Outcome after the early use of intra-aortic balloon pump in coronary bypass graft surgery in cases with impaired myocardial function

Original Article

Ehab F. Salem[a], Ayman M. Shaalan[a,b], Abdulkareem Alhuthaifi[b,c], Eman Elwakeel[d] and Ahmed M. Abdelazim[a]

Department of [a]Cardiothoracic Surgery, [d]Anatomy and Embryology, Faculty of Medicine, Benha University, Benha, Al-Qalyubia, Egypt, [b]Cardiology Department, Dallah Hospital, Cardiac Center, Riyadh, Saudi Arabia, [c]Department of Cardiology, Cardiac Center, Al Thawra Hospital, Sana, Yamen.

ABSTRACT

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

Objective: This study aimed to evaluate the early use of IABP preoperatively and the predictors in cases with severe to moderate impaired left ventricular (LV) function undergoing CABG, focusing on the outcomes.

Patients and Methods: This study enrolled 129 patients who underwent CABG with moderate to severe depressed LV function. Depending on the preoperative LV function, the patients were classified into two groups. Group I: n=49 cases who had their ejection fraction less than 35%, and it was subdivided into subgroups: (A) (n=26 who had preoperative IABP inserted for them) and (B) (n=23 who did not receive IABP preoperative). Group II: n=80 cases who had ejection fraction greater than or equal to 35%, and it was subdivided into subgroups (C) n=11 who received preoperative IABP and (D) (n=69 who did not receive preoperative IABP.

Results: Morbidity, mortality rate, and incidence of complications showed significant improvement in patients who had IABP inserted for them compared with those who did not 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: 0.975, 95% confidence interval: 0.956–0.993, *P=0.007*) and preoperative elevation of serum creatinine level was a significant risk factor for mortality (odds ratio: 1.007, 95% confidence interval: 1.000–1.014, *P=0.050*).

Conclusion: Among patients who underwent CABG with moderately and severely impaired LV function, preoperative insertion of IABP improves postoperative outcome.

Key Words: Coronary artery bypass grafting, intra-aortic balloon pump, left ventricular dysfunction.

Received: 25 May 2024, **Accepted:** 12 June 2024, **Published:** 4 October 2024

Corresponding Author: Ayman M. Shaalan, MD, Department of Cardiothoracic Surgery, Faculty of Medicine, Benha University, Benha, Al-Qalyubia, Egypt. **Tel.:** 01275584148, **E-mail:** shalaanayman@yahoo.com

ISSN: 1110-1121, October 2024, Vol. 43, No. 4: 1435-1444, © The Egyptian Journal of Surgery

INTRODUCTION

Coronary artery bypass graft (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].

Intra-aortic balloon pump (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. IABP is generally used in patients with acute heart failure, including ischemic cases and those who require CABG[4].

Because of their potential advantages, IABP has been used to treat high-risk patients undergoing CABG as a mechanical support in addition to medical therapy. Adjunctive use of IABP during reperfusion therapy enhances cardiac reperfusion at the tissue level and lessens 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, hemolysis, aortic or iliac dissection or hemorrhage, infection, stroke, and paraplegia are common complications that are linked to IABP[6]. Moreover, the

DOI: 10.21608/EJSUR.2024.292632.1085

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 use 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 the 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 (LV) dysfunction before 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 LV dysfunction undergoing CABG.

PATIENTS AND METHODS:

This study is a retrospective cohort study that 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 LV dysfunction n=129. Cases with normal LV ejection fraction (EF), 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 groups according to the EF. Group I: n=49 patients with severe LV 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 groups A and B. Group A: (n=26 cases) included patients who inserted IABP preoperative , and group B: n= 23 cases included patients who did not receive preoperative IABP. Group II was subdivided into groups C and D. Group C: n= 11cases included patients who received preoperative IABP, and group D: n= 69 cases included patients who did not receive preoperative IABP.

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

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

Statistical analysis

Data were analyzed using the SPSS version 26.0 (IBM Corp., Armonk, N.Y., USA). Categorical variables are presented as numbers and percentages and were compared using Pearson's χ^2 test and Fisher's exact tests as convenient. Continuous variables are expressed as the median ± interquartile range and were compared using the Mann–Whitney test. For the association between categorical and ordinal variables, the χ^2 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* less than 0.05 was considered statistically significant.

