

## ORIGINAL ARTICLE

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## Association between QRS score and myocardial viability in patients with stable angina pectoris

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### Abstract

To evaluate whether the electrocardiography-derived QRS score is associated with myocardial viability (MV) assessed by fluorodeoxyglucose positron emission tomography (FDG-PET/CT) in patients with stable angina pectoris (SAP), reduced left ventricular ejection fraction (LVEF), and significant left anterior descending artery (LAD) stenosis. This retrospective cross-sectional study included 65 patients with SAP, LVEF  $\leq$  45%, significant LAD stenosis on angiography, and FDG-PET/CT performed for further MV assessment after an infarcted myocardial region had been reported on myocardial perfusion scintigraphy during the pre-revascularization evaluation. QRS scores were calculated using a modified Selvester scoring system. Binary logistic regression was used to evaluate factors associated with MV. MV was identified in 26 patients (40%). Patients with MV had lower QRS scores than those without MV ( $1.65 \pm 1.38$  vs.  $4.54 \pm 1.48$ ,  $p < 0.001$ ). Lower QRS score was associated with MV (OR: 0.29; 95% CI: 0.17 – 0.51;  $p < 0.001$ ). For MV detection, QRS score yielded an AUC of 0.914 (95% CI: 0.84 – 0.98), and QRS score  $< 5$  threshold showed 92.3% sensitivity and 56.4% specificity. In this selected cohort, lower QRS scores were associated with FDG-PET/CT-defined MV in the LAD territory. QRS scoring may provide adjunctive information during initial viability assessment, but should not replace established imaging-based evaluation.

**Keywords:** Electrocardiography; myocardial viability; ventricular dysfunction, left; revascularization; positron emission tomography

### Introduction

Left ventricular systolic dysfunction frequently develops in the context of coronary artery disease (CAD) and may represent an important pathway to heart failure. When reduced left ventricular ejection fraction (LVEF) occurs together with significant coronary atherosclerosis, the condition is generally referred to as ischemic cardiomyopathy [1]. In appropriately selected patients, revascularization added to guideline-directed medical therapy may improve ventricular performance and clinical prognosis [1-3]. For this reason, identifying residual viable myocardium is clinically important in patients with stable angina pectoris

(SAP) and reduced LVEF who are being evaluated before revascularization [4]. Fluorodeoxyglucose positron emission tomography (FDG-PET/CT) is widely used for myocardial viability (MV) assessment; however, its use in daily practice may be restricted by limited availability, cost, and the need for technical expertise.

The surface 12-lead electrocardiogram (ECG) may provide indirect information about prior myocardial injury. The Selvester QRS scoring system was developed to estimate myocardial scar by evaluating QRS-complex features such as Q- and R-wave characteristics across different leads. Previous studies have linked

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higher QRS scores with larger infarct size and greater myocardial scar burden [5,6]. In addition, recent data in anterior myocardial infarction (MI) suggest that admission QRS score may be associated with infarct extent and impaired reperfusion [7].

Most available evidence regarding QRS scoring has been derived from acute MI populations. However, the relationship between QRS score and metabolically defined MV in chronic ischemic patients remains insufficiently investigated. In particular, limited data are available on whether an ECG-derived QRS score reflects FDG-PET/CT-defined MV in patients with SAP, reduced LVEF, and significant left anterior descending (LAD) stenosis undergoing viability assessment before revascularization. Therefore, the present study aimed to address this gap by evaluating the association between QRS score and FDG-PET/CT-defined MV in the LAD territory. We hypothesized that lower QRS scores would be associated with preserved MV.

Material and Methods

Study Design and Setting

This retrospective cross-sectional analysis was based on the cardiology records of Antalya Training and Research Hospital. The dataset comprised patients with SAP, reduced LVEF, significant LAD stenosis on angiography, and available FDG-PET/CT data obtained before revascularization for MV assessment. We examined whether the ECG-derived QRS score corresponded to FDG-PET/CT-defined MV in this selected cohort.

Ethics Approval

Ethical approval for the study was obtained from the Ethics Committee of Antalya Training and Research Hospital (Approval No: 4/1; February 27, 2025). The study was performed in accordance with the principles of the Declaration of Helsinki.

