Commentary: Vasa vasorum dysfunction and acute aortic syndromes: When guidelines do not follow the evolution of knowledge

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The aorta is a very strong structure. Aortic rupture does not occur if the intraluminal pressure ranges from 790 to 2070 mm Hg.1 Robertson and Smith, injecting water into the media of 42 fresh human aortas, found that the lowest pressure required to exceed the cohesive strength of the media was 273 mm Hg and the highest was 975 mm Hg, with a mean of 566 mm Hg.2 Therefore, the aorta is highly resistant to rupture or dissection.

In this issue of the Journal, Haverich and Boyle3 propose an appealing unifying theory on the genesis of aortic intramural hematoma (AIMH) and aortic dissection (AD). Vasa vasorum dysfunction is the link between these entities, which are seen as progression of one to the other. Rupture and bleeding of the vasa vasorum into the media is the cause of AIMH. It can remain limited to the thickness of the aorta or cause an intimal tear, which is at the basis of classic AD.

The vasa vasorum fill during diastole as in the coronary circulation. Thus, an increase in arterial diastolic pressure in the host vessel results in reduced perfusion,4 which can cause vessel wall hypoxia and neoangiogenesis, with the neovessels more fragile and prone to bleed. Hypertension also can reduce blood flow by distortion or compression of the vasa, generating changes in the walls of the vasa vasorum with critical ischemia and necrosis of the media. Other factors (eg, inflammation) can induce aberrant and adverse remodeling of the aortic wall, including smooth muscle cell loss in the media and extracellular matrix degradation in the media and the adventitia. The consequence is chronic dilation of the aorta, but an acute aortic syndrome (AAS) can superimpose at any moment.

The guidelines for prophylactic surgery of ascending aortic aneurysms include only the aortic size, with a cut-point of 55 mm in non-Marfan nonbicuspid valve aortas.5 Tozzi and colleagues6 found that 87.7% of patients with AD had a preoperative aortic size <45 mm, and that a threshold of 55 mm excluded ~99% of patients with AD in the host vessel results in reduced perfusion,4 which can cause vessel wall hypoxia and neoangiogenesis, with the neovessels more fragile and prone to bleed. Hypertension also can reduce blood flow by distortion or compression of the vasa, generating changes in the walls of the vasa vasorum with critical ischemia and necrosis of the media. Other factors (eg, inflammation) can induce aberrant and adverse remodeling of the aortic wall, including smooth muscle cell loss in the media and extracellular matrix degradation in the media and the adventitia. The consequence is chronic dilation of the aorta, but an acute aortic syndrome (AAS) can superimpose at any moment.

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from prophylactic surgery. The same findings have been re-
ported by others. Aortic size is only a surrogate marker,
often unreliable, of catastrophic events, and the guidelines
need to recognize the difficulty of linking aortic size to
AAS. An update of the natural history of ascending aortic
aneurysms from the Yale team found that the hinge point
for rupture or dissection was reduced from 60 mm in an
earlier study of 230 patients to 52.5 mm in a study of
3400 patients. Other unpredictable events, including vasa
vasorum dysfunction, can occur at any time. Genetic
screening in individuals with nonsyndromic aortic aneu-
rysms remains a work in progress, and clinical implications
are not widely accepted. As it is impossible to foresee
which aorta at which size could undergo an acute event,
reducing the aortic size for prophylactic surgery is our
only tool for treating more patients before AAS occurs.

References
1. Oppenhein F. Gibt es eine spontanruptur der gesunden aorta und wie kommt sie
zustande? Munchen Med Wchnschr. 1928;65:1234-7.
2. Robertson JS, Smith KV. Analysis of certain factors associated with production
of experimental dissection of aortic media in relation to pathogenesis of dissect-
ing aneurism. J Path Bact. 1948;60:43-9.
3. Haverich A, Boyle EC. Aortic dissection is a disease of the vasa vasorum. J Thorac
Cardiovasc Surg Open. 2021;5:30-2.
4. Scotland RS, Vallance PJ, Ahluwalia A. Endogenous factors involved in regula-
tion of tone of arterial vasa vasorum: implications for conduit vessel physiology.
Cardiovasc Res. 2000;46:403-11.
5. Erbel R, Aboyans V, Boileau C, Bossone E, Di Bartolomeo R, Eggebrecht H,
et al. 2014 ESC guidelines on the diagnosis and treatment of aortic diseases:
document covering acute and chronic aortic diseases of the thoracic and abdom-
inal aorta of the adult. The task force for the diagnosis and treatment of aortic
diseases of the European Society of Cardiology (ESC). Eur Heart J. 2014;35:
2873-926.
6. Tozzi P, Gunga Z, Niclauss L, Delay D, Roumy A, Pfister R, et al. Type A aortic
dissection in aneurysms having modelled pre-dissection maximum diameter
below 45 mm: should we implement current guidelines to improve the survival
benefit of prophylactic surgery? Eur J Cardiothorac Surg. October 2, 2020
[Epub ahead of print].
7. Rylski B, Ranchetti E, Bavaria JE, Vallabhajosyula P, Szeto WJ, Milewski RK,
et al. Modeling of predissection aortic size in acute type A dissection: more than
90% fail to meet the guidelines for elective ascending replacement. J Thorac
Cardiovasc Surg. 2014;148:944-8.e1.
8. Ziganshin BA, Zafar MA, Elefteriades JA. Descending threshold for ascending
aortic aneurysmectomy: is it time for a “left-shift” in guidelines? J Thorac
Cardiovasc Surg. 2019;157:37-42.
9. Brownstein AJ, Ziganshin BA, Kuwaniemi H, Body SC, Bale AE, Elefteriades JA. Genes associated with thoracic aortic aneurysm and dissection:
an update and clinical implications. Aorta (Stamford). 2017;5:11-20.
10. Bakoussis NG, Apostolakis EE, Papakonstantinou NA, Siminelakis SN,
Amaoustoglou H, Papadopoulos G, et al. The implication of vasa vasorum in
surgical diseases of the aorta. Eur J Cardiothorac Surg. 2011;40:412-7.