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Preoperative Serum Albumin Levels and Postoperative Acute Kidney Injury in Off-Pump Coronary Artery Bypass Surgery: A Single-Center Study in Bangladesh

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Abstract

Background: Serum albumin, a vital plasma protein, helps maintain intravascular colloidal osmotic pressure, cardiac output, and renal function. Low preoperative serum albumin is linked to poor outcomes, including acute kidney injury (AKI), after off-pump coronary artery bypass (OPCAB) surgery. This study aimed to assess the relationship between preoperative serum albumin levels and early postoperative renal injury. **Methods:** This prospective comparative cross-sectional study was conducted from August 2019 to February 2021 at the National Heart Foundation Hospital & Research Institute, Bangladesh. It included 160 adult patients with normal preoperative renal function undergoing OPCAB. Patients were divided into two groups: Group A (serum albumin ≥ 4.0 gm/dl) and Group B (serum albumin < 4.0 gm/dl). AKI was categorized based on the Acute Kidney Injury Network (AKIN) criteria within the first 48 hours of post-surgery. Multivariate regression analyses evaluated the association between preoperative serum albumin levels and postoperative AKI. **Results:** Preoperative serum albumin was significantly different between groups (Group A: 4.21 ± 0.05 gm/dl, Group B: 3.69 ± 0.04 gm/dl, $p = 0.028$). Group B had a higher incidence of hypertension (71.25% vs. 51.25%, $p < 0.05$). Postoperative blood loss and transfusion requirements were significantly higher in Group B. Serum creatinine levels on the 1st and 3rd postoperative days were higher in Group B ($p < 0.05$), although levels equalized by the 7th day. Postoperative AKI occurred in 18.75% of Group A and 36.25% of Group B. Multivariate regression indicated that low preoperative serum albumin is an independent risk factor for postoperative AKI (p = 0.012, OR = 1.815, CI: 0.675 - 1.162). **Conclusion:** Preoperative serum albumin level is a valuable predictor of postoperative renal function. Ensuring high normal serum albumin levels before surgery can help minimize the risk of postoperative AKI.

Keywords

Serum Albumin, Acute Kidney Injury (AKI), Off-Pump Coronary Artery Bypass Surgery, Bangladesh

1. Introduction

Albumin is the most abundant protein in plasma, making up about half of its total protein content (3.5 g/dL to 5 g/dL) in healthy individuals. Synthesized by liver hepatocytes, albumin is rapidly released into the bloodstream at a rate of 10 to 15 grams per day, with minimal storage in the liver itself [1]. This essential protein plays several critical roles, including maintaining plasma oncotic pressure, distributing fluid between body compartments, and binding various molecules such as fatty acids, bilirubin, metals, hormones, and drugs. Albumin also acts as a free radical scavenger and a reservoir for nitric oxide, impacting capillary membrane permeability [2].

Albumin is considered a negative acute-phase protein, as its concentration decreases during injury and sepsis. Research indicates that serum albumin can predict mortality in various clinical situations [3]. It is the predominant antioxidant in plasma, a compartment continuously exposed to oxidative stress [4]. The half-life of albumin is about 20 days, reflecting a balance between its hepatic synthesis, catabolism, and transcapillary escape.

Preoperative low serum albumin is a significant risk factor for acute kidney injury (AKI), which is associated with poor outcomes in patients undergoing off-pump coronary artery bypass (OPCAB) surgery [3]. Hypoalbuminemia has been causally linked to the development of postoperative AKI, rather than merely serving as a marker of other underlying processes [2]. Albumin has renoprotective effects at cellular and molecular levels, improving renal perfusion and glomerular filtration by forming S-nitroso-albumin through its reaction with nitrogen oxides [5]. Additionally, albumin inhibits renal tubular cell apoptosis by scavenging reactive oxygen species and carrying lysophosphatidic acid [6]. It also stimulates renal tubular cell proliferation, crucial for maintaining proximal tubular integrity and function [2].

