The Egyptian Cardiothoracic Surgeon

Vol. 4, No. 1, 5 - 11

Original Article

Early Outcomes of Coronary Artery Bypass Grafting in Patients with Preoperative Renal Dysfunction

Rafik Soliman[1], Walid Elsayed[2,3], Ahmed Dokhan[1], Mohammed El-Hag-Aly[1]

[1] Department of Cardiac Surgery, Faculty of Medicine, Menoufia University, Shebien El-Kom, Egypt

[2] Department of Cardiac Surgery, King Abdullah Medical City, Makkah, Saudi Arabia

[3] Department of Surgery, Gamasa Central Hospital, Gamasa, Egypt

Abstract

Background: Chronic kidney disease combined with coronary artery disease is a growing public health issue. Preoperative renal dysfunction is one of the major risk factors for perioperative morbidity and mortality in patients undergoing coronary artery bypass grafting (CABG). This study aimed to analyze the early clinical outcomes of CABG in patients with preoperative renal impairment.

Methods: The study was conducted from July 2017 to July 2019. We included 100 patients who underwent CABG. Group A (n= 50) included patients with preoperative renal impairment and group B (n= 50) had patients with normal renal functions.

Results: The mean age was 63.3±9.1 years in Group A and 57.1±8.5 years in Group B (P<0.001). There were 35 males in Group A and 47 in Group B (P<0.001). Blood transfusion was more in Group A (47 (94%) vs. 32 (64%) patients; P=0.001). There was no difference in mortality between both groups.

Conclusion: Preoperative renal impairment in patients undergoing CABG is more common in elder females. Patients undergoing CABG with preoperative renal impairment could have a higher risk for blood transfusion.

KEYWORDS

Coronary artery bypass; Health care; Outcome assessment; Renal insufficiency

Article History

Submitted: 28 Aug 2021

Revised: 13 Sep 2021

Accepted: 13 Oct 2021

Published: 1 Jan 2022

Introduction

Coronary artery bypass grafting (CABG) is still the standard of care for patients with coronary artery disease. Although more CABG surgeries are performed on patients with different stages of chronic kidney disease, earlier research demonstrated that pre-existing renal dysfunction is a risk factor for postoperative events following CABG [1]. Patients with earlier stages of chronic kidney disease are at increased risk for postoperative cardiac events and mortality. Therefore, reducing the risk of elective operations became essential. Doing so requires understanding the absolute risks related to a surgical procedure and the specific risk factors related to patients with kidney disease [2].

Acute kidney injury is a common and potentially life-threatening complication after cardiac surgery. It occurs in 5% to 45% of patients following cardiac surgery, depending on the type of the surgery. There is a higher mortality rate in those patients, and it is one of the causes of significant morbidities [3]. Several risk-prediction tools, such as the Cleveland Clinic Foundation Acute Renal Failure Scoring System and the Mehta scores, have been developed for the preoperative identification of patients at risk of postoperative

Corresponding author: Walid Elsayed walid.elsayed222@yahoo.com

acute kidney injury. These risk scores share common variables: preoperative kidney function, diabetes mellitus, cardiac surgery characteristics, and preoperative hemodynamics [4].

Preoperative renal dysfunction is associated with increased morbidity and prolonged mechanical ventilation. Moreover, there is a higher incidence of arrhythmias, blood transfusion requirements, and postoperative low cardiac output [5]. This study aimed to analyze the early clinical outcome of CABG in patients with preoperative renal impairment.

Patients and Methods

Design and patients

This prospective cohort study was conducted from July 2017 to July 2019. The study included 100 patients who underwent CABG. The study was approved by the Research Ethics Committee, Faculty of Medicine, Menoufia University, Shebeen El-Kom, Egypt (Reference number: 28102018). We obtained informed consent from all participants prior to participation.

We grouped the patients into two groups according to the preoperative renal functions. Group A (n= 50) included patients who underwent CABG with preoperative renal dysfunction (estimated glomerular filtration rate [eGFR] < 60 ml/min per 1.73 m2) and Group B (n= 50) included patients underwent CABG with preoperative normal kidney functions (eGFR levels > 60 ml/min per 1.73 m2). The Exclusion criteria were CABG combined with other cardiac operations, emergency, redo, and off-pump CABG.

Data

Preoperative data were recorded and included age, sex, height, weight, diabetes mellitus, hypertension, peripheral vascular disease, left ventricular ejection fraction, prior myocardial infarction, congestive heart failure, Canadian Cardiovascular Society angina class, serum creatinine, GFR, cerebrovascular accidents, and chronic obstructive pulmonary disease.

