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Review

Consideration of QRS complex in addition to ST-segment abnormalities in the estimation of the "risk region" during acute anterior or inferior myocardial infarction

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Abstract The myocardial area at risk (MaR) is an important aspect in acute ST-elevation myocardial infarction (STEMI). It represents the myocardium at the onset of the STEMI that is ischemic and could become infarcted if no reperfusion occurs. The MaR, therefore, has clinical value because it gives an indication of the amount of myocardium that could potentially be salvaged by rapid reperfusion therapy. The most validated method for measuring the MaR is ^{99m}Tc-sestamibi SPECT, but this technique is not easily applied in the clinical setting. Another method that can be used for measuring the MaR is the standard ECG-based scoring system, Aldrich ST score, which is more easily applied. This ECG-based scoring system can be used to estimate the extent of acute ischemia for anterior or inferior left ventricular locations, by considering quantitative changes in the ST-segment. Deviations in the ST-segment baseline that occur following an acute coronary occlusion represent the ischemic changes in the transmurally ischemic myocardium. In most instances however, the ECG is not available at the very first moments of STEMI and as times passes the ischemic myocardium becomes necrotic with regression of the ST-segment deviation along with progressive changes of the QRS complex. Thus over the time course of the acute event, the Aldrich ST score would be expected to progressively underestimate the MaR, as was seen in studies with SPECT as gold standard; anterior STEMI ($r = 0.21$, $p = 0.32$) and inferior STEMI ($r = 0.17$, $p = 0.36$). Another standard ECG-based scoring system is the Selvester QRS score, which can be used to estimate the final infarct size by considering the quantitative changes in the QRS complex. Therefore, additional consideration of the Selvester QRS score in the acute phase could potentially provide the "component" of infarcted myocardium that is missing when the Aldrich ST score alone is used to determine the MaR in the acute phase, as was seen in studies with SPECT as gold standard: anterior STEMI ($r = 0.47$, $p = 0.02$) and inferior STEMI ($r = 0.58$, $p < 0.001$). The aim of this review will be to discuss the findings regarding the combining of the Aldrich ST score and initial Selvester QRS score in determining the MaR at the onset of the event in acute anterior or inferior ST-elevation myocardial infarction.

Keywords: QRS complex; ST-segment abnormalities; Acute anterior or inferior myocardial infarction

Introduction

The myocardial area at risk (MaR) is an important aspect in acute ST-elevation myocardial infarction (STEMI) [1]. It represents the myocardium at the onset of the STEMI that is ischemic and could become necrotic if no reperfusion occurs. Assessment of the MaR, therefore, has clinical value because it gives an indication of the amount of myocardium that could potentially be salvaged by rapid reperfusion therapy. Several methods have been developed to assess the MaR. The most validated method is the ^{99m}Tc-sestamibi single-photon emission cardiac tomography (SPECT) [2]. The primary limitation of this method is that it is not easily applied in the clinical setting. Therefore other methods are

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being or have been developed such as cardiac magnetic resonance imaging (CMR) or ECG-based scoring systems.

In 1972, before the reperfusion era, Selvester et al. [3] developed the first quantitative ECG-based scoring system for estimating final myocardial infarct size. It consisted of a 54 criteria/32-point QRS scoring system in which each point represents approximately 3% of the left ventricle.

In 1988, Aldrich et al. [4] developed an ECG-based scoring system to estimate the extent of acute ischemia by considering quantitative changes in the ST-segments for either anterior or inferior left ventricular locations. The aim was to determine the MaR at onset, based on the assumption that this would serve as an estimate of the final infarct size in patients not receiving reperfusion therapy. Quantitative aspects of the ST-segment were evaluated on the presenting ECG and compared to the final infarct size, which was determined by applying the Selvester QRS score to the predischarge ECG. Different formulas for acute inferior and acute anterior myocardial infarction were developed: 3[0.6 (ΣST-elevation II, III, aVF) + 2.0] and 3[1.5 (number leads ST-elevation) − 0.4] respectively. Subsequent studies have been performed to determine how accurate the Aldrich ST formulas were in predicting the MaR in the acute phase. It was seen that the Aldrich ST score underestimated the MaR compared to the final infarct size determined by the Selvester QRS score [5,6] and also compared to the ^{99m}Tc-sestamibi SPECT [7,8].

