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Risk Factors for Intraaortic Balloon Pump Use in Coronary Artery Bypass Surgery

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A – research concept and design; **B** – collection and/or assembly of data; **C** – data analysis and interpretation; **D** – writing the article; **E** – critical revision of the article; **F** – final approval of article; **G** – other

Abstract

Objectives. The study was aimed at investigating the risk factors of using an intraaortic balloon pump (IABP) in coronary artery bypass surgery and presenting the authors' clinical experience of IABP use.
Material and Methods. The study included 1094 patients who underwent coronary artery bypass surgery at the authors' clinic between January 2009 and December 2011. A comparison was made between 17 patients in whom an IABP was used and 1077 patients in whom it was not used.
Results. An intraaortic balloon pump was used in 17 patients (1.55%) out of 1094 patients who underwent isolated coronary artery bypass surgery. The ratio of patients who had had preoperative myocardial infarction within the preceding 30 days, left main coronary artery stenosis of more than 50% and emergency surgery in Group 1 were higher than in Group 2 ($p < 0.05$). The total cardiopulmonary bypass time of Group 1 was found to be longer than that of Group 2 ($p < 0.05$). The demand for inotropics after weaning from cardiopulmonary bypass was greater in Group 1 than in Group 2 ($p < 0.05$). The need for reoperation (because of bleeding) was higher in Group 1 than in Group 2 ($p < 0.05$). The patients' stay on the intensive care unit was longer in Group 1 than in Group 2 ($p < 0.05$). Mortality rates were 29.4% in Group 1 and 1.2% in Group 2 ($p < 0.05$).
Conclusions. Preoperative myocardial infarction within the preceding 30 days, left main coronary artery stenosis of more than 50%, emergency surgery and long cardiopulmonary bypass time are important risk factors for IABP use in coronary artery bypass surgery (**Adv Clin Exp Med 2014, 23, 2, 253–257**).

Key words: intraaortic balloon pump, coronary artery bypass surgery, mortality.

In contemporary medical practice, the intraaortic balloon pump (IABP) is the most common mechanical support device used to treat low cardiac output syndrome when medical therapy fails [1]. The IABP reduces afterload and increases coronary arterial perfusion pressure by increasing diastolic pressure in the aortic root. Thus, the myocardial work load and oxygen consumption decrease. IABPs are most commonly used in cardiovascular surgery clinics, in coronary artery bypass graft surgery patients during the perioperative period when low cardiac output syndrome develops or when weaning from cardiopulmonary bypass fails.

The aim of this study was to investigate the risk factors of using an IABP in coronary artery bypass surgery and to present the authors' clinical experience in IABP use.

Material and Methods

The study included 1094 patients who underwent coronary artery bypass surgery at the authors' clinic between January 2009 and December 2011. Patients demanding carotid or valvular surgery were excluded from the study. A comparison was

made between 17 patients in whom an IABP was used and 1077 patients in whom it was not used. Routine transthoracic echocardiography was carried out in all patients before surgery and the ejection fraction was calculated by Simpson's method. For induction of anesthesia, fentanyl citrate (Fentanyl Citrate, Abbott) and midazolame (Dormicum, Roche) were used; sevoflurane (Sevorane, Abott) and vecuronium bromide (Norcuron, Organon) were used for maintenance. Coronary artery bypass grafting was performed either on the beating heart or under cardiopulmonary bypass (CPB). In beating heart operations 2 mg/kg heparin (Nevparin, Mustafa Nevzat) was used, and 4 mg/ /kg heparin was used in operations under CPB. In operations under CPB, mild systemic hypothermia was applied and cardiac arrest was maintained by antegrade warm blood cardioplegia through the aortic root. Cardioplegia given through the aortic root was repeated in every 20 min throughout the cross-clamp period. Antegrade cardioplegia was given through the proximal end of the saphenous vein grafts after each distal anastomosis. Proximal anastomoses were done with side-biting clamps. Neutralization of the heparin was maintained by protamine hydrochloride (Protamine ICN, Onko) in a ratio of 1:1. An intraaortic balloon pump (Datascope CS300, Maquet Datascope Corp., USA) was used in low cardiac output syndrome when medical therapy failed or in failures of weaning from cardiopulmonary bypass. The use of the IABP was randomized for all patients. The IABP was not used preoperatively. IABP catheters were placed percutaneously via the femoral artery in all patients. The intraaortic balloon pump was placed by surgical exploration of the femoral artery in one patient. Low molecular weight heparin therapy was used in patients after IABP placement until its removal. When the need for inotropic support decreased, patients were weaned from IABP support and then the catheter was removed. The demographic data of the patients, their operational data and postoperative complications were registered.

