Outcome after the early use of Intra-Aortic Balloon Pump in Coronary Bypass Graft Surgery in cases with impaired Myocardial Function

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Background: Preoperative intra-aortic balloon pump (IABP) usually used to improve myocardial perfusion through increasing coronary blood flow during diastole with optimal timing. Its use has debatable outcomes in cases with impaired function and in need for coronary artery bypass graft surgery (CABG).

Objectives: This study aimed to evaluate the early use of IABP preoperatively and the predictors in cases with severe to moderate impaired left ventricular function undergoing CABG upon the outcomes.

Methods: This study enrolled 129 patients underwent CABG with moderate to severe depressed left ventricular (LV) function. Depending on the preoperative left ventricular function, the patients were classified into two groups. Group I: n=49 cases who had their ejection fraction (EF) < 35%, and it was subdivided into subgroups A: (n=26 who had preoperative IABP inserted for them) and B: (n=23 who didn't receive IABP preoperative). Group II: n= 80 cases who had EF ≥ 35%, and it was subdivided into subgroups C: (n=11 who received preoperative IABP) and D: (n=69 who didn't receive preoperative IABP).

Results: The morbidity, mortality rate and the incidences of complications showed significant improvement in patients who had IABP inserted for them compared to those who didn't receive IABP preoperatively. In multivariant analysis, preoperative IABP was an independent risk factor for morbidity and mortality after CABG. Meanwhile, low platelet count was an independent risk factor for the development of complications (odds ratio (OR): 0.975, 95% confidence interval (CI): 0.956 to 0.993, p = 0.007) and preoperative elevation of serum creatinine level was a significant risk factor for mortality (OR: 1.007, 95% CI: 1.000 to 1.014, p = 0.050).

Conclusions: Among patients who underwent CABG with moderately and severely impaired left ventricular function, preoperative insertion of IABP improves the post operative outcome.

Keywords: Coronary artery bypass grafting; left ventricular dysfunction; Intra-aortic balloon pump.

Introduction

CABG surgeries are indicated in cases with significant coronary artery stenotic lesions suffering from angina and who had acceptable adequate coronary anatomy for anastomosis.[1] The decision to have CABG depends on multiple factors, including the severity of angina, the left ventricle's function, the amount of ischemia, quality and the morphology of the coronaries.[2] CABG restores the blood flow to the hypoperfused myocardium and recovers the left ventricle from systolic dysfunction. Therefore, the survival rate increases, and the incidence of repeat revascularization decreases.[3]

IABP is the popular mechanical circulatory support in advanced failing myocardium. It raises cardiac output by enhancing the diastolic blood flow to the coronary arteries and reducing the left ventricle's afterload during systole. Intra-aortic balloon pump is generally utilized in patients with acute heart failure, including ischemic cases and those who require CABG.[4]

Because of their potential advantages, IABP has been utilized to treat high-risk patients undergoing CABG as a mechanical support in addition to medical therapy. Adjunctive of the use of IABP during reperfusion therapy that, it enhances the cardiac reperfusion at the tissue level and lessen the severity of no-reflow brought on by microvascular obstruction. Also, IABP can lower respiratory and renal problems, and ultimately lower surgical mortality.[4,5] However, haemolysis, aortic or iliac dissection or haemorrhage, infection, stroke, and paraplegia are common complications that are linked to IABP.[6] Moreover, the quality, validity, and generalizability of studies to support the use of IABP have several flaws. The strength of the current data does not permit the use of IABP in risky patients. Thus, determining whether to utilize an IABP before electing to use CABG may therefore be quite crucial.[7]

Numerous perioperative risk factors were found to have an impact on the survival following CABG.[8] Identification of risk factors for CABG mortality and morbidity is crucial for proper selection of cases preoperatively. It enables assessment of the level of care and may aid in deciding the best course of action.[9] Few studies examined the effects of significant left ventricular dysfunction prior to surgery on the in-hospital and long-term outcomes of patients who had received an IABP.[3,10,11] This study aimed to evaluate the outcomes of early preoperative insertion of IABP and their predictors in patients with moderate to severe left ventricular dysfunction undergoing CABG.

Methods

This study is a retrospective cohort study evaluated hospitalized cases with CABG surgery using their medical records at two cardiac centers between May 2018 and May 2020. It was approved by the institutional review board and informed consent was obtained from each participant. We ensured the protection of patients' privacy. This study included cases who underwent elective CABG surgery with moderate to severe left ventricular dysfunction n=129. Cases with normal LV ejection fraction, significant pulmonary hypertension, cardiogenic shock, coupled CABG with additional valve surgery, and patients without postoperative echocardiography follow-up were all excluded.

