Original Research Article

Predictors of Left Ventricular Dysfunction after Percutaneous Primary Coronary Intervention in Acute Anterior Myocardial Infarction

Abstract

Background: Primary percutaneous coronary intervention has revolutionized the management and outcome of acute myocardial infarction. However, the occurrence of left ventricular dysfunction remains relatively common event after acute myocardial infarction and in associated with an adverse prognosis in these patients. The aim of this work was to investigate to the predictors of left ventricular dysfunction after percutaneous coronary intervention for anterior myocardial infarction (AMI) using different parameters: Biomarkers (Troponin, CK-MB), Echocardiography and Tissue Doppler imaging (TDI)

Methods: This study was conducted prospectively on 50 patients aged from 40 to 70 years old, presenting by first anterior myocardial infarction and treated with PCI. All patients were subjected to full history, full clinical examination, laboratory investigations, resting 12 leads electrocardiography, two dimensions echocardiography and tissue doppler imaging.

Results: Highly statistically significant between EF baseline with EF on discharge and EF on discharge with after 3 months p-value was <0.001. Pre balloon dilatation, S wave of tissue Doppler imaging on discharge and S wave tissue Doppler imaging after 3 months were predictors for left ventricular systolic function.

Conclusions: Persistent LV dysfunction following successful primary PCI is infrequent and is associated with poor clinical outcomes at 3 months clinical follow-up. Tissue Doppler on discharge and after three months after myocardial infarction are independent predictors of LV dysfunction after anterior STEMI and can be used to predict occurrence of LV remodelling after 6 months.

Keywords: Left Ventricular Dysfunction, Percutaneous Primary Coronary Intervention, Acute Anterior Myocardial Infarction.

Introduction:

Cardiovascular diseases are the most common causes of death in industrialized countries and are expected to become so in developing one. The American Heart Association, in conjunction with the National Institutes of Health, annually reports on the most up-to-date statistics related to heart disease and cardiovascular risk factors, including core health behaviors (smoking, physical activity, diet, and weight) and health factors (cholesterol, blood pressure, and glucose control) that contribute to cardiovascular health [1].

Primary percutaneous coronary intervention has revolutionized the management and outcome of acute myocardial infarction. However, the occurrence of left ventricular dysfunction remains relatively common event after acute myocardial infarction and in associated with an adverse prognosis in these patients [2].

Severe left ventricular (LV) dysfunction after acute myocardial infarction (MI) has important prognostic implications and is associated with increased morbidity and mortality from both congestive heart failure (HF) and sudden cardiac death [3].

The mechanisms responsible for LV dysfunction in acute phase myocardial infarction include myocardial loss and remolding due to infarction, ischemic stunting, atrial and ventricular arrhythmia and valvular dysfunction [4].

Global measures of left ventricular (LV) function, in particular LV ejection fraction (LVEF), are powerful predictors of outcomes in post- myocardial infarction (MI) patients with LV dysfunction, heart failure, or both [4]. Early reperfusion treatment improves survival by limiting infarct size and consequently preserving LV function. Early reperfusion therapy and patency of the infarct-related artery (IRA) is crucial for reducing infarct expansion and LV enlargement [5].

Coronary artery disease (CAD) is the leading cause of death worldwide. In Europe alone, CAD is the underlying cause in 20% of all global CAD mortality rate could be evident by

2030. Therefore, the considerable morbidity and socioeconomic burden of CAD will continue to have a major impact over the coming decades. Improved survival among patients with myocardial infarction (MI) may lead to an increased awareness of the population with stable post-MI CAD [6]. The aim of this work was to investigate to the predictors of left ventricular dysfunction after percutaneous coronary intervention for anterior myocardial infarction (AMI) using different parameters: Biomarkers (Troponin, CK-MB), Echocardiography and Tissue Doppler imaging (TDI)

Patients and Methods:

This study was conducted prospectively on 50 patients aged from 40 to 70 years old, presenting by first anterior myocardial infarction and treated with PCI. An informed written consent was obtained from the patient or relatives of the patients. The study was done after approval from the Ethical Committee Tanta University Hospitals.

Exclusion criteria were patient with associated organic valvular heart disease, previous coronary artery bypass graft, chronic liver disease, chronic kidney disease, malignant or hematological diseases, myocarditis, cardiomyopathy and ventricular paced rhythm.

