The Impact of Left Ventricular Noncompaction on Ventricular Arrhythmias in Human Hearts

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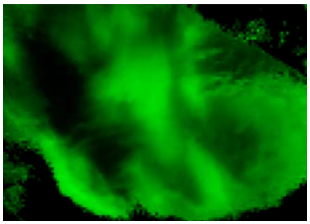
Aims: The relationship between noncompacted myocardium and the risk of arrhythmias remains a subject of ongoing research and debate in the medical and scientific community. Existing evidence suggests that excessive noncompaction may increase the risk of arrhythmia. In this study, we demonstrate that activation patterns in noncompacted excitable medium forming bridges contribute to the perpetuation of ventricular arrhythmias.

Methods: We investigated the effects of noncompacted myocardium using the Fenton-Karma three-variable model, as a two-layer medium consisting of a 2D homogeneous medium and a trabeculated layer forming bridges across the medium. Additionally, optical mapping measurements were performed on the left ventricle endocardium of a transplant recipient heart stained with a voltage-sensitive dye at the late stage of cardiomyopathy.

Results: Numerical simulations showed that in noncompacted hearts, the presence of preferential traveling pathways, such as those with formed bridges due to trabeculae, allows electrical waves to travel along the bridges and form reentrant circuits, promoting ventricular arrhythmias. Arrhythmia susceptibility increased with conduction slowing, a clinical situation associated with cardiomyopathic hearts. From optical mapping measurements, we observed preferential propagation of wave activity along the bridges (see Figure). This finding highlights the critical role that trabeculated regions play in sustaining ventricular arrhythmias.

Conclusions: Our findings provide evidence that excessive trabeculation may be responsible for the perpetuation of ventricular arrhythmias in hearts where conduction slowing is associated with cardiomyopathy. These results contribute to our understanding of the mechanisms underlying this relationship and may have important implications for the management and treatment of patients with excessive trabeculation.



Human endocardium: Activation patterns follows directions of trabeculas.