Study Population

Patients evaluated between January 1, 2014, and December 30, 2024, were identified from the cardiology records of Antalya Training and Research Hospital. Patients were considered eligible if they were ≥ 18 years old and had SAP, significant LAD stenosis on angiography, LVEF ≤ 45%, and an infarcted myocardial region within the LAD territory reported on myocardial perfusion scintigraphy (MPS), followed by FDG-PET/CT for further viability assessment. Significant LAD stenosis was defined as ≥ 70% luminal diameter narrowing, and reduced LVEF as LVEF ≤ 45%. A total of 110 patients who underwent FDG-PET/CT were screened. Of these, 45 were excluded because viability assessment involved coronary territories other than the LAD territory, leaving 65 patients with LAD-territory viability assessment for the final analysis. No otherwise eligible patient was excluded because FDG-PET/CT had not been performed. The patient selection process is shown in Figure 1.

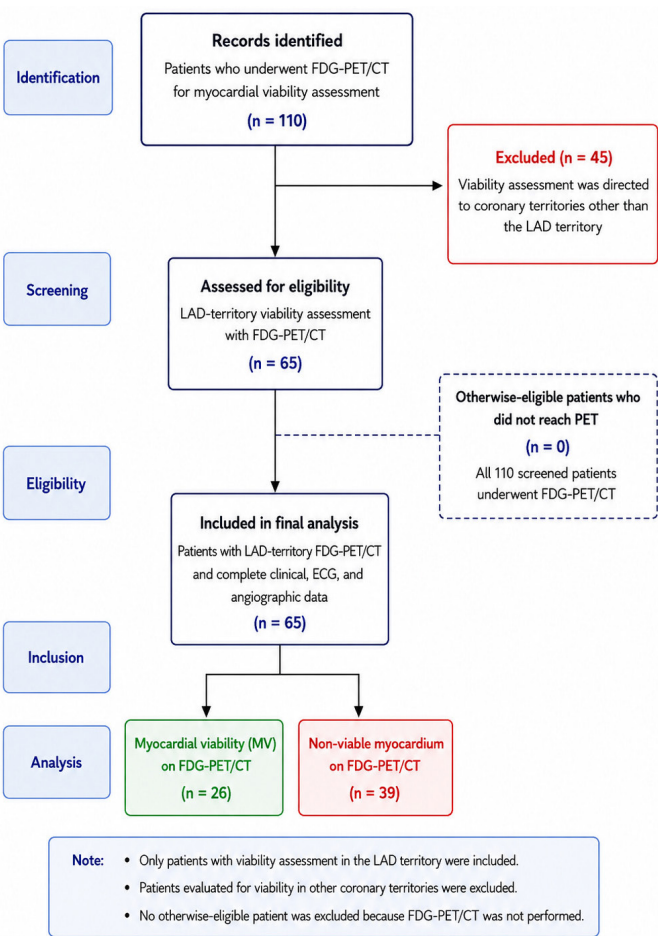


**Figure 1.** Patient selection flow diagram. The screening, exclusion, and final inclusion of patients undergoing FDG-PET/CT for myocardial viability assessment are shown. Abbreviations: ECG, electrocardiogram; FDG-PET/CT, fluorodeoxyglucose positron emission tomography/computed tomography; LAD, left anterior descending artery.

Demographic characteristics, comorbidities, laboratory measurements, ECG findings, angiographic data, and imaging results were obtained from electronic records and archived files. Descriptive and univariable analyses were performed using available data for each variable. Complete-case analysis was used for the multivariable logistic regression model, and missing-data imputation was not performed.

Definitions and Data Collection

Within our center’s pre-revascularization evaluation pathway, MPS is used as the first imaging method for MV assessment. Detailed MPS acquisition parameters and a uniform study-specific quantitative definition of an “infarcted region” could not be retrospectively verified; therefore, eligibility was determined based on the original clinical MPS report. When an infarcted myocardial region is identified on MPS, FDG-PET/CT is performed for further MV assessment.

FDG-PET/CT imaging was performed according to the routine myocardial viability protocol of our nuclear medicine

department. Patients received a 25-g oral glucose load, followed 30 minutes later by intravenous administration of  $^{18}\text{F}$ -FDG. Three-dimensional thoracic PET/CT images were acquired 60 minutes after radiotracer administration. PET findings were interpreted in comparison with the corresponding Tc-99m MIBI myocardial perfusion scintigraphy findings as part of the routine clinical viability assessment. Because of the retrospective design, fasting duration, target blood glucose levels, details of insulin administration, standardized tracer dose, reconstruction parameters, and the number and experience of the original PET readers could not be reliably verified for all patients.

