

On-pump Arrest Versus On-pump Beating Coronary Artery Bypass Surgery

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Abstract

Background: Studies that have specifically compared arrest and beating methods in on-pump coronary artery bypass grafting (CABG) are limited.

Objectives: In light of the aforementioned issues, the present study aimed to compare the results of two techniques of on-pump arrest CABG and on-pump beating CABG with the same surgical and anesthesiology team and the same protocol in a single center.

Methods: In this retrospective cohort study that was conducted in Ghaem Hospital of Mashhad between November 2020 and 2022, the needed data were extracted from the medical records of all patients that underwent on-pump beating CABG or on-pump arrest CABG. According to the method of operation, other variables, including post-operation bleeding, atrial and ventricular arrhythmia, returning the patient to the operating room for bleeding, need for inotrope, need for a balloon pump, hospital mortality, superficial and deep sternal infection and dehiscence, kidney injury, delayed extubation, length of hospital and intensive care unit (ICU) stay, and neurological complications were compared in the two groups.

Results: A total of 105 patients with a mean age of 61.07 ± 10.55 years were included in the study. Of these, 65 (61.9%) cases were male and the rest were female. Of the total patients included in the study, 60 subjects were in the beating group, and 45 cases were allocated to the arrest group. The postoperative outcomes were compared, and there was no significant difference between the two groups in terms of patients' outcomes ($P > 0.05$). Furthermore, the comparison of in-hospital and one-month mortality of patients in two groups demonstrated no significant difference between the two groups ($P > 0.05$).

Conclusion: As evidenced by the obtained results, postoperative complications, as well as in-hospital and one-month mortality, are not significantly different between on-pump arrest CABG and on-pump beating CABG.

Keywords: CABG, Ischemic heart diseases, Mortality, On-pump CABG

1. Background

Although today, the conventional method for coronary artery bypass grafting (CABG) is the on-pump arrest technique, other methods are also described for reducing the side effects of prolonged myocardial ischemia and cardiopulmonary bypass (CPB) (1-3). Worldwide, the gold standard method for coronary artery bypass surgery is on-pump arrest CABG. Cardiopulmonary bypass is established by the insertion of a cannula in arterial and venous circulation. Heart asystole is commenced by the insertion of a small cannula in the ascending aorta and cardioplegic infusion with local and systemic hypothermia, making a silent and dry field condition for coronary arteriotomy and distal anastomosis (4-7). On the other hand, on-pump beating CABG and off-pump CABG are described as alternative strategies (4).

In the on-pump beating CABG technique, after the establishment of CPB with the use of a designed tissue stabilizer device for fixing the limited area of the target coronary artery, distal anastomosis is performed on coronary arteries with prepared arterial or venous conduits without any need for aortic cross-clamping, cardioplegic infusion, and local hypothermia (7). In both techniques, after completing the distal anastomoses, proximal

insertion of grafts on the ascending aorta is performed using the partial aortic clamp. Other steps of surgery are similar in both techniques, and weaning of the patient from the CPB machine is performed with inotropic support.

2. Objectives

In light of the aforementioned issues, the present study aimed to compare the results of two techniques of on-pump arrest CABG and on-pump beating CABG with the same surgical and anesthesiology team and the same protocol in a single center.

3. Methods

Our retrospective study was conducted in the Department of Cardiac Surgery of Ghaem Hospital of Mashhad University of Medical Sciences from November 2020 to November 2022. A total of 105 consecutive patients were enrolled in this study, with 65 patients in on-pump beating CABG (group A) and 40 patients in on-pump arrest CABG (group B). In this study we have entered all of patients with confirmed diagnosis of Coronary Artery Disease but we decide to exclude the patients who were known case of CRF (Dialysis Dependent) and presence of

Significant Stenosis or regurgitation of Valvular Heart Disease, history of any Previous Cardiac Surgery. The information that were collected from Data Medical records were age, Male/Female, comorbidity consist of DM, COPD, stenosis of Carotid Artery disease. Other variables that were studied included postoperative bleeding one and six hours after the procedure, atrial or ventricular arrhythmia, the number of packed cell, platelet, and plasma units that were transfused during or after surgery, re-exploration of patients for bleeding control, need for inotropic support in first two hours after surgery, need for intra aortic balloon pump (IABP), in hospital and one-month mortality after surgery, superficial and deep sternal wound infection, and dehiscence, renal failure, neurologic complications, failure to extubation, need for ventilator support more than 48 hours after the procedure, as well as the duration of ICU and hospital stay.

