Original Article

Parameters of Intra Aortic Balloon Pumps in Patients Undergoing Open Heart Surgery

Feragat Uygur, PhD
Asst. Prof. SANKO University, Faculty of Medicine, Cardiovascular Surgery, Gaziantep, Turkey

Hatice Guzel, PhD
Asst. Prof. Dr SANKO University, Faculty of Health Sciences, Department of Nursing, Gaziantep, Turkey

Arzu Tuna, PhD
Prof. Izmir Tinaztepe University, Faculty of Health Sciences, Department of Nursing, Izmir, Turkey

Correspondence: Arzu Tuna, Izmir Tınaztepe University, Faculty of Health Sciences, Department of Nursing, Izmir, Turkey arzutunam@gmail.com

Abstract

Purpose: The aim of this study was to determine the hemodynamic impressions of patients who underwent open heart surgery in need of IABP after balloon insertion.
Method: This is a retrospective descriptive research and consisted of 28 patients who underwent open heart surgery in the cardiovascular surgery unit of a private hospital.
Results: The average age of the patients in the sampling was 62.50±10.69 (min:35; max:82). The duration of the application of the IABP in patients was 4,0741±2.40 (min:1, max: 9) days. The mean arterial pressure of the patients was 58.00±18.59 (min:27-max: 100) mm Hg before the application of the IABP, while it was 80.08±18.18 (min: 17-max: 108) mm Hg after the application of the IABP. After using drugs (such as Dobamin, Dobutrex, Adrenaline and Arterenol) to increase the cardiac output in the patients whose mean arterial pressure values were not within the normal range (MAP 70-100 mm Hg) and who had low MAP values, the IABP was applied in the patients. In spite of all these, ten patients died.
Conclusion: Although vasopressor drugs and the IABP administration in patients after open heart surgery bring hemodynamic mean arterial pressure to the normal limits, patients' Central Venous Pressure (CVP), body temperature, tissue perfusion and renal perfusion may not reach the normal limits. Renal and liver functions of patients can be supported by the IABP. Blood glucose levels of patients may be high due to stress despite positive changes in mean arterial pressure.

Keywords: Open heart surgery; Hemodynamic monitoring; Nursing

Introduction

The intra-aortic balloon pump (IABP) is a mechanical device which is usually used in cardiac operations in order to support transient circulation. Its main purpose is to minimise left ventricular burden and to increase artery pressure in patients with reduced mean arterial pressure (MAP) in order to increase cardiac output. The IABP is also used in patients with preoperative cardiac failure (Morton et al. 2005). It is a device that has been used since the 1960s (Ahmad, 2006).

The IABP is performed by placing a balloon in the thoracic aorta. It is most commonly used in the femoral artery. This pump increases aortic pressure and myocardial oxygenation during diastole. It helps to reduce oxygen consumption during systole. Good coronary blood flow is associated with the proximity of a balloon catheter to the aortic valve (Elliot et al. 2007). Drugs such as vasodilators and inotropic drugs are given to patients to increase cardiac output. If these drugs are unable to adequately increase the level of cardiac output, the IABP is used (Stenz, 2006). Before the operation, it is used to ensure the oxygenation of myocardium in case of a cardiac failure before cardiopulmonary bypass and to sustain hemodynamic stability. It is used

at the end of bypass application in the postoperative period (Morton et al. 2005).

The IABP indications are especially used in coronary artery bypass surgery, valve (AVR, MVR) diseases, left ventricular insufficiency, cardiogenic shock and angina (Hutton-Borghardt, 2010). The mortality of patients with cardiogenic shock increases. Inotropic drugs are used in these patients. In spite of this, it is used to maintain circulation in patients who do not improve. An increase in cardiac output results in a decrease in right heart pressure. The effect of the IABP starts to appear after 6-120 min (Morton et al. 2005).

