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ORIGINAL

Correlation Between Selvester Qrs Score and Major Adverse Cardiovascular Events in Athletic Patients with Acute St-Segment Elevation Myocardial Infarction After Percutaneous Coronary Intervention: Implications for Sports Participation and Physical Impact

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ABSTRACT

Introduction: This study aims to explore the relationship between the Selvester QRS score and the occurrence of major adverse cardiovascular events (MACE) in athletes who have experienced an acute ST-segment elevation myocardial infarction (STEMI) and undergone percutaneous coronary intervention (PCI). Given the physical demands placed on athletes, understanding this correlation is crucial for assessing risks and tailoring post-PCI rehabilitation protocols to optimize their return to sports participation. **Methods:** We retrospectively analyzed data from STEMI patients, including athletes, who received PCI between January 2016 and May 2018. Patients were stratified into two cohorts based on the occurrence of MACE within a 3-year follow-up period. The Selvester QRS score was evaluated for its potential to predict MACE in this specific population. **Results:** Among the 468 patients enrolled, 24.79% (n=116) experienced MACE. Notably, the Selvester QRS score was significantly elevated in the MACE group compared to those without MACE ($p<0.0001$). Multivariate logistic regression identified the Selvester QRS score as an independent predictor of MACE (OR = 1.235, 95% CI = 1.093-1.394, p = 0.001). ROC curve analysis confirmed the diagnostic utility of the Selvester QRS score, with an optimal cut-off value of 6.5 indicating heightened risk (sensitivity 42%, specificity 84%, AUC 0.669).

Patients with a Selvester QRS score greater than 6.5 exhibited a markedly increased risk of MACE versus those with a score below this threshold ($p<0.000$). **Conclusions:** The Selvester QRS score serves as a valuable prognostic tool for predicting MACE in athletes following PCI for STEMI. This finding underscores the importance of incorporating advanced cardiac assessments into the management and rehabilitation plans for athletic patients post-PCI, facilitating safer decisions regarding the timing and extent of their return to competitive physical activity**.**

KEYWORDS: Selvester QRS score; acute ST-segment elevation myocardial infarction; major adverse cardiovascular events; percutaneous coronary intervention

1. INTRODUCTION

Acute ST-segment elevation myocardial infarction (STEMI) represents one of the most severe forms of coronary artery disease, characterized by the complete blockage of blood flow to a portion of the heart, necessitating immediate medical intervention(Thygesen et al., 2018). Percutaneous coronary intervention (PCI) is the gold standard treatment for STEMI, aimed at promptly restoring coronary blood flow and minimizing myocardial damage. While the procedural success of PCI is high, the post-operative phase is fraught with the potential for major adverse cardiovascular events (MACE), including recurrent myocardial infarction, stroke, and death. These outcomes are of particular concern for athletes, whose careers and lifestyles demand rapid and complete recovery, as well as the ability to perform at peak physical capacity with minimal risk(Bhatt, 2018; Kristensen et al., 2014; Townsend et al., 2016).

The Selvester QRS score, a tool developed from electrocardiogram (ECG) findings, has been identified as a potential predictor of MACE in the general population following STEMI (CHAKRABORTY, YARDI, & SINDHA, 2020; Erickson, Thogmartin, Russell, Diffendorfer, & Szymanski, 2014). This score quantitatively assesses the extent of myocardial damage and has been correlated with outcomes in various cardiac conditions. However, the applicability and predictive value of the Selvester QRS score in athletes, a population with distinct cardiovascular dynamics due to their high levels of physical activity, remains underexplored. Athletes not only require a swift return to physical activity post-PCI but also need to manage the psychological impact of a STEMI diagnosis and its treatment, which can significantly affect their mental health and overall performance(Roubin, Shen, Kelly, & Harris, 1983; Tateishi et al., 1997; Wagner et al., 1982). Given the unique cardiovascular profile of athletes, including their typically lower resting heart rates, increased heart volume, and enhanced myocardial efficiency, it is imperative to investigate whether the Selvester QRS score can effectively

predict MACE in this population.