RESULTS:

This study enrolled n=129 patients with moderate and severe LV dysfunction who underwent elective CABG. Based on the preoperative EF, patients were divided into groups I and II. Group I n=49 patients with EF less than 35% and group II n=80 patients with EF greater than or equal to 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: 31–80 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 dyspnea occurred in more than half the patients, while one-third of the patients had grade III dyspnea. Preoperative myocardial infarction was reported in 41.1%, while diabetes mellitus and hypertension were reported in 61.2% and 75.2%, respectively. One-third of the patients were smokers. 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*). Subgroups C and D were comparable in most characteristics but nearly half of subgroup D patients had a preoperative myocardial infarction compared with subgroup C (54.3% vs. 0%, *P=0.001*, Table 1).

Preoperative and postoperative creatinine as well as postoperative EF, pulmonary artery systolic pressure, and platelet count postoperative 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 with 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 with only 11.6% in subgroup D (*P <0.001*), without a significant difference in the duration (*P=0.606*). In addition, both preoperative and postoperative end-diastolic diameters were significantly higher in subgroup A compared with 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 preoperative 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 with subgroups B and D (*P<0.001* and *0.009*, respectively). The duration of mechanical ventilation was significantly shorter in subgroup C compared with 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 end-stage renal disease (*P=0.018*) and wound infection (*P<0.001*). Hemodialysis 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 with 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 with subgroup D (81.8 vs. 0.0%, *P<0.001*). The doses of inotropes tended significantly to be lower in subgroup A compared with subgroup B, but the dose tended to be higher in subgroup C compared with subgroup D (*P<0.001*). The mortality rate was significantly lower in subgroup A compared with subgroup B (15.4 vs. 43.5%, *P=0.030*). No deaths were recorded in subgroup C compared with two deaths (2.9%) in subgroup D, but the difference was not significant (*P=1.000*; Table 3).

To evaluate the association between preoperative use of IABP and the probability of developing complications, univariate regression analysis showed a significant association between the complication and the NYHA classification, preoperative EF, postoperative IABP, preoperative end-stage renal disease, postoperative platelet count, and atrial fibrillation. In the multivariate analysis, preoperative IAPB was considered an independent risk factor for the complications (odds ratio (OR): 0.197, 95% confidence interval (CI): 0.040–0.985, *P=0.048*). Platelet count also showed a significant inverse relationship with the development of complications (OR: 0.975, 95% CI: 0.956–0.993, *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: 0.005–0.410, *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: 1.000–1.014, *P=0.050*; Table 5).

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

		Group I (≤35%)			Group II (EF ≥35%–50%)		
Patients' characteristics	Total (*N*=129) [*n* (%)]	A: (*N*=26) [*n* (%)]	B: (*N*=23) [*n* (%)]	*P* value	C: (*N*=11) [*n* (%)]	D: (*N*=69) [*n* (%)]	*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	1 (4.3)	0.003*	0	5 (7.2)	0.713
II	70 (54.3)	0	4 (17.4)		11 (100.0)	55 (79.7)	
III	42 (32.6)	17 (65.4)	16 (69.6)		0	9 (13.0)	
IV	11 (8.5)	9 (34.6)	2 (8.7)		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)	

Dyspnea							
Negative	9 (7.0)	7 (26.9)	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)	
Hemodialysis							
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 less than 35%+preoperative IABP; subgroup B: preoperative EF less than 35%; subgroup C: preoperative EF greater than or equal to 35%+preoperative IABP; subgroup D: preoperative EF greater than or equal to 35%; IQR: interquartile range (expressed as 25^{th} – 75^{th} 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* less than 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)

		Group I (≤35%)			Group II (EF ≥35%–50%)		
Patients' data	Total (*n*=129)	A (*n*=26)	B (*n*=23)	*P* value	C (*n*=11)	D (*n*=69)	*P*- alue
Precreatinine							
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	
Postcreatinine							
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, *n* (%)							
No	63 (48.8)	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)	

Postduration (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 less than35%+preoperative IABP; subgroup B: preoperative EF less than 35%; subgroup C: preoperative EF greater than or equal to 35%+preoperative IABP; subgroup D: preoperative EF greater than or equal to 35%; IQR: interquartile range (expressed as 25^{th} – 75^{th} 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* less than 0.05.

