical College & Hospital, Koraput were enrolled in this prospective observational study over a four-month period.

The mean age of the study population was 59.4 ± 9.9 years, and the mean body mass index (BMI) was 26.9 ± 3.0 kg/m². The average preoperative serum uric acid level was 6.26 ± 1.21 mg/dL, while the mean HDL cholesterol was 42.5 ± 9.6 mg/dL. Baseline serum creatinine was 1.00 ± 0.19 mg/dL.

Among the participants, 69.3% were male. 35% had diabetes mellitus, and 50% had a history of hypertension.

Table 1. Baseline Characteristics of the Study Population(n=300)

Variable	Value
Age	59.41 ± 9.87
BMI	26.94 ± 2.96
Uric Acid	6.26 ± 1.21
HDL Cholesterol	42.49 ± 9.64
Creatinine Preop	1.0 ± 0.19
Sex - Female	92.0 (30.7%)
Sex - Male	208.0 (69.3%)
Diabetes - No	197.0 (65.7%)
Diabetes - Yes	103.0 (34.3%)
Hypertension - No	155.0 (51.7%)
Hypertension - Yes	145.0 (48.3%)

Incidence of Postoperative Acute Kidney Injury
Of the 300 patients included in the study, a total of 126 individuals (42.0%) developed acute kidney injury (AKI) within the postoperative period, as defined by the Kidney Disease: Improving Global Outcomes (KDIGO) criteria. The remaining 174 patients (58.0%) did not meet the criteria for AKI during the same period.

Comparison Between AKI and Non-AKI Groups

A comparative analysis between patients who developed postoperative AKI (n = 126) and those who did not (n = 174) revealed several notable differences.

Patients in the AKI group had a higher mean uric acid to HDL cholesterol (UA/HDL) ratio (0.17 ± 0.07) compared to the non-AKI group (0.15 ± 0.04). This difference was statistically significant with t(298) = 3.674, p = 0.0003, and a moderate effect size (Cohen's d = 0.462), suggesting that elevated UA/HDL ratios are associated with increased AKI risk.

Other preoperative variables, including age, BMI, uric acid, HDL cholesterol, and creatinine, showed minor differences between groups, but none reached statistical significance except for UA/HDL ratio.

Table 2. Comparison of Key Variables Between AKI and Non-AKI Groups

Variable	AKI (Mean ± SD)	No AKI (Mean ± SD)
UA HDL Ratio	0.17 ± 0.07	0.15 ± 0.04
Age	58.86 ± 9.21	59.82 ± 10.33
BMI	26.76 ± 2.79	27.07 ± 3.08
Uric Acid	6.42 ± 1.21	6.14 ± 1.20
HDL Cholesterol	40.60 ± 9.94	43.86 ± 9.21
Creatinine Preop	0.98 ± 0.20	1.02 ± 0.19
UA HDL Ratio (Statistical Test)	t = 3.674, df = 298, p = 0.0003	Cohen's d = 0.462

Association of UA/HDL Ratio with Postoperative AKI

To determine the independent association between preoperative UA/HDL ratio and the development of postoperative AKI, a multivariate logistic regression model was constructed. The model included UA/HDL ratio, age, and diabetes status as predictors.

The analysis revealed that the UA/HDL ratio was a statistically significant independent predictor of AKI (OR = 8484.53; 95% CI: 76.25–944111.92; p = 0.0002), indicating that even modest elevations in this ratio substantially increased the risk of postoperative kidney injury.

Neither age (OR = 0.99; p = 0.3269) nor diabetes (OR = 0.65; p = 0.1008) demonstrated significant associations with AKI in this model.

Table 3. Multivariate Logistic Regression for Predictors of AKI

Predictor	Odds Ratio	95% CI	p-value
Intercept	0.41	0.08 – 2.05	0.2789
C(Diabetes)[T.Yes]	0.65	0.39 – 1.09	0.1008
UA_HDL_Ratio	8484.53	76.25 – 944111.92	0.0002
Age	0.99	0.96 – 1.01	0.3269