Patients were classified into two group according to the ejection fraction (EF). Group I: n=49 patients with severe left ventricular impaired function (low EF < 35%). Group II: n=80 included patients with moderate LV dysfunction (EF ≥ 35%-50%). Based on the preoperative insertion of IABP, group I was subdivided into group A and B. Group A: (n=26 cases) included patients who inserted IABP preoperative for them, and group B: n= (23 cases) included patients who did not receive preoperative IABP. Group II was subdivided into group C and D. Group C: n=(11cases) included patients who received preoperative IABP, and group D: n= (69 cases) inclouded patients who did not receive preoperative IABP.

All data were collected for analysis, demographic data, clinical, laboratory, echocardiographic, and surgical data were obtained from the records. The ejection fraction was measured through a conventional, two-dimensional echocardiogram.

The primary outcomes included mortality and complications after CABG. Mortality was defined as death during hospital admission or within 30 days after surgery. The secondary outcomes included factors contributing to the development of complications and mortality.

Statistical analysis

Data were analysed using the SPSS version 26.0 (IBM Corp., Armonk, N.Y., USA). Categorical variables are presented as numbers and percentages and were compared using the Pearson's Chi-Square test ($\chi 2$) and Fisher's exact tests as convenient. Continuous variables are expressed as the median ± interquartile range (IQR) and were compared using the Mann–Whitney test. For the association between categorical and ordinal variables, the Chi-square test for trend (linear-by-linear association) was used. For univariate and multivariate analyses, binominal logistic regression models were used to determine the effect of preoperative IABP predicting cardiac complications and mortality. A value of $P < 0.05$ was considered statistically significant.

Results

This study enrolled n=129 patients with moderate and severe left ventricular dysfunction who underwent elective CABG. Based on the preoperative EF, patients were divided into group I and II. Group I n=49 patients with EF < 35% and group II n= 80 patients with EF ≥ 35%. Within group I, subgroup A included 26 patients with severely depressed EF% who received IABP preoperatively, while subgroup B included 23 patients with severely depressed function who did not receive IABP preoperatively. Within group II, subgroup C included 11 patients who received IABP preoperatively and subgroup D n=69 cases who did not receive IABP preoperatively.

The median age of all cases was 60 (Range: 31 to 80 years). Males outnumbered females. According to NYHA classification, most patients were class II and III. Chest pain was observed in 70.5 % of the patients. Grade II dyspnoea occurred in more than half the patients, while one-third of the patients had grade III dyspnoea. Preoperative myocardial infarction was reported in 41.1%, while DM and hypertension were reported in 61.2% and 75.2%, respectively. One-third of the patients were smokers. The subgroups A and B were comparable

regarding the patients' characteristics and medical history, except the grade of NYHA classification that significantly increased in subgroup A ($p = 0.003$). The subgroups C and D were comparable in most characteristics but nearly half of subgroup D patients had a preoperative myocardial infarction compared to subgroup C (54.3% vs. 0%, $p = 0.001$, Table 1).

Preoperative and postoperative creatinine as well as postoperative EF, PASP, and platelet count post operative were comparable in all subgroups (All $p > 0.05$). Meanwhile, subgroup A had a significantly lower preoperative EF than subgroup B (Median, 30 vs. 34, respectively, $p = 0.041$). All subgroup A and B patients underwent postoperative IABP, with a significantly shorter duration in subgroup A compared to subgroup B (Median, 44 vs. 67, respectively, $p < 0.001$). As regards subgroups C and D, 81.8% of subgroup C underwent postoperative IABP compared to only 11.6% in subgroup D ($p <0.001$), without a significant difference in the duration ($p = 0.606$). In addition, both pre- and postoperative end diastolic diameter were significantly higher in subgroup A compared to subgroup B (Median, 5.7 vs. 5.4 and 6 vs. 5.2, respectively, $p < 0.001$). Likewise, subgroup C showed significantly higher values of pre-and postoperative end diastolic diameter than those of subgroup D (Median, 5.2 vs. 4.6 and 5.4 vs. 5, respectively, $p < 0.001$, Table 2).

