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Research Article

The Role of Akın, Kdıgo, Sofa, and Rıfle Criteria in Prediction of Mortality in Diabetic Patients who underwent Pump-Assisted Coronary Artery Bypass Surgery

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Abstract

Background

Different definitions and criteria have emerged today to diagnose acute kidney injury.

For this purpose, AKIN, RIFLE, SOFA and KDIGO classifications have been developed. Our aim in this study is to determine the role of AKIN, KDIGO, SOFA and RIFLE scores diabetic patients who underwent Pump-Assisted Coronary Artery Bypass Graft operation.

Materials and Methods:

Between January 2019 -December 2022, 310 diabetic patients who underwent Pump-Assisted Coronary Artery Bypass operation were included in this study. Our study is a cross-sectional retrospective study. In the cardiovascular surgery intensive care unit follow-up of the patients, perioperative data, intensive care follow-up charts, need for continuous renal replacement therapy, use of diuretics, use of inotropic agents, mechanical ventilator therapy, SOFA score, use of nephrotoxic drugs, and urine output were recorded. The RIFLE, KDIGO and AKIN scores of the patients were calculated daily and the highest value during the hospitalization was recorded. In addition to the length of stay in the intensive care unit, death and discharge status of the patients were also evaluated via The independent samples t-test (the distributions normal) was used to compare parametric data, whereas the Mann-Whitney U test was used to compare non-parametric data.

Results:

The mean age of 310 patients included in our study was 57.4±10.5 years. 132 (42.6%) of our patients were female and 178 (57.4%) were male. Death was observed in 7.8% of the patients included in the study. Not all of the deaths were due to renal failure, but these patients were seen to be in any stage of AKI according to the KDIGO, AKIN and RIFLE classification.

According to the RIFLE, AKIN and KDIGO classifications, it was found that the mortality rate increased statistically as the Acute kidney injury stage increased.

Conclusion:

As the staging level in RIFLE, AKIN and KDIGO scores increases, the risk of renal failure increases. Checking these scores in patients scheduled for coronary artery bypass may reduce mortality.

Keywords: kidney failure; sofas scores; diabetes mellitus; coronary artery bypass surgery; cardiac diseases

Introduction

Acute kidney injury (AKI) is a loss of kidney function defined by decrease in hourly urine output(1). It is diagnosed in critically ill patients, with its occurrence estimated at up to 50% in patients hospitalized in the intensive critical unit (1). Kidney Diseases are defined by markers of kidney damage (structural criteria) and/or decreased glomerular filtration rate (functional criteria) persisting for ≤3 months (AKD) or ≥3 months (2)

.AKI develops in up to 20-30% of patients undergoing coronary artery bypass (CABG) surgery, and it develops as a serious complication such as mortality in about 50% of them(2).

Different definitions and criteria have emerged today to acute kidney injury.

For this purpose, RIFLE (Risk-Injury-Failure-Loss-End stage) (3), AKIN (Acute Kidney Injury Network) (4) and KDIGO (The Kidney Disease: Improving Global Outcomes) (5) classifications have been developed. All three classifications are based on serum creatinine level, hourly urine output, or GFR (glomerular filtration rate) to define the presence or severity of kidney injury. Postoperative acute kidney injury can be detected in diabetic patients who will undergo cardiopulmonary bypass surgery and have normal renal function using RIFLE, KDIGO, AKIN and SOFA classifications. In this way, postoperative intensive care unit stay, mortality and morbidity can be reduced.

Our aim is to determine the effect of AKIN, KDIGO, SOFA and RIFLE scores diabet patients who underwent Pump-Assisted Coronary Artery Bypass Graft operation

Materials and Methods

Compliance with Ethical Standards This study was approved by the XXXX Hospital Clinical Research Ethics Committee (approval number: 2023/185, date: 16.10.2023) and conducted in accordance with the principles of the Helsinki Declaration. The participants were informed that the data would only be used for scientific purposes.