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

		Group I (≤35%)			Group II (EF ≥35%–50%)		
	Total (*n*=129)	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 (h)							
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, *n* (%)							
No	76 (58.9)	9 (34.6)	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, *n* (%)							
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	0.237	2 (18.2)	1 (1.4)	0.048*
ESRD	5 (9.4)	0	5 (21.7)	0.018*	0	0	NA
Limb ischemia	3 (5.7)	2 (11.8)	0	0.491	0	1 (1.4)	1.000
Pneumonia	5 (9.4)	4 (23.5)	0	0.112	0	1 (1.4)	1.000
Stroke	5 (9.4)	2 (11.8)	0	0.491	0	3 (4.3)	1.000

Wound infection	13 (24.5)	0	11 (47.8)	<0.001*	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, *n* (%)							
LM	11 (8.5)	2 (7.7)	0	0.491	9 (81.8)	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, *n* (%)							
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	7 (10.1)	
Inotropes, *n* (%)							
No	47 (36.4)	0	0	<0.001*	1 (9.1)	46 (66.7)	<0.001*
Mild	42 (32.6)	21 (80.8)	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	
Mortality, *n* (%)							
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	2 (2.9)	

Data are presented as median (minimum–maximum), or number of patients and percentage. Subgroup A: preoperative EF less than 35%+preoperative IABP; subgroup B: preoperative EF less than 35%; subgroup C: preoperative EF greater than or equal to 35%+preoperative IABP; subgroup D: preoperative EF greater than or equal to 35%; IQR: interquartile range (expressed as 25^{th} – 75^{th} 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, Pearson's Chi-square/Fisher's exact test. * Significant at *P* less than 0.05.

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

	Univariate regression			Multivariate regression		
Independent variables	*P* value	OR	95% CI	*P* value	OR	95% CI
Age (years)	0.079	1.023	0.997–1.049	0.112	1.030	0.993–1.068
Male sex	0.230	1.657	0.726–3.780			
NYHA	<0.001*	2.805	1.600–4.917	0.369	0.619	0.217–1.764
Pre-MI	0.314	0.690	0.336–1.419			
DM	0.367	0.719	0.350–1.474			
HTN	0.635	1.220	0.537–2.774			
Smoking	0.276	0.651	0.302–1.408			
Hemodialysis	0.198	4.500	0.455–44.494			
Precreatinine	0.328	1.002	0.998–1.006			
Pre-EF (%)	<0.001*	0.854	0.809–0.901	0.559	0.961	0.842–1.098
Pre-IABP	0.060	2.103	0.970–4.562	0.048*	0.197	0.040–0.985
Post-IABP	<0.001*	12.000	5.019–28.692	0.138	3.202	0.689–14.883
Pre-EDD	<0.001*	6.380	2.807–14.497	0.329	2.197	0.452–10.668
LM	0.740	0.805	0.223–2.900			
CX	0.057	2.120	0.976–4.601	0.210	1.963	0.683–5.636
RCA	0.579	1.242	0.578–2.670			
No of grafts	0.521	1.152	0.748–1.774			

Platelet count	<0.001*	0.963	0.948–0.978	0.007*	0.975	0.956–0.993
Atrial fibrillation	0.001*	7.784	2.428–24.959	0.298	2.235	0.491–10.166

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

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

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

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

DISCUSSION

The IABP has been widely used as a mechanical circulatory assistance device. Numerous studies have demonstrated its favorable effects. However, its influence on the CABG outcomes is still up for question[12]. This study aimed to assess the value of preoperative IABP insertion and the predictors in patients with severe and moderate LV dysfunction undergoing CABG, focusing on the outcomes post-CABG.

In our patients with moderate and severe depressed LV function, the mortality rate, incidences of complications, duration of ICU and hospital stays, mechanical ventilation, and inotrope doses showed significant improvement in patients who had IABP preoperatively compared with 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 postoperative was an independent risk factor for the development of postoperative complications, and preoperative elevation of serum creatinine level was a significant factor affecting the outcome. There is an increased incidence of thrombocytopenia after IABP insertion either preoperatively or post operatively 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 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 LV 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 improvements in EF after CABG. Surely, this lowered the inotrope's 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 less than 50%. A meta-analysis by Zangrillo *et al*.[19] demonstrated that preoperative IABP improved 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 with those with moderate EF. Furthermore, Okonta *et al*.[20] reported that early implementation of IABP shortened hospital stays and lowered mortality in high-risk patients undergoing CABG. A large single-center 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 low cardiac output syndrome and reduced 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 favorable 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 conditions and related issues. Shah *et al*.[22] noticed that IABP insertion increased rates of postoperative stroke, prolonged ICU stays, prolonged breathing, reopening due to bleeding, and mortality. The 30-day mortality and complications were more in cases with IABP, probably related to the worse overall clinical condition of the patient who received IABP[23]. The controversy regarding the benefits of IABP on cases undergoing CABG could be explained by lacking established standards 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 less than 50% who underwent CABG. Chronic renal disease was a risk factor for both long- and short-term morbidity and mortality after open heart surgery[27]. According to Okonta *et al*.[20], a rise 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 significant predictor for complications after CABG. The ideal preoperative antiplatelet therapy is not yet defined. Clopidogrel can suppress platelets and 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 with our finding that thrombocytopenia was associated with a high risk for postoperative stroke after CABG surgery. Karhausen *et al*. attributed this to the enhanced platelet reactivity. Moreover, low platelet counts in noncardiac surgical settings are predictive of deep vein thrombosis[30,31], and a decline in platelet count postoperative was a risk factor for recurrence of pulmonary embolism[32] and reinfarction following ST-elevation myocardial infarction[33]. Thus, a lower incidence of mortality and complications after CABG can be achieved by better assessment of patients, risk assessment, and 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 was performed on a 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 a larger multicenter study recruiting patients based on sample size calculation with a longer follow-up.

