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Research Article

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Extent and Severity of Coronary Artery Disease as Predictors of Myocardial Reperfusion in Acute Coronary Syndrome

Asem Abdallah Hemeda*, Naglaa Fahim Ahmed and Abdallah Mustafa Kamal

Abstract

Background: Worldwide, Coronary Artery Disease (CAD) is the single most frequent cause of death. Over seven million people every year die from CAD, accounting for 12.8% of all deaths. Every sixth man and every seventh woman in Europe die from Myocardial Infarction (MI).

Objectives: To assess the extent and severity of coronary artery disease as predictors of myocardial reperfusion in acute coronary syndrome.

Patients and Methods: A prospective cohort study included patients admitted with Acute coronary syndrome after approval from the Research and Ethics Committee of Faculty of Medicine, Menofeya University from January 2015 to January 2020. They divided into two groups: Group (I): included patients with ST Elevation Myocardial Infarction (STEMI) in whom primary Percutaneous Coronary Intervention (PCI) done or pharmacoinvasive therapy either total or subtotal revascularization. Group (II): included patients with Non-ST Segment Elevation Myocardial Infarction (NSTEMI and UA) in whom PCI done either total or subtotal revascularization.

Results: The cutoff value of Troponin, CK and CKMB in prediction of myocardial reperfusion in acute coronary syndrome. Our ROC results revealed that Troponin, CK and CKMB cutoff value is greater than 20, 440, and 50 and the area under the ROC curve is equal to 0.796, 0.732 and 0.690 which indicating that they are fair predictors for myocardial reperfusion in acute coronary syndrome. The sensitivity values of Troponin, CK, and CKMB were 78.2, 77.3 and 70 respectively and the specificity values of Troponin, CK and CKMB were 66.4, 65.7 and 64.3 respectively.

Conclusion: Our study indicated that there is a significant Association between both syntax score and extent of CAD and Myocardial perfusion.

Keywords

Coronary artery disease; Acute coronary syndrome; Myocardial reperfusion.

Introduction

Worldwide, CAD is the single most frequent cause of death. Over seven million people every year die from CAD, accounting for 12.8% of all deaths. Every sixth man and every seventh woman in Europe die from MI. The in – hospital mortality STEMI patients in the national registries of the European Society of Cardiology (ESC) countries varies between 6% and 14% [1].

Acute Coronary Syndrome (ACS) has evolved as a useful operational term that refers to a spectrum of conditions compatible with acute myocardial ischemia and/or infarction that are usually due to an abrupt reduction in coronary blood flow [2].

The term acute coronary syndrome is used to collectively describe acute myocardial infarction (heart attack) and unstable angina. Acute myocardial infarction or heart attack occurs when a plaque within one of the coronary arteries ruptures and forms a clot that completely blocks blood flow to the heart muscle (myocardium) [3].

A key branch point is ST-segment elevation (ST-elevation) or new left bundle-branch block on the Electrocardiogram (ECG), which is an indication for immediate coronary angiography to determine if there is an indication for reperfusion therapy to open a likely completely occluded coronary artery.

ST depression, transient ST elevation, and/or prominent T-wave inversions may be present but are not required for a diagnosis of NSTEMI. Abnormalities on the ECG and elevated troponins in isolation are insufficient to make the diagnosis of ACS but must be interpreted in the appropriate clinical context. Thus, UA and NSTEMI are closely related conditions whose pathogenesis and clinical presentations are similar but vary in severity. The conditions differ primarily by whether the ischemia is severe enough to cause myocardial damage leading to detectable quantities of myocardial injury biomarkers [4].

Delays in the timely implementation of reperfusion therapy are key issues in the management of STEMI, since the greatest benefit gained from reperfusion therapy occurs within the first 2–3 hours of symptom onset [5].

There is growing evidence to suggest benefit from an invasive strategy within 24 hours in patients with a high-risk profile. The Timing of Intervention in Patients with Acute Coronary Syndromes (TIMACS) trial revealed a significant 38% lower incidence of death, myocardial infarction, or stroke at 6 months in high-risk patients (Global Registry of Acute Coronary Events (GRACE) score.140), with an early (≤ 24 hours), as compared with a delayed (≥ 36 hours) strategy [6]

Myocardial perfusion imaging uses an intravenously administered radiopharmaceutical to depict the distribution of blood flow in the myocardium. Perfusion imaging identifies areas of relatively reduced myocardial blood flow associated with ischemia or scar. The relative regional distribution of perfusion can be assessed at rest, during cardiovascular stress, or both [7].

