

## Left Ventricular Function as An Independent Prognostic Factor for Coronary Artery Bypass Surgery

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### ABSTRACT

**Background :** Studies have suggested that patients with severe impairment of left ventricular function had a poor outcome following CABG surgery. **Objectives:** Evaluation of the role of pre-operative left ventricular function on the early post-operative mortality and morbidity following CABG. **Patients and methods:** This study was carried out from August 2016 to January 2017 including 40 patients undergoing CABG surgery. Patients were divided into two equal groups each containing 20 patients. Group A contained 20 patients with pre-operative ejection fraction > 50%, while group B contained 20 patients with pre-operative ejection fraction < 50%.

**Results:** Mortality was 2 patients in group A (10%) compared to 5 patients in group B (25%) (P value = 0.031). The mean ICU stay in group A was  $3.29 \pm 1.49$  days compared to  $4.22 \pm 1.98$  days in group B (P value = 0.028). Pre-operative renal dysfunction improved in 2 patients (10%) from group A, compared to 1 patient (5%) in group B (P value = 0.555). **Conclusion:** Left ventricular function as an independent factor is a good prognostic factor regarding the early postoperative outcome in coronary artery bypass grafting including mortality, operative times, ICU stay and hospital stay.

**Keywords:** Coronary artery bypass grafting; Ejection fraction; Left ventricular function; Prognosis of coronary artery bypass grafting.

### INTRODUCTION

Pre-operative left ventricular dysfunction is an established risk factor for early and late mortality after myocardial revascularization. Left ventricular ejection fraction is an important determinant of the severity of heart failure. Causes and etiologies of systolic heart failure include coronary artery disease, conduction disease and valvular heart diseases as well as some infectious and granulomatous diseases.

Ejection fraction (EF) is commonly measured by echocardiography, by dividing the volume ejected by the heart (stroke volume) by the volume of the filled heart (end-diastolic volume) <sup>(1)</sup>.

In a healthy 70 kg man, the stroke volume is approximately 70 ml and the left ventricular end-diastolic volume is 120 ml giving an ejection fraction of 0.58%. Healthy individuals typically have an ejection fraction between 50% and 65% <sup>(2)</sup>.

A low ejection fraction has its cut off below 40% with symptomatic manifestations constant at 25% <sup>(3)</sup>. In clinical practice, LVEF is frequently determined by “eye-balling” 2D echocardiography. This visual assessment is reliable when performed by an experienced echocardiographer. But due to personal variations, a more reliable method is to use volumetric measurements as described by the following equation:  $LVEF = (LVEDV - LVESV) / LVEDV$  where LVEDV and LVESV are left ventricular end diastolic volume and left ventricular end systolic volume respectively <sup>(4)</sup>. Cardiovascular magnetic resonance imaging (CMR) is derived from and based on the same basic principles as MRI but with optimization for use in cardiovascular system <sup>(5)</sup>. CMR uses several

different techniques within a single scan, one of them called spin echo, which identifies abnormal myocardium through differences in intrinsic contrasts. Another technique is using cine imaging called balanced steady state free precession (BSSFB). A third technique is infarct imaging using contrast, where normal heart muscle appears dark while areas of infarction appear bright white.

CMR perfusion: Contrast appears in the right ventricle than in the left ventricle before blushing into the muscle, which is normal (left) and abnormal (right, an inferior perfusion defect). The key disadvantages of CMR are limited availability, expense and special skills/technical training needed to perform CMR.

### Cardiac ventriculography:

Can be performed with a radionuclide or with an iodine-based contrast in cardiac chamber catheterization.

Pre-operative risk stratification:

There are three mortality measures that have traditionally been used to estimate pre-operative outcomes: In-hospital, 30-day and procedural (either in-hospital or 30 day) <sup>(6)</sup>.

Additionally, because complications occur more frequently than death, risk-adjusted major morbidity may differentially impact quality of care and enhance a surgical team ability to assess their quality <sup>(7)</sup>.

Over the decades, a lot of risk models have been proposed for the assessment of in-hospital mortality in patients undergoing cardiac surgery, such as Bernstein-Parsonnet model, the New York state

model, and the Northern New England model. Two successful and widely used models are the EuroSCORE Additive model which also comes in a full logistic version and the society of thoracic surgeons (STS) model.

The EuroSCORE Is the most vigorously evaluated scoring system in modern cardiac surgery. It has a significantly better discriminatory power to predict 30-day mortality than the STS risk algorithm for patients undergoing CABG <sup>(8)</sup>.

The additive EuroSCORE gives excellent discrimination that is as good as logistic version of the model, but it generally underestimates risk in high-risk patients <sup>(9)</sup>. The logistic EuroSCORE is more accurate at predicting mortality in CABG and valve surgery as the additive EuroSCORE significantly under predicts high-risk groups <sup>(10)</sup>.

**PATIENTS AND METHODS**

The study was done at Kasr Al Ainy, Beni-suef and Fayoum University Hospitals in the period from August 2016 to January 2017. It is a prospective comparative randomized controlled trial including 40 patients undergoing CABG surgery. Patients were divided into two equal groups, 20 patients each: group A including patients with a pre-operative EF >50%, while group B included 20 patients with EF <50%. All of them underwent CABG using standard CPB.

