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Factors predicting the peri-operative outcome following Intra Aortic Balloon Pump in cardiac surgery – a retrospective study

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ABSTRACT Patients undergoing cardiac surgery are increasingly at risk of morbidity and mortality because of advanced age, comorbidities, extensive coronary artery disease and severe Left Ventricular(LV) dysfunction. Several therapeutic options are available to support failing heart during the perioperative period. Intra Aortic Balloon Pump(IABP) is now the most commonly used form of circulatory assist in cardiac surgery. We conducted a retrospective study of all the patients who underwent IABP insertion during and after surgery during the last 18 months in our institution and analysed the various factors predicting the need for IABP and affecting the outcome following IABP.

KEYWORDS : Intra Aortic Balloon Pump, IABP, Peri operative Heart failure, Circulatory assist, Severe LV dysfunction

Background :
Patients undergoing cardiac surgery are increasingly at risk of morbidity and mortality because of advanced age, co-morbidities, extensive coronary artery disease and severe LV dysfunction. Several therapeutic options are available to support failing heart during the peri-operative period. These include inotrophes, vasopressors, Intra-aortic balloon pump (IABP), and assist devices. Intra Aortic Balloon Pump is now the most commonly used form of circulatory assist in cardiac surgery. The main effects of IABP are reduction of ventricular after load, improvement in diastolic coronary perfusion, and enhancement of sub endocardial perfusion. IABP could be used preoperatively, intra-operatively, or postoperatively. Time of insertion has been shown to affect hospital mortality significantly.

Objectives :
We conducted a retrospective study of all the patients who underw ent IABP insertion during and after cardiac surgery during the last 18 months in our institution and analysed the various factors involved in order to determine

1. The factors predicting the need for IABP during and after cardiac surgery.
2. The factors affecting the outcome following IABP insertion.

Materials and Methods :
All the patients who required IABP insertion during and after cardiac surgery in our institution during the period September 2015 to February 2017 were included the study. Those patients who were in cardiogenic shock preoperatively and who underwent emergency surgery were excluded from the study. A total of 21 patients were studied. Factors analysed were Age, preoperative pulmonary edema, Ejection fraction, Left main disease, presence of akinesia/infarct/scar in LV, associated Ventriculo Septal Rupture(VSR)/ Valve pathology, timing of IABP insertion, requirement of two high dose inotrophes, Cardio Pulmonary Bypass(CPB) duration and renal failure . Based on the observations made the factors predicting the need for IABP and outcome following IABP were determined.

Observations and Results :
Out of the 21 patients who required IABP, 10 patients were aged more than 55 years. 5 were females, 16 were males. 9 patients survived to discharge, 12 patients suffered mortality.

In the survival group, only one patient had left main disease of 30% stenosis. In the non survival group, 5 out of 12 patients had left main disease of more than 50% stenosis. Ejection fraction was less than 40% in 8 out of 12 patients in non survival group and in 2 out of 9 patients in the survival group.

Preoperative pulmonary edema was present in 3 patients in non survival group and 1 patient in survival group.

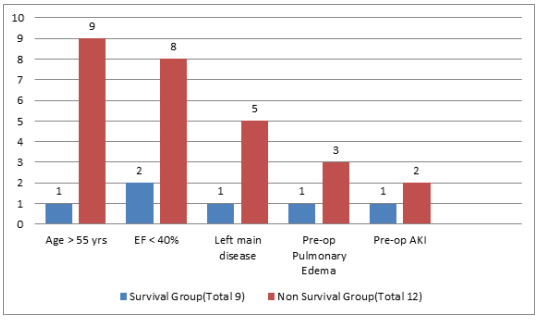

Figure 1 : Pre-operative factors

The primary pathology was coronary artery disease in all the cases. In the survival group, there were no coexisting valve pathologies, 1 patient had akinetic LV apex, 1 patient had a patchy small infarct. However in the non survival group, 1 patient had associated aortic stenosis, 4 patients had mitral regurgitation which was significant in 1 case, 2 patients had associated VSR, 1 patient had LV aneurysm and 7 out of 12 cases had either akinesia or infarct or scar in LV.

In the survival group, 4 patients underwent off pump Coronary Artery Bypass Grafting(CABG), remaining 5 underwent on pump CABG. In the nonsurvival group 5 patients underwent off pump CABG, one patient underwent CABG with Mitral Valve Replacement(MVR), one patient underwent CABG with Aortic Valve Replacement(AVR), 2 patients underwent CABG with VSR closure, one patient underwent CABG with surgical ventricular restoration and 2 patients underwent On pump CABG. Average duration of CPB in the survival group was 145 minutes while that in non survival group was 242 minutes.