We aimed in this study to assess the extent and severity of coronary artery disease as predictors of myocardial reperfusion in acute coronary syndrome.

***Corresponding author:** Dr. Asem Abdallah Hemeda, Department of Cardiology, Faculty of Medicine, Menofeya university, Egypt, Mobile: 96902294, E-mail: abdallahasem@yahoo.com.

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Patients and Methods

A prospective cohort study included patients admitted with Acute coronary syndrome after approval from the Research and Ethics Committee of Faculty of Medicine, Menofeya University from January 2015 to January 2020. They divided into two groups:

Group (I): included patients with STEMI in whom primary PCI done or pharmacoinvasive therapy either total or subtotal revascularization.

Group (II): included patients with (NSTEMI and UA) in whom PCI done either total or subtotal revascularization.

Inclusion criteria

1. 18 years old and older.
2. First time to diagnose as ischemic heart disease ACS (STEMI, NSTEMI).
3. STEMI during 12 hours maximum from onset of symptoms

Exclusion criteria

1. Patient known to be ischemic heart disease, valvular, congenital or cardiomyopathy before.
2. Mechanical cardiac complication requiring surgical intervention.
3. Patient who cannot do stress myoview (asthmatic with ECG abnormality incompatible with stress myoview as Left bundle branch block and paced rhythm)
4. Patients who develop another attack of ACS during first six months after PCI.
5. Patient with other comorbidities as renal failure, respiratory failure, cancer or liver failure.

Criteria of MI according to the third universal definition of MI:

The detection of a rise and/or fall of cardiac biomarkers, with at least one of the values being elevated (>99th percentile upper reference limit, or URL). The highly sensitive and specific Cardiac Troponin (cTn) is the preferred biomarker of myocardial necrosis. In addition, one of the five following predefined criteria should be satisfied before a diagnosis of MI is made: (1) symptoms of myocardial ischemia; (2) new (or presumably new) significant ST-segment/T-wave changes or left bundle branch block; (3) development of pathological Q waves on ECG; (4) new loss of viable myocardium or regional wall motion abnormality by imaging; (5) identification of intracoronary thrombus by angiography or autopsy [8].

Methods

All patients had been subjected to the following: full history taking, examination and investigation in the form of 12 lead surface ECG, CK, CK-MB fraction and Troponin–I and transthoracic echocardiography.

Patients had been classified to:

- Routine post fibrinolysis PCI group (consisting of immediate fibrinolysis followed by PCI in 3- 24 hours).
- Primary PCI group. Consisting of primary PCI within one hour of admission of infarct related artery via femoral or radial approach according to operator decision.
- PCI to NSTEMI patient during hospital stay either early within two hours or late before discharge according to grace score and guidelines.

All patients received the following treatment:

- Aspirin.
- Clopidogrel 600 mg loading dose in primary PCI and 300 mg in fibrinolysis group.
- Unfractionated heparin.
- B blocker.
- Statins.
- GP IIb/IIIa inhibitors: used according to the judgment of the treating physician.

Coronary angiography: had been done via femoral or radial approach with culprit vessel intervention or total revascularization according to operator decision and divided the patients according to angiography to two groups who we had compared between them and they had been the main groups which we do our statistics on them.

According to severity of CAD lesion: non subtotal (70-90%) and total and subtotal lesion (>90%).

According to extent of CAD: one vessel disease and multivessel disease.

Then we compared effect of severity and extent of CAD on myocardial reperfusion after 6 months of PCI.

Follow up of study end points:

Stress myoview after 6-12 month to evaluate the myocardial perfusion in condition that patient not complain of any cardiac symptoms.

Transthoracic usual ECHO to follow SWMA and EF

Statistical Analysis

The collected data were presented, summarized, tabulated and analyzed by using computerized software statistical packages by "Statistical Package for Social Science" (SPSS version 20). Qualitative data were represented as frequencies and relative percentages. Chi square test ($\chi 2$) and Fisher exact was used to calculate difference between qualitative variables as indicated. Quantitative data were expressed as mean ± SD (Standard deviation) for parametric and median and range for non-parametric data. Independent T test and Mann Whitney test were used to calculate difference between quantitative variables in two groups for parametric and non-parametric variables respectively. Pearson's and Spearman's correlation tests were used for correlating normal and non-parametric variables respectively. All statistical comparisons were two tailed with significance "level of P-value" which is a fixed threshold of significance at 5% level.

