Journal of Cardiovascular Magnetic Resonance

Poster presentation

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Quantification of global and regional left atrial function in paroxysmal atrial fibrillation using CMR derived 4-D wall motion analysis

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from 13th Annual SCMR Scientific Sessions
Phoenix, AZ, USA. 21-24 January 2010

Published: 21 January 2010

Journal of Cardiovascular Magnetic Resonance 2010, **12**(Suppl 1):P65 doi:10.1186/1532-429X-12-S1-P65

This abstract is available from: http://jcmr-online.com/content/12/S1/P65

Introduction

Current methods for quantifying LA function are suboptimal. More accurate quantification of atrial function would further the understanding of disease progression and response to therapies in patients with atrial fibrillation.

Purpose

We sought to quantify global and regional left atrial (LA) function in patients with paroxysmal atrial fibrillation (AF) using 4-D wall motion analysis of dynamic CMR.

Methods

Eight healthy volunteers (6 male, mean 29.7 yrs) and 6 patients (6 male, mean 61.7 yrs) with paroxysmal AF underwent imaging during sinus rhythm on a 1.5 T scanner. Steady state free procession imaging of the LA, acquired in an axial stack and parasagittal at 6 mm slice thickness with no interslice gap, was retrospectively reconstructed into 25 phases per R-R interval. Segmentation of the LA wall was performed manually using ARGUS software (Siemens Medical Solutions). The following landmarks were identified manually at each phase and used to construct a spherical coordinate system: four pulmonary vein ostia and four points on the mitral annulus (superior, inferior, left, right). Using MATLAB, contour points were fitted with a 16-element mesh to obtain a continuous description of changes in atrial radius through space and time. LA volume and radial fractional shortening of each element were calculated for each phase and subject. Elements were separated into superior, inferior, septal and free walls for regional analysis. Differences between patients and volunteers were determined with an unpaired t-test.

Results

Maximum and minimum LA volumes were higher in patients vs. volunteers ($p < 0.03$ and $p < 0.01$, respectively). Change in LA volume (Vmax - Vmin) was not different between groups ($p = 0.84$), but the relative contribution of passive and active phases differed: 71% of volume change occurred during passive emptying in volunteers vs. 44% in patients ($p < 0.001$). There was reduced fractional shortening during passive emptying in AF patients, particularly in the inferior and free walls ($P < 0.02$). Regional expansion rate heterogeneity during filling, as indicated by the standard deviation of time to maximum elemental radius, was significantly greater in patients than in volunteers ($p < 0.01$).

Conclusion

4-D quantitative wall motion analysis of CMR data can quantify both global and regional LA function. More of atrial emptying occurs during atrial contraction in

patients with paroxysmal atrial fibrillation, contributing to the clinical effect of losing active contraction during atrial fibrillation. Using this CMR approach to study left atrial pathophysiology could improve the understanding of potential benefits of therapies for atrial fibrillation.