The Egyptian Journal of Hospital Medicine (October 2022) Vol. 89, Page 5165- 5170

# In-Hospital Outcomes after Primary Percutaneous Coronary Intervention in Association with Left Ventricular Ejection Fraction

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## ABSTRACT

**Background:** The aim of primary percutaneous coronary intervention (pPCI) in acute STEMI is to restore the blood flow within the infarct-related artery, leading to improvement of survival and quality of life of the patient.
**Objective:** It was to assess the in-hospital outcomes of pPCI in relation to left ventricular ejection fraction (LVEF).
**Patients and Methods:** The study was observational cross-sectional. It included 270 patients who had undergone pPCI in the period between May 2018 and May 2019 at Assiut University Heart Hospital.
**Results:** Patients were divided according to LVEF into three groups; group I: 28 (10.4%) with LVEF <25%, group II: 150 (55.6%) with LVEF 25-50%, and group III: 92 (34.1%) with LVEF >50%. In-hospital complications; in group I: 17 patients (60.7%), 8 patients developed pulmonary edema, 7 patients with cardiogenic shock and 2 patients with ventricular tachycardia (VT). In group II: 22 patients (14.7%), 10 patients with pulmonary edema, 4 patients with cardiogenic shock and each of VT, complete heart block, re-infarction and stent thrombosis occurred in two patients. In group III: only 4 patients (4.4%), 2 patients with atrial fibrillation and 2 patients with complete heart block.
**Conclusion:** LVEF is an important predictor of clinical outcomes in STEMI patients. Reduced LVEF is a risk factor for in-hospital mortality in those patients after pPCI. Other predictors include age (>70 years), pulmonary edema, and SBP less than 100 mmHg. Awareness of these predictors may assist clinicians to make better clinical decisions for STEMI patients.
**Keywords**: In hospital outcomes, pPCI, LVEF.

## INTRODUCTION

The superiority of primary percutaneous coronary intervention (pPCI) over conventional thrombolytic treatment for ST-elevation myocardial infarction (STEMI) has been demonstrated in randomized controlled trials. This has resulted in it becoming the treatment of choice when available [1, 2].

The goal of pPCI is to restore normal coronary artery perfusion and it is generally effective. In patients with acute STEMI, the main goal of pPCI is not only to restore the blood flow in the infarct-related artery, but also to save the patients' quality and duration of their life. Given that left ventricular ejection fraction (LVEF) is a recognized indicator of clinical outcomes in STEMI patients, the potential correlation between pPCI patients' features and LVEF need to be evaluated [3].

**Objective:** The main objective of this study is to assess the in-hospital outcomes of pPCI in relation to left ventricular ejection fraction (LVEF).

## PATIENTS AND METHODS

Our observational cross-sectional study included 270 patients with STEMI presenting at the Emergency Department (ED) of Assiut University Heart Hospital between May 2018 and May 2019.

**Inclusion criteria**:

Patients who were diagnosed as acute STEMI and were treated by primary PCI within 12 hours or up to 24 hours of chest pain onset if there was ongoing chest pain or ST segment elevation at cath-lab of Assiut University Heart Hospital.

**Exclusion Criteria:**

- Patients presented with STEMI and treated with thrombolytic therapy.
- Patients presented more than 24 hours after chest pain onset.
- Patients presented with acute chest pain and ST segment elevation and coronary angiography showed normal or vaso-spastic coronary arteries.
- Patients who presented with STEMI and referred to the cath-lab and coronary angiography showed multi-vessel disease and referred to cardiothoracic surgery for coronary artery bypass graft (CABG) without any coronary intervention.
- Patients who refused to be included in the study.

A checklist was filled out for all patients regarding baseline characteristics [age, gender, family history of coronary artery disease (CAD), smoking, diabetes mellitus, hypertension and prior CAD], physical examination on admission (systolic and diastolic blood pressure, heart rate, presence of cardiogenic shock or pulmonary edema), location of myocardial infarction (MI) [anterior MI vs. non-anterior MI].

Furthermore, angiographic results, thrombolysis in myocardial infarction (TIMI) flow grade, EF at discharge, and in hospital adverse events (MACE). Electrocardiograms were recorded on arrival and 90 min after pPCI. In-hospital follow up including the incidence of MACE as, re-infarction, stent thrombosis, major bleeding, cerebrovascular accident, recurrent chest pain, cardiogenic shock, pulmonary edema and arrhythmias. All studied patients were examined by transthoracic 2D echocardiography on discharge using GE VIVDE S5 ultrasound system



Received: 13/6/2022
Accepted: 21/8/2022

device by a trained echocardiographer to assess left ventricular ejection fraction by the biplane method of disks (modified simpson method) [1,4,5,6].