- If the P value is of >0.05; indicating non-significant results.
- If the P value is of ≤ 0.0; indicates statistically significant results at 95% confidence interval

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Results

This study included 130 patients with STEMI and 120 patients with (NSTEMI and UA). Their age mean was 55.14 ± 12.7 and 57.38 ± 11.5 in STEMI and NSTEMI patients respectively with no statistically significant difference and as regards sex, males were more prevalent in both groups 94.6% in STEMI patients and 68.3% in NSTEMI patients.

As regard to syntax score there was statistically significantly higher than 21 in STEMI patients 71.5% than NSTEMI patients 43.3% and lower than 21 in STEMI patients 28.5% than NSTEMI patients 56.7% (Table 1).

As regard to total revascularization there was statistically significant higher in NSTEMI patients 88.3% than STEMI patients 53.8% (Table 2).

There was highly statistically significant Association between syntax score and Myocardial perfusion imaging after 3 months (P-value=0.000). Also, there was highly statistically significant Association between extent of CAD one vessel disease and multivessel disease and Myocardial perfusion imaging after 3 months (Table 3 and 4).

Receiver Operating Curve (ROC) was used to determine the cutoff value of Troponin, CK and CKMB in prediction of myocardial reperfusion in acute coronary syndrome. Our ROC results revealed that Troponin, CK and CKMB cutoff value is greater than 20, 440, and 50 and the area under the ROC curve is equal to 0.796, 0.732, and 0.690 which indicating that they are fair predictors for myocardial reperfusion in acute coronary syndrome. The sensitivity values of Troponin, CK, and CKMB were 78.2, 77.3 and 70 respectively and the specificity values of Troponin, CK, and CKMB were 66.4, 65.7, and 64.3 respectively (Figure 1).

There was statistically significant Association between both total revascularization and severity of Coronary artery lesion sub-total or total occlusion and Myocardial perfusion imaging after 3 months (Table 5 and 6).

Table 1: comparison between patients' groups as regards syntax score.

Group		syntax score		Total	X^2	P-value
		Syntax Score <21	Syntax Score >21			
STEMI patients	NN	37	93	130	20.378	0.000
	%	28.5%	71.5%	100.0%		
NSTEMI patients	N	68	52	120		
	%	56.7%	43.3%	100.0%		
Total	N	105	145	250		
	%	42.0%	58.0%	100.0%		

Table 2: comparison between patients' groups as regards Total revascularization.

Group		Total revascularization		Total	X^2	P-value
		No	Yes			
STEMI patients	N	60	70	130	35.62	0.000
	%	46.2%	53.8%	100.0%		
NSTEMI patients	N	14	106	120		
	%	11.7%	88.3%	100.0%		
Total	N	74	176	250		
	%	29.6%	70.4%	100.0%		

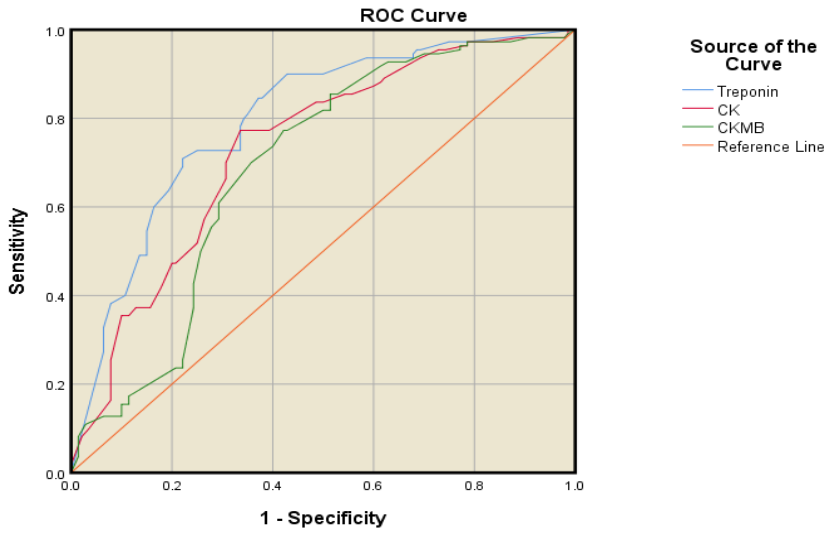

Figure 1: ROC curve of Troponin, CK, and CKMB as predictors of myocardial reperfusion in acute coronary syndrome.