The length of the ICU and hospital stays were significantly shorter in the A and C subgroups compared to subgroups B and D ($p < 0.001$ and 0.009, respectively). The duration of mechanical ventilation was significantly shorter in subgroup C compared to subgroup D ($p = 0.013$), but no difference was observed between subgroups A and B ($p = 0.841$). The overall rate of complications was significantly lower in subgroup A in comparison to subgroup B (65.4 vs. 100.0%, $p = 0.002$), particularly in the rates of the end stage renal disease ($p = 0.018$) and wound infection ($p < 0.001$). Haemodialysis was reported in only 3.1% of the patients. No significant difference in complications between subgroups C and D was reported ($p = 0.374$). However, a significantly higher rate of coagulopathy was observed in subgroup C compared to subgroup D ($p = 0.048$). The rate of atrial fibrillation was not significantly different within the groups. No significant difference in the operated coronary vessels was detected except for a significantly higher percentage of left main coronary in subgroup C compared to subgroup D (81.8 vs. 0.0%, $p < 0.001$). The doses of inotropes tended significantly to be lower in subgroup A compared to subgroup B, but the dose tended to be higher in subgroup C compared to subgroup D ($p < 0.001$). The mortality rate was significantly lower in subgroup A compared to subgroup B (15.4 vs. 43.5%, $p = 0.030$). No deaths were recorded in subgroup C compared to two deaths (2.9%) in subgroup D, but the difference was not reach significant ($p = 1.000$; Table 3).

To evaluate the association between preoperative use of IABP and the probability of developing complication, univariate regression analysis showed a significant association between the complication and the NYHA classification, preoperative EF, postoperative IABP, preoperative end stage renal disease, post operative platelet count and atrial fibrillation. In the multivariate analysis, preoperative IAPB was considered independent risk factor for the complications (odds ratio (OR): 0.197, 95% confidence interval (CI): 0.040 to 0.985, $p = 0.048$). Platelet count also showed a significant inverse relationship with the development of complications (OR: 0.975, 95% CI: 0.956 to 0.993, $p = 0.007$; Table 4).

Likewise, binomial logistic regression analysis was carried out to assess the effect of using preoperative IABP on the mortality of patients. The likelihood of mortality was significantly reduced with the preoperative use of IABP (OR: 0.044, 95% CI: 0.005 to 0.410, $p = 0.006$). Preoperative serum creatinine level showed a borderline significance ($p = 0.050$), with an increased probability of mortality with the elevation of creatinine level (OR: 1.007, 95% CI: 1.000 to 1.014, $p = 0.050$; Table 5).

Table 1: Baseline patients and clinical characteristics (Total n = 129)

Patients' characteristics		Total (n = 129)	Group I (≤35%)			Group II (EF ≥ 35%-50%)		
			A: (n = 26)	B: (n = 23)	p-value	C: (n = 11)	D: (n = 69)	p-value
Age (years)	Median [IQR]	60.0 [50.0 - 70.0]	63.5 [50.0 - 72.0]	60.0 [50.0 - 70.0]	0.573	55.0 [45.0 - 70.0]	60.0 [50.0 - 69.0]	0.633
	Min - Max	31.0 - 80.0	35.0 - 80.0	35.0 - 80.0		30.0 - 70.0	31.0 - 78.0	
Sex	Male	95 (73.6%)	20 (76.9%)	18 (78.3%)	0.911	8 (72.7%)	49 (71.0%)	1.000
	Female	34 (26.4%)	6 (23.1%)	5 (21.7%)		3 (27.3%)	20 (29.0%)	
NYHA	I	6 (4.7%)	0 (0.0%)	1 (4.3%)	0.003*	0 (0.0%)	5 (7.2%)	0.713
	II	70 (54.3%)	0 (0.0%)	4 (17.4%)		11 (100.0%)	55 (79.7%)	
	III	42 (32.6%)	17 (65.4%)	16 (69.6%)		0 (0.0%)	9 (13.0%)	
	IV	11 (8.5%)	9 (34.6%)	2 (8.7%)		0 (0.0%)	0 (0.0%)	
Chest pain	Negative	38 (29.5%)	8 (30.8%)	3 (13.0%)	0.138	5 (45.5%)	22 (31.9%)	0.494
	Positive	91 (70.5%)	18 (69.2%)	20 (87.0%)		6 (54.5%)	47 (68.1%)	
Dyspnoea	Negative	9 (7.0%)	7 (26.9%)	0 (0.0%)	0.074	1 (9.1%)	1 (1.4%)	0.792
	II	73 (56.6%)	13 (50.0%)	19 (82.6%)		4 (36.4%)	37 (53.6%)	
	III	47 (36.4%)	6 (23.1%)	4 (17.4%)		6 (54.5%)	31 (44.9%)	
Preoperative MI	Negative	76 (58.9%)	17 (65.4%)	17 (73.9%)	0.518	10 (90.9%)	32 (46.4%)	0.006*
	Positive	53 (41.1%)	9 (34.6%)	6 (26.1%)		1 (9.1%)	37 (53.6%)	
DM	Negative	50 (38.8%)	12 (46.2%)	10 (43.5%)	0.851	5 (45.5%)	23 (33.3%)	0.503
	Positive	79 (61.2%)	14 (53.8%)	13 (56.5%)		6 (54.5%)	46 (66.7%)	
HTN	Negative	32 (24.8%)	9 (34.6%)	7 (30.4%)	0.755	2 (18.2%)	14 (20.3%)	1.000
	Positive	97 (75.2%)	17 (65.4%)	16 (69.6%)		9 (81.8%)	55 (79.7%)	
Smoking	Negative	88 (68.2%)	21 (80.8%)	20 (87.0%)	0.706	9 (81.8%)	38 (55.1%)	0.113
	Positive	41 (31.8%)	5 (19.2%)	3 (13.0%)		2 (18.2%)	31 (44.9%)	
Haemodialysis	Negative	125 (96.9%)	25 (96.2%)	22 (95.7%)	1.000	10 (90.9%)	68 (98.6%)	0.258
	Positive	4 (3.1%)	1 (3.8%)	1 (4.3%)		1 (9.1%)	1 (1.4%)	

