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Original Article

# The relation between the timing of coronary angiography and renal function post coronary artery bypass grafting

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## Abstract

**Background:** Acute kidney injury is a serious complication after coronary artery bypass grafting (CABG). This work aimed to assess the impact of the timing of coronary angiography on kidney function after on-pump coronary artery bypass grafting.

**Methods:** We included 60 patients who underwent elective isolated on-pump coronary artery bypass grafting from 2017 to 2018 at the National Heart Institute and Benha University Hospital. We divided the patients into two groups; group I included 30 patients with coronary angiography performed less than seven days prior to CABG, and Group II included 30 patients who had coronary angiography more than seven days prior to CABG. Postoperative acute kidney injury was defined according to the consensus kidney disease: Improving Global Outcomes Definition and Staging criteria.

**Results:** The mean body mass index was significantly higher in group I (35.89 ±5.15 Kg/ m² vs. 31.72±4.99 Kg/ m², P = 0.002). The mean preoperative hemoglobin was higher in group II (12.7 ± 1.5 g/dl vs. 13.9 ± 1.5 g/dl, P = 0.004). The frequency of acute kidney damage was higher in patients who had coronary angiography less than seven days before CABG but did not reach a significant level (46.7 % vs. 30%, P =0.184). There was no difference in the creatinine postoperatively between both groups (1.2 ±0.5 vs. 1 ±0.3 mg/dl; p= 0.214).

**Conclusions:** We found no association between the timing of coronary angiography before on-pump coronary artery bypass graft surgery and postoperative acute kidney injury.

KEYWORDS

Coronary Angiography; Timing of Coronary Angiography; Kidney Function; On-Pump Coronary Artery Bypass

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## Introduction

Poor cardiac function can affect the kidney through several mechanisms [1]. Acute kidney injury (AKI) is common after coronary artery bypass grafting (CABG), especially when cardiopulmonary bypass (CPB) is used [2]. Preoperative coronary angiography may cause contrast-induced nephropathy and affect the renal function further in coronary artery disease patients [3].

Acute kidney injury (AKI) increases morbidity and mortality after CABG. The incidence of AKI varies among studies, which could be attributed to the different AKI definitions. Current guidelines for AKI diagnosis recommend the use of Kidney

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Disease Improving Global Outcomes (KDIGO) criteria, which are based on an exhaustive evidence-based review of the literature [4]. The aim of this work was to assess the impact of the timing of coronary angiography on kidney function after on-pump coronary artery bypass grafting.

## Patients and Methods:

### Study subjects:

This prospective cohort study included 60 patients with ischemic heart disease who underwent elective isolated on-pump coronary artery bypass grafting from 2017 to 2018 at the National Heart Institute and Benha University Hospital. The study protocol was approved by the Ethical Committee of Benha Faculty of Medicine. Written informed consent was obtained from the patients prior to enrollment. The patients were divided into 2 groups; Group I included 30 patients with coronary angiography performed less than 7 days before CABG, and Group II included 30 patients who had coronary angiography more than 7 days before CABG. We used 7 days as a cutoff according to statistical analysis of Kim and associates and a previous report suggesting that after exposure to contrast, renal function usually comes back to prior levels within 7 to 21 days [3, 5, 6].

Patient with poor cardiac function (ejection fraction < 30%), serum creatinine > 1.3 mg/dL, and those who had re-operative or concomitant operations and uncontrolled diabetes mellitus were excluded. The baseline laboratory values were recorded the day preceding surgery or just prior to surgery when coronary angiography was performed on the same day of the operation. Preoperative, operative and postoperative data were prospectively collected and entered into a computerized database.

### Data collection:

Preoperative data included patients' demographics, laboratory data (serum creatinine, and estimated glomerular filtration rate (eGFR) calculated using the Modification of Diet in Renal Disease (MDRD) study equation), echocardiographic findings and cardiac catheterization data.

Operative data included total CPB and cross-clamp times, intraoperative bleeding, arrhythmias, and urine output.

Postoperative data included serum creatinine levels, urine output, inotropic support, intraoperative balloon pump (IABP), blood transfusion, and complications (bleeding, reopening, chest Infection, wound infection, arrhythmia, reintubation, and renal dialysis), in-hospital mortality and intensive care unit (ICU) and hospital stay period.

