

## The Evaluation of Survival in Patients Who Need Intra Aortic Balloon Pump (IABP) after Cardiac Surgery

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### ARTICLE INFO

Article type:  
Original article

Article history:  
Received: 19 May 2014  
Revised: 15 Sep 2014  
Accepted: 24 Sep 2014

Keywords:  
Coronary Artery Surgery  
Intra-Aortic Balloon Pump  
Survival Rate

### ABSTRACT

**Introduction:** In some cases, assist devices are required to ensure an adequate cardiac output after cardiac surgery. Intra-aortic balloon pump (IABP) is the most commonly used cardiac assist device, which provides first-line support for patients with heart failure. The aim of this study was to determine factors affecting the mortality rate of patients receiving IABP.

**Materials and Methods:** In this retrospective cohort study, 235 patients requiring IABP support were analyzed over 14 years period (between January 1999 and December 2013) from which 137 patients survived the 30 days follow-up. Perioperative and demographic factors such as age, weight, underlying disease, ejection fraction, ventricular aneurysm and cardiopulmonary bypass (CPB) and cross clamp time were recorded and analyzed.

**Results:** The overall operative mortality was reported to be 41.7%. Male-to-female ratio was 131:104 and the mean age of the subjects was  $57.58 \pm 11.07$  years. Early mortality rate was higher among young subjects and those with prolonged CPB ( $162.71 \pm 35.25$ ,  $P < 0.001$ ) and ACC ( $129.94 \pm 54.39$ ,  $P < 0.001$ ). In addition, mortality rate was higher among females ( $P = 0.04$ ). Patients' weight, comorbidity, preoperative ejection fraction, ventricular aneurysm and stenosis of the left main coronary did not affect the mortality rate ( $P > 0.05$ ).

**Conclusion:** IABP is a simple, effective method for temporary cardiac support, especially for aged patients. In addition, lower duration of surgery is associated with better surgical outcomes.

► Please cite this paper as:

Mottahedi B, Esfahanizadeh J, Alizadeh K, Abbasi Shaye Z. The Evaluation of Survival in Patients Who Need Intra Aortic Balloon Pump (IABP) after Cardiac Surgery. *J Cardiothorac Med.* 2014; 2(4):227-230.

### Introduction

Intra-aortic balloon pump (IABP) is the most usable tool for temporary mechanical circulatory support in cardiac surgical patients suffering from low cardiac output in the early postoperative phase. Only in United States, more than 70,000 patients are supported annually by IABP (1,2). Its beneficial action is attributed to a concomitant reduction in afterload of left ventricle, and a substantial increase on coronary perfusion pressure due to an increase in aortic diastolic pressure in addition with subendocardial perfusion enhancement (3-6). The main indication of IABP in cardiac surgery patients is perioperatively in the treatment of a low cardiac output state refractory to the usual inotropic support. Furthermore, this device has been used

preoperatively for patients with refractory angina and those with sustained mechanical complications, following myocardial infarction (7-9).

In-hospital and 30-day mortality rates of patients requiring IABP are high (26-50%), given the underlying cardiac problems, which necessitate the application of this pump (2, 8, 10). Several studies have focused on the prognostic factors associated with mortality in patients with IABP. However, inconsistent results have been reported considering the diversity of indications for IABP in different patient populations (6).

The aim of this study was to analyze mortality rate of patients undergoing open heart surgery with IABP support and determine factors affecting the mortality rate of these patients.

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## Materials and Methods

In this retrospective cohort study A total of 235 patients, requiring IABP, were included in this cross-sectional study via convenience sampling. The subjects were selected from Tehran Modarres Hospital and Mashhad Qaem and Imam Reza teaching hospitals from January 1999 to December 2013. The ethics committee of Mashhad University of Medical Sciences approved this study.

Data pertaining to patients' medical history of diabetes mellitus (DM), hypertension (HTN), hyperlipidemia (HLP) and left main coronary artery disease (LMCA) were gathered. In addition, the following variables were collected from patients' medical records: age, gender, Body Surface Area (BSA), Body Mass Index (BMI), pre-operative ejection fraction (EF), presence of left ventricular (LV) aneurysm, operative priority (emergency surgery or not), cardiopulmonary bypass time (CPB), aortic cross-clamping (ACC) duration, reoperation during hospitalization and patient's status following the procedure.

Method of choice for myocardial protection was injection of cardioplegia solution every 20 minutes in an antegrade fashion.

Indications for IABP support were as follows: a) failure to discontinue CPB even with full-dose inotropes; b) low-cardiac output after a "difficult" termination of CPB (patient being supported by high-dose inotropes); c) difficult discontinuation from CPB, spontaneous appearance of arrhythmia (premature ventricular beats or ventricular tachycardia) and unresponsiveness to continuous infusion of anti-arrhythmics; and d) postcardiotomy low-output syndrome.

Prophylactic IABP support was not advocated in any of the cases. A datascope system (Datascope Corp., Paramus, NJ) was utilized and IABP was introduced precutaneously via the common femoral artery.

Correct placement of the device was routinely confirmed via chest X-ray examination at intensive care units (ICUs) of hospitals. Once the mediastinal drainage was at the minimum level (<50 ml/h), patients were anticoagulated with heparin infusion

to maintain Activated Clotting Time (ACT) >180-200 sec. First-generation cephalosporins were routinely administered during the IABP support.

