

ARITMIE

FIBRILLAZIONE ATRIALE (FA) (ARITMIE/STIMOLAZIONE/RISINCRONIZZAZIONE)
FISIOLOGIA INTEGRATIVA E MECCANISMI DI CONTROLLO (SCIENZA DI BASE)
MECCANISMI DELLE ARITMIE (ARITMIE/STIMOLAZIONE/RISINCRONIZZAZIONE)

NEW INSIGHTS INTO RATE CONTROL THERAPY OF ATRIAL FIBRILLATION: A LUMPED-MODEL APPROACH

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Background. Although rate control therapy is widely adopted as a treatment for atrial fibrillation (AF), clinical evidence demonstrating a heart rate target is lacking. Only the RACE II clinical trial suggested that lenient and strict rate control strategies may not differ in terms of mid-term cardiovascular outcomes. However, several limitations regarding this study have been raised, as the limited sample size and the modest differences in average heart rates achieved in study groups.

Objective. Aim of the present work is to run a lumped-parameter model, previously validated through comparison with several clinical studies, in order to simulate AF episodes with a different heart rate (HR), comparing hemodynamic variables for each situation.

Methods. The lumped model, representing the cardiovascular system, was run to simulate AF with HR of 50, 70, 90, 110 and 130 bpm, respectively.

Results. Left ventricular pressure increased by 57%, from 33.92 ± 37.56 mmHg to 53.15 ± 47.56 mmHg, and mean systemic arterial pressure increased by 27%, from 82.66 ± 14.04 mmHg to 105.3 ± 7.6 mmHg, at the 50 and 130 bpm simulations, respectively. Stroke volume (from 77.45 ± 8.50 to 39.09 ± 8.08 mL), ejection fraction (from 61.10 ± 4.40 to $39.32 \pm 5.42\%$) and stroke work (SW, from 0.88 ± 0.04 to 0.58 ± 0.09 J) decreased by 50, 36 and 34%, at the 50 and 130 bpm simulations, respectively. In addition, oxygen consumption indexes (rate pressure product – RPP, tension time index per minute – TTI/min, and pressure volume area per minute – PVA/min) increased from the 50 to the 130 bpm simulation, respectively, by 186% (from 5598 ± 1939 to 15995 ± 3219 mmHg/min), 56% (from 2094 ± 265 to 3257 ± 301 mmHg s/min) and 102% (from 57.99 ± 17.90 to 117.4 ± 26.0 J/min). In fact, left ventricular efficiency (SW/PVA) decreased from $80.91 \pm 2.91\%$ at 50 bpm to $66.43 \pm 3.72\%$ at the 130 bpm HR simulation.

Conclusions. Waiting for further clinical evidences, the present mathematical model gives new insights into AF rate control therapy, suggesting that lower HRs during permanent AF relates to improved hemodynamic variables and cardiac efficiency.

