

Preoperative Intra-Aortic Balloon Counterpulsation in Coronary Artery Bypass Graft Patients with Severe Left Ventricular Dysfunction

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Abstract

Background: The intra-aortic balloon pumping (IABP) is the most used ventricular mechanical assist device. In recent years, the preoperative use in patients with severe ventricular dysfunction presents itself as a great benefic strategy to the postoperative recovery. This paper aim is to evaluate the IABP post-operative benefit in patients with severe ventricular dysfunction. **Methods:** From January 2011 to March 2016, 125 patients underwent a coronary artery bypass graft (CABG) with cardiopulmonary bypass and preoperative IABP in Teaching Hospital of the ABC Medical School and Hospital Estadual Mario Covas. The inclusion criteria were the presence of severe ischemic cardiomyopathy with left ventricular ejection fraction (LVEF) less than or equal to 40%, estimated by Doppler echocardiography using the Simpson method. The preoperative LVEF was $30.25\% \pm 8.53\%$ and the diastolic diameter of the left ventricle (LVDD) 67.75 ± 16.37 mm. IABP was installed approximately 15 hours before the surgery. **Results:** The patients required the IABP for 2.4 ± 1.58 days, and vasoactive drugs, 4.8 ± 2.12 days. We performed 3.2 ± 1.9 grafts per patient and the total length of stay was 07 ± 5.52 days. Cardiopulmonary bypass time was 67 ± 10.95 minutes and anoxia time, 46.4 ± 10.06 minutes. Twelve patients (9.6%) had pneumonia and four (3.2%), atrial fibrillation. We observed a LVDD reduction to 63 ± 16.26 ($p = 0.068$) and LVEF enhancement to 36.50 ± 16.86 ($p = 0.144$). The data were analyzed statistically according to the Wilcoxon test. There were no deaths. **Conclusion:** The initial experience of the authors with the preoperative IABP in patients with severe left ventricular dysfunction suggests great benefit in post-operative recovery with improvement of LVEF and reduction of LVDD.

Keywords

Intra-Aortic Balloon Pumping, Left Ventricular Dysfunction, Coronary Artery Bypass Graft

1. Introduction

Despite advances in therapy, the management of patients with severe left ventricular dysfunction is still a challenge. The intra-aortic balloon (IAB) inserted through the femoral artery was at first described in 1962, as a circulatory support [1]. Due to the mechanical assistance, the IABP produces counter pulsation inside the descending aorta, determining an increase on coronaries arteries infusion during the diastole and cardiac work optimization due to the systole after load reduction.

In recent years, the device installed on myocardial revascularization preoperative in patients with severe cardiomyopathy has been shown as an important impact strategy to reduce morbid-mortality [2]-[4]. On the other hand, the IABP use is related to some complications, such as thromboembolism, ischemic lesions that depend, mainly, on the permanence time of the IABP and the surgeon's skill in the catheter installation [5] [6].

In a recent systematic review and meta-analysis, Poirier *et al.* included eleven randomized controlled trials and twenty two observational studies, analyzing a total of 46,067 patients. IABP prior to CABG was associated with a significant reduction in hospital and 30-day mortality compared to similar patients without preoperative IAPB [7].

The aim of this study is to evaluate the IAB post-operative benefit in patients with coronary artery disease and severe ventricular dysfunction.

2. Methods

From January 2011 to March 2016, a prospective study were performed at Teaching Hospital of The ABC Medical School and at Hospital Estadual Mario Covas, which analyzed patients undergoing to a coronary artery bypass graft (CABG) and IABP preoperative.

The group was composed by a hundred and twenty five patients, 108 (86%) of them were male and 17 (14%), female. Their age was 57.13 ± 8.12 years and all had severe left ventricular dysfunction, considering the left ventricular ejection fraction (LVEF), assessed in the Doppler echocardiography through the Simpson method and the diastolic diameter of the left ventricle (LVDD). None of the patients had aneurysm or left ventricular pseudoaneurysm. For ethical reasons, we chose to not form a control group without preoperative IAB.