There is a need for good nursing interventions in the follow-up of the IABP patients. As these patients have a low ejection fraction, fluid volume overdose may be seen because of a decrease in the pumping power of the heart and of water-sodium retention. This causes some unwanted conditions such as decreased diuresis, impaired mean arterial pressure, increased central venous pressure, and respiratory distress. Liquid electrolyte imbalance can be observed in relation to liquid volume deterioration. Close monitoring of ECG changes is important, especially in cases of dysrhythmia that may develop as a consequence of potassium excess. In terms of fluid retention, the patient should be monitored for weight loss and potential respiratory distress in the lungs and, if necessary, oxygenation should be provided (Morton et al. 2005). The nurse monitors the patient in whom the IABP is applied, evaluates the invasive and non-invasive blood pressure, respiratory rate and saturation of the patient and applies drugs enhancing cardiac output in accordance with the doctor's request (Mims et al. 2004). The IABP, which is an invasive procedure, has a risk of infection due to catheter. Therefore, the invasive site should be monitored for signs and symptoms of infection, fever should be monitored and dressings should be done under aseptic conditions (Comer, 2005).

The area of the incision site (femoral) should be monitored for bleeding. For this, blood count and coagulation tests should be performed (Comer, 2005). The patient who remains stabile due to the IABP should be given a position once in two hours in order to maintain skin integrity. The patient with the IABP might sometimes have sleep problems due to the noise of the pump. In such a case, the device can be muted. The patient who does not move due to the IABP might feel troubled because of a psychologically unknown situation. In this case, the patient should be supported psychologically (Elliot et al. 2007; Urden et al. 2002).

As a result, the IABP can be used for patients with heart failure where the pumping power of the heart decreases. By means of good nursing care, it can be seen that complications can be prevented, which would positively affect patient care. Vital signs, blood values, central venous pressure values, follow-up of fluids, ejection fractions (EF), inotropic drugs and fluids should be monitored and recorded by a team also consisting of nurses, and potential unexpected situations should be treated (Elliot et al. 2007; Urden et al. 2002).

Materials and Methods

This is a retrospective descriptive research and consisted of 28 patients who underwent open heart surgery in the cardiovascular surgery unit of a private hospital. The study data were obtained by extracting the files of the patients who underwent surgery between these years. Among the criteria for inclusion in the research; Patients with IABP before or after surgery were included in the study. The research data were collected in a private hospital in Gaziantep. The patients who were intubated, who needed an intra-aortic balloon pump, and who had undergone open heart surgery were included in the study. The patients were between 35 and 82 years of age. The operations of the patients were performed by two surgeons. After the operation, the patients stayed in the intensive care unit between 1 and 9 days. The data about the patients, such as blood pressure, pulse, mean arterial pressure, central venous pressure, fever, renal perfusion status live functions and inotropic support, after the insertion and the removal of the IABP were analysed. The sociodemographic characteristics of the patients were given in percentages and numbers, and the average of the numbers after the insertion and the removal of the IABP were taken into consideration. The relationship between the mean arterial pressure and the other parameters after the removal of the IABP was evaluated by means of the Pearson correlation analysis. The data were evaluated in SPSS statistics program.

Limitations of the Study: The most important limitation of the study is that it was studied in a single center. The study constitutes the patient population who had undergone cardiovascular

surgery in a private hospital and connected to the intra-aortic balloon pump.

Ethical Principles: Permission was obtained from the ethics committee and the institution for the study.

Results

The average age of the patients in the sampling was 62.50±10.69 (min:35; max:82). %71.4 (n=20) of the patients in our study were male. When the types of operation were considered, it was found that %53.6 underwent coronary artery bypass graft and their 3 coronary arteries were changed and %17.9 underwent coronary artery bypass graft and their 4 coronary arteries were changes. %28.6 of the patients had hypertension, while %50 had diabetes mellitus and %82.1 had atherosclerosis. When the comorbidities of the patients were taken into account, %17.9 had myocardial infraction (MI), %7.1 had chronic renal failure, while HCV and HbsAg were positive in %7.1 of the patients.

The duration of the application of the IABP in patients was 4,0741±2.40 (min:1, max: 9) days. The mean arterial pressure of the patients was 58.00±18.59 (min:27-max: 100) mm Hg before the application of the IABP, while it was 80.08±18.18 (min: 17-max: 108) mm Hg after the application of the IABP. After using drugs (such as Dobamin, Dobutrex, Adrenaline and Arterenol) to increase the cardiac output in the patients whose mean arterial pressure values were not within the normal range (MAP 70-100 mm Hg) and who had low MAP values, the IABP was applied in the patients. Some of the patients were extubated. In this period, the SIMV mode was used for the patients. The FiO2 values were between 45 and 60, and the tidal volumes and Positive End Expiratory Pressure values were arranged according to the needs of each patient. In spite of all these, ten patients died.

