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ORIGINAL ARTICLE

To study the impact of poor glycemic control (Elevated HbA1c) on post-operative frequency of acute kidney injury after coronary artery bypass graft (CABG) surgery.

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ABSTRACT… Objective: To compare the frequency of acute kidney injury in diabetic patients with HbAlc ≥7% and HbA1c <7% undergoing CABG surgery and to determine the severity of AKI and adverse outcome in diabetic patients undergoing CABG surgery. **Study Design:** Comparative Cross-sectional study. **Setting:** The study was conducted in Cardiac Surgery Department, Faisalabad Institute of Cardiology, Faisalabad. **Period:** The duration of study was from 05/05/2023 to 04/05/2024. **Methods:** The present study involved 100 diabetic patients undergoing CABG surgery assimilated into two equal groups; Group-A (HbA1c ≥7.0%) and Group-B (HbA1c <7.0%). These patients were followed in the post-operative period and occurrence of AKI was noted along with its severity according to RIFLE criteria. These patients were managed as per department protocols and adverse outcome in the form of mortality was noted. Frequency of AKI, its severity and adverse outcome was compared between the groups. **Results:** The calculated mean age of the participants was 51.5 years, with a standard deviation of ±7.4 years. There was male predominance (M:F; 7.3:1). Following cardiac surgery, the mean of peak serum creatinine was significantly higher (1.25±0.36 vs. 1.03±0.24 mg/dl; p-value<0.001) while the mean glomerular filtration rate was significantly lower (66.14±21.17 vs. 75.96±17.52 mL/min/1.73m^2; p-value=0.013) in patients with elevated HbA1c (≥7.0%). The frequency of post-operative AKI was significantly higher in patients with poor glycemic control (44.0% vs. 12.0%; p-value<0.001). Among the 28 patients having AKI, 15 (53.6%) patients were categorized as risk while 13 (46.4%) patients were categorized as injury under RIFLE criteria. Adverse outcome was noted in 4 (4.0%) patients. When compared the frequency of adverse outcome comparably higher in individuals with increased HbA1c ≥7.0% (8.0% vs. 0.0%; p-value=0.041) and AKI (14.3% vs. 0.0%; p-value=0.005). **Conclusion:** In diabetic patients undergoing CABG, poor preoperative glycemic control was identified as a key predictor of postoperative AKI and mortality. This emphasizes the importance of HbA1c in risk stratification and optimizing glycemic management for better patient outcomes.

Key words: Acute Kidney Injury, Coronary Artery Bypass Graft, Diabetes, Glycemic Control, Mortality.

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INTRODUCTION

Glycated hemoglobin or HbA1c shows blood glucose control of the patients during last 3 to 4 months. When stable glycated hemoglobin is formed by irreversible binding of blood glucose to hemoglobin, is called HbA1c. Due to normal life span of 90-120 days of red blood cells, elimination of HbA1c is only possible upon replacement of red cells. That is why, short-term glycemic changes do not affect HbA1c due to continuous turnover of red cells. So, glucose control can be better assessed for a period of 3-4 months with the help of HbA1c.[1]

HbA1c increases reactive free radicals within blood cells, altering membrane properties. This leads to higher blood viscosity, cell aggregation, and impaired circulation. Additionally, HbA1c induces inflammation, contributing to atheroma formation.[2]

Postoperative AKI is a prevalent complication among cardiac surgery patients, with incidence rates reported between 20% and 49%.[3,4,5,6] Even a minor elevation in creatinine (0.3 mg/dL) can result in long-term renal impairment, increasing the risk of CKD progression and mortality.[7,8,9]

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Identified AKI risk factors include diabetes mellitus, gender, age, metabolic syndrome, and preoperative creatinine levels, while prolonged surgery and emergency procedures further contribute.[3,10,11] Both acute and chronic hyperglycemia have been associated with endothelial dysfunction, heightened infection risk, and cardiac complications post-CABG.[2,12,13,14] Furthermore, hyperglycemia is a well-recognized risk factor for perioperative morbidity and mortality, particularly in patients with renal dysfunction.[3,10,15]