Data are presented as median ± IQR or number of patients and percentage. Subgroup A: preoperative EF < 35% + preoperative IABP; subgroup B: preoperative EF < 35%; subgroup C: preoperative EF ≥ 35% + preoperative IABP; subgroup D: preoperative EF ≥ 35%; IQR: interquartile range (expressed as 25th – 75th percentiles);n: number; Max: maximum; NYHA: New York Heart Association Functional Classification; MI: myocardial infarction; DM: diabetes mellitus; HTN: hypertension; p-values are based on the Mann-Whitney test, the Pearson's Chi-square /Fisher's exact test, and linear-by-linear association; * significant at p<0.05.

Table 2: Creatinine, ejection fraction, end stage renal diseases, PASP, platelet count, and postoperative use of IABP between the subgroups (total n = 129)

Patients' data		Total (n = 129)	Group I (≤35%)			Group II (EF ≥ 35%-50%)		
			A (n = 26)	B (n = 23)	p-value	C (n = 11)	D (n = 69)	p-value
Pre-Creatinine	Median [IQR]	90.0 [71.0 - 110.0]	97.5 [71.0 - 110.0]	80.0 [65.0 - 110.0]	0.495	90.0 [63.0 - 100.0]	88.0 [75.0 - 100.0]	0.654
	Min - Max	42.0 - 500.0	55.0 - 500.0	42.0 - 500.0		50.0 - 400.0	44.0 - 500.0	
Post-Creatinine	Median [IQR]	100.0 [75.0 - 140.0]	100.0 [80.0 - 125.0]	90.0 [65.0 - 108.0]	0.232	105.0 [70.0 - 200.0]	108.0 [80.0 - 160.0]	0.894
	Min - Max	40.0 - 500.0	60.0 - 400.0	45.0 - 400.0		40.0 - 450.0	43.0 - 500.0	
PRE EF (%)	Median [IQR]	45.0 [34.0 - 50.0]	30.0 [29.0 - 34.0]	34.0 [32.0 - 34.0]	0.041*	45.0 [45.0 - 50.0]	49.0 [46.0 - 50.0]	0.055
	Min - Max	25.0 - 51.0	25.0 - 34.0	25.0 - 34.0		45.0 - 50.0	38.0 - 51.0	
POST EF (%)	Median [IQR]	49.0 [40.0 - 55.0]	35.0 [34.0 - 40.0]	40.0 [35.0 - 45.0]	0.258	55.0 [49.0 - 60.0]	55.0 [50.0 - 60.0]	0.989
	Min - Max	30.0 - 65.0	30.0 - 45.0	32.0 - 50.0		45.0 - 65.0	45.0 - 65.0	
Postoperative IABP	No	63 (48.8%)	0 (0.0%)	0 (0.0%)	NA	2 (18.2%)	61 (88.4%)	<0.001*
	Yes	66 (51.2%)	26 (100.0%)	23 (100.0%)		9 (81.8%)	8 (11.6%)	
Post duration (H)	Median [IQR]	45.0 [41.0 - 67.0]	44.0 [43.0 - 45.0]	67.0 [64.0 - 67.0]	<0.001*	6.0 [6.0 - 7.0]	6.0 [6.0 - 6.0]	0.606
	Min - Max	5.0 - 78.0	41.0 - 72.0	45.0 - 78.0		5.0 - 8.0	6.0 - 48.0	
PRE EDD	Median [IQR]	5.0 [4.5 - 5.4]	5.7 [5.6 - 5.9]	5.4 [5.3 - 5.4]	<0.001*	5.2 [5.1 - 5.2]	4.6 [4.3 - 4.8]	<0.001*
	Min - Max	4.2 - 7.0	5.5 - 7.0	5.2 - 5.4		5.1 - 5.2	4.2 - 5.1	
POST EDD	Median [IQR]	5.0 [5.0 - 5.5]	6.0 [5.8 - 6.0]	5.2 [5.0 - 5.5]	<0.001*	5.4 [5.3 - 5.5]	5.0 [4.6 - 5.0]	<0.001*
	Min - Max	4.0 - 55.0	4.1 - 7.0	4.3 - 5.9		4.3 - 5.6	4.0 - 55.0	
PASP	Median [IQR]	38.0 [32.0 - 45.0]	37.5 [32.0 - 44.0]	35.0 [32.0 - 40.0]	0.702	40.0 [33.0 - 45.0]	40.0 [33.0 - 45.0]	0.866
	Min - Max	20.0 - 80.0	20.0 - 75.0	26.0 - 75.0		30.0 - 70.0	23.0 - 80.0	
Platelet count	Median [IQR]	112.0 [88.0 - 167.0]	78.0 [70.0 - 89.0]	86.0 [45.0 - 99.0]	0.549	114.0 [112.0 - 200.0]	155.0 [114.0 - 233.0]	0.106
	Min - Max	40.0 - 345.0	40.0 - 99.0	44.0 - 99.0		45.0 - 345.0	45.0 - 345.0	

