Reconstruction and Visualization of Left Ventricular Torsion using a Prolate Spheroidal B-solid Model

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Objective: This study aims at developing a novel method for high-accuracy 3D reconstruction and visualization of left ventricular (LV) torsion using a prolate spheroidal B-solid model, which is essential in examining myocardial dysfunction, such as diastolic heart failure and situs inversus totalis (SIT).

Methods: Tagged MRI of a patient with diastolic heart failure and one healthy volunteer were performed on a Siemens Sonata 1.5T MRI Scanner using a breath-hold spatial modulation of magnetization (SPAMM). From the end-diastole, we tracked the tags using an optimized Harmonic Phase (HARP) algorithm. Then, we built a 3D prolate spheroidal B-solid model to describe the typical LV shape. During the beating cycle, the LV torsion was reconstructed by fitting the twist motion of myocardial points to the tracked tags along the circumferential direction. Finally, the 3D LV torsion from apex region to base region was visualized in an interactive and comprehensive way.

Results: Quantitative 3D LV torsion was reconstructed and visualized in a compact and flexible way. During the LV torsion, we could intuitively and efficiently observe how large the base rotated in a clockwise direction and how significant the apex rotated in a counterclockwise direction when viewed from apex to base, from which the LV myocardial dysfunction, such as diastolic heart failure is possible to be observed.

Conclusions: Using a prolate spheroidal B-solid to model LV shape makes the reconstruction and visualization of the 3D LV torsion more compact and intuitive, which provides an effective alternative for the detection of myocardial pathological changes.