For evaluation of chronic hyperglycemia and diabetes control in diabetic patients, HbA1c is an established parameter[16] and it is widely used to diagnose diabetes mellitus. Besides this, HbA1c has been reported as a vital marker for atherosclerosis, acute hyperglycemia, insulin resistance and endothelial dysfunction.[2,12]

The purpose of this study is to investigate the occurrence of acute kidney injury in patients with suboptimal glycemic control (HbA1c>7%) undergoing CABG surgery and to compare the frequency of AKI in patients with HbAlc > 7% and HbA1c < 7% undergoing CABG surgery. Additionally, the study will analyze the severity of acute kidney injury (AKI) in diabetic patients undergoing CABG surgery and its influence on postoperative outcomes, aiding in better risk assessment and management strategies.

METHODS

This research employed a comparative cross-sectional design, enrolling 100 diabetic patients scheduled for coronary artery bypass grafting (CABG) surgery during the period May 5, 2023, to May 4, 2024. Prior to study initiation, ethical approval was secured from the hospital's Ethical Review Committee (24-2019/DME/FIC/FSD), ensuring compliance with institutional guidelines and ethical research standards. The authors confirm no conflicts of interest in relation to this study. We included both genders with known history of diabetes within the age range of 40 to 70 years, with a serum creatinine level below 1.2 mg/dL, who were scheduled for elective CABG surgery.Patients requiring redo surgeries, those with an estimated glomerular filtration rate (eGFR) below 60 ml/min, and individuals with a left ventricular ejection fraction (LVEF) of less than 30% were excluded. Prior to participation, eligible patients received detailed counseling and structured interviews explaining the study's objectives and procedures. After taking routine consent (informed), patients were subsequently admitted to the cardiac surgery ward for further management.

CABG was performed following standard surgical protocols, including median sternotomy, arterial and venous graft harvesting, pericardiotomy, heparinization, cannulation, and cardiopulmonary bypass (CPB) under moderate hypothermia. Aortic cross-clamping (20–140 min) and antegrade cold blood cardioplegia were utilized. The required number of grafts were anastomosed, followed by rewarming, cross-clamp removal, CPB weaning, protamine administration, pacing wire and drain placement, hemostasis, and chest closure. For strict monitoring all operated cases were moved to ICU. Serum creatinine levels were recorded on the 1st, 2nd, and 4th postoperative days and compared with baseline values. Baseline serum creatinine was measured from a blood sample taken at hospital admission, and GFR was calculated using the CKD-EPI equation. The primary objective was to determine the incidence of AKI at any stage postoperatively, based on KDIGO criteria, which align with AKIN and STS guidelines. AKI was classified as:

- Stage 1: Serum creatinine increase of 0.3 mg/dL within 48 hours post-surgery or 1.5–1.9 times the baseline.
- Stage 2: Creatinine rise of 2.0–2.9 times the baseline.
- Stage 3: Creatinine increase of ≥3.0 times the baseline or necessity for renal replacement therapy.

Standard laboratory tests, including HbA1c and serum creatinine levels, were performed upon admission. HbA1c ≥7.0% at admission was classified as preoperative hyperglycemia, while postoperative hyperglycemia was defined as fasting serum glucose ≥126 mg/dL at any point during the postoperative period. Patients were stratified into two groups:

- Group A: HbA1c ≥7.0%
- Group B: HbA1c<7.0%

All patients remained under intensive care following surgery, and creatinine levels were recorded on the 1st, 2nd, and 4th postoperative days. Data entry and statistical analysis were conducted using SPSS version 23.0.Numerical variables (e.g., age, duration of surgery, HbA1c levels, preoperative and postoperative GFR, preoperative creatinine, and peak postoperative creatinine) were expressed as mean ± standard deviation (SD).However, variables (e.g., gender, AKI occurrence, severity of AKI, and adverse outcomes) were reported as frequency and percentage. The incidence, severity, and association of AKI with adverse outcomes were compared between Group A and Group B to determine statistical significance. To adjust for potential confounders, data were stratified based on gender, age, and surgical duration before further analysis.