Data are presented as median (minimum-maximum), or number of patients and percentage. Subgroup A: preoperative EF <35%+preoperative IABP; subgroup B: preoperative EF <35%; subgroup C: preoperative EF ≥35%+preoperative IABP; subgroup D: preoperative EF ≥35%; IQR: interquartile range (expressed as 25th – 75th percentiles); Max: maximum; H: hour; IABP: intra-aortic balloon pump; pre: preoperative; post: postoperative; EF: ejection fraction; EDD: end diastolic diameter; PASP: pulmonary artery systolic pressure. p-values are based on the Mann-Whitney test, the Pearson's Chi-square / Fisher's exact test; * significant at p<0.05.

Table 3: ICU and hospital stays, the complications, the operated-upon vessels, number of grafts, the inotropes, and the mortality (total n = 129)

		Total (n = 129)	Group I (≤35%)			Group II (EF ≥ 35%-50%)		
			A (n = 26)	B (n = 23)	p-value	C (n = 11)	D (n = 69)	p-value
ICU stay (days)	Median [IQR]	7.0 [5.0 - 12.0]	11.0 [10.0 - 12.0]	16.0 [14.0 - 17.0]	<0.001*	5.0 [5.0 - 5.0]	6.0 [5.0 - 6.0]	0.009*
	Min - Max	4.0 - 18.0	8.0 - 15.0	12.0 - 18.0		4.0 - 6.0	5.0 - 8.0	
Hospital stays (days)	Median [IQR]	10.0 [9.0 - 16.0]	15.0 [15.0 - 16.0]	22.0 [21.0 - 23.0]	<0.001*	7.0 [7.0 - 7.0]	9.0 [9.0 - 10.0]	<0.001*
	Min - Max	7.0 - 26.0	12.0 - 20.0	17.0 - 26.0		7.0 - 10.0	8.0 - 11.0	
Mechanical ventilation (hours)	Median [IQR]	17.0 [12.0 - 90.0]	94.0 [72.0 - 110.0]	93.0 [75.0 - 99.0]	0.841	9.0 [8.0 - 12.0]	12.0 [10.0 - 16.0]	0.013*
	Min - Max	5.0 - 230.0	68.0 - 230.0	65.0 - 135.0		6.0 - 15.0	5.0 - 140.0	
Complications	No	76 (58.9%)	9 (34.6%)	0 (0.0%)	0.002*	8 (72.7%)	59 (85.5%)	0.374
	Yes	53 (41.1%)	17 (65.4%)	23 (100.0%)		3 (27.3%)	10 (14.5%)	
Types of complications	bleeding	16 (30.2%)	6 (35.3%)	7 (30.4%)	0.747	1 (9.1%)	2 (2.9%)	0.362
	coagulopathy	6 (11.3%)	3 (17.6%)	0 (0.0%)	0.237	2 (18.2%)	1 (1.4%)	0.048*
	ESRD	5 (9.4%)	0 (0.0%)	5 (21.7%)	0.018*	0 (0.0%)	0 (0.0%)	NA
	limb ischemia	3 (5.7%)	2 (11.8%)	0 (0.0%)	0.491	0 (0.0%)	1 (1.4%)	1.000
	pneumonia	5 (9.4%)	4 (23.5%)	0 (0.0%)	0.112	0 (0.0%)	1 (1.4%)	1.000
	stroke	5 (9.4%)	2 (11.8%)	0 (0.0%)	0.491	0 (0.0%)	3 (4.3%)	1.000
	wound infection	13 (24.5%)	0 (0.0%)	11 (47.8%)	<0.001*	0 (0.0%)	2 (2.9%)	1.000
Atrial fibrillation		20 (15.5%)	5 (19.2%)	11 (47.8%)	0.065	1 (9.1%)	3 (4.3%)	0.453
Diseased/Coronary vessels	LM	11 (8.5%)	2 (7.7%)	0 (0.0%)	0.491	9 (81.8%)	0 (0.0%)	<0.001*
	LAD	129 (100.0%)	26 (100.0%)	23 (100.0%)	NA	11 (100.0%)	69 (100.0%)	NA
	CX	85 (65.9%)	17 (65.4%)	18 (78.3%)	0.319	6 (54.5%)	44 (63.8%)	0.739
