

Off-Pump Total Myocardial Revascularization in Patients with Left Ventricular Dysfunction

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Summary

Objective: To assess off-pump myocardial revascularization in patients with significant left ventricular dysfunction.

Methods: Four hundred and five patients with an ejection fraction less than 35% underwent myocardial revascularization without extracorporeal circulation. The procedure was performed with the aid of a suction stabilizer and the LIMA stitch. The distal anastomoses were performed first.

Results: A total of 405 patients were evaluated whose mean age was 63.4 ± 9.78 years. Two hundred and seventy-nine patients were men (68.8%). With regard to risk factors, 347 patients were hypertensive, 194 were smokers, 202 were dyslipidemic, and 134 had diabetes. Two hundred and sixty patients were classified as NYHA functional class III and IV. Twenty patients suffered from chronic renal disease and were under dialysis. Fifty-one underwent emergency surgery, and 33 had been previously operated on. The mean ejection fraction was $27.2 \pm 3.54\%$. The mean EuroSCORE was 8.46 ± 4.41 . The mean number of anastomoses performed was 3.03 ± 1.54 per patient. Forty-nine patients (12%) needed an intra-aortic balloon inserted after induction of anesthesia, whereas 73 (18%) needed inotropic support during the perioperative period. As to complications, 2 patients (0.49%) had renal failure, 2 had mediastinitis (0.49%), 7 (1.7%) needed to be reoperated because of bleeding, 5 patients (1.2%) suffered acute myocardial infarction, and 70 patients (17.3%) experienced atrial fibrillation. Eighteen (4.4%) patients died.

Conclusion: Based on the data above, we concluded that myocardial revascularization without extracorporeal circulation in patients with left ventricular dysfunction is a safe and effective technique, and an alternative for high-risk patients. Results obtained were better than those predicted by EuroSCORE. (Arq Bras Cardiol 2007; 89(1) : 11-14)

Key words: Myocardial revascularization, no extracorporeal circulation, left ventricular dysfunction.

Introduction

The off-pump myocardial revascularization surgery showed its first results from large series of patients in the early 1980s^{1,2}. Its application did not increase significantly until the late 1990s, when studies were published about techniques for exposing the posterior wall of the heart³ and the use of new tissue stabilizer devices developed by the biomedical industry, giving a new momentum to this type of surgical procedure. In the United States, there was a significant increase in the number of coronary artery disease patients undergoing off-pump CABG, from 6.9% of cases in 1999 to more than 25% in 2002, with an estimate that this percentage would reach 50% by the end of 2005. Nevertheless, despite the increase in the number of patients operated, there is still reluctance to employ this technique in patients with significant ventricular dysfunction because of the fear of greater hemodynamic instability and increased mortality. It has been documented that patients with left ventricular dysfunction experience a less

favorable progression following myocardial revascularization when compared to patients with normal ventricular function⁴. It has been speculated that extracorporeal circulation may increase the injury to the myocardium in patients with ventricular dysfunction due to activation of the inflammatory response and geometric changes in the empty ventricle, blocking the flow to the ischemic areas and worsening the preservation of the interventricular septal motion⁵.

The purpose of this study was to assess the immediate results of the off-pump myocardial revascularization procedure in patients with significant left ventricular dysfunction, and compare the results with those predicted by EuroSCORE.

Methods

Between January 2000 and December 2005, 405 patients with an ejection fraction less than 35% underwent off-pump myocardial revascularization. After graft dissection in the conventional fashion⁶, the pericardium was opened and the LIMA stitch was applied³. Heparin was used at a dose of 2 mg/kg of body weight. As a rule, distal anastomoses were performed first, starting with the inferior wall vessels, followed by the lateral wall and the anterior wall vessels. The aorta was partially clamped only once in order to perform the proximal

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anastomoses. Intracoronary shunts were needed in a few cases, and all patients were operated with the aid of a suction stabilizer. To perform the distal anastomosis, the artery had its proximal portion temporarily occluded with a 4-0 prolene thread supported by a thin nasogastric probe.