**The study population was divided into three groups according to LVEF:**

- Group I; LVEF < 25%, 28/270 (10.4%).
- Group II; LVEF between 25-50%, 150/270 (55.6%).
- Group III; LVEF > 50%, 92/270 (34.1%).

**Ethical consent:**

An approval of the study was obtained from Assiut University Academic and Ethical Committee. Every patient signed an informed written consent for acceptance of participation in the study. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

***Statistical analysis***

Data was collected and analyzed using SPSS (Statistical Package for the Social Science, version 20, IBM, and Armonk, New York, USA). Continuous data was expressed in form of mean ± SD or median (range), while nominal data was expressed in form of frequency (percentage). Chi²-test was used to compare the nominal data of different groups of patients while continuous data were compared with ANOVA test followed by post-hoc analysis. Diagnostic accuracy ejection fraction if prediction of in-hospital complications was determined by ROC curve. Multivariate regression analysis was used to determine the independent risk factors for prediction of in-hospital complications. Level of confidence was kept at 95% and hence, P value was considered significant if < 0.05.

**RESULTS**

The current study was performed at Assiut University Heart Hospital in the period between May 2018 and May 2019. It aimed to assess the in-hospital outcomes after primary percutaneous coronary intervention (PCI) in association with left ventricular ejection fraction (LVEF).

Two hundreds and seventy patients were enrolled in the study. Based on LVEF, those patients were divided into; Patients with LVEF <25% (group I), 28/270 (10.4%), patients with LVEF between 25-50% (group II), 150/270 (55.6%), and patients with LVEF >50% (group III), 92/270 (34.1%).

**Clinical data of patients based on LVEF:**

Table **1** shows baseline clinical data of our patients based on LVEF. All groups had insignificant differences as regarding baseline heart rate, and door to balloon. Patients in group I had significantly lower systolic blood pressure (SBP) in comparison to those in group III (118.57 ± 24.29 vs. 130.79 ± 17.16 mmHg; *P*< 0.001).

Also, patients in group III had significantly higher diastolic blood pressure (DBP) in comparison to those in group I (82.17 ± 8.99 vs. 73.21 ± 12.78 mmHg; *P*< 0.001) and to patients in group II (82.17 ± 8.99 vs. 79.13 ± 11.52 mmHg; *P*< 0.001). We noticed that DBP was significantly higher in patients in group II in comparison to those in group I (79.13 ± 11.52 vs. 73.21 ± 12.78 mmHg; *P*< 0.001).

None of patients in group III had signs of HF, while 5 (17.9%) patients in group I and 19 (12.7%) patients in group II (EF 25-50%) had HF. The most frequent type of myocardial infarction (MI) in patients in group I was anterior MI (60.3%).

Patients in group III had significantly lower time of symptoms to ED in comparison to those in group I (6.72 ± 3.01 vs. 16.42 ± 3.31 hours; *P*< 0.001) and those in group II (6.72 ± 3.01 vs. 9.52 ± 4.38 hours; *P*< 0.001). Also, this time was significantly lower in patients in group II in comparison to those in group I (9.52 ± 4.38 vs. 16.42 ± 3.31 hours; *P*< 0.001).

We noticed that symptoms to ED time in majority (92.9%) of patients in group I exceeded 12 hours while in patients in group III and patients in group II, symptom to ED was less than 12 hours.

