The Effect of the Shape of Ischemic Regions in the Heart on the Resulting Extracellular Epicardial Potential Distributions

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Recently, computer simulations have been used to model the electrical behaviour of ischemia in the heart in an attempt to better understand the processes involved and increase accuracy in patient diagnosis. The vast majority of these studies assume ischemia progresses from the endocardium towards the epicardium and the ischemic region is rectangular in shape. The presence of sharp edges in these models has been found to play a significant role in the determination of ST segment epicardial potential distributions, with current loops forming around the sharp edges. This numerical study looks at ischemic geometries in which some or all of these sharp edges are removed and how this affects the resulting extracellular epicardial potentials during the ST segment. The two key ischemic region geometries studied are cylindrical and semi-ellipsoidal in shape.

Using a simple anisotropic model for the cardiac geometry and realistic conductivity values, results for the rectangular ischemic shape show a central depression over the ischemic region which separates into three depressions (one centred over the ischemic region and two on its lateral borders) as the ischemic thickness is increased. For ischemic thicknesses above 70%, elevation appears over the ischemic region which increases in magnitude as the ischemia becomes transmural. The cylindrical ischemic shape gives almost identical results due to the continued presence of similar current loops as in the rectangular model. Results from the semi-ellipsoidal shape, however, differ from the previous results for medium thicknesses of ischemia (30%-70%), with the central depression separating into only two depressions as the thickness increases. Elevation again occurs over the ischemic region when the ischemic thickness is above 70%. Here the potential distributions are quantitatively similar to the other shapes.

This study therefore shows that epicardial potential distributions depend both on the thickness of the ischemic region and its shape.