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The use of intra aortic baloon pump in patients undergoing coronary artery bypass grafting at the Aga Khan University Hospital, Karachi

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The use of Intra Aortic Baloon Pump in Patients undergoing Coronary Artery Bypass Grafting at the Aga Khan University Hospital, Karachi

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Abstract

Objective: To review the experience in the use of Intra Aortic Balloon Pump (IABP) in patietits undergoing Coronary Artery Bypass Grafting (CABG) at a tertiary care hospital with a new Open Heart surgery program. Design: Retrospective study.
Setting: The Aga Khan University Hospital, Karachi.
Patients: Medical records of all patients undergoing CABG between November 1994 and July 1997 were reviewed and those in whom IABP device was used, were included in this study.
Results: A total of 15 patients had IABP suppOrt during the study period. Four surgeries were done urgently while two were emergencies. There were three mortalities. Ejection fractions in all hut one patient were impaired. Among the surviving patients, the average pre-IABP Cardiac Index was 2.6 litres/mm/meter2 which registered an average increase of 21.15% after the initiation of the IABP. The Pulmonary Artery Wedge Pressure also showed an average reduction of 29.11% from the pre IABP levels reflecting an increase in the cardiac output with the use of the IABP.
Conclusion: This series represents the early experience of a new cardiac surgery center in Pakistan in the use of IABP. Although the numbers in this study are too small to derive any conclusions, the overall morbidity and mortality in this short series are within acceptable limits in the high risk patients included (JPMA 50:3, 2000).

Introduction

Moulopoulos in 1962[1] first described the principle of Intra Aortic Balloon Pump (IABP). This mechanical assist device works on the principle of diastolic counterpulsation, augmenting coronary perfusion and reducing afterload. This improves myocardial oxygen supply, reduces oxygen demand and enhances cardiac output. Kantrowitz in 1968 published the first report on the clinical performance of the Balloon Pump[2]. Since that time, the Intra Aortic Balloon Pump has gradually become an essential part of the cardiac surgeon's armamentarium.
At the Aga Khan University Hospital (AKUH), Open Heart Surgery was started in November 1994. This paper reviews the use and outcome of IABP inpatients undergoing CABG for coronary artery disease, highlighting the indications, benefits and complications of the device.

Patients and Method

Medical records of patitnts undergoing CABG for coronary artery disease at AKUH between November 1994 and July 1997 were retrospectively reviewed. Isolated CABG cases in which IABP was used were selected for the purpose of this study. Cases resulting from complications of Coronary Angioplasty and those in which a cardiac procedure other than CABG was carried out simultaneously were excluded. Both elective and emergency cases were included in this study.
Variables reviewed included age and gender of the patient, left ventricular ejection fraction, previous history of myocardial infarction and the Canadian Cardiology Society class of the patient. Timing of

insertion and the total duration of dependence on the balloon pump, the concomitant use of inotropes, the total length of stay and postoperative length of stay were also noted. Complications arising from the use of IABP were analyzed along with mortality.
The balloon pump system used was the Datascope 97. The Balloon catheters used included Datacope Cardiac Assist System R (Datascope Cardiac Assist Corp., Montvale, NJ, USA.) (9.5 and 10.5 French, 34cc) and Nicath TM Cardiac Assist, (Boston Scientific Corp., Watertown, MA, USA.) (9 French, 40cc). The size chosen depended upon the size and sex of the patient and the possibility of peripheral vascular atherosclerotic disease, the smaller size being chosen for women and those with diminished fern oral pulses. The method of insertion was by either percutaneous Seldinger technique or open cut down method through the Common Femoral artery. The position was determined at operation by approximating the tip of the catheter to the angle of Louis. The final position of the balloon was confirmed on the postoperative chest X-ray in the ICU and adjustments made if necessary.

Results

A total of 213 isolated CABG operations were performed at AKUH between November 1994 and July 1997. IABP support was used in 15 CABG cases during this period which have been included in this study (Table 1).

Table 1. Timing of Insertion of IABP.

