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Commentary: Biomechanics of the aorta: Insight into aortic pathology

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The management of patients with thoracic aortic aneurysmal disease remains complex. The decision to perform an elective operation, which is essentially prophylactic and can be associated with some risk, places a significant weight on the surgeon and the patient. While there are numerous established guidelines that recommend intervention at varying size thresholds,¹ there remains some controversy over the optimal timing for intervention.²⁻⁵ Although studies examining the risk of developing an aortic complication based on size are abundant, there remain significant knowledge gaps in our understanding of aortic biology and the mechanical properties of the aorta. Recognizing the importance of these variables in the pathophysiology of aortic disease, Durbak and colleagues⁶ present a novel study examining regional differences in elastic energy along zone 0 of the aorta in this issue of the *Journal*.

In this study, the authors examined multiple aortic samples obtained at the time of surgery from 65 patients, which included patients with trileaflet aortic valves, bicuspid aortic valves, as well as patients with connective tissue disease. The specimens were obtained from the aortic root (zone 0A), mid ascending aorta (zone 0B), and distal ascending aorta (zone 0C) as previously described by their group.⁷ Specimens were subjected to biaxial stretch to assess differences in elastic energy between the subzones of zone 0 and between patient groups.

The study resulted in a number of novel findings, some of which were expected, and others that were surprising. As the authors hypothesized, variations exist between the stored elastic energy in varying regions of the aorta. The

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CENTRAL MESSAGE

An understanding of the biomechanical properties of the aorta may lead to improved predictors for the risk of developing acute aortic complications.

aortic root reached inflection at lower stress and strain relative to more distal parts of the aorta, suggesting the aortic root may be less able to tolerate hemodynamic forces than the distal aorta, and providing some insight as to why patients with predominantly aortic root dilation experience a greater rate of aortic complications. Age was the most important predictor of elastic energy, which is not surprising, given the histologic changes that occur in the aorta with aging.⁸ While the aforementioned novel findings may have been predicted, the study found the presence of a connective tissue disorder did not have a major impact on elastic energy, nor did aortic diameter or the aortic cross-sectional area:height ratio—2 clinically used criteria for aortic intervention. These novel findings add additional support toward continual investigation into aortic biology and biomechanics to better guide our timing for intervention.

A few key points should be taken into consideration from the present study. (1) The median age of the patients in this study was 51 years old, which is significantly younger than in other large series.⁹ (2) More than one half of the samples obtained were from patients with bicuspid aortic valves, and (3) the median maximal aortic diameter in the study was 4.90 cm. The predominance of younger patients and <5-cm aortic diameters may limit the applicability of the current findings to larger populations. As the authors acknowledge, thus far there is no direct relationship between ex vivo modeling as performed

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in the current study and in vivo behavior of the aorta. While it is intuitive to consider the role of elastic energy in predicting aortic risk, further investigation is needed to confirm the relation.

The authors should be congratulated for a significant contribution to our understanding of aortic pathology. The findings of the current study will aid in understanding the pathophysiology of thoracic aortic aneurysms and the development of patient-specific risk models.

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