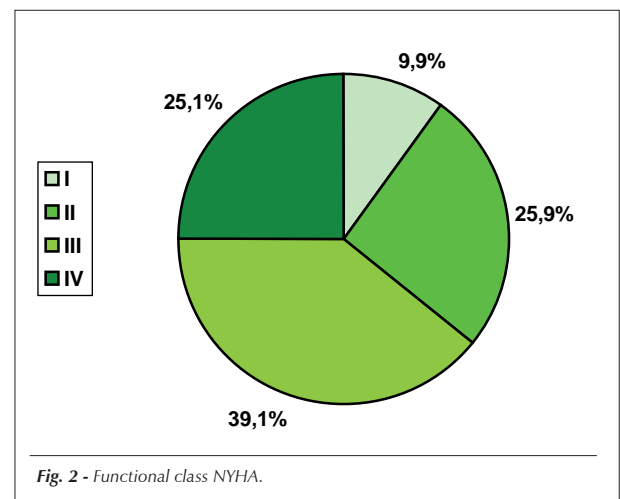
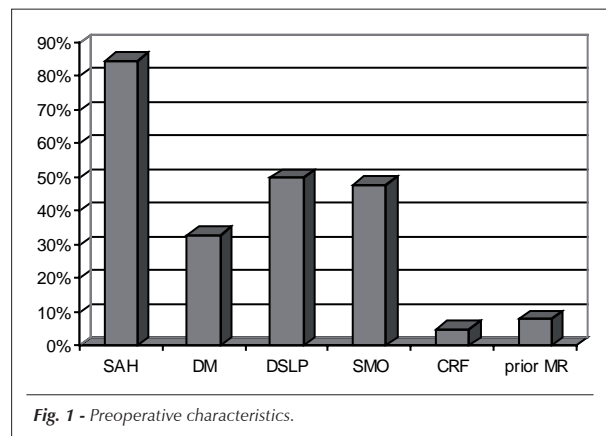
When all anastomoses were completed, the initial heparin dose was reversed by 75%. All patients received nitroglycerin during the surgery, and also during the entire period in ICU. Patients who experienced hemodynamic instability during the induction of anesthesia, besides receiving vasoactive drugs, had an intra-aortic balloon inserted before grafts were obtained. In patients whose systolic pressure was below 60 mmHg during the vessel exposure maneuvers, the procedure was temporarily interrupted and a 5 mg/kg dose of dopamine was given and increased as necessary.

Results

Between January 2000 and December 2005, 405 patients with an ejection fraction of less than 35% underwent myocardial revascularization without extracorporeal circulation. Their mean age was 63.4 ± 9.78 years, ranging from 39 to 88 years. Two hundred and seventy-nine patients (68.8%) were men and 126 (31.2%) were women. With regard to risk factors for coronary artery disease, 134 patients (33%) had diabetes, 194 (47.9%) were smokers, 202 (49.8%) had dyslipidemia, and 343 (84.6%) were hypertensive. Fifty-two patients (12.8%) had no detectable risk factor for coronary disease. Twenty patients (4.9%) had chronic renal failure, and 33 (8.1%) had undergone previous revascularization procedures (Figure 1).

As to functional class, 40 patients (9.9%) were classified as NYHA class I, 105 (25.9%) were class II, 158 (39.1%) were class III, and 102 (25.1%) were class IV. The mean left ventricular ejection fraction was $27.2 \pm 3.54\%$, ranging from 16 to 35%. The mean EuroSCORE in this group was 8.46 ± 4.41 , ranging from 3 to 24 scores. Fifty-one patients (12.8%) underwent emergency surgery (Figure 2).

A total of 1,229 distal anastomoses were performed, with a mean of 3.03 ± 1.54 per patient, ranging from 1 to six anastomoses. Three hundred and twenty patients (79%) received at least one arterial graft, whereas 102 (25.1%) patients



underwent revascularization with arterial grafts only. Forty-nine patients (12%) needed an intra-aortic balloon inserted because of hemodynamic instability after induction of anesthesia, and 73 patients (18%) were administered vasoactive drugs during the perioperative period due to hypotension triggered by the maneuvers to expose the vessels. No patient needed a new intra-aortic balloon inserted postoperatively. The mean duration of mechanical ventilation was 4.17 ± 2.89 hours, ranging from zero to 23 hours. Forty-seven patients (11.6%) were extubated in the operating room. Three hundred and five patients (75.3%) remained less than two nights at the ICU, and 68 of them (16.7%) remained just one night. Bleeding through the drains ranged from 150 to 1900 ml, with a mean of 620.6 ± 155.8 ml per patient. Seven patients (1.7%) needed to be reoperated due to bleeding.

With regard to complications observed during the postoperative period, 2 patients (0.49%) had acute renal failure, 2 patients (0.49%) had mediastinitis, 5 patients (1.2%) suffered acute myocardial infarction, and 70 patients (17.3%) had atrial fibrillation (Table 1). There was a case of hemorrhagic cerebrovascular accident in this group of patients.

Eighteen patients died (4.4%): 9 (2.2%) of them of cardiac causes, 2 (0.49%) due to generalized infection, 1 (0.24%) due to acute renal failure, 3 (0.74%) due to bronchopneumonia, 1 (0.24%) due to metabolic causes, 1 (0.24%) due to bleeding and 1 (0.24%) due to hemorrhagic cerebrovascular accident (Table 2).

Table 1 - Postoperative complications

Complications	n	%
ARF	2	0.49
Mediastinitis	2	0.49
AMI	5	1.2
AF	70	17.3

ARF - acute renal failure; AMI - acute myocardial infarction; AF - atrial fibrillation.