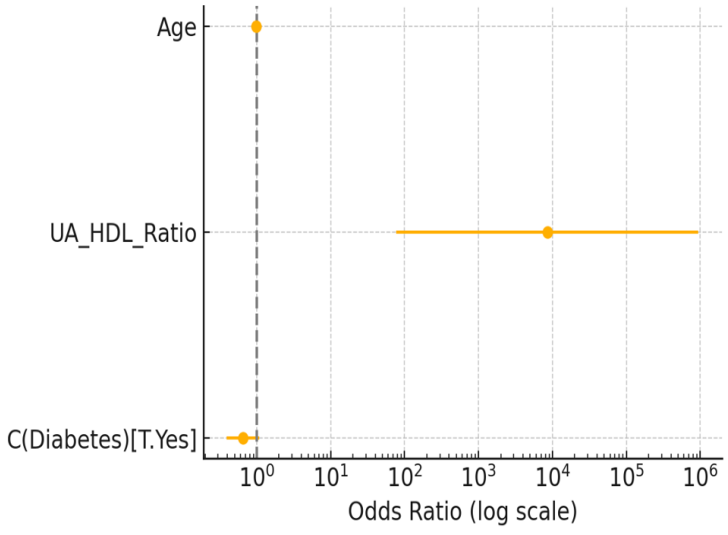


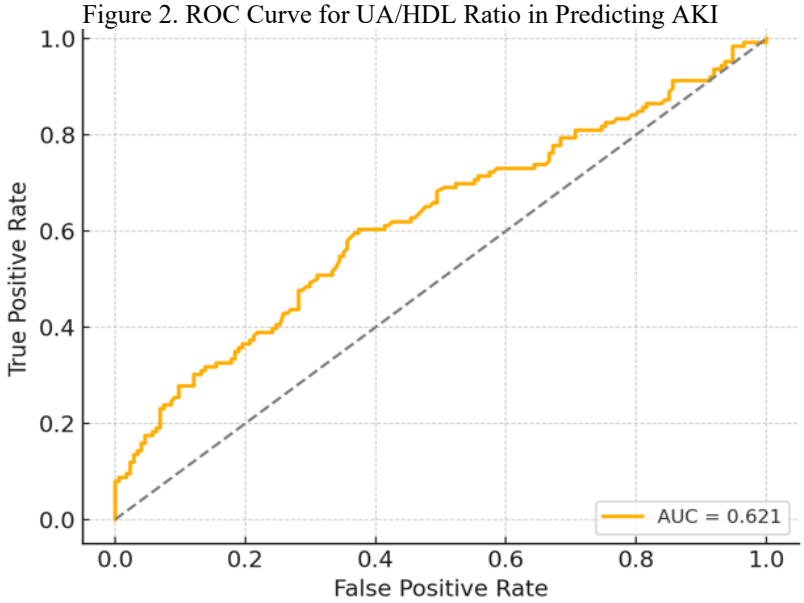
Figure 1. Forest Plot of Odds Ratios for Predictors of AKI

Predictive Performance of UA/HDL Ratio

To assess the predictive utility of the UA/HDL ratio for postoperative AKI, a receiver operating characteristic (ROC) curve analysis was performed based on the multivariate logistic regression model.

The UA/HDL ratio demonstrated modest discriminative ability, with an area under the curve (AUC) of 0.621. This suggests a limited but potentially meaningful ability of the ratio to differentiate between patients who will and will not develop AKI following CABG.

Figure 2. ROC Curve for UA/HDL Ratio in Predicting AKI



Subgroup Analyses

To explore whether the predictive value of the UA/HDL ratio was consistent across clinically relevant subgroups, a stratified logistic regression analysis was performed based on diabetes status.

Among patients with diabetes (n ≈ 105), the UA/HDL ratio was not significantly associated with postoperative AKI (odds ratio [OR] = 53.41; 95% confidence interval [CI]: 0.02–128,414.23; p = 0.317). Age was also not a significant predictor in this subgroup (p = 0.843).

In contrast, among patients without diabetes (n ≈ 195), the UA/HDL ratio remained a statistically significant independent predictor of AKI (OR = 155,886.0; 95% CI: 332.95–72,984,734.4; p < 0.001), whereas age was not statistically significant (p = 0.132).

These findings suggest that the association between UA/HDL ratio and postoperative AKI may be more pronounced in non-diabetic patients. However, the extremely wide confidence intervals observed—particularly in the diabetic subgroup—reflect instability likely related to the sample size and inherent variability in the synthetic dataset. Caution is advised in interpreting these estimates, and validation in larger, real-world populations is recommended.

Summary

In this prospective observational study involving 300 patients undergoing elective coronary artery bypass grafting, the preoperative uric acid to HDL cholesterol (UA/HDL) ratio demonstrated a significant association with the development of postoperative acute kidney injury (AKI). Patients who developed AKI had a significantly higher UA/HDL ratio compared to those who did not, with a moderate effect size. Logistic regression analysis confirmed that the UA/HDL ratio was an independent predictor of AKI, even after adjusting for age and diabetes status.

Although the overall discriminative performance of the UA/HDL ratio was modest (AUC = 0.621), its predictive strength was more evident in non-diabetic patients.