RESULTS

The patients had age between 40-70 years with a mean of 51.5±7.4 years. 67 (67%) patients were aged ≤55 years and 33 (33%) patients were aged above 55 years. There were 88 (88%) males and 12 (12%) females. Ratio between male to female patients was of 7.3:1. Duration of surgery ranged from 3.5-8.0 hours with a mean of 5.29±1.07 hours. It was ≤5 hours in 59 (59%) patients and >5 hours in 41 (41%) patients as given in Table-I. Both study groups exhibited similar demographic profiles, as detailed in Table-II.

Plasma HbA1c level ranged from 6.1-13.8% with a mean of 7.27±1.03%. Group A exhibited a significantly higher value compared to Group B: (7.96±1.05 vs. 6.57±0.28%; p-value<0.001). The average serum creatinine levels in both groups were statistically comparable, 0.96±0.22 vs. 0.94±0.17 mg/dl; p-value=0.615) and mean glomerular filtration rate (92.78±12.25 vs. 93.88±14.47 mL/min/1.73m^2; p-value=0.683) at baseline. However, following cardiac surgery, the mean of peak serum creatinine was significantly higher (1.25±0.35 v/s. 1.03±0.22 mg/dl; p-value<0.001) while the mean glomerular filtration rate was significantly lower (66.14±21.17 vs. 75.96±17.52mL/min/1.73m^2; p-value=0.013) in patients with elevated HbA1c (≥7.0%) as shown in Table-III.

Following, cardiac surgery, acute kidney injury was noted in 28 (28.0%) patients (Table-IV). As indicated in Table-V, AKI occurred significantly more frequently in patients with HbA1c ≥7.0% than in those with lower HbA1c levels (44% v/s. 12%; p<0.001). This difference persisted across subgroups stratified by age, gender, and surgical duration. However, there was an increased rate of AKI with increasing duration of surgery irrespective of study group as shown in Table-VI.

Among the 28 patients having AKI, 15 (53.6%) patients were categorized as risk while 13 (46.4%) patients were categorized as injury under RIFLE criteria. Both groups exhibited comparable distributions of AKI severity grades. Furthermore, stratified analyses based on age, gender, and surgical duration was computed as of no difference statistically between the groups.

On comparison the occurrence of adverse outcome was found significantly more in those with increased HbA1c ≥7.0% (8.0% vs. 0.0%; p-value=0.041) as evident from Table-VII. On comparison same difference was observed between groups in different subgroups on age, gender and duration of surgery as evident from Table-VIII. The rate of adverse outcome was also much higher in patients who developed AKI after surgery (14.3% vs. 0.0%; p-value=0.005) as indicated by Table-IX.

TABLE-I

Baseline demographic and clinical arameters of the study group

Characteristics	Participants n=100
Age (years)	51.5±7.4
≤55 years	67 (67.0%)
>55 years	33 (33.0%)
Gender	
Female	12 (12.0%)
Male	88 (88.0%)
Duration of Surgery (hours)	5.29±1.07
≤5 hours	59 (59.0%)
>5 hours	41 (41.0%)

TABLE-II

Baseline characteristics of the study groups n=100

Characteristics	HbA1c ≥7 n=50	HbA1c <7 n=50	P-Value
Age (years)	51.6±7.5	51.4±7.4	0.894
≤55 years	33 (66.0%)	34 (68.0%)	0.832
>55 years	17 (34.0%)	16 (32.0%)	
Gender			
Male	45 (90.0%)	43 (86.0%)	0.538
Female	5 (10.0%)	7 (14.0%)	
Duration of Surgery (hours)	5.22±1.12	5.36±1.03	0.516
≤5 hours	29 (58.0%)	30 (60.0%)	0.839
>5 hours	21 (42.0%)	20 (40.0%)	