AKI is a common and severe complication following cardiac surgery, occurring in 5% - 30% of patients and requiring dialysis in about 1% - 2% of cases [7] [8]. Although OPCAB is believed to reduce the risk of postoperative AKI by avoiding cardiopulmonary bypass, factors like inflammatory responses, oxidative stress, and transient circulatory failure still pose significant risks [9]. AKI significantly increases morbidity, ICU and hospital stay durations, infection risks, and overall hospitalization costs, underscoring its critical impact on postoperative outcomes [10].

Various independent risk factors for postoperative AKI have been identified, including age, BMI, baseline renal function, left ventricular ejection fraction, liver disease, diabetes, peripheral vascular occlusive disease, and chronic obstructive pulmonary disease [2]. Perioperative fluid management also influences postoperative renal function, with excessive saline-based solutions potentially leading to hyperchloremic acidosis and decreased renal blood flow [11].

Immediate postoperative hypoalbuminemia predicts poorer outcomes and longer hospital stays after adult cardiac surgery. Factors contributing to postoperative hypoalbuminemia include fluid resuscitation, increased catabolism, reduced synthesis, hemorrhage, gut loss, and altered vascular permeability. These issues are exacerbated by the systemic inflammatory response, intraoperative blood loss, and large fluid volumes, putting patients with low preoperative serum albumin at greater risk of complications [12] [13].

This study aims to establish preoperative serum albumin concentration as a reliable predictor of AKI following OPCAB surgery.

2. Materials and Methods

2.1. Study Design and Setting

This comparative cross-sectional study was conducted from August 2019 to February 2021 at the Department of Cardiac Surgery, National Heart Foundation Hospital and Research Institute, Mirpur, Dhaka.

2.2. Study Population

The study included 160 adult patients with normal preoperative renal function undergoing off-pump coronary artery bypass graft (OPCABG) surgery. Patients were divided into two groups: Group A, with serum albumin levels ≥ 4.0 gm/dl, and Group B, with serum albumin levels < 4.0 gm/dl. Each group consisted of 80 patients.

2.3. Sample Size Determination

The sample size was calculated using a statistical formula, ensuring 80 patients per group.

2.4. Inclusion and Exclusion Criteria

Inclusion criteria encompassed patients scheduled for elective OPCAB surgery who provided informed consent. Exclusion criteria included preoperative serum albumin levels below 3.5 gm/dl, cardiac failure, left ventricular ejection fraction under 30%, emergency or redo surgeries, and renal or hepatic impairment.

2.5. Pre-Testing and Screening

Before grouping, all patients underwent pre-testing and thorough screening to ensure no significant differences in baseline characteristics between the groups. This process involved a detailed review of medical histories, physical examinations, and relevant preoperative tests, including assessments of age, gender, BMI, smoking habits, diabetes mellitus, and hypertension. This pre-testing ensured that the groups were comparable and that observed differences in outcomes could be attributed to serum albumin levels.

2.6. Sampling Technique

A purposive sampling technique was employed to select the participants.

2.7. Data Collection

Data collection involved a semi-structured questionnaire addressing socio-demographic characteristics and preoperative, perioperative, and postoperative parameters. Data was gathered through face-to-face interviews and review of medical records. Preoperative serum albumin levels were measured using the Doumas, Watson, and Biggs method with a fully automated Atellica CH analyzer. Postoperative blood loss was monitored hourly for 24 hours, and total drain output was recorded.

2.8. Statistical Analysis

Statistical analysis was performed using SPSS version 26.0, with comparisons between groups using descriptive and inferential statistics. A significance level of p-value ≤ 0.05 was considered statistically significant.

2.9. Ethical Considerations

Human samples (subjects) were involved in this study, which was conducted in accordance with the Declaration of Helsinki. Ethical clearance was obtained from the National Heart Foundation Hospital and Research Institute Ethics Committee (Reference Number: NHFH & RI 4-14/7-AD/242). Informed written consent was secured from all participants, ensuring the protection of their dignity, rights, safety, and confidentiality.

