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ORIGINAL ARTICLE

Prediction of Successful Reperfusion in ST-Elevation Myocardial Infarction Patients Following Thrombolytic Treatment or Primary PCI Using Modified Selvester QRS Score

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ABSTRACT

Background: The purpose of this study was to see if the modified Selvester QRS score might predict ST-segment resolution in individuals who had their first acute STEMI following thrombolytic treatment or primary PCI.

Methods: The research included 122 people who had had an acute STEMI.
91 patients received thrombolysis, 31 received primary PCI, and all were subjected to 12-lead ECGs with estimation of the modified Selvester QRS score and the sum of ST-elevation (STE), as well as echocardiographic evaluation to measure LV ejection fraction (EF) and wall motion score index (WMSI), as well as coronary angiography.

Results: Patients with a QRS score more than 4 had significantly worse EF, longer time to admission, fewer patients without ST-segment resolution, higher WMSI, fewer patients with myocardial blush grade (MBG) 3, more patients with MBG 1, and more patients with three-vessel disease than patients with a QRS score less than 4.
QRS score 4 predicts ST-segment resolution ≥50% with a 59.3% sensitivity, 100% specificity, an 86% negative predictive value, a 62.1 percent positive predictive value, and a 75.6% total accuracy.
ST-segment resolution was negatively correlated with the QRS score (r = -0.483, p = 0.00078).

Conclusions: The Selvester QRS score method may give useful information on the myocardium at risk, the prognosis of residual left ventricular function, and the selection of therapy.

Keywords: ST-segment elevation myocardial infarction; Reperfusion; Modified Selvester score; primary PCI; Thrombolysis.

INTRODUCTION

As a general rule, reperfusion treatment is designed to restore complete antegrade flow in the infarct-related epicardial coronary artery and establish optimal cardiac perfusion at tissue level [1]. When ischemic myocardium is re-perfused early and maintained, it is saved, and TIMI-3 flow at 90 minutes after treatment is linked with enhanced survival [2].

Thrombolysis or primary percutaneous coronary intervention (PCI) might be used to reopen the coronary arteries. Patients with acute ST-elevation myocardial infarction (STEMI) who are treated with primary PCI rather than thrombolysis had a better prognosis, according to a number of studies. [3-6]. However, in developing countries like Egypt, facilities for performing primary PCI are not available in many centers, and transferring of patients to centers where primary PCI is available usually takes much time.

Some STEMI patients may get benefit from thrombolysis that is not inferior to primary PCI, such as those presenting in the first hour of symptoms onset [7]. So, it seems reasonable find a simple method to detect STEMI patients who will get benefit from thrombolysis.

Initially, the Selvester QRS scoring method was designed to determine the extent of a myocardial infarction electrocardiographically. A 32-point scoring system is based on 54 criteria [8].

In fact, the Selvester QRS score may be used to measure myocardial scar in the context of normal and defective ventricular conduction [9]. However,

the version that was modified by Wagner et al [10] was simple and valuable.

People who had a first acute ST segment elevation myocardial infarction and were given fibrinolytic therapy had a high sensitivity and a good specificity for the modified Selvester QRS score [11].

However, very little is known about how it predicts if a patient will get better after having a PCI for a heart attack.

The aim of our study was to see if the modified Selvester QRS scoring system, which is based on the ECG at the time of admission, can predict how well patients with a first acute STEMI will recover after thrombolytic therapy or primary PCI.

METHODS

The present comparative cross-sectional study was conducted at our Hospital's Cardiology department. The study was approved by the research ethical committee of Faculty of Medicine, Zagazig University. The study was done according to The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans. Informed written consent was obtained from all participants. The study group comprised 122 consecutive patients with acute STEMI were enrolled in the study, among them there were 112 males and 10 females; and their mean age was 55.4±7.4 years.

All the patients were in acute STEMI which was identified by the presence of more than two continuous leads with ST-segment elevation of more than 0.1 mV and more than 20 minutes of chest discomfort [12].

Patients with bundle branch block, paced rhythm, left fascicle block, ECG evidence of ventricular hypertrophy, those in cardiogenic shock, and those who had previously had a STEMI were not included in the study.

Informed written permission was obtained from all patients prior to the following: A comprehensive clinical examination and a complete history-taking. Admission ECG was done to all patients for diagnosis of acute MI. Analysis of QRS score was done for admission ECG. To determine the amount of myocardial necrosis, the modified Selvester QRS scoring method was utilised. [13]. In this scoring system, 37 criteria were searched for in 10 leads (I, II, aVL, aVF, V_{1-6}). The QRS scored was obtained by summating the score of each lead with maximum score of 29 (table 1). A higher means advanced myocardial necrosis and a QRS score > 4 on admission ECG was considered high [13].

