Clinical Validation of an Automated Technique for MRI-Based Quantification of Myocardial Perfusion

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Although cardiac magnetic resonance (CMR) is an attractive alternative for quantitative evaluation of myocardial perfusion, it relies on frame-by-frame manual tracing of myocardial regions of interest (ROIs). To overcome this tedious and potentially inaccurate methodology we recently developed an automated technique using noise-based level-set methods and non-rigid registration for endocardial and epicardial border detection as a basis for automated definition of myocardial ROIs (fig., left). The goal of the present work was to validate this technique against conventional manual analysis. To this effect, we studied 27 patients undergoing contrast-enhanced CMR imaging (1.5T) at rest and during adenosine stress. Throughout each contrast-enhancement sequence, myocardial ROIs were defined both using our automated technique and by manual tracing. Contrast enhancement time-curves were constructed (fig., middle and right) and used to calculate a number of perfusion indices (such as peak-to-peak amplitude and slope of the upslope portion of the curves). Our results were compared with manual analysis using quantitative coronary angiography as a reference for significant disease (stenosis >50%). Automated analysis of one sequence required <1 min. Measured segmental pixel intensities in each frame correlated highly with manual analysis (r=0.95, y=0.95x+5 at rest; r=0.95, y=0.95x+2 at stress). Bland-Altman analysis showed small biases (1.3 at rest; 0.0 at stress) and narrow limits of agreement (±13 at rest; ±14 at stress). The derived perfusion indices also correlated highly with (r up to 0.94) and showed the same diagnostic accuracy as manual analysis (AUC up to 0.72 vs. 0.73). Despite the extreme dynamic nature of contrast enhanced image sequences and respiratory motion, our automated technique allows fast detection of myocardial ROIs and quantification of stress-induced perfusion abnormalities, and was shown to be as accurate as manual analysis.