All patients were subjected to full history [age, sex and risk factors as diabetes mellitus, hypertension, smoking and positive family history], full clinical examination, laboratory investigations (cardiac enzymes (troponin and CKMB), random blood sugar and renal function (blood urea and serum creatinine) values).

Resting 12 leads electrocardiography

Two dimensions echocardiography (The ECHO study was performed by 2 operators for each case using (Vivid 6, Vingmed-General Electric, Horten, Norway) machine with multi-frequency transducer 2D, M mode and color flow Doppler, imaging was performed from (parasternal long axis, parasternal short axis, apical four chamber and apical two chamber view, apical five chamber view, subcostal and supra sternal views).

Tissue Doppler imaging (tissue Doppler imaging: by activating the TDI function in the same echocardiographic machine, recordings of the annular velocities were made with PW TDI to obtain the best quality recordings. The filter settings and gains were adjusted at the minimal optimal level to minimize noise and eliminate the signals produced by the Trans mitral flow. TDI was done to detect the peak systolic velocity (S), peak early diastolic velocity (E), and peak late diastolic velocity (A) waves of the septal and lateral mitral annuli [7].

Catheterization data (all studied patients were subjected to pre intervention preparation. Loading dose of dual anti platelet therapy (aspirin 300mgchewableplus P2Y12 inhibitor ticagrilor 180mg or clopidogril 600mg plus IV unfractionated heparin or low molecular weight heparin were used before the procedure. glycoprotein IIb IIIa inhibitors were used during or after the procedure in selected cases then the patient transformed to the Cath lab where they were studied by coronary angiography, In this study both femoral and radial arterial approaches were used.

Coronary angiographic evaluation (by using Selinger femoral technique by introducing 6 French femoral sheaths in right femoral artery, engagement of left and right system, angiogram in multiple projection was done to complete visualize both system).

The primary PCI can be done via femoral artery or radial artery but in many patients femoral artery route was used, number of stents can be detected by the cardiologist according to the case and using of pre and post stent balloon dilatation.

PCI with stenting was immediately performed with a 6-fr guiding catheter, thrombus aspiration, balloon pre and post dilatation was performed when indicated.

Follow up (follow up after 3 months for assessment of

- Resting 12 lead ECG
- 2D echocardiography assessment of LV ejection fraction, regional wall motion, diastolic function and tissue Doppler

Statistical analysis

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0. (Armonk, NY: IBM Corp). Statistical presentation and analysis of the present study was conducted, using the mean, standard deviation, paired Student T-test was used to compare between related sample in quantitative data and the Multinomial Logistic Regression procedure internally aggregates cases to form subpopulations with identical covariate patterns for the predictors, producing predictions, residuals, and goodness-of-fit tests based on these subpopulations. If all predictors are categorical or any continuous, predictors take on only a limited number of values. By (IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp. A two tailed P value < 0.05 was considered significant.

Results:

Error! Not a valid bookmark self-reference. shows patient demographic, risk factors, clinical examination and laboratory data, ECG and echo of the studied patients.

Table 1: Distribution of the studied cases according to demographic data, risk factors, clinical examination, laboratory data, ECG and echo (N=50).

		Patients (n = 50)
Age (years)		59.30±7.68
Sex	**Male**	36 (72%)
	Female	14 (28%)
Risk factors	**DM**	25(50%)
	HTN	26(52%)
	Smoking	26(52%)
	Positive family history	20(40%)
Clinical examination	**Systolic blood pressure (mm Hg)**	130.98±27.07
	Diastolic blood pressure (mm Hg)	83.14±17.49
	Pulse(B pm)	104.43±12.56
Labs results	**Urea (mg/dl)**	41.82±15.73
	Creatinine (mg/dl)	1.29±0.36
	HB (g/dl)	11.82±1.5
	TLC	10.98±2.64
	PLAT	214.72±49.74
	Random blood sugar	197.28±100.54
	CKMP	50 (100%)

	Troponin	50 (100%)
ECG	**ST elevation from V1 to V6 (anterior MI)**	40(80%)
	ST elevation I, AVL (High lateral MI)	14(28%)
	ST elevation II, II, AVF(inferior MI)	3(6%)
	Right bundle branch block	8(16%)
	Left bundle branch block	2(4%)
Echo	**LVEDD**	4.95±0.28
	LVESD	3.54±0.24
	LA	3.24±0.2
	AORTA	2.51±0.35

