

Comparing wall shear stress values by using different 4D flow postprocessing tools in cardiovascular magnetic resonance in bicuspid aortic valve disease

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Introduction: Over the last ten years 4D-flow in cardiovascular magnetic resonance has been established as a valid method to visualize hemodynamic flow patterns in congenital heart disease. During that period various tools for flow visualization and wall shear stress (WSS) evaluation have been improved constantly. In terms of reproducibility it is important that different software will calculate comparable results. The aim of this study is to evaluate differences in WSS estimation by comparing results generated in 2008 and recalculated 2018 based on the same data by reassessment with newer scientific 4D software.

Methods: Eighteen complete 4D flow datasets of patients with bicuspid aortic valve disease were evaluated for WSS in 2008 and reevaluated in 2018 by using MEVISFlow® (MEVISFlow®; Fraunhofer Institute for Medical Image Computing, v10.3, Bremen, Germany). In 2008 all values were generated with EnSight® and dedicated software based on Matlab® (EnSight®; CEI, Apex, NC, USA; The MathWorks, Natick, MA, USA). All data were analyzed by two skilled persons.

Results: Data analysis showed slight, but significant differences in WSS measurements depending on the software used for the evaluation. The mean difference (old vs. new) of the axial WSS at the level of the mid ascending aorta was $-0.26 \text{ N/m}^2 \pm 0.13 \text{ SD}$ ($p=0.0002$), the circumferential WSS differed by mean $-0.25 \text{ N/m}^2 \pm 0.17 \text{ SD}$ ($p=0.0003$) and the magnitudinal WSS showed a difference of mean $-0.14 \text{ N/m}^2 \pm 0.19 \text{ SD}$ ($p=0.0035$). Bland Altman analysis showed a 95% limit of agreement of -0.52 to -0.003 (Bias -0.26 ; Figure), -0.58 to 0.09 (Bias -0.25) and -0.51 to 0.23 (bias -0.14), respectively. Evaluation by the two different observers showed no difference (mean difference 0.02 N/m^2 ; 95% confidence interval -0.002 to 0.041).

The new postprocessing software systematically generated slightly higher WSS parameters.

Conclusions:

Different software tools for WSS assessment by 4D flow may generate different values. In our study we got slightly higher values by using a newer tool. For longitudinal 4D flow data evaluation it will be important to use the same postprocessing tools.