Preoperative	3
Intraoperative	9
Postoperative	3

The average age of the patients was 53 years, the range being from 37 years to 68 years including 10 men and 5 women.
All patients except one had some impairment of left ventricular function, ten of them having severe dysfunction i.e., EF<30% (Table 2),

Table 2. Left ventricular ejection fraction.

EF%	No. of patients
<20	1
20-30	9
31-40	2
41-50	2
>50	1

as determined by echocardiography or visual estimate from the left ventriculogram. Four operations were done urgently and 2 were emergencies. The remaining were elective cases.
Fifteen patients had a previous history of myocardial infarction, five of them within 21 days prior to admission. All patients were categorized according to the Canadian Cardiology Society criteria[3]. Two patients were in Class II. 3 in class III, 5 in class IV-A, 3 in class IV-B while the remaining 2 were in class IV-C (Table 3).

Table 3. Canadian Cardiology Society classification.

Class	Description
I and II	Asymptomatic/symptoms on maximal activity.
III	Chronic stable angina on normal activity.
IV	Unstable angina with or without ECG changes.
IV A	Patients become asymptomatic on medication.
IV B	Not responding to maximal medical therapy.
IV C	Hemodynamic instability.

All patients receiving the IABP were monitored with Swan-Ganz catheters and some with left atrial pressure lines as well. Among the surviving patients. the pre-IABP Cardiac Index (liters/rn in/meter^2) ranged from 1.86 to 3.2 1 (average 2.6). Post IABP Cardiac index ranged from 2.5 to 3.43 (average 3.15), an average increase of 21.15%. Pulmonary capillary wedge pressures pre-IABP ranged from 4 to

36 mm of Hg (average 15.87). Post-IABP, the pressures ranged from 3 to 2 I (average 11 .25), an average reduction of 29.11%. An increase in cardiac index with reduction of PCWP (left ventricular end-diastolic pressure) reflects an increase in cardiac output with reduction in oxygen demand, as is expected from the IABP.

IABP support was utilized preoperatively in 3 cases. One was a 41 year old diabetic male with an ejection fraction of 17% with high grade left main coronary artery stenosis and diffuse triple vessel disease. This patient also had bilateral symptomatic carotid artery stenoses of more than 90%. He underwent Carotid Endarterectomy on the left (dominant) side and a simultaneous CABG. The balloon catheter was inserted pre-induction and support continued during the Carotid Endarterectomy and then post-CABG for another 24 hours. The postoperative course was unremarkable.

