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Anti-arrhythmic Effect of Cardiac Pacing Without Feedback (20130273, Dr. Alena Talkachova)

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Preventing Alternans Formation

Researchers at the University of Minnesota have developed a new pacing protocol without feedback to prevent alternans formation and subsequently ventricular fibrillation (VF). This pacing protocol was tested using a physiological ionic model of cardiac myocyte, in the presence or absence of heart rate variability (HRV). They also incorporated the effects of short-term memory on diastolic interval (DI) to the action potential duration (APD) dependence, allowing the model myocytes time to adjust to pacing without feedback before predicting alternans formation. When myocytes were paced with fixed DI values, i.e. in the absence of feedback, no alternans occurred, even in the presence of HRV. Therefore, by controlling the feedback mechanism of DI to APD, an anti-arrhythmic effect can be established. This model could provide new algorithms to improve the functionality of existing pacemakers.

Current Cardiac Prediction Model is Unreliable

Alternans, a destabilization of myocyte APD, is believed to be a precursor to whole-heart VF. Currently, alternans is predicted based on the restitution curve, a functional relationship between the DI and the immediately preceding APD, which is constructed under assumption of periodic pacing. During periodic pacing, the DI is partially dependent on the previous APD, known as pacing feedback.

Heart Rate Variability

Under physiological conditions, cardiac tissue experiences HRV, influenced by factors such as hormones, activity level, disease, and medications. The presence of HRV means that the pacing is not periodic; the relationship between DI and APD is modified, and therefore the feedback is eliminated. All these render the restitution curve obtained during periodic pacing an unreliable method to prevent alternans and VF under physiological conditions. Additionally, the restitution curve doesn't take into account cardiac tissue short-term memory. Short-term memory affects the relationship between DI and the previous ADP for some time after pacing is altered.

BENEFITS AND FEATURES OF ANTIARRHYTHMIC EFFECT MODEL:

- Incorporates physiological conditions and factors
- Accurately predicts alternans formation in ionic model
- Could be used to improve pacemakers

Phase of Development Concept demonstrated in physiological model

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