Monophasic Versus Biphasic Stimulation of Single Cardiomyocyte Cell: a Simulation Study

Monica Caselli*, Aldo Casaleggio and Stefano Severi

University of Bologna, Vigarano Mainarda (FE), Italy

Introduction: Mechanisms involved in the initiation of fibrillation and debrillation are very complex and still not totally understood, despite the number and varieties of theoretical and experimental approaches that have been employed to define them. This paper aims to investigate the effect of a monophasic or biphasic stimulus on a single cardiomyocite (CM).

Methods: The CM action potential (AP) is simulated using a modified Ten Tusscher model. Stimulation protocol is characterized by two following stimuli (S1-S2) of variable form and duration: the S1 is a positive pulse, S2 is like S1 in monophasic simulation, and it is a double pulse with zero mean in biphasic simulation; S1-S2 duration is variable and related to the refractory period of CM cell. To quantify the effect of S1-S2 on CM AP and the total response duration (TRD) defined as the interval between the S1 onset and the end of the action potential generated by S2 are considered. The underlying ionic currents are also analysed.

Results: With S1-S2 duration within the refractory period of the CM several simulations are considered. They indicate that, while monophasic pulse lead to very short action potential until the S1-S2 interval is closed to the end of CM refractory period, biphasic pulse lead to quasi-normal new action potential with much shorter S1-S2 intervals. The interpretation of such observation is directly obtained by the simulated current analysis: the amplitude of both calcium and fast sodium current is larger with biphasic pulse.

Conclusion: Straight-forward interpretation lead to the following conclusion: biphasic pulse, anticipating recovery from inactivation of ionic currents, allows a new action potential activation more easily that monophasic pulse.