

Impact of Time Factor on Wall Motion Abnormalities in Patients with STEMI and Underwent Primary PCI

Abstract

Background: Left ventricular (LV) dysfunction is the single most accurate predictor of death and one of the most common and lethal consequences after ST segment elevation myocardial infarction (STEMI) that has been substantially decreased by primary percutaneous coronary intervention (PCI). This research investigated the impact of duration of ischemia on the severity and improvement of wall motion abnormalities after revascularization and 40-day follow-up.

Methods: This study was performed on 60 STEMI patients, treated with 1ry PCI and distributed in two groups; group1: 37 patients presented early before 12h and group II: 23 patients presented late after 12h. Echocardiogram (ECHO) was done for ejection fraction (EF) and resting segmental wall motion abnormalities (RSWMA) detection after revascularization within 24 h of hospitalization and follow up after 40 days.

Results: MI complication showed insignificant difference between both groups. Wall motion score index (WMSI) values in group I were significantly decreased relative to group II during the follow-up period ($p=0.001$). Major improvement in LV ejection fraction from hospital admission to follow-up ($p=0.001$) in group I from the beginning of chest pain compared to group II. Correlation between time to wire crossing and WMSI showed significant positive correlation after 40 days in group I ($p=0.016$) with significant negative correlation with EF after 40 days in group I ($p=0.018$).

Conclusions: Ischemic patients with ≤ 12 hours symptoms showed a significant degree of recovery from RWMA on follow up after 40 days.

Keywords: STEMI, PCI, wall motion, ischemia, RSWMA.

UNDER PEER REVIEW

Introduction

In the United States two millions of people suffer from myocardial infarction (MI) which is leading cause of death worldwide ^[1].

An occlusive thrombus is the causative factor in acute ST-segment elevation myocardial infarction (STEMI), which leads to ischemia and necrosis in the area supplied by the blocked artery ^[2].

Rapid recanalization reduces myocardial damage, but prolonged delay increases irreversible myocardial dysfunction and cell death ^[3].

During therapy, the main objective must be the prompt restoration of blood flow to the coronary artery that causes STEMI, with or without postconditioning ^[4].

Primary percutaneous coronary intervention (PCI) is essential for optimum therapy of STEMI. As it decreases infarct size and diminishes cardiac damage, it maintains cardiac function and reduces morbidity and death ^[5].

The electrocardiogram (ECHO) is the primary diagnostic tool for STEMI, ECHO indicates regional wall motion abnormalities (RWMA) and contributes to the assessment of the patient's real condition ^[6].

However, little is known about the relationship between the duration between the beginning of pain and revascularization (pain-to-treatment) and the severity of the WMA, i.e., the eventual degree of necrosis ^[7, 8].

Our purpose in this research was to determine whether or not the length of ischemia affected the degree to which WMA improved after revascularization and subsequent follow-up 40 days later.

Patients and Methods

60 patients hospitalised with STEMI for the first time within 24 hours in the cardiovascular medicine department of Tanta university hospitals and treated with 1ry PCI were recruited in

our research from August 2020 to August 2021 done in equipped center at covid-19 era. The study was started after being approved by Research Ethical Committee, Faculty of Medicine, Tanta University. Signed consent was received from all enrolled cases or their relatives.

The patients were categorized into two groups; group I: 37 patients presented early before 12h representing 61.7% and group II: 23 patients presented late after 12h representing 38.3%. Exclusion criteria were patients with prior myocardial infarction, previous coronary revascularization, prior cardiomyopathy, RWMA, bundle branch block (BBB), pre-excitation or pacemakers.

All patients were subjected to full history taken, clinical evaluation include monitoring of vital signs (blood pressure, heart rate and respiration rate), thorough assessment of the patient's physical condition (weight, height, , BMI, patient appearance, cyanosis, decubitus, jaundice, and symptoms of heart failure), resting 12 leads electrocardiogram (ECG), Baseline laboratory tests (serum urea and creatinine, cardiac enzymes including serum troponin and CK-MB and hemoglobin level), reperfusion (primary PCI for Infarct related artery (IRA)) and echocardiography.

Coronary angiography and percutaneous coronary intervention: IRA was identified and Based on the infarct site on the admission ECG and the angiographic findings (target vessel, lesion characteristics), an interventional cardiologist diagnosed the culprit lesion. Multi-vessel disease is defined by the presence of 1 or more lesions with higher than 50% stenosis in 1 \geq main epicardial coronary artery or its major branches far from the IRA.

