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Original Research Article

Modified Selvester QRS Score in Predicting Successful ST Segment Resolution in Patients with Acute Myocardial Infarction Receiving Thrombolytic Therapy

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ABSTRACT

Background
This study was conducted to ascertain whether the modified Selvester QRS scoring system would be able to predict the clearance of ST segment elevation in patients undergoing streptokinase-based thrombolytic treatment for acute myocardial infarction.

Methods
This study was conducted in a hospital setting and involved 61 patients aged between 30 and 80 years who were diagnosed with a new onset acute ST elevation myocardial infarction receiving thrombolytic therapy with streptokinase. Based on 37 criteria and a modified Selvester scoring method, the QRS score was determined, yielding a total of 29 points. A QRS score greater than four was regarded as non-resolution. Additionally, patients were divided into non-resolution groups (STR < 50% of STE1) and resolution groups (STR ≥ 50% of STE1). The SPSS 24 program was used to carry out the statistical analysis.

Results
Patients with diabetes exhibited high QRS scores, but there was no relationship between them and the ST resolution. There was a substantial association between the QRS score, ST resolution and cardiac failure. The QRS score was higher and the incidence of ST non-resolution was higher in patients with heart failure. In this investigation, there was no significance for patients with dyslipidemia or MI. The resolution group's QRS score was lower than that of the non-resolution group. A noteworthy inverse relationship was observed between the STR and QRS scores. Additionally, there was a negative connection between QRS score and ejection percentage.

Conclusion
When patients with STEMI are receiving thrombolytic therapy, the QRS score accurately predicts the resolution of the ST segment. Patients are more likely to experience non-

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resolution of the ST segment if their QRS score is greater than 4.
Keywords: Modified Selvester QRS Score, ST Segment Resolution, Acute Myocardial Infarction, Thrombolytic Therapy, Streptokinase.

INTRODUCTION

Restoring coronary blood flow and achieving myocardial perfusion-which can be identified by the early and full resolution of ST segment elevation following treatment are the primary goals of the reperfusion techniques of thrombolysis and PCI for acute MI. Therefore, before starting treatment, it is crucial to estimate how well the ST segment will resolve with thrombolysis. The modified Selvester QRS score, a scoring system, is helpful to us in this regard. In the beginning, the Selvester score[1] was created using 54 criteria totaling 32 points. Many iterations of the score were subsequently released, and for this study, we opted for the simplified form which has 29 points.[2]

The TIMI (Thrombolysis in Myocardial Infarction) trial flow grade classification has been used to evaluate the effectiveness of thrombolytic medications. Following thrombolysis, the coronary blood flow in the artery associated with the infarct is estimated by this categorization. Hemodynamics, coronary anatomy, the amount of remaining thrombus, and other cellular variables are some of the factors that appear to affect TIMI flow grade following fibrinolysis.

From this angle, the ST segment resolution has become increasingly significant recently. Clinical practice and numerous research studies are increasingly making extensive use of ST segment monitoring and resolution as a straightforward method of predicting reperfusion in patients undergoing reperfusion therapy for acute ST elevation myocardial infarction. In the absence of a coronary angiography, the ST-segment resolution has been very helpful in determining the likelihood of reperfusion. In terms of forecasting the results of patients undergoing primary angioplasty, ST segment resolution performs better than TIMI flow. Thus, a good indicator of effective myocardial reperfusion is ST-segment resolution 60–90 minutes following thrombolysis.

The widely used and straightforward ST-segment resolution test is used to evaluate the effectiveness of reperfusion treatment in myocardial infarction. An inadequate thrombolysis rate (<50%) is an accepted indicator of thrombolysis failure and an appropriate rescue angioplasty recruitment requirement. A high infarct-related arterial patency, a smaller infarct, a better left ventricular ejection fraction, and a decreased death rate at one, six, and six year intervals have all been linked to early resolution of the ST segment in MI patients, according to numerous clinical investigations. Numerous studies conducted up to this point have assessed the prognostic significance of ST segment resolution as early as 90 minutes and as late as 4 hours following fibrinolysis, and they have concluded that it is a valid bedside indicator of timely reperfusion of the infarcted artery. According to Watanabe et al. (2015), a relevant metric for verifying the existence or lack of microvascular blockage is the QRS score, which is obtained from an easily accessible and basic ECG.[3]

