leaflet thrombosis, which was also frequently observed in the authors' data set.

In any case, the authors need to be congratulated because the application of 4DCT in the subgroup of patients having received root replacement is definitely a step in the right direction. We, as surgeons, cannot close our eyes but need to embrace the new powerful imaging to prevent and/or treat potential evil.

References

- Atik FA, Navia JL, Svensson LG, Vega PR, Feng J, Brizzio ME, et al. Surgical treatment of pseudoaneurysm of the thoracic aorta. *J Thorac Cardiovasc Surg.* 2006;132:379-85.
- Matteucci M, Ferrarese S, Cantore C, Massimi G, Facetti S, Mantovani V, et al. Early aortic paravalvular leak after conventional cardiac valve surgery: a single-center experience. *Ann Thorac Surg.* 2020;109:517-25.
- Moss AJ, Williams MC, Newby DE, Nicol ED. The updated NICE guidelines: cardiac CT as the first-line test for coronary artery disease. *Curr Cardiovasc Imaging Rep.* 2017;10:15.
- Sonck J, Miyazaki Y, Collet C, Onuma Y, Asano T, Takahashi K, et al. Feasibility of planning coronary artery bypass grafting based only on coronary computed tomography angiography and CT-derived fractional flow reserve: a pilot survey of the surgeons involved in the randomized SYNTAX III revolution trial. *Interact Cardiovasc Thorac Surg.* 2019;ivz046.
- Laschinger JC, Wu C, Ibrahim NG, Shuren JE. Reduced leaflet motion in bioprosthetic aortic valves—the FDA perspective. *N Engl J Med.* 2015;373:1996-8.
- Makkar RR, Blanke P, Leipsic J, Thourani V, Chakravarty T, Brown D, et al. Subclinical leaflet thrombosis in transcatheter and surgical bioprosthetic valves: PARTNER 3 cardiac computed tomography substudy. *J Am Coll Cardiol.* 2020;75:3003-15.
- Makkar RR, Fontana G, Jilaihawi H, Chakravarty T, Kofoed KF, De Backer O, et al. Possible subclinical leaflet thrombosis in bioprosthetic aortic valves. *N Engl J Med.* 2015;373:2015-24.
- Dagnegard HSH, Sigvardsen PE, Ihlemann N, Kofoed KF, El-Hamamsy I, Bekke K, et al. Structural abnormalities after aortic root replacement with stentless xenograft. *J Thorac Cardiovasc Surg.* 2023;165:1285-97.e6.
- Melina G, De Robertis F, Gaer JA, Angeloni E, El-Hamamsy I, Bahrami T, et al. Long-term survival after xenograft versus homograft aortic root replacement: results from a prospective randomized trial. *J Thorac Cardiovasc Surg.* 2019;161:57-65.

See Article page 1285.

Commentary: Freestyle root replacement is not free and long-term radiographic surveillance should be in style

Charles M. Wojnarski, MD, MS

Holmgren-Dagnegard and colleagues¹ present a cross-sectional, radiographic study of a large population of patients who had undergone stentless xenograft (Free-style; Medtronic Incorporated, Minneapolis, Minn) aortic root replacement at 2 institutions (Rigshospitalet, University Hospital of Copenhagen and Montreal Heart Institute, University of Montreal).¹ They performed transthoracic echocardiography and contrast-enhanced,

From the Division of Cardiovascular and Thoracic Surgery, Department of Surgery, Duke University Medical Center, Durham, NC.

Disclosures: The author reported no conflicts of interest.

The *Journal* policy requires editors and reviewers to disclose conflicts of interest and to decline handling or reviewing manuscripts for which they may have a conflict of interest. The editors and reviewers of this article have no conflicts of interest.

Received for publication May 23, 2021; revisions received May 23, 2021; accepted for publication May 26, 2021; available ahead of print June 1, 2021.

Address for reprints: Charles M. Wojnarski, MD, MS, Division of Cardiovascular and Thoracic Surgery, Department of Surgery, Duke University Medical Center, 2301 Erwin Rd, Durham, NC 27710 (E-mail: charles.wojnarski@duke.edu).