Intraoperative data included cardiopulmonary bypass time and myocardial ischemic time in minutes, numbers and the types of grafts, and intraoperative complications.

Postoperative variables included evaluation of hemodynamics, postoperative inotropes, duration of mechanical ventilation in hours, and the intensive care unit (ICU) stay in hours.

The outcomes were in-hospital mortality, myocardial infarction, renal replacement therapy, need for blood transfusion, re-exploration, and prolonged ICU and hospital stay. We followed the patients for one month after surgery in the outpatient clinic.

Statistics analysis

Statistical analysis was done using SPSS statistical software (IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY, USA). Qualitative data were presented in the form of numbers and percentages, description of quantitative variables was in the form of mean and standard deviation (SD). Comparison between quantitative variables was carried out using the student T-test of two independent samples. The Chi-square test (X2) was used to assess the association between qualitative variables. The significance of the results was considered when p-value < 0.05.

Results

Group A had a mean age of 63.3± 9.1years, and the mean age in group B was 57.1±8.5 years (p<0.001). Thirty-five patients were males in Group A and 47 in group B (p=0.001). Group A's mean body mass index was 25.8±4.17 Kg/m2, while 29.3±4.3 Kg/m2 in Group B (p=0.001).

The mean grafts used in Groups A and B were 3.3±0.87 and 3±0.84, respectively (P=0.18). There was no significant difference between both groups regarding the mean cardiopulmonary bypass (CPB) time. The mean aortic cross-clamp time was 78.02± 32.35 minutes in Group A and 64.8± 19.52 minutes in Group B (P=0.05). Preoperative and operative data are presented in Table 1.

Postoperative complications are shown in Table 2. Six (12%) patients from Group A had re-exploration for bleeding compared to one patient

Table 1: Comparison of the preoperative data between both groups

	Group A (n = 50)	Group B (n= 50)	P-value
Gender (n, %)			
Males	35 (70%)	47 (94%)	<0.001
Females	15 (30%)	3 (6%)	
Age (years) (Mean ± SD)	63.3.1 ± 9.1	57.1 ± 8.5	<0.001
BMI (Kg/m^2) (Mean ± SD)	25.8 ± 4.1	29.3 ± 4.3	<0.001
Diabetes mellitus (n, %)	44 (88%)	41 (82%)	0.40
Hypertension (n, %)	46 (92%)	43 (86%)	0.33
Peripheral Vascular Disease (n, %)	5 (10%)	5 (10%)	>0.99
CVA (n, %)	4 (8%)	7 (14%)	0.38
Hepatic Failure (n, %)	8 (16%)	7 (14%)	0.77
COPD (n, %)	12 (24%)	9 (18%)	0.46
Current Smoking (n, %)	20 (40%)	36 (72%)	<0.001
ACEI (n, %)	19 (38%)	50 (100%)	<0.001
Hyperlipidemia (n, %)	16 (32%)	21 (42%)	0.30
Preoperative EF (n, %)			
Normal	23 (46%)	22 (44%)	0.747
Moderate	24 (48%)	24 (48%)	
Poor	3 (6%)	4 (8%)	
Preoperative AF (n, %)	3 (6%)	2 (4%)	0.65
Preoperative MI (n, %)	20 (40%)	22 (44%)	0.68
Angina class IV (n, %)	4 (8%)	10 (20%)	0.14
Heart failure (n, %)	7 (14%)	8 (16%)	0.782
Preoperative IABP (n, %)	4 (8%)	3 (6%)	0.78
EuroSCORE II			
Mean ± SD	6.2 ± 4.9	3.3 ± 3.3	0.001
Median (IQR)	4.5 (3-7.6)	2.1 (1.5-3.3)	
Internal mammary artery (n, %)	50 (100%)	50 (100%)	
Number of grafts (Mean ± SD)	3.3 ± 0.87	3 ± 0.84	0.18
Cardiopulmonary bypass time (Mean ± SD)	122 ± 56.39	98.9 ± 28.7	0.07
Cross-clamp time (Mean ± SD)	78.02 ± 32.35	64.8 ± 19.52	0.05

AF: atrial fibrillation; BMI: body mass; EF: left ventricular ejection fraction; index; eGFR: estimated glomerular filtration rate; IABP: intra-aortic balloon pump; IQR: interquartile range; MI: myocardial infarction; n: number; SD: standard deviation. Group A: eGFR < 60 ml/min, Group B: eGFR ≥ 60 ml/min

in Group B (p=0.11). Four (8%) patients from group A and one (2%) patient from group B required postoperative dialysis (P=0.36). Blood transfusion was more in Group A (47 (94%) vs. 32 (64%) patients; P=0.001). Hospital stay was longer in Group A (13.16± 15.55 days) than Group B (10.88± 9.20 days) but did not reach a significant level (P=0.65).