Statistical Analysis

SPSS 18.0 software was used for the statistical analysis. Qualitative data were summarized as numbers and percentage; quantitative data were summarized as mean and standard deviation (if necessary, as mean, minimum and maximum). The chi square test was used to compare the qualitative data from the two groups. In comparing quantitative data from two groups, the t-test was used in groups with normal data distribution and the Mann-Whitney *U* test was used for groups with non-normal distribution of data. In comparing numerical measurements of more than two groups, one way variance analysis was used for groups with normal data distribution and the Kruskal-Wallis test was used for groups with non-normal distribution of data. Logistic regression analysis was used to determine mortality risk factors. A p value of less than 0.05 was regarded as statistically significant.

Results

An intraaortic balloon pump was used in 17 patients (1.55%) out of 1094 patients who underwent isolated coronary artery bypass surgery. The patients in whom an IABP was inserted constituted Group 1 and those in whom it was not used constituted Group 2. The preoperative demographic features of the patients are listed in Table 1. The mean age of Group 1 was 60.7 ± 9.2 years, and the mean age of Group 2 was 59 ± 9.7 years. There was no statistically significant difference

Table 1. Preoperative demographic findings

	Group 1 (n = 17)	**Group 2 (n = 1077)**	**P**
Age	60.7 ± 9.2	59 ± 9.7	> 0.05
Male	14	767	> 0.05
Female	3	310	> 0.05
DM	4	346	> 0.05
HT	8	457	> 0.05
COPD	1	67	> 0.05
EF (%)	40.8 ± 17.3	46.8 ± 18.8	> 0.05
MI	9	254	< 0.05
LMCAD	5	87	< 0.05
Emergency Surgery	8	31	< 0.05

DM – diabetes Mellitus, HT – hypertension, COPD – chronic obstructive pulmonary disease, EF – ejection fraction
MI – myocardial infarction, LMCAD – left main coronary artery disease.

between two groups in terms of sex, cardiovascular risk factors like diabetes mellitus (DM), hypertension (HT), chronic obstructive pulmonary disease (COPD) or ejection fraction. The ratio of patients with preoperative myocardial infarction within the preceding 30 days, left main coronary artery stenosis of more than 50% and emergency surgery in Group 1 was higher than in Group 2, and the difference was statistically significant ($p < 0.05$). Coronary artery bypass surgery was carried out on the beating heart in two patients in Group 1 and 71 patients in Group 2 ($p = 0.315$). Although the mean cross clamping time in Group 1 was longer than that in Group 2, the difference was not statistically significant ($p = 0.282$). The total cardiopulmonary bypass time for Group 1 was longer than for Group 2 ($p = 0.012$). The demand for inotropics after weaning from cardiopulmonary bypass was greater in Group 1 than Group 2 ($p = 0.003$). The Intraoperative findings and data are listed in Table 2. Thrombocytopenia was seen in 6 patients and leg ischemia was noted in one patient in Group 1. The need for reoperation (because of bleeding) was higher in Group 1 than in Group 2 ($p = 0.013$). It was found that drainage and the need for blood transfusion were higher in Group 1 than in Group 2 ($p > 0.05$). When compared in terms of the incidence of postoperative atrial fibrillation, the duration of the hospital stay and the use of levosimendan, the two groups showed no statistically significant differences ($p > 0.05$). The patients' stay in the intensive care unit was longer in Group 1 than in Group 2 ($p < 0.001$). Mortality rates were 29.4% in Group 1 and 1.2% in Group 2 ($p < 0.001$). All the mortalities in Group 1 were due to multiorgan failure after low cardiac output. The complications of the cases are listed in Table 3. Multivariant analyses showed that cardiopulmonary bypass time, the use of an intraaortic balloon pump, the amount of drainage and transfused blood were the most important parameters that affected mortality (Table 4).

Table 2. Intraoperative findings

	Group 1 (n = 17)	**Group 2 (n = 1077)**	**P**
Cross Clamp Time (min)	47.4 ± 38.2	47.4 ± 38.2	> 0.05
Cardiopulmonary Bypass Time (min)	105.8 ± 68	67.1 ± 29.2	< 0.05
Beating Heart (n)	2	71	> 0.05
Need for inotropic support (n)	12	361	< 0.05

Table 3. Complications

	Group 1 (n = 17)	**Group 2 (n = 1077)**	**P**
Amount of blood transfusion (mL)	588.2 ± 545.3	428.9 ± 387.1	> 0.05
Drainage (mL)	755.9 ± 841.1	621.6 ± 421.4	> 0.05
Reoperation (n)	3	30	< 0.05
CVA	0	2	> 0.05
Exitus	5	14	< 0.05

CVA – cerebrovascular accident.