After the application of the IABP, the body temperature of the living patients (n=20) was 35.42±0.58 C (min: 35, max: 36:6 C), while their central venous pressure was 9.08±2.08 mm Hg (min: 5, max: 14) and normal. The intake-outputs values following the operation were 1193.51±1328.38 (min: -900/ max: +4150) and hypovolemic. The urea level was 25.81±12.36 (min:11-max:57), while the creatinine level was 1.49±0.88 (min:0.7-max: 5.1) and high within the normal range. However, the AST level was 132.48±316.03 (min:12-max:1655), and the ALT value was 97.40±254.28 (min:11- max:1255) and slightly higher than the normal range. The blood glucose level was 170.61±89.24 (min:79-max: 445) and higher than the normal range

The relationship between the hemodynamic and the blood parameters of the living patients (n=20) after the application of the IABP was determined by the correlation coefficient.

There was a nonsignificant and weak negative relationship between the pulse rate and the mean arterial pressure after the application of the IABP (p=0.981, r=-0.005). There was a significant and moderate negative relationship between the mean arterial pressure and the body temperature after the application of the IABP (p=0.003, r=-0.574).

There was a significant and moderate negative relationship between the mean arterial pressure and the 24-hour follow-up of the intake-output after the application of the IABP (p=0.005, r=-0.539).

There was a nonsignificant and weak positive relationship between the mean arterial pressure and the central venous pressure after the application of the IABP (p=0.734, r=0.071).

There was a nonsignificant and weak negative relationship between the mean arterial pressure and the serum urea values after the application of the IABP (p=0.140, r=-0.303).

There was a significant and moderate negative relationship between the mean arterial pressure and the serum creatinine levels after the application of the IABP (p=0.004, r=-0.558).

There was a nonsignificant and weak negative relationship between the mean arterial pressure and the AST values after the application of the IABP (p=0.935, r=-0.019).

There was a nonsignificant and strong positive relationship between the mean arterial pressure and the ALT values after the application of the IABP (p=0.441, r=0.173).

There was a nonsignificant and weak negative relationship between the mean arterial pressure and the blood glucose values after the application of the IABP (p=0.400, r=-0.180).

Table 1. **The Sociodemographic Characteristics of the Patients**

Sociodemographic Characteristic (n=28)	**Number (n)**	**Percentage (%)**
Age	62.50±10.69 (min:35-max:82)	
Gender		
Female	8	28.6
Male	20	71.4
Type of Operation		
CABG3	15	53.6
CABG1+VSD	1	3.6
CABG2	2	7.1
CABG2+MVR	1	3.6
CABG3+AVR	1	3.6
CABG3+AVR+MVR	1	3.6
CABG4	5	17.9
MVR	2	7.1
Medical History		
History of HT	8	28.6
History of DM	14	50
History of Atherosclerosis	23	82.1
Comorbidities		
Chronic Renal Failure	2	7.1
Gastritis	1	3.6
HCV, HBS	2	7.1
Nephrectomy + Triedectomy	1	3.6
Appendectomy	1	3.6
MI	5	17.9
REDO MVR	1	3.6
Mitral Insufficiency	1	3.6
None	13	46.4

Table 2. The Hemodynamic Parameters of the Patients in whom IABP was Applied

Parameters	**Results (n=28)**	
Duration of IABP	4,0741±2.40 day (min:1, max: 9 day)	
After the application of the IABP	Number	Percentage
Survival Status	18	64.3
Alive	10	35.7
Dead	18	100
Total		
Mean Arterial Pressure- MAP	**Before the application of the IABP** 58.00±18.59 (min:27-max: 100) mmHg	**After the removal of the IABP** 80.08±18.18 (min: 17-max: 108)mm Hg

