aortic valve implantation: the valve academic research consortium-2 consensus document. *J Thorac Cardiovasc Surg.* 2013;145:6-23.

10. Lancellotti P, Pibarot P, Chambers J, Edvardsen T, Delgado V, Dulghero R, et al. Recommendations for the imaging assessment of prosthetic heart valve. *Eur Heart J Cardiovasc Imaging.* 2016;17:589-90.
11. Sabik JF III, Rao V, Lange R, Kappetein AP, Dagenais F, Labrousse L, et al. One-year outcomes associated with a novel stented bovine pericardial aortic bioprosthesis. *J Thorac Cardiovasc Surg.* 2018;156:1368-77.
12. Formica F, D'Alessandro S. Prosthesis-patient mismatch: don't forget this match! *J Thorac Cardiovasc Surg.* 2018;156:1353-4.
13. Darko AP, Çelik M, Head SJ. Preventing prosthesis-patient mismatch: with the correct valve, with a correct formula, or with both? *J Thorac Cardiovasc Surg.* 2019;157:e119.

<https://doi.org/10.1016/j.jtcvs.2018.09.084>

PROSTHESIS-PATIENT MISMATCH

DEFINITION(S): LET'S AGREE TO AGREE

Reply to the Editor:

In their letter to the editor, Dr Durko and colleagues¹ advocated using the Valve Academic Research Consortium-2² adjusted criteria defining prosthesis-patient mismatch (PPM) in obese patients in the PERIGON trial of a novel aortic bioprosthesis.³ Their letter described a high rate of PPM in PERIGON (62.6% at discharge and 75.5% at 1 year), and they speculated that this may be due to a greater proportion of obese patients being included in the trial. Two meta-analyses have reported PPM rates of 44%^{4,5} for aortic prostheses; however, these studies included mechanical and tissue valves. One of these studies⁵ found the bioprosthetic valves had an odds ratio of 2.94 for PPM, so the rate of PPM found in PERIGON may be in keeping with expectations. Because outcomes in obese patients tend to be less affected by PPM,⁵ this has led some to suggest adjusting the definition of PPM in such patients.² The Valve Academic Research Consortium-2 guidelines advocating this adjustment were specifically intended for transcatheter valve implantation, but it would make sense for a standard definition to be applied to all types of aortic valves.

John Bozinovski, MD, MSc
Cardiac Surgery
University of British Columbia
Victoria, British Columbia, Canada

References

1. Durko AP, Çelik M, Head SJ. Preventing prosthesis-patient mismatch: with the correct valve, with a correct formula, or with both? *J Thorac Cardiovasc Surg.* 2019;157:e119.
2. Sabik JF III, Rao V, Lange R, Kappetein AP, Dagenais F, Labrousse L, et al; the PERIGON Investigators. One-year outcomes associated with a novel bovine pericardial stented aortic bioprosthesis. *J Thorac Cardiovasc Surg.* 2018;156:1368-77.e5.
3. Kappetein AP, Head SJ, Genereux P, Piazza N, van Mieghem NM, Blackstone EH, et al. Updated standardized endpoint definitions for transcatheter aortic valve im-

Authors have nothing to disclose with regard to commercial support.

plantation: the Valve Academic Research Consortium-2 consensus document. *J Thorac Cardiovasc Surg.* 2013;145:6-23.

4. Head SJ, Mokhles MM, Osnabrugge LJ, Pibarot P, Mack MJ, Takkenberg JJ, et al. The impact of prosthesis-patient mismatch on long-term survival after aortic valve replacement: a systematic review and meta-analysis of 34 observational studies comprising 27 186 patients with 133 141 patient-years. *Eur Heart J.* 2012;33:1518-29.
5. Dayan V, Vignolo G, Soca G, Paganini JJ, Brusich D, Pibarot P. Predictors and outcomes of prosthesis-patient mismatch after aortic valve replacement. *JACC Cardiovasc Imaging.* 2016;9:924-33.

<https://doi.org/10.1016/j.jtcvs.2018.09.056>

ECHOCARDIOGRAPHY UNDERESTIMATES THE AORTIC ROOT DIAMETER IN PATIENTS WITH BICUSPID AORTIC VALVE, BUT

SHORT-AXIS IMAGING CAN HELP

To the Editor:

We have read with great interest the article by Plonek and colleagues,¹ which concludes that aortic root diameters can be underestimated by single-plane long-axis echocardiographic measurements when compared with double-oblique computed tomography (CT) angiography maximum measurements, particularly in patients with bicuspid aortic valves (BAVs). We certainly agree with this important concept.² The authors further explain that underestimation of aortic diameters has been analyzed only for abdominal aortic aneurysms, but no study has analyzed the aortic root; therefore, theirs is the first to do so. This is an inadvertent incorrect statement as we have previously reported comprehensive differences comparing 2-dimensional transthoracic echocardiography (TTE) long-axis root measurements (diastolic leading edge to leading edge) with double-oblique CT-angiography maximum root diameters (diastolic inner wall to inner wall) in patients with BAV.² Indeed, we found systematic TTE underestimation of the root by 3.1 ± 2.6 mm by long-axis TTE compared with CT angiography. Therefore, we tested a new mid-diastolic short-axis 2-dimensional transthoracic root measurement method (leading edge to leading edge) (Figure 1) and found unbiased Bland-Altman agreement between that method and CT angiography (diastolic inner wall to inner wall) for root measurement in patients with BAV.² In addition, the underestimation of the BAV root by single-plane TTE and the importance of using inner wall to inner wall measurements with CT angiography