**Table (1): Clinical data of enrolled patients based on LVEF**

| | Left ventricular ejection fraction | | | Significance | | |
|---|---|---|---|---|---|---|
| | Group I (28 patients) | Group II (159 patients) | Group III (92 patients) | *P* 1 | *P*2 | *P*3 |
| Heart rate (beat/minute) | 85.71±14.84 | 84.89±10.60 | 84.79±10.54 | 0.05 | 0.68 | 0.91 |
| SBP (mmHg) | 18.57 ±24.29 | 126.80 ±21.83 | 130.79 ±17.16 | 0.05 | < 0.001 | 0.12 |
| DBP (mmHg) | '3.21 ± 12.78 | 79.13 ± 11.52 | 82.17 ± 8.99 | <0.001 | < 0.001 | 0.03 |
| Symptoms to ED (hours) | 16.42 ± 3.31 | 9.52 ± 4.38 | 6.72 ± 3.01 | < 0.001 | <0.001 | <0.001 |
| Class | | | | | | |
| < 12 hours | 2 (7.1%) | 97 (64.7%) | 85 (92.4%) | < 0.001 | < 0.001 | < 0.001 |
| > 12 hours | 26 (92.9%) | 53 (35.3%) | 7 (7.6%) | | | |
| Heart failure | 5 (17.9%) | 19 (12.7%) | 0 | 0.09 | < 0.001 | < 0.001 |
| Types of MI | | | | < 0.001 | < 0.001 | < 0.001 |
| Anterior MI | 17 (60.3%) | 93 (62%) | 27 (29.3%) | | | |
| None-anterior MI | 11 (39.3%) | 57 (38%) | 65 (70.7%) | | | |

Data expressed as frequency (percentage), mean (SD). *P* value was significant if < 0.05. **LVEF**: left ventricular ejection fraction; **SBP**: systolic blood pressure; **DBP**: diastolic blood pressure; **MI**: myocardial infarction; **ED**: emergency department. ***P* 1** compared between patients in group I and patients in group; ***P* 2** compared between patients in group I and group III; ***P* 3** compared between patients in group II and group III.

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Table **2** shows angiographic findings among our patients based on LVEF. As regarding the affected vessel; we found that LAD was frequently affected in patients in group I (92.9%) and in patients in group II (73.4%) while the most frequently affected vessels among patients in group III was RCA (44.6%).

The proximal lesion was significantly higher in patients of group I (82.1%) in comparison to group II (54.7%) and group III (54.3%). Based on length of the lesion; different groups of patients had insignificant differences but majority of patients in group II and those in group III had short lesion while majority of patients in group I had long lesion affection.

All patients in group I, 114 (76%) patients in group II and 54 (58.7%) patients in group III had TIMI flow grade 0. While TIMI grade I was found in 36 (24%), and 38 (41.3%) patients in group II and group III, respectively. None of patients in group I had TIMI flow grade I. There were significant differences between all groups of patients regarding the affected vessels, target lesion, and TIMI flow.

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**Table (2): Angiographic data of enrolled patients based on LVEF**

| | Left ventricular ejection fraction | | | Significance | | |
|---|---|---|---|---|---|---|
| | Group I (28 patients) | Group II (159 patients) | Group III (92 patients) | *P* 1 | *P*2 | *P*3 |
| IRA | | | | 0.04 | < 0.001 | < 0.001 |
| LAD | 26 (92.9%) | 110 (73.4%) | 31(33.7%) | | | |
| RCA | 2 (7.1%) | 29 (19.3%) | 41 (44.6%) | | | |
| LCx | 0 | 11 (7.3%) | 20 (21.7%) | | | |
| Target location | | | | < 0.001 | < 0.001 | 0.04 |
| Ostial lesion | 3 (10.7%) | 2 (1.3%) | 2 (2.2%) | | | |
| Proximal lesion | 23 (82.1%) | 82 (54.7%) | 50 (54.3%) | | | |
| Mid-lesion | 1 (3.6%) | 57 (38%) | 33 (35.9%) | | | |
| Distal lesion | 1 (3.6%) | 9 (6%) | 7 (7.6%) | | | |
| Length of lesion | | | | 0.18 | 0.18 | 0.07 |
| Long lesion | 15 (53.6%) | 73 (48.7%) | 35 (38%) | | | |
| Short lesion | 13 (46.4%) | 77 (51.3%) | 57 (62%) | | | |
| TIMI flow | | | | < 0.001 | < 0.001 | < 0.001 |
| 0 | 28 (100%) | 114 (76%) | 54 (58.7%) | | | |
| I | 0 | 36 (24%) | 38 (41.3%) | | | |

Data expressed as frequency (percentage), mean (SD). *P* value was significant if < 0.05. **LVEF**: left ventricular ejection fraction; **LAD**: left anterior descending; **RCA**: right circumflex artery; **LCx**: left circumflex artery; **TIMI**: thrombolysis in myocardial infarction.

Table **3** shows in-hospital complications among our patients based on LVEF. Complication occurred in only four patients in group III in form of atrial fibrillation and CHB while majority (95.6%) had no complications.