MV was defined as the presence of metabolically active, viable myocardial tissue within the LAD territory as reported in the routine clinical FDG-PET/CT interpretation. Patients were classified as having viable or non-viable myocardium according to the original clinical report.

Because this retrospective study relied on routine clinical reports, the percentage of viable myocardium was not recalculated from the original images, and quantitative assessment of perfusion-metabolism mismatch was not uniformly available. Accordingly, perfusion-metabolism mismatch was not required as a study-specific criterion for MV classification. Although previous literature has suggested that a viable myocardial burden exceeding approximately 10% of the myocardium may be clinically relevant when considering revascularization, this threshold was not quantitatively re-derived or applied as a classification cutoff in the present cohort [8]. No study-specific re-evaluation or centralized quantitative re-analysis of the original FDG-PET/CT images was performed.

Significant LAD disease was defined as  $\geq 70\%$  luminal diameter stenosis according to the procedural angiography report.

Standard 12-lead ECG recordings were jointly evaluated by two cardiologists experienced in ECG interpretation without knowledge of the FDG-PET/CT results, and QRS scores were assigned by consensus. After completion of the ECG assessment, MV data were obtained from the routine clinical FDG-PET/CT reports. Thus, QRS scoring was performed independently of the PET-defined MV status.

QRS scoring was based on the original Selvester QRS scoring framework [5], using a simplified modified approach restricted to eight predefined criteria in leads V1-V5 and aVL, consistent with the approach reported in Reference [7]. These criteria included Q-wave presence and duration, R-wave amplitude, and R/Q ratios. Each fulfilled criterion contributed one point, yielding a total score ranging from 0 to 8. Based on a previously reported threshold [7], a QRS score  $< 5$  was prespecified before the analysis. Although this threshold was originally reported in an acute ST-segment elevation myocardial infarction (STEMI) population, it was considered biologically plausible in the present chronic ischemic cohort because higher QRS scores reflect greater myocardial scar burden; however, it has not been specifically validated for chronic MV assessment. The individual

scoring criteria are presented in Figure 2, and a comparison between the original Selvester QRS scoring system and the simplified approach used in the present study is provided in Supplementary Table S1.

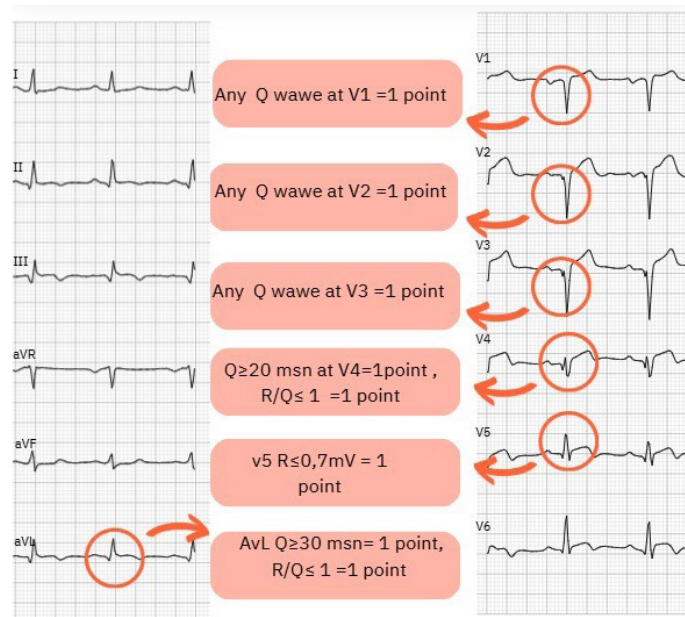


**Figure 2.** Calculation of the modified Selvester-based QRS score. One point was assigned for each predefined criterion: any Q wave in V1 (1 point), V2 (1 point), or V3 (1 point); Q-wave duration  $\geq 20$  ms in V4 (1 point); R/Q ratio  $\leq 1$  in V4 (1 point); R-wave amplitude  $\leq 0.7$  mV in V5 (1 point); Q-wave duration  $\geq 30$  ms in aVL (1 point); and R/Q ratio  $\leq 1$  in aVL (1 point). The total score ranged from 0 – 8.