CONCLUSION

Preoperative IABP insertion improves the outcome post-CABG in cases with moderate and severe depressed LV function. Furthermore, preoperative

insertion of IABP, preoperative serum creatinine level, and platelet count postsurgery are considered the main risk factors affecting the outcome post-CABG.

ABBREVIATIONS

CABG, coronary artery bypass grafting; **EF**, ejection fraction; **IABP**, intra-aortic balloon pump; **ICU**, intensive care unit; **LV**, left ventricle; **PASP**, pulmonary artery systolic pressure

CONFLICT OF INTEREST

There are no conflicts of interest.

REFERENCES

1. Ramadan R, Boden WE, Kinlay S. Management of Left Main Coronary Artery Disease. J Am Heart Assoc 2018; 7:■.

2. Neumann F-J, Sousa-Uva M, Ahlsson A, *et al*. ESC/EACTS Guidelines on myocardial revascularization. Eur Heart J 2018 2018; 40:87–165.

3. Abdalwahab A, Al-atta A, Egred M, *et al*. Coronary revascularization in patients with left ventricle systolic dysfunction, current challenges and clinical outcomes. Rev Cardiovasc Med 2022; 23:33.

4. Parissis H, Graham V, Lampridis S, *et al*. IABP: history-evolution-pathophysiology-indications: what we need to know. J Cardiothorac Surg 2016; 11:122.

5. Ding W, Ji Q, Wei Q, *et al*. Prophylactic application of an intra-aortic balloon pump in high-risk patients undergoing off-pump coronary artery bypass grafting. Cardiology 2015; 131:109–115.

6. de Jong MM, Lorusso R, Al Awami F, *et al*. Vascular complications following intra-aortic balloon pump implantation: an updated review. Perfusion 2018; 33:96–104.

7. Theologou T, Bashir M, Rengarajan A, *et al*. Preoperative intra aortic balloon pumps in patients undergoing coronary artery bypass grafting. Cochrane Database Syst Rev 2011; 2011:Cd004472.

8. Kamal YA, Al-Elwany SEM, Ghoneim AMF, *et al*. Predictors of adverse effects after coronary artery bypass grafting in patients with reduced left ventricular ejection fraction. J Egypt Soc Cardio-Thoracic Surg 2017; 25:20–27.

9. Awan NI, Jan A, Rehman MU, *et al*. The effect of ejection fraction on mortality in coronary artery bypass grafting (CABG) patients. Pak J Med Sci 2020; 36:1454–1459.

10. Fallahzadeh A, Sheikhy A, Ajam A, *et al*. Significance of preoperative left ventricular ejection fraction in 5-year outcome after isolated CABG. J Cardiothorac Surg 2021; 16:353.

11. Velagaleti RS, Vetter J, Parker R, *et al*. Change in left ventricular ejection fraction with coronary artery revascularization and subsequent risk for adverse cardiovascular outcomes. Circ Cardiovasc Interv 2022; 15:e011284.

12. Kimman JR, Van Mieghem NM, Endeman H, *et al*. Mechanical Support in Early Cardiogenic Shock: What Is the Role of Intra-aortic Balloon Counterpulsation? Curr Heart Failure Rep 2020; 17:247–260.

13. Koene RJ, Kealhofer JV, Adabag S, *et al*. Effect of coronary artery bypass graft surgery on left ventricular systolic function. J Thorac Dis 2017; 9:262–270.

14. He XY, Gao CQ. Peri-operative application of intra-aortic balloon pumping reduced in-hospital mortality of patients with coronary artery disease and left ventricular dysfunction. Chin Med J (Engl) 2019; 132:935–942.