Twenty two patients (14.7%) in group II developed in-hospital complications while majority (85.3%) of this group had no complications. The most frequent complications were pulmonary edema in 10 patients (6.7%) and cardiogenic shock in 4 patients (1.3%) while each of VT, complete heart block, re-infarction and stent thrombosis occurred in two patients.

In contrast to other groups, the majority (60.7%) of patients in group I developed in-hospital complications which included 8 patients (28.6%) with pulmonary edema, 7 patients (25%) with cardiogenic shock, and 2 patients (7.1%) with VT.

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**Table (3): In-hospital complications of enrolled patients based on LVEF**

| | Left ventricular ejection fraction | | | Significance | | |
|---|---|---|---|---|---|---|
| | Group I (28 patients) | Group II (159 patients) | Group III (92 patients) | *P* 1 | *P*2 | *P*3 |
| In-hospital complications | | | | < 0.001 | < 0.001 | < 0.001 |
| None | 11 (39.3%) | 128 (85.3%) | 88 (95.6%) | | | |
| Complications | 17 (60.7%) | 22 (14.7%) | 4 (4.4%) | | | |
| Type of complications | | | | < 0.001 | < 0.001 | < 0.001 |
| Pulmonary edema | 8 (28.6%) | 10 (6.7%) | 0 | | | |
| Shock | 7 (25%) | 4 (2.7%) | 0 | | | |
| VT | 2 (7.1%) | 2 (1.3%) | 0 | | | |
| Atrial fibrillation | 0 | 0 | 2 (2.2%) | | | |
| Complete heart block | 0 | 2 (1.3%) | 2 (2.2%) | | | |
| Re-infarction | 0 | 2 (1.3%) | 0 | | | |
| Stent thrombosis | 0 | 2 (1.3%) | 0 | | | |

Data expressed as frequency (percentage), mean (SD). *P* value was significant if < 0.05. **LVEF**: left ventricular ejection fraction; **LAD**: left anterior descending; **RCA**: right circumflex artery; **LCx**: left circumflex artery.

**Predictors for in-hospital complications among studied patients:**

Based on the current study; predictors for in-hospital complications in such patients were old age (odd's ratio= 2.10, 95% confidence interval= 1.22-9.78; *P*< 0.001), pulmonary edema (odd's ratio= 1.41, 95% confidence interval= 1.11-4.90; *P*< 0.001); SBP (odd's ratio= 2.32, 95% confidence interval= 1.09-4.87; *P*< 0.001) and ejection fraction < 50% (odd's ratio= 3.79, 95% confidence interval= 1.94-12.01; *P*< 0.001) with adjusted $R^2$ was 0.49.

**Table (4): Predictors for in-hospital mortality among studied patients**

| Predictors | Univariate analysis | | Multivariate analysis | |
|---|---|---|---|---|
| | OR (95% CI) | *P* value | OR (95% CI) | *P* value |
| Age > 70 years) | 1.98 (1.22-7.98) | 0.03 | 2.10 (1.22-9.78) | < 0.001 |
| Symptom to ED time | 2.22 (2.10-4.09) | 0.04 | | |
| Signs of HF | 1.33 (1.30-3.02) | < 0.001 | 1.41 (1.11-4.90) | < 0.001 |
| Anterior MI | 1.20 (1.10-2.22) | 0.03 | | |
| SBP (< 100 mmHg) | 2.10 (1.09-3.33) | < 0.001 | 2.32 (1.09-4.87) | < 0.001 |
| EF (< 50%) | 3.01 (2.39-10.99) | < 0.001 | 3.79 (1.94-12.01) | < 0.001 |
| LAD as IRA | 1.20 (1.11-3.21) | 0.01 | | |
| Ostial lesion | 2.19 (1.23-3.01) | 0.04 | | |
| Long lesion | 1.87 (1.18-3.90) | 0.03 | | |
| TIMI < I | 1.20 (1.11-4.56) | 0.01 | | |

**OR**: odd's ratio; **CI**: confidence interval; **ED**: emergency department; **MI**: myocardial infarction; **EF**: ejection fraction; **TIMI**: thrombolysis in myocardial infarction; **IRA**: infarct related artery; **SBP**: systolic blood pressure.