Table 4. Multi-variant analyses for mortality

	P	**OR**	**95% confidence interval for OR**
CPB time (minute)	< 0.001	1.024	1.012–1.037
IABP	0.002	10.512	2.415–45.764
Drainage (mL)	0.050	1.067	1.000–1.135
Blood transfusion (mL)	0.029	1.058	1.000–1.110

CPB – cardiopulmonary bypass, OR – odds ratio, IABP – intraaortic balloon pump.

Discussion

Low cardiac output syndrome, which develops after coronary artery bypass surgery, is a serious complication with high mortality [2]. Low cardiac output is seen more frequently in patients who have preoperative left ventricular dysfunction, inadequate protection of the myocardium, long cross clamp and cardiopulmonary bypass time, perioperative myocardial infarction and incomplete revascularization [3]. The intraaortic balloon pump is the most commonly used mechanical support device to treat low cardiac output syndrome when medical therapy fails [1]. Miceli et al. reported the rate of IABP use after coronary artery bypass surgery to be 2.1% [4]. In the current study, the rate of IABP use was calculated as 1.55% in isolated coronary artery bypass surgery.

In coronary artery bypass surgery, identifying high risk patients preoperatively is of critical importance for the surgeon's operation plan and for postoperative management. Preoperative prophylactic usage of an IABP is still controversial in patients who have stable hemodynamic parameters but are at high risk [5]. In some studies, it has been found that preoperative use of an IABP in patients who have stable hemodynamic parameters but are at high risk has reduced the incidence of postoperative myocardial infarction, low cardiac output and mortality [5, 6]. There is no consensus on determining which high risk patients will benefit from IABP in coronary artery bypass surgery [4]. In the study conducted by Miceli et al., it was detected that preoperative myocardial infarction within the preceding 30 days, left main coronary artery stenosis of more than 50%, emergency operation, previous cardiac surgery, age older than 70 years and poor left ventricular function were important risk factors for the need for IABP use [4]. In the present study, it was found that preoperative myocardial infarction within the preceding 30 days, left main coronary artery stenosis of more than 50%, emergency operation and a long cardiopulmonary bypass time were important risk factors necessitating IABP in isolated coronary artery bypass graft surgery. On the other hand, the present study did not demonstrate any effect of age, sex, diabetes mellitus, hypertension, chronic obstructive pulmonary disease or ejection fraction on the need for IABP.

Despite the positive hemodynamic effects of IABP, the complication rates related to IABPs are not low. In a study which reviewed the recent literature, the complication rates related to IABPs were reported to be between 32.6% and 50% [7]. IABPs may lead to complications like thrombocytopenia, bleeding, injury to the aorta and iliac arteries, dissection, thromboembolism and leg ischemia. Thrombocytopenia and bleeding are the most commons complications [8]. Additionally, complications related to malpositioning of the balloon catheter can be observed [9]. In the current study, the most common complication was thrombocytopenia (35.2%). Mild leg ischemia developed in one patient, which diminished in the course of the hospital stay. Although it was speculated that open surgical insertion of IABP via the femoral artery can decrease the vascular complication rates, Iverson et al. reported decreasing vascular complication rates with IABP catheters placed into femoral artery percutaneously [10, 11]. In the present study, all IABP catheters except one were placed percutaneously via the femoral artery and no serious vascular complications were seen.

In this study, it was found that the patients in whom an IABP was placed had more bleeding; the need for reoperation (because of bleeding) was more common; and their stay in the intensive care unit was longer than for patients who did not receive IABP therapy. Mortality rates in patients that undergo CABG surgery and have IABP placement are reported to be between 27% and 52.6% [1, 6, 12, 13]. In the present study, it was found that the mortality rate of patients that were treated with an IABP was 29.4% and the mortality rate of patients that were not treated with an IABP was 1.2%.

The authors concluded that the mortality rates of patients that undergo coronary artery bypass surgery and receive an IABP are still high. Preoperative myocardial infarction within the preceding 30 days, left main coronary artery disease greater than 50%, emergency surgery and long cardiopulmonary bypass time are important risk factors for IABP usage in coronary artery bypass surgery. Although the number of cases in Group 1 was small, the results of this study may contribute to the formulation of a consensus statement that preoperative prophylactic IABP insertion might be beneficial in patients with a high risk for coronary bypass surgery. Further research with larger populations is needed to determine the effectiveness of preoperative prophylactic IABP insertion in high risk patients.

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