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The Early Effects of Coronary Artery Bypass Grafting on Heart Failure Patients with Borderline versus Reduced Ejection Fraction

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ABSTRACT

Background: The standard of treatment for treating individuals with severe left main stem and three-vessel coronary artery disease (CAD) is coronary artery bypass graft (CABG) surgery. Compared to medical care, it is linked to better survival.

Objective: To compare the early effects of coronary artery bypass grafting on individuals with borderline vs decreased ejection fraction (EF).

Patients and methods: This is a prospective study that included 61 patients with CAD who were subjected for CABG. The included patients were divided into 2 groups; HF with border line EF (HFbEF) group included 29 patients with borderline ejection fraction and HF with reduced EF (HFrEF) group included 32 patients in reduced ejection fraction. All patients were operated upon in Zagazig University Hospitals, Egypt and followed up during the period from September 2018 till September 2021. Each patient underwent: full history taking, thorough clinical examination, laboratory investigations and echocardiographic assessment.

Results: There was great improvement of EF in HFrEF group exceeding HFbEF group. The EF at 6 months post-operative EF was 40.5±9.5% versus 43.2±7.85% in the HFbEF group versus in the HFrEF group respectively (p=0.151). Among borderline EF group there was no significant difference regarding EF before and after coronary artery revascularization (P-value= 0.34). There was a statistically significant improvement post-CABG regarding New York Heart Association (NYHA) classification among HFbEF group and HFrEF (P-value = 0.00004 and <0.0001, respectively).

Conclusion: There was great improvement of systolic left ventricular EF in reduced ejection fraction group exceeding borderline EF group.

Keywords: NYHA, CAD, CABG, EF.

INTRODUCTION

Based on decreased rates of major cardiovascular and cerebrovascular events at 1-year, coronary artery bypass graft (CABG) surgery is the gold standard of treatment for the management of patients with severe three-vessel and left main stem coronary artery disease (CAD) [1,2].

In contrast to medical therapy alone, the goal of the randomised trial Surgical Treatment for Ischemic Heart Failure (STICH) was to determine whether patients with heart failure (HF) and coronary artery disease (CAD) who underwent coronary artery bypass grafting (CABG) and guideline-directed medical therapy would likely live longer. The CABG group had decreased mortality from cardiovascular reasons (or any cause), according to the results of this early trial [3,4].

The 10-year extended follow-up study was subsequently performed to examine the long-term effects of CABG in ischemic cardiomyopathy patients. Findings from this study showed that patients receiving CABG as well as medical therapy had a significantly lower rate of all-cause mortality or hospitalization than those patients who received only medical therapy [5,6].

Patients with CAD with left ventricular failure (ejection fraction 35%) provide a clinical challenge. Both CABG and percutaneous coronary intervention (PCI) in patients with CAD are linked with better survival compared to medical therapy, according to several randomised trials and observational studies [7-9].

The purpose of this study was to compare the early effects of coronary artery bypass grafting on individuals with borderline vs decreased ejection fraction (EF).

PATIENTS AND METHODS

The present study was conducted as a prospective study included 61 patients with CAD who were subjected for CABG.

The included patients were divided into 2 groups; HFbEF group included 29 patients with borderline ejection fraction and HFrEF group included 32 patients with reduced ejection fraction. All patients were operated upon in Zagazig University Hospitals, Egypt and followed up during the period from September 2018 till September 2021.

Inclusion criteria included; heart failure patients with ischemic heart disease need elective CABG according to American College of Cardiology Foundation/American Heart Association Guidelines [10] for coronary artery bypass graft surgery 2012, which were reviewed in 2017 and patients with ejection fraction less than 50% with viable myocardium, which was based on echocardiography, doputamine stress echocardiography or nuclear studies.

Exclusion criteria were: patients who were candidates for CABG without left anterior descending coronary artery (LAD) grafting, the patients who were candidates for urgent or emergency CABG, patients with severe comorbidity (end stage renal or liver diseases, intractable malignancies, and intractable hematological

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diseases), patients with previous coronary arteries stents, CABG with valve surgery (ischemic or organic) and the patients who were above 70 years old.

Each patient underwent: A complete history was taken, a comprehensive clinical examination was performed, laboratory tests were performed, and echocardiographic assessment was done.

Ethical approval:

Before participating in the study, all patients provided informed written consent to verify that they were comfortably participating in research and publishing the results. The Zagazig Faculty of Medicine's Ethical Committee oversaw and authorised the completion of all study procedures in compliance with the Helsinki Declaration. Identifying information that wasn't necessary was left out. If there was any uncertainty that anonymity was preserved, informed consent was obtained. For this study, participant names were stored in a password-protected database and connected exclusively with a study ID number.

