

Prognostic Value of Area Flow Index in Patients with Acute ST Elevation Myocardial Infarction: Clinical and Echocardiographic Outcomes

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Abstract

Background: Early restoration of patency of infarct related artery is a universally accepted goal in the treatment of acute myocardial infarction. These could be achieved by Primary PCI or fibrinolysis. Primary PCI is preferred reperfusion strategy over fibrinolysis. Identifying initial area at risk in patients with acute myocardial infarction had been shown to have a direct impact on patients adverse clinical outcomes as well as prediction of systolic dysfunction. Area flow index (AFI) calculation in patients with acute myocardial infarction may predict initial area at risk during primary PCI.

Aim: To investigate the clinical utility of Area flow index to predict systolic dysfunction and adverse clinical outcomes in patients with acute anterior ST elevation myocardial infarction

Patients: 250 consecutive patients with acute anterior ST elevation myocardial infarction treated with primary PCI presenting to Alexandria main university hospital and ICC hospital from June 2013 till December 2014.

Methods: Echocardiographic assessment of LV systolic function 5-7 days after myocardial infarction by calculation of ejection fraction using modified simpson method.

Area flow index was calculated by dividing culprit segment cross sectional area to total coronary cross sectional area.

$$AFI = \frac{DC^2}{D1^2 + D2^2 + D3^2}$$

Where DC is the culprit segment diameter, D1 left anterior descending diameter, D2 left circumflex diameter, D3 right coronary diameter.

All patients were followed one month for the occurrence of MACE.

Results: Patients were grouped according to their ejection fraction following myocardial infarction into 3 groups:

-Group I: severe LV systolic dysfunction EF <30%.

-Group II: moderate LV systolic dysfunction EF 30-45%.

-Group III: mild LV systolic dysfunction EF >45%

There was a significant negative correlation between AFI and LVEF ($r = -0.58$, $P < 0.001$). The mean AFI for patients in group I was 33.1 ± 7.4 , patients in group II was 26.6 ± 7.4 , and those in group III was 20.0 ± 6.1 . AFI >28.4% had a 75.6% sensitivity and 78.1% specificity in predicting severe LV systolic dysfunction. Also the composite one month MACE was higher in the group with AFI >28.4% ($p < 0.001$).

Conclusion: Area flow index calculated from coronary angiography at time of primary PCI is a new strong independent predictor of LV systolic dysfunction and 1month MACE in patients with acute anterior myocardial infarction.

Keywords: Myocardial infarction; Patients; Systolic dysfunction; Heart failure

Introduction

ST-elevation myocardial infarction (STEMI) remains one of the leading causes of death globally [1]. Thrombolysis was a major step forward in the treatment of STEMI [2] and further progress was done when primary percutaneous coronary intervention (PCI) was established as a golden therapeutic standard [3].

Primary PCI is defined as percutaneous coronary intervention in the setting of STEMI, without previous fibrinolysis. It has replaced fibrinolysis as the preferred reperfusion strategy in patients with STEMI, provided it can be performed in a timely manner in high volume PCI centers with experienced operators and 24-hour, 7-day catheterization laboratory activation [4].

Compared with fibrinolytic therapy, primary PCI produces higher rates of infarct artery patency, TIMI 3 flow, and access site bleeding and lower rates of recurrent ischemia, reinfarction, emergency repeat revascularization procedures, intracranial hemorrhage, and death. Early, successful PCI also greatly decreases the complications of STEMI that result from longer ischemic times or unsuccessful fibrinolytic therapy, allowing earlier hospital discharge and resumption of daily activities. Primary PCI has its greatest survival benefit in high-risk patients. PCI outcomes have been shown to be worse with delays to treatment and with low-volume hospitals and operators [5].

Primary percutaneous coronary intervention (PCI) has become the predominant reperfusion strategy for ST-segment elevation myocardial infarction (STEMI) throughout western healthcare systems. Recent estimates in the United States suggest that primary PCI is used in 85% of all STEMI cases that undergo reperfusion, with thrombolytic agents used in only 9% and the combination of thrombolytic agents with PCI in 6% [6]. In Europe, fibrinolysis for STEMI is becoming a rare therapy; for example 6% of cases in the UK, 7% in Poland, and 8% in France. It is interesting to note that, even in countries with a large catchment area, such as Denmark with one primary PCI center per 1.4 million inhabitants and correspondingly long transportation distances, the STEMI case fatality rate is among the lowest recorded in Europe, with an in-hospital mortality of only 3% [7].