The main comorbidities found in the study group were: smoking (96.8%); hypertension (84.8%); previous myocardial infarction (67.2%); dyslipidemia (21.6%) and alcohol consumption (18.4%). We included patients with coronary disease requiring surgical treatment and LVEF less than or equal to 40%. Patients with absolute contraindication to the intra-aortic balloon, such as severe aortic insufficiency and aortic dissection,

were excluded [6]-[8].

All patients underwent coronary artery bypass grafting with cardiopulmonary bypass (CPB) under mild hypothermia (34°C) and crystalloid prime exclusively with volume of 1000 ml. In 103 patients (82%) we used the Affinity^R Medtronic oxygenator, and in 22 patients (18%), Medizintechnik AG Medos^R. All CPB circuits had centrifugal pump. Myocardial protection was performed by intermittent aortic cross-clamping associated with mild hypothermia (34°C). Complete revascularization was possible in 121 (96%) cases; in three patients (2.4%), one marginal branch of the circumflex artery had less than 1.25 mm diameter, forbidding the manipulation. In another patient (1.6%), the right coronary artery was totally occluded in the middle third without distally refilling. The group used as grafts to the left internal thoracic artery and saphenous vein in all cases, performing 3.2 ± 1.9 grafts per patient.

The IABP was installed about fifteen hours before the surgery, through puncture of the femoral artery using the Seldinger technique and positioning the device with the fluoroscopy assistance. The catheter was chosen according to the patient's height, following the manufacturer's instructions. The IABP was maintained with full operation (1:1) from the time of installation and discontinued only during CPB. The weaning was begun in the first post-operative day, after the vasoactive drugs dependence reduction and according to the parameters which indicated adequate cardiac output. The IABP was removed right after shutdown, being at least 6 hours working 1:8 without causing increased demand for vasopressors or inotropics.

We chose norepinephrine and dobutamine for all patients. In 26 (20.8%), vasopressin was needed. The removal of vasoactive drugs was early: started immediately after surgery by vasopressin, noradrenaline, and then, finally, without the IABP, dobutamine.

Another echocardiogram was performed around the tenth postoperative day and the results were compared to that carried out in the run up surgery. The good prognosis of these patients was suggested by the bilirubin normality throughout this evaluated period, relevant criteria according to SAPS (Simplified Acute Physiology Score). The data was undergone to a statistical treatment according to the Wilcoxon test, being considered statistically significant when p less than 0.05.

3. Results

Demographic characteristics from the 125 patients included are exposed on **Table 1**. Most of them were young diabetic, hypertensive and smoking men, with LVEF around 30%. The CPB time was 87 ± 10.95 minutes and anoxia, 56.4 ± 10.06 minutes. All patients have used IAPB for 2.4 ± 1.58 days, including the preoperative day, and vasoactive drugs were needed for 4.8 ± 2.12 days. The total hospital stay was 11 ± 5.52 days. The authors noticed LVEF improvement in comparison to the preoperative, from $30.25\% \pm 8.53\%$ to 36.50 ± 16.86 ($p = 0.144$). There was also LVDD reduction, from 67.75 ± 16.37 mm in the period before the surgery, to 63 ± 16.26 mm ($p = 0.068$). Clinical outcomes are provided on **Figure 1**.

Table 1. Baseline characteristics.

	n	sd	<i>p</i>
Age (years)	57.13	8.12	0.27
Male	108 (86%)	-	
Female	17 (14%)	-	
LVEF before surgery (%)	30.25	8.53	
LVEF 30 days after surgery (%)	36.50	16.86	0.144
LV diastolic dimension before surgery(mm)	67.75	16.37	
LV diastolic dimension 30 days after surgery(mm)	63	16.26	0.068
Vessels diseased			
Left main coronary artery	13 (10.4%)	-	0.183
Left anterior descending	125 (100%)	-	0.42
Right coronary artery	113 (90.4%)	-	0.283
Left circumflex artery	108 (86.4%)	-	0.115
Total bilirubin before surgery	0.7	0.09	0.258
Total bilirubin after surgery	0.99	0.27	0.331
Cerebrovascular disease	20 (16%)	-	0.136
Hypertension	106 (84.8%)	-	0.221
Unstable angina	15 (12%)	-	0.328
Previous myocardial infarction	84 (67.2%)	-	0.280
Hypercholesterolemia	27 (21.6%)	-	0.108
Diabetes mellitus	98 (78%)	-	0.245
History of PCI	42 (33.6%)	-	0.362
Smoking	121 (96.8%)	-	0.06
Peripheral vascular disease	10 (8%)	-	0.098
Alcohol consumption	23 (18.4%)	-	0.321
Preoperative renal insufficiency (creatinine > 1.3)	45 (36%)	-	0.25