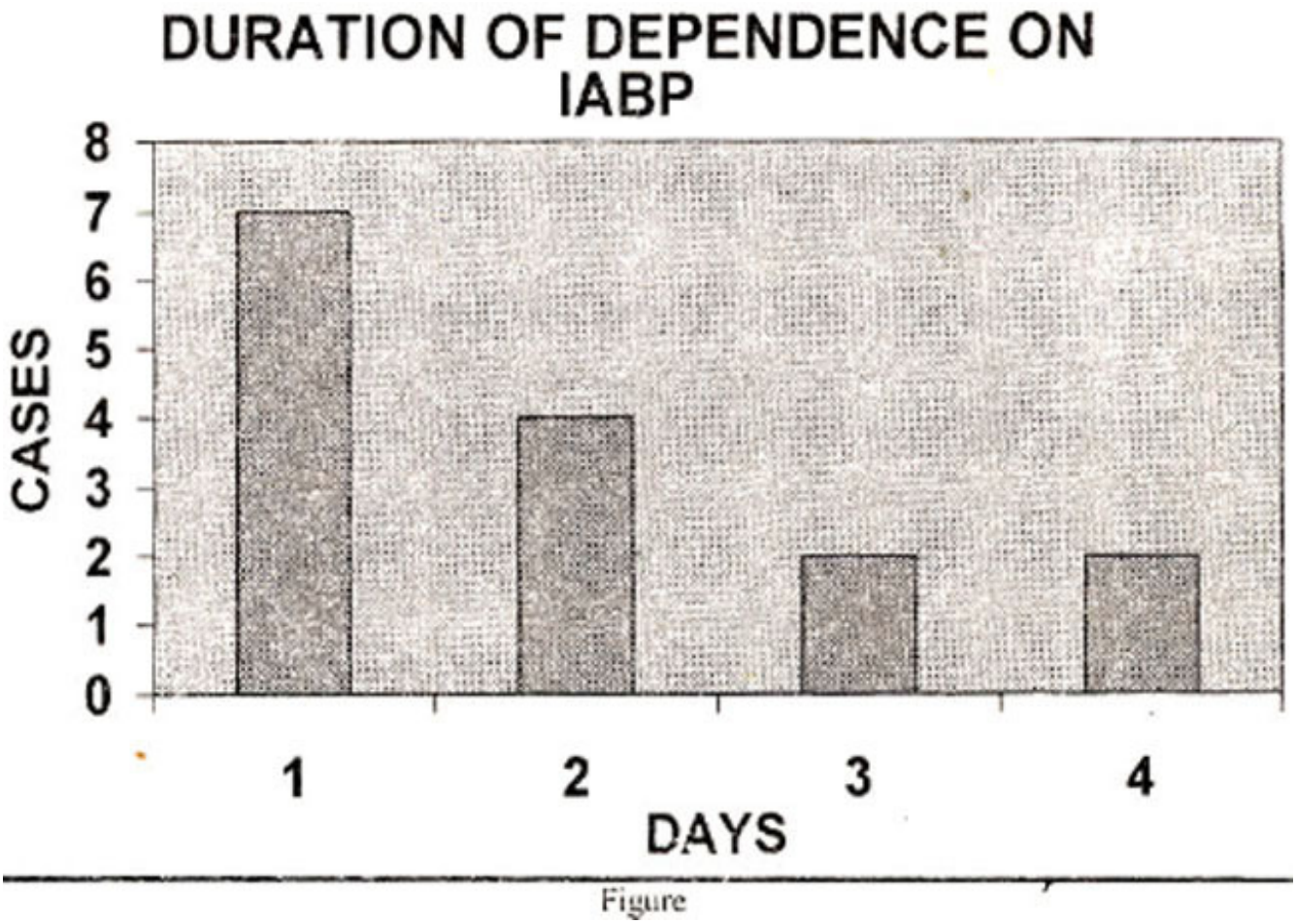
The other patient was a 49 year old male with an ejection fraction of 20% who had congestive cardiac failure (CCF) secondary to an ongoing myocardial infarction. He underwent CABG as an emergency with the IABP inserted preoperatively to stabilize him. His operation was uneventful but he continued to have congestive cardiac failure and resistant pleural effusion for the next six months. He eventually had bilateral pleurodeses and subsequently did well.

The third case was of a 64 year old male with post infarction unstable angina and a second evolving myocardial infarction complicated by CCF. He had an estimated ejection fraction of 49% on echocardiography done prior to the second myocardial infarction. An intraaortic balloon was inserted several hours preoperatively to relieve ischernia and stabilize his hernodynamic status and to maintain circulation. His surgery was uneventful. He had persistent mild postoperative congestive cardiac failure, which was managed medically with eventual relief Nine patients had the IABP inserted intraoperatively while coming off cardiopulmonary bypass. They had low cardiac outputs and did not respond thvorably to inotropic support or had ECG changes with apparently patent grafts.

Three patients required IA BP insertion postoperatively. One patient with an election fraction of 6 1% had undergone a two vessel bypass on the beating heart without being put on cardiopulmonary bypass. He sustained a myocardial infarction overnight and had to be re-explored for low cardiac output the next morning. The distal ends of both grafts had thrombosed inspite ol patent anastamoses and were replaced with new grafts on cardiopulmonary bypass. His postoperative course was unstable and was on inotropes and IABP support for 4 days. He was successfully weaned off from both the pharmacological as well as the mechanical support.

The second patient was 68 vears old and had unstable angina post mvocardial infarction with an ejection fraction of 20%. He underwent CABG for severe triple vessel disease. lie had to he taken bacL to the operating room the same day for bleeding and was re-explored. IABP was inserted for intermittent pulmonary artery pressure elevations at lower perfusion pressures. H is recovery was uneventful.