*Table 1: Demographic data. (Continuous variables are presented as mean and standard deviation and categorical variables as number and percent)*

| | Group I (n = 30) | Group II (n = 30) | P-value |
|---|---|---|---|
| Age (years) | 54 ±9 | 55 ±8 | 0.736 |
| Males | 24 (80.0 %) | 26 (86.7 %) | 0.488 |
| Height (cm) | 165 ±5 | 166 ±5 | 0.361 |
| Weight (kg) | 98±14 | 87 ±13 | 0.005 |
| BMI (kg/ m²) | 35.89±5.15 | 31.72±4.99 | 0.002 |
| Hypertension | 20 (66.7 %) | 18 (60.0 %) | 0.592 |
| Diabetes mellitus | 14 (46.7 %) | 12 (40.0 %) | 0.602 |
| Smoking | 18 (60.0 %) | 17 (56.7 %) | 0.793 |
| Present history of RD | 1 (3.3 %) | 3 (10.0 %) | 0.612 |
| Past history of RD | 0 (0.0) | 3 (10.0 %) | 0.237 |
| Medications for RD | 0 (0.0) | 1 (3.3 %) | >0.99 |

BMI: Body Mass Index; RD: Renal Disease

*Table 2: Preoperative laboratory data. (Continuous variables are presented as mean and standard deviation and categorical variables as number and percent)*

| | Group I (n = 30) | Group II (n = 30) | P-value |
|---|---|---|---|
| HB (g/dl) | 12.7 ±1.5 | 13.9 ±1.5 | 0.004 |
| HbA1C (%) | 6.1 ±0.8 | 6 ±0.9 | 0.765 |
| Serum creatinine(mg/dl) | 1 ±0.3 | 0.9 ±0.2 | 0.605 |
| Serum urea (mg/dl) | 38.5 ±18 | 33.2 ±9.7 | 0.163 |
| eGFR (ml/min/1.73m²) | 86 ±33 | 88 ±27 | 0.792 |

Hb: Hemoglobin; HbA1C: Glycated Hemoglobin Test; eGFR: Estimated Glomerular Filtration Rate

### Definitions and endpoint:

The primary endpoint was the postoperative AKI defined according to Kidney Disease: Improving Global Outcomes Definition and Staging (KDIGO) criteria utilizing the maximal change in serum creatinine (sCr) during the initial seven postoperative days compared to the preoperative values. AKI was defined by one of the following: an elevation in sCr 0.3 mg/dL or more within 48 hours or an increment in sCr 1.5 times the baseline value or more, which was known to have happened within the earlier seven days. AKI additionally was staged for severity by the following features: Stage 1, increase in sCr 0.3 mg/dL or more or up to 1.5 till 1.9 times the baseline value. Stage 2; increase in sCr to 2.0 to 2.9 times the baseline value. Stage 3; rise in sCr 3.0 mg/dL or higher or the initiation of renal replacement therapy (RRT) [3-7].

### Statistical Analysis

Data management and statistical analysis were performed using SPSS vs.25. (IBM, Armonk, New York, United States). Numerical data were summarized as means and standard deviations. Categorical data were summarized as numbers and percentages. Comparisons between two groups were performed using the independent t-test. Categorical data were compared using the Chi-square test or Fisher's exact test when appropriate. P-values less than 0.05 were considered significant [8].

## Results

### Preoperative data:

The demographic data of the patients are shown in Table 1. The mean weight was higher in patients who underwent coronary angiography in less than seven days before CABG (98 ± 14 Kg vs. 87 ± 13 Kg, P = 0.005). The mean body mass index (BMI) was significantly higher in Group I (35.89 ± 5.15 Kg/m² vs. 31.72±4.99 Kg/m², P = 0.002). There was no difference between groups in other variables.

*Table 3: Preoperartive cardiac catheterization data. (Continuous variables are presented as mean and standard deviation and categorical variables as number and percent)*

| | Group I (n = 30) | Group II (n = 30) | P-value |
|---|---|---|---|
| LM | 11 (36.7 %) | 6 (20.0 %) | 0.152 |
| LAD | 29 (96.7 %) | 30 (100.0 %) | >0.99 |
| Diag. | 7 (23.3 %) | 7 (23.3 %) | >0.99 |
| LCX | 27 (90.0 %) | 21 (70.0 %) | 0.053 |
| OM | 12 (40.0 %) | 10 (33.3 %) | 0.592 |
| RCA | 27 (90.0 %) | 22 (73.3 %) | 0.095 |
| PDA | 5 (16.7 %) | 4 (13.3 %) | >0.99 |