Table 2 - Causes of death

Causes	n	%
Cardiogenic shock	9	2.2
Generalized infection	2	0.49
Renal failure	1	0.24
Bronchopneumonia	3	0.74
Metabolic causes	1	0.24
Bleeding	1	0.24
Encephalic vascular accident	1	0.24

Discussion

With the introduction of maneuvers that allow the exposure of all heart vessels with minimal hemodynamic instability³, the improvement in tissue stabilizer devices, and the introduction of intra-coronary shunts⁷, renewed interest was stimulated in myocardial revascularization operations without extracorporeal circulation. The initial limitation of not being able to approach the vessels of the lateral and posterior walls was overcome, making it feasible to perform total myocardial revascularization without extracorporeal circulation.

The first studies published at the end of the 1990s⁸⁻¹² compared operations with and without extracorporeal circulation, but most had been conducted with low-risk patients, excluding the group with significant left ventricular dysfunction. This may reflect a certain fear of performing off-CPB operations in high-risk patients. From our point of view, this is not the case in two studies that we evaluated^{13,14}, in which one can clearly see that high-risk patients are the ones who benefit most from off-pump surgery.

Cases of patients with major left ventricular dysfunction who underwent conventional surgery for the revascularization of the myocardium have been analyzed at length^{15,16}; nevertheless, the few articles published comparing surgeries with and without CPB in patients with ejection fractions under 35%¹⁷⁻¹⁹, present a few important differences between the groups, and this may complicate a clear evaluation of the results.

Arom et al¹⁷, retrospectively compared two groups of patients with ejection fractions less than 35%, in which 45 were operated without CPB and 132 operated with CPB. On average, 2.8 bypasses per patient were performed in the group without CPB, and 3.3 in the group with CPB. The incidence of atrial fibrillation, need for prolonged respiratory assistance, and the length of hospital stay was lower in the group without CPB. In two other studies^{18,19}, Sternik et al also compared the two types of procedures in patients with ejection fractions less than 35% and found a lower incidence of complications, immediate mortality, and mid-term mortality in the group of patients who underwent surgery without CPB. However, it is worth mentioning that in this series, the number of bypasses per patient was much smaller in the group without CPB (1.9 vs 3.5), possibly reflecting a less significant degree of coronary disease in the first group.

A key study published¹⁴ by Goldstein et al evaluated

100 patients with an ejection fraction less than 30% who had undergone total myocardial revascularization. Each patient received, on average, 3.5 bypasses; the incidence of mediastinitis, chronic renal failure, cerebrovascular accident, myocardial infarction, and atrial fibrillation was lower than that observed by the STS database. Immediate mortality rate was 3% against a predicted 5.3% rate. In their comments, the authors attributed the low mortality rate to several factors. First, the total myocardial revascularization that has already been shown to increase early survival in young and old people^{20,21}. Second, a more liberal use of the intra-aortic balloon guarantees a greater hemodynamic stability, thus allowing the necessary maneuvers to be performed on the heart. And, finally, perhaps the most important factor was the presence of an attentive anesthesiologist closely monitoring the hemodynamic parameters. The authors concluded by saying that operations without CPB in this group of patients are safe and effective, and that a more liberal use of the intra-aortic balloon should be recommended for this subgroup of patients.

At the end of 2005, Puskas et al²² published the results of a meta-analysis comparing operations with and without CPB. In the group of patients with left ventricular dysfunction, the off-CPB operation produced better results concerning 30-day mortality (3.8% vs 6.9%), atrial fibrillation (14.1% vs 17.3%), renal dysfunction (36.7% vs 52.7%), use of inotropic drugs (3.7% vs 7.2%), pulmonary dysfunction (2.7% vs 4.1%), and use of the intra-aortic balloon (76.6% vs 91.4%). No difference was observed as to cerebrovascular accident, myocardial infarction, reoperation due to bleeding and mediastinitis in patients with left ventricular dysfunction. The authors concluded that the use of off-CPB revascularization should be considered for high-risk patients.

In our study, 405 patients were evaluated, with a mean age of 63.4 ± 9.78 years. Two hundred and sixty patients (64.1%) were classified as NYHA functional class III and IV, and the mean ejection fraction of the group was $27.2 \pm 3.54\%$, showing that this is a high-risk group for myocardial revascularization. The number of distal anastomoses performed, 3.03 ± 1.54 per patient, shows that total myocardial revascularization was possible. No arterial grafts were used in patients who underwent emergency surgery or in those whose left internal thoracic artery had been previously used. The incidence of complications in this group was similar to those experienced by patients without ventricular dysfunction. No patient needed to be switched to extracorporeal circulation. The mortality rate (4.4%) was less than the predicted rate (8.46%), and only 2.2% of the deaths were related to cardiac causes.

In concluding, based on these data and on reports in medical literature, particularly the work carried out by Puskas et al²², we can say that myocardial revascularization surgery without extracorporeal circulation in patients with left ventricular dysfunction is safe and has low rates of mortality and complications. This type of operation should be considered for patients with a high risk for myocardial revascularization.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Study Association with Graduate Work

This study is not associated with any graduation program.

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