Electrocardiographic Predictor of Final Infarct Size by Selvester QRS Score in Correlation to Rest Tc99M Sestamibi SPECT after Primary PCI


The Department of Cardiovascular Medicine, Faculty of Medicine, Benha University

Abstract

Objective: To assess the ability of Selvester QRS score to predict final size of myocardial infarction in correlation to rest Tc99 sestamibi SPECT in patients with ST-segment elevation myocardial infarction who underwent primary coronary intervention.

Patients and Methods: The study was conducted on 30 patients with acute STEMI eligible for primary PCI. The initial and final size of myocardial infarction was estimated by Selvester QRS and resting Tc-99m sestamibi imaging then myocardial salvage was calculated.

Results: The mean age was 55.27 ± 10.74, 25 males (83.3%) and 5 females (16.7%). There was a significant correlation between Selvester QRS score and resting Tc-99m sestamibi imaging (r = 0.774, p = 0.001) for initial size, (r = 0.659, p = 0.001) for final size and (r = 0.886, p = 0.001) for myocardial salvage. Significant correlation was found in anterior MI patients (r = 0.674, p = 0.002) for initial size, (r = 0.546, p = 0.016) for final size and (r = 0.936, p = 0.001) for myocardial salvage. The correlation was significant in patients with post procedural TIMI 3 flow, it was (r = 0.817, p = 0.001) for initial size (r = 0.678, p = 0.001) for final size and (r = 0.939, p = 0.001) for myocardial salvage. Also significant correlation in single vessel (r = 0.955, p = 0.001) for initial size and (r = 0.989, p = 0.001) for myocardial salvage. Time of reperfusion didn’t affect the correlation as it was significant when reperfusion was < 6 hours.

Conclusion: Selvester QRS score is simple, bedside, easy and cheap tool that correlate well with resting TC99m sestamibi SPECT for estimation the infarction size especially in patients with anterior MI, single vessel and with post procedure TIMI flow 3.

Key Words: Primary PCI – Selvester QRS score – Resting TC99 sestamibi SPECT.

Introduction

ACUTE myocardial infarction (AMI) remains a leading cause of morbidity and mortality worldwide. Myocardial infarction occurs when irreversible myocardial cell damage or death occurs [1].

Primary coronary intervention (PCI) is the preferred reperfusion strategy especially when performed by an experienced team within the shortest possible time from first medical contact [2].

One of the methods to estimate infarct size is 12 lead ECG by using QRS score system. As well as pathologic infarct size, QRS score has also correlated with left ventricular function after initial myocardial infarction. Each point of Selvester QRS score corresponded to 3% of left ventricular mass [3].

On the basis of the available scientific evidence, SPECT imaging with Tc-99m sestamibi is the best available measurement tool for infarct size in clinical medicine. Tc-99m sestamibi scintigraphy is considered a reliable method to assess myocardial salvage (difference between the actual and potential infarct size) achieved by reperfusion therapy [4].

Aim of the work:

To assess the ability of Selvester QRS score to predict the final size of myocardial infarction in correlation to rest Tc99 sestamibi SPECT in patients with ST-segment elevation myocardial infarction (STEMI) who underwent primary coronary intervention.

Patients and Methods

This study was conducted on thirty patients who were admitted to the coronary care unit (CCU)
at Kobri El-Koba Millitary Hospital with acute STEMI eligible for reperfusion within the period from November 2011 to July 2012.

Inclusion criteria:

**Patients who presented with:**

- New ST segment elevation at the J point in two contiguous leads with cut off points: 0.2mV in men and 0.15mV in women in leads V2 and V3 and/or 0.1mV in other leads.
- Ischemic chest pain.
- Typical rise and fall of cardiac enzyme typical to myocardial necrosis.

Exclusion criteria:

**Patients who had one or more of the following were excluded from the study:**

- Previous AMI.
- Patients with contraindication to primary PCI such as high risk bleeding as intracranial hemorrhage.
- Patient who were hemodynamically unstable or clinically unfit to be transferred to myocardial perfusion scan laboratory.
- Previous CABG surgery.
- Re-infarction during CCU admission before acquiring second SPECT image.
- Basline ECG that may significantly over or underestimate the myocardial infarction size measured by QRS score including bundle branch block or left and right ventricular hypertrophy.

All patients were subjected to:

1. **Thorough history taking:**
   - Full history was taken from all cases as regards: Age, gender, and risk profile as diabetes mellitus, hypertension, and smoking.

