Aneurysm Presence at the Anterior Communicating Artery Bifurcation is Associated with Tapering of the A1 Segment.

Alexandra Lauric; Luke Antonio Silveira BS; Pablo Esquer MD; Emal Lesha; Adel M. Malek MD PhD
Cerebrovascular and Endovascular Division, Department of Neurosurgery
Tufts Medical Center and Tufts University School of Medicine, Boston, MA 02111

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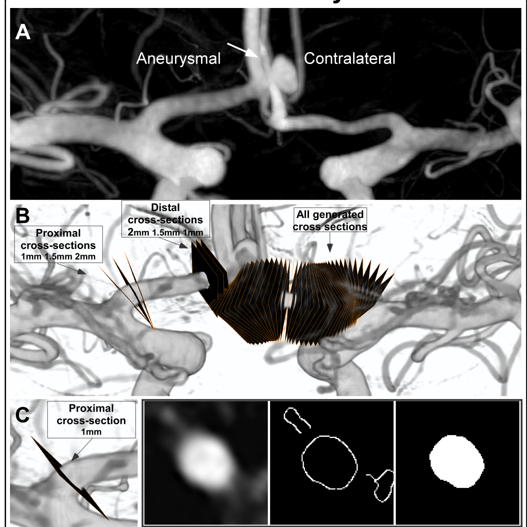
Introduction

We have recently shown that M1 segments leading to middle cerebral artery bifurcation aneurysms harbored progressive tapering not seen in controls. This upstream vessel narrowing creates hemodynamic conditions associated with aneurysm initiation. The anterior communicating artery (ACOM) is a frequent location for aneurysm formation, with high risk for rupture. We sought to determine if ACOM aneurysm presence is associated with tapering of the corresponding A1 segment of the anterior cerebral artery.

Methods

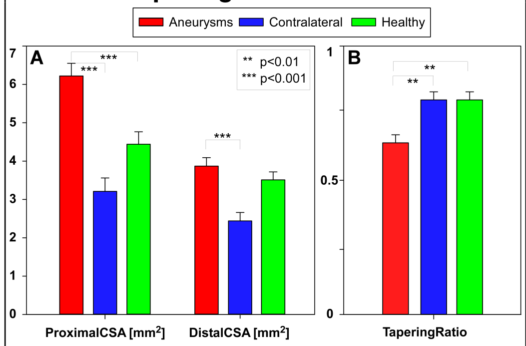
Bilateral catheter 3D rotational angiographic studies were analyzed for 23 bilateral datasets from patients with unruptured ACOM aneurysms, and 26 datasets from healthy controls. A1 segments were labeled as dominant, co-dominant, and non- dominant, depending on the angiographic filling of the A2 segments. Equidistant cross-sectional cuts were generated along the A1, and cross-sectional area (CSA) was evaluated proximally and distally, using edge-detection filtering. The relative tapering of the A1 segment was evaluated as the TaperingRatio (distal/proximal CSA).

Anterior Cerebral Artery Cross-Sectional Analysis



(A) Maximum intensity projection of bilateral 3DRA data for a patient with unruptured ACOM aneurysm and non-aneurysmal contralateral. The aneurysmal A1 (left/right) segment of the anterior cerebral artery was selected as the side which provided a complete filling of the aneurysm on the corresponding angiographic images. (B) Cross-sectional cuts are automatically generated along the A1 segments, and the distal and proximal cross-sections are selected at 1mm, 1.5mm, and 2mm from the bifurcations. (C) Edge detection filter is applied on each cross-sectional cut plane. Cross-sectional area of the A1 is calculated based on the detected A1 edge.

Tapering Phenomenon



(A) Bar representation of differences in proximal and distal cross-sectional area (ProximalCSA and DistalCSA) between A1 segments leading to aneurysmal, contralateral and healthy datasets. (B) Bar representation of differences in tapering ratio (TaperingRatio) between A1 segments leading to aneurysmal, contralateral and healthy bifurcations. Dominant and co-dominant healthy samples are represented as one group.

Results

All aneurysms occurred on dominant (91%) or co-dominant (9%) A1 segments. Consequently, aneurysmal segments were compared to dominant and co-dominant healthy controls only. A1 segments leading to ACOM aneurysms had significantly lower TaperingRatio (0.64±0.14) compared to contralateral (0.80±0.17, p=.006), but also with dominant (0.78±0.16, p=.03) and co-dominant (0.81±0.19, p=.002) healthy controls. Lower TaperingRatio indicates high tapering of the vessel. There was no statistically significant difference in tapering values between contralateral studies and healthy controls.

Conclusions

Aneurysmal, but not contralateral or control, A1 segments demonstrate significant progressive distal tapering, previously associated with aneurysmogenic hemodynamic conditions at the apex, consistent with our MCA results. Tapering of vessel segments leading to bifurcations is associated with aneurysm presence in both MCA and ACOM aneurysms, which together represent more than 50% of all intracranial aneurysms. The magnitude of this phenomenon warrants future analysis for predictive relevance and potential therapeutic strategies.

Learning Objectives

By the conclusion of this session, participants should be able to: 1) Describe the association of proximal parent vessel tapering and bifurcation aneurysm at the Acom and MCA locations , 2) Discuss the putative mechanotransduction of hemodynamic forces and vessel wall degradation 3) Propose next possible steps in understanding the potential mechanism of vessel wall tapering in aneurysm progression.

References

1-Meng H, Swartz DD, Wang Z, Hoi Y, Kolega J, Metaxa EM, et al. A model system for mapping vascular responses to complex hemodynamics at arterial bifurcations in vivo. Neurosurgery. 2006;59:1094-1100; discussion 1100-1091