Four-dimensional flow magnetic resonance imaging: Just beautiful pictures or clinical relevant analysis?

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In this issue of the *Journal*, Bollache and colleagues¹ investigated by 4-dimensional (4-D) flow magnetic resonance imaging (MRI) changes in pre- and postsurgical aortic wall shear stress (WSS) in patients undergoing aortic valve and/or proximal thoracic aortic replacement.

Out of a large 4D flow MRI database, 33 patients with a full data set (pre- and postsurgery) were identified. The surgery included aortic valve replacements, valve-sparing aortic root reconstructions, Bentall operations, as well as hemiarch replacements. In addition, a matched cohort of 20 “control” aortopathy patients without surgical intervention was investigated.

The main findings of this study are that peak aortic WSS and at-risk tissue area decreased after surgery in patients who underwent biological aortic valve replacement whereas aortic WSS was increased distal to the Dacron graft after root surgery. No differences were observed between hemiarch replacement and ascending aortic repair. The authors conclude that different proximal aortic interventions induce distinct changes in aortic WSS. This noninvasive imaging biomarker may help to identify patients at risk for future events and optimize operative strategies.

The authors have to be congratulated for the sophisticated elaboration of the study. However, because of the heterogeneity of interventions, small sample size, and the lack of follow-up on clinical outcome, no strong evidence can be obtained with respect to the clinical relevance of the findings. The transformation from “beautiful pictures” to clinical relevant results has to be demonstrated in the future. It has to be proven that aortic WSS plays a role in disease progression indicated by expansion or pathologic alteration of the aorta. Increase in aortic WSS distal to an incompliant Dacron prosthesis after replacement of the native elastic tissue is a well-known phenomenon. Retrograde type A aortic dissections after placement of a rigid endovascular stent graft in the proximal descending aorta may be explained by the increase in aortic WSS proximal to the stent graft.

Central Message

4-D flow MRI identifies distinct patterns of post-surgical changes in aortic WSS in patients with valve and/or aortopathy. The implication of these results on disease progression has yet to be proven.

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Previous studies² demonstrated that aortic root versus aortic valve replacement alone had more impact on WSS than additional hemiarch repair. Van Ooij and colleagues³ showed in 2015 using 4-D flow MRI that in bicuspid valve patients the greatest level of WSS was found on the outer curvature of the ascending aorta. Illapani et al⁴ examined the correlation between aortic wall stiffness and aortic WSS. The study demonstrated a negative trend with no significant correlation between aortic WSS and aortic wall stiffness.

Bollache and colleagues¹ have to be complimented for this first work using noninvasive 4D flow MRI data combined with a 3-dimensional method with the goal to establish a noninvasive biomarker supporting clinical decision making in patients with aortic disease. 4D flow MRI has the potential to identifying patients at high risk for future events and to optimize surgical procedures. However, the implication of these distinct patterns of aortic WSS on the progression of aortopathy and on risk assessment has to be investigated in future studies.

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