2. **Presenting complaint:**
   - Chest pain was analyzed as regards duration prior to admission, associated symptoms, and presence of angina equivalents.

3. **Full clinical examination:**
   - Each patient was thoroughly examined by:
     
     **A- General examination:**
     - With special emphasis on vital data especially arterial blood pressure and heart rate.
     
     **B- Local cardiac examination:**
     - All patients were subjected to full cardiac examination stressing on the presence of mechanical complications as mitral regurgitation or ventricular septal defects and signs of heart failure as: S3 gallop and basal rales.

4. **Twelve lead surface ECG:**

   ECG was done to all patients immediately on admission and 90 minutes after primary PCI and calculated infarction size by Selvester QRS score before and after reperfusion. The myocardial salvage was calculated by subtracting Selvester score before reperfusion and Selvester score after reperfusion. ECG machine was used to record standard 12-lead ECG. They were recorded at a paper speed of 25mm/sec and a gain of 10mm/mV.

   **Table (1): Selvester QRS scoring system [3].**

<table>
<thead>
<tr>
<th>Lead</th>
<th>Duration (msec)</th>
<th>Points</th>
<th>Amplitude ratios</th>
<th>Points</th>
<th>Max lead points</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Q≥30</td>
<td>(1)</td>
<td>R/Q≤1</td>
<td>(1)</td>
<td>2</td>
</tr>
<tr>
<td>II</td>
<td>Q≥40</td>
<td>(2)</td>
<td>R/Q≤2</td>
<td>(2)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Q≥30</td>
<td>(1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AVI</td>
<td>Q≥30</td>
<td>(1)</td>
<td>R/Q≤1</td>
<td>(1)</td>
<td>2</td>
</tr>
<tr>
<td>AVf</td>
<td>Q≥50</td>
<td>(3)</td>
<td>R/Q≤1</td>
<td>(2)</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Q≥40</td>
<td>(2)</td>
<td>R/Q≤1</td>
<td>(2)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Q≥30</td>
<td>(1)</td>
<td>R/Q≤2</td>
<td>(1)</td>
<td></td>
</tr>
<tr>
<td>V1</td>
<td>Any R</td>
<td>(1)</td>
<td>R/S≥1</td>
<td>(1)</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>R≥50</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>R≥40</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>...</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V2</td>
<td>Any Q or R</td>
<td>(4)</td>
<td>R/S≥1.5</td>
<td>(1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>R≤20</td>
<td></td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>R≥60</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>...</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>R≥50</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>...</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V3</td>
<td>Any Q or R</td>
<td>(1)</td>
<td>R/S≤1</td>
<td>(1)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>R≤30</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V4</td>
<td>Q≥20</td>
<td>(1)</td>
<td>R/Q or R/S≤0.5</td>
<td>(2)</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>R≥20</td>
<td></td>
<td>R/Q or R/S≤1</td>
<td>(1)</td>
<td></td>
</tr>
<tr>
<td>V5</td>
<td>Q≥30</td>
<td>(1)</td>
<td>R/Q or R/S≤1</td>
<td>(2)</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>R≥20</td>
<td></td>
<td>R/Q or R/S≤2</td>
<td>(1)</td>
<td></td>
</tr>
<tr>
<td>V6</td>
<td>Q≥30</td>
<td>(1)</td>
<td>R/Q or R/S≤3</td>
<td>(2)</td>
<td>3</td>
</tr>
</tbody>
</table>

5. **Laboratory results:**

   Full labs were withdrawn from all patients on admission and at follow-up, with special emphasis on:

   - Cardiac enzymes (CK and CK-MB).
   - Renal profile (serum creatinine).
   - Sodium and potassium.
   - Complete blood count (hemoglobin and platelet count).

6. **Primary PCI protocol:**

   **All cases were given:**

   - **Clopidogrel:** All patients were given a loading dose of 600mg clopidogrel prior to the procedure and kept on 75mg daily thereafter.
- **Unfractionated heparin**: All patients were given 10000 international unit (IU) unfractionated heparin at the beginning of intervention and kept on it till discharge with partial thromboplastin time adjusted at 1.5-2 the basal level.

Then all patients underwent primary PCI after diagnostic coronary angiography and the IRA was identified and treated using bare metal stents ± predilatation by balloons according to decision of treating physician.

At the end of revascularization TIMI flow grading was done according to the following classification.