The 30-day mortality rate of patients with STEMI is between 2.5 and 10% [8]. Among patients with STEMI enrolled in trials, approximate in-hospital or 30-day mortality rates were 13% with medical therapy alone, 6-7% with optimal fibrinolytic therapy, and as low as 3 to 5% with primary percutaneous coronary intervention (PCI) when performed within two hours of chest pain onset [9-12].

Some of the independent predictors of early death from STEMI include age, Killip class, time to reperfusion, cardiac arrest, tachycardia, hypotension, anterior infarct location, prior infarction, diabetes mellitus, smoking status, renal function, number of diseased vessels and biomarker findings. Whereas the Thrombolysis in Myocardial Infarction (TIMI) risk score was developed specifically in patients with STEMI, the GRACE model predicts in-hospital and 6-month mortality rate across the spectrum of patients presenting with ACS, including those with ST elevation or ST depression. Risk assessment is a continuous process that should be repeated throughout hospitalization and at time of discharge [13].

Identifying initial area at risk in patients with acute myocardial infarction had been shown to have a direct impact on patients adverse

clinical outcomes as well as prediction of systolic dysfunction. Area flow index (AFI) calculation in patients with acute myocardial infarction may predict initial area at risk during primary PCI [14].

Aim: In this study we investigated the clinical utility of Area flow index as a predictor of systolic dysfunction and adverse clinical outcomes in patients with acute anterior ST elevation myocardial infarction

Patients and Methods

250 consecutive patients with acute anterior ST elevation myocardial infarction treated with primary PCI presenting to Alexandria main university hospital and ICC hospital from June 2013 till December 2014.

Echocardiographic assessment of LV systolic function 5-7 days after myocardial infarction by calculation of ejection fraction using modified Simpson method.

Area flow index was calculated by dividing culprit segment cross sectional area to total coronary cross sectional area.

$$AFI = \frac{DC^2}{D1^2 + D2^2 + D3^2}$$

Where DC is the culprit segment diameter, D1 left anterior descending diameter, D2 left circumflex diameter, D3 right coronary diameter (Figure 1).

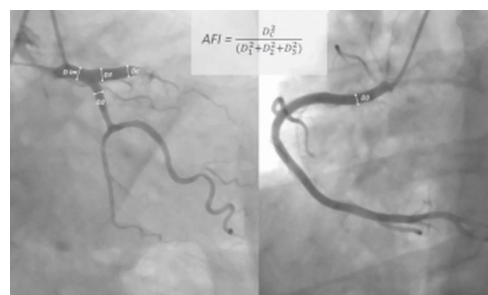


Figure 1: AFI index calculation.

All patients were followed one month for the occurrence of MACE.

Patients were grouped according to their ejection fraction following myocardial infarction into 3 groups:

- Group I: Severe LV systolic dysfunction EF<30%.
- Group II: Moderate LV systolic dysfunction EF 30-45%.
- Group III: Mild LV systolic dysfunction EF>45%.

Results

There were no significant differences between three groups regarding the demographic data, risk factors or medications used (Tables 1 and 2).

The mean age in group I was 66 ± 14, in group II 61 ± 14, and in group III 60 ± 15.

The incidence of Hypertension in group I was 46.2%, in group II 44.7%, and in group III 37.9%.

Regarding the incidence of diabetes, in group I 18.6%, group II 16.5% and in group III 15.9%.

	"Group 1" Severe LV dysfunction (EF <30%) "n=52"	"Group 2" Moderate LV dysfunction (EF =30-44%) "n=132"	"Group 3" Mild LV "EF > 45%" "n=66"	p
Age (years)	66.0 ± 14.0	61.0 ± 14.0	60.0 ± 15.0	0.103 NS
Sex, F/M	15/37	26/106	18/48	0.236 NS
Hypertension, n (%)	24 (46.2)	59 (44.7)	25 (37.9)	0.352 NS
Dyslipidemia, n (%)	15 (28.8)	49 (37.1)	20 (30.3)	0.411 NS
Diabetes mellitus, n (%)	6 (18.6)	15 (16.5)	7 (15.9)	NS

Table 1: Relation between three groups and demographic data and risk factors.

Drug use	"Group 1" Severe LV dysfunction (EF <30%) "n=52"	"Group 2" Moderate LV dysfunction (EF =30-44%) "n=132"	"Group 3" Mild LV "EF > 45%" "n=66"	p
β-blocker, %	78.5	96.7	95.4	0.32
ACE inhibitor, %	90.6	95.6	93.2	0.425
Statin, %	96.9	100	97.7	0.365
Glycoprotein IIb/IIIa Inhibitors, %	9.4	8.8	11.4	0.25

Table 2: Relation between three groups and drugs used.