PCI with or without stenting was immediately performed with a 6-Fr guiding catheter. Thrombus aspiration, balloon pre-dilatation and post-dilatation was performed when indicated. Operators had the choice in selecting stents (drug-eluting stents).

The thrombolysis in myocardial infarction (TIMI) blood flow grade is used to evaluate the efficacy of reperfusion therapy. According to the TIMI blood flow grade, reperfusion was either effective (TIMI 3) or aberrant (TIMI 0-1-2).

Statistical analysis

SPSS V.20 (IBM Inc., Chicago, IL, USA) was used for the statistical analysis. The mean and standard deviation (SD) were used to evaluate quantitative data, and the paired Student's t-test was used for comparing them in the same group. Qualitative analysis included numbers and percentage % and the Chi-square test was used to compare qualitative variables. Significance was considered at two-tailed P value ≤ 0.05 .

Results:

The symptoms duration of the study population was 12 hours or less in group I and more than 12 hours in group II. There was no significant statistical variation between both groups regarding sex. Regarding age, group II were elder than group I. **Table 1**

Table 1: Comparing the studied groups according to symptoms duration and demographic data (n=60).

		Total (n=60)	Group I (n=37)	Group II (n=23)	P value
Time of wire crossing(hours)		9.50(5.50 – 18.0)	≤ 12	>12	-
Sex	Male	39 (65%)	21 (56.8%)	18 (78.3%)	0.09
	Female	21 (35%)	16 (43.2 %)	5 (21.7%)	
Age		59.18 \pm 9.43	57.11 \pm 9.71	62.52 \pm 8.07	0.023*

Data were presented as mean \pm SD or frequency (%)

Regarding the risk factors and clinical data there was no remarkable difference between both groups. ECG STEMI location and stent deployment showed no significant variation between groups. (P value =0.836 and 0.566, respectively). **Table 2**

Table 2: Cases distribution according to patient data (n = 60).

	Total (n=60)	Group I (n = 37)	Group II (n = 23)	P Value
Smoker	36 (60%)	22 (59.5%)	14 (60.9%)	0.914

HTN	39 (65%)	21 (56.8%)	18 (78.3%)	0.090
DM	36 (60%)	21 (56.8%)	15 (65.2%)	0.515
Dyslipidemia	29 (48.3%)	21 (56.8%)	8 (34.8%)	0.098
Family history of IHD	16 (26.7%)	13 (35.1%)	3 (13.0%)	0.060
ECG				
Anterior STEMI	12 (20%)	9 (24.3%)	3 (13.0%)	0.836
Anteroseptal STEMI	4 (6.7%)	3 (8.1%)	1 (4.3%)	
Extensive anterior Semi	15 (25%)	9 (24.3%)	6 (26.1%)	
Inferior STEMI and posterior STEMI	5 (8.3%)	3 (8.1%)	2 (8.7%)	
Inferior and right STEMI	5 (8.3%)	2 (5.4%)	3 (13.0%)	
Inferior STEMI	10 (16.7%)	5 (13.5%)	5 (21.7%)	
Lateral STEMI	9 (15%)	6 (16.2%)	3 (13.0%)	
Systolic BP	119.8 ± 20.77	121.8 ± 21.61	116.3 ± 19.32	0.327
Diastolic BP	79.42 ± 10.86	80.41 ± 11.02	77.83 ± 10.64	0.375
Heart Rate (bpm)	87.25 ± 13.94	86.76 ± 12.65	88.04 ± 16.08	0.731
Stent deployment				
LAD	30 (50%)	20 (54.1%)	10 (43.5%)	0.566
LCX	13 (21.7%)	9 (24.3%)	4 (17.4%)	
RCA	13 (21.7%)	6 (16.2%)	7 (30.4%)	
OMI	4 (6.7%)	2 (5.4%)	2 (8.7%)	

Data were presented as mean ± SD or frequency (%). HTN: hypertension, DM: diabetes mellitus, ECG: electrocardiogram, IHD: ischemic heart disease. STEMI: ST-Segment elevation myocardial infarction: blood pressure, LAD: left anterior descending artery; LCx: left circumflex artery, RCA: right coronary artery, OMI: Old myocardial infarction.

Complication of MI including heart failure, heart block and valvular lesion showed no significant statistical variation between groups (P value 0.066, 1.000 and 0.153, respectively).

Table 3: Cases distribution according to complication of MI (n = 60).

