ON THE INDUCIBILITY OF VENTRICULAR TACHYCARDIA BY MEANS OF DIFFERENT STIMULATION PROTOCOLS: AN ELECTROPHYSIOLOGY SIMULATION STUDY.

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ABSTRACT. To date, in the European Union alone, annual incidences of sudden cardiac death (SCD) and out-of-hospital cardiac arrest (OHCA) reach 250,000 and 344,000 cases, respectively [1]. In particular, SCD following myocardial infarction poses a significantly critical public health problem [2]. In this context, there is a need of developing new effective and non-invasive predictive tools for arrhythmia risk stratification. Thus, a comprehensive understanding of the impact that each arrhythmic substrate component has on the electrophysiological function is necessary for accurate outcome predictions.

Besides the clinical and experimental studies, computer modeling is a powerful, reliable and effective tool that can be used to predict the arrhythmia risk of post-infarction patients as well as the ablation targets, as proposed in recent modelling works [3, 4].

In this work we propose to leverage on computer simulations to study the inducibility of ventricular tachycardia (VT) by replicating the stimulation protocols typically employed in the clinics, but testing different locations of the stimulus site. This will allow us to gain insight into the effect of stimulus location on the electrophysiologic response in the presence of scar tissue.

To this effect, we use an improved equivalent formulation of the Mitchell-Schaeffer model as in Djabella et. al. [5]. This modified Mitchell-Schaeffer (mMS) model alleviates the so-called "pacemaker cell behaviour" problem present in the usual Mitchell-Shaeffer model.

To numerically solve the mMS model, we used FEniCSx (`https://fenicsproject.org/`), an open-source computing platform that implements the finite element method to solve partial differential equations in an automated manner.

Here we present the full pipeline used of the current study: (i) Mesh generation and labelling of zones of interest (healthy tissue, GZ and dense scar); (ii) Numerical methods (Crank-Nicolson and a modified Adam-Bashford schemes for time and space, respectively) and variational formulation of the modified Mitchell-Schaeffer model; (iii) exemplary results for VT inducibility for different stimulation locations.

Keywords: Finite element, reaction-diffusion systems, numerical methods, electrophysiology

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