Patients with ECG findings that could compromise the reliability of QRS score assessment were excluded. These findings included left or right bundle branch block, interventricular conduction delay, paced rhythm, ECG evidence of ventricular hypertrophy, and ECG recordings of insufficient technical quality.

### Statistical Analyses

Statistical evaluation was performed using Jamovi version 2.7.38.0. Continuous data were summarized according to their distribution. Variables showing normal distribution were given as mean  $\pm$  standard deviation, and skewed variables were given as median and interquartile range. Group comparisons were made with the independent-samples t-test or Mann-Whitney U test, as appropriate. Categorical data were presented as counts and percentages and analyzed using the chi-square test or Fisher's exact test. Complete-case analysis was performed for the multivariable logistic regression model. Due to missing baseline clinical and laboratory data (including hypertension and diabetes mellitus status in 7 patients, as well as missing values in other continuous covariates), a total of 53 patients with complete data were included in the final multivariable calibration, discrimination, and classification analyses.

Logistic regression was applied to evaluate the association between QRS score and FDG-PET/CT-defined MV. The first

model was unadjusted. Model 1 included age and sex, while Model 2 was considered an exploratory adjusted model. Age and sex were included as basic demographic covariates, whereas diabetes mellitus, hypertension, and triglyceride level were selected a priori based on clinical relevance rather than solely on univariable statistical significance. Multicollinearity testing demonstrated VIF values < 2 for all included covariates. Results were presented as ORs with 95% CIs. Model calibration was evaluated using the Hosmer-Lemeshow goodness-of-fit test, with  $p > 0.05$  indicating acceptable goodness-of-fit.

Receiver operating characteristic (ROC) analysis was used to assess the discriminative ability of QRS score for MV. For Model 2, ROC analysis was performed using the predicted probabilities generated from the multivariable logistic regression model. Sensitivity, specificity, positive predictive value, negative predictive value, and AUC were calculated using the prespecified QRS score < 5 threshold [7] for the univariable analysis, while the optimal probability threshold for Model 2 was determined using the Youden index. Statistical significance was set at a two-sided  $p < 0.05$ .

Results

The study cohort comprised 65 patients. MV was identified by FDG-PET/CT in 26 patients (40%), and 39 patients (60%) had non-viable myocardium. Patients with MV were older than those without MV ( $67.8 \pm 10.0$  vs.  $61.7 \pm 11.5$  years,  $p = 0.030$ ). The proportion of male patients was numerically lower in the MV group than in the non-viable group, although the difference did not reach statistical significance (73.1% vs. 89.7%,  $p = 0.079$ ).

Hypertension was more common in the MV group (80.8% vs. 46.9%,  $p = 0.008$ ), whereas diabetes mellitus did not differ significantly between groups (61.5% vs. 46.9%,  $p = 0.266$ ). LVEF, total cholesterol, high-density lipoprotein cholesterol, low-density lipoprotein cholesterol, and creatinine levels were

comparable. Triglyceride levels were lower in the MV group (median: 98, IQR: 81.8 – 136 vs. median: 127, IQR: 102 – 184;  $p = 0.043$ ) (Table 1).

QRS score was lower in patients with MV ( $1.65 \pm 1.38$  vs.  $4.54 \pm 1.48$ ,  $p < 0.001$ ). In unadjusted logistic regression, each 1-point increase in QRS score was associated with lower odds of MV (OR: 0.29; 95% CI: 0.17 – 0.51;  $p < 0.001$ ). This association persisted in Model 1 (OR: 0.27; 95% CI: 0.14 – 0.51;  $p < 0.001$ ) and Model 2 (OR: 0.26; 95% CI: 0.12 – 0.56;  $p < 0.001$ ) (Table 2). The multivariable model demonstrated good overall calibration, as confirmed by the Hosmer-Lemeshow goodness-of-fit test ( $X^2 = 6.309$ ,  $df = 4$ ,  $p = 0.177$ ).

