Defining Early Activation Sites in the Ventricular Myocardium Using Extended Cobiveco Coordinates for the Creation of Digital Twins

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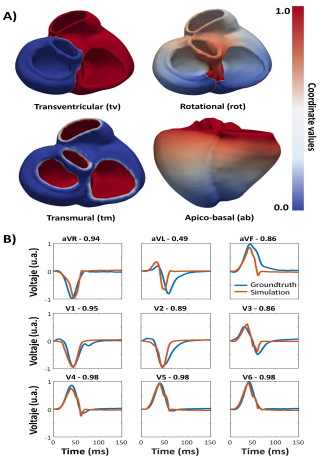
Introduction: Detailed biventricular geometries and location of the earliest activation sites (EAS) are essential to create physiological simulations and a base for creating digital twin.

Methods: We expand the cobiveco coordinate system for application in an anatomical detailed biventricular geometry (Figure panel A). This extension includes the tricuspid valve and pulmonary outlet in the right ventricle, as well as the mitral valve and aortic outlet in the left ventricle. Leveraging the extended cobiveco coordinates, we establish the initial EAS in the endocardium to replicate a healthy potential distribution at the torso's surface. Pearson's correlation coefficient was calculated between the torso potential of a healthy subject and the simulation to verify the location of the EAS.

Results: Bidomain simulations were performed, and potentials at the torso were extracted. Location on the endocardial surface of EAS defined using the extended cobiveco coordinate system achieved a mean Pearson's correlation coefficient of 88$\pm$15% with respect to the potential in the torso of the healthy subject (Figure panel B). The highest correlation was obtained in leads V4, V5 and V6, whereas the lowest was in lead aVL.



A) Extended covibeco coordinate system.
B) 12-lead ECG correlation between simulation and healthy subject.

Conclusion: This paper presents an extension of the cobiveco coordinate system, applied to a highly detailed human ventricular model. The identification of the EAS within this anatomically accurate geometry successfully replicated the healthy torso potential distributions observed in healthy subjects. Furthermore, our extension of the cobiveco coordinate system may allow the study of pathologies that develop in the area of the pulmonary and aortic outlet and serve as a basis for constructing a digital twin.