Discussion

Renal dysfunction could affect the outcomes of CABG. Several studies characterized patients with renal dysfunction and found a higher prevalence in females, smokers, hypertensives, and diabetics and in association with respiratory disease [5-11]. We found a higher prevalence of renal impairment among women; however, the prevalence was lower among smokers. The pathogenesis of renal impairment in patients with diabetes and hypertension is well-established [11, 12]. This study's lower percentage of current smokers among renal patients may be attributed to the lower percentage of male patients as smoking is more prevalent among men [13].

Table 2: Comparison between the postoperative complications in both groups

	Group A (n = 50)	**Group B (**n = 50)	**P-value**
Exploration (n, %)	6 (12%)	1 (2%)	0.11
Inotropes (n, %)	45 (90%)	44 (88%)	0.74
Postoperative IABP (n, %)	10 (20%)	4 (8%)	0.84
Postoperative dialysis (n, %)	4 (8%)	1 (2%)	0.36
Blood transfusion (n, %)	47 (94%)	32 (64%)	<0.001
Wound infections (n, %)	10 (20%)	12 (24%)	0.62
Stroke (n, %)	1 (2%)	0 (0%)	>0.99
Myocardial infarction (n, %)	4 (8%)	1 (2%)	0.36
Hepatic dysfunction (n, %)	7 (14%)	1 (2%)	0.06
Mechanical ventilation (hours) (Mean ± SD)	8.56 ± 3.59	9.1 ± 3.7	0.55
Mortality (n, %)	3 (6%)	1 (2%)	0.61
Intensive care unit stay			
Mean ± SD	6.72 ± 14.71	4.46 ± 8.64	0.21
Median (IQR)	3 (2-4)	3 (2-4)	
Hospital stay			
Mean ± SD	13.16 ± 15.55	10.88 ± 9.20	0.65
Median (IQR)	9 (7-14)	8.50 (6.75-12)	

eGFR: estimated glomerular filtration rate; IABP: intra-aortic balloon pump; SD: standard deviation

On the other hand, a higher prevalence of the male gender was observed among renal patients in several studies [8- 10]. In addition, the reported rates of diabetes, hypertension, and chronic obstructive pulmonary disease were similar between the two groups in the study by Marui and colleagues [7]. These differences in preoperative characteristics between the two groups across the studies may be attributed to differences in the eligibility criteria adopted in each study and variations in comorbidities' prevalence.

The prevalence of preoperative impairment of left ventricular ejection fraction, atrial fibrillation, myocardial infarction, and anginal class IV did not differ significantly between the two groups in the present study. Marui and coworkers [7] found that the prevalence of preoperative AF was similar between patients with occult renal disease and non-renal patients. Gelsomino and associates [5] found no significant difference in ejection fraction between renal and non-renal patients undergoing CABG. On the other hand, other studies reported a significantly higher percentage of renal patients suffering from heart failure and myocardial infarction before cardiac surgery [5-8] as well as atrial fibrillation [5,6,8]. Additionally, a significant, progressive deterioration in ejection fraction with the severity of renal dysfunction was also reported [6,8,10].

The mean EuroSCORE II was significantly higher in the renal group in this study, which coincides with the findings of previous studies [6,10]. This was anticipated as renal dysfunction, and other associated comorbidities are incorporated into the calculation of EuroSCORE II.

The current study reported no significant differences between both groups regarding the number of grafts, cardiopulmonary bypass time, and cross-clamp time. These findings are in accordance with others [5, 7, 8]. However, Al-Sarraf and colleagues [10] reported a significantly longer mean cardiopulmonary bypass time and cross-clamp time in patients with renal dysfunction. Xu and coworker [9] stated that the mean cardiopulmonary bypass time was significantly longer in renal patients, while the mean clamp time was similar between the two groups.