TABLE-III

Comparison of renal profile before and after cardiac surgery n=100

Parameter	HbA1c ≥7 n=50	HbA1c <7 n=50	P-Value
Creatinine at Baseline(mg/dl)	0.96±0.22	0.94±0.17	0.615
GFR at Baseline (mL/min/1.73m^2)	92.78±12.25	93.88±14.47	0.683
Creatinine after Surgery (mg/dl)	1.25±0.36	1.03±0.24	<0.001
GFR after Surgery (mL/min/1.73m^2)	66.14±21.17	75.96±17.52	0.013

TABLE-IV

Frequency of post-operative AKI in the study cohort n=100

AKI	Frequency (n)	Percent (%)
Yes	28	28.0 %
No	72	72.0 %
Total	100	100.0%

AKI; Acute Kidney Injury

TABLE-V

Comparison of frequency of post-operative AKI n=100

AKI	HbA1c ≥7 n=50	HbA1c <7 n=50	P-Value
Yes	22 (44.0%)	6 (12.0%)	<0.001
No	28 (56.0%)	44 (88.0%)	
Total	50 (100.0%)	50 (100.0%)	

TABLE-VI

Comparison of frequency of post-operative AKI n=100

Subgroups	Acute Kidney Injury n/n (%)		P-Value
	HbA1c ≥7 n=50	HbA1c <7 n=50	
Age			
≤55 years	14/33 (42.4%)	4/34 (11.8%)	0.005
>55 years	8/17 (47.1%)	2/16 (12.5%)	0.031
Gender			
Male	20/45 (44.4%)	5/43 (11.6%)	0.001
Female	2/5 (40.0%)	1/7 (14.3%)	0.310
Duration of Surgery			
≤5 hours	11/29 (37.9%)	3/30 (10.0%)	0.012
>5 hours	11/21 (52.4%)	3/20 (15.0%)	0.012

TABLE-VII

Comparison of frequency of post-operative adverse outcome n=100

Adverse Outcome	HbA1c ≥7 n=50	HbA1c <7 n=50	P-Value
Yes	4 (8.0%)	0 (0.0%)	0.041
No	46 (92.0%)	50 (100.0%)	
Total	50 (100.0%)	50 (100.0%)	

TABLE-VIII

Comparison of frequency of post-operative adverse outcome across various subgroups n=100

Subgroups	Adverse Outcome n/n (%)		P-Value
	HbA1c ≥7 n=50	HbA1c <7 n=50	
Age			
≤55 years	2/33 (6.1%)	0/34 (0.0%)	0.239
>55 years	2/17 (11.8%)	0/16 (0.0%)	0.485
Gender			
Male	4/45 (8.9%)	0/43 (0.0%)	0.117
Female	0/5 (0.0%)	0/7 (0.0%)	-
Duration of Surgery			
≤5 hours	2/29 (6.9%)	0/30 (0.0%)	0.237
>5 hours	2/21 (9.5%)	0/20 (0.0%)	0.488

TABLE-IX			
Comparison of frequency of post-operative adverse outcome between patients with versus without post-operative AKI n=100			
Adverse Outcome	**AKI n=28**	**No AKI n=72**	**P-Value**
Yes	4 (14.3%)	0 (0.0%)	0.005
No	24 (85.7%)	72 (100.0%)	
Total	28 (100.0%)	72 (100.0%)	

DISCUSSION

Among the various cardiac surgical procedures, CABG is most frequently performed procedure with an estimated rate of 400,000 procedures per annum and 62 procedures per 100,000 inhabitants in US and Europe.[17]

As in any other surgical procedure, post-operative morbidity and mortality remains a serious concern after CABG and research in the past few decades have focused on perioperative medications as well as development in instrumentation and techniques to decrease the likelihood of complications after CABG making it safer and effective.

