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**Original Article**

# Timing of Coronary Artery Bypass Grafting Surgery after Acute Myocardial Infarction

**Ahmed Fakhry[1], Yahia Balbaa[2], Waleed G Abo Senna[2], Hesham Z Saleh[2]**

[1] Department of Cardiothoracic Surgery, Faculty of Medicine, Beni-Suef University, Beni-Suef, Egypt

[2] Department of Cardiothoracic Surgery, Faculty of Medicine, Cairo University, Giza, Egypt.

## Abstract

**Background:** The optimal timing for coronary artery bypass grafting (CABG) surgery after myocardial infarction remains a matter of debate. Our study aimed to analyze the effect of the timing of CABG surgery after acute myocardial infarction on operative mortality and morbidity.

**Methods:** This prospective study included 60 patients who underwent isolated CABG within 30 days of acute myocardial infarction from November 2014 to June 2016 in Kasr Al-Ainy University Hospitals. Patients were divided into two groups according to the timing of surgery; the early group (0 – 3 days) included 14 patients (23.3%), and the late group (4 – 30 days) included 46 patients (76.7%). The outcomes of the study were all-cause hospital mortality and morbidity.

**Results:** Our study included 43 males (71.7%), and the mean age was 58.4 ± 7.3 years. Five patients had preoperative arrhythmia (36%) in the early group vs. two patients in the late group (4%) (p=0.006). The use of an intra-aortic balloon pump (IABP) preoperatively was required in four patients (6.7%); all were in the early group (p= 0.002). Preoperative high inotropic support was required in 11 (78.6%) in the early group vs. 5 (10.9%) in the late group (p< 0.001). Postoperative IABP was required in 6 (42.9%) patients in the early group vs. 4 (8.7%) patients in the late group (p= 0.007). The duration of mechanical ventilation was 19.9±18.9 hours in the early group vs. 9±13.6 hours in the late group (p= 0.001). The duration of ICU stay was 102.5±77.8 and 55.8±22 hours in the early and late groups, respectively (p= 0.001). The total mortality rate was 5 (8.3%) patients; 3 (21.4%) in the early group vs. 2 (4.3%) in the late group (p = 0.078).

**Conclusion:** We reported higher mortality and morbidity if CABG is performed in the first three days after acute myocardial infarction. The course of patients who had late CABG was better than who had early CABG.

**KEYWORDS**

Acute myocardial infarction; Coronary artery bypass grafting; Timing; Hospital mortality

**Article History**

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## Introduction

About 20% of patients with myocardial infarction (MI) will have coronary artery bypass grafting (CABG) surgery [1]. The optimal timing for performing CABG after acute MI remains a matter of debate [2].

Recent studies showed that primary percutaneous coronary intervention (PCI) has superior results than thrombolytic therapy leading to the wide use of primary PCI in the peri-infarct period [3]. This recent approach reveals more patients requiring surgical revascularization after

**Corresponding author:** Ahmed Fakhry fakhry2000@hotmail.com

MI, especially when they have failed PCI or when PCI is not feasible [4].

Early surgical intervention after acute MI was accompanied by a higher incidence of operative and postoperative complications. However, mortality rates are widely variable between different studies ranging from 3.6% to 42.9% [5]. The introduction of new strategies, such as mechanical circulatory support and myocardial protection, has improved the outcome of emergency CABG after myocardial infarction, even in the setting of cardiogenic shock [6, 7].

Identification of the optimal timing of CABG after acute MI and recognition of the risk factors for mortality and morbidity could improve the outcomes of surgery. This study aimed to analyze the effect of timing of CABG after acute MI on postoperative mortality and morbidity and to determine factors associated with mortality in CABG after acute MI.

## Patients and Methods:

### Study design

This study was conducted in the Department of Cardiothoracic Surgery in Kasr Al-Ainy University hospitals, as a prospective observational study in the period between November 2014 and June 2016. The study involved 60 patients who underwent coronary artery bypass surgery after acute myocardial infarction. Patients were divided into two groups; the early group included patients who underwent CABG between days 0 – 3 from acute MI, and the late group included patients who underwent CABG from day four up to day 30 after acute MI.