	Total (n=60)	Group I (n = 37)	Group II (n = 23)	P Value
Complication of MI				
Heart failure	5 (8.3%)	1 (2.7%)	4 (17.4%)	0.066
Heart block	3 (5%)	2 (5.4%)	1 (4.3%)	1.000
Valvular Lesion	4 (6.7%)	1 (2.7%)	3 (13%)	0.153

Data were presented as frequency (%), MI: Myocardial infarction.

EF on discharge and wall motion score index (WMSI) showed insignificant variation between both groups (P value =0.657 and 0.712, respectively). EF and WMSI after 40 days showed considerable difference between groups (P value =0.002 and 0.001, respectively). Valvular lesion (mitral incompetence) showed insignificant difference between the two groups. (P value =0.153). **Table 4**

Table 4: Comparison between two groups on discharge and after 40 days according to ECHO (n= 60)

	Total (n=60)	Group I (n = 37)	Group II (n = 23)	P value
Valvular lesion	4(6.7%)	1(2.7%)	3(13.0%)	0.153
WMSI on discharge	1.32 ± 0.12	1.32 ± 0.12	1.33 ± 0.12	0.712
WMSI after 40 days	1.27 ± 0.11	1.24 ± 0.09	1.33 ± 0.12	0.001*
p₁		<0.001*	<0.001*	
EF on discharge	44.12 ± 7.49	44.46 ± 7.39	43.57 ± 7.79	0.657
EF after 40 days	47.22 ± 7.32	49.49 ± 6.07	43.57 ± 7.79	0.002*
p₁		<0.001*	<0.001*	

Data were presented as mean ± SD or frequency (%). P: p value for comparing between the studied groups. P1: p value for t: Paired t-test for comparing between before and after. WMSI: wall motion score index. EF: Ejection fraction.

Correlation between time to wire crossing and ECHO showed significant positive correlation with WMSI after 40 days in total (p<0.001) and group I (p=0.016) with significant negative correlation with EF after 40 days in total (P < 0.001) and group I (p=0.018). **Table 5**

Table 5: Correlation between Time to wire crossing and ECHO (n= 60)

	Time to wire crossing					
	Total		Group I		Group II	
	r _s	P	r _s	P	r _s	P
WMSI						
On discharge	0.165	0.206	0.268	0.109	0.400	0.059
After 40 days	0.513	<0.001*	0.395	0.016*	0.400	0.059
EF						
On discharge	-0.179	0.172	-0.218	0.194	-0.416	0.058
After 40 days	-0.512	<0.001*	-0.387	0.018*	-0.416	0.058

rs: Spearman coefficient. *: Statistically significant at p ≤ 0.05

Discussion

Ischemia and necrosis in the area supplied by the blocked artery characterise acute STEMI [2]. During therapy, the main objective must be the prompt restoration of blood flow to the coronary artery generating the STEMI, with or without preconditioning [4] [5].

Males represent 65%, while females represent 35% of the patients presented by STEMI. The age range of the study participants was 35 to 80 years.

In Vaidya et al.^[9] study, the ratio of MI males to females in the study participants was 5:1. Also, this agrees with the AHA statistical annual updated reported by Mozaffarian et al.^[10] who revealed that STEMI is more frequent in males than in women. Also, this is consistent with the findings of Blondeau et al.^[11] who found that around 70% of STEMI patients were male. In another study done by Duan et al.^[12] men showed a greater frequency of ACS than women across various age groups and follow-up periods.

Similarly, a study performed on 7,450 ACS patients in Bahrain, by Garadah et al.^[13] showed that the mean age of STEMI patients was 61.3 ± 13.2 years (range 18-85); 417 were males (65.6%).

As women age, their risk of CAD approaches that of men. Prior to menopause, natural estradiol seems to protect certain women against cardiovascular disease and stroke. There are many pathways through which estrogens influence the atherosclerosis process. Researchers have shown that estrogens reduce levels of total cholesterol, LDL, lipoprotein (a), and homocysteine. Estrogens boost HDL levels and enhance lipid metabolism after meals. Inhibition of smooth-muscle cell growth is one mechanism by which estrogens exert their athero-protective impact. Acute vasodilator action on the arterial wall is another mechanism^[14].

In this study 36 patients were diabetic 60% in all study population this is similar to study done by Tillin et al.^[15] more than 40% of patients with acute coronary syndrome (ACS) have DM. Additionally in study done by Arnold et al.^[16] showed that mortality in patients with ACS is 2-3 fold elevated in diabetic patients compared with non-diabetic ones.

