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# Selvester score and myocardial performance index in acute anterior myocardial infarction

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## SUMMARY

**BACKGROUND:** The simplified Selvester QRS score is a parameter for estimating myocardial damage in ST-elevation myocardial infarction. ST-elevation myocardial infarction leads to varying degrees of impairment in left ventricular systolic and diastolic function. Myocardial performance index is a single parameter that can predict combined left ventricular systolic and diastolic performance.

**OBJECTIVE:** We investigated the relationship between Selvester score and myocardial performance index in patients undergoing primary percutaneous coronary intervention for acute anterior myocardial infarction.

**METHODS:** The study included 58 patients who underwent primary percutaneous coronary intervention for acute anterior myocardial infarction. Selvester score of all patients was also calculated at 72 h. Patients were categorized into two groups according to the Selvester score. Those with a score <6 (low score) were considered group 1 and those with a score ≥6 (high score) were considered group 2.

**RESULTS:** When compared with group 1, patients in group 2 were older (p=0.01) and had lower left ventricular ejection fractions (50.3±4 vs. 35.6±6.9, p=0.001), and conventional myocardial performance index (0.52±0.06 vs. 0.69±0.08, p=0.001), lateral tissue Doppler-derived myocardial performance index (0.57±0.08 vs. 0.72±0.08, p=0.001), and septal tissue Doppler-derived myocardial performance index (0.62±0.07 vs. 0.76±0.08, p=0.001) were higher. There was a high correlation between lateral tissue Doppler-derived myocardial performance index and conventional myocardial performance index and Selvester score (r=0.80, p<0.001; r=0.86, p<0.001, respectively) and a moderate correlation between septal tissue Doppler-derived myocardial performance index and Selvester score (r=0.67, p<0.001).

**CONCLUSIONS:** The post-procedural Selvester score can predict lateral tissue Doppler-derived myocardial performance index and conventional myocardial performance index with high sensitivity and acceptable specificity in patients undergoing primary percutaneous coronary intervention for acute anterior myocardial infarction.

**KEYWORDS:** Echocardiography. Infarction. Percutaneous coronary intervention.

## INTRODUCTION

The severity of myocardial damage in survivors of ST-elevation myocardial infarction (STEMI) has great prognostic importance[1,2]. In 12-lead electrocardiography (ECG), the Selvester QRS scoring system, developed by Selvester et al., calculates the infarct area (IS) based on QRS waveforms[3]. This system is easy to use, accessible, and inexpensive and provides important information about prognosis after acute MI. Many studies have been performed by comparing Selvester QRS scoring with radionuclide ventriculography, creatinine kinase peak level, and myocardial perfusion imaging by single-photon emission computed tomography (SPECT) in determining IS and showed that Selvester QRS scoring provides comparable information with these methods[4]. Delayed enhancement magnetic resonance imaging (DE-MRI) is an important imaging tool that can provide accurate and direct measurement of IS[5]. Recent studies have also shown a good correlation between the Selvester QRS scoring system and DE-MRI in determining IS[6].

Myocardial performance index (MPI) provides important information in the evaluation of left heart systolic and diastolic functions. The prognostic value of MPI in various cardiac diseases such as MI has been proven in many studies. In the classical approach, MPI is obtained using a pulsed-wave Doppler. In recent years, tissue Doppler-derived MPI (tMPI) has been used instead of conventional MPI (cMPI). This is due to the fact that tMPI is not affected by preload and heart rate variability[7]. To the best of our knowledge, there are no studies investigating the relationship between Selvester QRS score and MPI in patients undergoing pPCI for acute anterior MI. Our aim was to examine the relationship between Selvester QRS score and both cMPI and tMPI.

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# METHODS

## Study population

Between January 2021 and May 2022, 58 patients with anterior STEMI who were admitted to our hospital within the first 12 h of MI were included in the study. STEMI was diagnosed according to the European Society of Cardiology Guidelines[7]. Patients with left bundle branch block on ECG, >50% stenosis in vessels other than the vessel responsible for the lesion, pacemaker rhythm, left fascicular block, evidence of left ventricular (LV) hypertrophy on ECG, atrial fibrillation, and patients with severe heart failure and cardiogenic shock were excluded. The study protocol was approved by the local ethics committee and informed written consent was obtained from all patients. The study was conducted in accordance with the Declaration of Helsinki. The definition of risk factors was explained in previous studies.

