Fully-automated Quantification of Left and Right Ventricular Volumes Throughout the Cardiac Cycle from MRI

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Quantitative information about ventricle performances are really important in heart disease assessment. Left ventricle (LV) has been widely studied and many segmentation methods have been proposed allowing accurate volume estimation. Asymmetry and anatomical complexity of the right ventricle (RV) have made accurate determination of RV shape and volume difficult. In this work we propose a fast and fully automated method for dynamic RV and LV segmentation from cardiac magnetic resonance imaging (CMRI). Methods. Five patients referred for CMRI to assess LV function were studied (GE, 1.5T). In every slice, RV and LV endocardial contours were manually traced at end-diastole (ED) and end-systole (ES), by an experienced investigator. The CMRI datasets were then blindly analyzed using custom software, which allows automated endocardial contours detection of both ventricles. Heart chambers position was automatically detected by studying pixel intensity variations throughout the cardac cycle. The dataset was first cropped to include only the ventricles and pre-processed by contrast-stretching operations. A region-based level set model considering the intensity of the gray levels was then applied to obtain the final boundaries followed by a regularization motion. For both techniques, disk-area summation method was applied to compute volumes throughout the cardiac cycle. Volumes at ED and ES were used to compute ejection fraction (EF) and compared by linear regression and Bland-Altman analyses. Results. LV and RV volumes and EF resulted in high level of agreement (LV volumes: r=.99, y=0.98x+3.6; RV volumes: r=.99, y=0.96x+4.3; EF: r=.97, y=0.94x) with no bias and narrow limits of agreement (bias: -0.3ml; -0.3ml; -3%; SD: 8ml; 4.9ml; 3.7%, respectively). Conclusion. The results of this initial study showed that the proposed technique allows fast automated detection of LV and RV boundaries, which provide the basis for accurate quantification of LV and RV size, function and volume change throughout the cardiac cycle.