### Inclusion and exclusion criteria:

This study included patients who underwent isolated coronary artery bypass surgery within 30 days of acute myocardial infarction. Patients who underwent redo-CABG surgeries, concomitant cardiac procedures such as valve replacement or repair or ventricular surgical restoration, and patients with severe comorbidities (renal or liver failure) were excluded from this study.

### The protocol of management:

Patients were diagnosed with acute MI in the Cardiology Department. Trials of reperfusion with the primary percutaneous coronary intervention (PCI) or thrombolytic therapy were done as a first choice.

Patients were referred for surgical revascularization under the following conditions; 1) failed PCI or unsuitable anatomy for PCI; 2) patients with persistent ischemia refractory to nonsurgical therapy and 3) emergency CABG was done for those with a left-main disease, hemodynamic instability refractory to medical therapy and cardiogenic shock or life-threatening ventricular arrhythmias.

### Operative protocol:

All patients were subjected to peri-operative monitoring of arterial blood pressure by insertion of the radial arterial line. Central venous (subclavian or jugular) and peripheral venous lines were used. Five-lead ECG and peripheral oxygen saturation were monitored continuously. The nasopharyngeal temperature probe was used for monitoring the core temperature, and a Foley catheter was used to monitor the urine output.

After median sternotomy, the left internal mammary artery was dissected, and harvesting of the saphenous vein was performed simultaneously. After full heparinization, aortic and venous cannulation was performed, and ventricular venting was accomplished through aortic root cannula. Cardiopulmonary bypass (CPB) was commenced, and we administered antegrade warm blood cardioplegia. Distal anastomoses were performed with continuous 7/0 or 8/0 polypropylene sutures, and proximal anastomoses were performed under partial aortic occlusion using 6/0 polypropylene sutures. Intra-aortic balloon pump (IABP) was used in case of failure of weaning from bypass with inotropes.

All patients were transferred to the intensive care unit (ICU) on mechanical ventilation, where monitoring of the hemodynamic parameters was ensured. All patients were observed for the development of postoperative complications, including; arrhythmia, postoperative myocardial infarction, low cardiac output, re-exploration for bleeding, wound infection, respiratory complications, neurological problems, or renal dysfunction. Additionally, hospital mortality, duration of mechanical ventilation, ICU, and postoperative hospital stay were recorded.

### Definitions:

Myocardial Infarction was diagnosed by the detection of the rise of cardiac biomarkers and symptoms of ischemia and/or ECG changes consistent with myocardial ischemia or infarction [8]. Cardiogenic Shock was defined as a systolic blood pressure less than 90 mmHg in the presence of inotropic support and adequate intravascular volume with evidence of poor peripheral perfusion (oliguria, cyanosis, and cool extremities) [9].

### Statistical analysis:

Continuous data were expressed as mean ± standard deviation (SD) and categorical data as number (%). A comparison between categorical data was performed using the Chi-square test or Fisher exact test when appropriate. According to the normality, a comparison between continuous variables between the two groups was performed using either unpaired t-test or Mann-Whitney test whenever appropriate. Statistical Package for Social Sciences (SPSS) computer program (version 19 windows, IBM Corp- Chicago- IL- USA) was used for data analysis. P-value < 0.05 was considered statistically significant.

## Results

### Demographic characteristics:

The age of our patients ranged between 40 and 74 years. The mean age was 58.4 ± 7.3 years. The study included 43 males (71.7%). The mean body mass index (BMI) was 28.1 ±3.6 Kg/m2. Thirty-four patients had diabetes (56.7%), and 39 patients had hypertension (65%).

### Clinical and echocardiographic characteristics:

The preoperative ejection fraction (EF) ranged from 35% to 68%, with a mean of 50.6 ± 8.9%. Six patients (10%) had EF less than 40%. ST-elevation MI (STEMI) was reported in 32 patients (53.3%), and NSTEMI was reported in 28 patients (46.7%). According to the area of infarction, the distribution of STEMI patients is illustrated in Figure 1. Seven patients (11.7%) had preoperative arrhythmia. The use of IABP was recorded in 4 patients (6.7%); all of them were in the early group. The study included six patients (10%) who had a preoperative cardiogenic shock. Preoperative mechanical ventilation was required in one patient (1.7%). Baseline characteristics are shown in Table 1.