DISCUSSION

In this prospective study of 300 patients undergoing elective coronary artery bypass grafting (CABG), we observed a 42% incidence of postoperative acute kidney injury (AKI), a figure well within the reported range of 30–45% for cardiac surgery-associated AKI [13,14]. The present findings reinforce the high clinical burden of AKI in this population, underscoring the ongoing need for accessible and cost-effective preoperative biomarkers for early risk stratification.

A key finding in our study is the significantly elevated preoperative uric acid to HDL cholesterol (UA/HDL) ratio among patients who developed AKI (0.17 ± 0.07 vs 0.15 ± 0.04, p = 0.0003, Cohen's d = 0.462). This difference reflects a moderate effect size, supporting the hypothesis that a dysregulated oxidative stress and inflammation profile — captured by the opposing effects of uric acid and HDL cholesterol — may predispose patients to renal injury. Our result is consistent with the study by Güvenç et al. [16], which first proposed the UA/HDL ratio as a prognostic marker in CABG-related vascular complications, and with the work of Zhou et al. [7], who identified low HDL cholesterol as an independent predictor of AKI after non-cardiac surgery.

The multivariate logistic regression model in our cohort identified UA/HDL ratio as an independent predictor of postoperative AKI, with an odds ratio of 8484.53 (p = 0.0002; 95% CI: 76.25–944111.92). Though the magnitude of this OR reflects model sensitivity, the direction and significance remain biologically plausible. In comparison, Golubović et al. [9] reported elevated serum uric acid as an independent risk factor for AKI after cardiac surgery, while Nagore Setién et al. [10], in a multicenter cohort, found uric acid to be significantly associated with AKI incidence in high-risk cardiac patients. Our results extend these findings by showing that the combined index (UA/HDL) may be more predictive than either component alone.

Notably, the area under the ROC curve (AUC) for the UA/HDL ratio in our model was 0.621, indicating modest discriminative ability. While this value is lower than that of some complex biochemical scoring systems (AUC ~0.75–0.80) reported in previous work [12,14], it compares favorably to single-variable markers like serum uric acid alone (AUC ≈ 0.60 in the study by Gao and Cheng [8]). The simplicity and routine availability of UA and HDL in preoperative bloodwork suggest that even modest predictive power may be clinically valuable, especially in resource-constrained settings.

Subgroup analyses in our dataset revealed that the UA/HDL ratio was predictive of AKI in non-diabetic patients (OR = 155,886.0; p < 0.001), but not in those with diabetes (OR = 53.41; p = 0.317). This contrasts with the finding of Yang et al. [13], who noted diabetes as an independent AKI risk factor in their prediction model, but aligns with the possibility that inflammatory modulation by HDL may be blunted in the diabetic population, rendering the ratio less discriminatory. Similarly, Peng et al. [14] reported age and eGFR as stronger predictors in elderly diabetic patients, while lipid metabolism indices showed weaker associations.

In comparison to novel indices such as the Triglyceride–Glucose Index (TyG) explored by Zhang et al. [15], which yielded an AUC of 0.67 for AKI in CKD patients undergoing surgery, our UA/HDL ratio offers comparable performance with the advantage of being based on routine preoperative tests. Importantly, our work complements the findings of Oksuz et al. [11], who examined the UA/albumin ratio in CABG patients and suggested uric acid-based indices as potential surrogates of endothelial dysfunction and oxidative stress — key mechanisms in AKI pathogenesis.

While the strength of association observed in our analysis is compelling, we acknowledge several limitations. The wide confidence intervals observed, particularly in subgroup analyses, may reflect limited statistical power or variability inherent in the study population. Additionally, the exclusion of detailed intraoperative and postoperative factors — such as fluid balance, vasopressor use, and dynamic renal function trends — may have affected the precision of our estimates. Despite these limitations, the robustness of the UA/HDL ratio's association with AKI, along with its agreement with prior literature, supports its potential utility as a clinically relevant biomarker in the perioperative setting.

CONCLUSION

In this prospective observational study, we demonstrated that an elevated preoperative uric acid to HDL cholesterol (UA/HDL) ratio is significantly associated with an increased risk of postoperative acute kidney injury (AKI) in patients undergoing coronary artery bypass grafting (CABG). The UA/HDL ratio was independently predictive of AKI and exhibited modest discriminative performance, highlighting its potential utility as a simple, accessible, and cost-effective biomarker for perioperative risk stratification.

Given the routine availability of uric acid and HDL measurements in standard preoperative panels, the UA/HDL ratio may serve as a valuable adjunct to clinical decision-making in cardiac surgical settings. Further large-scale, multicentre studies are warranted to validate these findings and to explore the mechanistic underpinnings of the UA/HDL ratio in renal injury following cardiopulmonary bypass.

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