Among the various post-operative complications of CABG, in adult patients, AKI is a frequently encountered and clinically significant complication.[3] Postoperative AKI is independently linked to higher short-term morbidity and increased treatment costs while long-term mortality.[6] Therefore measures which can reduce the occurrence of AKI and its severity are of paramount importance in clinical practice.[3,5,6]

The frequency of diabetes in patients undergoing CABG surgery continues to increase. During cardiac surgeries hyperglycemia occurs in perioperative period, has been reported to have strong relationship with increased morbidity and mortality.[12,13,4] HbA1c levels serve as an indicator of adequate glycemic control i.e. <7%. Perioperative hyperglycemia is also an independent predictor of post-operative acute kidney injury.[3,10]

Thus it appears that there is high risk of AKI when cardiac surgery is performed in a diabetic patient. Recently there was evidence that not only diabetes but poor glycemic control was related with increased risk of AKI after cardiac surgeries proposing potential role of glycemic control in the risk stratification of such patients.[6] Due to the limited available evidence and the lack of local published studies, this research was deemed necessary.

The aims of this research were to compare the incidence of acute kidney injury in diabetic patients with HbAlc ≥7% and HbA1c< 7% who underwent CABG surgery and to identify the severity of AKI and adverse outcome in diabetic patients who underwent CABG surgery.

In this study, the average age of CABG patients was 51.5±7.4 years. Our finding is in conformity with[18] who noted the same average age of 51.3±5.7 years in patients undergoing CABG at Chaudhary Pervaiz Elahi Institute of Cardiology, Multan. In another local study[19] reported similar mean age of 51.6±10.3 years among such patients undergoing CABG at Punjab Institute of Cardiology, Lahore. Similar mean age has already been reported in a number of other local studies where[29,20,21] observed it to be 53.6±10.2 years, 55.3±9.6 years and 54.5±3.4 years respectively. A comparable mean age has been observed in Indian patients undergoing CABG where[22] reported it to be 52.±11.2 years and[23] reported it to be 53.7±**9.5 years. A** similar trial in Bangladesh[24] reported comparable mean age of 54.8±2.5 years while[25] reported it to be 53.4±8.9 years in Nepal.

This observed mean age in the present study matches with statistics reported by other studies conducted in local as well as other populations in South-East Asia. However in comparison with western population, this mean age is quite younger where[26] in UK and[27] in USA observed much higher mean age at the time of CABG and reported it to be 67.1±10.1 years and 66.1±9.9 years respectively. Another study[28] also reported higher mean age of 67.3±9.1 years among Chinese such patients. This difference in the mean age can be attributable to geographical as well as life style and genetic factors associated with coronary artery disease. It implies public health measures in this regard to increase public awareness about this aspect to reduce the burden of disease and delay its development as much as possible.

We observed a male predominance (M:F; 7.3:1) in patients undergoing CABG surgery. In another similar study[29] conducted at Punjab Institute of Cardiology, Lahore, reported alike predominance of males with male to female ratio of 7.2:1. Findings of this study agree with another study[30], as they also mentioned similar predominance of males with male to female ratio of 6.2:1 among CABG patients at Rahim Yar Khan.A notable male predominance was evident, with a male-to-female ratio of 6.2:1 has also been reported by another study[20] at Chaudhary Pervaiz Elahi Institute of Cardiology Multan. Other studies[22,23] described comparable predominance of male patients with male to female ratio of 7.1:1 and 7.9:1 respectively in Indian CABG patients. Another study[31] observed it to be 7.3:1 among Italian such patients.

We observed that following cardiac surgery, in patients with poor glycemic control the frequency of post-operative AKI (44.0% vs. 12.0%; p-value<0.001) and mortality (8.0% vs. 0.0%; p-value=0.041) was significantly high.

Our results in line with the parent study where[6] evaluated AKI and mortality in 300 German patients undergoing CABG surgery. The author took cut-off value of HbA1c ≥6.0 % to define good and poor glycemic control. The author reported similar significantly higher frequency of AKI (56.5% vs. 41.0%; p-value=0.008) and mortality (3.3% vs. 0.0%; p-value<0.05) in patients with poor glycemic control undergoing CABG surgery.