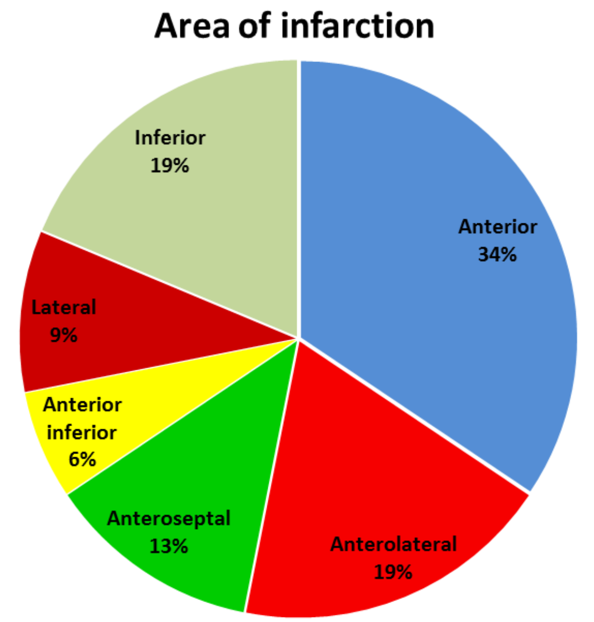


*Figure 1: distribution of STEMI patients according to the area of infarction*

### Operative data:

Cardiopulmonary bypass (CPB) time ranged from 40 to 132 minutes, with a mean of 89.8 ± 17.8 minutes. Cross-clamp time ranged from 28 to 75 minutes, with a mean of 54.1 ± 4.1 minutes. The number of distal anastomoses in our study ranged from 1 to 5 distal anastomoses. The mean value was 3.2 ±1, and the median was 3.

### Postoperative outcomes:

After transfer to the ICU, high inotropic support was reported in 16 patients (26.7%). IABP was used in 10 patients (16.7%); Four patients (6.7%) had IABP before the operation and three patients (5%) after the operation. Three patients (5%) had IABP inserted in the ICU. Six out of 10 patients with IABP (60%) weaned successfully and survived. The duration of mechanical ventilation ranged from 4 to 96 hours. The mean duration in our study was 11.6 ± 15.5 hours, and the median was 7 hours. Postoperative arrhythmias were recorded in 14 patients (23.3%); 10 patients (16.7%) had atrial fibrillation, and four patients

*Table 1: Comparison of baseline characteristics between groups*

| Baseline characteristics | | Total (n=60) | Groups | | p value |
|---|---|---|---|---|---|
| | | | Early (n=14) | Late (n=46) | |
| **Age** (years): (Mean ± SD) | | 58.4 ± 7.3 | 58.7 ± 7.2 | 58.3 ± 7.4 | 0.871 |
| **Gender**: n (%) | Male | 43 (71.7) | 9(64.3) | 34(73.9) | 0.484 |
| | Female | 17(28.3) | 5(35.7) | 12(26.1) | |
| **BMI** (Kg/m$^2$) | Mean ± SD | 28.1 ± 3.6 | 29.6 ± 3.9 | 27.6 ± 3.4 | 0.075 |
| | BMI ≥ 30: n (%) | 21 (35) | 7 (50) | 14 (30.4) | 0.179 |
| **DM**: n (%) | | 34 (56.7) | 10 (71.4) | 24 (52.2) | 0.203 |
| **HTN:** n (%) | | 39 (65) | 10 (71.4) | 29 (63) | 0.565 |
| **EF%** | Mean ± SD | 50.6 ± 8.9 | 42.9 ± 6.9 | 53 ± 8.2 | 0.001 |
| | EF<40: n (%) | 6 (10) | 4 (28.6) | 2 (4.3) | 0.008 |
| **Type of MI** | STEMI: n (%) | 32 (53.3) | 11 (78.6) | 21 (45.7) | 0.037 |
| | NSTEMI: n (%) | 28 (46.7) | 3 (21.4) | 25 (54.3) | |
| **Preoperative arrhythmia:** n (%) | | 7 (11.7) | 5 (35.7) | 2 (4.3) | 0.006 |
| **Preoperative IABP:** n (%) | | 4 (6.7) | 4 (28.6) | 0 (0) | 0.002 |
| **Shock:** n (%) | | 6 (10) | 5 (35.7) | 1 (2.2) | 0.001 |
| **Mechanical Ventilation:** n (%) | | 1 (1.7) | 1 (7.1) | 0 (0) | 0.233 |

n: number; SD: standard deviation; BMI: body mass index; DM: diabetes mellitus; HTN: hypertension; EF: ejection fraction; MI: myocardial infarction; STEMI: ST elevation myocardial infarction; NSTEMI: non-ST elevation myocardial infarction; IABP: intra-aortic balloon pump