- **Grade 0 (no perfusion)**: There is no antegrade flow beyond the point of occlusion.
- **Grade 1 (penetration without perfusion)**: The contrast material passes beyond the area of obstruction but "hangs up" and fails to opacify the entire coronary bed distal to the obstruction for the duration of the cine-angiographic filming sequence.
- **Grade 2 (partial perfusion)**: The contrast material passes across the obstruction and opacifies the coronary bed distal to the obstruction. However, the rate of entry of contrast material into the vessel distal to the obstruction or its rate of clearance from the distal bed (or both) is perceptibly slower than its entry into or clearance from comparable areas not perfused by the previously occluded vessel (the opposite coronary artery or the coronary bed proximal to the obstruction).
- **Grade 3 (complete perfusion)**: Antegrade flow into the bed distal to the obstruction occurs as promptly as antegrade flow into the bed from the involved bed and is as rapid as clearance from an uninvolved bed in the same vessel or the opposite artery.

7- **SPECT imaging protocol**:

The patients were given an intravenous dose of Tc-99m labeled sestamibi (20-30mCi) followed by their designated reperfusion therapy via primary intervention then SPECT 1st image was taken within 6 hours from the time of injection of the radioactive material to assess the initial size of the perfusion defect prior to reperfusion (myocardium at risk).

A dual head cardiac dedicated gamma camera with high resolution collimator was used for acquisition of the SPECT images. An arc of 180 degrees was used, spanning from the 45-degree right anterior oblique to the 45-degree left posterior oblique projection. A total of 64 images were obtained, 25 seconds each using a 64 x 64 acquisition matrix with photon energy limits set at 20% window around the 140 KeV Tc-99m peak.

With semi-quantitative visual analysis and displaying the images using 4 D M SPECT, a score was assigned to represent myocardial perfusion.

A segmentation model has been standardized for this approach by dividing the myocardium into 17 segments on the basis of three short-axis slices and a representative long-axis slice to depict the apex.

Perfusion was graded within each segment on a scale of 0 to 4, with 0 representing normal perfusion and 4 representing a very severe perfusion defect.

Scores for all 17 segments were added to create a summed score representing myocardium at risk.

Prior to discharge the patients received another dose of Tc-99m labeled sestamibi (20-30mCi) and follow-up SPECT images were taken to assess the final perfusion defect and to calculate myocardial salvage.

The sum of the 17 segmental scores from the 2nd image represented the final size of infarction.

Myocardial salvage is the difference between initial perfusion defect (myocardium at risk) and final perfusion defect (final size of infarction).

**Statistical analysis**:

Data were collected, verified, revised then edited on personal computer. Categorical variables were expressed as absolute and relative frequencies (percentage) while continuous variables were presented as mean values ± standard deviation (SD). Comparisons were made between the two groups using t-test for continuous variables and chi-square test and pearson correlation coefficient for categorical variables. Statistical analysis was performed using SPSS (statistical package version sixteen). Difference was considered statistically significant at a p-value <0.05 and highly significant at p-value <0.01.

**Results**

The study population consisted of thirty patients with acute STEMI eligible for reperfusion; their age ranged from 33 to 72 years. The mean age in years was 55.27±10.74. It included twenty five males (83.3%) and five females (16.7%), nineteen patients (63.3%) were smokers, thirteen patients (43.3%) were hypertensive, twelve patients (40%)
were diabetics and only two patients (6.7%) had positive family history for CAD. Anterior wall myocardial infarction was the presenting picture in 19 patients (63.4%), whereas 11 patients (36.6%) presented with non-anterior wall myocardial infarction.

Time of reperfusion by primary PCI ranged between 0.5 to 12 hours with a mean time of 5.9 ± 3.8 hours. Primary PCI was done to 15 patients (50%) within 6 hours of the onset of chest pain, whereas in 15 patients (50%) it was done after 6 hours of the onset of pain.

Coronary angiography revealed that 23 patients (76.7%) had single vessel disease, 7 patients (23.3%) had multiple vessel disease. The post procedure TIMI flow ranged from TIMI 2 flow in 7 patients (23.3%) and TIMI 3 flow in 23 patients (76.7%).

The initial size of myocardial infarction in all patients was estimated before primary PCI by ECG score (Selvester QRS) and by resting Tc-99m sestamibi imaging. Then the final infarction size was estimated after reperfusion by ECG score and another image of TC99 then myocardial salvage was calculated.