Data are presented as mean ± SD or frequency (%). DM: diabetes mellitus, HTN: hypertension, B pm: beat per minute, LVEDD: (left ventricular end diastolic diameter) LVESD: left ventricular end systolic diameter LA: Left atrium, MI: myocardial infarction, HB: Hemoglobin

EF% was non significantly different at base line compared to on discharge, while after 3 months it was significantly higher than baseline and on discharge ($p<0.001$). Table 2

Table 2: Comparison between baseline, on discharge and after 3 months ejection fraction (EF)

	EF%	**Paired t-test**	
		T	**P-value**
Baseline	39.78 ± 4.01		
On discharge	39.66 ± 3.96	1.137	0.261
After 3 Months	45.1 ± 8.38	5.649	<0.001*

Data are presented as mean ± SD, EF: ejection fraction

Table 3 shows distribution of the studied cases according to the wall motion of the left ventricle, route of primary PCI, number of stents, culprit artery, TIMI flow and stent balloon dilatation. Table 3

Table 3: Distribution of the studied cases according to the wall motion of the left ventricle, R**oute of primary PCI, Number of stents, Culprit artery, TIMI flow and Stent balloon dilatation**

The wall motion of the left ventricle	**Lateral**	12(24%)
	Anterior	21(42%)
	Antroseptal	40(80%)
	Apicoseptal	5(10%)
	Anterolateral	21(42%)
	Midanterior	16(32%)

	Inferior	12(24%)
	Basal	9(18%)
	Apical	22(44%)
	Septal	3(6%)
	Apicolateral	4(8%)
	Apicoanterior	4(8%)
	Posteroanterior	2(4%)
Route of primary PCI	Femoral	41(82%)
	Radial	9(18%)
Number of stents	1	41(82%)
	2	9(18%)
Culprit artery	LAD	40(80%)
	LAD+LCX	6912%)
	LAD+RCA	3(6%)
TIMI flow	II	6(12%)
	III	44(88%)
Stent balloon dilatation	No dilatation	11(22%)
	Pre	16(32%)
	Post	10(20%)
	Both	13(26%)

Data are presented as frequency (%). LAD: left anterior descending artery, LCX: left circumflex artery RCA: right coronary artery

Tissue Doppler S wave was significantly higher at follow-up than on discharge ($p<0.001$). Table 4

Table 4: Comparison of tissue Doppler S wave values on discharge and after 3 months follow up

	Tissue Doppler S wave	**Paired t-test**	
		t	**P-value**
On discharge	0.049 ± 0.009		
Follow up	0.055 ± 0.011	3.830	<0.001*

Data are presented as mean ± SD, M/sec: millimeter per second.

On multivariate analysis for all studied parameters, pre balloon dilatation, S wave of tissue Doppler imaging on discharge and S wave tissue Doppler imaging after 3 months were predictors for left ventricular systolic function. Table 5

Table 5: Multivariate analysis for parameters predicting LV systolic dysfunction (impaired ejection fraction)

	Odd ratio	95% CI		t	P-value
		Lower	Upper		
DM	0.835	-3.013	4.682	0.440	0.662
HTN	-0.820	-4.763	3.122	0.422	0.675
Route	2.514	-2.352	7.380	1.049	0.301
Culprit artery	-1.077	-2.489	0.334	1.549	0.130
Dilatation	1.852	0.193	3.510	2.266	0.030*
TIMI flow	-3.579	-10.109	2.950	1.113	0.273
Urea	-0.215	-0.471	0.040	1.710	0.096
Creatinine	11.286	-0.324	22.896	1.973	0.056
LVEDD	2.865	-3.994	9.724	0.848	0.402
LVESD	-1.845	-10.424	6.733	0.437	0.665
HB	-0.044	-1.301	1.213	0.071	0.944
PLAT	-0.008	-0.048	0.032	0.427	0.672
Tissue Doppler imaging S wave on discharge	263.734	31.506	495.963	2.306	0.027*
Tissue Doppler imaging S wave after 3 months	443.875	258.518	629.233	4.861	<0.001**

DM: diabetes mellitus, HTN: hypertension, LVEDD: (left ventricular end diastolic diameter) LVESD: left ventricular end systolic diameter, PLAT: platelet. HB: Hemoglobin.

Discussion

Recent studies have highlighted a fall in acute and long-term mortality following STEMI in parallel with greater use of reperfusion therapy, including PCI [8]. Notably, primary PCI in patients with STEMI can limit the infarct size and preserves left ventricular (LV) systolic function [9]. However, a problem with this approach is that not all patients with STEMI improve or maintain heart function following PCI. In fact, 4.7–8.6% patients may experience decreased heart function even after undergoing successful primary PCI [10].