## Percutaneous coronary intervention procedure

Coronary angiography was performed using the Judkins technique via femoral or right radial artery access. Guideline-directed medical and interventional therapies were performed on all our patients.

## Echocardiographic evaluation

Patients were evaluated in the lateral decubitus position with a Philips Envisor C echocardiograph (Philips Medical Systems, Andover, MA, USA) using a 3.5-MHz transducer, and ECG recording was performed simultaneously 72 h after the onset of MI. The interval between the end and beginning of the mitral inflow velocity was determined as "a." Pulsed Doppler analysis of LV outflow was performed by placing the sample volume just below the aortic valve in all five cavity windows and the interval between the beginning and end of LV outflow was determined as "b." The mean values of ''a" and ''b" were calculated as the average of the values obtained from three consecutive cardiac cycles, and the conventional MPI was calculated as (a–b)/b. Peak early (Em) and late (Am) diastolic velocities and peak systolic (Sm) annular velocity were recorded from these sites. MPI, based on TDI (tMPI), was calculated as follows: (IVCT + IVRT) / ET.

## Electrocardiography interpretation and Selvester QRS score calculation

All patients underwent ECG on admission, after primary PCI, 90 min after PCI, and daily thereafter during hospitalization. The height of ST elevation was measured 20 ms after the J point. Total ST elevation was measured as the sum (mm) of ST elevation in leads D1, aVL, and V1 to V6. Total ST elevation was determined as STE1 at admission and as STE2 at 90 min. Modified Selvester QRS scoring was used in the study[8].

## Statistical analysis

The SPSS 22.0 statistical software (SPSS Inc., Chicago, IL, USA) was used for statistical analysis. Data conforming to normal distribution were expressed as mean±standard deviation (SD) and the data not conforming to normal distribution were expressed as median (minimum-maximum). Categorical variables were expressed as percentages and compared using $\chi^2$ or Fischer's exact test. Continuous data with normal distribution were compared with Student's t-test. ROC analysis was performed to determine the optimum threshold value of septal tMPI, lateral tMPI, and cMPI for the prediction of patients with high Selvester score. Univariate and multivariate logistic regression analyses were performed to identify independent predictors of high Selvester score. The Spearman's correlation test was performed to determine the relationship between high Selvester score and septal tMPI, lateral tMPI, and cMPI. A $p<0.05$ was considered statistically significant.

# RESULTS

A total of 64 patients with acute anterior MI were included in the study. Six patients were excluded from the study due to poor echocardiographic appearance. The mean age of the patients was 58.13±11.3 years and 20.7% of patients were female. Baseline demographic and laboratory characteristics are shown in Table 1. The patients were divided into two groups according to Selvester scores: group 1 with score <6 (low score) and group 2 with score ≥6 (high score).

Group 2 was older (56±12.6 vs. 60±9.8; p=0.01) and LVEFs were lower (50.3±4 vs. 35.6±6.9, p=0.001), and cMPI (0.52±0.06 vs. 0.69±0.08; p=0.001), lateral tMPI (0.57±0.08 vs. 0.72±0.08, p=0.001), and septal tMPI (0.62±0.07 vs. 0.76±0.08, p=0.001) were higher. Notably, 72 h QRS time and STE2 were lower in group 1 (Table 2). According to logistic regression analysis, septal tMPI, lateral tMPI, and cMPI were independent risk factors for high Selvester score (p<0.001) (Table 3). Correlation analysis was also performed to reveal the relationship between Selvester score and septal/lateral tMPI, and cMPI. The Spearman's correlation analysis showed a high correlation (r=0.80, p<0.001; r=0.86, p<0.001, respectively) between lateral tMPI and cMPI and Selvester score.

In our ROC curve analysis to identify patients with high Selvester scores, the findings were as follows: septal tMPI [(AUC=0.84, 95%CI 0.72–0.96, p<0.001)], lateral tMPI (AUC=0.90, 95%CI 0.82–0.98, p<0.001), and cMPI (AUC=0.88, 95%CI 0.78–0.97, p<0.001).