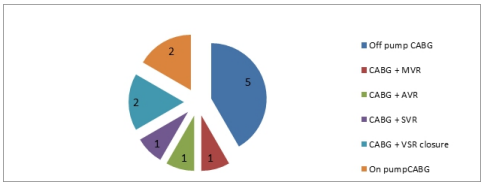

Figure 2 : Nature of Surgery in Non Survival Group

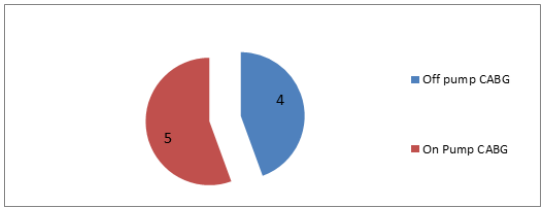

Figure 3 : Nature of Surgery in Survival Group

Intra-operative IABP insertion was done in 5 out of 9 patients in the survival group and in 6 out of 12 patients in the non survival group. Compared to those cases in which IABP was inserted post operatively, these cases with intra-operative insertion had better outcome in the form of shorter ICU stay, lesser requirement of inotrophes and higher post operative ejection fraction. In the survival group only 4 out of 9 cases required more than 2 high dose inotrophes while all the cases in other group required multiple high dose inotrophes. The average duration of IABP was 2.5 days.

Post operative AKI was observed in 1 case in survival group while in 5 cases in non survival group. Re-exploration was done in 4 cases in non survival group while in 2 cases in survival group. The mortality was due to refractory low cardiac output state following sustained severe LV dysfunction in most of the cases. 5 deaths were due to multi-organ failure and 1 death was due to respiratory failure. The complications encountered were thrombocytopenia in 5 patients and limb ischaemia in 2 patients.

Out of the 21 patients who underwent IABP implantation, 43% (9 out of 21 patients) survived. However in the non survival group the basic pathology included coexisting valve pathologies and ventriculo septal rupture. Thus if we consider the cases of CABG alone that required IABP, survival percentage is 56%(9 out of 16 patients). Similarly out of these 5 cases with coexisting pathologies, IABP was implanted intra-operatively in 4 cases, since there was difficulty in weaning off bypass. Thus if we exclude them, of the 16 CABG cases, 7 cases underwent IABP insertion intra-operatively while 9 cases underwent postoperative insertion and the Survival percentage was 71% in preoperatively IABP inserted patients while it was 44% in postoperative IABP inserted patients.

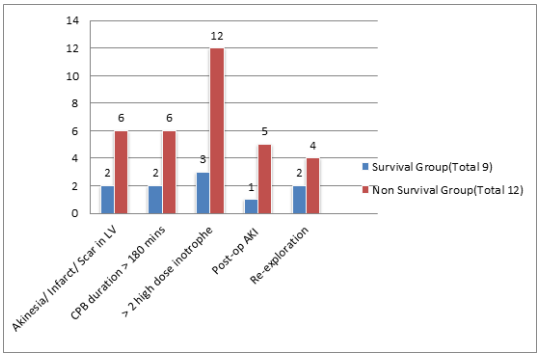

Figure 4 : Intra-operative & Post-operative Factors

S.No	Factor	Survival group (Total 9)	Nonsurvival group (Total 12)
1	Age > 55 years	1	9
2	Female : Male	1:9	1:3(4:12)
3	Ejection fraction < 40%	2	8
4	Left main disease	1	5
5	Preoperative pulmonary edema	1	3
6	Coexistent pathology	-	5
7	Akinesia/Infarct/Scar in LV	2	7
8	Preoperative renal disease	1	2
9	Offpump vs On pump Surgery	4:5	5:7
10	Re-exploration	2	4
11	Average CPB duration	145 mins	242 mins
12	Timing of IABP insertion Intra-op VS Post-op	5 vs 4	6 vs 6
13	Requirement of more than 2 high dose inotrophe	3	12
14	Post op AKI	1	5

Table 1 : peri-operative factors predicting IABP need and outcome

Discussion :

The intraaortic balloon pump (IABP) has been used in cardiac operations since the late 1960s. Over the recent years, with refinements in technology, its use has expanded, indications have increased, percutaneous insertion [4] has evolved and preoperative use have increased. This is mainly due to the fact that the patient population has changed and now includes older patients with multi-vessel disease and more impaired ventricles. On the other hand, there is a lower threshold for IABP use due to improve technology and lower rate of complications [3]. Over the past decade, IABP is the most commonly used mechanical assist device in cardiac operative procedures.

Results of cardiac operative procedures continue to improve despite ever-increasing numbers of older and sicker patients [6]. Of those who die, many do so of complications relating to low cardiac output during the perioperative period. The intraaortic balloon pump has been widely used during the perioperative period to support patients with low cardiac output. The IABP was first used clinically in 1968 for supporting patients with cardiogenic shock after acute myocardial infarction [9]. Soon its use was expanded to postoperative support and as an aid in weaning patients from cardiopulmonary bypass [8, 11]. Use of the IABP has continued to increase, particularly over the past decade with the expansion of interventional cardiology, and the increasing age and acuity of cardiac surgical patients. Also the use has extended to prophylactic use in selected patients.

