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Commentary: Tipping the balance toward better understanding of aortic dissection

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The role for thoracic endovascular aortic repair (TEVAR) to treat Stanford type B aortic dissection is evolving. It is the treatment of choice for acute complicated dissection, and there is a growing body of evidence in support of TEVAR during the subacute phase for uncomplicated dissection. Treatment goals of TEVAR in aortic dissection include coverage of the primary entry tear and optimization of flow into the true lumen to promote reverse positive remodeling of the aorta. Although TEVAR is safe and well tolerated for these indications, it has been met with limited success.¹ Approximately one third of patients will experience continued thoracic false lumen perfusion and pressurization, aneurysmal growth, and associated risk of rupture and death.

In a recent analysis of computed tomography imaging and subacute phase treatment with TEVAR in 51 patients with type B dissection, Xu and colleagues² performed computational hemodynamics and 3-dimensional structural analyses in an attempt to better understand the effects of TEVAR on aortic remodeling. They propose a novel indicator for predicting successful treatment of type B aortic dissection termed the first balance position of luminal pressure difference and determine the point at which flow balance occurred between the true and false lumen both before and after treatment with TEVAR. Following treatment with TEVAR, they demonstrate that the balance position shifts distally, and the more distally this shift occurs,

CENTRAL MESSAGE

Novel computational imaging analysis for type B aortic dissection may improve our understanding of the important hemodynamic, morphologic, and functional features important for treatment.

the better the true lumen expansion and false lumen reduction.

The authors are to be congratulated for ingenuity in developing a novel method of image modeling to assess the complex morphologic issues posed by type B aortic dissections. They use standard-of-care imaging techniques (ie, computed tomography scans) combined with typical clinical data (ie, blood pressure) to perform highly detailed finite volume analyses in the attempt to better define the pathogenesis of late complications.

Although this study is a unique and provocative initial investigation, the conclusions must be taken with a grain of salt. In the creation of their models, the authors make multiple assumptions about biomechanics and hemodynamics (eg, the vessel wall is no-slip and rigid). The innate relationships of these factors are much more complex in any individual throughout the length of their aorta and over an extended period of time. Also, it is important to appreciate that multiple etiologies underlie the development of dissection, and the course of the degenerative process is unique to each individual patient, even in those with the same genetic predisposition. The different phenotypic expressions of aortopathy and the contribution of various genetic predispositions that can occur make this disease process and the response to intervention far more complicated than the model takes into account. Admittedly, this is a proof-of-

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concept study and future studies are sure to build on this initial work in understanding this complex disease state.

The authors divided patients into 3 groups based on location of shift of the balance point after TEVAR: group 1 was above the infrarenal aorta, group 2 was below the infrarenal aorta, and group 3 included patients with true lumen and a higher modeled pressure throughout the whole aorta. The location of shift and optimization of true lumen flow defined what they termed to be positive remodeling. This is an idea that is theoretically sound and is worthy of further exploration. However, the sample size of the study is small, and there was limited follow-up. Most importantly, they did not correlate this novel method of assessing aortic remodeling with actual patient outcomes. The lack of correlation with important clinical outcomes like reintervention or, most importantly, survival provides little evidence of a translational application of this novel methodology.

Part of the problem with our current understanding of TEVAR for aortic dissection is that it is still unclear how best to describe reverse positive remodeling. In a recent consensus statement from the Society of Vascular Surgery and the Society of Thoracic Surgeons, positive remodeling after TEVAR included various stages of false lumen thrombosis within the definition.³ Yet, it has been shown previously that achieving the combination of both false lumen thrombosis and a reduction in the overall size of the aorta correlated best with survival.⁴

Although exploratory in nature, this study does provide further fuel for speculation. Is the balance point relevant in all patients? Do additional clinical-level factors (ie, refractory hypertension) play a significant role? Could risk

factor modification provide additional improvements in aortic remodeling? Does lack of distal shift of the first balance position correlate with time-to-late complications? It will be interesting to see if novel machine learning techniques can provide real-time, automated image analysis like what was done by Xu and colleagues.² Could this then be integrated into the electronic medical record and inform surgeons during the acute and subacute treatment period of the likelihood of requiring reintervention? Some of these questions may be best answered in larger cohort studies that incorporate genetics, hemodynamics, varying morphologies, and clinical risk factors to enable correlation with outcomes.

This novel study describing the first balance position of luminal pressure in aortic dissection is sure to be the first of many using sophisticated computational techniques that tip the balance in favor of improving our understanding of this complex disease.

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