(6.6%) had ventricular arrhythmias; 3 cases had ventricular fibrillation, and one case had ventricular tachycardia. Stroke occurred in 3 patients (5%). The duration of the postoperative ICU stay ranged from 32 to 334 hours. Four patients died in the ICU, and one patient died in the ward. The duration of hospital stay ranged from 4 to 23 days. The mean hospital stay was 5.1 ± 2.6 days, and the median was five days. The total mortality occurred in 5 (8.3%) patients. Postoperative outcomes are shown in Table 2.

## Discussion

Our study included 60 patients who underwent CABG within 30 days of acute MI. Despite the lack of standardized timing intervals for the performance of CABG after acute MI, many studies had similar timing to our study [3, 10 - 12].

Regarding the baseline characteristics, the male gender predominated, which is similar to other studies; this can be explained with the higher prevalence of MI in males. [3, 12] The age and body mass index of our patients was comparable to other studies, which showed an increased incidence of MI in elder and obese patients. [11, 13] The incidence of diabetic patients in our study was high, while hypertension rates were comparable to other studies [10, 12,13].

As regards the echocardiographic characteristics, the mean ejection fraction and the association of low EF with early CABG were comparable to other studies [14 - 16]. Patients with lower ejection fraction had early surgery. STEMI was more associated with early CABG in our study; this can be explained by the extensive myocardial insult in those patients with hemodynamic instability requiring rapid intervention. This was similar to studies done by Weiss and coworkers and Nichols and colleagues [3, 14]. Consequently, the preoperative use of IABP was exclusively associated with early CABG. Weiss and colleagues found a significant association between cardiogenic shock and early CABG [3]. One patient in our study (1.7%) required preoperative ventilation and had an early surgery.

*Table 2: Postoperative outcomes, early versus late groups*

| Outcome | Total (n=60) | Early (n=14) | Late (n=46) | p value |
|---|---|---|---|---|
| **Hight Inotropic support:** n (%) | 16 (26.7) | 11 (78.6) | 5 (10.9) | <0.001 |
| **Postoperative IABP:** n (%) | 10 (16.7) | 6 (42.9) | 4 (8.7) | 0.007 |
| **Ventilation time:** (Mean ± SD) | 11.6±15.5 | 19.9±18.9 | 9±13.6 | 0.001 |
| **Postoperative arrhythmia:** n (%) | 14(23.3) | 4(28.6) | 10(21.7) | 0.720 |
| **Stroke:** n (%) | 3(5) | 1(7.1) | 2(4.3) | 0.556 |
| **ICU stay (hours):** (Mean ± SD) | 66.7±45.8 | 102.5±77.8 | 55.8±22 | 0.001 |
| **Hospital stay (days):** (Mean ± SD) | 5.1±2.6 | 5.4±1 | 5±2.9 | 0.720 |
| **Mortality:** n (%) | 5(8.3) | 3(21.4) | 2(4.3) | 0.078 |

n: number; IABP: intra-aortic balloon pump; ICU: internsive care unit; SD: standard deviation.

Bárta and colleagues reported a higher incidence (3.2%) in their study [13]. Patients with preoperative IABP, cardiogenic shock, and mechanical ventilation were unstable patients and required early intervention. These findings demonstrate that patients who had early CABG were more hemodynamically compromised, which put them at higher surgical risk.

Analysis of the operative data in our study revealed that cardiopulmonary bypass (CPB) time, cross-clamp time, and the number of distal anastomoses were comparable to many other studies [10, 11, 14, 15, 17]. Patients in our cohort had internal mammary artery harvest, which made the operative and bypass times comparable to patients with elective surgery.