Postoperatively, the present study results showed that re-exploration, inotrope use,

postoperative IABP, dialysis, stroke, hepatic dysfunction, and MI were slightly higher in the renal dysfunction group. Although there were no significant differences between the renal and the non-renal groups, these differences may bear a clinical significance that was not depicted by the statistical tests, presumably due to the relatively small sample size in the current study. Meanwhile, a significantly higher percentage of renal patients required postoperative blood transfusion. Previous studies support these findings [6-8,10], with variations in the statistical significance of their results. The higher need for blood transfusion in renal patients may be attributed to anemia and reduced erythropoiesis [14]. These results suggest that impairment of renal function before CABG is a risk factor for more deterioration in renal function and the development of acute kidney injury. Additionally, it is a risk factor for developing MI and cerebrovascular accidents following surgery.

In the current study, a slight increase in the in-hospital mortality, intensive care unit stay, and hospital stay were detected in the renal dysfunction group, with no statistically significant difference. This is in partial accordance with Marui and coworkers [7], who stated that renal patients had a significantly higher in-hospital mortality rate. Gelsomino and associated [5] recorded significantly higher mortality and prolonged length of stay in patients with mildly impaired renal function. However, Holzmann and Sartipy [6] found that renal impairment was associated with a higher mortality risk on univariate analysis. Still, multivariable analysis showed significant association only when the eGFR was below 45 (ml/min/1.73 m2). In addition, Ji and coworkers [15] recorded that the surgical mortality rate was similar between the two groups, but long-term mortality was significantly higher in renal patients. Nevertheless, Zakeri and coworkers [8] found a higher in-hospital and mid-term mortality rate in renal patients even after adjusting for confounders.

The variations in the eGFR of patients across the studies may contribute to these differences. Another potential factor is the basic preoperative characteristics of patients that can also vary across the studies.

The exact mechanisms underlying the effect of chronic renal dysfunction on morbidity and mortality following CABG are not precisely defined. A suggested mechanism is that the presence of both cardiac and renal diseases accelerates the progression of failure of either organ [16,17]. Another proposed mechanism is that impaired renal function is associated with exacerbated inflammation and oxidative stress [18,19] as well as elevated blood levels of homocysteine, uric acid, and urea [20]. Meanwhile, cardiac morbidities in those patients may be caused by other co-occurring pathological conditions, such as diabetes and hypertension, which are often associated with renal disease [21]. The contribution of comorbidities to cardiac complications following CABG in renal patients is supported by the findings of Ji and associates [15]. They found in a propensity score-matched analysis that the incidence of in-hospital outcomes (including stroke, myocardial infarction, respiratory failure, pneumonia, bleeding, blood transfusion, and acute kidney injury requiring dialysis) did not differ significantly between the two groups of patients, despite a slight tendency to be higher in renal patients.

Furthermore, the increased risk of cardiovascular morbidities could be attributed to lower coronary flow reserve after CABG surgery due to deterioration of the microvascular bed in patients with preoperative renal insufficiency [22]. Another possible explanation is that patients with impaired preoperative renal function may have a more advanced cardiovascular disease and a reduced cardiac output before surgery. Along with aging, inflammatory mediators, endothelial dysfunction, and left ventricular hypertrophy, these factors may contribute to the poor outcome [9].

Study limitations and prospects

The present study was limited by the relatively small number of patients included and the short follow-up period. The conduction of prospective cohort studies with a larger sample size and with a longer follow-up duration is recommended.

Conclusion

Preoperative renal impairment in patients undergoing CABG is more common in elder females. Patients undergoing CABG with preoperative renal impairment could have a higher risk for blood transfusion. Patients undergoing elective CABG with preoperative renal dysfunction should be considered as a special group of patients requiring more meticulous care and follow-up to avoid the expected risks and morbidities.

Conflict of interest: Authors declare no conflict of interest.

