Acute Ischemia and Ventricular Arrhythmias: A Computational Study

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Introduction: The prediction of arrhythmias formation induced by acute ischemia is of great importance in the clinical practice to drive specific therapeutic choices.

Methods: We start from stress-CTP acquisitions, providing myocardial blood flow (MBF) maps and information about the localization of acute ischemic regions experienced by patients during exercise. We developed a computational framework in the Finite Elements library LifeX (MOX/LaBS, Politecnico di Milano), employing a modified Ten Tusscher-Panfilov model, accounting for hypoxia, hyperkalemia, acidosis. Computational experiments with patient-specific MBF maps highlighted the formation of arrhythmias under a stimulation protocol.
We also proposed a pure geometric index RCI returning the probability of arrhythmias formation. The idea is to use an in-silico risk index (IRI) for some patients to calibrate a gaussian curve built on the space *vastness of the ischemic region/asymmetry of its distribution*.
Finally, we analyzed the repolarization phase as a further source of prediction of arrhythmias. Started from an existing index, we elaborated a postprocessing of the repolarization phase able to provide information about the arrhythmic risk.

Results: Figure 1, left, shows a representative case of prediction of arrhythmia formation due to the acute ischemic region represented in blue.
Figure 1, middle, shows RCI index (continuous maps) obtained by calibration of a gaussian curve owing IRI values (circle data). Square data represent validation patients, whose IRI was not used to calibrate the gaussian map, showing very promising outcomes.
In Figure 1, right, we report, for a selected case, the proposed index associated to the repolarization phase, which highlights its ability to well predict the region of loop formation.

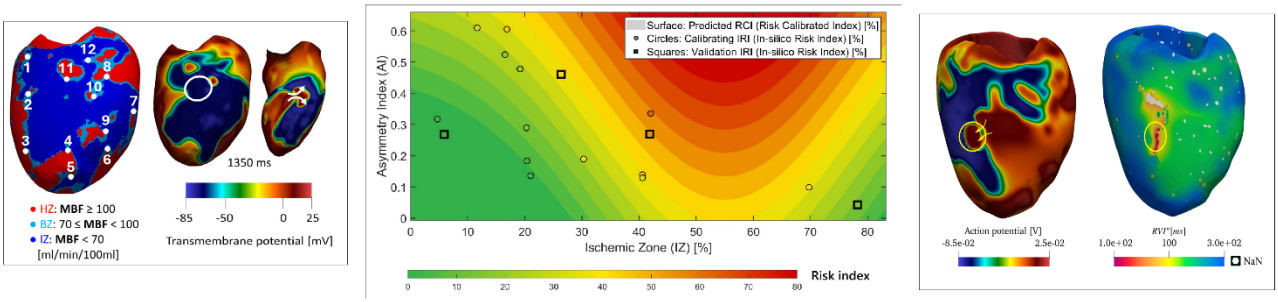

Fig. 1: Arrhythmia due to acute ischemia (left); geometric prevision of the risk (middle); repolarization risk index (right)

Conclusions: We proposed and successfully applied two indices for the computational prediction of ventricular arrhythmias in the case of acute ischemia.