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Longitudinal assessment of morphological characteristics during intracranial aneurysm growth

E. L. Leemans[1,2], B. M. W. Cornelissen[1,2,3], H. A. Marquering[1,2], R. van den Berg[2], W. P. Vandertop[4] C. H. Slump[3], C. B. L. Majoie[2]

[1]AMC, Department of Biomedical Engineering and Physics, Amsterdam, Netherlands
[2]AMC, Department of Radiology and Nuclear medicine, Amsterdam, Netherlands
[3]University of Twente, MIRA institute, Enschede, Netherlands
[4]AMC, Department of Neurosurgery, Amsterdam, Netherlands

Introduction: Several morphological characteristics, such as aspects ratio (AR) and non-sphericity index (NSI), are frequently used to predict which unruptured aneurysm is more likely to rupture. However, these characteristics may change as aneurysm shape evolves. Therefore, evaluating rupture risk based on a single time point might be inaccurate. In this study we aimed to answer the following research questions: (1) To what extent do morphological characteristics change during aneurysm evolution? (2) Are changes in these characteristics consistent throughout the entire patient population?

Materials and Methods: We retrospectively included all patients with imaging of a growing unruptured cerebral aneurysm between 2012 to 2016 from a population of 250 patients with 326 aneurysms who underwent serial imaging using the same modality. 3D vascular models were created using level-set segmentation. Aneurysms were isolated from the vasculature, using parent vessel reconstruction and neck plane detection. Eight morphological parameters were determined: neck diameter, AR, size ratio, bottleneck factor (BNF), height-width ratio, undulation index, ellipticity index (EI), and NSI.

Results: We identified 64 (26%) patients with 60 (18%) growing aneurysms. Most aneurysms (n=40, 66%) were smaller than 7 mm on initial imaging. The most common location was the middle cerebral artery (n=20, 33%). Preliminary results of eight aneurysms show an average increase in all morphological parameters (20-80% change). Changes in AR, BNF and EI were most prominent, with an increase of 31%, 25% and 60% respectively. However, for some growing aneurysms the AR (n=1, 13%), BNF (n=3, 28%) and EI (n=2, 25%) decreased.

Conclusion: Rupture risk-related characteristics are dynamic and may change during aneurysm growth. Although on average all morphological indices increase with increasing aneurysm size, the increase was inconsistent over the entire patient population. This study suggests that single-time frame imaging is not sufficient for accurate rupture risk prediction using morphological characteristics.