Diabetes is an important risk factor which was found in study done by Mohanan et al.^[17], reporting 35.5% having DM/ Interestingly.

In this study 39 were hypertensive representing 65% of all study population. This may be due to increased incidence of hypertension in Egyptian population even in young age.

While 36 which represent 60% were active smokers this is comparable to a study performed by Chow et al. ^[18] who reported that smoking has a powerful prothrombotic impact, and smoking cessation may be the most effective secondary preventive intervention.

It is noteworthy that Baker et al. ^[19] said that a successful smoking therapy required continuous care, a concept that emphasises the immense challenge of stopping smoking effectively and permanently. 49.3% of all study population were found to have history of dyslipidemia which is large portion of population. Higher incidence of dyslipidemia may be due to hereditary factors and mostly due to bad dietary habits.

This is similar to study done by Montalescot et al. ^[20] that also showed very high incidence of dyslipidemia among all ACS patients

12 patients of the study population presented with anterior STEMI representing 20%, 4 patients presented with anteroseptal STEMI representing 6.7, 15 patients presented with Extensive Anterior STEMI representing 25%, 5 patients presented by inferior and posterior STEMI representing 8.3%, 5 patients presented by inferior and right STEMI representing 8.3, 10 patient presented by inferior STEMI represented 16.7% and 9 patients suffered from lateral STEMI represent 15%.

In the study conducted by Newman, Jonathan D et al. ^[21] which showed 37.2% of STEMI's were inferior; 32.8% anterior; 16.8% developed in various sites of infarction; and 13.2% were lateral.

5 patients of the study presented by heart failure and 3 patients presented by heart block.

In the study conducted by Kelly, Damian J et al. ^[22] 8.0% of the HORIZONS-AMI cohort of 3602 patients enrolled between 2005 and 2007 and treated with 1ry PCI were Killip class II-

IV upon presentation. After 30 days, 4.6% of patients had clinical HF syndrome (as defined by NYHA/Killip class), rising to 5.1% at 2 years.

The symptoms duration of the study population ranged from 1 hour to 48 hours with Median (IQR) 9.50(5.50 – 18.0). (Group I) 37 patients representing 61.7% ranged from 1 hour to 12 hours (group II) 23 patients representing 38.3 % ranged from 12 hours to 48 hours.

In the study conducted by Nozari, Younes et al. ^[23] exhibited symptom-to-balloon duration. The median (interquartile range) time from self-reported beginning of symptoms to time of reperfusion (i.e. wire crossing) was <180 minutes.

Regarding Echocardiography on discharge and follow up after 40 days : During the follow-up period, the WMSI values of patients with total ischemia durations of 12 hours or less were substantially lower than those of patients with total ischemic times of more than 12 hours this came in line with study conducted by Jeong Hun Seo et al ^[24]. This study done on 300 patient WMSI decrease significantly on 109 patient who came early while other group who came late no significant improvement

Also, study conducted by Rácz et al. ^[7] show Wall motion improvement was significantly reliant on how rapidly circulation could be restored to the blocked artery.

The LVEF from hospital admission to follow-up showed a significant statistical improvement ($p=0.001$) in patients who arrived within 12 hours or less of the onset of chest pain, whereas patients who arrived more than 12 hours after the onset of chest pain did not demonstrate improvement.

At admission, there was no major variation between the two subgroups in LVEF; nevertheless, the difference became considerable at the follow-up this came is comparable to study conducted by Rácz et al. ^[7] this study done on 55 patients 33 patients came early and 22 came the study show no significant difference between two groups at admission while at

follow up there was significant improvement in group came early as regarding EF and SWMA.

The present research seemed to have some limitations, including two-dimensional echocardiography usage, which does not provide very accurate data about ventricular volumes or infarct size; it is preferable to assess LV function using cardiac magnetic resonance imaging, which is currently considered the gold standard; and it was a single-center study with a relatively small sample size. In addition, the short follow-up period and the difficulty in locating patients, as well as the lack of understanding about late-stage IRA patency. Coronary angiography was not performed during the 3-month follow-up; thus, it is not possible to rule out the potential that repeated ischemia had a role in initiating the remodelling process. In addition, we did not investigate myocardial perfusion after 1ry PCI, which play a crucial role in LV remodelling development.

Conclusions

In the current reperfusion of STEMI, individuals with total ischemic periods of 12 hours or fewer had a greater degree of recovery from RWMA than those with total ischemia times exceeding 12 hours on follow up after 40 days. Every possible effort should be made to reduce total ischemic times.

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