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Original Article

Cardiopulmonary Bypass Grafting Surgery in Patients with Reduced Ejection Fraction

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Abstract *- Background: The role of CABG in patients with reduced ejection fraction has been unclear, and several studies have shown that CABG can be performed safely in those patients. Aim: The purpose of this study was to evaluate the final outcome of isolated CABG surgery in patients with reduced EF before surgery. Materials and Methods: This retrospective analytical study involved 350 patients who underwent isolated CABG and were admitted to the Department of Cardiac Surgery, Tishreen University Hospital, Lattakia, during the four-year period 2017-2020. Patients were divided into two groups according to EF: <35%(47 cases) and ≥35%(303 cases), and final outcomes were compared between the two groups. Results: Ages of the study population range from 31 to 84 years, with a mean age of 61.9±6.8. Males represented 71.7% of the patients with a male-to-female ratio of 2.5:1. There was an increase in post-operative EF on average of 4.6% in patients with EF <35%)33.7±1.8 versus 30.5±2.6 before surgery). Lower levels of EF were associated significantly with higher frequency of post-operative use of inotropic agents (12.8 versus 3.3%, p:0.03), reoperation due to bleeding (4.2% versus 1.6%, p:0.04), kidney injury (6.4% versus 0.3%, p:0.01) and mortality (8.5% versus 2.6%, p:0.03). Duration of hospitalization was significantly longer in patients with EF<35%(6.7±2.3 versus 4.2±1.9, p:0.005). In multivariate regression analysis, reduced EF was associated with prolonged use of inotropic agents (OR: 2.7,95% CI: 1.2-9.3, p: 0.0001), kidney injury (OR:2.1,95% CI: 0.9-7.2, p:0.001), reoperation due to bleeding (OR: 2.1,95% CI 1.1-5.7, p=0.01), and mortality (OR:2.2,95% CI: 0.9-5.3, p:0.004).Conclusion: Low ejection fraction at admission is a prognostic factor for morbidity and mortality in patients who underwent CABG surgery.*

Keywords *- CABG surgery, Reduced EF, Final outcome.*

1. Introduction

Heart failure(HF) is a common clinical syndrome that results from a structural or functional cardiac disorder that leads to impairment of the ventricle's ability to fill or pump blood [1]. It is considered a major global public health problem affecting approximately 26 million people worldwide with suspected increasing global economic burden of health care costs associated with HF, especially in advanced age [2].

HF with reduced ejection fraction HFrEF represented approximately half of the HF cases and is associated with significant morbidity and reduced quality of life. Many disorders initiate primary pathogenesis, leading to reduced ventricular function and HF, including myocardial infarction, specific infectious diseases, and endocrine disorders. Management of HFrEF includes management of cause, preventive care, pharmacologic therapy, device therapy and cardiac transplantation [3]. Despite advancements in the management of HF, it has been a challenge to healthcare providers with poor prognosis and higher mortality rates [3].

Coronary artery bypass grafting(CABG) surgery is a surgical procedure in which a section of a blood vessel is grafted into the coronary artery to bypass the blocked section of its circulation. CABG is performed for patients with coronary artery disease(CAD) to improve quality of life and reduce cardiac-related mortality. It is still the most commonly performed cardiac surgery procedure worldwide [4]. There are two basic ways of performing CABG: On pump CABG and off-pump CABG.

The role of CABG in patients with CAD and heart failure is considered unclear. Several studies demonstrated that the final outcome in patients with HFrEF who underwent CABG was better than medical therapy or percutaneous coronary intervention(PCI) [5]. CABG can be performed safely in those patients and is associated with a significant reduction in all-cause mortality and improvement in quality of life, but mortality and morbidity were higher compared with normal EF patients [6]. Therefore, our study aimed to elucidate the impact of performing isolated CABG on the final outcome in patients admitted with HFrEF.

2. Materials and Methods

This is an analytic retrospective study of a group of patients older than 18 years attending the Department of Cardiovascular Surgery at Tishreen University Hospital in

Lattakia-Syria during the period (2017-2020) who underwent coronary artery bypass grafting(CABG) surgery. The exclusion criteria were the presence of one of the following: patients who underwent off-pump CABG, non-coronary cardiac surgery such as malformation repairs, cardiac valve replacement, complex cardiac surgery procedures such as valve replacement repair combined with coronary surgery, and patients with renal or liver failure. Patients' baseline characteristics, such as gender, age, and cardiovascular factors such as smoking, hypertension, diabetes mellitus etc, were reported. Laboratory investigations, echocardiographic parameters were performed, and patients were divided into two groups according to ejection fraction (EF); <35 and ≥ 35.