References

1. Cooper WA, O'Brien SM, Thourani VH, et al. Impact of renal dysfunction on outcomes of coronary artery bypass surgery: results from the Society of Thoracic Surgeons National Adult Cardiac Database. Circulation 2006; 113 (8): 1063-1070.
2. Bahrainwala JZ, Gelfand SL, Shah A, Abramovitz B, Hoffman B, Leonberg-Yoo AK. Preoperative risk assessment and management in adults receiving maintenance dialysis and those with earlier stages of CKD. Am. J. Kidney Dis. 2020; 75 (2): 245-255.
3. Petra MA. A Cross-Sectional Study: Progression Into Renal Replacement Therapy in Post Coronary Bypass Artery Graft Surgery Patients with Varying Pre-Operative Serum Creatinine Levels. Sch. J. App. Med. Sci. 2021; 3: 424-427.
4. Arellano DL. Acute kidney injury following cardiothoracic surgery. Crit. Care Nurs. Clin. North Am. 2019; 31 (3): 407-417.
5. Gelsomino S, Del Pace S, Parise O, et al. Impact of renal function impairment assessed by CKDEPI estimated glomerular filtration rate on early and late outcomes after coronary artery bypass grafting. Int. J. Cardiol. 2017; 227: 778-787.
6. Holzmann MJ, Sartipy U. Relation between preoperative renal dysfunction and cardiovascular events (stroke, myocardial infarction, or heart failure or death) within three months of isolated coronary artery bypass grafting. Am. J. Cardiol. 2013; 112 (9): 1342-1346.
7. Marui A, Okabayashi H, Komiya T, et al. Impact of occult renal impairment on early and late outcomes following coronary artery bypass grafting. Interact. Cardiovasc. Thorac. Surg. 2013; 17 (4): 638-643.
8. Zakeri R, Freemantle N, Barnett V, et al. Relation between mild renal dysfunction and outcomes after coronary artery bypass grafting. Circulation 2005; 112 (9_supplement): I-270-I-275.
9. Xu J, Yu J, Xu X, et al. Preoperative hidden renal dysfunction add an age dependent risk of progressive chronic kidney disease after cardiac surgery. J. Cardiothorac. Surg. 2019; 14 (1): 1-7.
10. Al-Sarraf N, Thalib L, Hughes A, et al. The effect of preoperative renal dysfunction with or without dialysis on early postoperative outcome following cardiac surgery. Int. J. Surg. 2011; 9 (2): 183-187.
11. Goldberg I, Krause I. The Role of Gender in Chronic Kidney Disease. EMJ 2016; 1 (2): 58-64.
12. Kazancioğlu R. Risk factors for chronic kidney disease: an update. Kidney Int. Suppl. 2013; 3 (4): 368-371.
13. Cui Y, Zhu Q, Lou C, et al. Gender differences in cigarette smoking and alcohol drinking among adolescents and young adults in Hanoi, Shanghai, and Taipei. J. Int. Med. Res. 2018; 46 (12): 5257-5268.
14. Portolés J, Martín L, Broseta JJ, Cases A. Anemia in Chronic Kidney Disease: From Pathophysiology and Current Treatments, to Future Agents. Front. Med. (Lausanne) 2021; 8 (328).
15. Ji Q, Xia L, Shi Y, et al. Impact of mild preoperative renal insufficiency on in-hospital and long-term outcomes after off-pump coronary artery bypass grafting: a retrospective propensity score matching analysis. J. Cardiothorac. Surg. 2016; 11 (1): 1-8.
16. Schrier RW. Role of Diminished Renal Function in Cardiovascular Mortality: Marker or Pathogenetic Factor? J. Am. Coll. Cardiol. 2006; 47 (1): 1-8.
17. van Dokkum RPE, Eijkelkamp WBA, Kluppel ACA, et al. Myocardial Infarction Enhances Progressive Renal Damage in an Experimental

Model for Cardio-Renal Interaction. J. Am. Soc. Nephrol. 2004; 15 (12): 3103-3110.
18. Cachofeiro V, Goicochea M, de Vinuesa SG, Oubiña P, Lahera V, Luño J. Oxidative stress and inflammation, a link between chronic kidney disease and cardiovascular disease: New strategies to prevent cardiovascular risk in chronic kidney disease. Kidney Int. 2008; 74: S4-S9.
19. Shlipak MG, Fried LF, Crump C, et al. Elevations of inflammatory and procoagulant biomarkers in elderly persons with renal insufficiency. Circulation 2003; 107 (1): 87-92.
20. Edelstein CL. Biomarkers of acute kidney injury. Adv. Chronic Kidney Dis. 2008; 15 (3): 222-234.
21. Muntner P, Hamm LL, Kusek JW, Chen J, Whelton PK, He J. The Prevalence of Nontraditional Risk Factors for Coronary Heart Disease in Patients with Chronic Kidney Disease. Ann. Intern. Med. 2004; 140 (1): 9-17.
22. Günday M, Çiftçi Ö, Çalışkan M, Özülkü M, Bingöl H, Körez K.. Does mild renal failure affect coronary flow reserve after coronary artery bypass graft surgery. Heart. Surg. Forum; 2014; 17 (1): 18-24.