Electrocardiography is still the primary clinical test that is most crucial for the diagnosis of MI. It is a great tool for a patient who suspects MI because of its inexpensive cost, relative ease of use, and non-invasiveness and quickness. Computer models based on studies of the activation sequence in QRS complexes in both human and canine hearts have suggested an orderly and predictable series of alterations in QRS associated with infarcts of different sizes and locations. Selvester et al, improved the outcomes of these computer simulations to get both qualitative and quantitative criteria for estimating infarct size through a series of pilot investigations in patients with localised wall motion abnormalities revealed by ventriculography The QRS score has a significant impact on early risk categorization for STEMI. In STEMI patients treated with primary PCI, a high QRS score is thought to be an

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independent predictor of inadequate ST recovery and 30-day MACE.[4]

Numerous studies have demonstrated that the prognostic information on the QRS score measured in patients following MI was useful. A higher QRS score indicates a higher risk of ventricular tachyarrhythmias, a greater requirement for defibrillatory shocks, and a reduced response to cardiac resynchronization therapy. This QRS scoring system is used to electrocardiographically estimate the extent of a myocardial infarct and provide a point value. As determined by Selvester et al., the ten ECG leads (I, II, aVL, aVF, V1-V6) are weighted based on their capacity to represent infarct size.[5] Once confounding variables like left or right ventricular hypertrophy, left or right bundle branch block, or left anterior or posterior fascicular block are eliminated, the modified Selvester QRS scoring system reaches a satisfactory level of specificity. Every criterion showed at least 95% specificity, and when a score of more than two points was needed to identify myocardial infarction, the whole 29-point scoring system obtained 98% specificity. The QRS score counts Q waves, but it also counts the amplitude and breadth of Q waves and the number of R waves. Therefore, compared to Q waves alone, it might be a more reliable indicator of the infarction stage.[6]

According to thrombolysis trials, patients with acute STEMI who did not achieve appropriate ST segment resolution were more likely to develop congestive heart failure, grow infarct size, and die.[7] Full ST-segment resolution, on the other hand, indicates sustained cardiac tissue perfusion and infarct-related arterial patency.[8,9] A delayed and less complete ST-segment resolution was observed in acute STEMI patients with abnormal Q-waves at arrival, suggesting a reduction in myocardial perfusion.[10]

A simple, quick, non-invasive test that is straightforward to administer to all patients should be the ideal early prognostic indicator for patients suffering from acute myocardial infarction. The mean QRS score was found to be considerably lower in the ST resolution group (2.88 +/- 1.34 vs 5.93 +/- 1.56, respectively, $p < 0.001$) when compared to the non-resolution group, according to Abdel-Salam et al.[11]

In MI patients, a greater QRS score is linked to a higher death rate. At the one-year and five-year intervals, the survival rates of patients with a score of 0 were 95% and 88%, respectively; patients with a score of 10 or above had survival rates of 81% and 52%. The Selvester QRS score has demonstrated superiority over a number of other scoring systems in the estimation of infarct size, including the Minnesota score, Novacode, and cardiac infarction injury score. In addition to providing the most information possible on the prognosis, this scoring method proven to be helpful in anticipating the recovery of LV function following an acute MI. In patients with acute myocardial infarction undergoing streptokinase-based thrombolytic treatment, the purpose of this study was to ascertain if the modified Selvester QRS scoring system would predict the clearance of ST segment elevation.

MATERIALS & METHODS

This study took place in a hospital setting and involved 61 patients aged between 30 and 80 years who were diagnosed with new-onset acute ST elevation myocardial infarction and eligible for reperfusion therapy (presenting within 12 hours of symptom onset or presenting thereafter with persistent symptoms). The patients received thrombolytic therapy with streptokinase at Chengalpattu Medical College Hospital for a year, from April 2021 to March 2022, after receiving approval from the institutional ethics committee and providing written informed consent from study participants. The study excluded individuals with cardiogenic shock, bundle branch block, timed rhythm, fascicular block, ECG evidence of ventricular hypertrophy, and other causes of ST elevation, such as pericarditis. A standard 12-lead ECG was used to diagnose the patients with acute myocardial infarction. Streptokinase 1,50,000 IU was then infused intravenously over the course of 60 minutes to thrombolyze the infarcted heart. Ninety minutes after the treatment began, another standard 12-lead ECG was taken.

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Based on 37 criteria and a total of 29 points, the QRS score was determined using the modified Selvester scoring system. A QRS score greater than four was regarded as non-resolution. The elevation of the ST section measured 20 ms after the J point. When there was an anterior infarction, leads I, aVL, V1 through V6 were used. For an inferior infarction, leads II, III, aVF, V5, and V6 were used to measure the height (in mm) of ST segment elevations. STE1 was the total of all measured ST segment elevations. The total of the detected ST elevations in the ECG after 90 minutes of therapy was determined to be STE2. The ST segment resolution (STR) was determined by taking the difference between STE1 and STE2. Additionally, patients were divided into non-resolution groups (STR < 50% of STE1) and resolution groups (STR ≥ 50% of STE1).

