Machine-learning phenotypic classification of bicuspid aortopathy: Did the mountain give birth to a mouse?

Jean Bachet, MD, FEBCTS

From ADETEC, Suresnes, France.

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Address for reprints: Jean Bachet, MD, FEBCTS, ADETEC 1, Place Marcel Legras, Suresnes 92150, France

(E-mail: jean.bachet@yahoo.fr).

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In their article titled “Machine-Learning Phenotypic Classification of Bicuspid Aortopathy,” Wojnarski and colleagues¹ report on a large study aimed at establishing a correlation between the various types of dilatation of the proximal aorta with the presence and type of a bicuspid aortic valve. To achieve their project, they have used a sophisticated statistical method, the “machine-learning” phenotypic classification. Through this methodology, the authors determined 3 phenotypes of aortic lesions associated with the bicuspidy: the aortic root, ascending aorta, and aortic arch phenotypes.

As a whole, this well-written and clearly organized article is convincing. However, some points deserve some discussion.

Among those points, one seems particularly relevant and still unanswered: “Are aortopathies associated to bicuspid valves the result of an hemodynamic process or a genetic disease of the aortic wall?”^{2,3} This discussion has been going on for several decades and, with variable evolutions toward one theory or the other, remains unresolved.⁴ Unfortunately, the present study partly fails to shed some light on the matter.

As discussed by Wojnarski and colleagues,¹ the description of 3 phenotypes might be excessive. It seems that the ascending aortic and aortic arch phenotypes could be 2 variants of the same phenotype and the consequence of the hemodynamic through the left ventricular outflow tract and the ascending aorta. This notion is not new and seems to be receiving some renewed interest.⁵ If we accept this pathophysiology, the slight difference in the location of the aortic dilatation could be explained only by the difference in the verticality of the ascending aorta and in the angulations between the left ventricle outflow track and the ascending aorta. According to those parameters, the stress of the vortex blood flow on the outer convexity would be applied more or less distally. This theory is supported by the fact that those lesions are mostly observed in older patients with a severe aortic valve stenosis.

Conversely, it appears that the root phenotype is observed in younger patients and is mostly associated with aortic

A long and comprehensive study.

Central Message

Phenotype classification of aortic aneurysmal dilatation associated with a bicuspid valve is important, but is it enough to facilitate the surgical analysis and management?

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valve regurgitation and annulus dilatation. The probability of a genetic connective tissue disorder origin of the root dilatation is likely as already speculated and demonstrated in several histologic and genetic studies.⁶⁻⁸

However, no clear recommendation for the surgical analysis and management of those lesions can be found. This illustrates the clear difference between surgery and science. The present article is clearly a sophisticated scientific one. Yet, one of the conclusions is that “Use of this machine-learning technology is not necessary for incorporating the characteristic of bicuspid aortopathy phenotype into future analyses, because by applying simple visual classification rules, we were able to obtain excellent concordance with the machine-learning results. Concordance between unsupervised clustering phenotype and visual classification by these rules was 94%.”¹

So is eyeball analysis of the lesions informative enough and is all the scientific classification surgically useless? When should the root, ascending aorta, or hemi-arch be replaced?

Should we keep on replacing the root with composite grafts or valve-sparing procedures in root phenotypes of whatever size? Should we replace the ascending aorta only when its larger diameter reaches or exceeds 4.5 cm? No clear answer is provided.

The answer still belongs to the surgeon and only to the surgeon (or the heart team).

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