LVEF: left ventricular ejection fraction; LV: left ventricular; PCI: percutaneous coronary intervention; SD: standard deviation

At the postoperative period, twelve patients (9.6%) had pneumonia and four (3.2%), atrial fibrillation. There were neither deaths nor mechanical complications due to the IABP catheter use.

4. Discussion

In recent years, the development of drug therapy and percutaneous coronary insufficiency left for surgery the most severe cases. Frequently, surgery treats patients with advanced ischemic cardiomyopathy, low LVEF (<40%) and older age (>65 years), known as poor prognostic indicators. In order to improve the postoperative outcome of

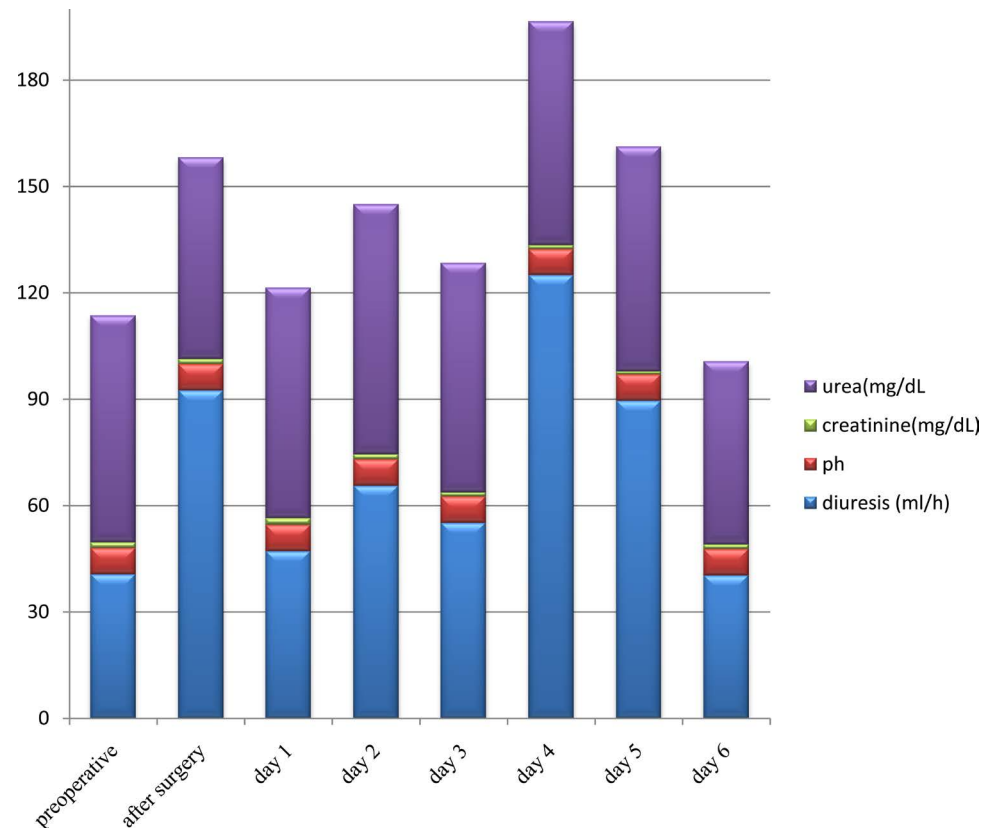


Figure 1. Subgroup analysis for diuresis, urea, creatinine and arterial ph from the preoperative and first days after surgery.

these patients, the IABP preoperatively use is already gaining prominence, seeking to provide greater energy reserve for the intraoperative period of ischemia and improving postoperative cardiac function [7].