These data were recorded on standard forms and give database. statistical analyses that was used for our study, was SPSS version 21 for Windows (SPSS Inc., Chicago, IL). Our criteria were presented

as mean \pm standard deviation. Proper test including Chi-Square and Man-Whitney and p value < 0.05 was considered statistically significant is the test of choice in this study.

4. Results

From November 2020 to November 2022, a total of 105 cases of Coronary Artery Disease were selected for Coronary Artery Bypass Surgery with On Pump Arres and OnPump Beating Methods. The mean age of patients was 61.07 ± 10.55 , and 61.9% of patients were male. A number of 60 patients were enrolled in the beating group, and 45 cases were assigned to the arrest group. Demographic data of patients are presented in Table 1. Among all parameters, only COPD showed a statistically significant difference among the two groups (P=0.024).

Statistical analysis for evaluation of the variables was performed with proper tests; nonetheless, none of the variables showed a statistically significant difference between the two groups (Table 2).

Table 1. Demographic data of patients

Variable	on-pump arrest	on-pump beating	P-Value
	Mean+ SD	Mean+ SD	
Age (M/F)	25/20	40/20	0.311*
SEX	61.95 \pm 10.4	60.41 \pm 10.6	0.464**
COPD	4 (11.1%)	0	0.024*
Renal failure	0	0	0
Diabetes	22 (52.4%)	20 (34.5%)	0.101*
1VD	1 (2.2%)	2(3.3%)	0.99*
2VD	5 (11.1%)	12 (20%)	0.288*
3VD	39(86.7%)	46 (76.7%)	0.22*
Left Main	9 (20%)	12 (20%)	0.99*
Ejection fraction	43.2 \pm 11.6	40.75 \pm 12.1	0.295 *

*with Fisher Test

** With T Test

Table 2. Statistical analysis of the two Groups

Variable	On-pump arrest	On-pump beating	P-Value
	Mean \pm SD	Mean \pm SD	
AF	2 (4.4%)	2 (3.4%)	>0.999*
VT/VF	1 (2.2%)	1 (1.7%)	>0.999*
ICU Stay	3.96 \pm 6.7	3.73 \pm 4.0	0.835**
Inotrope support (first 2h)	16 (35.6%)	19 (32.2%)	0.835*
IABP	5 (11.1%)	7 (11.9%)	>0.999*
Superficial Wound Infection	0	0	0
Deep wound infection and dehiscence	2(4.4%)	0	0.186*
Creatinine Increase	2 (4.4%)	5 (8.6%)	0.464*
Ventilatory support> 48 h	1(2.3%)	2 (3.4%)	>0.999*
Neurologic Complications	2 (4.4%)	2(3.4%)	>0.999*
Bleeding in 1 h	34.4 \pm 61.0	32.20 \pm 79.2	0.875*
Bleeding in 6 h	248.8 \pm 221.9	283.0 \pm 260.5	0.482**
Re-exploration for Bleeding	5 (11.4%)	7 (11.9%)	>0.999**
Hospital Stay	7.42 \pm 6.3	7.40 \pm 4.3	0.983**

*with Fisher Test

** With T Test

5. Discussion

The CABG is the treatment of choice for most cases of coronary artery disease. Coronary artery bypass grafting can be performed with different

strategies, and any of them have advantages and disadvantages in comparison to the others (8-10). After the introduction of cardiopulmonary bypass (CPB), cardiac surgery procedures have been developed rapidly. Conventional CABG with the use

of CPB is the most common type of bypass surgery. After heparin infusion, cardiopulmonary circulation with arterial and venous cannulation is initiated, and after aortic cross-clamping and cardioplegic infusion, cardiac arrest occurs. Thereafter, after the target coronary artery is cleared, arterial and venous conduit grafting is performed, and finally, weaning the patient from cardiopulmonary bypass is tried.

Alternative procedures were introduced to the cardiac surgery field to reduce and eliminate the complications and side effects of myocardial ischemia after aortic cross-clamping and cardiopulmonary bypass circulation, especially in case of complex procedures and long duration of CPB and myocardial ischemia. (11,12). On Pump Beating CABG is interesting option for performing Bypass Surgery with support of Cardiopulmonary Bypass but without Aortic Cross Clamp and Cardioplegic infusion with Tissue Stabilizer around Diseased Coronary Arteries (13). The main advantage of on-pump beating CABG is the lack of complications caused by myocardial ischemia, especially in long-duration procedures. (14-17).