2.1. Surgical Procedure On-Pump CABG

It employs a midline incision through the sternum, placement of the patient on coronary bypass, and heart arrest with cardioplegia. The primary endpoint of this study was defined as the occurrence of mortality, whereas the secondary endpoint included the development of complications. Sternal wound infection; is defined as an infection that occurred during 30 days post-operative, confirmed by culture. Kidney injury; is defined by acute injury post-operative with elevated levels of urea and creatinine compared with levels before surgery, hyperkalemia, acidosis and the need for dialysis. Stroke; is defined by the occurrence of neurological symptoms 24-48 hours post-operative, and a CT scan confirms injury.

2.2. Statistical Analysis

Statistical analysis was performed by using IBM SPSS version20. Basic Descriptive statistics included means, standard deviations(SD), median, frequency and percentages.

The chi-square test was used to examine the relationships and comparisons between the two groups. An Independent t student test was used to compare 2 independent groups. At first, Univariate analysis was done, factors with statically significance were put in multivariate analysis, and an odd ratio(OR) of more than 2 was considered significant. All the tests were considered significant at a 5% type I error rate($p<0.05$), β:20%, and power of the study:80%.

Table 1. Demographic characteristics and echocardiographic parameters of the study population

Variable	
Age (years)	61.9±6.8(31-84)
Sex-n(%) Male female	 251(71.7%) 90(28.3%)
EF **<35** ≥ 35	 47(13.4%) 303(86.8%)

Table 2. Demographic and laboratory characteristics of the study population by comparison of the two group

Variables	**Group I** **EF<35** **(n=47)**	**Group II** **EF≥ 35** **(n=303)**	**P value**
Age (years)	66.8±9.1	61.4±7.9	0.0001
Sex Male Female	 37(78.8%) 10(21.3%)	 213(70.3%) 90(29.7%)	 0.1
BMI(kg/m2)	29.5±3.2	28.8±3.9	0.5
Comorbidities Diabetes mellitus Atrial fibrillation Pulmonary diseases Previous heart operations Prior PTCA LMT disease	 22(46.8%) 1(2.1%) 4(8.5%) 1(2.1%) 7(14.8%) 5(10.6%)	 138(45.5%) 1(0.3%) 29(9.6%) 2(0.7%) 39(12.9%) 24(7.9%)	 0.3 0.06 0.9 0.09 0.5 0.8
Creatinine	1.54±0.3	1.11±0.2	0.04
EF1	32.2±2.4	54.4±2.4	0.0001

Table 3. Outcome of the study population by comparison of the two group

Variables	Group I EF<35 (n=47)	Group II EF≥ 35 (n=303)	P value
Duration of the surgery(hour)	5.6±0.4	4.2±0.7	0.03
CPB time (min)	145.3±22.5	122.4±23.5	0.0001
Number of grafts	3.2±0.5	3.5±0.4	0.9
Cross-clamp time	73±15	75±17	0.8
EF2	33.7±1.8	55.3±2.1	0.001
In hospital stay(days)	6.7±2.3	4.2±1.9	0.005
Duration of admission to ICU(days)	2.7±1.3	2.04±1.1	0.09
Complications			
Prolonged use of inotropic agents	6(12.8%)	10(3.3%)	0.03
Need for IABP insertion	1(2.1%)	1(0.3%)	0.8
Stroke	2(4.2%)	4(1.3%)	0.06
Reoperation due to bleeding	2(4.2%)	5(1.6%)	0.04
Atrial fibrillation	15(31.9%)	99(32.7%)	0.09
Sternal wound infection	1(2.1%)	1(0.3%)	0.5
Kidney injury	3(6.4%)	1(0.3%)	0.01
Death	4(8.5%)	8(2.6%)	0.03

Table 4. Effect of reduced EF on clinical outcome of the study population

Risk factors	OR a [CI95%]	p-value
Prolonged use of inotropic agents	2.7[1.2– 9.3]	0.0001
Mortality	2.2[0.9 – 5.3]	0.004
Reoperation due to bleeding	2.1[1.1 – 5.7]	0.01
Kidney injury	2.1[0.9 – 7.2]	0.001

3. Result

The baseline characteristics of the participants were as shown in (Table 1). Males represented 71.7% of the study population and females 28.3%, with a male: female ratio was 2.5:1. Ages range from 31 years to 84 years (mean 61.9±6.8 years), and 47 cases (13.4%) had EF lower than 35**.** As shown in Table (2), patients in group I were significantly older (66.8±9.1 versus 61.4±7.9 in group II, p:0.0001). There were no significant differences between the two groups regarding sex, BMI, and the presence of comorbidities(p>0.05). In group, I, males represented 78.8% and females 21.3%, with a mean value of BMI 29.5±3.2. Diabetes mellitus represented the most frequent comorbidities (46.8%), followed by prior PTCA (14.8%), presence of left main trunk(LMT) disease (10.6%), pulmonary disease (8.5%), atrial fibrillation (2.1%) and previous history of cardiac surgery (2.1%). In group II, males represented 70.3% and females 29.7%, with a mean value of BMI 28.8±3.9. Diabetes mellitus represented the most frequent comorbidities (45.5%), followed by prior PTCA (12.9%), pulmonary diseases (9.6%), presence of LMT disease (7.9%), previous heart operations (0.7%), and atrial fibrillation (0.3%).