J Thorac Cardiovasc Surg 2023;165:1299-300

0022-5223/\$36.00

Copyright © 2021 by The American Association for Thoracic Surgery

<https://doi.org/10.1016/j.jtcvs.2021.05.041>

Charles M. Wojnarski, MD, MS

CENTRAL MESSAGE

After Freestyle root replacement, incidence of pseudoaneurysm, ostial coronary stenosis, and leaflet degeneration is not insignificant and may be identified with routine CT follow-up.

echocardiography-gated 4-dimensional cardiac computed tomography (4DCT) on all included patients (N = 253) and present data on the prevalence of various established, long-term anatomic abnormalities that can occur after aortic root replacement with this valve conduit. Furthermore, the authors present the clinical implications of the findings by presenting prospective follow-up data on 197 patients

from Rigshospitalet regarding the need for intervention and survival.

Initially, the authors identified 539 patients who underwent the above procedure at the 2 institutions from 1999 to 2017. Almost one-third of these patients (27% [n = 144]) had died before the study start date and another 26% (n = 140) were excluded for various appropriate reasons. This left a study population of 253 patients (47%) who underwent transthoracic echocardiography and 4DCT over an approximately 1-year period. Indications for Freestyle root replacement were heterogeneous: root aneurysm (34% [n = 87]), endocarditis (25% [n = 63]), small root at time of valve replacement (15% [n = 37]), type A dissection (12% [n = 31]), and other (14% [n = 35]).

In this study population, the authors found that at a median of 3.3 years from surgery, 46% of patients had a structural abnormality on their 4DCT: 21% significant ostial coronary stenosis, 20% moderate-severe leaflet abnormality, and 13% pseudoaneurysm. Routine echocardiography failed to identify all of the above structural abnormalities save 1 pseudoaneurysm. At a median of 1.4 years after 4DCT, 25% of patients with pseudoaneurysm, 13% with ostial coronary stenosis, and 8% with leaflet abnormality required intervention.

The main limitation of this analysis is its design. As clinicians, we see patients in follow-up and make decisions based on history and physical exam (and radiographic and physiologic studies). We see the present and use retrospective information to predict the future. It is difficult to approach systematic research design in the same fashion. As we follow a population of patients undergoing an intervention, there is undoubtedly loss to follow-up due to death, reintervention, and the like. By excluding these patients, we are not able to estimate the true incidence of events over time. Most likely, we end up underestimating incidence by decreasing the denominator or patients at risk. But we also lose information on events that might otherwise be

included to increase estimates of incidence. It is critical that studies of incidence of events over time are prospective and treat death from other causes as a competing risk.² For these and other reasons, it is important to take the actual estimates presented (and the authors' Euler diagram in their Figure 2¹) with a large grain of salt.

Almost all of the abnormalities found were in asymptomatic patients. Only 10% required intervention at a median of 1.4 years after identification of a radiographic abnormality; however, as these patients continue to be followed, it is possible that this number may increase.

The most important message of this article is that long-term anatomic abnormalities can occur in asymptomatic patients and are likely to be missed on echocardiographic follow-up alone. 4DCT is recommended by the authors given its sensitivity and use in this study, but the role of magnetic resonance imaging in identifying these abnormalities is unresolved. The authors present a reasonable radiographic follow-up protocol involving 4DCT yearly for the first 2 years postoperatively and every 2 years onward (if without abnormality) based on their findings that very few abnormalities occurred within 1 year of follow-up. Given that 10% of patients either develop symptoms or have worrisome enlargement of pseudoaneurysm at a median of 1.4 years, the authors recommend 6-month imaging (if no intervention is required) until findings are stable.

Given the short clinical follow-up of the study, it will be important to update this work in the future to continue to understand the natural history of the stentless xenograft aortic root replacement. One thing is certain: Patients undergoing aortic root replacement require lifelong clinical and radiographic follow-up—regardless of conduit choice.

References

1. Dagnegard HSH, Sigvardsen PE, Ihlemann N, Kofoed KF, El-Hamamsy I, Bekke K, et al. Structural abnormalities after aortic root replacement with stentless xenograft. *J Thorac Cardiovasc Surg.* 2023;165:1285-97.e6.
2. Rajeswaran J, Blackstone EH. Competing risks: competing questions. *J Thorac Cardiovasc Surg.* 2017;153:1432-3.