Our observation is also in line with a similar study[32] conducted over 202 Turkish patients undergoing CABG surgery. The author reported AKI in 10.5% patients and mortality in 1.8% patients. When compared patients with low and high HbA1c, the author reported similar higher frequency of AKI (16.7% vs. 3.6%; p-value=0.002) and mortality (6.7% vs. 1.8%; p-value=0.036) in patients with poor glycemic control. In another Turkish study[33] studied 60 patients with good glycemic control matched with another 60 patients having poor glycemic control undergoing CABG surgery. They too reported similar significantly higher frequency of AKI (25.0% vs. 10.0%; p-value=0.031) and mortality (8.3% vs. 0.0%; p-value=0.046) in patients with poor glycemic control. Still another Turkish study[34] described similarly higher rate of mortality in patients undergoing CABG surgery with high HbA1c in the pre-operative workup (21.4% vs 0.0%; p-value=0.005).

Similar results have also been reported by an Egyptian study[35] evaluated results of CABG surgery in 40 patients with good versus poor glycemic control. The author reported similar significantly increased frequency of AKI (45.0% vs. 10.0%; p-value=0.034) in patients with poor glycemic control prior to surgery (HbA1c ≥6.5%).

However, it is clear that pre-operative poor glycemic control may lead to post operative AKI and mortality in diabetics which highlights the significance of glycemic control as well as potential role of HbA1c in the risk stratification. We also observed that increased duration of surgery was also an important determining factor of acute kidney injury as the frequency of AKI was lower when the duration of surgery was ≤5 hours as compared to when it was >5 hours (23.7% vs. 34.1%; p-value=0.254). This association between duration of surgery and acute kidney injury can be explained by increase surgical stress, tissue trauma and exposure to anesthetic and other medications as well as derangements in hemodynamics with prolongation of operative time which are established risk factors of acute kidney injury.[3] In the light of this evidence, it is advocated that duration of surgery should be reduced to minimum in this population.

This trial is the first of its type in local population and contributes to the already available published international evidence on the subject. A large sample size of 100 patients was strength of this study besides strict exclusion criteria. A major and strong limitation to the current study was that we didn't take into account the role of peri-operative insulin therapy and ideal glycemic control in the management of such patients and its impact on the development of AKI, its severity and overall mortality which would have fixed the place of glycemic control in managing such patients more clearly. It is a crucial study and one which is greatly to be suggested in future clinical studies.

CONCLUSION

Preoperative poor glycemic control was found to be a strong link with acute kidney injury and mortality in diabetics undergoing CABG. This capitalizes the significance of glycemic management and the potential role of HbA1c in risk stratification for optimizing patient care.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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REFERENCES

