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DYNAMICS OF INFARCTION IN THE HUMAN CARDIAC CONDUCTION SYSTEM: A CELLULAR AUTOMATA APPROACH

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ABSTRACT

In this contribution, we present a cellular automaton model that reproduces the microstructure and bioelectric conduction of the human cardiac conduction system, with particular emphasis on the sinoatrial node (SAN). The model accounts for cellular differentiation (myocytes, fibroblasts, collagen) as well as the presence of connexins (Cx43, Cx45, Cx40) with their assigned conduction resistance. Infarction in the SAN head region is represented as a progressive gradient affecting both cellular biophysical properties and connexin degradation. Our results demonstrate that the progression of infarction disrupts SAN conduction, interrupts the signal to the atria, and may trigger an escape rhythm from the atrioventricular node (AVN). Moreover, the model reveals electrophysiological phenomena not previously reported in the SAN context, though known from neurophysiological studies. By reproducing physiological mechanisms, the approach provides a promising tool for investigating cardiac pathology and exploring potential therapeutic strategies.

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