RESEARCH ARTICLE

ELECTIVE INTRA-AORTIC BALLOON PUMP IN PATIENTS UNDERGOING CORONARY ARTERY BYPASS GRAFT

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Manuscript Info

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Abstract

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Introduction: Preoperative elective intra-aortic balloon pump (IABP)prompts improve result in helpless left ventricular function patients going throughcoronary artery bypass graft (CABG)**.**The aim of this work was to assess the efficacy of preoperative intra-aortic balloon pump treatment on postoperative cardiac performance, morbidity and mortality.

Method:a prospective, cohort study was conducted on 40 patients with preoperative left ventricular ejection fraction< 40%, who went throughcoronary artery bypass graft. These patients were divided preoperatively into two groups:Group I (N.=20) received intraaortic balloon pump insertion 1-2 hours prior to aortic cross clamp.Group II (N.= 20) control group who did not receive intra-aortic balloon pump preoperatively.

Results: Both group were matched regarding age, sex distribution and body surface area,mean cardiac index in group I was significantly higher(2.5± 0.21 vs. 2±0.32) (P<0.0001). The mean cardiopulmonary bypass time in group I was significantly less (72.56± 21.62 vs. 86.68±20.57) (P=0.04).The ventilation time (hours) and total intensive care unit stay (days) were significantly less in group I (p<0.0001).

Conclusion: poor left ventricular function patients going through coronary artery bypass grafting possibly need perioperative intra-aortic balloon pump support to diminish morbidity and mortality.

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Introduction:-

Since it was first brought into clinical practice by Dr. Adrian Kantrowitz in the last part of the 1960s, the intra-aortic balloon pump (IABP) has stayed a significant treatment in patient management with coronary artery disease (CAD) (Townsley, 2018).Its valuable physiological impacts are very much perceived, the IABP acts by increasing diastolic blood pressure and improving diastolic coronary perfusion. Besides, it increments cardiac output and stroke volume by decreasing afterload(Zangrillo et al., 2015).The expanding age of the general patients population requiring coronary artery bypass graft (CABG) surgery further worsens the medical issues of numerous surgical candidates (Baskett et al., 2002). These patients are at significantly expanded danger of developing low cardiac output

following myocardial revascularization (Ferrari et al., 2001). An ongoing studies on IABP use in CABG surgery was underpowered to affirm the valuable impacts of IABP on survival and concluded that in patients going through non emergent coronary operations, with a stable hemodynamic profile and a left ventricular ejection fraction below 35%, the preincision (after induction of anesthesia and before skin incision) insertion of IABP did not bring about a superior result (Ranucci et al., 2013).The preoperative utilization of IABP was related with reduction of the risk of 30-day mortality risk in cases with poor LVEF in a population submitted to high-surgical-risk CABG (Escutia-Cuevas et al., 2020).

Material and methods:-
This prospective study was conducted on 40 patients need CABG with poor LVEF (EF≤ 40%) admitted at El-sheikh Zayed specilized hospital in the period between May 2019 and August 2020.All patients gave written informed consent before participation

The patients were divided into 2 groups; group
1. Patient received elective preoperative IABP insertion1-2 hours before aortic cross clamp.and group
2. control group who did not receive IABP.

Inclusion Criteria:
Isolated CABG with poor left ventricular function (EF ≤ 40%)

Exclusion Criteria:
Urgent or redo CABG, presence of any cardiac procedures, previous cardiac operation and off pump procedure.

These patients were randomized preoperatively into either of two groups:

Group I (N. 20) received IABP insertion 1-2 hours before aortic cross clamp.

Group II (N. 20) control group, did not receive IABP preoperatively.

Patients were subjected preoperatively to detailed history and clinical examination, routine laboratory investigations including complete blood count (CBC), urea, creatinine, serum glutamic pyruvic transaminase (SGPT), serum glutamic oxaloacetic transaminase (SGOT), bilirubin, prothrombine time (PT), partial thromboplastin time (PTT), clotting time, fasting blood sugar and lipid profile,ECG, chest-X-ray, transthoracic echocardiography, cardiac catheterization, femoral arterydoppler ultrasound when needed, carotid duplex when needed and dobutamine stress test.

Left ventricular ejection fraction (LVEF%) was measured preoperatively by echocardiography. Cardiac output and cardiac index were calculated.

$$CI=LVOT - VTI*HR*LVOTd^{2}*0.7854/BSA$$

CI: cardiac index, LVOT: left ventricular outflow tract, VTI: velocity time integral, HR: heart rate, $LVOTd^{2}$: Left ventricular outflow tract diameter, BSA: body surface area

All data were collected, tabulated and statistically analyzed.