For identifying MV, the QRS score yielded an AUC of 0.914 (95% CI: 0.84 – 0.98;  $p < 0.001$ ). Using the prespecified QRS score < 5 threshold, sensitivity was 92.3% (95% CI: 74.87 – 99.05), specificity was 56.4% (95% CI: 39.62 – 72.19), PPV was 58.5% (95% CI: 49.27 – 67.23), and NPV was 91.7% (95% CI: 73.85 – 97.72). In a separate exploratory analysis, the Youden index identified a QRS score cutoff of 3 as the optimal threshold in the present cohort. In the complete-case subset ( $n = 53$ ), Model 2 yielded an AUC of 0.944 (95% CI: 0.88 – 1.00;  $p < 0.001$ ). At the Youden index-derived optimal predicted-probability cutoff of 0.406, sensitivity was 95.8% (95% CI: 78.9 – 99.9), specificity was 89.7% (95% CI: 72.6 – 97.8), PPV was 88.5% (95% CI: 69.8 – 97.6), and NPV was 96.3% (95% CI: 81.0 – 99.9). For the pairwise AUC comparison, the QRS score ROC curve was recalculated in the same complete-case subset, yielding an AUC of 0.893. The AUC of Model 2 was not significantly different from that of the QRS score alone according to DeLong’s test (0.944 vs. 0.893;  $z = -1.17$ ,  $p = 0.240$ ), indicating no statistically significant incremental improvement in discrimination after the addition of the clinical covariates (Table 3, Figure 3). The distribution of myocardial viability according to QRS score category is presented in Table 4.

Table 1. Baseline characteristics stratified by myocardial viability status

| Demographics                         | Total (n = 65) | Viable Myocardium (n = 26) | Non-viable Myocardium (n = 39) | p value |
|--------------------------------------|----------------|----------------------------|--------------------------------|---------|
| Age (mean ± SD), years               | 64.2 ± 11.2    | 67.8 ± 10.0                | 61.7 ± 11.5                    | 0.030   |
| Male sex, n (%)                      | 54 (83.1)      | 19 (73.1)                  | 35 (89.7)                      | 0.079   |
| Diabetes mellitus, n (%)*            | 31 (53.4)      | 16 (61.5)                  | 15 (46.9)                      | 0.266   |
| Hypertension, n (%)*                 | 36 (62.1)      | 21 (80.8)                  | 15 (46.9)                      | 0.008   |
| LVEF (mean ± SD), %                  | 33.9 ± 9.8     | 31.4 ± 10.9                | 34.5 ± 8.9                     | 0.243   |
| Total cholesterol (mean ± SD), mg/dL | 167.9 ± 46.2   | 155.5 ± 43.2               | 177.5 ± 46.8                   | 0.080   |
| HDL cholesterol (mean ± SD), mg/dL   | 42.9 ± 9.3     | 40.8 ± 8.3                 | 44.6 ± 9.8                     | 0.143   |
| LDL cholesterol (mean ± SD), mg/dL   | 99.1 ± 37.7    | 93.1 ± 37.5                | 103.7 ± 37.9                   | 0.306   |
| TG (median [IQR]), mg/dL             | 118 (88 – 166) | 98 (81.8 – 136)            | 127 (102 – 184)                | 0.043   |
| Creatinine (mean ± SD), mg/dL        | 1.07 ± 0.2     | 1.10 ± 0.3                 | 1.04 ± 0.2                     | 0.140   |

\*: 7 patients baseline data for hypertension and diabetes were missing in non-viable myocardium group. Abbreviations: HDL, high-density lipoprotein; IQR, interquartile range (25th – 75th percentile); LDL, low-density lipoprotein; LVEF, left ventricular ejection fraction; SD, standard deviation; TG, triglycerides.

**Table 2.** Logistic regression analysis for the presence of myocardial viability

| Variables                  | Univariable analysis OR (95% CI) | p value | Model 1* OR (95% CI) | p value | Model 2† OR (95% CI) | p value |
|----------------------------|----------------------------------|---------|----------------------|---------|----------------------|---------|
| QRS score                  | 0.29 (0.17 – 0.51)               | < 0.001 | 0.27 (0.14 – 0.51)   | < 0.001 | 0.26 (0.12 – 0.56)   | < 0.001 |
| Age                        | 1.06 (1.00 – 1.11)               | 0.035   | 1.05 (0.97 – 1.13)   | 0.202   | 1.05 (0.94 – 1.16)   | 0.390   |
| Female sex                 | 3.22 (0.83 – 12.43)              | 0.089   | 2.65 (0.29 – 23.39)  | 0.381   | 3.88 (0.17 – 88.12)  | 0.395   |
| Hypertension               | 4.76 (1.43 – 15.76)              | 0.011   | —                    | —       | 8.38 (0.84 – 83.79)  | 0.070   |
| Diabetes mellitus          | 1.81 (0.63 – 5.19)               | 0.267   | —                    | —       | 1.77 (0.28 – 11.36)  | 0.547   |
| TG (per 10 mg/dL increase) | 0.89 (0.81 – 0.99)               | 0.043   | —                    | —       | 0.85 (0.68 – 1.05)   | 0.124   |