Table 3: Association between syntax score and Myocardial perfusion imaging after 3 months.

syntax score	Myocardial perfusion imaging after 3 months		Total	X^2	P-value
	Normal and mild stress induced ischemia	Moderate and severe stress induced ischemia			
Syntax Score <21	N	82	23	105	35.869	0.000
	%	78.1%	21.9%	100.0%		
Syntax score >21	N	58	87	145		
	%	40.0%	60.0%	100.0%		
Total	N	140	110	250		
	%	56.0%	44.0%	100%		

Table 4: Association between extent of CAD one vessel disease and multivessel disease and Myocardial perfusion imaging after 3 months.

Extent of CAD	Myocardial perfusion imaging after 3 months		Total	X^2	P-value
	Normal and mild stress induced ischemia	Moderate and severe stress induced ischemia			
one vessel disease	N	82	27	109	29.003	0.000
	%	75.2%	24.8%	100.0%		
Multi vessel disease	N	58	83	141		
	%	41.1%	58.9%	100.0%		
Total	N	140	110	250		
	%	56.0%	44.0%	100%		

Table 5: Association between severity of Coronary artery lesion sub-total or total occlusion and Myocardial perfusion imaging after 3 months.

Coronary artery sub-total or total occlusion		Myocardial perfusion imaging after 3 months		Total	X^2	P-value
		Normal and mild stress induced ischemia	Moderate and severe stress induced ischemia			
NO	N	87	35	122	22.67	0.000
	%	71.3%	28.7%	100.0%		
YES	N	53	75	128		
	%	41.4%	58.6%	100.0%		
Total	N	140	110	250		
	%	56.0%	44.0%	100.0%		

Table 6: Association between Total revascularization and Myocardial perfusion imaging after 3 months.

Total revascularization		Myocardial perfusion imaging after 3 months		Total	X^2	P-value
		Normal and mild stress induced ischemia	Moderate and severe stress induced ischemia			
NO	N	11	63	74	72.185	0.000
	%	14.9%	85.1%	100.0%		
YES	N	129	47	176		
	%	73.3%	26.7%	100.0%		
Total	N	140	110	250		
	%	56.0%	44.0%	100%		

Discussion

ACS describes a spectrum of clinical conditions ranging from ST segment elevation MI to non-ST segment elevation MI and unstable angina (ACS without enzyme or marker release). ACS ranges from unstable angina without detectable myocyte necrosis to extensive MI. Unstable angina is characterized by the clinical syndrome, undetectable markers (troponin and CK-MB) but with ECG changes (typically ST depression or T wave inversion or transient ST elevation): the risk of death from hospitalization to six months is approximately 5–8%. Markers are elevated in acute MI in proportion to the extent of myocyte necrosis. For those hospitalized alive, the risk of death is 12–15% in the following six months (GRACE registry data). A spectrum of left ventricular dysfunction exists across ACS ranging from no measurable dysfunction to remodeling, dilatation of the ventricle, and severe systolic dysfunction [9].

We try to evaluate patient with acute coronary syndrome regarding extent and severity of coronary artery disease to identify patient with successful reperfusion.

Our study showed that there was statistically significant higher in NSTEMI patients 88.3% than STEMI patients 53.8% as regard to total revascularization.

Also, the study in our hand revealed that there was highly statistically significant Association between both syntax score, extent of CAD one vessel disease and multivessel disease and Myocardial perfusion imaging after 3 months.

In the current study, the Troponin, CK, and CKMB cutoff value greater than 20, 440, and 50 respectively, indicating that they are fair predictors for myocardial reperfusion in acute coronary syndrome.

Our study revealed that there was statistically significant Association between both total revascularization and severity of Coronary artery lesion sub-total or total occlusion and Myocardial perfusion imaging after 3 months.