	RCA	89 (69.0%)	15 (57.7%)	19 (82.6%)	0.059	6 (54.5%)	49 (71.0%)	0.306
Number of graft	1	17 (13.2%)	7 (26.9%)	2 (8.7%)	0.100	2 (18.2%)	6 (8.7%)	0.223
	2	44 (34.1%)	6 (23.1%)	5 (21.7%)		5 (45.5%)	28 (40.6%)	
	3	58 (45.0%)	12 (46.2%)	14 (60.9%)		4 (36.4%)	28 (40.6%)	
	4	10 (7.8%)	1 (3.8%)	2 (8.7%)		0 (0.0%)	7 (10.1%)	
Inotropes	No	47 (36.4%)	0 (0.0%)	0 (0.0%)	<0.001*	1 (9.1%)	46 (66.7%)	<0.001*
	Mild	42 (32.6%)	21 (80.8%)	0 (0.0%)		4 (36.4%)	17 (24.6%)	
	Moderate	15 (11.6%)	4 (15.4%)	1 (4.3%)		4 (36.4%)	6 (8.7%)	
	High	25 (19.4%)	1 (3.8%)	22 (95.7%)		2 (18.2%)	0 (0.0%)	
Mortality	No	113 (87.6%)	22 (84.6%)	13 (56.5%)	0.030*	11 (100.0%)	67 (97.1%)	1.000
	Yes	16 (12.4%)	4 (15.4%)	10 (43.5%)		0 (0.0%)	2 (2.9%)	

Data are presented as median (minimum-maximum), or number of patients and percentage. Subgroup A: preoperative EF <35%+preoperative IABP; subgroup B: preoperative EF <35%; subgroup C: preoperative EF ≥35%+preoperative IABP; subgroup D: preoperative EF ≥35%; IQR: interquartile range (expressed as 25th – 75th percentiles); Max: maximum; n: number; ESRD: end stage renal disease; LM: left main; LAD; left anterior descending; CX: circumflex; RCA: right coronary artery; p-values are based on the Mann-Whitney test, the Pearson's Chi-square /Fisher's exact test. * Significant at p<0.05

Table 4. Binomial logistic regression analysis to assess factors contributing to the development of complications (Total n = 129)

Independent variables	Univariate regression			Multivariate regression		
	p-value	OR	95% CI	p-value	OR	95% CI
Age (years)	0.079	1.023	0.997 to 1.049	0.112	1.030	0.993 to 1.068
Male sex	0.230	1.657	0.726 to 3.780			
NYHA	<0.001*	2.805	1.600 to 4.917	0.369	0.619	0.217 to 1.764
Pre-MI	0.314	0.690	0.336 to 1.419			
DM	0.367	0.719	0.350 to 1.474			
HTN	0.635	1.220	0.537 to 2.774			
Smoking	0.276	0.651	0.302 to 1.408			
haemodialysis	0.198	4.500	0.455 to 44.494			
Pre-Creatinine	0.328	1.002	0.998 to 1.006			
Pre-EF (%)	<0.001*	0.854	0.809 to 0.901	0.559	0.961	0.842 to 1.098
Pre-IABP	0.060	2.103	0.970 to 4.562	0.048*	0.197	0.040 to 0.985
Post-IABP	<0.001*	12.000	5.019 to 28.692	0.138	3.202	0.689 to 14.883
Pre-EDD	<0.001*	6.380	2.807 to 14.497	0.329	2.197	0.452 to 10.668
LM	0.740	0.805	0.223 to 2.900			
CX	0.057	2.120	0.976 to 4.601	0.210	1.963	0.683 to 5.636
RCA	0.579	1.242	0.578 to 2.670			
N of grafts	0.521	1.152	0.748 to 1.774			
Platelet count	<0.001*	0.963	0.948 to 0.978	0.007*	0.975	0.956 to 0.993
Atrial fibrillation	0.001*	7.784	2.428 to 24.959	0.298	2.235	0.491 to 10.166