2.10. Study Funding

This study was self-funded.

3. Results

Table 1 presents the demographic variables, indicating no significant age difference between the two groups ($p > 0.05$), with most participants aged 45-54 and 55-64 years. Gender distribution was also not statistically significant ($p > 0.05$). The mean BMI was 26.10 ± 3.51 in Group A and 25.90 ± 4.38 kg/m^2 in Group B, showing no significant difference ($p > 0.05$).

Table 1. Comparison of age, gender and BMI between two groups.

Demographic Variables	Groups		p-value
	Group A f (%) n = 80	Group B f (%) n = 80	
^B^Age Group (years)			
35 - 44	15 (18.75)	13 (16.25)	0.788^NS^
45 - 54	27 (33.75)	29 (36.25)	
55 - 64	26 (32.5)	27 (33.75)	
65 - 75	12 (15)	11 (13.75)	
^A^Mean Age and SD	55.47 ± 11.74	53.50 ± 10.50	0.802^NS^
^B^Gender			
Male	67 (83.75)	61 (76.25)	
Female	13 (16.25)	19 (23.75)	0.140^NS^
^B^BMI Categaries (kg/m^2)			
Underweight	4 (5)	6 (7.5)	0.692^NS^
Normal	42 (52.5)	39 (48.75)	
Overweight	23 (28.75)	26 (32.5)	
Obese	11 (13.75)	9 (14.06)	
^A^Mean BMI & SD	26.10 ± 3.51	25.90 ± 4.38	0.846^NS^

^A^Unpaired *t*-test was done to measure the level of significance. ^B^Chi-square (χ^2) test was done to measure the level of significance. Figure within parenthesis indicates percentage. p-value > 0.05 was considered not to be significant. n = Number of subjects, f = Frequency, NS = Not significant, BMI = Body mass index.

Table 2 highlights the major risk factors. Smoking history and diabetes mellitus were not significantly different between the groups ($p > 0.05$). However, hypertension was more prevalent in Group B (71.25%) compared to Group A (51.25%), which was statistically significant ($p = 0.003$).

Table 3 details preoperative serum albumin levels and echocardiographic findings. Group A had a mean serum albumin level of 4.21 ± 0.05 gm/dl, while Group B had 3.69 ± 0.04 gm/dl, a statistically significant difference ($p = 0.001$). Echocardiography revealed no significant difference in LVEF (%) between Group A (52.7 ± 10.21) and Group B (51.33 ± 9.45) ($p = 0.773$), and the RWMA results were also not statistically significant ($p > 0.05$).

Table 4 displays the mean ± SD levels of serum creatinine, creatinine clearance, blood urea, and eGFR. For Group A, these values were 1.13 ± 0.208 mg/dl, 85.18 ± 7.35 ml/min, 25.86 ± 2.67 mg/dl, and 77.18 ± 9.51 ml/min, respectively. For Group B, the values were 1.14 ± 0.204 mg/dl, 84.36 ± 6.61 ml/min, 26.18 ± 4.05 mg/dl, and 76.63 ± 10.43 ml/min. The differences between the groups were not statistically significant ($p > 0.05$).

Table 2. Comparison of the preoperative comorbidities between two groups.

Variables	Groups			p-value
	Group A f (%) n = 80	Group B f (%) n = 80	Total f (%) n = 160	
[A]Risk Factors				
Smoking	38 (47.5)	40 (50)	78(48.75)	0.874[NS]
HTN	41 (51.25)	57 (71.25)	98(61.25	0.003[S]
DM	28 (35)	35 (43.75)	63(39.38)	0.332[NS]

[A]Chi-square test (χ^2) was done to measure the level of significance. Figure within parenthesis indicates percentage. p-value > 0.05 was considered not to be significant. n = Number of subjects, f = Frequency, NS = Not significant, HTN = Hypertension, DM = Diabetes mellitus.

Table 3. Comparison of preoperative echocardiographic and serum albumin level.