Authors have nothing to disclose with regard to commercial support.

and cardiac magnetic resonance imaging (as opposed to outer wall)³ are discussed in the recent American Association for Thoracic Surgery consensus guidelines on BAV-related aortopathy.⁴ In light of the authors' clinically important results and the known inconsistency of measurement methodologies across institutions, we believe it would be of importance for the readers to know what measurement method (ie, inner vs leading, inner vs outer) was used for their echocardiographic and CT diameter measurements. In addition, analyzing whether our proposed new echocardiographic method² improves Bland–Altman agreement between modalities in a subset of their patients would

support a potential point-of-care simple solution (ie, the mid-diastolic short-axis measurement) for prevention of root underestimation in patients with BAV.

Hector I. Michelena, MD^a

Thomas A. Foley, MD^b

Maurice Enriquez-Sarano, MD^a

Departments of ^aCardiovascular Diseases

^bRadiology

Mayo Clinic

Rochester, Minn

References

1. Plonek T, Berezowski M, Bochenek M, Filip G, Ryłski B, Golesworthy T, et al. A comparison of aortic root measurements by echocardiography and computed tomography. *J Thorac Cardiovasc Surg*. 2019;157:479-86.
2. Park JY, Foley TA, Bonnicksen CR, Maurer MJ, Goergen KM, Nkomo VT, et al. Transthoracic echocardiography versus computed tomography for ascending aortic measurements in patients with bicuspid aortic valve. *J Am Soc Echocardiogr*. 2017;30:625-35.

FIGURE 1. Two patients with BAV with root less than 45 mm by conventional TTE method and greater than 45 mm by TTE mid-diastolic short-axis method. Patient 1: Parasternal long-axis sinuses measurement (A) and parasternal short-axis sinuses measurement, largest diameter from right-to-noncoronary sinus (B). Patient 2: Parasternal long-axis sinuses measurement (C) and parasternal short-axis sinuses measurement, largest diameter from right-to-left coronary sinus (D). Reprinted with permission.²

3. Rodriguez-Palomares JF, Teixido-Tura G, Galuppo V, Cuellar H, Laynez A, Gutierrez L, et al. Multimodality assessment of ascending aortic diameters: comparison of different measurement methods. *J Am Soc Echocardiogr*. 2016;29:819-26.e814.
4. Borger MA, Fedak PWM, Stephens EH, Gleason TG, Girdauskas E, Ikonomidis JS, et al. The American Association for Thoracic Surgery consensus guidelines on bicuspid aortic valve-related aortopathy: full online-only version. *J Thorac Cardiovasc Surg*. 2018;156:e41-74.

<https://doi.org/10.1016/j.jtcvs.2018.09.063>

SHORT-AXIS VIEW IN TRANSTHORACIC ECHOCARDIOGRAPHY FOR THE EVALUATION OF THE AORTIC ROOT MAXIMUM DIMENSION Reply to the Editor:

My coauthors and I read with great interest the letter by Michelena and colleagues commenting on our article and mentioning their study (Park and colleagues¹) regarding the problem of the underestimation of aortic root dimensions in patients with bicuspid aortic valves. First and foremost, we would like to congratulate them on their impressive research regarding this clinically important diagnostic problem.

In our study,² the inner wall to inner wall measurement method was used for computed tomographic (CT) angiography, and the inner edge to inner edge method was applied in the long-axis view in the transthoracic echocardiography (TTE). We used the inner edge to inner edge modality for the TTE because we believed that it reflected the inner wall to inner wall CT angiography measurements. The maximum root dimension differed between these CT and TTE measurements on average by 4.2 ± 2.8 mm. The difference is comparable with the findings from the study by Park and colleagues.¹ These results indicate that the measurements of the aortic root performed in a long-axis view in the TTE carry an unacceptable risk of underestimation

Author has nothing to disclose with regard to commercial support.

of its maximum dimensions. We agree with Michelena and colleagues that the short-axis TTE view with a leading edge to leading edge method should become the first-line approach for the assessment of the aortic root maximum dimensions. We believe that it could be a standard method not only for patients with bicuspid aortic valve but for all patients.

Nevertheless, we would like to emphasize that CT angiography should also be performed as part of the preoperative assessment in all patients with a bicuspid aortic valve or a significant aortic dilatation as it allows for detailed evaluation of the entire aorta and enables detection of other aortic pathologies that are common in these subsets of patients.

Tomasz Plonek, MD, PhD

Department of Cardiothoracic Surgery

Wrocław Medical University

Wrocław, Poland

Department of Cardiothoracic Surgery Heart Center

OLVG

Amsterdam, The Netherlands

References

1. Park JY, Foley TA, Bonnicksen CR, Maurer MJ, Goergen KM, Nkomo VT, et al. Transthoracic echocardiography versus computed tomography for ascending aortic measurements in patients with bicuspid aortic valve. *J Am Soc Echocardiogr*. 2017;30:625-35.
2. Plonek T, Berezowski M, Bochenek M, Filip G, Rylski B, Golesworthy T, et al. A comparison of aortic root measurements by echocardiography and computed tomography. *J Thorac Cardiovasc Surg*. 2019;157:479-86.

<https://doi.org/10.1016/j.jtcvs.2018.10.068>