Statistical Analysis:
The collected data were coded, processed and analyzed using Statistical Package of Social Science (SPSS) program for windows (version 16)**.** Quantitative data were presented in mean and standard deviation. Qualitative variables are presented as number and percent. Chi square were used for testing significance of categorical data. Student t test was used for testing significance of quantitative data for parametric distribution. Mann- Whitney test was used for testing significance of quantitative data for non parametric distribution.

Results:-
There was no significant difference among studied group regarding age, sex distribution or BSA (Table 1).

Common risk factors for coronary artery disease in the studied group were hypertension, diabetes mellitus, hyperlipidemia, chronic obstructive pulmonary disease, myocardial infarction either recent or old and current smoking with no significant difference between them**.** Also, no significant difference was found between both group regarding LVEF% and number of affected vessels (Table 2).

Regarding operative data, no difference was found between number of distal anastomosis thrombendartectomy (TEA) was necessary to recanalize obstructed vessels in 2 patients (10%) in group I, while in group II, it was necessary in 1 patients (5%)**.** Left anterior descending artery (LAD) was included in all patients in both groups. Also, other arteries including diagonal, circumflex and right coronary artery were involved with no statistically significant difference between the two groups. Ischemic time did not differ between the studied groups while CBP was significantly shorter in group II. **(Table 3)**

In group II (controls) of poor left ventricular function patients who did not receive preoperative IABP support.Two patients had received IABP intraoperatively while 4 patients of them had received IABP support postoperatively (within the first 6 hours after discharged from the operating room to the ICU) because they showed hemodynamic deterioration in spite of maximum pharmacological support**.**Intraaortic balloon pump related complications occurred in 4 out of 40 patients in the entire study. The complications were limb ischemia in all cases. 1 patients in group I (1/20) developed leg ischemia 25 hours postoperatively without obvious cause so, it was managed by removal of the balloon only. Leg ischemia occurred in 15% (3/20) of the patient in group II, the 3 patients were received the balloon postoperatively) two patients developed leg ischemia 48 hours postoperatively and unfortunately the patients still needed IABP support (removal of the balloon and insertion of another one in contralateral side), the third patient develop leg ischemia 56 hours postoperatively (removal of the balloon and thromboembolectomy). All cases of limb ischemia due to IAB catheter improved and showed no ischemia after removal of catheter or removal of catheter and thrombectomy. MV, ICU stay and total hospital stay were significantly lower in group I. (Table 4)

Cardiac index was significantly higher in group I before CBP and after weaning until 48 hours postoperatively (Table 5).

Low cardiac output, MI, ventricular arrhythmia and acute renal failure were significant complication that occurred in group II. Also, hospital mortality was significantly higher in group II (Table 6).

Three months' follow up of hospital survivors showed satisfactory results with a significant improvement in the patients' functional status (New York Heart Association and Canadian Cardiovascular Society Class) as well as left ventricular ejection fraction measured by echocardiography in both groups without difference (Table 7).

Discussion:-
This work aimed to evaluate the value of using of counterpulsation IABP as an elective preoperative cardiac support as a way of efficient preparation of poor left ventricle patients in which we can predict higher morbidity and mortality.In 1996, Rao et al. found left ventricular ejection fraction below 30% and unstable angina among the indicator of low cardiac output syndrome after CABG. They additionally found that patients in whom low cardiac output syndrome developed had longer CPB times, longer aortic cross clamp times, a longer postoperative ICU stay, more days of ventilatory support, a more extended hospital stay, and a higher postoperative CKMB level. Patients in whom low cardiac output syndrome developed had a higher death rate (17%), and they were more likely to have perioperative myocardial infarction (Rao et al., 1996). Patients subjected to preoperative IABP had decreasedthe percentage of postoperative complication and hospital mortality. In a similar study by Moursi and Fakharany, they found that patients subjected to preoperative IABP had lower rate of complication postoperativelyincluding acute kidney insult, cardiac surgical intensive care unit (CSICU) stay anddiminish the need for postoperative inotrope (Moursi and Fakharany, 2018). In another study by Escutia-Cuevas and his collegues, they observed that the subgroup of patients under IABP support had a reduced 30-day mortality risk. IABP use was related with a lower prevalence of acute renal failure and renal replacement therapy, yet with a more extended stay in ICU and longer hospitalization time (Escutia-Cuevas et al., 2020).