Also regarding the door to balloon time and the final TIMI flow, there no significant difference between the three groups, the mean door to balloon were 48 ± 10 min in group I, 51 ± 9 min in group II, and 47 ± 11 min in group III (Table 3).

There was a significant negative correlation between AFI and LVEF (r=-0.58, P<0.001). The mean AFI for patients in group I was 33.1 ± 7.4, patients in group II was 26.6 ± 7.4, and those in group III was 20.0 ± 6.1. AFI>28.4% had a 75.6% sensitivity and 78.1% specificity in predicting severe LV systolic dysfunction. Also the composite one month MACE was higher in the group with AFI>28.4% (p<0.001) (Table 4).

There were statistically significant correlations between LV EF and MACE after one month

The incidence of MACE were 43.5% in group I, 15.4% in group II and 2.3% in group III (P=0.013). Also the incidence of new congestive heart failure were significantly higher in patients of group I 21.9%, then in group II 4.4%, then in group III 0% (P=0.002) (Table 5).

	"Group 1" Severe LV dysfunction (EF <30%) "n=52"	"Group 2" Moderate LV dysfunction (EF =30-44%) "n=132"	"Group 3" Mild LV "EF > 45%" "n=66"	p
Final TIMI flow 2-3, %	90.6	93.4	93.2	0.236
Door-to-balloon time, min	48 ± 10	51 ± 9	47 ± 11	0.254
Symptom-to-balloon time, hr	4 (3-6)	3.5 (3-6)	3 (2-4)	0.32

Table 3: Relation between three groups and primary PCI data.

	"Group 1" Severe LV dysfunction (EF <30%) "n=52"	"Group 2" Moderate LV dysfunction (EF =30-44%) "n=132"	"Group 3" Mild LV "EF > 45%" "n=66"	p
AFI (%)	33.1 ± 7.4	26.6 ± 7.4	20.0 ± 6.1	0.021*

Table 4: Relation between LVEF and AFI.

MACE	"Group 1" Severe LV dysfunction (EF <30%) "n=52"	"Group 2" Moderate LV dysfunction (EF =30-44%) "n=132"	"Group 3" Mild LV "EF > 45%" "n=66"	p
Death, n (%)	4 (12.5)	7 (7.7)	1 (2.3)	0.365
Stroke, n (%)	0 (0)	1 (1.1)	0 (0)	-
Non fatal MI, n (%)	3 (9.3)	2 (2.2)	0 (0)	0.175
New CHF, n (%)	7 (21.9)	4 (4.4)	0 (0)	0.002*
Composite MACE, n (%)	14 (43.5)	14 (15.4)	1 (2.3)	0.013*

Table 5: Relation between LVEF and one month MACE.

Discussion

Worldwide, coronary artery disease (CAD) is the single most frequent cause of death. In-hospital (approximately 5% to 6%) and 1 year (approximately 7% to 18%) mortality rates from STEMI also have decreased significantly in association with greater use of reperfusion therapy, Primary Percutaneous Coronary Intervention (Primary PCI), modern antithrombotic therapy and secondary prevention treatments [14].

The mortality of STEMI is influenced by many factors, among them: age, Killip class, time delay to treatment, mode of treatment, history of

prior myocardial infarction, diabetes mellitus, renal failure, number of diseased coronary arteries, ejection fraction, and treatment.

Approximately 30% of patients with STEMI are women. Female sex was a strong independent predictor of failure to receive reperfusion therapy among patients who had no contraindications. Compared with men, women presented later after symptom onset, had longer door-to-fibrinolysis and door-to-balloon (or device) (D2B) times and less often received aspirin or beta blockers within 24 hours of presentation. Approximately 23% of patients with STEMI in the United States have diabetes mellitus, and three quarters of all deaths among patients with diabetes mellitus are related to coronary artery disease. Diabetes mellitus is associated with higher short- and long-term mortality after STEMI.

In our study we aimed to correlate the clinical utility of a simple index calculated at time of coronary angiography during primary PCI (Area flow index) with left ventricular systolic dysfunction and MACE

The results of our study were similar to the study conducted by Agac et al. [14]. In our study we had a significant negative correlation between AFI and LVEF ($r=-0.58$, $P<0.001$). Also in the study of Agac et al. [14] they had a significant negative correlation between AFI and LVEF ($p<0.001$)

In our study we had statistically significant correlations between LV EF and MACE after one month ($p=0.013$) which was similar to the results of Agac et al. [14].

Conclusion

Area flow index calculated from coronary angiography at time of primary PCI is a new strong independent predictor of LV systolic dysfunction and 1month MACE in patients with acute anterior myocardial infarction.

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