Patients were, subsequently, classified into two groups:

Group I: Patients with QRS score ≤ 4 (75 patients, 68 males and 7 females, their mean age were 54.7±7.7 years).

Group II: Patients with QRS score > 4 (47 patients, 44 males and 3 females, their mean age were 56.6±7 years).

1) The sum of all measured ST segment elevations was expressed as STE1. Resting ECG was repeated for all patients 90 minutes following the initiation of fibrinolytic therapy, from which the sum of ST segment elevations was measured again, and expressed as STE2.

2) The difference between STE1 and STE2 was then measured and accepted as the sum of ST segment resolution, expressed as STSR. Patient was considered to have ST-segment resolution when STSR was ≥ 50 % of STE1.

3) *Cardiac enzymes* (CK, CKMB, and Troponin-T).

4) *Reperfusion therapy:* All patients received reperfusion therapy according to ESC guidelines. [14] Ninety one patients received thrombolysis and thirty one patients underwent primary PCI.

Thrombolytic therapy: Streptokinase (1.5 million units were given by intravenous infusion over 30-60 minutes) within 30 minutes of admission to 91 patients after exclusion of contraindications.

Primary PCI: Primary PCI was performed for 31 patients. A metal wire is moved beyond the thrombus over which a balloon catheter (with or without a stent) was positioned and inflated, mechanically restoring antegrade flow. The premedication given to all patients was Acetylsalicylic Acid (ASA) 325 mg tablet, Clopidogrel 600 mg orally and Enoxaparin 30 mg intravenously, and possible GP IIb/IIIa receptor inhibition. The intention was to perform primary angioplasty within 90 minutes from the diagnosis. It was determined that myocardial blush grades were based on the following criteria:

Myocardial blush or contrast density may range from 0 (no myocardial blush or contrast density) to 3 (normal myocardial blush or contrast density).

A staining of the myocardium (myocardial blush) occurred when the contrast media was leaking into the extravascular space and was scored 0.

Myocardial blush grades 0, 1, and 2 were used to identify patients with impaired myocardial reperfusion [15].

5) *Within one week of AMI for patients received fibrinolysis.* The coronary artery narrowing was visually estimated and expressed as percentage of Lumina. All of the patients who had a diameter stenosis in their coronary arteries underwent coronary angiography. It was regarded important when the major pericardial and left main coronary arteries were both narrowed by 70% or 50%, respectively, on an angiographic basis [16].

6) *Echocardiography:* All patients had echocardiograms and Doppler tests within one week from AMI, using a Hewelett Pakard (SONOS 5500) echo-set using a 2.5 MHz transducer. The individuals were in the left lateral decubitus posture for the echocardiograms. Left ventricular end-diastolic dimension (LVEDD), fraction of shortening (FS), and ejection fraction (EF) were measured in two-dimensional guided M-mode. Wall motion score index (WMSI) was calculated for each patient according to the 16-segments model. The LV was divided into 16 segments, and segmental wall motions were graded for each segment from 1 to 4 as following: 1 = normal wall motion, 2 = hypokinesis, 3= akinesis, and 4 = dysknesis). The WMSI was calculated by summation of the scores of the 16 segments and dividing it by the total number of segments "16" [17] (Figure 1).

Statistical Analysis:

The SPSS 11.5 package application was used to examine all of the datasets. Categorical data was summarized using absolute frequencies, while quantitative data was presented as the mean standard deviation. Student t-tests and 2-tests were used to examine the differences between the study groups. Pearson correlation analysis was used to examine the correlations between various variables. *p*-value less than five percent were defined as "significant" statistically.

RESULTS

The study included 122 acute MI patients. Table 2 shows no significant differences in age, sex, or CAD risk factors between the research groups.

Patients with a QRS score > 4 had a substantially longer duration to first symptom (5.961.15 hours versus 3.381.66 hours, p=0.00001). Ejection fraction was lower in patients with QRS > 4 than in those with QRS ≤ 4 (45.30±4.70 versus 59.95±5.68 %). WMSI was greater in patients with QRS > 4 than those with QRS ≤ 4 (2.39±0.25) (p= 0.0001). Peak CKMB was higher in patients with QRS > 4 than in those with QRS ≤ 4 (206.37±74.52 versus 155.08±86.22, p = 0.022).

The reperfusion therapy was similar in both groups. Patients with QRS > 4 received primary PCI (29.7%) and those with QRS ≤ 4 received thrombolysis (68.0 %), p > 0.05.