## DISCUSSION

Coronary artery disease (CAD) is the main cause of death where it accounted for 13% in 2010. Recently, the rate of death from CAD has been reduced by the advent of 2 efficacious and widely available treatments: Coronary artery bypass graft (CABG) surgery and percutaneous coronary intervention (PCI) [(1)].

The potential of LVEF to contribute as a marker of cardiac function is well known, and it is frequently used in daily clinical practice. Some previous studies have shown that the decline in EF is a risk factor for many diseases.

Our study revealed that none of those patients in group III had pulmonary edema but 5 (17.9%) of those in group I and 19 (12.7%) of those in group II had pulmonary edema. This high frequency of pulmonary edema at group I is consistent with **Vakili *et al.*** [(3)] that 6 (26.1%) of those in group I and 3 (2%) of those in group II had pulmonary edema. They also, reported that no pulmonary edema occurred in group III.

The current work showed that Patients in group III had significantly lower time of symptoms to ED in comparison to those in group I (6.72 ± 3.01 vs. 16.42 ± 3.31 hours) and to those in group II (6.72 ± 3.01 vs. 9.52 ± 4.38 hours). Also, this time was significantly lower in patients in group II (EF 25-50%) in comparison to those in group I (9.52 ± 4.38 vs. 16.42 ± 3.31 hours).

We noticed that non-anterior myocardial infarction had good LVEF. We reported that 65 patients (70.7%) in group III had non-anterior myocardial infarction. This was significantly higher in comparison to the other groups of patients that were noticed to have higher frequency of anterior myocardial infarction. Consistent with prior studies that anterior myocardial infarction was associated with decreased LVEF. An anterior MI has been shown to have greater irreversible ischemic LV damage because of the greater area supplied of myocardium [(7, 8, 9)].

The current study showed that LAD artery was frequently affected in patients in group I (92.9%) and in patients in group II (73.4%) while the most frequently affected vessels among patients in group III was RCA (44.6%). Also, in the majority (82.1%) of patients in group I, the location of the lesion was proximal and all of them had TIMI flow zero.

This demonstrates the incremental pathophysiologic and prognostic importance of proximal lesion location. Proximal culprit lesions subtend a larger area of myocardium, and it could be speculated that these larger infarcts would be associated with a higher risk of impaired LVEF or arrhythmic complications, and thus with increased short-term mortality[(10)].

Also, in agreement with the current study, many previously published studies noticed that patients with baseline TIMI grade <1 had usually impaired cardiac function. Generally, The TIMI flow grading system is a qualitative method for evaluation of reperfusion[(11)].

Low LVEF is generally related to a larger infarct size that, besides causing more microvascular damage and interstitial edema, also decreases the coronary perfusion pressure as a result of higher left ventricular end-diastolic pressure [(12)].

In the current study, we found that only four patients in group III developed in-hospital complications while majority (95.6%) of this group of patients had no complications. Twenty two (14.7%) patients in group II (EF 25-50%) developed in-hospital complications while majority (85.3%) of such group had no complications .

In contrast to other groups, majority (60.7%) of patients in group I developed in-hospital complications. We found that 8 (28.6%), 7 (25%), and 2 (7.1%) patients developed pulmonary edema, shock and VT respectively.

Also, the current work revealed that predictors for in-hospital complications were old age (odd's ratio= 2.10, 95% confidence interval= 1.22-9.78; P< 0.001), signs of HF (odd's ratio= 1.41, 95% confidence interval= 1.11-4.90; P< 0.001); lower SBP (odd's ratio= 2.32, 95% confidence interval= 1.09-4.87; P< 0.001) and ejection fraction < 50% (odd's ratio= 3.79, 95% confidence interval= 1.94-12.01; P< 0.001)

Consistent with previous studies, our study also found a significant negative correlation between LVEF and in-hospital morbidity in patients after pPCI. It means that patients with low EF are more likely to develop complications at the hospital [(13)].

**Study limitations:** Lack of follow up of left ventricle ejection fraction so that we could not detect possible LV function recovery with time.

## CONCLUSION

LVEF is an important predictor of clinical outcomes in STEMI patients. Reduced LVEF is a risk factor for in-hospital mortality in those patients after pPCI. Other predictors include age (>70 years), pulmonary edema, and SBP less than 100 mmHg. Awareness of these predictors may assist clinicians to make better clinical decisions for STEMI patients.

**Financial support and sponsorship:** Nil.
**Conflict of interest:** Nil.

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