

Wall shear stress in the ascending aorta in patients with bicuspid aortic valves differs significantly from tricuspid aortic valves

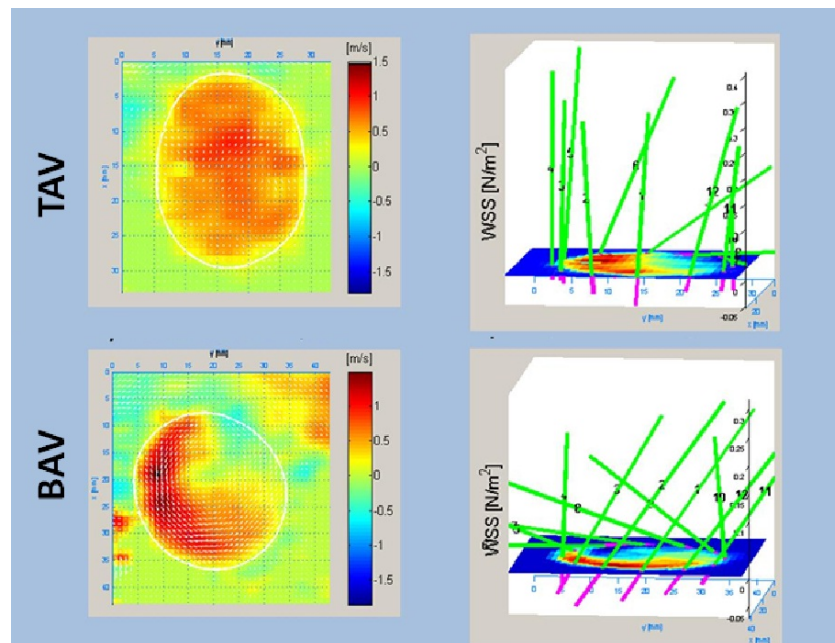
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Introduction: Bicuspid aortic valves (BAV) are frequently associated with dilation of the ascending aorta. The dilation may yield in aneurysm formation and dissection of the aorta. Connective tissue defects as cystic media necrosis or dilation secondary to altered blood flow patterns in the ascending aorta are discussed to cause vessel disease in BAV. We evaluated different wall shear stress (WSS) patterns in the ascending aorta of BAV patients compared to individuals with tricuspid aortic valves (TAV) using four-dimensional cardiovascular magnetic resonance (CMR).

Methods: Eighteen healthy individuals with normally functioning BAV, without aortic stenosis, no aortic regurgitation, no dilation of the ascending aorta and no coarctation were compared with an age and sex matched control group of volunteers with TAV. 4D blood flow data were obtained by CMR (spatial resolution = $2.1 \times 1.7 \times 2.5 \text{ mm}^3$, temporal resolution = 39.2 ms). Visualization and WSS measurement were performed with specific software tools.

Measurement of the WSS in the ascending aorta was performed in the mid ascending aorta approximately on the level of the main pulmonary artery and in the proximal aortic arch at the level of the origin of the brachiocephalic trunk.



Results: WSS in the ascending aorta is significantly higher in patients with BAV compared to TAV. The mean magnitudinal WSS in the ascending aorta was 0.60 N/m^2 in patients with BAV and 0.49 N/m^2 in TAV ($p=0.028$). At the level of the proximal aortic arch the magnitudinal WSS did not show a significant difference between BAV and TAV. The figure shows the visualization of blood flow in the ascending aorta in two 32-year old women. The left panels show time-resolved 2D flow profiles and the right panels show the magnitude-vector profiles of the WSS in the ascending aorta.

Conclusions: WSS patterns in the ascending aorta in patients with BAV without concomitant valve or vessel disease are significantly different compared to TAV. Those significantly higher shear forces may have an important impact on the development of aortic dilation in patients with BAV and are more likely to be the driving force for aortic dilatation than suggested connective tissue disorders.