As regards Laboratory result of the studied group we found that urea level it ranges from 20-87mg/dl with mean 41.82 ±15.73mg/dl. Regarding to creatinine level 0.9-2.5mg/dl with mean

1.29±0.36mg/dl. Regarding to hemoglobin level it ranges from 10-15g/dl with mean 11.82±1.5. Regarding to total leukocyte count (TLC) it ranges from 8-19 with mean 10.98±2.64. Regarding to platelet it ranges from 134-350 with mean of 214.72±49.74. Regarding to random blood sugar it ranges from 80-400g/dl with mean 197.28±100.54g/dl. Regarding to cardiac enzymes (troponin and CKMP) all patients was positive.

With matching values like our results Kim et al., [11] revealed that the mean creatinine 1.1±0.9 and 1.2±1.3 for patient without and with Left ventricular dysfunction respectively. The mean Peak CKMB was 198.5±301.5 and 359.2±712.3 for patient without and with LVD. The Peak Troponin I, (ng/dl) were 52.5±70.6 and 98.1±112.6. There was significant difference between the study group regarding creatinine and highly significant difference regarding cardiac enzymes (troponin and CKMP) meaning that left ventricular dysfunction was associated with elevated troponin and CKMP. This result supported our results as we found that all patients with left ventricular dysfunction were cardiac enzymes (troponin and CKMP) positive.

In contrast, the study by Khaled et al., [12] revealed that there were no significant differences between the study group regarding all Laboratory data including Peak troponin, creatinine, Platelet count and Hemoglobin. As well You et al., [13] reported that that there were no significant differences between the study group regarding Laboratory data including HbA1C, Creatinine, Platelets, troponin and CK-MB.

Regarding ECG of the studied cases, we found that all patients were in sinus rhythm, heart rate ranged from82 to 140 bpm. All patients diagnosed as anterior myocardial infarction with some patients add another wall as inferior, right or lateral infarction as following. Patients who had ST elevation V1-V6 (anterior myocardial infarction) were 40 patients with percentage 80%, patients who had anterior MI plus lateral MI were 14 patients with percentage 28%, the patients who had anterior MI plus inferior MI were 3 patients with

percentage 6%, patients who were right bundle branch block 8 patients with percentage 16% and patients who were left bundle branch block 2 patients with percentage 4%.

Our results were supported by the study by Khaled et al., [12] who revealed that more than half of the patients (171, 55.5%) had anterior STEMI diagnosed by ECG, and this was predominant in the LVT (+) group. There was highly significant difference between the groups with and without LVT as regard anterior STEMI, 94% of patients with LVT have anterior STEMI.

Also, the study by Niazi et al., [14] reported that in the LVT there were 86% have anterior STEMI and in the Without LVT group 52% had anterior STEMI with high significant difference.

As well the study by Świątkiewicz et al., [15] reported that left ventricular systolic dysfunction was highly correlated to anterior STEMI.

Regarding Echocardiography we found that as regard to left ventricular dimensions, (LVEDD) left ventricular end diastolic

dimensions range from 4.2-5.5 cm with percentage 4.95±0.28% and (LVESD) left ventricular end systolic dimensions range from 3-3.9 cm with percentage 3.54±0.24%. We also found that ejection fraction on admission the values range from 30-48 with Mean ± SD 39.78±4.01, on discharge there was slight change with range of 29-49 and mean ± SD 39.66±3.96. But on follow up after 3 months there was improvement in values with range 25-57and Mean ± SD 45.1±8.38. Left atrium range from 3-3.6with percentage 3.24 ±0.2%, regarding to aorta it ranges from 1.9-3 with percentage 2.51±0.35%. All patients in this study were grade I diastolic dysfunction.

While the study by Zhang et al., [16] reported that the mean LVEDD for the group with and without LVT were 51.2 (48.1, 56.4) and

48.25 (44.5, 53.64) respectively (p=.012) and the mean LVEF for the group with and without LVT were 39.84 ± 10.05 and 41.78 ± 6.72 respectively (p=.138).

In contrast the study by You et al., [13] reported that there was no significant difference between LVT group and controls as regard LVEDD, LVESD and LVEF.