**Exclusion criteria:** Patients with associated vascular or congenital heart disease, those with coagulopathies or other systemic diseases of high impact on the outcome as renal, hepatic or cerebral insults were excluded from the study.

**Preoperatively,** full history taking, clinical examination, full laboratory investigations, 12 lead ECG and radiological examination including chest x-ray, echocardiography for assessment of LVEF and coronary angiography were done at most six months before surgery. Pre-operative counseling was done for all patients.

**Intraoperatively,** all patients were operated using CPB with antegrade warm blood cardioplegia. The

grafting strategies were according to each patient’s target vessels anatomical pattern. The distal anastomoses were done first using SVGs, left radial artery or left IMA for targets as diagonals, obtuse marginal and the right coronary, and the last one was the LIMA to LAD. Proximal anastomoses to ascending aorta were done after declamping using a partial occlusion clamp. The following data were collected for statistical analysis:

- Number of distal anastomoses and arterial grafts used.
- Operative time, CPB time and cross clamp time.
- Use of IABP or inotropic supports.

**Postoperative evaluation:**

- Total mechanical ventilation time, blood loss and blood transfusion, total ICU stay were recorded.
- Morbidities such as renal dysfunction requiring hemodialysis, post-operative MI (with new abnormal Q waves, CK-MB more than 50 U/L and cardiac Troponin I > 12 µg/ml) and wound infection.
- Operative mortality occurring within 30 days of the operation.
- Postoperative inotropic support.
- Total hospital stay.

Statistical analysis:

Results were expressed as means ± standard deviation. Comparison between the two was performed using unpaired t test. Comparison between categorical data was performed using chi-square test. The data were considered significant if p values was ≤ 0.05 and highly significant if P < 0.01.

**RESULTS**

**Demographic data**

The age ranged from 48 to 67 years in group A with a mean of 57.06 ± 5.2 years, while in group B the range was from 41 to 69 years with a mean of 56.14 ± 6 years. There were five females in group A (25%) and six females in group B (31.4%) with no statistically significant difference. There was no statistically significant difference between the two groups regarding the BMI with a p value = 0.678.

**Table (1):** Demographic data

	Demographic data	Group A	Group B	P value
	Age	57.06 ± 5.2	56.14 ± 6.05	0.5 (NS)
<b>Gender</b>	females	5 (25%)	6 (30%)	0.597 (NS)
	males	15 (75%)	14 (70%)	
<b>BMI</b>	normal	11 (55%)	9 (45%)	0.678 (NS)
	overweight	8 (40%)	8 (40%)	
	obese	1 (5%)	3 (15%)	

**Risk factors:**

Hypertension was found in all patients in group A (100%) and group B (100%). 5 patients of group A were diabetic (25%) while 6 of group B were diabetic (31.4%). The EuroSCORE in group A ranged from 1 to 4 with a median of 3, while in group B it ranged from 1 to 5 with a median of 4. The mean in group A was  $2.8 \pm 1.02$  while in group B it was  $3.7 \pm 0.9$  with a statistically significant difference (p value = 0.0002). The mean EF in group A was  $61 \pm 7.1\%$ , while in group B it was  $40.26 \pm 6.31\%$  (highly significant).

**Table (2): Risk factors**

Risk factors	Group A	Group B	P value
<b>Diabetes</b>			
No	14 (70%)	13 (65%)	0.597 (NS)
Yes	6 (30%)	7 (34%)	
<b>Hypertension</b>	20 (100%)	20 (100%)	-
<b>COPD</b>	8 (40%)	11 (55%)	0.087 (NS)
<b>Previous MI</b>	1 (5%)	3 (15%)	0.545 (NS)
<b>Left main disease</b>	3 (15%)	3 (15%)	-
<b>EuroSCORE</b>	$2.8 \pm 1.02$	$3.7 \pm 0.9$	0.0002 (highly significant)
<b>Ejection fraction %</b>	$61 \pm 7.1\%$	$40.26 \pm 6.31\%$	0.0001 (highly significant)

**Operative data:**

The total operative time and CPB time were prolonged significantly in group B compared to group A, which might be due to the need for more mechanical support and a re-circulation time in the low ejection fraction group.

**Table (3): operative data**

Operative times (minutes)	Group A (EF >50%)	Group B (EF < 50%)	P value
<b>Operative time</b>	$310 \pm 43.92$	$340.57 \pm 54.9$	< 0.019 **
<b>CPB time</b>	$61.45 \pm 18.10$	$83.9 \pm 37.42$	< 0.005 ***
<b>Cross clamp time</b>	$47.70 \pm 14.2$	$72.49 \pm 83.74$	< 0.092 *

\* Non-significant, \*\* Significant, \*\*\* Highly significant

**Postoperative data:**

2 patients died in group A (10%) while in group B, 5 patients died (25%) which was statistically significant. Total mortality was 17.5%. The causes of death were mediastinitis in 2 patients with secondary hemorrhage 2 to 3 weeks following operation, ST-elevation and re-exploration in 2 patients from which one patient required intraortic balloon Pump, COPD and respiratory failure in 1 patient, cardiogenic shock and low cardiac output requiring inotropic drugs for longer than 30 minutes to maintain systolic blood pressure higher than 90 mmHg in 2 patients as shown in table (4).