All 32 thrombolysis patients with QRS > 4 had no ST-segment resolution (100%), while 36 patients with QRS ≤ 4 had successful ST-segment resolution (62.1%) and 22 patients had no resolution (37.9%), p = 0.0046.

All primary PCI treated patients in both groups showed TIMI-flow III, however myocardial blush grade (MBG) varied.

In patients with QRS > 4, MBG 1 was found in 8 patients (57.1%), but not in those with QRS ≤ 4, p = 0.02.

In patients with QRS > 4, MBG 2 was found in 6 patients (42.9%), but not in those with QRS ≤ 4, p = 0.07.

There was no MBG 3 in patients with QRS > 4, whereas there were 16 MBG 3 patients (100%) in those with QRS ≤4.

The proportion of patients with single- and two-vessel disease was similar in both groups. However, patients with QRS > 4 (23 patients; 48.9%) had more three-vessel disease than those with QRS ≤ 4 (15 patients; 20%); p = 0.01.

Table 1: Modified Selvester QRS-scoring system [13].

Lead	Duration (msec)		Amplitude ratios		Max points
I	Q ≥ 30	(1)	R/Q ≤ 1	(1)	2
II	Q ≥ 40	(2)			
	Q ≥ 30	(1)			2
aV_L	Q ≥ 30	(1)	R/Q ≤ 1	(1)	2
	Q ≥ 50	(3)	R/Q ≤ 1	(2)	
aV_F	Q ≥ 40	(2)			
	Q ≥ 30	(1)	R/Q ≤ 2	(1)	5
	Any Q	(1)			
V_1	R ≥ 50	(2)			
	R ≥ 40	(1)	R/S ≥ 1	(1)	4
	Any Q or R ≤ 20	(1)			
V_2	R ≥ 60	(2)			
	R ≥ 50	(1)	R/S ≥ 1.5	(1)	4
V_3	Any Q or R ≤ 30	(1)			1
V_4	Q ≥ 20	(1)	R/Q or R/S ≤ 0.5	(2)	
			R/Q or R/S ≤ 1	(1)	3
V_5	Q ≥ 30	(1)	R/Q or R/S ≤ 1	(2)	
			R/Q or R/S ≤ 2	(1)	3
V_6	Q ≥ 30	(1)	R/Q or R/S ≤ 1	(2)	
			R/Q or R/S ≤ 3	(1)	3

Table 2: Comparison between two groups:

	QRS score ≤ 4 (n = 75)	QRS score > 4 (n = 47)	*p*
Age (ys)	54.7 ± 7.7	56.6 ± 7.0	> 0.05
Sex Male Female	68 (90.6 %) 7 (9.3 %)	44 (93.6 %) 3 (6.4 %)	> 0.05
Diabetes	30 (40.0 %)	24 (51.0 %)	> 0.05
HTN	36 (48.0 %)	24 (51.2 %)	> 0.05
Dyslipidemia	32 (42.6 %)	20 (42.5 %)	> 0.05
Smoking	46 (61.3 %)	34 (72.3 %)	> 0.05
Family History	26 (34.6 %)	16 (34.0 %)	> 0.05
Time to Admission (H)	3.38±1.66	5.96±1.15	< 0.00001
Ejection Fraction (%)	59.95±5.68	45.30±4.70	< 0.0001
WMSI	1.31±0.34	2.39±0.25	< 0.0001
CKMB peak (U/L)	155.08±86.22	206.37±74.52	0.022
Type of Reperfusion Thrombolysis	58 (77.3 %)	32 (68.0 %)	> 0.05
Primary PCI	16 (21.3 %)	14 (29.7 %)	
ST-segment after Thrombolysis - Resolution	36 (62.1 %)	0 (0 %)	0.0046
- Non-resolution	22 (37.9 %)	32 (100 %)	
TIMI flow after PCI - I	0 (0 %)	0 (0 %)	1
- II	0 (0 %)	0 (0 %)	1
- III	16 (100 %)	14 (100 %)	1

	QRS score ≤ 4 (n = 75)	QRS score > 4 (n = 47)	*p*
Myocardial Blush Grade - I	0 (0 %)	8 (57.1 %)	0.02
- II	0 (0 %)	6 (42.9 %)	0.07
- III	16 (100 %)	0 (0 %)	<0.0001
Number of diseased vessels - Single vessel	34 (45.3 %)	14 (29.7 %)	0.23
- Two vessels	26 (34.6 %)	10 (21.2 %)	0.27
- Three vessels	15 (20 %)	23 (48.9 %)	0.01

HTN: hypertension; PCI: percutaneous coronary intervention; WMSI: wall motion score index