The SPSS 24 program was used to carry out the statistical analysis. If a continuous variable had a normal distribution, it was shown as the mean ± standard deviation. To compare the two individual groups, the unpaired t-test (parametric) was employed. The association between the QRS score and the STR was examined using Pearson's correlation coefficient test. Every test was conducted in duplicate, with a probability value of $p < 0.05$ being statistically significant.

RESULTS

In all, 61 patients were included in the research. Table 1 displays the baseline characteristics of the two study groups and the entire group with regard to ST segment resolution. The study population had a mean age of 56.07 ±11.845, with 43 men (70%) and 18 women (30%). The non-resolution group had a higher percentage of older people than the resolution group ($p < 0.05$), and the older age group had a higher QRS score ($p < 0.05$). Regarding sex ($p = 0.202$, $p = 0.842$), smoking (0.117, 0.839), alcohol (0.105, 0.839), and hypertension ($p = 0.268$, $p = 0.178$), there was no difference between the groups. There was no statistically significant correlation observed between these variables and the QRS score or ST resolution. Nonetheless, 50% of the study's participants who had diabetes demonstrated a significant relationship with their QRS score ($p = 0.027$) and a high QRS score, while no link was seen with the ST resolution ($p = 0.154$). There was a strong connection between cardiac failure and both the ST resolution ($p = 0.01$) and QRS score ($p = 0.002$). Sixty-nine percent of the heart failure patients had a high QRS score, and seventy-four percent of them exhibited ST non-resolution. In this investigation, there was no significant relationship between the type of MI or dyslipidemia (Tables 1-4).

	Whole Cohort N = 61	**Resolution Group N = 33**	**Non-Resolution Group N = 28**	**P-Value**
Age	56.07±11.845	51.82 ±11.015	61.07±10.951	**0.002**
Male	43 (70.5%)	21 (48.8%)	22 (51.9%)	0.202
Female	18 (29.5%)	12 (66.6%)	6 (33.7%)	
Smoking	24 (39.3%)	10 (41.6%)	14 (58.4%)	0.117
Alcohol	28 (45.9%)	12 (42.8%)	16 (57.9%)	0.105
Hypertension	28 (45.9%)	13 (46.4%)	15 (53.5%)	0.268
Diabetes	31 (50.8%)	14 (45.1%)	17 (54.9%)	0.154
Cardiac Failure	23 (37.7%)	6 (26.1%)	17 (73.9%)	**0.01**
Anterior	40 (65.6%)	17 (42.5%)	23 (57.5%)	0.12
Inferior	21 (34.4%)	16 (76.2%)	5 (23.8%)	
Dyslipidaemia	26 (42.6%)	16 (61.5%)	10 (38.5%)	0.315
Base Line Characteristics of Whole Study Cohort and the Two Study Groups with Respect to ST Segment Resolution				
	Whole Cohort	**QRS<4**	**QRS>4**	**p-value**

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Age	56.07 ±11.845	52.18 ±11.574	60.96 ±10.442	**0.003**
Smoking	24 (39.3%)	13 (54.1%)	11 (45.9%)	0.842
Alcohol	28 (45.9%)	16 (57.1%)	12 (42.9%)	0.839
Hypertension	28 (45.9%)	13 (46.4%)	15 (53.6%)	0.178
Diabetes	31 (50.8%)	13 (41.9%)	18 (58.1%)	**0.027**
Cardiac Failure	23 (37.7%)	7 (30.4%)	16 (69.6%)	**0.002**
Anterior	40 (65.6%)	18 (45%)	22 (55%)	0.20
Inferior	21 (34.4%)	16 (76.1%)	5 (23.9%)	
Dyslipidaemia	26 (42.6%)	15 (57.6%)	11 (42.4%)	0.791

Base Line Characteristics of Whole Study Cohort and the Two Study Groups with Respect to QRS Score

