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Key Words: venous valve, accommodate growth, semilunar valve, simulation, reconstruction, repair

EDITORIAL COMMENTARY

Design, dynamism, and valve repair

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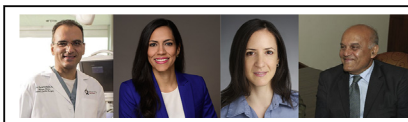

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Central Message

Heart valves derive their finer function from the dynamic behavior of their component parts. The study of their design characteristics in simulation models can optimize the results of valve repair.

See Article page 389.

One of the most constant aspects of biology is that nothing is constant. This concept is called *dynamism*, and it is almost ubiquitous from atoms to organs, operating at a wide range of time domains and importantly influencing function. Heart valves are no exception and derive most of their finer functions as well as their durability from the dynamic behavior of their component parts.[1] Valve dynamism may be active or passive.[2] The latter is dependent on the design[3] and the material characteristics of the tissue. Defining these characteristics can be of value in tissue engineering and valve repair, including valve-conserving operations for aneurysms of the aortic root[4] (Figure 1).

The article in this issue of the *Journal* by Hammer and colleagues[5] is a welcome addition to the literature, because it provides an in depth comparison between the design of venous valves and cardiac outlet valves with regard to the number of cusps; their size, shape, and length of attachment to the vessel wall; and also the influence of these designs on the function of the valve when the size of the vessel is changed in a simulation model. Even though

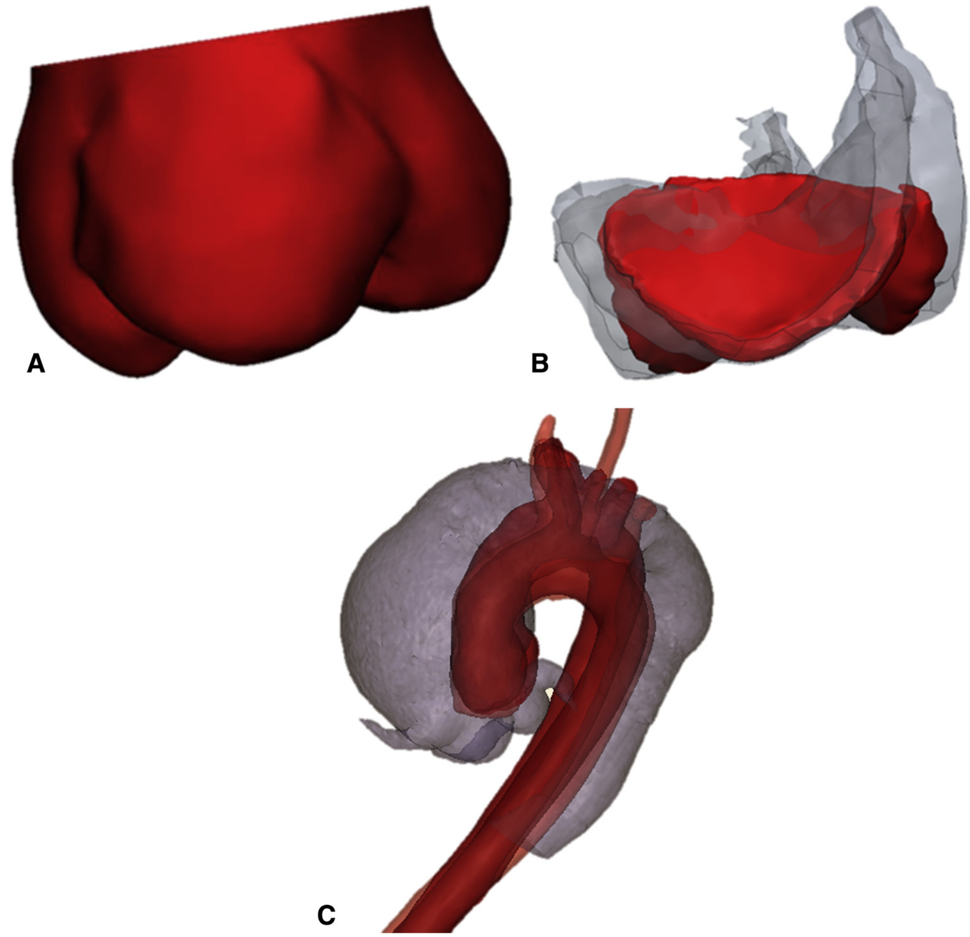

FIGURE 1. Study of the normal morphology as an aid to design repair. A, Normal aortic root. B, Aortic root in a patient with ascending aortic aneurysm. *Gray* represents area before repair; *red* represents area after repair. C, Three-dimensional models of normal and patient's aortic morphology. Measurements from the model were used for designing the personalized, valve-conserving repair (unpublished data from the Aswan Heart Centre).

previous studies have shown that bicuspid aortic valve[6] introduces abnormal hemodynamics and strain on the valve mechanism[7] and the ascending aorta,[8] which could have important clinical implications,[9] the study of Hammer and colleagues[5] was designed with the aim of testing a potential pulmonary valve more than an aortic valve model because of the greater need in the child for a growing valve in that position. Furthermore, the venous valves and bicuspid aortic valves share only the superficial feature of having two leaflets, because the valve proportions, most importantly the much longer free edge of the venous valves, are quite different. Salient features of much taller leaflet edge and the specific leaflet morphology of the venous valves result in a more competent valve with a growing vessel diameter in the current model. The main limitation of this study is that it does not take into consideration the important differences in pressures and flow conditions in the veins and the root of the aorta. With respect to growth, the Ross operation for the left cardiac outlet, or in future tissue-engineered heart valves[10,11] or leaflets, can be used with the guidance of studies such as this one by Hammer and colleagues.[5] The design of natural tissue valves is exquisitely site specific, carefully tailored to suit the varying prevailing conditions and the particular functions needed at that site.

Hammer and colleagues[5] are to be complimented on their excellent detailed studies of the design characteristics of valves. These studies will no doubt stimulate further exploration of these important issues with the sophisticated imaging and simulation methods currently available to optimize the results of valve repair and replacement through precision personalized medicine.

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