Attributes	Groups			p-value
	Group A f (%) n = 80	Group B f (%) n = 80	Total f (%) n = 160	
[A]Serum Albumin (gm/dl)				
Mean and SD	4.21 ± .05	3.69 ± .04	-	0.001[S]
Echocardiography LVEF (%)				
[A]Mean ± SD	52.7 ± 10.21	51.33 ± 9.45	-	0.773[NS]
RWMA[B]				
Present	73 (91.25)	76 (95)	146(93.13)	
Absent	7 (8.75)	4 (5)	11(6.88)	0.534[NS]

[A]Unpaired *t*-test was done to compare between the means. [B]Chi-square test (χ^2) was done to measure the level of significance. Figure within parenthesis indicates percentage. p-value > 0.05 was considered not to be significant.

Table 4. Comparison of the preoperative renal function between the groups.

[A]Investigations	Groups		p-value
	Group A Mean ± SD n = 80	Group B Mean ± SD n = 80	
S. Creatinine (mg/dl)	1.13 ± 0.208	1.14 ± 0.204	0.405[NS]
Creatinine Clearance (ml/min)	85.18 ± 7.35	84.36 ± 6.61	0.128[NS]
Blood Urea (mg/dl)	25.86 ± 2.67	26.18 ± 4.05	0.622[NS]
eGFR (ml/min/1.73m^2)	77.18 ± 9.51	76.63 ± 10.43	0.335[NS]

[A]Unpaired *t*-test was done to compare between the means. p-value > 0.05 was considered not to be significant. n = Number of subjects, NS = Not significant, eGFR = Estimated glomerular filtration rate.

Table 5 compares the per-operative findings between the two groups. The mean number of coronary anastomoses was 3.28 ± 0.66 in Group A and 3.31 ± 0.90 in Group B, with a p-value of 0.180, indicating no statistical significance. The mean ± SD duration of the operation was 288.5 ± 14.44 minutes for Group A and 290.45 ± 16.22 minutes for Group B, with a p-value of 0.685, which was also not statistically significant.

Table 5. Comparison of group number bypass grafts and duration of operation.

Attributes	Groups		p-value
	Group A f (%) n = 80	Group B f (%) n = 80	
Number of Graft			
1	2 (2.5)	1 (1.25)	
2	8 (10)	9 (11.25)	
3	39 (48.75)	35 (43.75)	
4	27 (33.75)	34 (42.5)	
5	4 (5)	1(1.25)	
^{A}Mean and SD	3.28 ± 0.66	3.31 ± 0.90	0.180^{NS}
Duration of Operation (min)	288.5 ± 14.44	290.45 ± 16.22	0.685^{NS}

^{A}Unpaired *t*-test was done to compare between the means. p-value > 0.05 was considered not to be significant. n = Number of subjects, S = Significant, NS = Not significant.

Table 6. Distribution of patients according to post-operative findings between the groups.

^{A}Post-Operative Parameters	Groups		p-value
	Group A Mean ± SD n = 80	Group B Mean ± SD n = 80	
Duration of Mechanical Ventilation (hours)	6.54 ± 1.36	6.86 ± 1.72	0.373^{NS}
Blood Loss within 1st 24 Hours (ml)	80.25 ± 20.35	160.90 ± 20.25	0.001^{S}
Blood Transfusion Required (ml)	420.45 ± 50.95	625.90 ± 95.69	0.001^{S}
Duration of ICU Stay (hours)	32.09 ± 7.45	34.63 ± 9.63	0.245^{NS}
Duration of Hospital Stay (days)	7.22 ± 0.97	9.81 ± 2.54	0.001^{S}

^{A}Unpaired *t*-test was done to compare the means between two groups. p-value > 0.05 was considered not to be significant. n = Number of subjects, S = Significant, NS = Not significant.

