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Original Article

INTRA-AORTIC BALLOON COUNTERPULSATION IN THE MANAGEMENT OF LOW CARDIAC OUTPUT SYNDROME AFTER CORONARY ARTERY BYPASS SURGERY

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ABSTRACT:

Objective: To assess the efficacy of pharmacological management as compared to early and primary institution of Intra-aortic balloon counterpulsation in the management of low cardiac output syndrome after coronary artery surgery.

Setting: Postoperative Intensive Care Unit of a tertiary care cardiac hospital.

Design: It is a retrospective study of 124 patients who developed post operative low cardiac output syndrome after coronary artery bypass surgery. These patients were treated either with multiple inotropes, plus vasodilators (GP-I, n=65) or with single inotrope and IABP support within 02 hours after hemodynamic compromise (GP-II, n=59). Different hemodynamic variables were compared among both the groups by Statistical Package for Social Sciences (SPSS)

Outcome studied: Mean arterial pressure (MAP), Cardiac index (CI), Pulmonary capillary wedge pressure (PCWP), Central venous pressure (CVP), Urine output & ICU stay were compared. Overall survival in both the groups was also noted.

Results: Both groups showed improvement in CI, MAP, Urine output, CVP and PCWP, however the improvement was more pronounced in GP-II which was statistically significant after 24 hours. Mean duration of IABP support and stay in ICU was less in GP-II. Survival in GP-I was 24/65 (36.9%) as compared to 34/59 (57.6%) in GP-II.

Conclusion: Early initiation of IABP support results in better hemodynamic profile, reduced mortality, reduced ICU stay in patients developing low cardiac output syndrome after coronary artery bypass surgery as compared to pure pharmacologic support or late addition of mechanical support.

KEYWORDS: Intra-aortic Balloon Counterpulsation, Coronary Artery Bypass Surgery and Post Cardiotomy Cardiogenic Shock, Post operative low cardiac output syndrome.

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INTRODUCTION

Medical science has always been on the look out for some sort of mechanical circulatory assistance that might help to stabilize the patients in severe cardiac failure. The choice of circulatory assist device depends upon whether the patient's ventricle is expected to recover or not. Intra-aortic balloon pump (IABP) is the most commonly used circulatory assist device that can be lifesaving in these desperate conditions. In this technique an indwelling balloon is introduced mostly via the femoral artery and is positioned in the descending thoracic aorta just distal to left subclavian artery. The balloon

pump is synchronized with left ventricle contractions by means of electrocardiogram or arterial pressure tracing. Machine pumps pre determined volume of gas into the balloon during diastole and withdraws it during systole producing the dual hemodynamic response; augmentation of diastolic pressure resulting in an increase in coronary artery perfusion pressure and reduction in systolic pressure and left ventricle afterload. These two factors favorably affect the myocardial oxygen supply/demand ratio.

The use of IABP counter pulsation at AFIC/NIHD Rawalpindi for postcardiotomy low cardiac output after coronary artery bypass graft surgery was started in 1980. Earlier studies showed the use of IABP in 2.5% cases[1], however, as our understanding and expertise grew and more high-risk cases underwent surgery in our setup, this led to an increase in number of patients requiring IABP support. Recently Naseem Riaz et al have reported 21% incidence of low cardiac output after coronary bypass surgery, 10% patients were provided IABP support[2]. In coming years more patients may require IABP or left ventricular assist devices due to enormous increase in incidence of coronary artery disease[3,4] and prevalence of left main lesion[5].

MATERIAL AND METHODS

Design

From Jan 1993 to March 1998 a total of 1243 patients underwent coronary bypass graft surgery in this institute. The record of all these patients was reviewed retrospectively and analyzed by Statistical Package for Social Sciences version 7.5 (SPSS 7.5). Out of 1224 patients, 19 patients were provided IABP support preoperatively due to very low ejection fraction (i.e. 20%). These patients were not included in the final analysis. Out of the remaining 1205 patients 124 (10.09%) developed post operative low cardiac output syndrome which is defined as "inability to maintain adequate hemodynamics i.e. mean arterial pressure (MAP) <70mmHg, PCWP >18mmHg despite correction of hypovolaemia, acidosis and infusion of low dose single inotrope plus a vasodilator." These patients were managed with either maximal dose of multiple inotropes along with vasodilators or with single inotrope and early IABP support.

On the basis of management, the patients were divided into two groups and their hemodynamics were studied and compared at 02, 12, 24 and 48 hours after institution of treatment.

Group 1 included 65 patients with low cardiac output syndrome managed initially by heavy doses of multiple inotropes and vasodilators and were provided IABP support much after 02 hours of hemodynamic compromise.

Group 2 included 59 patients who were provided IABP support electively within 02 hours of hemodynamic compromise as primary mode of treatment along with the moderate doses of single inotrope and vasodilator.