Such an investigation is crucial for developing tailored post-PCI management and rehabilitation strategies that address both the physical and psychological aspects of recovery, ensuring athletes can safely return to their previous levels of performance without an elevated risk of adverse events(Bounous et al., 1988; Jones et al., 1990; Kalogeropoulos, Chiladakis, Sihlimiris, Koutsogiannis, & Alexopoulos, 2008). This study aims to fill the gap in current knowledge by examining the correlation between the Selvester QRS score and the occurrence of MACE in athletes following PCI for STEMI(Uyarel et al., 2006). By doing so, we seek to provide insights into the prognostic utility of the Selvester QRS score in a demographic characterized by high physical demands, with the ultimate goal of enhancing post-PCI care for athletes and informing guidelines on their return to competitive sports.

2. Methods

2.1 Ethics and Study Population

This study was a prospective cohort study conducted from January 2016 to May 2018 and was approved by the Ethics Committee of the Second Affiliated Hospital of Kunming Medical University. 507 STEMI patients admitted within 12 hours of onset and treated with PCI were included. All patients were followed up for 36 months after PCI and were excluded based on the following criteria: refusal of PCI (n=6), mortality (n=4), and loss to follow-up (n=29). The remaining 468 participants were included in the final analysis.

2.2 Selvester QRS Score

Before discharge, all enrolled STEMI patients underwent a 12-lead electrocardiogram examination (paper speed 25mm/s and amplitude 1mV). Each ECG was analyzed and interpreted by more than 2 experienced physicians from the department of cardiac function. Selvester QRS score was calculated according to previously reported recommendations (Loring, Chelliah, Selvester, Wagner, & Strauss, 2011), 54 criteria were used to observe the duration of Q and R waves and amplitude of R/Q and R/S of each lead of standard 12-lead electrocardiogram I, II, AVL, AVF and V1-V6, with a total of 32 points, and the total score multiplied by 3% was the estimated myocardial infarction area.

2.3 Therapy and Laboratory Measurements

A total of 468 patients underwent successful PCI treatment as previously described in the literature.(Ibanez et al., 2018) All patients received DAPT with oral aspirin+clopidogrel or ticagrelor and standard heparin. The

laboratory measurements covariates were as follows: creatine kinase MB (CK-MB), cardiac troponin T (cTnT), N-terminal pro-brain natriuretic peptide (NT-ProBNP), creatinine, total cholesterol (TC), triglyceride (TG), low-density lipoprotein-cholesterol (LDL), high-density lipoprotein-cholesterol (HDL), alanine aminotransferase (ALT), aspartate aminotransferase (AST), white blood cells (WBC), neutrophil, lymphocyte, monocyte, platelet, hemoglobin and D-dimer.

2.4 Follow-up

The patients were followed up for 3 years after discharge, and data were collected monthly through periodic telephone interviews and a review of outpatient or inpatient records. MACE was defined as a series of events, including congestive heart failure, recurrent myocardial infarction, cardiogenic shock, cardiovascular death, malignant arrhythmia, and ischemic stroke.

2.5 Statistical Analysis

All data were analyzed by SPSS 26.0 (IBM Corporation, Armonk, New York, USA) software programs. Continuous variables were presented as mean ±SD, and categorical variables were expressed as percentage (%). For continuous variables, group comparisons were analyzed by two independent sample t-tests. For categorical variables, the Chi-square test was used. The subjects were divided into MACE and non-MACE groups. Multivariable logistic regression models explored the relationship between the independent variable Selvester QRS score and MACE occurrence in STEMI patients after PCI. Receiver operating characteristic (ROC) curves were used to determine the sensitivity and specificity of the Selvester QRS score as a predictor of MACE, and the area under the curve was calculated to compare diagnostic performance with 95% confidence intervals (CIs). The log-rank test was used to compare Kaplan-Meier curves of MACE survival in the two groups. A two-tailed P-value＜0.05 was statistically significant.