In the early postoperative period, some patients needed pharmacological and/or mechanical support. High inotropic support was reported in 26.7% and IABP in 16.7% of our patients. These results were higher than in other studies. Bana and colleagues reported high inotropic support in 12.5% and IABP support in 9.7% of patients [18]. There was a significant association between pharmacological and mechanical support and early CABG. The mean mechanical ventilation time in our study was lesser than that reported by other studies and was significantly higher in the early group, which reflects their hemodynamically unstable condition. A study done by Thielmann and coworkers on 138 STEMI patients reported a mean ventilation time of 18 hours [19].

Regarding the incidence of postoperative arrhythmia, our results were comparable to the study done by Nichols and associates. They also reported no significant difference between early and late groups [14]. On the other hand, studies done by Abd-Alaal and coworkers and Creswell and colleagues reported a significantly higher incidence of postoperative arrhythmia in the early group [15, 20]. The incidence of postoperative stroke in our patients was similar to other studies with no significant difference between early and late groups [13, 20, 21]. The length of the postoperative ICU stay in our study was significantly higher in the early group. Regarding the postoperative hospital stay, there was no significant difference between early and late groups.

Analysis of the postoperative outcomes revealed that early CABG was significantly associated with high inotropic support, IABP use, longer mechanical ventilation time, and prolonged ICU stay. There was no significant difference between early and late CABG regarding postoperative arrhythmia, stroke, and duration of hospital stay.

Hospital mortality was reported in 5 cases (8.3%). Three patients were in the early group (21.4%), and two patients were in the late group (4.3%) (p=0.078). The early group showed a higher mortality rate but did not reach a statistically significant level, which could be attributed to the sample size. Despite the variation in the mortality rates between different studies, most of them agreed with the conclusion that early CABG is associated with higher mortality.

Weiss and colleagues found that mortality in the entire study was 4.7% and revealed that early CABG was highly associated with an increased risk of mortality (5.6% versus 3.8%, with P=0.001). They showed that the risk of early CABG was substantially higher before day 3, with a doubling of mortality risk compared with patients who underwent later surgery [3]. A study done by Lee and coworkers reported that total mortality was 3.1% of their whole study population. Mortality reached 10.9% in early CABG versus 2.8% in late CABG [17]. Another study conducted by Voisine and associates on 7219 patients found that total mortality was 2.9% with a higher rate in early CABG (13%) in comparison with late CABG (2.8%) [4]. Assmann and colleagues studied 1168 patients and reported a total mortality rate of 3.2%. The mortality rate in early CABG was 10.8%, while in late CABG was 2.8% [11]. A study done by Nishi and coworkers found that the in-hospital mortality rate was 8.9% [10]. Another study done by Ladeira and associates concluded that the in-hospital mortality rate was 6.7% [21].

In this study, we tried to determine the optimal timing of CABG in patients with acute MI. We found that early CABG was associated with a higher mortality rate than late CABG. We observed a lower mortality rate when CABG was delayed for more than three days, consistent with previous reports. The less favorable results in the early group may be attributed to the higher incidence of some preoperative risk factors. These factors included low ejection fraction, STEMI, preoperative arrhythmia, use of IABP, and cardiogenic shock. We believed that time by itself is not the only factor to decide on surgical intervention, but the acuity of illness is an important determinant of outcomes. Delaying surgical intervention may be reasonable if reversal of the acuity of illness can be expected. Therefore, choosing the timing of CABG after MI should balance ongoing ischemia and high-risk comorbidities and reducing the unnecessary waiting period.

## Study limitations

This study bears some limitations. First, the small sample size in our study resulted in some difficulties in our statistical analysis; therefore, we were not able to study independent predictors of mortality. Despitet the higher mortality in early CABG patients, it did not reach a significant level. Second, there was no differentiation between STEMI and NSTEMI patients, while there were many previous reports about the better prognosis of NSTEMI concerning the timing of surgery. Third, emergency CABG carried a higher risk of mortality and morbidity than elective CABG. Therefore, we thought that it was better to study both of them separately.

## Conclusion

We reported higher mortality and morbidity if CABG is performed in the first three days after acute myocardial infarction. The course of patients who had late CABG was better than who had early CABG.

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

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