**Table 1.** Demographic and clinical characteristics.

| | Patients (n=58) |
|---|---|
| Gender (M/F), n (%) | 46/12 (79.3%/20.7%) |
| Age (years), mean±SD | 58.13±11.3 |
| Weight (kg), mean±SD | 80.2±9.8 |
| Height (cm), mean±SD | 173.13±6.6 |
| BMI (kg/m²), mean±SD | 26.7±3.5 |
| Diabetes, n (%) | 24 (41.4%) |
| Hypertension, n (%) | 24 (41.4%) |
| Hyperlipidemia, n (%) | 32 (55.2%) |
| Smoking, n (%) | 28 (48.3%) |
| Family history of coronary artery disease (%) | 14 (24.1%) |
| Echocardiographic measurements | |
| LVEF (%) | 42.76±9.3 |
| Mitral E velocity (cm/s) | 68.7±18.5 |
| Mitral A velocity (cm/s) | 76.4±17.6 |
| Mitral E/A ratio | 0.94±0.38 |
| IVRT (ms) | 95.6±11.4 |
| IVCT (ms) | 68.1±16.5 |
| ET (ms) | 266.6±15.2 |
| cMPI | 0.61±0.11 |
| Lateral IVRT (ms) | 92.8±11.4 |
| Lateral IVCT (ms) | 76.1±18.7 |
| Lateral ET (ms) | 257.6±15.5 |
| Lateral tMPI | 0.65±0.11 |
| Septal IVRT (ms) | 100.2±11.2 |
| Septal IVCT (ms) | 77.3±17.5 |
| Septal ET (ms) | 254.3±13.6 |
| Septal tMPI | 0.70±0.1 |
| Electrocardiographic measurements | |
| STE1 (mV) | 11.5±4.9 |
| STE2 (mV) | 5.2±3.34 |
| 72 h Selvester score | 6.1±2.4 |
| Laboratory results | |
| Glucose (mg/dl) | 198.72±105.9 |
| Creatinine (mg/dl) | 1.08±0.42 |
| Sodium (mmol/L) | 140±8.5 |
| Hemoglobin | 16.3±5 |
| Platelet count (×10³/μl) | 294.6±71.8 |
| High-density lipoprotein (mg/dl) | 36.5±5.6 |
| Low density lipoprotein (mg/dl) | 133.3±28.8 |
| Total cholesterol (mg/dl) | 216.2±39.9 |
| Triglycerides (mg/dl) | 178.3±22.5 |
| Medication | |
| Acetylsalicylic acid | 30 (51.7%) |
| ACE-I /AT-II blocker | 26 (44.8%) |
| Beta-blocker | 14 (24.1%) |
| Statin | 12 (20.7%) |

BMI: body mass index; LVEF: left ventricular ejection fraction; IVRT: isovolumetric relaxation time; IVCT: isovolumetric contraction time; ET: ejection time; cMPI: conventional myocardial performance index; tMPI: tissue Doppler-derived myocardial performance index; Sm: mitral annular peak systolic; Em: mitral annular early diastolic velocity; Am: mitral annular late diastolic velocity; STE1: the sum of ST segment elevations at baseline; STE2: the sum of ST segment elevations at 90 min; ACE-I: angiotensin-converting enzyme inhibitors; AT-II: angiotensin-II.

## DISCUSSION

Myocardial performance index (MPI) provides important information about both systolic and diastolic functions of the heart as a single parameter and is used in many cardiac diseases including MI leading to myocardial dysfunction. Conventional MPI is the sum of IVCT and IVRT divided by the ejection time (ET). The intervals here are not intervals of the same cardiac cycle but are derived from consecutive cycle intervals. Therefore, many factors, especially heart rate variability, reduce the reliability of cMPI. However, tMPI can be obtained by the ratio of the relaxation and contraction intervals to the ET of the same cardiac cycle. Therefore, it also provides reliable measurements in cases of heart rate fluctuation. To the best of our knowledge, there are no studies investigating the relationship between Selvester QRS score and LV MPI. In addition, previous studies have shown that the efficacy of the Selvester QRS score is more valuable in patients with anterior MI. Some studies have shown that there are differences between cMPI and tMPI, especially in patients with previous MI. In this study, both cMPI and tMPI values measured from the lateral and septal regions of all patients were higher than normal. When we categorized the patients into high Selvester score and low Selvester score, it was also revealed that both cMPI and septal and lateral tMPI were more impaired in patients with high Selvester score. The correlation analysis between MPI and Selvester score showed that there was a strong correlation between Selvester score and cMPI and lateral tMPI. This was interpreted that both cMPI and tMPI were globally affected by systolic and diastolic functions of the heart. In patients with MI, changes in TDI-based intervals occur due to the intraventricular conduction system, asynchrony, and the effects of relaxation and contraction times, resulting in an increase in MPI. Rojo et al.[9], on a control group consisting of healthy individuals and patients who had a previous MI, revealed the incompatibility between tMPI and cMPI. They interpreted this difference as longer systolic intervals and shorter diastolic intervals in TDI-based measurements. In our study, it was revealed that cMPI and septal/lateral tMPI values were numerically different. This discordance in MPI values is also present in the measurements of healthy individuals, but this difference is even more prominent in MI survivors[8]. Therefore, this should be taken into account when using TDI-based MPI.

