

The Effect of Heart Rate and Atrial Contraction on Left Ventricular Function

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Heart rate (HR) and effective atrial contraction affect left ventricular (LV) output. This is particularly relevant in atrial fibrillation (AF) patients, where HR is fast and irregular and atrial contraction almost completely absent. The effect of AF on the LV remains understudied, although a better understanding of these mechanisms could improve AF patient care.

We have used a four-chamber electromechanics model to quantify how AF impacts LV function. Our model accounts for the effect of the pericardium and the coupling with the circulatory system, represented as a closed loop, providing physiological preload and afterload for the heart. The heart model was used for a factorial study with two HRs (70 bpm and 120 bpm) and in the presence and in the absence of atrial contraction.

We found that an increased HR and lack of atrial contraction alone led to a small decrease in ejection fraction (42% to 40% and 42% to 41%, respectively). However, the interaction between an increased HR and lack of atrial contraction led to a drop in ejection fraction from 42% to 36%. We also found that the maximum pressure in the LV increased with an increase in HR (+20 mmHg) but decreased with a lack of atrial contraction (-3 mmHg).

This study demonstrates that our four-chamber heart models can be used to investigate the effect of rapid HR and ineffective atrial contraction on LV output and that AF can significantly impact LV function. This motivates further studies investigating the effect of AF on the whole heart.