A Vectorial Approach for Evaluation of Depolarization Changes during Acute Myocardial Ischemia

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Changes in the repolarization phase (ST-T segment) of the electrocardiogram (ECG) are conventionally used to detect acute myocardial ischemia. Previous studies have also reported changes in the depolarization phase (QRS complex) during acute ischemia. Among those, a method based on QRS slope measurements in the 12 standard leads has been proposed to characterize ischemia induced QRS changes. In the present study we evaluated the upslope (IUS) and downslope (IDS) of the R wave of the QRS complex in ECG leads obtained from spatial QRS loops of 79 patients undergoing prolonged, elective percutaneous coronary intervention (PCI). The QRS loops were obtained by two methods: i) from orthogonal ECG leads X, Y and Z corresponding to the vectorcardiogram (VCG); ii) from the first three orthogonal leads derived after applying principal component analysis (PCA) over the 12-lead ECG. The dominant direction of each QRS loop was determined, and a new lead, denoted by VCG or PCA, was generated by projecting the corresponding QRS loop onto that dominant vector. For each patient, the slope indices IUS and IDS were evaluated in the PCI recording as well as in a control recording acquired before the PCI procedure, and relative factors of change during PCI were calculated. We showed that IUS and IDS computed over VCG and PCA leads present higher sensitivity to the ischemia-induced changes than the same indices evaluated over the standard 12-lead ECG. Mean relative factors of change were 10.5 and 12.4 for IUS and IDS in PCA, and 7.87 and 13.7, respectively, in VCG, representing an increase in sensitivity of up to 103% for IUS and 46% for IDS compared to measurements obtained in lead V3 of the standard ECG, which was the lead showing the most marked changes among the 12 standard leads. We conclude that evaluation of slope indices in leads derived from QRS loops significantly increases their potential value for detection of acute myocardial ischemia.