NYHA: New York Heart Association Functional Classification; MI: myocardial infarction; DM: diabetes mellitus; HTN: hypertension; N: number; IABP: intra-aortic balloon pump; pre: preoperative; post: postoperative; EF: ejection fraction; LM: left main; CX: circumflex; RCA: right coronary artery; EDD: end stage renal disease; CI: confidence interval; OR: odds ratio; * significant at p<0.05

Table 5. Binomial logistic regression analysis to assess factors contributing to mortality (Total n = 129)

Independent variables	Univariate regression			Multivariate regression		
	p-value	OR	95% CI	p-value	OR	95% CI
Age (years)	0.058	1.046	0.999 to 1.095	0.061	1.055	0.998 to 1.116
Male sex	0.195	2.765	0.595 to 12.862			
NYHA	0.005*	2.822	1.358 to 5.863	0.640	1.356	0.379 to 4.855
Pre-MI	0.756	0.843	0.286 to 2.479			
DM	0.328	0.592	0.207 to 1.693			
HTN	0.551	1.496	0.398 to 5.625			
Smoking	0.241	0.455	0.122 to 1.696			
Pre-Creatinine	0.040*	1.005	1.000 to 1.009	0.050	1.007	1.000 to 1.014
Pre-EF (%)	0.001*	0.874	0.810 to 0.943	0.772	1.030	0.844 to 1.257
Pre- IABP	0.728	0.808	0.243 to 2.688	0.006*	0.044	0.005 to 0.410
Post-IABP	0.006*	18.235	2.329 to 142.769	0.113	11.847	0.555 to 252.665
Pre-EDD	0.009*	3.130	1.328 to 7.379	0.185	5.160	0.455 to 58.457
LM	0.729	0.687	0.082 to 5.754			
CX	0.177	2.468	0.664 to 9.170			
RCA	0.266	2.110	0.566 to 7.861			
Number of grafts	0.428	1.305	0.676 to 2.521			
Atrial fibrillation	0.014*	4.243	1.335 to 13.488	0.951	1.050	0.218 to 5.068
Platelet count	0.003*	0.974	0.958 to 0.991	0.360	0.989	0.966 to 1.013

NYHA: New York Heart Association Functional Classification; MI: myocardial infarction; DM: diabetes mellitus; HTN: hypertension; N: number; IABP: intra-aortic balloon pump; pre: preoperative; post: postoperative; EF: ejection fraction; LM: left main; CX: circumflex; RCA: right coronary artery; EDD: end stage renal disease; CI: confidence interval; OR: odds ratio; * significant at p<0.05

Discussion

The IABP has been widely used as mechanical circulatory assistance device. Numerous studies have demonstrated its favourable effects. However, its influence on the CABG outcomes is still up for question.[12] The aim of this study was to assess value of preoperative IABP insertion and the predictors in patients with severe and moderate left ventricular dysfunction undergoing CABG upon the outcomes post CABG.

In our patients with moderate and severe depressed LV function, the mortality rate, the incidences of complications, duration of ICU and hospital stays, mechanical ventilation, and inotrope doses showed significant improvement in patients who had IABP preoperatively compared to patients who did not receive preoperative IABP for CABG. In multivariate analysis, preoperative IABP was an independent risk factor for mortality and morbidity. Meanwhile, low platelet count post operative was an independent risk factor for the development of post operative complications, and preoperative elevation of serum creatinine level was a significant factor affecting the outcome. There is increased incidence of thrombocytopenia after IABP insertion either preoperative or post operative because of its mechanical effect or may be secondary to other medication given to the patients.

Our baseline cases' demographic, clinical, and surgical characteristics were similar to previous studies. Koene et al.[13] showed that IABP insertion improved the LV systolic function in patients with decreased preoperative EF. He and Gao,[14] reported that IABP could improve coronary circulation and lessen cardiac workload and left ventricular stress. According to Khan et al.[15] and Thalji et al.[16] preoperative cardiac unloading with IABP decreases the need for postoperative inotropic support. The improved coronary blood flow and afterload reduction continue to have a positive impact during the recovery stage. Moreover, there were improvement in EF after CABG. Surely, this lowered the inotropes needs. Khan et al.[15] confirmed that IABP significantly reduced the length of ICU stay. Yang et al.[17] found that preoperative IABP use was linked to a lower incidence of IABP-related complications. Preoperative IABP was considered safe with moderate and severe low EF.