Table 1

	QRS <4	**QRS >4**	**P-Value**
Smoker	54.1%	45.9%	0.842
Non-Smoker	56.8%	43.2%	
Effect of Smoking on QRS Score and ST Segment Resolution			
	Resolution Group	**Non-Resolution Group**	**P-Value**
Smoker	41.7%	58.3%	0.117
Non-Smoker	62.2%	37.8%	
Effect of Smoking on ST Segment Resolution			
	QRS <4	**QRS >4**	**P-Value**
Alcoholic	57.1%	42.9%	0.839
Non-Alcoholic	54.5%	45.5%	
Effect of Alcohol on QRS Score			
	Resolution Group	**Non-Resolution Group**	**P-Value**
Alcoholic	57.1%	42.9%	0.117
Non-Alcoholic	36.4%	63.6%	
Effect of Alcohol on ST Segment Resolution			
	QRS <4	**QRS >4**	**P-Value**
Hypertensives	46.4%	53.6%	0.178
Non-Hypertensives	63.6%	36.4%	
Effect of Hypertension on QRS Score			

Table 2

	Resolution Group	**Non- Resolution Group**	**P-Value**
Hypertensives	46.4%	53.6%	0.268
Non-Hypertensives	60.6%	39.4%	
Effect of Hypertension on ST Segment Resolution			
	QRS <4	**QRS >4**	**P-Value**
Diabetic	41.9%	58.1%	**0.027***
Non Diabetic	70%	30%	
Effect of Diabetes on QRS Score			
	Resolution Group	**Non-Resolution Group**	**P-Value**
Diabetic	45.2%	54.8%	0.154
Non-Diabetic	63.3%	36.7%	
Effect of Diabetes on ST Segment Resolution			
	QRS <4	**QRS >4**	**P-Value**

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CCF	30.4%	69.6%	**0.002***
NO CCF	71%	29%	
Effect of CCF on QRS Score			
	Resolution Group	**Non-Resolution Group**	**P-Value**
CCF	26.1%	73.9%	**0.001***
NO CCF	71%	29%	
Effect of CCF on ST Segment Resolution			
Table 3			

	QRS <4	**QRS >4**	**P-Value**
Anterior	45%	55%	**0.02***
Inferior	76.2%	23.8%	
Effect of Type of MI on QRS Score			
	Resolution Group	**Non- Resolution Group**	**P-Value**
Anterior	42.5%	57.5%	**0.012***
Inferior	76.2%	23.8%	
Effect of Type of MI on ST Segment Resolution			
	QRS <4	**QRS >4**	**P-Value**
Dyslipidemia	57.7%	42.3%	0.791
No Dyslipidemia	54.3%	45.7%	
Effect of Dyslipidaemia on QRS Score			
	Resolution Group	**Non-Resolution Group**	**P-Value**
Dyslipidemia	61.5%	38.5%	0.315
No Dyslipidemia	48.6%	51.4%	
Effect of Dyslipidaemia on ST Segment Resolution			
Table 4			

The resolution group had a lower QRS score (3 ±1.436) compared to the non-resolution group (6.43 ±2.91), and this difference was statistically significant (p = 0.001). Additionally, the resolution group's STE1 (18.55 ± 10.025) was lower than that of the non-resolution group (25.18 ± 13.485). The non-resolution group had a lower STR ($p<0.05$). Table 2 indicates a statistically significant negative connection (r = -0.37) between the QRS score and STR. Additionally, Table 5 showed a negative connection (p = 0.01) between QRS and ejection fraction.

	Whole Cohort (N = 61)	**Resolution Group (N = 33)**	**Non- Resolution Group (N = 28)**	**P-Value**
QRS Score	4.57 ±2.807	3 ±1.436	6.43 ±2.911	**0.001**
STE1	21.59±12.106	18.55 ±10.025	25.18 ±13.485	0.032
STR	9.049±6.727	12.212 ±7.44	5.321 ±2.89	0.020
Ejection Fraction	40.98±7.300	45.06 ±5.172	36.18 ±6.515	**0.001**
Electrocardiographic Data of the Overall Cohort and ST Resolution				
	Whole Cohort (N = 61)	**QRS <4**	**QRS >4**	**P-Value**
STE1	21.59±12.106	18.18 ±9.712	25.89±13.566	**0.012**
STR	9.049 ±6.727	11.12 ±7.64	6.296 ±4.140	**0.003**
Ejection Fraction	40.98 ±7.300	44.44 ±5.106	36.63 ±7.386	**0.001**
Electrocardiographic Data of the Overall Cohort and QRS Score				
Table 5				

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DISCUSSION

Numerous clinical studies have demonstrated a link between non-resolution of the ST segment and a higher risk of complications and death.[12] In this case, the slower and less complete resolution of the ST segment can be predicted by the presence of Q waves prior to reperfusion. The modified Selvester score, a 29-point system that is a simplified form, was used in our study to quantify the QRS score in the early stage of the disease to determine the effectiveness of reperfusion after treatment. The Selvester QRS score[13] was originally developed to predict infarct size using ECG using 10 ECG leads. As a criterion for successful and unsuccessful reperfusion, respectively, we established a cutoff of ≥ 50% and <50% of ST resolution.