**Table (4): postoperative data**

Post-operative Data	Group A (EF >50%)	Group B (EF < 50%)
<b>Mortality</b>	2 (10%)	5 (25%)
<b>Wound infection</b>	1 (5%)	2 (10%)
<b>Renal impairment</b>	0 (0%)	0 (0%)
<b>Cerebral complications</b>	0 (0%)	0 (0%)

Table (5) showed that the total hospital stay in group A was  $5.47 \pm 2.47$  days, while in group B it was  $5.74 \pm 2.78$  days. The ICU stay in group A was  $3.28 \pm 1.62$  days, while in group B it was  $4.24 \pm 1.89$  days, which was statistically significant.

**Table (5):** ICU stay and hospital stay

Days	Group A	Group B	P value
ICU stay	3.28 ± 1.62	4.24 ± 1.89	0.028
Hospital stay	5.47 ± 2.47	5.74 ± 2.78	0.028

## DISCUSSION

Even in high-risk patients, CABG carries a low risk of major adverse cardiovascular and cerebrovascular events (MACCE) including death when compared to PCI<sup>(11)</sup>.

The main finding of this study was that the pre-operative ejection fraction is a very important predictor of the post-operative early mortality after CABG. In group A, the mean age was 57.06 ± 5.2 years while in group B it was 56.14 ± 6.05 years. In a study done by **Hamad et al.**<sup>(12)</sup>, the mean age for group 1 (EF > 50%) was 64.5 ± 9.5 years, while in group 2 (EF < 50%) it was 65.0 ± 9.7 years.<sup>(12)</sup>

In our study, group A included 15 males (75%) while group B included 14 males (70%) with no statistically significant difference, which also confirms with the study done by **Hamad et al.**<sup>(12)</sup>.

The total operative time in this study was 310 ± 43.92 minutes in group A, while in group B it was 340.57 ± 54.9, which was statistically significant. The longer times in group B is attributed to the longer mechanical support and cardiopulmonary bypass, and longer re-circulation times needed before weaning in patients with low EF.

In this study, group B (EF < 50%) had a longer bypass times (27.8%) compared to group A (EF > 50%) with p value < 0.005, which also confirms with the study done by **Hamad et al.**<sup>(12)</sup> which reported that patient with low EF had a longer bypass time with a P value = 0.001.

The cross-clamp time in group A had a mean of 47.7 ± 14.2 minutes while in group B it was 72.49 ± 83.74 minutes. In a study done by **Hillis et al.**<sup>(13)</sup> in 2006, the mean cross-clamp time was 50 minutes with a P value of 0.76. It was noticed that the cross-clamp time didn't significantly differ in group A compared to group B with a P value < 0.092, however the total bypass time difference was highly significant between both groups.

Among 20 patients in group A (EF > 50%) mortality was 2 patients (10%), while in group B (EF < 50%) mortality was 5 patients (25%) with statistically significant difference (P value = 0.032).

**Hamad et al.**<sup>(12)</sup> reported that mortality in group (1) (EF > 50%) was 29 (1.6%) and in group (2) (EF 35-50 %) was 63 (3.7%), while in group (3) (EF < 35%) Was 38 (10.5%) which was statistically significant (P value = 0.0001). The main cause of mortality in our study was cardiogenic shock (2

patients). This may be explained by the late time of patient presentation, missing an ongoing ischemia, or underestimation of the burden of previous MI.

Another reason that is less was availability of cardiac supports, whether medical e.g. intra-operative Levosimendan or mechanical (ECMO-LVAD), Or the possibility of providing advanced surgery such as cardiac transplantation.

Other causes of mortality in this study was deep sternal wound infection (mediastinitis) In 2 patients (10%), ST segment elevation and re-exploration in 2 patients (10%), and respiratory failure in 1 patient (5%). The incidence of infection can be attributed to lack of proper sterilization in low socioeconomic patients, or it may be due to the bad nutritional habits especially in diabetic patients.

Concerning the renal functions in this study, there was no statistical significance between both groups. **Hillis et al.**<sup>(13)</sup> reported that impaired renal functions were an independent predictor of mortality with a 30-day mortality rate of 5.5%<sup>(13)</sup>.

**Cooper et al.**<sup>(14)</sup> reported that operative mortality increases with declining renal function, from 1.3% for those with normal renal function, to 9.3% for patients with severe renal disease not on dialysis and 9% for those who were dialysis dependent.

This study was limited by relatively small number of cases and the short period of postoperative follow-up as well as the inclusion of results of three centers only.

## CONCLUSION

Left ventricular function as an independent factor can be a good predictor for the early postoperative outcome of coronary artery bypass grafting. The postoperative morbidities and mortality can be estimated in relation to the patient's preoperative ejection fraction.

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