LM: The Left Main Coronary Artery; LAD: Left Anterior Descending branch of LM; Diag.: Diagonal branches of LAD; LCX: Left Circumflex branch of LM; OM: Obtuse Marginal branches of LCX; RCA: The Right Coronary Artery; PDA: The Posterior Descending Artery

*Table 4: Urine Output (ml/kg/hr) Intraoperative and postoperative. (Continuous variables are presented as mean and standard deviation and categorical variables as number and percent)*

| Urine output | Group I (n = 30) | Group II (n = 30) | P-value |
|---|---|---|---|
| Intraoperative (ml/kg/hr) | 7.8 ±3.4 | 9.4 ±3.9 | 0.086 |
| Immediate postoperative (ml/kg/hr) | 1.7 ±0.5 | 1.9 ±0.7 | 0.076 |
| At day 1 (ml/kg/hr) | 1.6 ±0.5 | 1.8 ±0.7 | 0.118 |
| At day 2 (ml/kg/hr) | 1.6 ±0.5 | 1.5 ±0.5 | 0.543 |

Preoperative laboratory findings of the patients are described in Table 2. The mean preoperative hemoglobin was higher in those who underwent coronary angiography in less than seven days before CABG (13.9 ±1.5 g/dl vs. 12.7 ±1.5 g/dl, P = 0.004). The preoperative cardiac catheterization findings showed no differences between the two groups. (Table 3)

### Operative and postoperative data:

Urine Output did not differ significantly between the two groups. (Table 4) Inotropic support, IABP, blood transfusion, and postoperative complications showed non-significant differences between the two groups. (Table 5) IABP was inserted post-CABG surgery for 2 patients, and during the induction of anesthesia in one patient with high-risk CABG surgery in group I. Temporary renal dialysis (≤ 3 times) was reported in one patient in group II. Creatinine level, AKI, and KDIGO staging showed non-significant differences between the two groups. (Table 6 and 7) We did not have operative mortality reported in our study.

## Discussion

In this prospective study of 60 patients who underwent elective isolated CABG using CPB, we found that the period between coronary angiogram and surgery had no effect on postoperative AKI. In this study, postoperative AKI was defined according to Kidney Disease: Improving Global Outcomes Definition and Staging (KDIGO) criteria utilizing the maximal change in serum creatinine during the initial seven postoperative days in comparison to preoperative baseline values.

The 30 patients in Group I who underwent surgery after less than seven days of coronary angiogram had an increased incidence of postoperative AKI (n=14; 46.7%) than those in Group II (n=9; 30%). However, AKI and KDIGO staging showed non-significant differences between the two groups.

Despite the transient nature of contrast-induced nephropathy, it may cause persistent renal impairment and adverse cardiovascular consequences. There are a variety of risk factors that may affect the occurrence of contrast-induced nephropathy, and the prediction of CIN remains difficult [9]. Consistent with our study, Ko and colleagues found that the time between coronary angiogram and cardiac surgery was not a risk factor of AKI. AKI happened in 35% of 433 patients operated within three days of coronary

*Table 5: Comparison of postoperative complications between the groups. (Continuous variables are presented as mean and standard deviation and categorical variables as number and percent)*

| | Group I (n = 30) | Group II (n = 30) | P-value |
|---|---|---|---|
| Inotropic Support | 26 (86.7 %) | 23 (76.7 %) | 0.317 |
| IABP | 3 (10.0 %) | 0 | 0.237 |
| Blood transfusion | 26 (86.7 %) | 27 (90.0 %) | >0.99 |
| Hemorrhage | 6 (20.0 %) | 4 (13.3 %) | 0.488 |
| Reopening | 2 (6.7 %) | 4 (13.3 %) | 0.671 |
| Chest infection | 0 | 3 (10.0 %) | 0.237 |
| Wound infection | 3 (10.0 %) | 1 (3.3 %) | 0.301 |
| Other complications | 3 (10.0 %) | 4 (13.3 %) | >0.99 |

