Is wall stress like Wall Street when it comes to speculating on bicuspid versus tricuspid aortic valve aneurysm?

Davide Pacini, MD, PhD, Giacomo Murana, MD, and Luca Di Marco, MD, PhD

From the Cardiac Surgery Unit, Cardio-Thoracic-Vascular Department, S Orsola Hospital, University of Bologna, Bologna, Italy.

Disclosures: Authors have nothing to disclose with regard to commercial support.

Received for publication April 1, 2018; accepted for publication April 6, 2018; available ahead of print May 17, 2018.

Address for reprints: Davide Pacini, MD, PhD, Cardiac Surgery Unit, Cardio-Thoraco-Vascular Department, S Orsola Hospital, University of Bologna, Via Massarenti 9, 40138 Bologna, Italy (E-mail: davide.pacini@unibo.it).

J Thorac Cardiovasc Surg 2018;156:501-2

0022-5223/\$36.00

Copyright © 2018 by The American Association for Thoracic Surgery

<https://doi.org/10.1016/j.jtcvs.2018.04.004>

Breaking news from *The Aortic Wall Stress Journal*.

Central Message

Patient-specific aortic wall stress characterization should be considered to determine the risk of rupture in patients with any degree of aortic dilatation.

See Article page 492.

A literature review using the search term phrase *bicuspid aortic valve aortopathy* in the PubMed central database results in 172 full-text journal articles dealing with this subject just in the past decade. As illustrated by these many and varied studies, the guidelines^{1,2} on management of aortic diseases for elective surgical repair of aneurysms in the bicuspid aortic valve (BAV) have been moving target: From 5 to most recently ≥ 5.5 cm (the same criterion for patients with tricuspid aortic valve [TAV]), based only on a retrospective cohort study from a Mayo Clinic group.³ None of the many experimental studies available were even considered.

Because the heterogeneity of BAV in terms of aortopathy is well known, more recent histopathologic and respectable studies continue to highlight the increased risk of acute aortic syndrome for lower aortic diameter thresholds than the recommended ones.^{4,5} As such, who could speculate on the correct timing for patients with BAV and ascending thoracic aortic aneurysm (aTAA)? Furthermore, does a magic number exist? Probably not or at least not 1 that is true for everyone. Details usually make the difference in surgery, and the possibility to tailor patient-specific clinical and biomechanical risk factors could anticipate the occurrence of dissection at smaller aTAA sizes.

These preliminary considerations bring us to the value of the translational study from Xuan and colleagues.⁶ The article emphasizes that patient-specific aortic wall stress characterization is the most appropriate way to determine risk of dissection in patients with any degree of aortic dilatation with or without BAV. Aortic wall stress has been determined using a finite element analysis: Only patients with BAV or TAV aneurysms > 4.5 cm identify those with an increased risk of dissection.

Two major findings arise from the study: An old confirmation and a new thought.

First, diameter alone has been confirmed to be a poor predictor of aTAA dissection risk. The relationship between the aneurysm size and peak wall stress was very weak for

BAV ($r = -0.004$) and more strongly and linearly related for TAV aTAAs ($r = 0.677$).⁶

On the other hand, new insight comes from the comparison of regional stress magnitude in specific high-risk areas of the aorta. In other words, it is well recognized that most Type A aortic dissections initiate on the greater curvature of the ascending aorta near the sinotubular junction. Looking for differences in these areas, the results clearly showed that in both circumferential and longitudinal directions, the wall stress at the level of the sinotubular junction for BAV aTAA was significantly higher compared with TAV aTAA (739 kPa vs 560 kPa and 405 kPa vs 329 kPa, respectively).⁶ These data support the hypothesis that a BAV aTAA might be at increased risk of dissection over a TAV aTAA at smaller diameter in specific aortic regions.

Taken together, these results suggest that aneurysm dimension may not be a good criterion for evaluation of dissection risk for BAV aTAAs and that wall stresses based on patient-specific geometry may improve risk stratification.

The authors should be applauded for the use of clear definitions and explanations in their finite element analysis. The article has the advantage of translating many biomechanical definitions, procedure steps, and terms into text that is easily comprehensible by cardiac surgeons. The use of simple terminology is crucial to encourage similar studies and spread this type of knowledge among the surgical and aortic community.

The new aortic Wall Street described by the current study should stimulate us to speculate more on patient-specific factors such as aneurysm wall stress evaluation in patients who do not meet the current criteria for surgery.

References

1. Erbel R, Aboyans V, Boileau C, Bossone E, Bartolomeo RD, Eggebrecht H, et al. 2014 ESC Guidelines on the diagnosis and treatment of aortic diseases: document covering acute and chronic aortic diseases of the thoracic and abdominal aorta of the adult. The task force for the diagnosis and treatment of aortic diseases of the European Society of Cardiology (ESC). *Eur Heart J*. 2014;35:2873-926.
2. Hiratzka LF, Creager MA, Isselbacher EM, Svensson LG, Nishimura RA, Bonow RO, et al. Surgery for aortic dilatation in patients with bicuspid aortic valves: a statement of clarification from the American College of Cardiology/American Heart Association task force on clinical practice guidelines. *J Am Coll Cardiol*. 2016;67:724-31.
3. Michelena HI, Khanna AD, Mahoney D, Margaryan E, Topilsky Y, Suri RM, et al. Incidence of aortic complications in patients with bicuspid aortic valves. *JAMA*. 2011;306:1104-12.
4. Wojnarski CM, Svensson LG, Roselli EE, Idrees JJ, Lowry AM, Ehrlinger J, et al. Aortic dissection in patients with bicuspid aortic valve-associated aneurysms. *Ann Thorac Surg*. 2015;100:1666-74.
5. Leone O, Biagini E, Pacini D, Zagnoni S, Ferlito M, Graziosi M, et al. The elusive link between aortic wall histology and echocardiographic anatomy in bicuspid aortic valve: implications for prophylactic surgery. *Eur J Cardiothorac Surg*. 2012;41:322-7.
6. Xuan Y, Wang Z, Liu R, Haraldsson H, Hope MD, Saloner DA, et al. Wall stress on ascending thoracic aortic aneurysms with bicuspid compared to tricuspid aortic valve. *J Thorac Cardiovasc Surg*. 2018;156:492-500.