With advances in cardiac surgeons' experiences and anesthesiologists, the newer technique of off-pump CABG was introduced in order to eliminate the side effects of cardiopulmonary circulation. It is performed with off-pump facilities with the use of a tissue stabilizer and some special techniques in the hands of experienced cardiac surgeons. In early years, only some selected cases with one vessel disease (Commonly LAD) and normal EF index were candidates for off-pump CABG; nonetheless, recently, nearly all cases of CAD, including 3VD, left main disease, recent MI, and low EF patients, can be operated with off-pump CABG with good results and low morbidity (16-18). The main advantage of off-pump CABG is the avoidance of complications and side effects of cardiopulmonary bypass circulation. The most common side effects of CPB are renal and pulmonary complications (13).

Due to low continuous non-pulsatile flow during CPB and inflammatory mediators that are released due to CPB circulation, the risk of acute renal failure is increased. Moreover, due to the inflammatory response, the possibility of respiratory failure and the need for prolonged ventilator support is increased after CPB. One of the most important factors that increase mortality and morbidity of conventional CABG is postoperative left ventricle dysfunction due to myocardial ischemia during aortic cross-clamping and lack of myocardial protection (18). To eliminate this event, the on-pump beating CABG strategy was introduced to decrease ischemic complications and LV dysfunction due to unsatisfactory myocardial protection (19). With the measurement of troponin and CPK-MB in on-pump CABG, there is enough

evidence to defend that in on-pump arrest CABG, there is some degrees of myocardial ischemic injury, especially in prolonged and complicated surgeries (20).

Although in our study, there were no significant differences between arrest and beating CABG in terms of morality, high dose inotropic support, and need for intra-aortic balloon pump (IABP) insertion, in some studies, these side effects are clearly lower in on-pump beating CABG in comparison with on-pump arrest CABG. Although, like off-pump CABG, there is concern over incomplete coronary revascularization in comparison with on-pump arrest CABG, most studies reveal complete or near complete revascularization with on-pump beating CABG (21). Some studies also present better renal protection and lower incidence of postoperative acute renal failure after on-pump beating CABG due to better hemodynamic condition in comparison with on-pump arrest CABG (22-24).

In a study conducted in 2008 by Pegg et al., the authors randomly assigned 50 patients with impaired ventricular function to two groups of beating and arrest methods. In the beating group compared to the arrest group, there was a greater decrease in the end-systolic volume index and a higher troponin level, and the incidence of irreversible myocardial damage was significantly higher in the beating group (23-25). In our study, there was no significant difference in mortality rate and major complications between the two groups. In a study conducted in 2018 by Kim et al., which compared ONBEAT with ONSTOP, 645 patients who underwent elective CABG were included. They showed no significant difference in early mortality and major complications (e.g., stroke) between the two groups (21). In another study, the authors analyzed 5,851 patients who underwent non-elective on-pump CABG within the first seven days after acute MI, and the result demonstrated no significant difference in 30-day mortality and 12-year survival between the two groups (22). Moreover, the rate of major cardiac and cerebrovascular events was similar between the two groups.

LV Systolic Dysfunction with reduced EF is important factor that have prognostic factor for increase or decrease the Mortality and Morbidity and also final results of Coronary Artery Bypass surgery. One of the main concern in these patients is myocardial protection during procedure. Despite the advance in better Myocardial Protection, anesthesia and surgical techniques, postoperative side effect of intraoperative Myocardial ischemia have not been completely eliminated and present with Decrease of LV EF in Post CABG in short Time and Long Time Theoretically, alternative method for solve to this problem and Save the Myocardium from Ischemic Injury is alternative techniques,

consist of OFF Pump CABG and On Pump Beating CABG.

6. Conclusion

Although conventional on-pump arrest CABG is worldwide and the gold standard technique for bypass Surgery, the results of the present study pointed out that postoperative complications, as well as in-hospital and one-month mortality, are not significantly different between on-pump arrest CABG and on-pump beating CABG. On-pump beating CABG is a safe and effective strategy for CABG without any need for aortic cross-clamp and myocardial ischemic injury.

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Conflicts of interest

The authors of the article declared no conflict of interest.

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