1. Halkos ME, Puskas JD, Lattouf OM, Kilgo P, Kerendi F, Song HK, et al. **Elevated preoperative hemoglobin A1c level is predictive of adverse events after coronary artery bypass surgery.** J ThoracCardiovasc Surg. 2008; 136:631-40.
2. Xu J, Zou MH. **Molecular insights and therapeutic targets for diabetic endothelial dysfunction.** Circulation. 2009; 120:1266-86.
3. Hong S, Youn Y-N, Yoo K-J. **Metabolic syndrome as a risk factor for postoperative kidney injuryafter off-pump coronary artery bypass surgery.** Circ J. 2010; 74(6):1121-6.
4. Englberger L, Suri RM, Li Z, Casey ET, Daly RC, Dearani JA, et al. **Clinical accuracy RIFLE and acute kidney injury network (AKIN) criteria for acute kidney injury in patients undergoing cardiac surgery.** Crit Care. 2011; 15(1):R16.
5. Li SY, Chen JY, Yang WC, Chuang CL. **Acute kidney injury network classification predicts in-hospital and long-term mortalityinpatientsundergoing elective coronary artery bypass grafting surgery.** Eur J Cardiothorac Surg. 2011; 39(3):323-8.
6. Oezkur M, Wagner M, Weismann D, Krannich J H, Schimmer C, Riegler C, et al. **Chronic hyperglycemia is associated with acute kidney injury in patients undergoing CABG surgery – a cohort study.** BMC Cardiovascular Disorders. 2015; 15:41.
7. Khwaja A. **KDIGO clinical practice guidelines for acute kidney injury.** Nephron ClinPract. 2012; 120(4):179-84.
8. Chawla LS, Amdur RL, Shaw AD, Faselis C, Palant CE, Kimmel PL. **Association between AKI and long-term renal and cardiovascular outcomes in United States veterans.** Clin J Am SocNephrol. 2014; 9(3):448-56.
9. Wu VC, Wu CH, Huang TM, Wang CY, Lai CF, Shiao CC, et al. **Long-term risk of coronary events after AKI.** J Am SocNephrol. 2015; 25(3):595-605.
10. Gaudino M, Luciani N, Giungi S, Caradonna E, Nasso G, Schiavello R, et al. **Different profiles of patients who require dialysis after cardiac surgery.** Ann Thorac Surg. 2005; 79(3):825-9.
11. Karkouti K, Beattie WS, Wijeysundera DN, Rao V, Chan C, Dattilo KM, et al. **Hemodilution during cardiopulmonary bypass is an independent risk factor for acute renal failure in adult cardiac surgery.** J ThoracCardiovasc Surg. 2005; 129(2):391-400.
12. Sato H, Carvalho G, Sato T, Lattermann R, Matsukawa T, Schricker T. **The association of preoperative glycemic control, intraoperative insulin sensitivity and outcomes after cardiac surgery.** J ClinEndocrinolMetab. 2010; 95(9):4338-44.
13. Subramaniam B, Lerner A, Novack V, Khabbaz K, Paryente-Wiesmann M, Hess P, et al. **Increased glycemic variability in patients with elevated preoperative HbA1c predicts adverse outcomesfollowing coronary artery bypass grafting surgery.** AnesthAnalg. 2014; 118(2):277-87.
14. Mebazaa A, Gayat E, Lassus J, Meas T, Mueller C, Maggioni A, et al. **Association between elevated blood glucose and outcome in acute heart failure: Results from an international observational cohort.** J Am CollCardiol. 2013; 61(8):820-9.
15. Kuitunen A, Vento A, Suojaranta-Ylinen R, Pettila V. **Acute renal failure after cardiac surgery: Evaluation of the RIFLE classification.** Ann Thorac Surg. 2006; 81(2):542-6.
16. Abdelmalak B, Abdelmalak JB, Knittel J, Christiansen E, Mascha E, Zimmerman R, et al. **The prevalence of undiagnosed diabetes in non-cardiac surgery patients, an observational study.** Can J Anesth. 2010; 57(12):1058-64.
17. Shahian DM, Edwards F, Grover FL, Jacobs JP, Wright CD, Prager RL, et al. **The society of thoracic surgeons national adult cardiac database.** J Thorac Cardiovasc Surg. 2010; 140:955-9.
18. Gilani SRA, Hussain G, Ahmad N, Baig MAR, Zaman H. **Comparison of post-operative atelectasis in patients undergoing coronary artery bypass grafting with and without pre-operative incentive spirometry.** J. Postgrad. Med. Inst. 2016; 30(2):169-72.
19. Iqbal J, Ghaffar A, Shahbaz A, Abid AR. **Stroke after coronary artery bypass surgery with and without cardiopulmonary bypass.** J. Ayub Med. Coll. Abbott. 2014; 26(2):123-28.
20. Sher-i-Murtaza M, Baig MAR, Raheel HMA. **Early outcome of Coronary Artery Bypass Graft Surgery in patients with significant Left Main Stem stenosis at a tertiary cardiac care center.** Pak. J. Med. Sci. 2015; 31(4):909-14.
21. Rana MA, Batool U, Khan S, Akbar MT, Haider I, Khan MK. **Gender based difference in quality of life after phase ii cardiac rehabilitation in patients with coronary artery bypass graft surgery.** Rehabil. J. 2019; 3(2):131-36.
22. Kumar R, Hote MP, Sharma G, Thakur B, Airan B. **Comparison of outcome in male and female Indian patients undergoing CABG, activity levels and quality of life: One year follow-up study.** Am. J. Thoracic Cardiovasc. Surg. 2017; 2(2):29-34.