Research by Liu et al. and Uyarel H et al.[14,15] revealed that patients with a high 2-year mortality rate following PCI treatment had a higher QRS score. Compared to thrombolysis, PCI's reperfusion of the occluded arteries results in less myocardial salvage over time. The effectiveness of thrombolysis declines with time, although PCI seldom causes this issue.[16] Determining the effectiveness of thrombolysis following treatment is therefore crucial.

Early and full resolution of ST-segment elevation is known to be a strong predictor of both tissue-level myocardial perfusion preservation and infarct-related arterial patency. Depending on how far along the infarction process is, different ECG signs of restored myocardial perfusion can indicate different outcomes for a successful ST segment resolution. When a first acute STEMI occurs, the presence of Q waves indicates a more advanced stage of the infarction process.[15] Many thrombolysis trial studies have examined the prognostic significance of ST segment resolution. These studies have demonstrated that patients with acute STEMI who have incomplete ST segment resolution are more likely to have larger infarct sizes, a higher risk of death and congestive heart failure, and persistent infarct-related artery occlusion.[17-19] However, it has been shown that full ST segment resolution is a highly reliable indicator of both maintained myocardial tissue perfusion and infarct-related arterial patency.[20,21] According to a study, in patients with STEMI treated with primary percutaneous coronary intervention, a high QRS score is an independent predictor of inadequate ST segment recovery and 30-day severe cardiac events.[5] The non-resolution group had a higher incidence of anterior infarction than inferior infarction due to insufficient ST segment resolution. Anterior infarction was observed in a similar proportion of patients in our study who had a higher QRS score and, consequently, no resolution. Accordingly, despite very slight variations in epicardial blood flow, De Lemos et al.[17] showed that individuals with anterior infarction have much less ST segment resolution than those with inferior infarction. This implies that in patients with anterior vs. inferior infarction, ST resolution correlates less with epicardial blood flow. Compared to inferior infarction, anterior infarction is frequently linked to higher infarct sizes and more tissue damage. It should come as no surprise that patients with partial ST segment resolution (the non-resolution group) had more symptoms of left ventricular dysfunction. Similarly, individuals with myocardial contrast echocardiography-detected no-reflow had a significantly higher Killip class upon hospital admission than those without such evidence (Iwakura et al).[22] More contractile units would be lost as a result of inadequate myocardial perfusion at the tissue level, which would impair contractile performance and cause pump failure. We found that the non-resolution group with a QRS score > 4 had a higher incidence of CCF in this trial as well. In addition to counting the number of Q waves, the QRS score is a quantitative indicator of myocardial injury that is derived from decreased R wave amplitude and width and increased Q wave width. The degree of myocardial damage is closely correlated with the Selvester QRS score, and it is commonly recognised that heart failure develops when LVEF is decreased, which is linked to

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the size of the infarct in STEMI patients.[23] A high QRS score was observed to be associated with infarct size in STEMI patients receiving primary PCI, low LVEF, incomplete ST-segment resolution, heightened frequency of anterior wall infarction, high CK-MB levels, and a high total number of ST-segment elevated events on ECG. Major adverse cardiovascular outcomes, including congestive heart failure, cardiac death, sudden cardiac death, and all-cause death, were more likely in the group with a higher QRS score in the same study.[24] Uyarel et al. found that significant adverse cardiac events on day 30 were more common in STEMI patients receiving primary PCI than in the patient group with a high QRS score.[15] Tjandrawidjaja et al. discovered that in STEMI patients receiving initial PCI on day 90, if they had a QRS score of ≥4, their probability of dying was doubled.[25]

A significant inverse relationship was discovered by Shereef, A. et al.[26] between the QRS score and ST-segment resolution ($r = -0.483$, $p = 0.00078$). Abdel-Salam et al. discovered similar outcomes.[11]

Additionally, they proposed that, in comparison to ST segment resolution, a QRS score of 4 can predict successful reperfusion with a 59.3% sensitivity and a 100% specificity. The results of the current study also demonstrated that almost all patients had a QRS score of ≤ 4 for successful ST segment resolution.

Similar to the current study, Abdel-Salam et al. discovered that STEMI patients who would benefit from thrombolytic treatment could be accurately identified using a simplified Selvester QRS score.[11]

CONCLUSION

When patients with STEMI are receiving thrombolytic therapy, the QRS score accurately predicts the resolution of the ST segment. Patients are more likely to experience non-resolution of the ST segment if their QRS score is greater than 4.

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