The current study evaluated the advantage of elective preoperative IABPin supporting patients with coronary artery disease with poor left ventricle function. The CPB-time, which was significantly longer in group II, the mean ischemic time did not differ between the two groups this implies that the time distinction between cardiac reperfusion and termination of extracorporeal circulation was more limited in group I compared with the second

group, showing less trouble in weaning from CPB as an after effect of better cardiac performance. Difficult weaning from CPB observed more in group II. This finding of this study agreed with Ranucci et al., in prolonged the CPB-time which was significantly longer in group without IABP (79.00 ± 19.99) compared to group with IABP (89.60 ± 20.61), the mean ischemic time did not differ between the two groups(Ranucci et al., 2013). Dokhan et al observed longer CBP time and difficult weaning in the similar type of patients who did not use preoperative IABP (Dokhan et al., 2019).The comparison of the evolution of the CI in the early postoperative period studied groups was positive for the elective preoperative utilization of the IABP in patients with poor left ventricular function. Our finding in the current study concurred with Christenson et al., who randomized 33 patients with LVEF<40%. The intervention group (19 patients) had a two hour period of preoperative augmentation with an IABP. Preoperative CI was noted to increase significantly following preoperative IABP insertion (1.73+/- 0.57 vs. 2.84+/-0.63, P<0.001) and 30 minutes following CPB (2.53+/-0.71 vs. 3.74 +/1 0.85, P<0.001). Post-operative low CI requiring pharmacological support was required in 11% of patients in the intervention group. Interestingly, 64% of patients in the control group required IABP insertion post operatively (P<0.01) (Christenson et al., 1995). Also, Mousi and Fakharany in a comparative report found significant higher CI in patient who had elective preoperative IABP (Mousi and Fakharany, 2018).Yang et al in a study on 416 patients with serious LV dysfunction (ejection fraction < 35%) 191 of them enrolled in elective IABP and the remaining as control group, thy found that there was a significant reduction in low cardiac output syndrome in the IABP group compared with the control group (Yang et al., 2016).Dokhan et al found the same result.But Castel vecchio et al., disagree with our study as the postoperative CI was not distinctive between the study groups (Dokhan et al., 2019). This is presumably the after effect of the interventions of the clinicians dealing with the patients as they applied the standard measures to keep up the CI and the systemic blood pressure at the desired values. This included volume filling of the patient and the utilization of inotropic and vasoactive drugs. In actuality, patients in the control group received larger doses of fluids and were more likely to receive dopamine to keep up the hemodynamic variables within the target. Consequently, it might be presumed that minor adjustments of the volemia and a larger use of minor inotropic drugs were adequate to keep up the CI in the control group at a similar value of the IABP group (Ranucci et al., 2013)**.**Ventricular arrhythmias, low COP and acute renal failure were prominant complications in group II compared with group I, this might be because of better cardiac performance of group I (Khan et al., 2014). All invasive procedures are related with certain risks to the patients. This is similarlyvalid for IABP. Complications relating to IABP are vascular in nature and influencing the lower extremity (Arafa et al., 1999). The IABP complication rate has been reported in the recent literatures as 4% to 11% (Christenson, 2012; Christenson et al., 2010). In the current study, IABP group reported less complication percentage than the control one. Our generally low IABP-related complication rate, without major sequelae, might be due to preoperative assessment of peripheral arterial status, using sheathless insertion technique, and close observation of peripheral circulation with special emphasis on noting early signs of acute ischemia to permit early intervention (Barnett et al., 1994). Khan et al in a comparative study, 80 patients of both gendergoing through elective on-pump CABG having an ejection fraction less than 30%. 30 patients received prophylactic preoperative IABP support, though 50 patients didn't. They found that postoperative AKI, need for postoperative inotropic support, stoke, ICU stay and in hospital mortality were significantly less in in patients received preoperative IABP.(Khan et al., 2014). Also Dokhan and his collagues during studying patients with poor left ventricular function undergoing CABG found that preoperative elective IABP associated with less ICU and hospital stay, less postoperative arrhythmia, better COP and less AKI. (Dokhan et al., 2019). Postoperative kidney injury and short term death was less in a similar study (Wang et al., 2016).Thirty days mortality was notably less in IABP group, but no difference was found in the duration of mechanical ventilation or total length of ICU stay in groups utilizing IABP or not while prolonged mechanical ventilation more than 48 hours was less in IABP group. There was a significant reduction in postoperative low cardiac output syndrome in the IABP group (14 vs. 6.2%, p = 0.039). The postoperative myocardial infarction, reoperation for bleeding, tracheotomy, hemodialysis, and neurologic events were comparable between the studied groups (Yang et al., 2016).Significant postoperative improvement in NYHA class, CCS angina class and LVEF was reported in both groups. Dokhan and his collagues reported the same result (Dokhan et al., 2019)

Table (1): Age, sex, BSA distribution among the studied groups:

Variable	Group I (IABP)	Group II	P value
Age	51±4.58	54.60±7.45	0.07
Female/Male	5/15	4/16	0.7
BSA	1.97±0.08	2.04±0.16	0.09

BSA: Body surface area, IABP: intra-aortic balloon pump

Table 2:- Preoperative classic risk factors, ECHO finding and number of vessels affected.

