

Quantification of Aortic Insufficiency: Comparison Between Phase Contrast and Volumetric Techniques

B. Balaravi¹, J. F. Glockner¹, D. L. Johnston²

¹Radiology, Mayo Clinic, Rochester, MN, United States, ²Cardiology, Mayo Clinic, Rochester, MN, United States

Background:

Quantitation of aortic valvular regurgitation remains a challenge but provides vital information for the assessment of severity of regurgitation and for monitoring of disease progression. Accurate quantification of regurgitation is clinically important for decision making regarding valve replacement. Cine phase contrast velocity mapping permits accurate direct quantification of aortic regurgitant volume. Although several studies have shown the validity of this modality in vitro and in vivo, the accuracy of this method may depend on the slice location in the ascending aorta. An alternative technique which may be less dependent on technical parameters involves measurement of the difference between LV and RV stroke volumes from short axis steady state free precession cine images.

Purpose:

The purpose of this study is to compare and correlate the aortic regurgitant volume and regurgitant fraction obtained using direct velocity mapping measurement and indirect volumetric quantification.

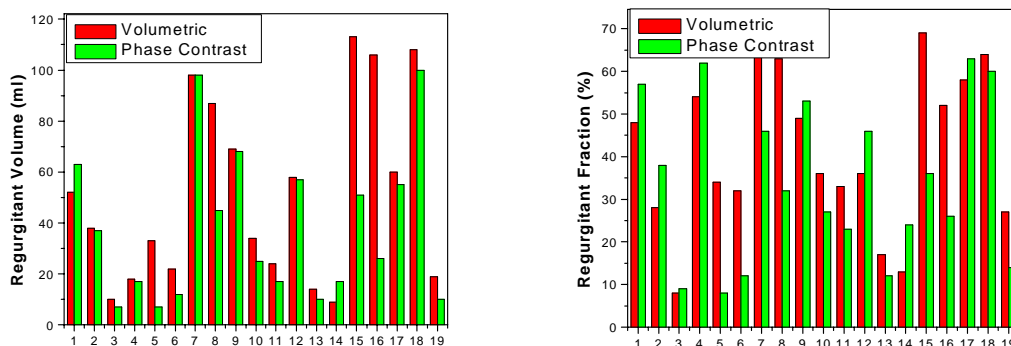
Methods:

We examined 19 consecutive patients referred for the evaluation of severity of aortic regurgitation who underwent both velocity mapping measurement and volumetric analysis between January and September 2003. Exclusion criteria included significant other valvular insufficiency, missing data or technically unsatisfactory magnetic resonance images. Magnetic resonance data were acquired on a GE 1.5 T twin speed EXCITE system using a phased array surface coil. After initial localizing scout scans, cine four chamber and 8-10 contiguous short-axis (8mm-slice thickness) images were obtained (20 frames per slice) using a cine SSFP sequence (FIESTA). Scan parameters were as follows: FOV=32-42, matrix=256x160-192. Short-axis slices from apex to base were used to calculate LV and RV volumes. End systolic and end diastolic frames were identified by inspection, and the right and left ventricular endocardial contours were traced manually excluding the papillary muscle and trabeculae. Regurgitant volume was calculated from the difference between the right and left ventricular stroke volumes. The regurgitant fraction was given as the ratio of the aortic regurgitant volume to the left ventricular stroke volume.

Breath-hold ECG gated cine phase contrast velocity measurement was performed in a transverse section through the ascending aorta. Multiple slices (5mm thickness) were placed in the region of the coronary sinus. Scan parameters were as follows: FOV=26, matrix=256x160-192, 20 phases, 6-8 views per segment. Aortic flow was determined using standard software by tracing an ROI around the aorta and integrating the resulting time-velocity curve. The regurgitant volume represented the retrograde flow through the proximal aorta, and the regurgitant fraction the ratio of retrograde to antegrade flow.

Results:

Regurgitant volumes ranged from 9 ml - 110 ml, and regurgitant fractions from 8% - 69%. Agreement between regurgitant volumes and regurgitant fractions obtained using phase contrast and volumetric methods was evaluated with paired t-test statistics. There was good agreement for the regurgitant fraction measurements, with a p-value of 0.014 and correlation coefficient .77 (below left). Agreement between regurgitant fraction measurements was only moderate, with a p-value of 0.112 and correlation coefficient 0.63 (below right). In 3 cases there were large differences between calculated regurgitant volumes.



Conclusion:

Although there was generally good agreement between the volumetric and phase contrast techniques, notable discrepancies did arise, particularly in determination of regurgitant fraction. Considerable variation in flow measurements using cine phase contrast techniques can occasionally result from small changes in slice position. On the other hand, volumetric measurements are limited in patients with more than one valvular lesion, and in patients who do not reliably suspend respiration in the same position for each short axis cine slice. Both methods are relatively easy to perform, and we routinely employ both techniques to serve as an internal check of our results. Patients with large discrepancies may need additional evaluation or follow up MRI. Improvements in both methods are needed, but these techniques remain valuable tools for assessing the severity of aortic insufficiency.