Operative mortality was reported as 30-day mortality. Patients who remained alive during the first 30 days were allocated to group A and those who passed away were considered as group B.

## Statistical analysis

All analyses were performed using SPSS version 11.5. Variables were retrospectively collected and carefully validated before the analysis. Categorical variables were analyzed using Chi-square test. Quantitative variables were compared using parametric tests including independent t-test because of normal distribution of the data. Normality of the data was checked with Kolmogorov-Smirnov test. P-value less than 0.05 was considered statistically significant.

## Results

Baseline and operative characteristics of 235 patients were recorded. Overall, 104 (44.3%) female and 131 (55.7%) male patients were recruited in this study. The overall 30-day mortality rate was 41.7% and female-to-male mortality rate was 51:47 (P=0.4); therefore, patients' sex not affected the mortality rate in our study.

The mean age of the subjects was 57.58±11.07 years (range: 24-87). The first operation was carried out for 208 (88.5%) patients and reoperation was conducted on 27 participants (11.5%).

Patients in group B had a longer CPB, compared to those in group A (162.7±35.25 vs. 82.18±33.15 min) (P<0.001); similar results were obtained regarding ACC duration (129.94 ± 54.39 vs. 72.38 ± 36.87) (P<0.001).

The mortality rate was higher among younger patients and those undergoing prolonged ACC and CPB. Mortality rate was not significantly associated with the prevalence of diabetes mellitus, HTN, hyperlipidemia, LMCA, BSA, BMI, preoperative EF, presence of LV aneurysm or operative priority (P>0.05) (Tables 1 and 2).

**Table 1.** Baseline characteristics of patients and impact of each variable on mortality rate

	Group A	Group B	Results
Number of patients	137	98	
Age (years)	59.38±11.39	55.06±10.6	P=0.026* CI <sub>95%</sub> : 1.47,7.19
BSA (m <sup>2</sup> )	1.7±0.2	1.67±0.16	P=0.25 CI <sub>95%</sub> : -0.02,0.07
BMI (kg/m <sup>2</sup> )	25.64±4.09	25.34±2.26	P=0.38 CI <sub>95%</sub> : -0.06,1.2
Diabetes mellitus	25(18%)	26(27%)	P=0.13
Hypertension	47(34%)	37(38%)	P=0.59
Hyperlipidemia	42(31%)	35(36%)	P=0.42
Left ventricle aneurysm	13(9%)	5(%)	P=0.21
Preoperative Ejection fraction (%)	35.13±11.84	37.10±16.16	P=0.26
Left main coronary artery involvement	46(34%)	37(38%)	P=0.50

\*Statistically significant

**Table 2.** Intraoperative characteristics of patients and impact of each variable on mortality rate

Cardio pulmonary bypass duration (min)	82.18±33.15	162.71±35.25	P<0.001* CI <sub>95%</sub> : -89.43,-71.64
Aortic cross clamp duration (min)	72.38±36.78	129.94±54.39	P<0.001* CI <sub>95%</sub> : -69.33,-45.8
Emergency surgery	27(20%)	17(17%)	P=0.65
Reoperation	17(12%)	10(10%)	P=0.60

\* Statistically significant

This table shows a significant relation between mortality rate, CPB and ACC after IABP application.

## Discussion

The Need for increased use of IABP during cardiac surgery, reported by many studies in recent years (7,11). This is mainly due to changes in patient populations and inclusion of older patients with multi-vessel diseases and ventricular dysfunctions. On the other hand, there is a lower threshold for IABP application due to improved technologies and lower rate of complications (7).

As the current findings indicated, mortality rate is significantly associated with age, CPB duration and ACC time. These findings are in accordance with the results of Gutfingers et al, who showed that mortality rate of high-risk patients (older than 70 years), undergoing coronary artery bypass grafting and preoperative IABP, was lower than the control group (12).

CPB duration was prolonged (162.71±35.25 min) in complicated cases, which was mostly due to bleeding, prolonged "resting" on CPB after ACC removal (given the difficulties in weaning patients off CPB) and a rather high threshold for intraoperative IABP insertion. According to the previous studies, mortality rate ranged widely from 7% to 86% (13, 14); this is probably due to the inclusion of heterogeneous groups of patients. Considering the wide range of indications, some studies have included low-risk patients, for whom the device was inserted prophylactically, resulting in favorable outcomes. The overall mortality rate in our study was approximately 41.7%, which is indicative of a population of high-risk patients.

Incremental risk factors for perioperative death have been reported by various investigators (15-17). In a large retrospective study by Torchiana et al. (16), age, mitral valve replacement, prolonged CPB time, emergency operation, preoperative renal dysfunction, ventricular arrhythmias, right ventricular, failure and emergency reinstatement of cardiopulmonary bypass were independent predictors of mortality.

In another study by Arafa et al. (17), serum creatinine level, EF, preoperative myocardial infarction, timing of IABP insertion and indications for operation were independent predictors of early death. Although our study included a smaller number of patients, the incremental risk factors for early mortality were age and prolonged CPB duration. One of the

limitation in our study that we can mentioned is long duration of study and improvement in surgical technics along the time that could influence on the result.

## Conclusion

IABP is a simple, effective method for temporary cardiac support, especially for aged patients. In addition, lower duration of surgery is associated with better surgical outcomes.

## Conflict of Interest

Authors declare no conflict of interest.

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