Statistical analysis

The SPSS version 21 for Windows® was used to code, process, and analyse the collected data. The Shapiro-Wilk test was used to determine whether the data distribution was normal or abnormal. Frequencies and relative percentages were used to depict qualitative data. To assess differences between qualitative variables, chi square test (X^2) was used. Mean, standard deviation (SD), median, and interquartile rang (IQR) were used to express quantitative data. To compare two independent groups of regularly distributed variables (parametric data), the independent samples t-test was employed, while Mann-Whitney (U) test was to compare abnormally distributed quantitative data. P values lower than 0.05 were regarded as significant.

RESULTS

There was no statistically significant difference found between the two groups regarding demographics. Our study was conducted on 61 patients, 88.5% of them were males. The median age of cases was 60 (**Table 1**).

Table (1): Demographic data of the study population

Demographics		All cases (n=61)		HFbEF group (n = 29)		HFrEF group (n = 32)		Test of significance	p
		No	%	No.	%	No.	%		
Gender	Male	54	88.5	25	86.2	29	90.6	χ^2= 0.292	0.59
	Female	7	11.5	4	13.8	3	9.4		
Age (years)	Min. – Max.	42-69		44 – 69		42 –69		U=396.5	0.33
	Median (IQR)	60 (54.5-64.5)		61 (55-63)		60 (53.25-63)			

χ^2: Chi square test, U: Mann-Whitney test. (HFbEF= heart failure borderline ejection fraction and HFrEF= heart failure reduced ejection fraction).

There was no statistically significant difference regarding any of the procedural data (**Table 2**).

Table (2): Procedural data

	All patients (n=61)		HFbEF group (n = 29)		HFrEF (n = 32)		Test of significance χ^2	P
	No.	%	No.	%	No.	%		
LAD	61	100	29	100	32	100	0	1
LCX	50	82	22	75.9	28	87.5	1.39	0.24
RCA	37	60.7	17	58.6	20	62.5	0.09	0.76
No of GRAFTS							4.99	0.29
1	5	8.2	3	10.3	2	6.2		
2	18	29.5	10	34.5	8	25		
3	30	49.2	14	48.4	16	50		
4	7	11.5	1	3.4	6	18.8		
5	1	1.6	1	3.4	0	0		
IABP	5	8.2	3	10.3	2	6.2	0.34	0.56

χ^2: Chi square test. (HFbEF= heart failure borderline ejection fraction, HFrEF= heart failure reduced ejection fraction, LAD= left anterior descending, LCX= left circumflex, RCA= right coronary artery and IABP= intra-aortic balloon pump).

There were no significant differences between the 2 groups regarding bleeding, wound, acute kidney injury, myocardial infarction, cerebrovascular accidents, and mortality (**Table 3**).

Table (3): In-hospital outcomes

	All patients (n=61)		HFbEF group (n = 29)		HFrEF (n = 32)		Test of significance χ^2	P
	No.	%	No.	%	No.	%		
Bleeding	2	3.3	0	0	2	6.3	1.87	0.17
Wound infection	5	8.2	3	10.3	2	6.3	0.34	0.56
AKI	1	1.6	0	0	1	3.1	0.92	0.34
MI	1	1.6	1	3.4	0	0	1.12	0.29
CVA	2	3.3	0	0	2	6.3	1.87	0.17
Mortality	5	8.2	1	3.4	4	12.5	1.7	0.2

χ^2: Chi square test. (AKI= acute kidney injury, MI= myocardial infarction, CVA= cerebrovascular accidents, HFbEF= heart failure borderline ejection fraction, HFrEF= heart failure reduced ejection fraction).

The mean EF was significantly higher in the borderline EF group versus in the reduced EF group respectively. There was great improvement of systolic left ventricular EF in reduced ejection fraction group exceeding borderline EF group **(Table 4)**.

Table (4): Ejection fraction among the studied groups pre-operative and 6-months post-operatively

Ejection fraction	HFbEF Group (n = 29)	HFrEF Group (n = 32)	Test of significance	p
Pre-procedural	46.5±1.9	32.6±4.6	0.001	0.001*
6-month post CABG	40.5±9.5	43.2±7.85	423.5	0.56
Test of significance	0.97	1.3		
P-value	0.34	0.216		

*: Significant

In the HFbEF, there was a statistically significant difference regarding NYHA classification (**Table 5**). There was a statistically significant difference regarding NYHA classification in the HFrEF (**Table 6**).

