Reproducible Evaluation of Diastolic Function Using Phase-Contrast Magnetic Resonance Data

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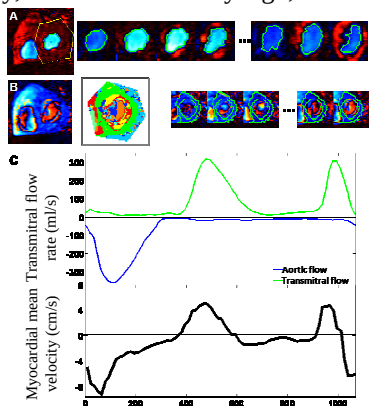
Left ventricular diastolic dysfunction is an early sign of heart failure; thus, its early detection is crucial for patients management. Its clinical estimation is currently performed using Doppler echocardiography, which allows estimating conventional diastolic parameters based on blood flow and myocardial velocities. Despite recent developments in trough-plane velocity-encoded Magnetic Resonance (MR) using phase-contrast (PC) imaging, MR evaluation of diastolic function in clinical routine is not established yet. Accordingly, our aim was to provide a robust, fast and reproducible technique to estimate diastolic parameters from PC MR images.

We studied 40 healthy volunteers (23 women, 17 men, age: 33 ± 12 years), who had a transmitral flow and a mitral annulus longitudinal velocity sequences. To analyze these data, we developed a semi-automated segmentation process based on: 1) pixels connectivity, in terms of velocity sign, for the transmitral and aortic flows, and 2) a k-means clustering of the myocardial velocity profiles. Diastolic parameters were automatically extracted from velocity and flow rate curves. For variability evaluation, the segmentation, as well as the curves analysis, were achieved by two operators on a sub-group of 20 subjects.



A) Transmitral flow segmentation, B) myocardial clustering, and C) extracted flow rate and myocardial velocity curves

The flows segmentation was reproducible as reflected by a mean percentage of overlap between the two segmentations of 99.5 ± 2.1%, resulting in a slight functional parameters variability (<3.7%). For tissue maximal velocities, the inter-operator variability was 2.4 ± 3.2%. Furthermore, our conventional parameters were consistent with echographic literature and our new flow rate-related parameters were well related to those with a high prognostic value.

A reproducible and robust method was proposed and successfully tested on 40 subjects in terms of inter-operator variability and consistency of the derived diastolic parameters. The addition of such developments to MR tools may prove clinically useful.