Variable	Group I No.(%)	Group II No.(%)	P value
Hypertension	19(95)	17(85)	0.29
Diabetes	15(75)	9(45)	0.11
Hyperlipidemia	9(45)	7(35)	0.1
COPD	3(15)	4(20)	0.67
Old MI > 6 week	13(65)	15(75)	0.49
Recent MI < 6 weeks	3(15)	5(25)	0.43
Current smokers	15(75)	14(70)	0.72
LVEF%	31.66 ± 4.82	30.45 ± 4.17	0.4
No. of diseased vessels	2.70 + 0.65	2.80 + 0.41)	0.56

COPD: chronic obstructive pulmonary disease, MI: myocardial infarction, LVEF: left ventricular ejection fraction.

Table 3:- Operative data of the studied group.

Variables		Group I	Group II	P value
number of distal anastomosis		2.91 + 0.67	2.79 + 0.55	0.54
Coronary Vessels Involved in Distal Anastomosis	LAD	100%	100%	0.06
	Diagonal	10%	25%	
	Circumflex	40%	55%	
	RCA	75%	75%	
Ischemic time		55.19 + 18.52	58 + 11.63	0.57
CPB time		72.56 + 21.62	86.68 + 20.57	0.04

LAD: left anterior descending, RCA: right coronary artery, CPB: cardiopulmonary bypass.

Table (4):- Intraaortic balloon and related complications, MV, ICU stay and total hospital stay in the studied group.

		Group I	Group II	P-value
The need for Placement of IABP	Intraoperative IABP	0	4(20%)	0.15
	Postoperative IABP	0	2(10%)	
MV(hrs)		23.5 + 1.70	70.39 + 18.92	<0.0001
ICU stay (hrs)		93.1+ 4.17	119.69 + 25.38	<0.0001
Total hospital stay (days)		8.48+0.51	13.6+3.82	<0.0001
IABP-Related Complications		1	3	0.27

MV: mechanical ventilation, ICU: intensive care unit, IABP: intra-aortic balloon pumb.

Table 5:- Shows mean cardiac index in the different stages among patients of study.

Cardiac Index (L/M^2/min)	Group I	Group II	P value
On admission	2.02+0.17	1.98+0.33	0.63
Before CPB	2.5+0.21	2+0.32	< 0.0001
Weaning	2.86+0.16	2.02+0.37	< 0.0001
6 hours	3.15+0.21	2.1+0.41	< 0.0001
24 hours	3.59+0.29	2.33+0.56	< 0.0001
48 hours	4.19+0.29	2.98+0.76	< 0.0001

CBP: cardiopulmonary bypass.

Table (6):- Postoperative complication and hospital mortality:

	Group I	Group II	P value
Low COP	1	6	0.037
MI	1	6	0.037
Ventricular arrhythmia	1	7	0.017

Acute renal failure	1	6	0.037
Reoperation for bleeding	1	2	0.54
Pl effusion	2	3	0.63
Pneumothorax	1	2	0.54
Wound infection	2	3	0.63
Hospital mortality [no.(%)]	1(5%)	6(30%)	0.037

COP: cardiac output, MI: myocardial infarction, Pl: pleural.

Table 7:- Shows comparison between preoperative NYHA, CCS and LVEF and 3 months postoperative for both groups of study.

Parameter		Group I	Group II
NYHA Class	**Preoperative**	3.55 ± 0.54	3.68 ± 0.45
	Postoperative	1.18 ± 0.38	1.45 ± 0.50
	p-value	< 0.0001	< 0.0001
CCS angina Class	**Preoperative**	2.17 ± 0.38	2.40± 0.70
	Postoperative	1.25 ± 0.40	1.45 ± 0.50
	p-value	< 0.0001	< 0.0001
LVEF	**Preoperative**	31.66 ± 4.82	30.45 ± 4.17
	Postoperative	53.76 ± 2.73	52.40 ± 2.28
	p-value	< 0.0001	< 0.0001

NYHA: new York heart association, CCS: Canadian Cardiovascular Society, LVEF:left ventricular ejection fraction.

Conclusion:-
IABP has remarkable beneficial effects in haemodynamically unstable patients in diminishing the mortality rate. Low cardiac output, myocardial infarction and ventricular dysrhythmia were the main morbidity.Shorter postoperative ventilation time, ICU stay and better cardiac indexwere the main advantage noticed with elective IABP.

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