Patients who underwent Pump-Assisted Coronary Artery Bypass Graft (CABG) operation and had diabetic were included in the study. Among 1258 patients who were operated on in our clinic between January 2019 and December 2022, 310 diabetic patients who underwent Cabg operation, between 30-80 years old, elective operation, were included in this study. After the patients were admitted, the procedures to be performed were explained. Informed consent form was signed by the patients. We are our exclusion criteria in our study are with disease requiring additional surgical intervention such as valve replacement, without diabetes, previously known renal failure, renal transplantation, preoperative creatinine level >2.5 mg/dL, and those who died within the perioperative period and the first 24 hours of the postoperative period. Additionally, those with HbA1c values below 6.5 mg/dl were not included in the study.

Preoperative demographic information and laboratory values (2) of the patients [complete blood count (CBC), aspartate aminotransferase (AST), alanine aminotransferase (ALT), blood urea nitrogen (BUN), creatinine, sodium (Na+), potassium (K+), calcium (Ca2+), coagulation profile] was recorded. Preoperative creatinine value was accepted as baseline value.

Median sternotomy was performed in all patients. The cannulas of the heart-lung pump were placed in the patients and the extracorporeal circulation was kept ready, the aorta was not clamped, cardioplegia and systemic hypothermia were not applied. The pump was activated when the mean blood pressure fell below 50 mmHg, and the pump was not activated when the hemodynamics was stable. In this way, access to the circumflex system was also provided when necessary

Perioperative hemodynamic data, pump duration, perioperative urine output, use of inotropes, and hemoglobin values before and after the pump were recorded.

In the cardiovascular surgery intensive care unit follow-up of the patients, anesthesia card, intensive care follow-up charts, need for continuous renal replacement therapy, use of diuretics, use of inotropic agents, mechanical ventilator therapy, SOFA score, use of nephrotoxic drugs, and urine output were recorded. The RIFLE, KDIGO and AKIN scores of the patients were calculated daily and the highest value during the hospitalization was recorded. In addition to the length of stay in the intensive care unit and hospital, the death and discharge status of the patients were also evaluated.

The standardization of diagnosis, Risk, Injury, Failure, Loss and End-stage (RIFLE) of Acute Kidney Injury (AKI) was defined in 2004 by Bellomo et al. (3). Then, in 2007, Mehta et al.(4) Acute Kidney Injury Network (AKIN) and in 2012 Arif Khwaja.(5) Kidney Disease: Improving Global Outcomes (KDIGO) classifications were defined.

These classifications are calculated according to serum creatinine and urine levels. It consists of 3 sections within itself. In RIFLE classification is 2 stages (“L - Loss” and “E-End Stage Kidney Disease. Additionally, 48-hour creatinine and urine changes are taken into account in the AKIN classification. (6,7).

Definitions

- KDIGO:

  Creatinine increase by > 0.3 mg/dL over 48 hours; or

  Increase in creatinine value more than 1.5 times normal. or

  Urine volume in 6 hours is less than 0.5 ml/kg/hour(8).
- RIFLE:
  Increased creatinine by 1.5 times; or

  GFR decrease by >25%; (9).

- AKIN:
  Increase 1.5-1.9 times from baseline; or
  ≥0.3 mg/dl increase within 48 h (10).

Statistical Method

Statistical evaluation was performed using the SPSS 15.0 ((SPSS Inc., Chicago, IL, USA) package. Parametric data are expressed as mean ± standard deviation, and non-parametric data as median (mean, standard deviation, minimum, maximum, median for the numerical). The independent samples t-test (the distributions normal) was used to compare parametric data, whereas the Mann-Whitney U test was used to compare non-parametric data. A Logistic Regression model was used to analyze categorical data. Statistical significance level was accepted as $p<0.05$.

Results

The mean pump time of the patients was 106.3±78.5 minutes. The mean baseline creatinine value was 0.7±0.2 mg/Dl, GFR rate was 81.2±31.6, and the mean preoperative hemoglobin level was 12.1±1.8 g/dL.

77.1% of the patients had at least one chronic disease, 27.8% had only hypertension, 15% had peripheral artery disease, 22.8% had COPD, 12.5% had other diseases (CVO, thyroid pathology, epilepsy, infective endocarditis).