Nowadays, there is no agreement over which LVEF value would be benefited with the preparative IAB therapy. Some studies suggest that using preoperatively IAP has significant impact when LVEF is less than or equal to 40% [1] [9], while others indicate when it is less than 30% [10]. For this study, were included patients with LVEF less than or equal to 40% ($31.25\% \pm 8.53\%$). Theologou *et al.* detected more effective benefit for cases of LVEF less than 40%, identifying more reliable results. It was also observed that most of these patients, when selected for the control group, the IABP is needed after surgery, during period three times higher when compared to the group with preoperative IABP. Besides, patients using IABP preoperatively showed hospital mortality lower than the control group [11]. In view of this, the group opted not to have control group.

There is no consensus on the best moment to install the IABP. While some groups do on the day before the surgery, others choose to install it right after anesthesia [1] [12]-[14]. In this study, the authors chosen to install the IABP on the day before the surgery and, in cases of LVEF less than 30%, it was associated dobutamine at doses of 5 - 7.5 micrograms per kilogram per minute, aiming the full inotropic prepare to the

surgery time.

There are several methods to estimate LVEF, and the cub method, the Teicholtz and Simpson are most used. In this study, it was chosen the Simpson method that, unlike the other two, does not estimate the LV volume by a predetermined geometric shape. In short term, this volume is calculated by the multiple cavity fragmentation. Changes in segmental contractility often present in patients with coronary artery disease are encompassed in the calculations, making the LVEF estimated value more accurate. [12]

Christenson JT *et al.* demonstrated that patients treated with IABP in the preoperative had CPB duration lower than patients who did not [1]. Furthermore, Kern F *et al.* observed that CPB time lower than or equal to 90 minutes is significantly associated with a higher incidence of postoperative myocardial infarction [9]. On this study, mean CPB time was less than 90 minutes and there were no ischemic complications.

The use of preoperative IABP in high-risk patients reduces the length of hospital stay compared to patients with IABP installed after surgery or when unused [11] [13]-[15]. The length of stay for this study is within of the average found in the literature.

Cardiac performance improves immediately after myocardium revascularization. Besides, Christenson JT *et al.* displayed that the use of preoperative IABP increases this performance even before starting the CPB. After surgery, the gain is also more effective [1] [7]. On this study, the good postoperative evolution, joint by LVEF improvement and LVDD reduction, although without statistical relevance, suggests that there is benefit in the strategy that link preoperative IABP and myocardium revascularization, even though it cannot be disposed that the hemodynamic improvement occurred only by revascularization.

Last year, some studies observed that the mortality of the patients who received IABP in the preoperative of the myocardium revascularization surgery was 13.6%, while the mortality in patients who received the balloon in the trans or post-operative was, approximately, 35% [15]-[17].

Suzuki T detected that patients who received preoperative IABP had a lower incidence of ventricular arrhythmia than those who received IABP postoperatively [18]. There were no cases of ventricular arrhythmia in this study.

Complications often encountered in the use of IABP are: lower limb ischemia, related to the insertion site, embolization of thrombi and thrombocytopenia for consumption. These complications are, mainly, related to the diameter of the balloon catheter, IABP usage time, prolonged hypotension periods and the presence of previous vasculopathy. Vascular complications arising from the IABP can reach rates of up to 20% [19] [20]. The evaluated group did not have any complications associated with the use of the IABP catheter.

5. Conclusion

In conclusion, due to the considerable evolution postoperative, as well as the improvement of LVEF and LVDD, the use of preoperative IABP is shown as an effective measure, safe and decisive in the treatment of patients with severe coronary artery disease

and severe left ventricular dysfunction undergoing coronary artery bypass surgery.

6. Limitations

The authors faced some limitations inherent in any observational study from a single center. The nonrandomized design might have procedural bias, or detection bias. The experience of the surgeon can influence the results of CABG: four experienced cardiac surgeons performed the CABG procedures in this study.

This study was conducted in the setting of a tertiary cardiovascular center in a developing country; the results might not be generalizable to other centers in developed countries. Patients requiring concomitant cardiac surgical procedures, or with mechanical complications of acute myocardial infarction, were excluded from this study and the results cannot be extended to these extreme high-risk patient populations.

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