Table 6 presents post-operative parameters. The mean ± SD duration of mechanical ventilation was 6.54 ± 1.36 hours for Group A and 6.86 ± 1.72 hours for

Group B, with no statistically significant difference (p > 0.05). Blood loss within the first 24 hours was 80.25 ± 20.35 ml in Group A and 160.90 ± 20.25 ml in Group B, a statistically significant difference (p < 0.05). Blood transfusion required was 420.45 ± 50.95 ml for Group A and 625.90 ± 95.69 ml for Group B, also statistically significant. The mean ± SD ICU stay was 32.09 ± 7.45 hours for Group A and 34.63 ± 9.63 hours for Group B, not statistically significant (p > 0.05). However, the duration of hospital stay was 7.22 ± 0.97 days for Group A and 9.81 ± 2.54 days for Group B, which was statistically significant (p < 0.05).

Table 7 shows post-operative renal function. Mean ± SD serum creatinine on the 1st and 3rd post-operative days (POD) was 1.19 ± 0.173 and 1.17 ± 0.165 mg/dl for Group A, and 1.84 ± 0.245 and 1.93 ± 0.244 mg/dl for Group B, both statistically significant differences (p < 0.05). No significant difference was observed on the 7th POD (p > 0.05). Blood urea levels on the 1st, 3rd, and 7th PODs were 29.52 ± 4.135, 33.69 ± 5.67, and 26.75 ± 4.28 mg/dl for Group A, and 52.61 ± 11.523, 55.11 ± 9.93, and 43.15 ± 4.725 mg/dl for Group B, all statistically significant (p < 0.05). No significant differences in urine output over 24 hours on the 1st, 3rd, and 7th PODs were observed between the groups (p > 0.05).

Table 7. Comparison of the post-operative (1st, 3rd and 7th) attributes between two groups regarding.

^{A}Post-Operative Parameters	*Groups*		p-value
	Group A Mean ± SD n = 80	Group B Mean ± SD n = 80	
S. Creatinine (mg/dl)			
1st POD	1.19 ± 0.173	1.84 ± 0.245	0.001^{S}
3rd POD	1.17 ± 0.165	1.93 ± 0.244	0.001^{S}
7th POD	1.11 ± 0.141	1.15 ± 0.173	0.101^{NS}
Blood Urea (mg/dl)			
1st POD	29.52 ± 4.135	52.61 ± 11.52	0.001^{S}
3rd POD	33.69 ± 5.67	55.11 ± 9.93	0.001^{S}
7th POD	26.75 ± 4.28	43.15 ± 4.725	0.001^{S}
24 hours Urine Output (ml)			
1st POD	1276.91 ± 113.38	1277.18 ± 131.93	0.200^{NS}
3rd POD	42 (52.5)	39 (48.75)	0.099^{NS}
7th POD	23 (28.75)	26 (32.5)	0.114^{NS}

^{A}Unpaired *t*-test was done to compare the means between two groups. p-value > 0.05 was considered not to be significant. N = Number of subjects, S = Significant, NS = Not significant.

Table 8 compares post-operative morbidities and mortality between the two groups. Wound infection occurred in 2 (2.5%) patients in Group A and 8 (10%) patients in Group B, a statistically significant difference ($p = 0.043$). New onset arrhythmia (AF, VT, PVC) was observed in 10 (12.5%) patients in Group A and 14 (17.5%) patients in Group B, which was not statistically significant ($p = 0.685$). There were no reoperations for bleeding and no mortality in either group.

Table 9 details the distribution of patients according to AKI. In Group A, 15 (18.75%) patients developed AKI, compared to 29 (36.25%) in Group B, with the majority in stage 1 (15% in Group A and 26.25% in Group B). This difference was statistically significant ($p < 0.05$).

Table 8. Comparison of the post-operative morbidities & mortality between two groups.