The third patient was a 37 year old male with an ejection fraction of 35% who had an urgent CABG for post-infarction unstable angina and diffuse three vessel coronary artery disease. He required re-exploration for excessive bleeding and sustained a myocardial infarction and went into biventricular failure. lie had both a balloon catheter and a ventricular assist device placed but could not he weaned off bypass and expired on the table. The average duration for which the balloon pump remained in use was 1.8 (range of I to 4) days (Figure).



Figure

Fourteen patients required sim ultaneous inotropic support along with IABP to maintain hemodynarnic stability. This was gradually reduced to a minimum or stopped prior to removal of the balloon in surviving patients.

The total length of stay ranged from 6 to 38 (average 19.4) days in surviving patients. The post-operative length of stay ranged from 6 days to 27 (average 11.2) days among the surviving patients.

There was one major morbidity as a result of IABP insertion. This was in a 50 years old obese, diabetic lady who had an urgent CABG performed for unstable angina with diffuse 3 vessel coronary artery disease following 10 days of intravenous antibiotic therapy for bacteraemia secondary to a urinary tract infection. She underwent CABG but had difficulty being weaned off cardiopulmonary bypass and needed IABP insertion. A size 9.5 Fr. Balloon catheter was inserted via the right common femoral artery using the percutaneous Seldinger technique. She required mediastinal re-exploration for postoperative ECG changes and an elevated CVP and was found to have thrombosed her right coronary artery graft. An RCA graft thrombectomy was done since the anastomosis was patent. The IABP was removed on the 3rd postoperative day. She developed severe vascular compromise in the affected limb 3 days postoperaively and was found to have occlusion of the right superficial femoral artery on doppler for which she underwent a thrombectomy. A peripheral arterial bypass was not performed because of the severe persistent infection she had developed in the thrombectomy wound. Her limb ischaetnia recurred after 5 days. An angiogram done at that time showed subtotal occlusion of the common femoral artery. An angioplasty was not considered for fear for disrupting the recent arteriotomy. Her limb ischaemia persisted and she required toe amputations but ultimately had to have a below knee amputation 7 months post CABG.

There were three mortalities in this series. One was a 56 year old male with a low ejection fraction

having sustained a myocardial infarction within the past 24 hours and had to undergo an emergency CABG. He had profound LV dysfunction and required the insertion of IABP and a left ventricular assist device to maintain circulation. These measures failed and the patient succumbed to circulatory failure. The second was a 38 year old male who had undergone an urgent CABG for post myocardial infarction unstable angina with an estimated ejection fraction of 35%. He had uneventful surgery but had to be re-explored for excessive haemorrhage 6 hours later. He had prolonged hyoptension culminating in myocardial infarction. Both the IABP and a left ventricular assist device were employed but were unable to maintain his circulation.
The third lady was 65 years old with mild left ventricular dysfunction had an elective CABG for unstable angina. She had a left internal mammary artery sequentially grafted to a diffusely diseased left anterior descending artery which thrombosed, resulting in left ventricular damage and hypotension. The chest was reopened immediately after closure and another Saphenous vein Y-graft was applied to the LAD. She sustained myocardial damage and an IABP was inserted to maintain circulation. She was shifted to the Intensive Care Unit with an open
chest but had a cardiac arrest later that night and could not be revived.