Table 3: Validity of QRS score in prediction of successful reperfusion after thrombolysis as assessed by ST segment resolution:

		No Resolution	Resolution	Total
QRS score	> 4	32	0	32
	≤ 4	22	36	58
Total		54	36	90

Sensitivity	Specificity	PPP	NPV	Overall accuracy	Kappa	*p*
59.3 %	100 %	62.1 %	86 %	75.6 %	0.538	< 0.0001

PPV = positive predictive value, NPV = negative predictive value

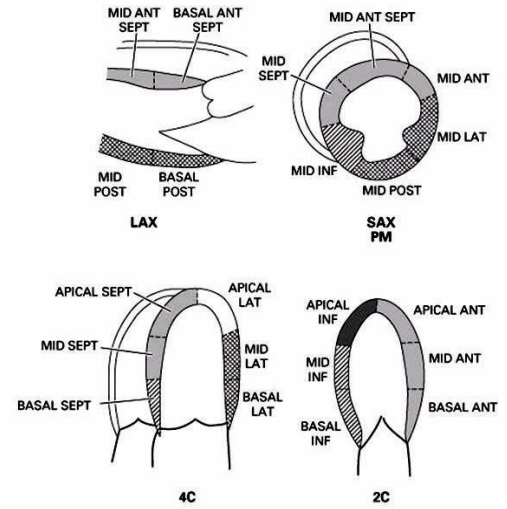

Figure 1: Illustrating the 16-segments model for measuring WMSI [14].

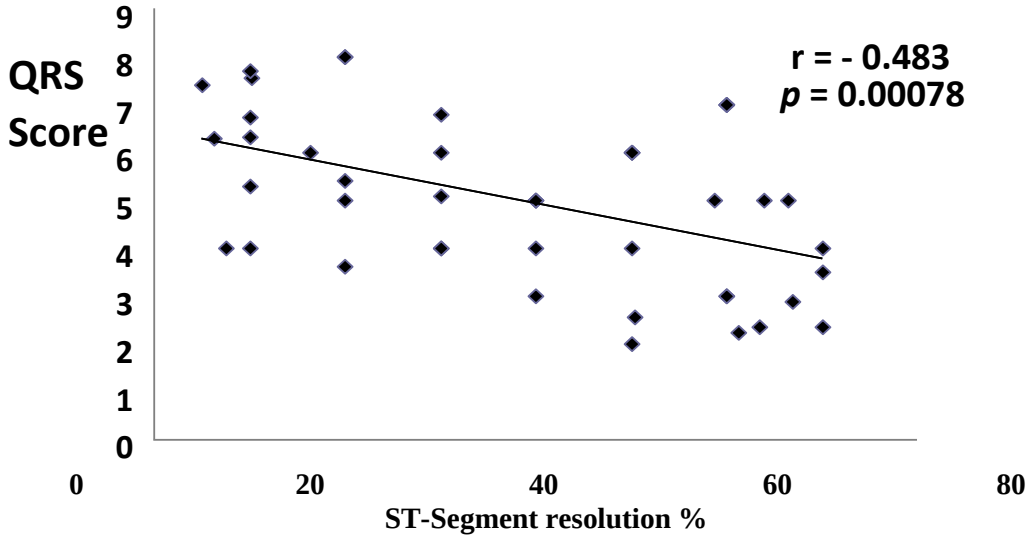

Figure 2: Illustrating negative correlation between QRS score and ST segment resolution.

DISCUSSION

Acute myocardial infarction signals coronary artery disease. It has major consequences and a high fatality rate. In the first month after a suspected MI or ACS, the overall case mortality rate is 50%, with half of these deaths occurring within 2 hours. Myocardial necrosis occurs after 15-30 minutes of acute ischemia (no forward or collateral flow). Length and remaining left ventricular function of acute myocardial infarction patients determine clinical outcome [18].

In thrombolysis studies, individuals with acute STEMI who have inadequate ST segment resolution had a greater risk of persisting infarct associated arterial blockage [19], increased infarct size (20), mortality and congestive heart failure [21].

However, full ST-segment resolution predicts infarct-related arterial patency and maintained cardiac tissue perfusion [22, 23].

Acute STEMI patients with aberrant Q-waves on arrival had a delayed and less complete ST-segment resolution, indicating decreased myocardial perfusion even with patent IRA [24].

A previous investigation utilising a Doppler guide wire indicated a significant no-reflow pattern in certain patients at the time of reperfusion. These patients exhibited more Q waves than those with a microvascular perfusion velocity pattern [25].