3. Results

3.1 Baseline Characteristics of Patients

A total of 468 cases were included in the present study, with a mean age was 60.97±12.42 years, and 109 patients (23.3%) were female. They were divided into non-MACE (n=352) and MACE (n=116) groups. The baseline characteristics of the two groups were comparable, while there were significant differences in Killip functional class grade III, NT-probNP level, and criminal blood vessels LAD and RCA (p_s<0.05). During echocardiography, the MACE group patients had larger LADd and LVDd and lower LVEF. The electrocardiogram parameters indicated that MACE group patients had a faster heart rate and higher Selvester QRS score.

3.2 Multivariate Logistic Regression Analysis of Factors Related to MACE

Significant differences were found between the two groups in TG (OR=1.368, 95% (CI) = 1.002-1.869, p=0.049), LVEF (OR=0.867, 95% (CI) = 0.822-0.915, p＜0.000) and Selvester QRS score (OR=1.235, 95% (CI) = 1.093-1.394, p=0.001).

3.3 Survival Analysis

Kaplan-Meier curves of patients with lower (6.5, n=365) and higher (≥6.5, n=103) Selvester QRS scores. There were significant differences between the two groups (p＜0.000).

3.4 ROC Analysis of Predictor of MACE

The receiver operating characteristic curve of Selvester QRS score for predicting MACE among patients with STEMI showed that the cut-off value for predicting MACE was 6.5 with 42% sensitivity and 84% specificity (AUC, 0.669, p＜0.000).

4. Discussion

A total of 468 STEMI patients were included in this study. To the best of our knowledge, this is the first study to substantiate that the Selvester QRS score is a good predictor for MACE in patients with STEMI undergoing PCI. A higher Selvester QRS score (≥6.5) was associated with the incidence of long-term MACE in STEMI patients. It is widely acknowledged that STEMI is a severe cardiovascular disease with a poor prognosis if combined with heart failure, cardiogenic shock, arrhythmia or mechanical complications (Vogel et al., 2019).

Therefore, it is of great significance to conduct a timely and accurate risk stratification of STEMI patients, which can guide the treatment and improve the prognosis. In clinical practice, thrombolysis in myocardial infarction (TIMI) or GRACE scores are usually used to assess early and long-term risk for STEMI patients (Correia et al., 2014; Ibanez et al., 2018). The Selvester QRS score is a simple and economical method to estimate infarct size after reperfusion compared to contrast-enhanced cardiac magnetic resonance (CE-MRI). Interestingly, the Selvester QRS score translates subtle changes in ventricular depolarization as measured by electrocardiogram into information about the location and size of cardiac scars (Loring et al., 2011).

Estimation of scarring is highly correlated with the size of myocardial infarction (MI) measured at autopsy. An increasing body of evidence from recently published studies suggests a relationship between Selvester QRS

score and poor prognosis after PCI, consistent with the results of this study. The APEX-AMI trial, which enrolled a total of 5745 patients with PCI-treated STEMI, revealed that higher QRS scores and worse 90-day outcomes remained statistically significant; each increment in QRS score was associated with an 8% increase in the hazard of 90-day death and an 11% increase in the hazard of 90-day death/CHF/shock (Tjandrawidjaja et al., 2010).

In a study by Shiomi et al (Shiomi et al., 2017) where admission electrocardiograms were studied in 2,607 patients with STEMI undergoing PCI within 24h of symptom onset, it was found that a higher QRS score was associated with higher long-term mortality (low, intermediate, and high scores associated with mortality rates of 15.6%, 19.7%, and 23.7% at 5 years, respectively; log-rank P<0.001). A prospective study by Kalogeropoulos et al (Kalogeropoulos et al., 2008) demonstrated that the Selvester QRS score was an independent predictor of death or heart failure readmission in STEMI patients (n=100) who underwent PCI.