Serum creatinine levels were significantly higher in group I (1.54±0.3 versus1.11±0.2, p:0.04). The mean value of EF before surgery in group I was 32.2±2.4 versus 54.4±2.4 in group II, p: 0.0001. As shown in Table (3), duration of surgery, CBP, and in-hospital stay were significantly longer in group I versus group II (5.6±0.4 versus 4.2±0.7, p:0.03), (145.3±22.5 versus 122.4±23.5, p:0.0001), and (6.7±2.3 versus 4.2±1.9, p:0.005) respectively. EF was increased significantly in two groups (33.7±1.8 in group I versus 55.3±2.1 in group II, p: 0.001) and the percentage of increase in group I was 4.6%. The mean duration of admission to the ICU was 2.7±1.3 in group I versus 2.04±1.1 in group II, p:0.09.

Four cases (8.5%) died in group I versus eight cases (2.6%) in group II, p:0.03. Regarding complications that occurred in group I versus group II were as follows; prolonged use of inotropic agents (12.8% versus 3.3%,p:0.03), need for IABP insertion(2.1% versus 0.3%, p:0.8), stroke(4.2% versus 1.3%,p:0.06), reoperation due to bleeding(4.2% versus 1.6%,p:0.04), atrial fibrillation(31.9% versus 32.7%,p:0.2), sternal wound infection(2.1% versus 0.3%,p:0.5) and kidney injury(6.4% versus 0.3%,p:0.01).

4. Discussion

This Analytic retrospective study of 350 patients with HFrEF who underwent isolated on-pump CABG assessed the procedure's efficiency according to the EF and the safety of the procedure according to the EF and the safety of the procedure according to the levels of EF. Our clinical trial demonstrated that most patients were males and of advanced age, which might be explained by the high frequency of CAD, representing the most frequent indication of CABG. Lower levels of EF (<35) were detected in 33% of the cases, and the final outcome was compared between the two groups. Patients were significantly older in the reduced EF group with elevated creatinine levels, which might be related to reduced renal perfection and the development of renal injury. The mean duration of operation, CPB time, and hospital stay were significantly longer, with reduced EF and a high mortality rate in this group. The percentage of EF increasing was 4.6% in patients with EF lower than 35. It reduced EF represented an independent risk factor for prolonged use of inotropic agents, mortality, reoperation due to bleeding, and kidney injury $p<0.05$. These results are comparable to the findings reported by previous studies. Veli et al. (2005) demonstrated in a study conducted in 55515 patients who underwent CABG during the period three years and classified according to EF into four groups <20%, 21-30%, 31-40%, and >40% that complications were observed more frequently in patients with EF<20% compared with >40%; respiratory failure (10.1% versus 2.9%), renal failure (2.5% versus 0.6%), and infection (2.5% versus 0.6%), with lower rate of discharge to home (73% versus 88%, p:0.0001) [7]. Hillis et al. (2006) showed in a study conducted on 379 with reduced EF (<35%) who underwent CABG during four years period that survival rate at month, 1 year, and 3 years was 95%,88%, 81% respectively and presence of renal failure pre-operative was an independent risk factor for mortality [8]. Inamdar et al. (2017) demonstrated in a study conducted on 35 patients with reduced EF (<35%) who underwent CABG during the period of four years that the mortality rate was 11% and myocardial infarction represented the most observed complication (5.6%) with the improvement of EF values after CABG [9]. Elnagar et al. (2020) showed in a study conducted on 120 patients with EF<40% and 50 patients with EF >40% during one year that the mean duration of surgery was significantly higher with reducing EF. There was a significant increase in EF after surgery in patients with EF<40%(37.49±2.89 versus 40.3±8.1,p:0.0001) and reduced EF was associated significantly with prolonged use of inotropic agents, stroke, and readmission due to heart failure, with a high rate of mortality without significant difference[10]. Awan et al. (2020) showed in a study conducted on 1214 patients during two years period who were divided into three groups according to EF value; I(>50%), II(35-50%), III(<50%) that elevated levels of creatinine were observed more frequently in group III(56%) versus(36%) in group I with the high rate of stroke 2.9% versus 0.8%. The need for IABP insertion and mortality were higher in group III versus I;39% versus 3.2% and 8.6% versus 3%, respectively [11].In summary, it is recommended to perform CABG in patients with HFrEF due to improvement in EF with the low rate of associated morbidity and mortality.

5. Conclusion

Low ejection fraction at admission is a prognostic factor for morbidity and mortality in patients who underwent CABG surgery.

Availability of Data and Materials

Most of the data were in the article, and other data can be asked from the corresponding author.

Author Contribution

All authors performed the measurements and wrote the article. Hazem Souleiman did the literature review, and all authors performed analytic calculations and performed numerical simulations.

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