Advanced imaging unveils aortic valve secrets: What is next, theoretic biology?

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*Numquam invenietur, si contenti fuerimus inventis.
[New things will never be discovered if we rest
contented with discoveries already made.]*

—Lucius Annaeus Seneca
(c. 4 BCE–65 CE)

In this issue of the *Journal*, Yacoub and colleagues¹ present for the first time a sophisticated multimodality imaging study highlighting their continuing efforts to dive deeper into the exciting secrets of the aortic valve for optimizing repair techniques. Geometry and dynamism are preconditions for optimal blood flow, which is the cornerstone in circulation. Blood flow was measured by cardiac magnetic resonance imaging and echocardiography and also by computational fluid dynamics on the basis of calculation of flow according to assumptions with excellent resolution up to computer capacity. Not only were comprehensive geometric data of all valve components analyzed, but so were sophisticated novel items, such as tilting angle of the root, flow characteristics in the sinuses of Valsalva, cyclic change of annulus diameter, and the elliptic appearance of the annulus. All components, their dynamism, and crosstalk aim to optimize circulation by minimizing stress on the structures and energy loss to warrant long-term, complication-free function.

Although the data after remodeling showed nearly normal conditions, one would have wished to see more patients evaluated in this sophisticated way on longer-term follow-up, especially with respect to the surgically induced reduction of the annulus diameter, to support the excellent long-term clinical reports²⁻⁴ underlining the theoretic advantages of the Yacoub operation as a valve-preserving root replacement technique. The results are best if the native structures are not already too affected by the pathologic process (annulus too large or leaflets deteriorated because of long-standing aortic insufficiency, as in their patient 2), raising the question of whether an earlier intervention would have achieved a more favorable result, particularly in this patient but also in general. Furthermore it would

Prophetic Eye, sculpted in bog oak by H.-H.S.

Central Message

Innovation in imaging technology allows us to dive deeper into nature's secrets, here the aortic valve for optimizing repair.

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be interesting to see the same multimodality imaging study on patients after the reimplantation technique (David operation), which is also reported to yield excellent long-term results,^{4,5} although the indications have turned out through the years to be different, with a larger annulus and connective tissue disease–related root dilatation being more favorable for the reimplantation technique, making comparability difficult.

In the meantime, science proceeds rapidly and new measurement tools and items emerge, such as magnetic resonance imaging–derived blood flow energy loss caused by viscous friction of turbulent diseased flow. Low blood flow energy loss may have important clinical implications and again supports the paradigm of nature as the optimal solution for a particular biologic purpose and the best blueprint for surgery.^{6,7}

In this study, the repair procedure was not really steered by preoperative imaging. The operative technique itself was more or less based on the experience of the surgeon, and postoperative imaging confirms the excellence of the procedure (a posteriori). It would be more favorable if preoperative imaging (a priori) could precisely determine how and when to repair the valve to fit the surgical technique to the given geometry and condition of the components of the aortic valve for optimal function. And even more sophisticated, something like theoretic biology, may emerge as a new scientific field aiming at calculating what to search for with new imaging techniques.⁸ That is, if the root fulfills

FIGURE 1. Infinite but imaginary sculptures are in the raw stump before being touched, and also the prophetic eye, but only if we look at it or sculpt for it does it become real. (*Prophetic Eye*, sculpted in bog oak by H.-H.S. Used with permission.)

a torsion movement, there must be the force to let it work, probably related to a rotational movement of blood flow in the left ventricular outflow tract or a movement of the outflow tract itself. To come behind these secrets and that of the fine-tuned dynamism and crosstalk of the aortic valve, perhaps we must investigate the entanglement of small-scale elements in that area. Now we are here in the

mysterious world of quantum mechanics, making imaginary things real—if we search or sculpt for it. For example, infinite but imaginary sculptures are in the raw stump before being touched, and also the prophetic eye, but only if we look at it or sculpt for it does it become real (Figure 1). Although hard to understand, quantum physics is the basis of modern imaging technologies in particular and science in general—and also in cardiovascular biology, offering a bright future to dive deeper into the secrets of life.

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