[A]Post-Operative Parameters	Groups		p-value
	Group A f (%) n = 80	Group B f (%) n = 80	
Wound infection	2 (2.5)	8 (10)	0.043^{S}
New onset of arrhythmia (AF, VT, PVC)	10(12.5)	14 (17.5)	0.840^{NS}
Reoperation for bleeding	0 (0)	0 (0)	-
Mortality	0 (0)	0 (0)	-

[A]Chi-Square test (χ^2) was done to measure the level of significance. p-value > 0.05 was considered not to be significant. Figure within parenthesis indicates percentage. S = Significant, NS = Not significant, AF = Atrial fibrillation, VT = Ventricular tachycardia, PVC = Premature ventricular contraction.

Table 9. Comparison of patients according to stages of AKI.

AKI Stage	Groups			p-value
	Group A f (%) n = 80	Group B f (%) n = 80	Total f (%) n = 160	
Stage 1	12 (15)	21 (26.25)	33 (20.63)	
Stage 2	2(2.5)	7 (8.75)	9 (5.63)	
Stage 3	1 (1.25)	1 (1.25)	2 (1.25)	
[A]Total AKI	15 (18.75)	29 (36.25)	44 (27.5)	0.012^{S}
Normal	65 (81.25)	51 (63.75)	116 (72.5)	

[A]Chi-Square test (χ^2) was done to measure the level of significance. Figure within parenthesis indicates percentage. p-value > 0.05 was considered not to be significant. n = Number of subjects, S = Significant, AKI = Acute Kidney Injury.

Table 10 presents a multivariate logistic regression analysis identifying independent risk factors for post-operative AKI. It was found that pre-operative serum albumin levels were statistically significant (p = 0.012, OR = 1.815, CI: 0.675 - 1.162).

Table 10. Multivariate logistic regression analysis of predictor of AKI.

Variables	B	p-value	OR	95% CI for OR	
				Lower	Upper
Preoperative Serum Albumin	−0.175	0.012^{S}	1.815	0.675	1.162
DM	1.325	0.358^{NS}	0.825	0.431	6.635
HTN	−0.020	0.286^{NS}	0.923	0.675	1.262
Post-Operative LVEF (%)	−0.065	0.458^{NS}	0.943	0.832	1.075
Blood Loss within 1st 24 Hours	0.209	0.604^{NS}	0.732	0.675	1.273
Blood Transfusion	−0.019	0.975^{NS}	0.981	0.292	3.292
Wound Infection	0.195	0.645^{NS}	0.931	0.318	1.025
New Onset of Arrhythmia	−0.275	0.164^{NS}	0.664	0.675	1.315

p-value was determined by multivariate analysis of logistic regression. AKI = Acute kidney injury, DM = Diabetes mellitus, HTN = Hypertension, LVEF = Left ventricular ejection fraction.

4. Discussion

This study aimed to assess the impact of preoperative serum albumin levels on early postoperative renal function following off-pump coronary artery bypass (OPCAB) surgery. Previous research has indicated a correlation between preoperative serum albumin levels and postoperative outcomes in various surgical contexts, suggesting that lower albumin levels may predict poorer recovery and higher complication rates. This study builds on existing literature by specifically examining this relationship in the context of OPCAB surgery, a less invasive alternative to traditional coronary artery bypass grafting.

The average age and BMI of patients in both groups were comparable, with no significant differences. The majority of patients were males, which is consistent with the higher incidence of ischemic heart disease in males as reported by Koertzen *et al.* [14]. Although there was no significant difference in smoking habits and diabetes mellitus between the groups, Group B had a significantly higher incidence of hypertension (p = 0.003), aligning with the findings of de la Cruz *et al.* [13]. Despite some patients being overweight (28.75% in Group A and 32.5% in Group B), serum albumin levels remained within the normal range, aligning with findings by Bhamidipati *et al.* [15].

Preoperative serum albumin levels were significantly higher in Group A (4.21 ± 0.05 gm/dl) compared to Group B (3.69 ± 0.04 gm/dl) (p = 0.001). This suggests that higher preoperative serum albumin levels are associated with better postoperative outcomes. The study by de la Cruz *et al.* [13] similarly found that higher serum albumin levels correlated with improved surgical results.