Death was observed in 7,8 % of the patients included in the study. Not all of the deaths were due to renal failure, but these patients were seen to be in any stage of AKI with respect to the KDIGO, AKIN and RIFLE classification. When we compared these classifications, it was found that the mortality rate increased statistically as the AKI stage increased (A Logistic Regression model was used to analyze categorical data. Statistical significance level was accepted as $p<0.05$.) **(Table1).**

.		Exitus n=27 (%10)	Taburcu n=283 (%70,6)	p
Gender n (%)	Men	57 (62,6)	121 (55,3)	0,231
	Women	34 (37,4)	98 (44,7)	
Age		56,8±10,3	58,9±10,6	0,207
Weight (kg)		77,7±13,1	78,5±12,9	0,915
Size (cm)		171,4±42,2	168,1±8,0	0,457
BMI		27,2±4,7	27,9±4,7	0,465
Background n (%)	HT	35 (38,5)	83 (37,9)	1,000
	Ischemic Heart Disease	49 (53,8)	136 (62,1)	0,177
	Peripheral Artery Disease	3 (3,3)	11 (5,0)	0,765
	Other Systemic Diseases	16 (17,6)	62 (28,3)	0,047
CPB duratıon		106,7±91,7	105,3±28,3	0,315
EF%		50,5±10,4	48,5±10,3	0,068

Table 1. Demographic data of the patients

It was determined that 38.6% of the patients according to the KDIGO and AKIN classifications and 29.4% according to the RIFLE classification were at one of AKI stages.

Death occurred in 17.8% of those with any stage AKI according to the KDIGO and AKIN classification. The incidence of AKI in patients with chronic disease was found to be statistically significantly higher in the AKIN and KDIGO classifications. In the RIFLE classification pump time, perioperative and postoperative blood transfusion averages were found to be statistically significant in patients with AKI. (Table 2).

According to the RIFLE classification, the mean preoperative hemoglobin level was found to be statistically significantly lower in patients with AKI.

In the AKIN classification, mean basal creatinine value was statistically significantly higher in patients with AKI, and mean preoperative hemoglobin level and mean GFR level were statistically significantly lower.

Each increase in the preoperative hemoglobin level was found to be protective for the development of AKI according to the RIFLE, AKIN, and KDIGO classifications (A Logistic Regression model was used to analyze categorical data. Statistical significance level was accepted as $p<0.05$.) **(Table 2).**

.		Total	Exitus (n=27)	Discharged (n=283)	p
AKI Stage according to AKIN Criteria n (%)	0	105 (33,9)	30 (33,0%)	75 (34,2%)	0,991
	1	160 (51,6)	47 (51,6%)	113 (51,6%)	
	2	23 (7,4)	7 (7,7%)	16 (7,3%)	
	3	22 (7,1)	7 (7,7%)	15 (6,8%)	
AKI Stage according to KDIGO Criteria n (%)	0	107 (34,5)	31 (34,1)	76 (34,7)	0,993
	1	158 (51,0)	46 (50,5)	112 (51,1)	
	2	23 (7,4)	7 (7,7)	16 (7,3)	
	3	22 (7,1)	7 (7,7)	15 (6,8)	
AKI Stage according to RIFLE Criteria n (%)	0	261 (84,2)	76 (83,5%)	185 (84,5%)	0,996
	1	30 (9,7)	9 (9,9%)	21 (9,6%)	
	2	16 (5,2)	5 (5,5%)	11 (5,0%)	
	3	3 (1,0)	1 (1,1%)	2 (0,9%)	
SOFA Score (renal) n (%)	Score 0	233 (75,2)	68 (74,7%)	165 (75,3%)	0,988
	Score 1	42 (13,5)	12 (13,2%)	30 (13,7%)	
	Score 2	22 (7,1)	7 (7,7%)	15 (6,8%)	
	Score 3	13 (4,2)	4 (4,4%)	9 (4,1%)	

Table 2: Characteristics of mortality data according to AKIN, RIFLE, KDIGO and SOFA

Discussion

Acute renal failure (ARF) is the loss of renal function that occurs with a sudden increase in serum creatinine level (1). Acute kidney injury seen after operation cause high mortality rates, long hospital stays and increased health expenditures (11). Similar results were found in our patients

Acute kidney injury (AKI) after coronary artery bypass surgery (CABG) is associated with many adverse outcomes, including increased risk of renal failure (ESBD), prolonged hospital stay, increased morbidity, and short- and long-term mortality (12)

The need for postoperative inotropes and additional support devices such as intra-aortic balloon pumps (IABPs) may impair renal functions by affecting renal perfusion(13).