Intubation Mode	During the application of the IABP The SIMV Mode was used in all the patients. FİO2: 45-55
	After the removal of the IABP (n=20)
Body temperature	35.42±0.58 C (min: 35,max: 36:6 C)
The 24-hour follow-up of the intake-output of the Patients after the operation	1193.51±1328.38 (min: -900/ max:+4150)
Central Venous Pressure (CVP)	9.08±2.08 mm Hg (min: 5, max: 14)
Urea	25.81±12.36 (min:11-max:57)
Keratin	1.49±0.88 (min:0.7-max: 5.1)
AST	132.48±316.03 (min:12-max:1655)
ALT	97.40±254.28 (min:11- max:1255)
Glucose	170.61±89.24 (min:79-max: 445)
Glasgow Come Scale	It was between 14 and 15 in the extubated patients.
Tissue Perfusion	The periphery in the patients was cold; however, the capillary filling was within the normal limits.
Abdomen Evaluation	All the patients had bowel sounds; however, they had mild distention.

Table 3. The Hemodynamic and Blood Parameters of the Patients After the Application of the IABP

Parameters	After the removal of the IABP, the mean arterial pressure (MAP) was 80.08±18.18 (min: 17-max: 108) mm Hg	
(n=20)	**Rho**	**p**
Pulse	-0.005	0.981
Body Temperature	-0.574	**0.003**
The 24-hour follow-up of the intake-output	-0.539	**0.005**
Central Venous Pressure	0.071	0.734
Urea	-0.303	0.140
Creatinine	-0.558	**0.004**
AST	-0.019	0.935
ALT	0.173	0.441
Glucose	-0.180	0.400

Discussion

The cardiac output level of a patient undergoing an open heart surgery decreases, and the cerebral, renal, mesenteric and peripheral tissue perfusion of a patient also decreases. Through vasoconstrictor drugs, the IABP increases the cardiac output and ensures tissue perfusion (Parissis et al. 2016). Ten of 28 patients included in the research sample died although they were provided with drugs increasing the cardiac output level and the IABP was applied in them (Stenz, 2006). Through inotropic drugs such as Dobamin, Dobutrex, Adrenaline and Arterenol, the cardiac output level of the patients was aimed to be increased (Levy et al. 2011; Unverzagt et al. 2015). The mean arterial pressure of the patients before the application of the IABP was 58.00±18.59 (min:27-max: 100) mm Hg, while it was 80.08±18.18 (min: 17-max: 108) mm Hg

after the application of the IABP. The Glasgow come scale of the extubated patients was between 14 and 15. When the tissue perfusion was analysed, it was seen that the periphery in the patients was cold; however, the capillary filling was within the normal limits. All the patients had bowel sounds; however, they had mild distention. As can be found in the literature; by means of positive inotropic vasopressor drug support, the IABP helped the patients with a low cardiac output level to bring the mean arterial pressure within its normal range. These findings in our study support the fact that the myocardium of the patients was oxygenated and the cerebral, renal, mesenteric and peripheral tissue perfusion was also ensured (Morton et al. 2005; Unverzagt et al, 2015). During the application of the IABP, the patients were intubated, and the mechanical ventilation was in the SIMV mod. The tidal volumes of the patients were adjusted according to their weights, and the oxygenation of the patients' lungs was ensured. The patients were monitored in terms of respiratory rate and consciousness after the extubation. When the patients were discharged from the intensive care unit, their saturation level was over 90 and the Glasgow coma scale score was between 14 and 15. In this way, through mechanical ventilation and the IABP support, their heart and lung functioned properly. In fact, ventilation can be described as a two-edged sword for patients in cardiogenic shock (Champion, 2014). PEEP and mechanical ventilation are universally used for cardiogenic shock (Elliot et al. 2007). However, some studies revealed that PEEP might reduce ventricular pulse power and affect left ventricular pulse power positively (Wiesen et al. 2013). Moderate PEEP level might also result in some hemodynamic advantages. Therefore, researchers agree with the fact that PEEP might be benefited for its clinic advantages although high PEEP level might have some side effects (Kontoyannis et al. 1999).