Variables

In order to compare both the group following demographic variables including age, sex, angina status, NYHA class, extent of disease, risk factors like diabetes mellitus, hypertension and renal dysfunction (serum urea >60-70mg/dl) and left ventricular dysfunction were studied and analyzed statistically (Table I).

In order to assess the efficacy of management hemodynamic variables including MAP, PCWP, CVP, Cardiac Index along with urine output and stay in ICU were compared among both the groups.

Anaesthetic technique

All patients were operated under general anaesthesia induced and maintained with opiates, benzodiazepines and muscle relaxant.

DATA AND RESULTS

1. In Gp-I, out of 44 patients, percutaneous insertion of IABP was done in 39 (88.6%) patients and open method was employed in 5 (11.4%). While in Gp-II, out of 59 patients 54 (91.5%) were provided IABP support by percutaneous method and 5 (8.4%) required open method.

2. Demographic variables in Gp-1 and Gp-II along with statistical analysis and p value were comparable and identical as regard age, sex and preoperative disease status.
3. Comparison of hemodynamic variables including MAP, cardiac index, PCWP, CVP and urine output showed no statistically significant difference in these parameters between the two groups at the time of institution of treatment (Table-I).
4. CI, MAP and urine output increased while PCWP decreased in both the groups, but this improvement was more pronounced in Gp-II. Initially the difference among the groups was not statistically significant but it became significant after 06-12 hours and the trend continued at 24 hours and at 48 hours (Table-II). These findings suggest that in patients with low cardiac output syndrome after coronary bypass surgery, early and primary IABP support led to progressive improvement in left ventricle function.
5. There was statistically significant increase in the urine output in GP-II after 24 hours but in GP-I increase in the urine output was not statistically significant perhaps because of high dose of adrenaline. However after 48 hours, the increase in urine output was statistically significant in both the groups. This could be due to survival selection bias i.e. patients who did not improve in 48 hours (Table-III) were treated with peritoneal dialysis or haemofiltration.
6. ICU stay duration was 6.12 ± 5.32 days in Gp-I and 4.23 ± 4.12 days in Gp-II.
7. Overall survival in Gp-I was 24/65 (36.9%) and in Gp-II was 34/59(57.6%). The difference is statistically significant (p=0.023) emphasizing that early and primary IABP support in patients with low cardiac output syndrome after coronary artery surgery produces much more favorable results than multiple high dose inotropes and late IABP support.
8. Table-III shows overall morality within first 12-24 hours between 24-48 hours and after 48 hours as described earlier, maximum deaths occurred with 24-48 hours.

Table-I: Demographic variables in Group-I and Group-II

Variables	*GP-I*	*GP-II*	*P Value*
Age (Years)	55.2 ± 8.2	58.56 ± 4.9	0.09 (paired "t" test)
Sex			
Male	57 (87.69%)	51 (86.4%)	0.68 (Chi Test)
Female	8 (12.3%)	8 (13.55%)	
Angina Status			
CCS - I/II	26 (40%)	23 (38.9%)	0.89 (Chi Test)
CCS -III/IV	39 (60%)	36 (61.01%)	
NYHA Status			
NYHA - I/II	51 (78.46%)	44 (74.57%)	0.09 (Chi Test)
NYHA - III/IV	14 (21.53%)	15 (25.43%)	
Extent of Disease			
SVCAD	1 (1.53%)	2 (3.3%)	0.23 (Chi Test)
DVCAD	13 (20%)	11 (18.54%)	
TVCAD	51 (78.46%)	46 (77.6%)	

Table-II: Hemodynamic variables in Group-I and Group-II

Group	*Variable*	*0 hrs.*	*02 hrs.*	*06 hrs.*	*12 hrs.*	*24 hrs.*	*48 hrs.*
GP-I	MAP(mmHg)	68.18±10.78	73.34±10.78	76.12±13.56	72.23±17.3	70.7±12.45	78.23±8.3
GP-II	MAP(mmHg)	68.67±9.2	74.9±8.45	78.98±12.67	75.11±11.56	72.23±14.23	81.9±12.3
	P-value (Paired "t" test)	0.737	0.23	0.056	0.045	0.049	0.017
GP-I	CI(L/min/m2)	1.86±0.39	1.98±0.42	2.12±0.38	2.08±0.42	2.01±0.44	2.67±0.389
GP-II	CI(L/min/m2)	1.79±.040	2.08±0.41	2.24±0.94	2.19±0.412	2.14±0.42	2.84±0.41
	P-value (Paired "t" test)	0.22	0.14	0.033	0.041	0.012	0.003
GP-I	PCWP(mmHg)	21.86±3.8	21.96±3.6	22.24±1.8	22.12±4.67	21.98±3.879	16.43±5.78
GP-II	PCWP(mmHg)	21.71±2.72	22.01±2.45	21.01±2.5	20.72±5.7	21.10±4.67	14.01±4.12
	P-value (Paired "t" test)	0.12	0.116	0.023	<0.001	0.04	<0.001
GP-I	CVP (cmH2O)	13.75±3.5	14.34±4.3	14.97±5.3	16.63±4.7	15.78±5.6	13.2±4.8
GP-II	CVP (cmH2O)	14.12±5.1	15.01±5.2	15.08±6.4	16.98±5.7	16.21±4.5	12.9±6.5
	P-value (Paired "t" test)	0.187	0.21	0.11	0.36	0.42	0.62
GP-I	URINE (ml/kg/Hr)	1.32±0.13	0.67±34	1.02±0.23	1.36±0.32	1.31±0.34	1.78±0.23
GP-II	URINE (ml/kg/Hr)	1.35±0.14	0.75±0.39	2.12±0.45	2.34±0.52	1.89±0.12	2.28±0.31
	P-value (Paired "t" test)	0.08	0.078	0.003	<0.001	<0.001	<0.001

