Accurate Quantification of Aortic Regurgitation with PC-MRI

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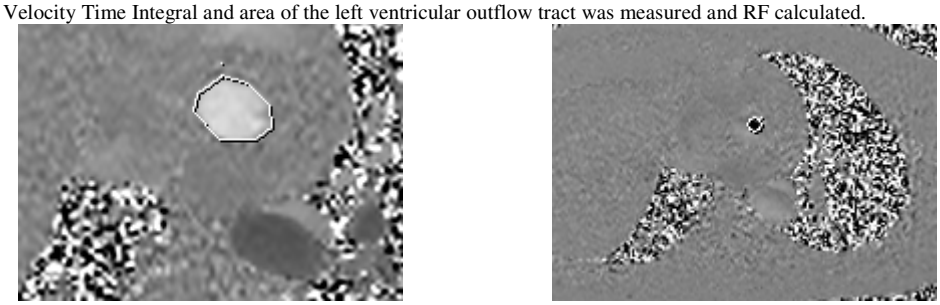
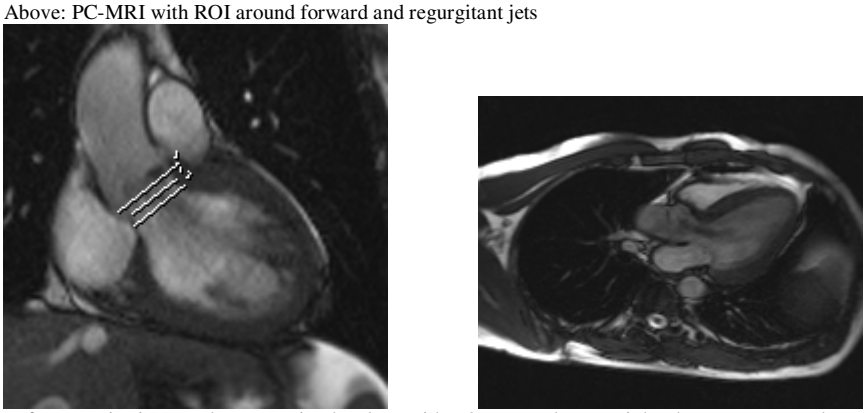
INTRODUCTION: Echocardiography, which is widely used to assess aortic regurgitation (AR), has a number of disadvantages including poor spatial resolution, limited penetrance and operator dependence. MRI is increasingly utilized to evaluate cardiac disease and has the advantage of being able to provide high quality images in a reproducible manner. Phase contrast MRI (PC-MRI) is a well recognized technique for measuring velocity and flow, however to date a reproducible standardized method for measuring AR and calculating regurgitant fraction (RF) has not been clearly defined. [1]

PURPOSE: The purpose of this study was to determine an accurate method for assessing AR based on multi-level PC-MRI of the aortic valve and correlate the results with echocardiography.

MATERIALS AND METHODS: 71 patients (52 male, 19 female) with suspected AR on MRI identified through retrospective chart review. All patients had undergone PC-MRI as part of a cardiac MRI study, which included cine TrueFISP, MR angiography and delayed enhanced viability imaging. Cine PC-MRI was carried out with the following parameters: TR/TE: 8/4 msec, flip angle: 250, FOV: 250 x 380; matrix: 180 x 256; iPAT acceleration x 2. Cine PC-MRI was carried out in 3 axial orientations through the aortic valve: above valve (level 1), at valve (level 2), below valve (level 3). A long axis 3-chamber orientation was also acquired, with velocity encoding in-plane to the image, to ensure imaging below the valve was axial to the regurgitant jet. PC-MRI images were analyzed using the ARGUS program (Siemens) and velocity and flow were measured at all 3 levels in a standardized manner. Forward (Vf) and reverse volumes (Vr) were recorded at all 3 levels. RF (%) was calculated by Vr / Vf at each level (1,2,3). Two additional calculations of RF were made: Vr (level 3) / Vf (level 2); Vr (level 3) / Vf (level 1). Correlation with echo was obtained in 23 patients. Velocity Time Integral and area of the left ventricular outflow tract was measured and RF calculated.



Above: PC-MRI with ROI around forward and regurgitant jets



Left: True Fisp images demonstrating levels at with ROIs were drawn. Right: demonstrates moderate AI.

RESULTS: Vr measured below the valve by PC-MRI had the highest correlation with echo (table 1). There was no significant difference in RF means between PC-MRI and echo for measurements taken in location 3, 4 and 5 (table 2). Intraobserver variability for both echo (R=0.76) and PC-MRI (R=0.98) was good.

Regurgitant Volume			
	Mean volume Echo (mL)	Mean volume MRI (mL)	r
At valve	35	6.39	.82
Above valve	35	1.91	.52
Below valve	35	21.71	.71

Regurgitant Fraction			
	Mean Echo	Mean MR	p
At valve	.26	.05	<.0001
Above valve	.26	.02	<.0001
Below valve	.26	.22	.47
Below/at	.26	.2	.16
Below/above	.26	.21	.22

DISCUSSION: It is essential that PC-MRI assessment of AR be carried out by taking multiple measurements of flow at a minimum of 3 slice positions through the aortic valve. Regurgitant volume is best evaluated by measuring flow at or below the aortic valve. Regurgitant fraction can be calculated by measuring forward and reverse flow both at and below the valve. Reproducibility of results is better with MRI than echo.

References:

Caruthers, SD et al. Practical Value of Cardiac Magnetic Resonance Imaging for Clinical Quantification of Aortic Valve Stenosis: Comparison With Echocardiography. Circulation.2003;108 (18): 2236-2243