**Correlation between Selvester QRS score and resting Tc-99m sestamibi for the initial size, the final size of myocardial infarction and myocardial salvage:**

- The initial and final size of myocardial infarction and myocardial salvage in all patients were estimated by Selvester QRS score were (21.9 ± 9.12, 13.0±6.78, 9.08±6.34) respectively while by using resting Tc-99m sestamibi imaging were (29.47 ± 13.76, 19.37±11.73, 10.37±6.98) respectively. For all patients there was a significant correlation between Selvester QRS score and resting Tc-99m sestamibi imaging (r=0.774, p=0.001) for initial size of myocardial infarction, and (r=0.659, p=0.001) for final size of myocardial infarction, and (r=0.886, p=0.001) for myocardial salvage respectively (Table 2) and Figs. (1,2).

Table (2): Correlation between Selvester QRS score and resting Tc-99m sestamibi for the initial size, the final size of myocardial infarction and myocardial salvage.

<table>
<thead>
<tr>
<th>Estimation infarction size by Selvester QRS score</th>
<th>By resting Tc-99m sestamibi</th>
<th>Pearson correlation</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial size</td>
<td>Initial size</td>
<td>0.774</td>
<td>0.001</td>
</tr>
<tr>
<td>21.9±9.12</td>
<td>29.47±13.76</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Final size</td>
<td>Final size</td>
<td>0.659</td>
<td>0.001</td>
</tr>
<tr>
<td>13.0±6.78</td>
<td>19.37±11.73</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Myocardial salvage</td>
<td>Myocardial salvage</td>
<td>0.886</td>
<td>0.001</td>
</tr>
<tr>
<td>9.08±6.34</td>
<td>10.37±6.98</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Correlation between Selvester QRS Score and Tc99 sestamibi in patients with anterior Vs non-anterior MI:**

Among patients with anterior MI, significant correlation was found between Selvester QRS score and resting Tc-99m sestamibi imagine (r=0.674, p=0.002) for initial size of myocardial infarction and (r=0.546, p=0.016) for final size of myocardial infarction and (r=0.936, p=0.001) for myocardial salvage respectively.

While in patients with non-anterior MI, there was no significant correlation between Selvester QRS score and resting Tc-99m sestamibi imagine (r=0.454, p=0.16) for initial size of myocardial infarction.
infarction and \((r=0.588, p=0.057)\) for final size of myocardial infarction and \((r=0.519, p=0.102)\) for myocardial salvage respectively (Table 3).

**Correlation between QRS score and resting TC99 as regard to procedural TIMI flow:**

Post procedural TIMI flow is an important factor that affects the correlation between QRS score and resting TC99 sestamibi. The correlation was significant in patients with post procedural TIMI 3 flow. The correlation was \((r=0.817, p=0.001)\) for initial size, \((r=0.678, p=0.001)\) for final size and \((r=0.939, p=0.001)\) for myocardial salvage.

Patients with post procedure TIMI 2 flow had no significant correlation between ECG score and resting TC99 \((r=0.481, p=0.275)\) for initial size of MI, \((r=0.66, p=0.107)\) for final size of MI and \((r=0.693, p=0.084)\) for myocardial salvage respectively (Table 4).

**Correlation between QRS score and resting TC99 as regard to number of vessel disease:**

Patients with single coronary artery disease had a high significant correlation between QRS score and resting TC99 sestamibi, as follow \((r=0.955, p=0.001)\) for initial size of MI, \((r=0.927, p=0.001)\) for final size of MI and \((r=0.989, p=0.001)\) for myocardial salvage respectively.
Discussion

The primary goal in the management of acute STEMI is to start reperfusion therapy as early as possible weather mechanical or pharmacological reperfusion [5].

Primary (PCI) according to the (ESC) guidelines is the preferred treatment if performed by an experienced team within 90 minutes [5].

Compared with fibrinolytic therapy, primary PCI had shown more effective restoration of patency, less re-occlusion, less bleeding complications, improved residual LV function and better clinical outcome [6].

Maintenance of myocardial viability is the goal of reperfusion therapy during AMI. Myocardial salvage defined as the amount of myocardium that was jeopardized by a coronary occlusion but spared from infarction and can be used to compare different treatment options so that strategies that show a benefit in salvage could be implemented in clinical practice [7].