\*Model 1: Adjusted for age (VIF = 1.17) and sex (VIF = 1.25). Deviance = 42.7, AIC = 50.7,  $R^2_{McF}$  = 0.512, Overall Model Test  $p < 0.001$ . †Model 2: Adjusted for age (VIF = 1.59), sex (VIF = 1.67), triglycerides (VIF = 1.17), diabetes mellitus (VIF = 1.08), and hypertension (VIF = 1.44). Deviance = 32.7, AIC = 46.7,  $R^2_{McF}$  = 0.552, Overall Model Test  $p < 0.001$ . Hosmer-Lemeshow  $\chi^2 = 6.309$ ,  $df = 4$ ,  $p = 0.177$ . Abbreviations: CI, confidence interval; OR, odds ratio; TG, triglycerides.

**Table 3.** ROC analysis of the discriminative ability of QRS score for myocardial viability

| ROC analysis parameters   | Univariable (QRS Score) | Multivariable (Model 2) |
|---------------------------|-------------------------|-------------------------|
| Cut-off value             | < 5                     | 0.406                   |
| AUC (95% CI)              | 0.914 (0.84 – 0.98)     | 0.944 (0.88 – 1.00)     |
| p value                   | < 0.001                 | < 0.001                 |
| Sensitivity               | 92.3% (74.87 – 99.05)   | 95.8% (78.9 – 99.9)     |
| Specificity               | 56.4% (39.62 – 72.19)   | 89.7% (72.6 – 97.8)     |
| Positive predictive value | 58.5% (49.27 – 67.23)   | 88.5% (69.8 – 97.6)     |
| Negative predictive value | 91.7% (73.85 – 97.72)   | 96.3% (81.0 – 99.9)     |

Model 2 included QRS score, age, sex, triglyceride level, diabetes mellitus, and hypertension. Model 2 analyses were performed in the complete-case subset ( $n = 53$ ). The optimal predicted-probability cutoff for Model 2 was determined using the Youden index. For the pairwise AUC comparison, the QRS score ROC curve was recalculated in the same complete-case subset ( $n = 53$ ): QRS score AUC = 0.893 vs. Model 2 AUC = 0.944;  $z = -1.17$ ,  $p = 0.240$ . Abbreviations: AUC, area under the curve; CI, confidence interval.

