

Modelling the effect of ischemia on myocardial electrophysiology

P. N. A. Nasuha Mohd Nor¹ and M. J. Mohamed Mokhtarudin²

¹Department of Mechanical Engineering , College of Engineering, Universiti Malaysia Pahang , Lebuhraya Tun Razak, 26300 Gambang, Kuantan, Pahang , Malaysia

²Centre for Research in Advanced Fluid and Process (Fluid Centre), Universiti Malaysia Pahang , Lebuhraya Tun Razak, Kuantan, Pahang 26300 , Malaysia

ABSTRACT

Myocardial infarction (MI), also known as a heart attack is one of the lifelong chronic diseases that can give a permanent damage to the heart muscle. This creates a disruption of oxygen supply to the myocardium that could lead to arrhythmia. However, the underlying mechanism that relate MI and arrhythmia is difficult to be described. In this study, a mathematical model to investigate the relationship between MI and arrhythmia is developed using the oxygen diffusion model coupled with the myocardium electrophysiological model based on the work by Ten Tusscher et al. Four levels of ischemia are simulated by modifying the initial oxygen percentage, which are reduced by 10%, 40%, 50%, and 90%. From the simulations, the myocardium electrophysiology is affected by the reduction of oxygen and validated some of the findings from previous clinical works. It is also found that a larger oxygen reduction within the myocardium causes overload of intracellular sodium and calcium ions, which has been previously studied that this could potentially give higher risk of myocardial injury. In addition, oxygen reduction in myocardium causes changes in the morphology of the action potential, which could initiate arrhythmia post-ischemia.

KEYWORDS

Electrophysiology; Ischemia; Membrane Potential; Myocardial Cell