A study done by Andrade et al. [10] included total of 647 patients who underwent MPS consecutively between 2008 and 2012 after PCI were selected. The MPS were classified as normal and abnormal, the perfusion scores, Summed Stress Score (SSS), and Summed Difference Score (SDS) were calculated and converted into percentage of total perfusion defect and ischemic defect. The follow-up was undertaken for 5.2 ± 1.6 years. 47% of MPS were normal, 30% were abnormal with ischemia, and 23% were abnormal without ischemia. There were 61 deaths, 27 being cardiovascular, 19 non-fatal AMI, and 139 revascularizations. The annual death rate was higher in those with abnormal perfusion without ischemia compared to the groups with ischemia and normal perfusion (3.3% × 2% × 1.2%, p=0.021). The annual revascularization rate was 10.3% in the ischemia group, 3.7% in those with normal MPS, and 3% in those with abnormal MPS without ischemia. The independent predictors of mortality and revascularization were, respectively, total perfusion defect greater than 6%, and ischemic defect greater than 3%. Forty-two percent of the patients underwent MPS less than 2 years after PCI, and no significant differences were observed in relation to those who underwent it after that period.

In 2017 Zellweger et al. [11] found abnormal MPS findings 5 years after PCI are frequent irrespective of symptoms. The predictive power of abnormal MPS lies more in the detection of persistent or progressing coronary artery disease in remote vessel areas than in diagnosis of late intervention –related problems in treated vessels.

In 2017 Angelidis et al. [12] reported that over the last decades, SPECT MPI has proven an invaluable tool for evaluating patients in cardiovascular medicine. In addition, PCI procedures are widely used in patients with CAD. By assessing myocardial perfusion, SPECT imaging aids in diagnosis of CAD and patient risk stratification, providing important information on extent of myocardium at risk and scar- myocardial viability, disease progression, hemodynamic significance of coronary artery stenosis (culprit lesions) and myocardial function using gated-SPECT technique. Evaluating the aforementioned data, nuclear imaging helps in decision about revascularization and is well suited to assess patients after intervention. The literature has demonstrated the usefulness of nuclear imaging after PCI, providing significant data in patients with recurrent symptoms after revascularization, and more importantly, providing prognostic information after the intervention, independently of symptoms. Chest pain and exercise ECG could be considered unhelpful in identifying patients at risk after revascularization but MPI is of proven value, although there is still debate on whether or not myocardial perfusion SPECT should be performed routinely and also about the certain time period. As PCI techniques expand and evolve, mainly with the increasing use of drug-eluting stents with low restenosis rate, the role of nuclear imaging will require further investigation.

Another study by Georgoulias et al. [13] including Tc-99m tetrofosmin Myocardial Perfusion Imaging (MPI) which performed 6 months post-percutaneous coronary intervention, has an independent and powerful clinical value to predict hard and soft cardiac events in asymptomatic patients after PCI.

Also, a study by Kim et al. [14] showed that reversible perfusion defects on M-SPECT were observed in 26% of the patients and in 36% of lesions following successful PTCA with stent implantation. The incidence of late restenosis was significantly higher in patients and lesions with reversible perfusion defects (47% *vs.* 18%). According to binary logistic regression analysis, the presence of a reversible perfusion defects was the only independent predictor of late restenosis.

In 2007 Solodky et al. [15] did study to evaluate the value of MPI in predicting Major Adverse Cardiovascular Events (MACE) in symptomatic and asymptomatic patients after PCI. They revised retrospectively patients after PCI that underwent MPI and were followed for a year for the presence of MACE. They found no differences in the incidence of MACE between symptomatic and asymptomatic patients. On multivariate analysis, the presence of ischemia by MPI was the most important independent predictor of MACE (OR 5.09, CI 95% 2.15–12.05, p<0.001). The presence of myocardial ischemia by MPI performed after PCI, and no symptom status, predicts a worse outcome during 1 year of follow-up.

In conclusion our study came to go through from another way. Our study was conducted to assess the extent and severity of coronary artery disease as predictors of myocardial reperfusion in acute coronary syndrome not as studies which correlate between MPI as noninvasive risk stratification and CAD severity (Antegrade) or studies which correlate between MPI after PCI and MACE or restenosis later.

Conclusion

Our study concluded that syntax score<21 may predict to normal or mild stress induced ischemia and syntax score>21 may predict to moderate or severe stress induced ischemia.

Also, one vessel disease may predict to normal or mild stress induced ischemia and multivessel disease may predict to moderate or severe stress induced ischemia.

Conflict of interest

The authors declare no conflict of interests.

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Data sharing

The data underlying this article will be shared on reasonable request to the corresponding author.

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Author Affiliations Top

Department of Cardiology, Faculty of Medicine, Menofeya university, Egypt