Infarction size is a strong prognostic indicator of morbidity and mortality. Thus accurate estimation of infarct size together with the size of myocardium at risk at the time of insult is crucial and vital for choice of treatment [8].

QRS Scoring systems represent a simple convenient method for evaluation of myocardial infarct size in which a number of independent risk factors on presentation are shown to have prognostic significance [9].

This study involved 30 patients with acute STEMI eligible for reperfusion (25 males and 5 females) their age ranged from 33 to 72 years and mean age was 55.27 ± 10.74 years. Each patient was evaluated by history which focused on risk factors for coronary artery disease, physical examination and ECG. All patients underwent resting TC99 to estimate the initial size of myocardial infarction before mechanical reperfusion by Iry PCI then another image of resting TC99 was done for all patients before hospital discharge.

In the present study gender had no effect on infarction size and this may be explained by the small number of the female patients included. This is supported by Adamus et al., [10] who observed that gender didn't affect the size of myocardial infarction. But in contrary to the study conducted by Soleimani et al., [11] who found that male gender affected infarction size.

In present study a good correlation was found between QRS score (Selvester QRS) and resting TC99 Sestamibi for estimation the myocardial infarction size especially in patients with anterior wall MI. These findings are in agreement with those reported by Mazomenos et al., [12] who studied the correlation between Selvester QRS and resting TC99 for estimating the final size of myocardial infarction. Their study included 37 patients with AMI treated with primary PCI. The correlation was highly significant between QRS score and resting TC 99.

Also result these result are supported by the results reported by Strauss et al., [13] who found that there was a high correlation between size of myocardial infarction estimated by Selvester QRS scores and size of myocardial infarction measured by resting TC99 especially in patients with anterior myocardial infarction.

Also these results are in agreement with Valentia et al., [14] they addressed the accuracy of the Selvester score in estimating myocardial infarct size in patients treated by primary coronary angioplasty using quantitative thallium-201 perfusion imaging as a parameter of infarct size. They found that the Selvester QRS score correlates well with infarct size measured with quantitative thallium perfusion imaging particularly in patients with anterior infarction.

These results are also in agreement with Hisd-maa et al., [15]. They studied 38 patients (34 men, 4 women; age 54±10 years with a first AMI, and estimated the size of myocardial infarction by QRS score and resting TC99. The QRS Score was calculated 30.9±3.1 for initial size of myocardial infarction, 15.6±3.4 for final size of myocardial infarction and 9.08±6.34 for myocardial salvage. While TC99 was calculated 34±11 % for initial size of myocardial infarction, 15±9 for final size of myocardial infarction and 10.37±6.98 for myocardial salvage. The correlation was (r=0.79, p<0.00 1) for initial perfusion defect ( r=0.79, p<0.005) for final size and (r=0. 88 6, p=0. 00 1) for myocardial salvage.

There were also several studies that were in agreement with these results. Engblom [16] reported a good correlation between thallium-201 perfusion image and Selvester QRS score for estimation of infarct size.

These results are also concordant with those reported by StrausSand and Selvester [17]. They reported that there was a good correlation between
the size of myocardial infarction calculated by Selvester QRS score and resting TC99. Their study included 42 patients with acute AMI and final size of MI by Selvester QRS was 15.9±4.5 and by resting TC99 was 30±3.9 the correlation was \( r=0.49, p<0.001 \).

In the present study the correlation between Selvester QRS Score and resting TC99 was higher in patients with single coronary artery disease rather than patients with multiple coronary artery disease.

These results are concordant with those of Palmus [18] who reported that the correlation between QRS Score and resting TC99 higher in patients with single coronary artery disease \( r=0.91, p=0.01 \) than patients with multiple coronary artery diseases \( r=0.48, p=0.09 \).

In the current work the correlation between QRS score and TC99 for estimate the final size of myocardial infarction and myocardial salvage in patients with post procedure TIMI 3 flow higher than patients with post procedure TIMI 2 flow.

In this study the time of reperfusion did not affect the correlation between QRS score and resting TC99. There was no significant difference between patients treated by 1ry PCI within <6 hours of the onset of chest pain and others treated within >6 hours of the onset of chest pain.

Conclusion:

Selvester QRS score is simple, bedside, easy and cheap tool that correlates well with resting TC99 sestamibi SPECT for the estimation the infarction size especially in patients with anterior MI, single vessel and with post procedure TIMI flow 3.

References


506 Electrocardiographic Predictor of Final Infarct Size by Selvester QRS Score