Table (5): Classification of NYHA pre-and post-CABG in the borderline EF group

NYHA class	Pre-CABG		Post-CABG		Test of significance	P
	No.	%	No.	%		
I	6	20.7	21	75	22.9	0.00004*
II	4	13.8	7	25		
III	9	31	0	0		
IV	10	34.5	0	0		

*: Significant

Table (6): Classification of NYHA pre-and post-CABG in the reduced EF group

NYHA class	Pre-CABG		Post-CABG		Test of significance	P
	No.	%	No.	%		
I	4	12.5	19	67.9	28.5	0.0000*
II	5	15.6	9	32.1		
III	14	43.8	0	0		
IV	9	28.1	0	0		

*: Significant

Table (7) showed that by comparing the difference between pre-operative and 6 months left ventricular ejection fraction in each group among survivors, we revealed that in group A (HFbEF), the mean difference was negative and in group B (HFrEF), the mean difference was positive. The difference in EF pre- and post CABG between the two groups was statistically significant.

Table (7): The difference in EF pre- and post-CABG between the two groups

ECHO parameter	HFbEF Group (n = 29)	HFrEF Group (n = 29)	Test of significance U	p
Difference in EF (%) mean±SD	**-5.9 ±9.3**	**10.1 ±7.04**	**37**	**0.0001****

*: Significant

DISCUSSION

In our study, the mean ejection fraction was 46.5±1.9 % versus 32.6±4.6 % in the borderline EF group versus in the reduced EF group respectively, p=0.001. In a previous study, the mean ejection fraction was 29.76 ± 4.868 [11]. In another study, the mean ejection fraction was 32.13% [12].

In the current study, none of the procedural data showed a statistically significant change. All of cases had LAD grafts, 82% of cases had LCX system grafts 60.7% of cases had RCA system grafts. Three cases (10.3%) of borderline group and two (6.2%) of reduced EF group had IABP. According to **Khaled *et al.*** [11], 20.9% of cases had IABP.

The discharge ejection fraction (EF) revealed that; the mean post-operative EF was 41±3.4% versus 39.6±6.1% in the borderline EF group versus in the reduced EF group respectively. This difference was not statistically significant between the two groups although the difference that we started with. Prior research found that the mean ejection fraction before surgery was 32.1±3.9% and that it considerably improved to 36.1±4.1% after 5 days of surgery [12].

Regarding the post-operative outcomes, there were bleeding in two cases of reduced group (6.3%), wound infection (8.2%), acute kidney injury in one case of reduced group (3.1%), myocardial infarction in one case of borderline group (3.4 %), cerebrovascular accidents in two cases of reduced group (6.3%), and mortality (3.4% for HFbEF group and 12.5% in HFrEF group); without significant difference between groups. In a previous study, there were bleeding (3%), wound infection (15%), acute kidney injury (5%), cerebrovascular accidents (3%), and mortality (5.8%)[11].

At 6 months, the EF was 39.9±9.8% versus 43.2±6.8 in the borderline EF group versus in the reduced EF group respectively. This was not statistically significant difference between the two groups. This meant that the difference between the two groups pre-operatively disappeared after 6 months post coronary artery bypass grafting.

On comparing the ejection fraction between mean baseline and 6-month post CABG in borderline EF group, we revealed that the mean ejection fraction was decreased from 46.6±1.9% to 40.5±9.5%.

On comparing the ejection fraction between mean baseline and 6-month post CABG in reduced EF group, we revealed that the mean of ejection fraction was increased from 32.6±4.6% to 43.2±7.85%. So, the difference in ejection fraction pre- and post-CABG between the two groups was statistically significant. In a previous study, in the subset of patients who had pre-operative LV dysfunction, there was a considerable improvement in LVEF [from (36±9%) to (41±12 %)] [11].

On comparing between NYHA classification before and after CABG in borderline EF group, we revealed that there was a statistically significant difference regarding NYHA classification pre-and post-CABG as twenty-one (75%) cases were NYHA class I and the rest (seven cases 25%) were NYHA class II. In the same line **Sharma *et al.*** [12], found that pre-operative mean and median EF were 48.2±10.5% and 50% respectively. Post-operatively the mean and median EF was 52.6±6% and 55% respectively. Pre-operatively median NYHA class was 3 whereas the post-operative median NYHA class was 1 respectively.

On comparing the difference between pre-operative and 6 months left ventricular ejection fraction in each group among survivors, we revealed that in group A (HFbEF), the mean difference ± SD was negative 5.9±9.3 and in group B (HFrEF), the mean difference ± SD was positive 10.1±7.04. The difference in EF pre- and post CABG between the two groups was statistically significant, p=0.0001.

CONCLUSION

Pre-operative LVEF in patients having CABG appears to be a key factor in predicting changes in LV function after surgery. In our study, the lowered ejection fraction group outperformed the borderline EF group in terms of systolic left ventricular EF. The rate of functional improvement following CABG is based on the degree of left ventricular remodeling. Low ejection fraction CABG patients have benefited from the procedure early on.

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