Glomerular filtration rate (GFR), which are measured in the preoperative period as an indicator of acute kidney injury that may occur in the postoperative period, are used to evaluate kidney functions (14).A minimal increase in creatinine after coronary artery bypass grafting can increase 30-day mortality by 3-fold and cause severe ABD requiring dialysis. (15)

Duminda et al. (16) showed that the basal creatinine value was substantially higher and the GFR level was significantly lower in their retrospective study. We did not find any significant results between the basal creatine value and postoperative acute renal failure.

During coronary bypass; hypoperfusion, inflammation, oxidative stress, nephrotoxins and mechanical factors are the factors affecting renal functions. Acute kidney injury due to CPB used in cardiac surgery continues despite new methods and materials used. Peng et al. (17) stated in their study that prolonged cardiopulmonary bypass (CPB) duration increases hemolysis. They also reported that increased hemolysis causes free hemoglobin to act as an endogenous toxin and causes pigment nephropathy, which is a risk factor for AKI. (17).

A decrease in the patient's hematocrit values increases the likelihood of AKI. It has been revealed that the incidence rate is high in patients with a hematocrit level below 21-24% (18). In a study by Erdost et al.(19), they showed that a preoperative hemoglobin level of <10 mg/dL increased the risk of developing AKI 2.83 times according to RIFLE classifications.

These classifications are calculated according to serum creatinine and urine levels. It consists of 3 sections within itself. In RIFLE classification is 2 stages (“L - Loss” and “E-End Stage Kidney Disease). Additionally, 48-hour creatinine and urine changes are taken into account in the AKIN classification (17).

In most of the related studies, it has been reported that all three classifications can be used to predict mortality (6,7). In our study, it was determined that the mortality rate increased statistically as the AKI stage increased according to the RIFLE, AKIN and KDIGO classification.

Sampaio et al.(20) found the incidence of AKI to be 15% according to the RIFLE classification, 51% according to the AKIN classification and 19% according to the KDIGO classification. In a prospective study involving 282 patients, Maarten et al.(21) found AKI at any stage to be 45.8% according to the RIFLE classification and 44.7% according to the AKIN classification. Robert et al. (22) found the frequency of AKI to be 30% according to the AKIN classification and 31% according to the RIFLE classification in their study in which 25086 patients were included. In our study, it was determined that 38.6% of the patients were in one of the AKI stages according to the KDIGO and AKIN classification, and 29.4% according to the RIFLE classification.

While acute renal failure due to hospitalization is seen in 2-18%, this rate is approximately 30% after coronary artery bypass surgery (23). Englberger et al.(24,25) reported in study in which they included 4836 patients after cardiac surgery, that hospital mortality rate increased as AKI stage increased according to RIFLE and AKIN classifications and ıt was shown that the hospital mortality rate was significantly higher in patients with renal failure at any stage according to the RIFLE and AKIN classifications (26,27).

Although some studies show that these classifications are effective in determining mortality, there are also studies that do not support this. (28,29). In our study, while mortality increased as the degree of ABY increased in all 3 staging systems, a statistically significant increase was observed only in stage 3 of the KDIGO classification. In our study, it was determined that the mortality rate increased statistically as the AKI stage increased according to the RIFLE, AKIN and KDIGO classification.

Depending on whether there is CPB, it can be divided into pumped off-pump and non-pumped off-pump(30). In general, it has been reported that the pump-operated group has a higher AKI rate than the non-pumped group(31), but there is no difference in mortality and renal failure outcomes (32,33). In our study, we used the off-pump bypass method in our intervention to the patients.

Study limitations

The data used in this study were obtained from one hospital. Despite these limitations, the study is important in terms of early diagnosis of acute renal failure after cardiopulmonary bypass, reducing postoperative intensive care unit stay, mortality, and morbidity.

Conclusion

Determining acute renal failure in coronary artery bypass patients supports the healthier outcome of the patients' postoperative period. In this study, we were able to determine this with certain tests.

Ethics Committee Approval: The study protocol was approved by the SBU Istanbul Training and Research Hospital Clinical Research Ethics Committee (16.102023 / 185-2023).

Conflict of Interest: There is no conflict of interest.

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Use of artificial intelligence: This work did NOT use artificial intelligence (AI)-enabled technologies (such as Large Language Models [LLMs], chatbots, or image generators) in its production.

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