15. Khan I, Mian H, Iqbal M, *et al*. Prophylactic use of a preoperative intra-aortic balloon pump in patients with severe left ventricular dysfunction undergoing coronary artery bypass grafting. Egypt J Cardiothorac Anesthesia 2014; 8:97–100.

16. Thalji NM, Maltais S, Daly RC, *et al*. Risk of conventional cardiac surgery among patients with severe left ventricular dysfunction in the era of mechanical circulatory support. J Thorac Cardiovasc Surg 2018; 156:1530–40.e2.

17. Yang F, Wang J, Hou D, *et al*. Preoperative intra-aortic balloon pump improves the clinical outcomes of off-pump coronary artery bypass grafting in left ventricular dysfunction patients. Scientific Reports 2016; 6:27645.

18. Khaled S, Kasem E, Fadel A, *et al*. Left ventricular function outcome after coronary artery bypass grafting, King Abdullah Medical City (KAMC)-single-center experience. Egypt Heart J 2019; 71:2.

19. Zangrillo A, Pappalardo F, Dossi R, *et al*. Preoperative intra-aortic balloon pump to reduce mortality in coronary artery bypass graft: a meta-analysis of randomized controlled trials. Crit Care 2015; 19:10.

20. Okonta K, Anbarasu M, Kanagarajan K. Intra-aortic balloon pump in coronary artery bypass graft - factors affecting outcome. J West Afr Coll Surg 2011; 1:28–40.

21. Wan Y-D, Sun T-W, Kan Q-C, *et al*. The Effects of Intra-Aortic Balloon Pumps on Mortality in Patients Undergoing High-Risk Coronary Revascularization: A Meta-Analysis of Randomized Controlled Trials of Coronary Artery Bypass Grafting and Stenting Era. PLOS ONE 2016; 11:e0147291.

22. Shah SMA, Awan NI, Jan A, *et al*. Characteristics, morbidity and mortality factors associated with Intra-Aortic Balloon Pump in Coronary Artery Bypass Graft Surgery patients. Pak J Med Sci 2020; 36:1318–1324.

23. Gunnarsdóttir SLX, Gunnarsdóttir ELT, Heimisdottir AA, *et al*. The use of Intra Aortic Balloon Pump in Coronary Artery Bypass Graft Surgery. Laeknabladid 2020; 106:63–70.

24. Grieshaber P, Niemann B, Roth P, *et al*. Prophylactic intra-aortic balloon counterpulsation in cardiac surgery: it is time for clear evidence. Critical Care 2014; 18:662.

25. Parissis H, Leotsinidis M, Akbar MT, *et al*. The need for intra aortic balloon pump support following open heart surgery: risk analysis and outcome. J Cardiothorac Surg 2010; 5:20.

26. Soliman Hamad MA, van Straten AHM, Schönberger JPAM, *et al*. Preoperative ejection fraction as a predictor of survival after coronary artery bypass grafting: comparison with a matched general population. J Cardiothorac Surg 2010; 5:29.

27. Pieri M, Belletti A, Monaco F, *et al*. Outcome of cardiac surgery in patients with low preoperative ejection fraction. BMC Anesthesiol 2016; 16:97.

28. Kacar SM, Mikic A, Kačar MB. Postoperative bleeding following preoperative clopidogrel administration in patients with haemoglobin level above 110 g/L undergoing urgent CABG. Braz J Cardiovasc Surg 2018; 33:59–63.

29. Karhausen JA, Smeltz AM, Akushevich I, *et al*. Platelet counts and postoperative stroke after coronary artery bypass grafting surgery. Anesth Analg 2017; 125:1129–1139.

30. He J, Jiang Q, Yao Y, *et al*. Blood cells and venous thromboembolism risk: a two-sample mendelian randomization study. Front Cardiovasc Med 2022; 9:919640.

31. Cil H, Yavuz C, Islamoglu Y, *et al*. Platelet count and mean platelet volume in patients with in-hospital deep venous thrombosis. Clin Appl Thromb Hemost 2012; 18:650–653.

32. Siddiqui F, García-Ortega A, Kantarcioglu B, *et al*. Cellular indices and outcome in patients with acute venous thromboembolism. Clin Appl Thrombosis/ Hemostasis 2022; 28:10760296221113346.

33. Małyszczak A, Łukawska A, Dyląg I, *et al*. Blood platelet count at hospital admission impacts long-term mortality in patients with acute coronary syndrome. Cardiology 2020; 145:148–154.