Subject-specific MRI-based Verification of RF Sensing for Tracking Ventricular Volume Curves

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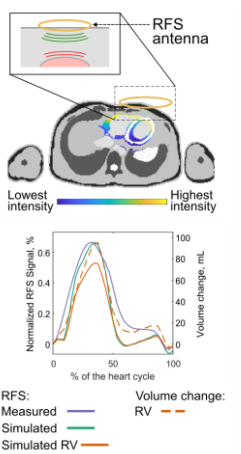
Aim: Radiofrequency Sensing (RFS) is a novel non-invasive cardiac sensing method that employs on-body RF antennas to track hemodynamic parameters, such as cardiac stroke volume. We hypothesized that the RFS signal primarily reflects changes in the volume of the left or right ventricle (LV or RV); however, its exact origin remains unknown. This study aims to verify an in silico RFS signal model against experimental data using numerical electromagnetic simulations based on subject-specific segmented MRI scans.

Methods: To enable simulation of RFS signals and their spatial sensitivity, we generated subject-specific RFS signal simulations based on transversal CINE MRI scans of the thorax of two healthy subjects. These simulations were compared against experimentally acquired data. RFS measurements were performed in a supine position with the RFS antenna in two different positions: on the frontal and lateral left side of the chest. Segmented 4D MRI data were segmented with a task-specific approach to create numerical models for electromagnetic simulations in Sim4Life that replicate the experimental setup.



Principle of the RFS method and example of measured and simulated RFS waveforms vs RV volume change curve.

Results: For both subjects, good alignment between the simulated and experimental RFS waveforms was observed, with a Pearson correlation coefficient of 0.98. Using heart-chamber masks derived from segmentation, it was found that the RFS signal captured from the frontal placement was dominated by the RV (80%), with only 19% signal coming from the LV. For the lateral placement, the LV contributed mostly (83%), with 16% from the RV. In both cases, atrial motion had a negligible impact of 1%.

Conclusion: Subject-specific MRI-based simulations verified the RFS signal model, showing high correlation with experimental data and demonstrated that RFS is sensitive to ventricular volume curves.