Automatic Right Ventricle Segmentation from Magnetic Resonance Images using Shape-Specific Statistical Model

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Right ventricle (RV) role in cardiac evaluation has been underestimated for long years as opposed to Left Ventricle (LV). Recently, many studies have demonstrated the prognostic value of the RV function in cardiovascular diseases such as heart failure, RV myocardial infarction, congenital heart disease and pulmonary hypertension. Magnetic Resonance Imaging (MRI) can provide clear images of the RV at any required cross-section that allow quantitative assessment of the RV morphology, volume and function. Nevertheless, this requires manual delineation of the RV borders throughout the cardiac cycle, which is a tedious and time consuming process. Most of the automatic segmentation techniques have been devoted to LV or LV in conjunction with RV, but not RV in particular, resulting in lower performance of RV segmentation results compared to LV. However, the RV border segmentation is a challenging task because of the coarse trabeculations that cross the RV cavity which are difficult to outline because of their complex shape (especially in patients with Hypertrophic Cardiomyopathy (HCM)). To handle these RV complex shape challenges, we propose a method for automatic RV segmentation that is based on the RV shape-specific variations. First, a point distribution model (PDM) of 57 points is built to represent the different RV shapes from a short-axis cine MRI dataset of 18 subjects (7 Normal and 11 with HCM). Then, the principal component analysis is used, within the Active shape model (ASM) framework, to capture the most important modes of shape variations in the training dataset. Finally, an iterative ASM searching procedure is used to locate the instance in the test images that best matches the PDM. The method is applied to the aforementioned dataset and the comparison with manual segmentation using 5-fold cross-validation showed that our results outperforms previous RV segmentation results yielding 99% accuracy, 98% sensitivity and 92% specificity.