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On-pump beating versus arrested heart (conventional) revascularization in severe left ventricular dysfunction

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ABSTRACT

Background: For revascularization of myocardium, the on-pump beating heart technique has been successfully used in patients with either low or high risk. However, the use of this technique in patients with low ejection fraction is not well thoroughly evaluated. The aim of the work was to evaluate the on-pump beating heart technique in subjects with severe left ventricular dysfunction and to compare results with on-pump non-beating (conventional) technique.

Methods: The present study was held at Al-Azhar University Hospitals, Cairo, Egypt during the period from January 2014 till June 2016. The study included 200 patients who achieved the inclusion criteria. They were allocated either to on-pump beating heart (n = 84) or conventional group (n = 116). Patients were evaluated for in hospital mortality or major postoperative complications.

Results: On-pump beating heart was found to be associated with low in hospital mortality, postoperative CK-MB, new myocardial infarction, renal dysfunction and need for hemodialysis.

Conclusions: On-pump beating heart technique was better than conventional technique for cardiac revascularization in patients with severe left ventricular dysfunction.
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1. Introduction

Myocardial infarction is treated by fibrinolytic medications and/or percutaneous coronary intervention (PCI). These modalities are the first line modalities of treatment for those patients [1].

There is a steady increase in people with severe left ventricular dysfunction (LVD) (ejection fraction (EF) 35% or less) referred for coronary artery bypass grafting (CABG). Myocardial revascularization techniques in people with LVD are usually sufficient to relieve symptoms, inhibit future ischemia and associated with increased survival rate. The advances in techniques for myocardial protection and complete revascularization measures has decreased the morbidity and mortality related to CABG. However, preoperatively, morbidity and mortality are still high in populations with marked LVD who undergo CABG. Thus, bypass grafting for those patients remains a challenge for cardiothoracic surgeons [2,3].

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Conventional coronary artery revascularization is advocated as an appropriate management method for surgical revascularization. However, patients with LVD submitted to this technique are at higher risk for hemodynamic deterioration in the operation theater with incomplete revascularization. This hemodynamic compromise and incomplete revascularization are associated with increased incidence of postoperative mortality and morbidity. On the other hand, on-pump beating heart CABG has been recently introduced for high risk patients. It had the advantages of avoidance of cardioplegic arrest or aortic cross clamping [4–6].

However, despite these advantages, on-pump beating heart CABG had disadvantage of being connected to high postoperative complications due to the use of cardiopulmonary bypass (CPB). In addition, there is a lack of sufficient experience with applying on-pump beating heart CABG for surgical revascularization in high risk patients with LVD [7]. Thus, the use of on-pump beating heart or conventional revascularization in patients with LVD is still a matter of debate.

The aim of this work was to assess both on-pump beating heart versus conventional coronary artery revisualization in patients with LVD (EF% of 35% or less) in a trial to elucidate which technique is better to be used in those patients.

2. Patients and methods

The present study was prospective comparative trial, which was held at Al-Azhar University Hospitals, Cairo, Egypt during the period from January 2014 till June 2016. The study included 200 patients who achieved the inclusion criteria. They were allocated either to on-pump beating heart or conventional group. The decision to allocate the patient to either on-pump beating heart or conventional group was according to the preference of the cardiothoracic surgeon.

Inclusion criteria included the following: systolic dysfunction (left ventricular EF $\leq$ 35%), who underwent non-emergent, primary, isolated CABG surgery.

Exclusion criteria: Patients with one or more of the following were excluded from the study: 1) presence of left ventricular aneurysm, 2) ventricular septal defect that occurred post-infarction, 3) aortic regurgitation (medium to severe), and 4) previous cardiac surgery.

In the present work, LVD was defined as an echocardiographic estimated EF $\leq$ 35%.

The study procedures were accepted by the local Ethics Committee of Al-Azhar University. In addition, patient's consent for inclusion was obtained after full clarification of the study targets and techniques. Patient's privacy and their right to withdraw at any time from the study were ascertained.

Anesthesia: All patients were submitted to general anesthesia as the following: propofol (3 mg/kg/h) combined with remifentanyl (0.5–1 g/kg/min) were used. Neuro-muscular block was done by 0.1–0.15 mg/kg of pancuronium or vecuronium. In on-pump beating heart group, phentolamine was used to preserve the systemic blood pressure between 50 and 60 mmHg and, if essential, esmolol Hcl (11 mg/kg) was introduced to slow the heart rate.

Surgical technique: It was done as pronounced by Erkut et al. [3]. Briefly, all patients were submitted to CABG by a median sternotomy. Conduits were harvested and prepared. For all patients, heparin was administered to reach an activated clotting time (ACT) of more than 450s. In conventional group, patients were used mild hypothermic state (temperature between 30 and 32 °C). Intermittent antegrade and retrograde cardioplegia of the blood were used for myocardial protection after the aorta was cross-clamped. With 7-0 polypropylene running sutures, the distal anastomoses were constructed, while proximal anastomoses were connected to the ascending aorta with 6–0 polypropylene sutures. Heparin was reversed by protamine sulfate infusion (1–1.5 mg protamine/1 mg heparin), after weaning from CPB and decannulation. In the on-pump beating heart group, the patient normothermic (temperature was kept approximately at 36 °C without cooling. Distal anastomoses were performed before the proximal ones. Myocardial immobilization was confirmed with a suction stabilizer. Target vessel homeostasis was obtained by temporary occlusion of the proximal coronary artery, during the process of anastomosis. Distal anastomoses were achieved by polypropylene 7–0 running sutures. Perfusion was maintained by warm blood through the pump using anastomosed saphenous veins after each distal anastomosis. Proximal anastomoses were created under partial occlusion clamp, with polypropylene 6–0 sutures. After weaning from CPB and decannulation, the heparin was reversed as in conventional group.

The primary outcome was in-hospital mortality, which was defined as death occurring during the first 30 postoperative days, either in hospital or after discharge, provided that, the cause of death is related to the surgical intervention. The secondary outcome was the occurrence of major postoperative complications, such as low cardiac output syndrome (LCOS), new acute myocardial infarction (MI), pneumonia, respiratory failure, renal failure needing dialysis, stroke, re-surgical intervention. LCOS was defined as cardiac index less than 2.0 L/min/m^2 needing inotropic support and/or intra-aortic balloon pump (IABP) insertion [8]. In addition, new onset MI was defined as any recent Q wave or R wave disappearance on a postoperative ECG within 24 h of the operation [9]. Pneumonia was defined as a positive sputum culture with the need of anti-infection treatment, or chest X-ray confirmed diagnosis. Respiratory failure was defined as a more than 72 h of mechanical ventilation (MV) or re-intubation after the surgery. In addition, the duration of intensive care unit (ICU) stay, amount of drainage in the first 24 h, duration of MV, and IABP support were also documented.

Statistical data analysis: The collected data were statistically analyzed using statistical package for social science (SPSS), version 22 (IBM®SPSS®, USA). Numerical data were presented as mean and standard deviation (SD), while categorical data were presented as relative frequency and percentage. Independent samples (t) and chi-square tests were used for comparison between groups. P value < 0.05 was considered significant.

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