MAP.... Mean Arterial PressureCI .... Cardiac Index

CVP.... Central Venous PressurePCWP.... Pulmonary Capillary Wedge Pressure

Table-III: Mortality

S. No.	*Mortality*	*Group-I (n=65)*	*Group-II(n=59)*
1.	Total 66/124 (53.3%)	41/65(63.07%)	25/59 (42.3%)
2.	Within first 12 hrs.	5/41 (12.1%)	3/25 (12%)
3.	12 - 24 hrs.	8/41 (19.5%)	5/25 (20%)
4.	24 - 48 hrs.	17/41 (41.4%)	9/25 (36%)
5.	After 48 hrs.	11/41 (26.8%)	8/25 (32%)

DISCUSSION

Postcardiotomy ventricular dysfunction is increasing as the population referred for surgical treatment increases in age and severity of preoperative left ventricular dysfunctin[6,7]. Previous investigators have demonstrated that under conditions of cardiogenic shock, left ventricular performance is not significantly improved with after load reduction alone[7,8,9,10,]. This is because of underlying hypoxia. Moreover in potentially ischemic conditions myocardial performance is dependent on coronary artery bypass graft blood flow. In patients treated with inotropic agents in combination with vasodilator left ventricular work load is increased concomitantly without increase in myocardial perfusion whereas actual decrease in coronary flow and myocardial perfusion occurs due to decreased coronary perfusion pressure[7,8,9]. These observations have led to the development and increasing use of mechanical devices in postcardiotomy patient[11,12]. IABP is the most commonly used mechanical assist device. The major benefit of the IABP support appears to be achieved by reduction in myocardial oxygen demand due to systolic unloading and maintenance of coronary perfusion and viability without increase in left ventricular workload as occurs with the use of inotropes and vasodilators[7,12]. Various studies have demonstrated an increase in flow in parent arteries, collaterals and grafts with IABP and its usefulness in myocardial ischaemic[13,14,15,16,17,18,19,].

The present study, which includes clinical material from one post surgical intensive care unit was undertaken to analyze the effect of IABP on various hemodynamic parameters and to compare these effects with the use of high doses of multiple inotropes and vasodilators. In our unit we had restricted the use of IABP by instituting rigid hemodynamic criteria for its application because of the high cost and associated morbidity. However, over last three years, there has been a tendency towards increased use of IABP in our setting due to increase in workload and surgery on more sick patients. This is in consistence with other reports.[20,21,22,] Our annual rate of postoperative IABP insertion during the study period was 10.12% (range 9.2 to 11.3%), which is similar to the rates documented in other reports.[20,23,24,25]

A total of 124 patients out of 1224 patients subjected to CABG developed postoperative low cardiac output syndrome. They were treated by inotropes and IABP support. The early mortality rate for patients with low cardiac output who were treated pharmacologically and / or with IABP was 53.3% (table - IV), which is consistent with other series.[6,11,12,19,20,21,22,23,24,25]

Analysis of the hemodynamic variables including MAP, cardiac index, PCWP, CVP and urine output in both the groups revealed that

the patients in both the groups showed statistically significant improvement after 24 hours and 48 hours (table-II). However the comparison of both the groups revealed that patients who were provided early IABP support had much better response, which was statistically significant. This may well be the main explanation for the beneficial results obtained in the patients who received early IABP support.

As a consequence of better response in patients of group-II patients as compared to those in group-I patients, ICU stay and IABP support duration was 6.12 ± 5.32 days vs. 4.23 ± 4.12 days and 47.34 ± 11.23 vs. 32.56 ± 7.21 hours respectively. Need of peritoneal dialysis and haemofiltration was also less in group-II. Overall survival in group-I and II were 36.9% & 57.6% respectively.

CONCLUSION

After examining the results of our study it is concluded that early commissioning of IABP in the management of low cardiac output syndrome results in better hemodynamic profile of the patients and reduced ICU stay as compared to pure pharmacological inotropic support or late addition of mechanical support. It was further highlighted that incidence of acute renal failure requiring peritoneal dialysis or haemofiltration was less when IABP was instituted early. However it does significantly affects right ventricular function.

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