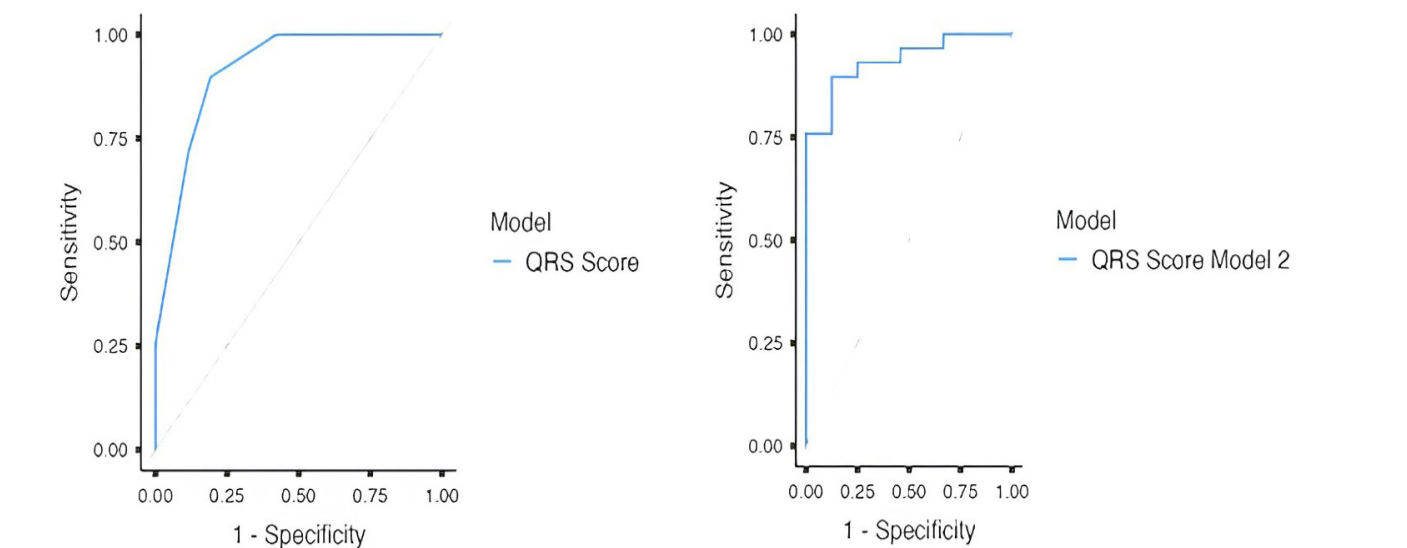


**Figure 3.** Receiver operating characteristic curves for the QRS score and the multivariable model in identifying myocardial viability. The multivariable model included QRS score, age, sex, triglyceride level, diabetes mellitus, and hypertension.

**Table 4.** 2×2 contingency table for QRS score

| QRS score category |       | Presence of viable tissue |            | Total |
|--------------------|-------|---------------------------|------------|-------|
|                    |       | Viable                    | Non-viable |       |
| QRS score          | < 5   | 24 (92.3%)                | 17 (43.5%) | 41    |
|                    | ≥ 5   | 2 (7.6%)                  | 22 (56.4%) | 24    |
|                    | Total | 26                        | 39         | 65    |

Values are presented as n (%). Percentages are calculated by column.

Discussion

In this study, FDG-PET/CT-defined MV was associated with lower QRS scores in patients with SAP, reduced LVEF, and significant LAD stenosis. The lower QRS scores observed in patients with viable myocardium indicate that this surface ECG-derived parameter may provide indirect information about MV in the LAD territory. This relationship may be particularly relevant in chronic ischemic patients undergoing evaluation before revascularization. In this clinical setting, simple and readily available parameters that may support the interpretation of advanced viability imaging could have practical value during the initial assessment. These findings add to the limited evidence on the relationship between QRS score and FDG-PET/CT-defined MV in a chronic ischemic population and extend previous observations from acute MI settings to patients undergoing elective viability assessment.

In ischemic left ventricular dysfunction, MV provides clinically relevant information when estimating the expected benefit of revascularization [9,10]. Viable tissue may recover contractile function after restoration of blood flow and may be associated with better outcomes [9,11,12]. However, in predominantly scarred myocardium, revascularization may offer limited functional improvement while still carrying procedural risk [13].

The LAD artery supplies a substantial proportion of the left ventricular myocardium, and significant LAD stenosis in the setting of reduced LVEF carries important clinical and prognostic implications [14,15]. In this context, accurate viability assessment may be particularly relevant when planning surgical or percutaneous revascularization strategies.

ECG is universally available and represents a low-cost diagnostic modality. Traditional electrocardiographic markers, such as the absence of pathological Q waves, have been associated with preserved MV [16]. The Selvester QRS scoring system, based on quantitative alterations in Q and R wave characteristics, has historically been used to estimate infarct size and myocardial scarring.

The clinical relevance of the QRS score has been extensively investigated in acute MI populations. Previous studies have demonstrated associations between higher QRS scores, infarct size, and adverse outcomes in patients with STEMI [17,18]. More

recently, Tsutsumi et al. reported that elevated admission QRS scores were associated with larger infarct burden and impaired microvascular reperfusion in anterior STEMI [7]. These data support the concept that the QRS score reflects the extent of irreversible myocardial injury in acute coronary syndromes.

In contrast to these acute settings, the present study examined a chronic ischemic cohort undergoing elective viability assessment. Our findings suggest that in patients with SAP and reduced LVEF, the QRS score may serve as an indirect marker of myocardial tissue integrity, differentiating predominantly scarred myocardium from metabolically viable tissue as defined by FDG-PET/CT. This distinction is clinically meaningful, as the pathophysiological substrate in chronic ischemic cardiomyopathy differs from that observed in acute infarction, involving varying proportions of fibrosis, hibernating myocardium, and remodeling.