Kurisu et al.[10] showed that there is a good correlation between total perfusion defect measured by SPECT and Selvester score in patients who underwent pPCI for anterior MI. Therefore, the Selvester score can be used in the prediction of IS in clinics like ours where cardiovascular magnetic resonance (CMR) is not common and we used it in our study.

**Table 2.** Comparison of clinical characteristics of patients with 72 h Selvester score values of <6 and ≥6.

| Variables | Group 1 (72 h Selvester score <6) (n=28) | Group 2 (72 h Selvester score ≥6) (n=30) | p |
|---|---|---|---|
| Age | 56±12.6 | 60±9.8 | 0.01 |
| LVEF (%) | 50.3±4 | 35.6±6.9 | <0.001 |
| cMPI | 0.52±0.06 | 0.69±0.08 | <0.001 |
| Lateral tMPI | 0.57±0.08 | 0.72±0.08 | <0.001 |
| Septal tMPI | 0.62±0.07 | 0.76±0.08 | <0.001 |
| 72 h QRS duration (ms) | 83±10.7 | 94±10.3 | <0.001 |
| STE1 | 10.4±5.2 | 12.3±4.4 | 0.141 |
| STE2 | 3.2±1.7 | 6.8±3.5 | <0.001 |

**Table 3.** Univariate and multivariate logistic regression analyses of the independent indicators of high Selvester score.

| Variables | Univariate analysis | | Multivariate analysis | |
|---|---|---|---|---|
| | OR (95%CI) | p | OR (95%CI) | p |
| Age | 1.070 (1.013–1.131) | 0.016 | 1.042 (0.943–1.153) | 0.417 |
| Septal tMPI | 1.205 (1.091–1.331) | <0.001 | 0.99 (0.797–1.246) | 0.02 |
| Lateral tMPI | 1.45 (1.191–1.765) | <0.001 | 1.28 (0.787–2.083) | 0.04 |
| cMPI | 1.308 (1.146–1.492) | <0.001 | 1.198 (0.903–1.591) | 0.01 |

Myocardial performance index (MPI) is a parameter related to both systolic and diastolic performance and is not affected by heart rate, blood pressure, or ventricular geometry. Sasao et al.[11] showed that cMPI had a good correlation with the IR in patients with acute MI and that cMPI was an important indicator for prognosis in this patient group. We investigated the relationship between Selvester score and MPI in determining IS. We also showed a high correlation between the Selvester score and both MPI methods. We believe that the sum of these factors causes an increase in myocardial damage by impairing coronary perfusion and consequently contributes to the increase in the Selvester score. Some limitations of the study also exist. First, this was a single-center study and the number of patients was small. Second, measurements were taken only on the third day after MI and not in the post-discharge period; therefore, the change and correlation of MPI and Selvester score can be seen in the chronic phase. Third, there is a lack of CMR examination to reveal the concordance between these two parameters and CMR.

## CONCLUSION

Both MPI and Selvester score are important, easy, reproducible, and inexpensive methods for predicting IS after MI in clinics like ours where CMR is not common. This study also demonstrated a strong correlation between these two methods.

## AUTHORS' CONTRIBUTIONS

**MK:** Conceptualization, Data curation, Formal analysis, Funding acquisition, and Writing – original draft. **CA:** Writing – review & editing, Investigation, Methodology, Resources. **KT:** Software, Supervision, Validation Visualization, and Project administration

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