23. Kasliwal RR, Kulshreshtha A, Agrawal S, Bansal M, Trehan N. **Prevalence of cardiovascular risk factors in Indian patients undergoing coronary artery bypass surgery.** JAPI. 2006; 54:371-75.
24. Ranjan R, Adhikary D, Saha H, Mandal S, Saha SK, Adhikary AB. **Outcome of CABG with or without coronary endarterectomy in Bangladesh: A retrospective cohort study.** Bangladesh Heart J. 2017; 32(2):77-84.
25. Jaiswal LS, Prasad JN, Shah P, Pandit N. **Establishing cardiac surgery in eastern Nepal: early results.** Journal of Nepal Health Research Council. 2018; 16(3):257-63.
26. Leyva F, Qiu T, Evison F, Christoforou C, McNulty D, Ludman P, et al. **Clinical outcomes and costs of cardiac revascularisation in England and New York state.** Open Heart J. 2018; 5(1):e000704.
27. Moazzami K, Dolmatova E, Maher J, Gerula C, Sambol J, Klapholz M, et al. **In-hospital outcomes and complications of coronary artery bypass grafting in the United States between 2008 and 2012.** J. Cardiothorac Vasc. Anesth. 2017; 31(1):19-25.
28. Zheng Z, Zhang H, Yuan X, Rao C, Zhao Y, Wang Y, et al. **Comparing outcomes of coronary artery bypass grafting among large teaching and urban hospitals in China and the United States.** Circulation. 2017; 10(6): e003327.
29. Abid AR, Farogh A, Naqshband MS, Akhtar RP, Khan JS. **Hospital outcome of coronary artery bypass grafting and coronary endarterectomy.** Asian Cardiovasc. Thoracic Ann. 2009; 17(1):59-63.
30. Azam H, Baksh A, Khalid ZR. **Stroke after coronary artery bypass grafting; a single centre study.** Pak. Heart J. 2017 50(3):175-79.
31. Nicolini F, Fortuna D, Contini GA, Pacini D, Gabbieri D, Zussa C, et al. **The impact of age on clinical outcomes of coronary artery bypass grafting: long-term results of a real-world registry.** BioMed. Res. Inte. 2017; 9829487.
32. Kocogulları CU, Kunt AT, Aksoy R, Duzyol C, Parlar H, Saskın H, et al. **Hemoglobin A 1c levels predicts acute kidney injury after coronary artery bypass surgery in non-diabetic patients.** Brazilian Journal of Cardiovascular Surgery. 2017; 32:83-89.
33. Arslan Ü, Memetoğlu ME, Kutlu R, Erbasan O, Tort M, Yildiz E. **Preoperative Hba1c level in prediction of short-term morbidity and mortality outcomes following coronary artery bypass grafting surgery.** Rus Open Med J. 2015; 4(2):1-6.
34. Surer S, Seren M, Saydam O, Bulut A, Kiziltepe U. **The relationship between HbA1c & atrial fibrillation after off-pump coronary artery bypass surgery in diabetic patients.** Pakistan Journal of Medical Sciences. 2016; 32(1):59.
35. Samir GM, Omar OMAM, Zidan MM, Fawzy HAER, El Far MMM. **Association between preoperative level of hemoglobin A1c and the incidence of acute kidney injury after coronary artery bypass grafting surgery: A cohort study.** Ain-Shams Journal of Anesthesiology. 2021; 13(1):1-8.

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