Should we believe in peak velocities?
Comparisson of peak velocities determined by 2D phase-contrast MRI with those assessed by real-time phase-contrast MRI and pulse wave echocardiography?

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Introduction: Determination of peak velocities is an important parameter for estimation of the severity of stenosis, analysis of arterial stiffness and assessment of the pulmonary flow pattern. Magnetic resonance imaging (MRI) is a noninvasive tool for evaluation of aortic distensibility and PW velocity based on its high accuracy and reproducibility. MRI is known to underestimate peak velocities due to the typical long data acquisition times, echocardiography is considered as operator dependent. The aim of this study was to compare peak velocities (Vmax) assessed by two-dimensional (2D) phase-contrast velocity mapping (PC-MRI), real-time PC-MRI and pulse wave echocardiography regarding the degree of discrepancy.

Material and Methods: Quantitative through-plane PC-MRI flow/Vmax measurements were performed in the ascending aorta of 11 healthy subjects (mean age = 42.6±13.7 years; 6 male) with a 3 T scanner. Using (a) retrospectively gated standard 2D PC-MRI, (b) 2D PC-MRI (comparable to a) but with flow encoding in 3 spatial directions for 3D vector calculating; (c) real-time PC-MRI; (d) pulse wave echocardiography. Measurements were performed without repositioning of the subject. Normally distributed data were analyzed by paired Student-t-test regarding a p-value of 0.05 as statistically significant, Bland-Altman statistics and by calculating of regression coefficients.

Results and Discussion: Average Vmax(MR_3D) exceeded Vmax(MR_ref) by 4.4% (=mean, limits-of-agreement: +14.1 % to -5.3 %, r~0.96, p<0.05). This may be related to the occasionally non-perpendicular blood flow direction in a curved vessel underscoring the need for calculating of three-dimensional velocity vectors. Peak velocities were higher applying real-time PC-MRI compared to MR_ref (28.1 %; +51.4 % to +4.9 %, r~0.64, p<0.05), which can be explained by the non-averaging character of this technique representing a snap-shot of the actual blood flow in the region-of-interest (Abb. 1). Accordingly, Vmax(echo) was increased by 25.2 % in relation to Vmax(MR_ref) (+69.0 % to -18.5 %, r<0.5, p<0.05). Comparing real-time PC-MRI and pulse wave echocardiography high agreement was observed between both methods (2.7 %; +44.5 % to -39.2 %, r<0.5, p<0.05) but with substantial scatters and a low correlation coefficient.

Conclusion: Peak velocities assessed by standard quantitative two-dimensional PC-MRI were underestimated by 25-30% in comparison to real-time PC-MRI and pulse wave echocardiography.