Discussion

The use of aortic balloon counterpulsation has become a well established mechanism for assisting circulation in patients undergoing Open Heart Surgery. The augmented aortic pressure during diastole improves coronary circulation and the decreased aortic pressure during systole decreases the afterload of the heart. It is of proven benefit in patients with hemodynamic instability following CABG[4]. The benefits of instituting IABP support preoperatively inpatients with low ejection fraction undergoing CABG has also been well demonstrated[5].
At the Aga Khan University Hospital, 250 open heart operations have been performed since November 1994, of which 213 were isolated CABG's. In the tertiary care setting of this hospital, it has not been possible to exclude high risk cases, as is customary for centers initiating open heart surgery. Mechanical assist devices for circulatory support like the lntra Aortic Balloon Pump and Ventricular Assist Device are available and have been used when indicated. This study looks at the use of IABP inpatients undergoing isolated CABG.
Some of the indications for which IABP is used in clinical practice include haemodynam ic stabilization in patients with cardiogenic shock, insertion prior to Coronary Artery Bypass Grafting (CABG) in patients with refractory myocardial ischaemia, in patients with acute ischaeniia secondary to coronary angioplasty failure and in patients with cardiac failure or ischaemia following CABG[6]. In this study all the patients having required IABP support had one or more of the above indications present. The beneficial role of preoperative balloon catheterization in high risk patients with unstable to refractory angina is proven. This maneuvre provides protection to the circulation till the time the patient is put on cardiopulmonary bypass (CPB). Three patients in our series were in this category. Nine patients required mechanical support to facilitate weaning them off CBP as they were unable to maintain adequate blood pressure and cardiac output despite optimal pharmacological manipulation. The remaining 3 patients needed IABP support postoperatively. All three needed mediastinal re-exploration for various reasons and had the balloon catheters inserted during the second visit to the operating room as they were unable to maintain stable circulation.
With the benefits of IABP becoming evident, another proposed indication of IABP is the preoperative insertion in high risk patients with known coronary artery disease undergoing non-cardiac surgery[7]. The choice of the method of insertion of the balloon catheter depended upon the timing of insertion, all preoperative insertions being percutaneous and also on the presence of a palpable femoral artery pulsation. Patients in whom a femoral pulse was palpable at the time of insertion had the catheter

inserted via the percutaneous route while those in whom a distinct pulse was not palpable had the placement done by the open technique. Ninety-four percent of the patients in this series had an ejection fraction of less than 50% and 87% patients were in the Canadian Cardiology Society Classification category Ill or IV, indicating the extent and severity of ischaemic heart disease in the patients included. Ever since Kantrowitz in 1 968? showed the clinical benefits of IABP, its wider usage has also brought up the possible complications that can accompany its insertion. Kantrowitz et al[2] classified complications as being vascular, infectious and bleeding occurring in 22%, 22°/o and 7% patients respectively in their series. Among women and diabetics, vascular complications occurred in 32%. Naunheim et al[8] reported a 12.4% complication rate and a mortality of 44% as is the case in most reports. This essentially reflects the severity of the patient's illness and not the effect of the IABP. The complication rate in this series was 6%, one of the 15 sustaining ischaemia of the involved leg. Limb ischaernia is a known complication of IABP insertion[9] and may be the result of diffuse peripheral vascular disease or a mismatch between the artery size and the catheter caliber. Female sex, diabetes and unstable angina are independent risk factors for limb ischaemia in IABP patients[2]. All three risk factors were present in our patient. Described methods of avoiding this complication include using the smallest sized balloon catheter for the particular patient, insertion without the sheath or to insert the balloon via the subclavian artery or into the aorta directly or through an attached vein graft Oconduit. Other possible complications include arterial dissection, in situ rupture of the balloon and gas embolism, thromboembolism and arterial perforation, major vessel blockage like the left subclavian artery or the renal arteries. These are however.
rare complications. IABP is contraindicated when significant aortic regurgitation is present. The device must therefore be used after careful consideration of the possible problems it can cause.
In three patients, all the pharmacological and mechanical support instituted was unable to maintain hemodynamics. In two of these patients, the IABP was inserted intraoperatively while in the third patient, the balloon catheter was inserted postoperatively to assist circulation. The overall mortality in this series is 20%, which is less than to that noted in most other studies. This represents the total mortality ol 1 .4% in our own series of 213 CABG patients.
The numbers in this present series are too small to derive any conclusive results but represent the early experience of a new center in Pakistan using the IABP in patients undergoing coronary artery bypass surgery. The overall morbidity and mortality rates in this short series are within acceptable limits in the high risk patients included.

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