Love the root, not the flowers everyone sees

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The aortic root is a complex, 3-dimensional structure with heterogeneous behavior during the cardiac cycle.¹ The intricate dynamic geometry of the aortic root is thought to minimize leaflet stresses and transvalvular turbulence, leading to optimal hemodynamic profile and durability. Perturbations of normal root dynamics may lead to abnormally high leaflet stresses and premature structural valve deterioration. Whether valve-sparing procedures mimic the dynamic geometry of the native aortic root remains unclear, but the hemodynamic and flow profile of valve-sparing root procedures, as derived from in vivo time-resolved 3-dimensional magnetic resonance phase-contrast imaging, was recently found to be superior to that of bioprosthetic valved conduit replacement.² Addition of a sinus-shaped aortic graft prosthesis may confer further physiologic advantage.³ In this issue of the *Journal*, Yacoub and colleagues⁴ add further insight into the dynamic behavior of the aortic root after the root remodeling procedure. With phase-contrast cardiac magnetic resonance and computed tomographic angiography and computational flow dynamics, Yacoub and colleagues⁴ studied 2 young patients who underwent the root remodeling procedure and 4 age-matched control subjects. The remodeling operation was associated with nearly normal aortic root dynamic geometry and flow patterns in the ascending aorta and sinuses of Valsalva. These findings add support to the “physiologic” repair of aortic root aneurysms that has been championed by Yacoub for more than 4 decades. The current report of Yacoub and colleagues⁴ must be interpreted in the appropriate context, however, especially because both presented patients were young women of small body habitus. It is unknown whether these findings are generalizable to the greater cardiac population, because the aortic root and ascending aorta complex is disproportionately small in young patients, particularly women. The mean age of patients undergoing a valve-sparing root operation was reported in a recent comprehensive summary at 51 ± 14.7 years,⁵ and, because age-related changes to aortic stiffness alter human ascending aortic hemodynamics derived by computational modeling,⁶ the extrapolation of

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Central Message

Valve-sparing aortic root replacement with the remodeling technique preserves dynamic motion and physiologic flow patterns of the aortic root.

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the current finding to older patients remains to be established. The 2 study patients had the same body surface area (1.8 m^2); however, annular area was almost double in patient 2 (Figure 4 in the article of Yacoub and colleagues⁴), and postoperative annular diameter was approximately 35 mm (Figure 8 in the article of Yacoub and colleagues⁴). These anatomic features were associated with less complete leaflet coaptation after the procedure (Figure 2, B, in the article of Yacoub and colleagues⁴), with a residual regurgitation of 9.3%. Without an annular stabilizing or reducing procedure, the durability of the remodeling surgery may not be equivalent in these 2 patients, because an aortoven-tricular junction diameter of 28 mm or greater has been shown in a large patient cohort to be an independent predictor of reoperation for root remodeling.⁷ Maintained dynamic motion of the large annulus in patient 2, although physiologic, may contribute to further dilation and increased aortic insufficiency; as such, preservation of “normal” annular dynamics may not always be advantageous. Annular stabilization has been identified as a potential advantage of the root reimplantation technique,⁸ although leaflet dynamics, as elegantly demonstrated in the current report of Yacoub and colleagues,⁴ have been purported to be more physiologic with the remodeling procedure.^{9,10} Torsion is an important component of the aortic root deformation that “winds” and “unwinds” throughout the cardiac cycle to facilitate ejection and aortic flow¹ yet was not investigated in the study. Although the graft prosthesis may limit this evaluation, data from control subjects

may better elucidate the optimal material properties of graft prostheses to normalize torsional deformation.

Harnessing advanced imaging and computational techniques, Yacoub and colleagues⁴ have provided us with a unique glimpse into detailed dynamic physiology of the aortic root after the root remodeling procedure. Multimodal imaging promises to enhance our understanding of the 3-dimensional geometry and flow patterns of the aortic root and potentially guide surgical repair to optimize leaflet stresses and yield improved durability. Much work remains to better characterize the heterogeneity of human aortic root pathology, but studies such as that of Yacoub and colleagues⁴ will continue to reveal the complex wonder of the aortic root.

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