IABP: Intra-aortic Balloon Pump insertion

*Table 6: Postoperative serum creatinine levels (mg/dl) during the hospital stay. (Continuous variables are presented as mean and standard deviation and categorical variables as number and percent)*

| | Group I (n = 30) | Group II (n = 30) | P-value |
|---|---|---|---|
| Immediate postoperative | 1.1 ±0.4 | 1 ±0.3 | 0.21 |
| At day 1 | 1.2 ±0.5 | 1 ±0.3 | 0.214 |
| At day 2 | 1.1 ±0.5 | 1 ±0.4 | 0.483 |
| At day 3 | 1.1 ±0.4 | 1 ±0.3 | 0.307 |
| At day 4 | 1 ±0.3 | 1 ±0.4 | 0.687 |
| At day 5 | 1 ±0.3 | 1 ±0.4 | 0.843 |
| At day 6 | 0.9 ±0.3 | 1 ±0.4 | 0.776 |
| At discharge | 0.9 ±0.3 | 0.9 ±0.2 | 0.89 |

angiogram versus 31% of 1700 patients operated after three days. Acute kidney injury was defined according to the AKI network and the Risk, Injury, Failure, Loss, End-stage (RIFLE) criteria [10]. Similarly, Palazouelos and colleagues have shown that the timing of coronary angiography did not affect the development of postoperative AKI [11].

Andersen and coworkers in a study of 285 consecutive patients, concluded that cardiac surgery within 1-3 days of coronary angiography was safe and not associated with acute kidney injury [12].

*Table 7: AKI and KDIGO Staging in the study groups. (Continuous variables are presented as mean and standard deviation and categorical variables as number and percent)*

| | | Group I (n = 30) | Group II (n = 30) | P-value |
|---|---|---|---|---|
| **AKI** | | 14 (46.7 %) | 9 (30.0 %) | 0.184 |
| **KDIGO** | **0** | 16 (53.3 %) | 21 (70.0 %) | 0.180 |
| | **1** | 14 (46.7 %) | 8 (26.7 %) | |
| | **2** | 0 (0.0) | 1 (3.3 %) | |

AKI: Acute kidney injury; KDIGO: Kidney Disease Improving Global Outcomes

In contrast to our study, Kim and colleagues found the rate of acute kidney injury was greater in patients who had coronary angiography 7 days or less before coronary artery bypass grafting. There was notable interaction between the timing of coronary angiography and the utilization of cardiopulmonary bypass for postoperative acute kidney injury [5].

In the study by Mehta and coworkers, they found the risk of post-CABG AKI was related to the time between cardiac catheterization and CABG, with the greatest frequency in those operated ≤1 day after cardiac catheterization in spite of their lower risk profile. AKI was characterized as an increase in post-CABG serum creatinine ≥ 50% above baseline or the requirement for new dialysis. AKI occurred in 17.1% of CABG patients and occurred in 24.0%, 18.4%, 17.3%, 16.4%, and 15.8% for days ≤1, 2, 3, 4, and ≥5, respectively; (P= 0.019) [13].

Jiang and colleagues in a study on 1069 patients who underwent cardiac catheterization and cardiac surgery successively found that catheterization within 7 days of cardiac surgery was associated with the onset of acute kidney injury [14].

Tecson and colleagues in a study on 965 patients who had coronary angiography followed by cardiac surgery found that 13.1% had contrast-induced acute kidney injury; 13.8% had major adverse renal and cardiac events within 30 days and 26.2% within 1 year of surgery. They reported that patients undergoing coronary artery bypass graft surgery within one day of coronary angiography had a twofold increment in the risk of adverse cardiac and renal complications [15].

The difference between studies could be attributed to the different definitions of acute kidney injury and various patients' population [16]. This study found no effect of the timing of coronary angiography on postoperative renal outcomes in patients undergoing on-pump coronary artery bypass grafting, and patients can proceed with surgery within 7 days of the coronary catheterization.

## Study limitations

The study has several limitations, including the small patients' number compared to the published series. There was a difference in the preoperative characteristics, and the postoperative renal function can be affected by several variables not measured in this study. Another limitation is the different surgical teams and perfusionists who performed the surgery in our cohort, which could have affected the outcomes.

## Conclusion

We found no association between the timing of coronary angiography before on-pump coronary artery bypass graft surgery and postoperative acute kidney injury. According to the current study, recent cardiac catheterization should not be a contraindication for coronary artery bypass surgery; however, we recommend conducting larger study to confirm our findings.

**Conflict of interest:** Authors declare no conflict of interest.

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