The ST-segment changes that occur following an acute coronary occlusion represent the ischemic changes that take place in the transmurally jeopardized myocardium. As times passes the ischemic myocardium will become necrotic, if no rapid resolution of the occlusion occurs, with regression of the ST-segment deviation along with progressive changes of the QRS complex [9]. The Aldrich score based on the ST-segment deviation only considers the ischemic myocardium. Thus over the time course of the acute event the Aldrich ST score alone would be expected to progressively underestimate the MaR. Therefore, additional consideration of the Selvester QRS score in the acute phase could potentially provide the "component" of infarcted myocardium that is missing when the Aldrich ST score alone is used to determine the MaR in the acute phase. This concept led to the studies of van Hellemond et al. [10,11] to determine if the correlation with ^{99m}Tc-sestamibi SPECT improved when the Aldrich ST score was combined with the initial Selvester QRS score, so that both the ischemic and infarcted myocardium are considered when determining the MaR in the acute phase. The aim of this review will be to discuss the findings regarding the combining of the Aldrich ST score and initial Selvester QRS score in determining the MaR at the onset of the event in acute anterior or inferior ST-elevation myocardial infarction.

Combining Aldrich ST score and Selvester QRS score

Van Hellemond et al. [10,11] combined the Aldrich ST score and the initial Selvester QRS score to see whether this would improve the estimated MaR in the acute phase as compared to the Aldrich ST score, using the ^{99m}Tc-sestamibi SPECT as gold standard. In the first study, the population consisted of 25 patients with an acute anterior STEMI [10]. All patients underwent coronary angiography (CAG) and prior to this the tracer (bolus of 700 ± 70 MBq technetium Tc 99 m-sestamibi) was injected. Tomographic imaging was performed within 2 hours after CAG. Since the tracer has minimal redistribution once bound to viable myocardium, the perfusion defects reflect the MaR prior to intervention [12]. The target ECG was recorded immediately prior to the CAG. The Aldrich ST score formula for anterior STEMI was applied. The result represented the ischemic component of the MaR in % of the left ventricle (%LV). In the same ECG, the initial Selvester QRS score was determined, representing the infarcted component of the MaR in %LV. The combined score was the sum of the Aldrich ST score and the initial Selvester QRS score (%LV). The correlation was assessed between the individual/combined ECG scores and the myocardial perfusion SPECT. The best correlation with myocardial perfusion SPECT was achieved by the combined ECG score ($r = 0.47$, $p = 0.02$) and the Selvester QRS score ($r = 0.49$, $p = 0.01$). All ECG scores separately (Aldrich ST score: $r = 0.21$, $p = 0.32$) or combined underestimated the total MaR ($p < 0.01$) (Fig. 1). However the difference between the MaR calculated by myocardial perfusion SPECT was smaller for the combined ECG method than either ECG method alone ($p < 0.01$).

The second study by van Hellemond et al. [11] was done in a study population consisting of 32 patients with an acute inferior STEMI. In this study the Aldrich ST score for inferior STEMI was applied. Again it was found that the best correlation with myocardial perfusion SPECT was achieved by the combined ECG score ($r = 0.58$, $p \leq 0.001$. Aldrich ST score: $r = 0.17$, $p = 0.36$. Selvester QRS score: $r = 0.55$, $p = 0.001$). Due to the fact that an acute inferior STEMI can be caused by either an RCA (71.9%) or LCX (28.1%) occlusion, the study population was divided into two subgroups for analysis. The results showed that the correlation between the combined ECG score and myocardial perfusion SPECT was significant for the RCA subgroup

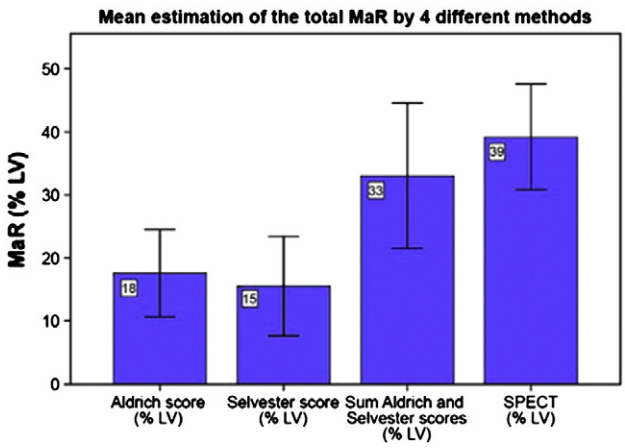

Fig. 1. The mean (±1SD) estimated total MaR by four different methods [10]. The three ECG methods significantly underestimated the total MaR by SPECT ($p < 0.01$), although the difference with the total MaR by SPECT for the sum of Aldrich and Selvester scores was significantly lower than for either score alone ($p < 0.01$; number bars represent the mean MaR in %LV for each method).