Using the prespecified QRS score < 5 threshold, QRS scoring showed high sensitivity and a high negative predictive value for detecting MV, whereas specificity was relatively modest. This performance profile suggests that a low QRS score may support the presence of preserved MV in the LAD territory; however, given its relatively modest specificity, a low QRS score alone cannot definitively establish myocardial viability. Accordingly, QRS scoring should not be used as a stand-alone assessment tool but rather as an adjunctive ECG-based parameter during the initial viability assessment. Importantly, QRS scoring should not be used to guide revascularization decisions and cannot replace established imaging-based assessment of MV. In settings where advanced imaging is not readily accessible, QRS scoring may provide additional supportive information; however, it should not replace advanced cardiac imaging for definitive assessment of myocardial viability.

In the present cohort, diabetes mellitus and hypertension were not independently associated with MV. This finding suggests that MV may be influenced not only by traditional cardiovascular risk factors, but also by several clinical and anatomical features, such as lesion location, duration of ischemia, collateral circulation, infarct extent, and residual myocardial metabolic reserve. Although diabetes mellitus and hypertension have well-established roles in the development of ischemic heart disease, they may not independently determine whether viable myocardial tissue is preserved within a specific coronary territory. Therefore,

the present findings should not be interpreted as diminishing the cardiovascular importance of these risk factors; rather, they suggest that FDG-PET/CT-defined MV reflects a more complex and multifactorial process.

Several limitations should be acknowledged. First, the retrospective, single-center design and the relatively small, selected cohort introduce the potential for selection bias. The study population was restricted to patients who underwent FDG-PET/CT after an infarcted myocardial region had been identified on MPS during pre-revascularization assessment and, for the present analysis, to those undergoing viability evaluation in the LAD territory. This selection pathway may have introduced spectrum and selection bias and limits the generalizability of the findings to broader chronic ischemic populations. Accordingly, the observed discriminative performance of the QRS score may differ in unselected populations; in particular, PPV and NPV are prevalence-dependent and should not be directly extrapolated to populations with a different prevalence of MV, while sensitivity and specificity may also vary across different clinical spectra.

Second, the small sample size precluded a formal sample size calculation and limited the reliable application of internal validation methods such as bootstrapping or cross-validation. Given the 26 MV events and the number of covariates included in Model 2, the adjusted analysis should be considered exploratory. The wide confidence intervals observed for some covariates suggest coefficient instability, and the possibility of model overfitting cannot be excluded. Because the apparent discriminative performance of Model 2 was assessed in the same cohort in which the model was developed, the reported discrimination and classification measures may be optimistic and should be externally validated. Therefore, the association between a QRS score < 5 and MV should be interpreted cautiously, and this threshold requires confirmation in larger and more heterogeneous populations.

Third, the retrospective dataset did not allow adjustment for all potential confounders. Potential confounders that were not consistently available in the retrospective dataset included the timing and location of prior myocardial infarction, multivessel coronary artery disease, LAD lesion location, collateral circulation, prior revascularization, QRS duration, pathological Q waves, cardiac rhythm, and details of guideline-directed medical therapy. Residual confounding by these unmeasured or incompletely recorded variables cannot be excluded.

Finally, MV classification was based on retrospective review of routine clinical FDG-PET/CT reports rather than centralized re-analysis of the original images specifically for this study. Therefore, detailed quantitative parameters such as segment-based uptake thresholds or perfusion-metabolism mismatch were not uniformly available. Accordingly, the present findings should be considered preliminary and hypothesis-generating and require validation in larger, prospective, preferably multicenter studies before being translated into routine clinical practice.

## Conclusion

In conclusion, lower QRS scores were associated with FDG-PET/CT-defined MV in patients with SAP, reduced LVEF, and significant LAD stenosis. A low QRS score may provide supportive information regarding the presence of MV; however, it is not definitive on its own and cannot replace advanced cardiac imaging. These findings should be considered hypothesis-generating and require confirmation in larger prospective studies to establish their clinical relevance.

## Ethical Approval

*Ethical approval for the study was obtained from the Ethics Committee of Antalya Training and Research Hospital (Approval No: 4/1; February 27, 2025). The study was performed in accordance with the principles of the Declaration of Helsinki.*

## Patient Consent

*Due to the retrospective nature of the study, informed consent was not obtained from the patients.*

## Conflict of Interest

*The authors confirm the absence of any conflicts associated with this work.*

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