

## Thrombus morphology may be an indicator for aneurysm expansion

TO THE EDITOR: Abdominal aortic aneurysms (AAAs) are a major health problem affecting 4-8% of men and 0.5-1% of women above 50 years of age, with rupture being the most severe complication accompanied by high mortality.<sup>1</sup> Since small AAAs well under the critical threshold of 5.5cm of maximum diameter to be considered suitable for surgical repair, can also experience rupture with catastrophic outcomes,<sup>2</sup> there is a considerable effort in the literature for markers to be found, to determine more accurately risk of rupture and growth potential than the currently used universal criterion of maximum diameter alone. Morphometric characteristics of small AAAs, currently managed with surveillance, are under investigation by many research groups to identify any markers that predispose to rapid growth or rupture. Most surgeons have come across gigantic AAAs (*e.g.*, 11 or 12 cm) that have not yet ruptured, as well as small aneurysms <5.5 cm that ruptured or presented rapid expansion. The examination of such cases could provide useful observations and guide future research towards an individualized model for AAAs risk of rupture estimation.<sup>3</sup>

As small AAAs enlarge, a variety of geometrical changes can take place, including the tortuosity of iliac arteries, the angulation of the iliac bifurcation, the length and angulation of AAA neck and the asymmetry of the lumen centerline. Assessment of AAA morphometric characteristics has currently become possible from contrast-enhanced high-resolution spiral CT-angiography images, through realistic 3D-AAA model reconstruction using both manual and automatic segmentation. This way, several geometric indices can be calculated and related to the AAA growth rate. The aneurysm surface area can be divided in sections vertical to the corresponding centerline and various parameters of each section can be estimated. Parameters such as surface section area, section maximum distance that corresponds with maximum diameter as well as section shape that is an index of asymmetry. These parameters can be calculated with regard to sections in determined distance from the aortic bifurcation thus making it possible to detect any changes in the AAA between follow-ups that refer to specific regions of the aneurysm. Recording of morphometric characteristics of regions that present greater enlargement during follow-ups could offer great services towards identification of risk markers for rupture risk and rapid

growth potential estimation. Moreover, it could determine the AAA segments more prone to unfortunate events of rupture or rapid expansion.

AAAs that present high growth rate may indicate characteristics of AAA segments more susceptible to rapid expansion. We have found (unpublished data) that the presence of thrombus seems to correlate well with rapid enlargement as regions of maximum thrombus deposition and thickness tend to grow discontinuously fast compared to the rest of the AAA wall. This could imply a causal link between thrombus deposition and AAA growth. The above observation is enhanced by pathologic studies that indicate a relationship between thrombus deposition and presence of regions of wall inflammation, local hypoxia and subsequently wall weakening.<sup>4</sup> Furthermore, other prospective studies suggest that small AAAs with larger amount of thrombus even though they present lower values of Peak Wall Stress (PWS), experience higher growth rates, dictating that thrombus deposition may be a stronger indicator of rapid growth rate susceptibility than PWS.<sup>5</sup> Geometric parameters that possibly predispose AAA to thrombus deposition and thus enlargement should be further investigated. Regions of high curvature, possibly due to disturbed patterns of flow, may be related with increased thrombus deposition.

In conclusion, there are indications that suggest a critical role for thrombus with concern to the AAAs pattern of expanding which may identify regions of maximum thrombus deposition as the AAA segments more prone to rapid growth. Hopefully further investigation of patients' anatomic and physiologic characteristics that may predispose to thrombus deposition and subsequent AAA enlargement may shed light in identifying AAAs prone to enlargement and rupture.

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