Together with the IABP, PEEP reduces the left ventricular load, increases diastolic coronary arterial perfusion pressure and enables the redistribution of coronary blood flow to the ischemic myocardium (Poss et al. 2014). Mechanical ventilation also triggers respiratory muscles which produce more work during pulmonary edema and affect a large part of the heart index. Finally, it is evident that mechanical ventilation improves pH and oxygen and thus increases the survival change of myocardium (Davis 3 rd et al. 2012).

In our study, mechanic ventilation and PEEP were applied along with the IABP and vasopressor drugs in the living patients (n=20), and the patients were extubated. The applications were similar to those in the literature (Davis 3 rd et al. 2012; Kontoyannis et al. 1999; Poss et al. 2014; Wiesen et al. 2013).

The IABP increases mean arterial pressure. In our study, when the mean arterial pressure was within its normal range, the patients were discharged from intensive care unit (Cheng et al. 2009). The duration of the application of the IABP in the patients was 4,0741±2.40 days.

There was a weak relationship between the mean arterial pressure, the pulse rate and the central venous pressure of the patients in whom the IABP was applied. When the mean arterial pressure of the patients was within the normal range, their pulse rate and central venous pressure were within the normal range. This is in line with the findings of the study conducted by Unvrzagt et al. (2015) (Unvrzagt et al. 2015).

The body temperature of the living patients was 35.42±0.58, and there was a moderate negative relationship between this value and the mean arterial pressure of the patients after the removal of the IABP. Although patients are warmed in intensive care units, drugs used for sedation. Patients might undergo hypothermia in intensive care units as temperature might be very low (Hoedemaekers et al. 2007).

The intake-output values showing the renal functions 24 hours after the operation was 1193.51±1328.38 (min: -900/ max: +4150) and hypovolemic. There was a moderate negative relationship between the mean arterial pressure and the intake-output after the removal of the IABP. In particular, it was found that hemodilution applied to a patient during an operation created plus balance (Shander et al. 2005). The pulse balance values of the patients in our study had similarities with those of other studies in the literature. After the removal of the IABP, the urea of the patients was 25.81±12.36 while the creatinine was 1.49±0.88 and close to the normal limits. However, these patients did not need dialysis. %7.1 of the patients had a renal failure story before the operation while %17.9 had a myocardial infarction history. The decrease in the cardiac output of the patients after the open

heart surgery might have negatively affected the renal perfusion (Türköz ve ark. 1995; Swartz et al.1992]. Increasing mean arterial pressure through positive inotropic drugs and the IABP might also positively affect renal perfusion (Sloth et al. 2008).

When the levels of urea and creatinine are high within the normal range, it might be about open heart surgery and the medical history of a patient before an operation. The moderate relationship between the urea and the creatinine in our study might be a consequence of this situation.

The AST of the patients, showing the liver function of the patients was 132.48±316.03, while the ALT was 97.40±254.28 and slightly higher than the normal limits. In the literature, high levels of AST and ALT decrease as a result of the IABP (Estep et al. 2013). In our study, there was a weak relationship between the AST and ALT values and the mean arterial pressure. Although there was blood supply of the liver when the mean pressure was within the normal range, high levels of AST and ALT might be related to the fluid and medication support given to the patients. It might also be about the fact that the liver functions of the patients might have been affected more compared to the low levels of mean arterial pressure (Leise et al. 2014). The glucose level of the patients was 170.61±89.24 and higher the normal range. There was a weak relationship between the mean arterial pressure and the glucose level. During an open heart surgery, a patient's stress level is extremely high. Stress-induced cortisone release increases the glucose level (Swenne et al. 2005). Although a patient's mean arterial pressure is within the normal range, the glucose level might be high in relation to high level of stress. In particular, stress and stress-related problems experienced by a patient in intensive care unit might increase cortisone release and blood glucose. Despite the fact the patients were informed about every process in our study, their stress level might not have been reduced properly. In this regard, we can point out that their blood glucose level was high.

Conclusion: In conclusion; although vasopressor drugs and the IABP administration in patients after open heart surgery bring hemodynamic mean arterial pressure to the normal limits, patients' CVP, body temperature, tissue perfusion and renal perfusion may not reach the normal limits. Renal and liver functions of patients can be supported by the IABP. Blood glucose levels of patients may be high due to stress despite positive changes in mean arterial pressure.

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