Overall mortality in patients receiving IABPs intra- and postoperatively ranges from 21% to 73%[9,10]. Patients receiving IABPs intra-operatively and postoperatively differ from those receiving the device preoperatively. They may have been considered lower risk or were more stable preoperatively than those receiving a preoperative IABP. The outcome of these patients may have been worse without the support of the IABP. Intraaortic balloon pump use for weaning from cardiopulmonary bypass is well established, although the specific indications and the threshold for use are hard to analyze. There is class I level C evidence for the use of the IABP for weaning from bypass in CABG patients. There is class IIa level C evidence for postoperative IABP use in CABG patients. Survival of patients requiring intraoperative IABP support is usually reported to be more than 50% [10]. These patients likely would not have been separated from bypass without IABP assistance and would have died. However on the other hand, in a large series, 40% of the patients receiving an IABP intraoperatively ultimately required a ventricular assist device [9].

Intraoperative and postoperative IABP insertion is an indication of serious complications, which are often not correctable. As such, these patients face a high mortality. An IABP inserted for low cardiac output rather than ischemia is clearly associated with a poorer

prognosis [6]. Not surprisingly, patients requiring intraoperative or postoperative IABP insertion have mortalities similar to those patients receiving an IABP for medical treatment of postmyocardial infarction shock. In addition the effect of the IABP on flow in bypass grafts is unclear and seems to be related at least in part to the graft used and its proximal origin. Thus in some cases IABP use may be of uncertain benefit.

Through out the literature the mortality rates range widely from 7% to 86% [4,7]. This is probably due to the heterogeneous groups of patients considered. With the wide range of indications some series have included low risk patients, whereby the device was inserted prophylactically, with subsequent favourable outcome. The overall mortality in our series was around 57%%. This obviously reflects a population of high risk patients. Further the mean age of the patients were high and a significant number of patients had additional pathologies. When we consider CABG cases alone, the mortality in our series was 44%. In addition among these CABG cases the mortality in intraoperative IABP inserted group was 29% while that in post operatively IABP inserted patients was 56% thus signifying the superiority of early identification of the need for IABP and early insertion of IABP.

Prolonged CPB time had an impact on the overall outcome. The prolonged CPB time was most probably due to bleeding, a prolonged "resting on CPB" after aortic cross-clamp removal because of difficulties in weaning from CPB and also a rather high threshold for intraoperative IABP insertion.

Incremental risk factors for perioperative death have been reported by various investigators [2, 10, 12]. In a large retrospective study by Torchiana et al [12] independent predictors of death were age, MVR, prolonged CPB time, emergency operation, emergency reinstitution of cardiopulmonary bypass, preoperative renal dysfunction, ventricular arrhythmias and right ventricular failure. In another study by Arafa et al [2] serum creatinine levels, EF, perioperative MI, timing of IABP insertion and indication for operation were independent predictors of poor outcome. Although our study includes smaller number of patients the risk factors for poor outcome were similar with the aforementioned reports.

Nevertheless the use of IABP is justifiable. However the peri-operative mortality of patients needed IABP support remains high. The mortality is increased exponentially with presence of multiple aforementioned risk factors especially in those who also required concomitant valve surgery or concomitant surgery for the mechan ical complications. Timing of IABP insertion had a definite impact on outcome. Furthermore the current trend is towards pre-operative IABP insertion in selected cases for better outcome and choosing ventricular assist devices rather than IABP when there are multiple factors predicting bad outcome with IABP insertion.

Conclusion :

The factors predicting the need for IABP were age> 55 years, preoperative recurrent pulmonary edema, left main disease, Akinesia/Infarct/Scar in LV, coexisting valve pathologies/ mechanical complications(VSR/LV aneurysm), and preoperative ejection fraction<40%, especially when more than one of these factors were present. The factors affecting IABP outcome were CPB duration>180 minutes, associated mechanical complications, requirement of more than 2 high dose inotrophe even after IABP insertion, post operative oliguria/Acute Kidney Injury, post operative ejection fraction < 40%. Besides these timing of IABP insertion had a big impact on outcome. Intra-operative IABP insertion patients had better outcome than the patients who had postoperative IABP insertion. Infact, the current trend is towards pre-operative IABP insertion in selected cases for better outcome and choosing ventricular assist devices rather than IABP when there are multiple factors predicting bad outcome with IABP insertion. The difficulty lies in identifying those patients who are at risk of perioperative decompensation and thus would benefit most from a prophylactic IABP and those who will require ventricular assist device rather than an IABP.

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