Fusion of Electro-Anatomical Mapping and Speckle Tracking Echography for the Characterization of Local Electro-Mechanical Delays in CRT Optimization

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Cardiac Resynchronization Therapy (CRT) has been shown to improve cardiovascular function and reduce mortality rates in a specific subpopulation of patients suffering from heart failure. However, about 1/3 of the patients implanted do not respond appropriately to this therapy. One way to decrease this non-response rate would be to better select the candidates to a CRT. A characterization of the electro-mechanical activation periods of each region of the left ventricle (LV) could be useful for this selection process. This study aims to perform this characterization by the fusion of electrical, mechanical and anatomical information acquired from Electro-Anatomical Mapping (EAM), Speckle Tracking Echocardiography (STE) and Multislice CT (MSCT) imaging, respectively. LV surfaces automatically extracted from 4D MSCT images are chosen as a reference for the registration and fusion of EAM and STE data. EAM provides 3D anatomical points of the LV and associated local activation time (LAT) delays. STE produces 2D contours of the LV and their displacements and strains. In a previous work, we proposed a semi-automatic rigid registration method for the fusion of EAM and MSCT LV-surfaces. In this paper, we propose an additional automatic rigid registration method of STE and MSCT data, based on the minimization of a metric calculated between STE contours and 2D contours extracted from MSCT surfaces. This metric includes distance terms, weighted according to anatomical a priori knowledge. After registration, local electrical and mechanical activation times can be compared in the same space through 2D quantitative maps, providing means to compute and to characterize local electro-mechanical couplings on the LV. Correlation ratios (r) between local and global electro-mechanical delays from 6 different LV regions were computed for two patients (Patient 1: r=0.978; Patient 2: r=0.783). The complementary information obtained from the local electro-mechanical indexes may be useful for a better patient selection for CRT.