Role of the Dual AV Nodal Pathway Physiology in the Ventricular Response during Atrial Fibrillation

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Dual AV nodal pathway physiology is described as two different wavefronts that propagate from the atria to the His bundle: one with a longer effective refractory period (ERP) (fast pathway, FP) and a second with a shorter ERP (slow pathway, SP). By using His electrogram alternance (HEA), we have developed a mathematical model of atrioventricular conduction that incorporates dual AV nodal pathway physiology. Experiments were performed on 5 rabbit atrial-AV nodal preparations to develop and test the presented model. HEAs from the inferior margin of the His bundle were used to identify fast and slow wavefront propagations. The ability to predict AV conduction time and the interaction between FP and SP wavefronts have been analyzed during regular and irregular atrial rhythms (e.g., atrial fibrillation, AF). In addition, the role of dual AV nodal pathway wavefronts in the generation of multimodal ventricular response patterns during AF has been evaluated by generating AA interval series with realistic statistical moments. The model accurately reproduced interactions between FP and SP during regular and irregular atrial pacing protocols. In all experiments specificity and sensitivity higher than 85% were obtained in the prediction of the pathway responsible for conduction and the root mean square errors of the calculated conduction times via the FP and SP were 9 ± 5ms and 14 ± 9ms, respectively. Finally, we have shown that a unimodal HH histogram does not necessarily imply the presence of a single pathway since an intact node with two active pathways can produce this ventricular response pattern. In added, our results demostrate that a multimodal ventricular response pattern can be obtained when only one AV nodal pathway is active. The presented mathematical model can help in understanding some of the intriguing AV node mechanisms and should be considered as a step forward in the studies of AV nodal conduction.