Birnbaum et al. previously shown that aberrant Q-waves on admission were linked to greater peak creatine kinase levels, heart failure prevalence and death in patients with anterior myocardial infarction [26].

A simple, quick, non-invasive, and easy-to-perform early prognostic predictor in acute myocardial infarction patients is ideal. An ECG evaluation meets all of these requirements [21].

Q-waves upon presentation in individuals with initial acute STEMI indicate a more advanced state of the infarction [27].

Our goal was to use the Selvester QRS scoring method (in a simplified version) to measure the QRS complexes at an early stage of an ongoing infarction process [8].

So, we could gauge the infarction's progress. Because it's an indication of thrombolysis failure. [28], a bad prognosis, and even a recruitment condition for rescue angioplasty [29], we used 50% ST segment resolution to predict unsuccessful reperfusion.

In this study, we try to evaluate that if the modified Selvester QRS score derived from admission electrocardiograph would provide information that could help in taking decisions of management. This study included 122 patients, 112 males and 10 females all of them suffered their first myocardial infarction (STEMI), with no underlying abnormalities in their ECG as ventricular enlargement, bundle branch blocks or other conduction abnormalities. Each patient was evaluated by history focused on risk factors for coronary artery disease, physical examination, ECG, echocardiography and coronary angiography.

91 patients received their reperfusion therapy in the form of thrombolytic agents (streptokinase), and the remaining 31 underwent primary PCI.

According to admission QRS score, the patients were divided into those who had QRS score less than or equal to 4 and with score more than 4.

This study shows that a high QRS score on admission ECG correlated well with CK-MB (p = 0.022) as a marker of myocardial damage, also QRS score correlated with markers of myocardial dysfunction as echocardiographic EF ($p < 0.0001$), wall motion score index ($p < 0.0001$).

Q waves emerge in the infarct leads with ST segment elevation when infarction progresses to permanent necrosis. Initial Q-waves indicate a more advanced infarction. The presence of baseline Q-waves has been linked to bigger infarcts and an increased risk of death in AMI patients, outperforming time from symptom onset. In addition to the number of Q waves, the QRS score measures Q wave amplitude and breadth, as well as the number of R waves. It may therefore be a more accurate indication of infarction stage than Q waves alone [30].

This is in line with our findings, where the QRS specificity and sensitivity were assessed in normal persons and patients with single anterior and inferior infarcts. The QRS score correlated with the amount of left ventricular infarction in both anterior and inferior regions [31].

In a study of 55 patients, Palmeri et al. found a high connection (r = 0.88) between the QRS score and left ventricular ejection fraction by radionuclide imaging [32].

In patients with re-perfused acute myocardial infarction, Engblom et al. showed a high connection between contrast enhanced cardiac magnetic resonance and the Selvester QRS score assessment of infarct size [33].

In our study, we have found that patients presented with high QRS score presented late (5.96 ± 1.15 hours). Similar results were found by Abdel-Salam et al [11].

Also we have found a strong negative correlation between QRS score and ST-segment resolution (r = - 0.483, p = 0.00078). Similar results were found by Abdel-Salam et al [11].

The current study revealed that all patients showed that successful ST segment resolution has QRS score ≤ 4 ($p < 0.0001$). It is also suggested that at value 4 QRS score can predict successful reperfusion with sensitivity 59.3% and specificity 100% when compared with ST segment resolution.

Similarly to our work, Abdel-Salam et al. found that a simplified Selvester QRS score may accurately identify STEMI patients who would benefit from fibrinolytic treatment [11].

In both groups, all 31 patients treated with primary PCI attained TIMI flow III. MBG was greater in the group with QRS > 4.

A QRS score > 4 increases the risk of poor myocardial reperfusion, perhaps due to delayed presentation or increased baseline ST-segment elevation. They had more proximal left anterior descending coronary artery occlusions, poor collateral circulation, and impaired initial and ultimate culprit vessel flow [34].

The study's sample size (31 patients) is too inadequate to draw any definitive conclusions.

Limitations of the study

- The results were obtained from a single medical center.
- Sample size was small. Facts that make it difficult to generalize our results to cover all patients with acute STEMI.
- Assessment of coronary artery disease by a rough method.
- Streptokinase was the only fibrinolytic agent used.
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- The number of patients underwent primary PCI was small.

CONCLUSIONS

Selvester QRS scoring method regains clinical significance in initial STEMI patients. It may help identify at-risk myocardium, forecast remaining left ventricular function, and guide therapy options. The QRS score from the admission ECG should be calculated in every STEMI patient. The QRS score may assist determine whether patients may benefit from thrombolytic treatment. Further studies are needed to confirm its relation with terminal MBG in the primary PCI era.

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