Echocardiographic findings, including left ventricular ejection fraction (LVEF) and regional wall motion abnormalities (RWMA), showed no significant differences between the groups ($p > 0.05$). Preoperative renal function tests also revealed no pre-existing renal disease in either group, consistent with the parameters used by Lee *et al.* [16]. The number of grafts and the duration of operations were similar between the groups, reflecting good revascularization efforts [14].

While the duration of mechanical ventilation and ICU support was similar between groups, Group B experienced significantly more blood loss and higher transfusion requirements ($p = 0.001$). Group B also had a longer hospital stay ($p < 0.05$), consistent with de la Cruz *et al.* [13]. Serum creatinine and blood urea levels were significantly higher in Group B on postoperative days 1, 3, and 7, indicating a greater incidence of acute kidney injury (AKI) ($p = 0.001$). These results are supported by Lee *et al.* [12], who highlighted the relationship between low serum albumin levels and AKI.

New onset arrhythmias and wound infections were more common in Group B, with wound infections being significantly higher ($p = 0.043$), as noted by Engelman *et al.* [17]. AKI stages revealed that Group B had a higher proportion of patients in Stage 1 AKI, supporting findings by Yu *et al.* [18]. Multivariate regression analysis confirmed that low preoperative serum albumin levels are an independent risk factor for postoperative AKI.

This study has several limitations, including a relatively small sample size and the challenge of fully excluding patients with confounding variables. The single determination of preoperative serum albumin levels may not adequately capture variations over time. Additionally, the complexity of cardiac surgery patients and the presence of numerous confounding factors can influence renal outcomes and overall mortality. Future studies should consider larger sample sizes and multiple measurements of serum albumin levels to better understand their fluctuations and impacts. Additionally, exploring additional biomarkers alongside serum albumin could provide a more comprehensive risk assessment for postoperative complications. Long-term follow-up studies are also needed to evaluate the lasting effects of preoperative serum albumin levels on patient outcomes. Moreover, this study was conducted with a small patient population over a limited period, and it was constrained by the challenges posed by the COVID-19 pandemic. These factors may have impacted the study's findings and should be addressed in future research to provide a more robust understanding of the relationship between preoperative serum albumin levels and postoperative outcomes.

The study's findings underscore the predictive value of preoperative serum albumin levels for postoperative kidney injury following OPCAB surgery. By identifying low serum albumin levels as an independent risk factor for AKI, this research highlights the importance of preoperative nutritional status in optimizing surgical outcomes. These insights can help cardiac surgeons minimize acute kidney injury and improve overall patient management. Despite its limitations, this study contributes valuable knowledge to the field and sets the stage for future research on improving surgical outcomes through preoperative assessment and intervention.

5. Conclusion

This study demonstrated that patients with preoperative serum albumin levels in the upper normal range experienced better postoperative renal function following OPCAB compared to those with lower, but still normal, albumin levels. Therefore, maintaining serum albumin levels within the upper normal range could be beneficial in routine practice to prevent postoperative acute kidney injury (AKI). This proactive approach could enhance patient outcomes and reduce the risk of complications after surgery.

6. Recommendations

- Preoperative estimation of serum albumin levels should be routinely conducted.
- Correcting serum albumin levels before surgery is crucial to reducing postoperative adverse events. It should be used as a screening tool to identify patients at higher risk for complications following OPCAB.
- Maintaining preoperative serum albumin levels within the upper normal range is advisable to minimize postoperative AKI and enhance overall postoperative outcomes.
- Larger, multicenter prospective studies are needed to validate and expand upon the findings of this study.

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Authors' Contributions

The first author led the conceptualization and design of the study, meticulously collected data from the hospital, conducted data analysis, and drafted the manuscript. The second author played a crucial role in preparing the manuscript and provided a critical analysis of the study. The last author provided guidance throughout the entire study process. All authors collaborated in interpreting the findings and have collectively endorsed the final version of the manuscript.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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