Furthermore, Kamal et al.[8] and Khaled et al.[18] documented that the insertion of IABP was an independent predictor of mortality among patients with EF < 50%. A meta-analysis by Zangrillo et al.[19]

demonstrated that preoperative IABP improved the mortality in high-risk patients undergoing CABG. Awan et al.[9] confirmed that CABG had a higher risk of postoperative death in patients with poor EF compared to those with moderate EF. Furthermore, Okonta et al. [20] reported that early implementation of IABP shortened the hospital stays and lowered the mortality in high-risk patients undergoing CABG. A large single centre propensity score-matching study included 18,719 patients with significant LV dysfunction who had CABG. The researchers reported that preoperative IABP insertion was linked to lower mortality and marked decrease in the low cardiac output syndrome and reduced the hospital stays.[17] However, it was probable that there were still certain confounders that the adjustment algorithm did not take into consideration.

A meta-analysis included 12 randomized trials that enrolled a total of 2155 patients undergoing high-risk coronary surgery.[21] The study revealed that the use of IABP did not significantly decrease mortality. Khan et al.[15] reported that the prophylactic use of IABP does not decrease patients mortality, but it has a favourable outcome on postoperative course and complications in patients with depressed function EF% < 30% undergoing CABG. It could be explained by the fact that patients using IABP as a mechanical support, are already at a very high risk of developing more serious health problems especially due to unstable hemodynamic condition and related issues. Shah et al.[22] noticed that IABP insertion increased rates of postoperative stroke, prolonged ICU stays, prolonged breathing, re-opening due to bleeding, and mortality. The 30 days mortality and complications were more in cases with IABP, probably related to worse overall clinical condition of the patient that received IABP.[23] The controversy regarding the benefits of IABP on cases undergoing CABG could be explained by lacking established standard for prophylactic IABP implantation, besides the different identification of high-risk patients in different studies.[17,24]

Preoperative serum creatinine level was a predictor of mortality. Parissis et al.[25] found that administration of IABP improved renal status, which decreased mortality. Furthermore, Soliman Hamad et al.[26] documented that renal dysfunction was a significant risk factor for mortality in patients with EF < 50% who underwent CABG. Chronic renal disease was a risk factors for both long and short term morbidity and mortality after open heart surgery.[27] According to Okonta et al.[20] a rising in creatinine levels of more than 1.5 mg/dl was a sign of bad prognosis. The balloon or clot at the juxta-renal area, or potential consequences of iatrogenic aortic dissections in this location, could be the causes. Hence, preoperative serum creatinine should be considered during CABG with preoperative IABP.

In our study, low platelet count was a signficant predictor for complications after CABG. The ideal preoperative antiplatelet therapy is not yet defined. Clopidogrel is able to suppress platelets and to lessen ischemic difficulties in patients having CABG surgery. However, preoperative clopidogrel therapy is frequently stopped before surgery because of the medication's increased risk of perioperative bleeding issues.[28] Karhausen et al.[29] agreed to our finding where thrombocytopenia was associated with high risk for postoperative stroke after CABG surgery. Karhausen et al. attributed this to the enhanced platelet reactivity. Moreover, low platelet counts in non-cardiac surgical settings are predictive of deep vein thrombosis,[30,31] and a decline in platelet count post operative was a risk factor for recurrence of pulmonary embolism,[32] and re-infarction following ST-elevation myocardial infarction.[33] Thus, lower incidence of mortality and complications aafter CABG can be achieved by better assessment of patients, risk assessment, planning of surgical and anesthesiologic management. All possible precautions and preparations must be considered to improve the surgical outcome.

Limitations

This was a retrospective, nonrandomized study that performed on small number of cases and was liable for procedural bias, detection bias, or unmeasured confounds. In addition, our results may not be generalizable to all practices. Finally, long-term follow-up was not available. However, our results may pave the way for larger multicenter study recruiting patients based on sample size calculation with longer follow-up.

Conclusions

Preoperative IABP insertion improve the outcome post CABG in cases with moderate and severe depressed left ventricular function. Furthermore, preoperative insertion of IABP, preoperative serum creatinine level and platelet count post-surgery are considered the main risk factors affecting the outcome post CABG.

Abbreviations

IABP: Intra-aortic balloon pump, CABG: Coronary artery bypass grafting, EF: Ejection fraction, LV: Left ventricle, ICU: intensive care unit, PASP: Pulmonary artery systolic pressure.

Declarations

Consent for publication: informed consent for publication was taken and available if requested.

Conflict

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