As regard Tissue Doppler on discharge the tissue Doppler range 0.3-0.07 m/sec with Mean ± SD 0.049 ±0.009. On follow up after 3 months the range 0.3-0.07m/sec with Mean ± SD 0.055±0.011. There was highly statistically significant between Tissue Doppler baseline and discharge with After 3 Months where p-value was <0.001*.

In disagreement with our results Świątkiewicz et al.,[15] reported that the average peak systolic mitral annular velocity and average septal and lateral peak systolic mitral annular velocity weren't significantly decreased at follow up as regard the discharge values, while there were highly significant difference between groups EF > 40% vs EF < 40% at both the discharge and at 12 month follow-up.

Furthermore, Bastawy et al., [17] revealed that there was no significant difference between both the regarding assessment of diastolic function using trans-mitral inflow pattern parameters ''Mitral E wave, mitral A wave, DT and E/A ratio". And the TDI mitral annulus velocities showed significantly less both lateral e' and septal e' waves, and significantly higher E/e' ratio in LV remodeling group. (ie tissue Doppler parameters were worse in remodeling group at baseline echocardiographic assessment while pulsed wave Doppler was not).

The affected walls of the left ventricle were varied from patient to other and had different varieties. In this study all patients were anterior myocardial infarction but, in some patients, they added to anterior inferior, right, posterior or lateral infarction.

Our results were supported by Rajic et al., [18] who revealed that Anterior wall infarction were found in 89.9% of the EF < 40% group and 31.6% of EF > 40% group with significant difference.

Regarding to the culprit artery affected the LAD artery affected in 40 patients with percentage80%, 6 patients with percentage 12% LAD artery plus LCX artery were affected, LAD artery plus RCA artery affected in 3patients with percentage 6%.

While the study by Khaled et al., [12] reported that LAD artery affected in 55%, RCA artery affected in 34%and LCX artery affected in 11% of the total cohort, with highly significant difference between patients with and without LVT.

Our results were supported by Rajic et al., [18] who revealed that in patients with LVEF ≤ 40% LAD artery affected in 88.4%, RCA artery affected in 4.3%and LCX artery affected in 5.8%, with highly significant difference between patients with LVEF ≤ 40% and LVEF > 40%.

In addition, You et al., [13] revealed that in LVT patients LAD artery affected in 100%, RCA artery affected in 44%and LCX artery affected in 52%.

Regarding to TIMI flow 88% was TIMI III with number 44 patients and 6 patients with 12% was TIMI I.

While the study by Rajic et al., [18] reported that in patients with LVEF ≤ 40%, TIMI flow 3 were 97.1% and TIMI flow 2 were 2.9%. And in patients with LVEF > 40%. TIMI flow 3 were 98.7% and TIMI flow 2 were 1.3%.

Regarding to the dilatation done 11 patients had no dilatation with percentage 22%, pre dilatation done in 16 of patients with percentage 32%, post dilatation done in 10 of patients with percentage 20% and 13 of patients with percentage 26% had both pre and post dilatation.

Finally, our results revealed that Left Ventricular Dysfunction after percutaneous primary coronary intervention was significantly correlated with dilatation, Tissue Doppler on discharge and highly significantly correlated to tissue after 3 months.

A study by Frisch et al., [19] identified that periprocedural LVEF <30% was an independent predictor of LV dysfunction, as was demonstrated in the present study. Therefore, it was hypothesized that the presence of features marking LV dysfunction may confer high risk of experiencing MACEs and by identifying patients who experience persistent myocardial damage and poor clinical outcomes during their index hospitalization, physicians may be able to consider more appropriate use of post-infarction therapies.

In the study by Kim et al.[11] troponin I levels were also significantly associated with LV dysfunction. Previous studies have identified an association between troponin elevation and long - term mortality in patients with acute coronary syndrome. A study by Rasoul et al., [20] demonstrated that peak cardiac muscle troponin T (cTnT) was negatively correlated with the LVEF measured by myocardial scintigraphy after 3 months and was an independent predictor of heart failure development during a 1-year follow-up. Presentation delay, anterior myocardial infarction location and older age were independent predictors of peak cTnT levels [20].

Limitations: The sample size was relatively small. The study was in a single center. The follow up of patients was limited for relatively short period.

Conclusions:

Persistent LV dysfunction following successful primary PCI is infrequent and is associated with poor clinical outcomes at 3 months clinical follow-up. Tissue Doppler on discharge and after three months after myocardial infarction are independent predictors of LV dysfunction after anterior STEMI and can be used to predict occurrence of LV remodelling after 6 months.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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