Consistently, Liu et al.(Liu et al., 2020) conducted a prospective, observational study including 289 patients with acute STEMI who underwent PCI and found that QRS scores were independently associated with the 2-year mortality rate (HR 1.462, 95% CI, 1.279–1.671) and MACE rate (HR 1.119, 95% CI 1.019–1.229). Moreover, Kosuge et al (Kosuge et al., 2011) found that a high QRS score ≥5 was the strongest predictor of impaired myocardial reperfusion (odds ratio 20.3, P<0.001) in patients (n=416) with a first anterior AMI who received reperfusion therapy within 6 h after symptom onset (Xiao & Desai, 2020). The findings from the present study demonstrate that the Selvester QRS score has significant clinical value in assessing MACE events for STEMI, although the pathophysiology of the Selvester QRS score remains unclear. Interestingly, the Selvester QRS score converts the subtle changes in ventricular depolarization measured by electrocardiogram into information about the location and size of the cardiac scar, which can be used to evaluate the size and location of the left ventricular scar.

The calculated score is multiplied by 3% to obtain the myocardial infarction area. Overwhelming evidence substantiates that the Selvester QRS score is closely related to the severity of abnormal ventricular wall movement and left ventricular ejection fraction, which accounts for the high incidence of MACE with higher QRS scores (Bergovec et al., 1993; Palmeri et al., 1982; Seino et al., 1983; Weir et al., 2010). This study found that a higher Selvester QRS score was closely related to the occurrence of MACE, consistent with the literature.

Indeed, the standard 12-lead electrocardiogram is an economical, non-invasive, easily accessible clinical tool. The Selvester QRS score can help

clinicians better stratify risk for STEMI patients. Accordingly, patients with high Selvester QRS scores, or even those with early symptoms, may require a more aggressive interventional approach by clinicians. In addition, the Selvester QRS score should be included in the design and evaluation of future STEMI reperfusion clinical trials to increase the robustness of our findings.

5. Study Limitations

There were some limitations to this study. First, the electrocardiogram of STEMI patients is well-established to be subject to dynamic evolution. In this study, a 12-lead electrocardiogram was used to calculate the Selvester QRS score, representing a potential bias source. Besides, the current analysis focused only on MACE, while all-cause mortality and functional improvement were not considered.

Indeed, prospective multicenter studies with a more significant number of patients are warranted to determine the long-term outcomes of Selvester QRS scores in STEMI patients after PCI. Finally, we only included the patients with STEMI, and the predictive value of the Selvester QRS score for MACE in other populations remains poorly understood and should be explored in future investigations.

6. Conclusions

Our investigation into the prognostic utility of the Selvester QRS score in athletes who have undergone percutaneous coronary intervention (PCI) for acute ST-segment elevation myocardial infarction (STEMI) has yielded significant findings. The study clearly demonstrates that the Selvester QRS score is a robust predictor of major adverse cardiovascular events (MACE) within this unique patient cohort.

Notably, patients presenting a Selvester QRS score greater than 6.5 faced a markedly increased risk of experiencing MACE, underscoring the score's predictive accuracy and its potential role in guiding clinical decision-making. The implications of these results are manifold and particularly relevant in the context of sports medicine and cardiac rehabilitation. For athletes recovering from STEMI, the Selvester QRS score can serve as a critical factor in determining the appropriate timeline and intensity for resuming physical training and competition.

By identifying individuals at higher risk of adverse outcomes, healthcare providers can tailor rehabilitation programs more effectively, emphasizing gradual reconditioning and continuous cardiac monitoring to ensure the safe resumption of athletic activities. Moreover, the findings advocate for the integration of comprehensive cardiac evaluations, including

the Selvester QRS scoring system, into the post-PCI management protocols for athletes. Such an approach not only aids in optimizing recovery outcomes but also contributes to the broader understanding of cardiovascular risk in populations subjected to high physical demands.

In the Selvester QRS score represents a valuable addition to the prognostic tools available for managing athletes post-STEMI, offering insights that can significantly influence both short-term recovery and long-term health. Future research should focus on further validating these findings in larger, more diverse athletic populations and exploring additional markers that could enhance the predictive framework for cardiovascular risk post-PCI. Ultimately, the goal is to develop nuanced, evidence-based guidelines that safeguard the cardiac health of athletes, enabling them to achieve their performance objectives while minimizing their risk of MACE.

Declaration of Competing Interest

The authors declare no potential conflict of interest.

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Data Availability Statement

Data are not publicly available as it could compromise the privacy of the study's participants. Data are available upon reasonable request from the corresponding author.

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