Variability in Growth Rates of Fusiform, Dysmorphic Intracranial Aneurysms as Evaluated by CE-MRA

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Introduction

Patients with intracranial aneurysms are at substantial risk for a severe injury should the aneurysm grow and create symptoms from mass effect, or if the aneurysm were to rupture. Assessment of the risk presented by a given aneurysm depends on a variety of factors, such as: where the aneurysm is located in the intracranial circulation; geometric features of the aneurysm; and whether the aneurysm is changing rapidly over time. Given the potentially devastating consequences of aneurysm rupture, clinicians will often resort to high risk interventions to treat the aneurysm. However, there is limited knowledge of the growth potential of different classes of aneurysms, and methods for mesuring aneurysm changes are imprecise. This project extends our earlier work in the non-invasive assessment of changes in aneurysmal vessels. In addition to fusiform basilar aneurysms, we have now included dysmorphic, fusiform aneurysms of the distal internal carotid artery in our analysis. We report on their growth rate as determined from MRA studies using evaluation of the full three-dimensional anatomy of these vessels.

Methods

Ten subjects with fusiform, dysmorphic aneurysms of the internal carotid artery were recruited to this study under an approved IRB consent. Patients underwent serial MRI studies at annual intervals. Five patients had a baseline study and one follow-up study, while the other five patients had two or more follow-up studies. At each imaging session MRA and MRI studies were conducted to assess the lumenal volume and whether there was any thrombus present in these aneurysms. The MRA study used was a contrast-enhanced 3D acquisition with a parallel acceleration factor of 2 resulting in high-resolution (0.6 x 0.63 x 1.2 mm) CE-MRA images of the cerebral vessels. The MRI study used was a 3D balanced steady state free precession sequence with orientation and resolution selected to match the CE-MRA study. In order to ensure accurate assessment of volume changes over time two important steps were performed: 1) The 3D lumenal volumes from multiple time points were co-registered using internal fiducial markers such as bifurcation points (Fig. 1 left showing baseline in blue, and one year follow up in red; and 2) Consistent threshholding was enforced by ensuring that the volume of undiseased reference vessels remain iunchanged over time (Fig. 1 center shows reference vessel with arrowheads). Volumes of the aneurysmal segments alone were then plotted as a function of time (Fig. 1 right).

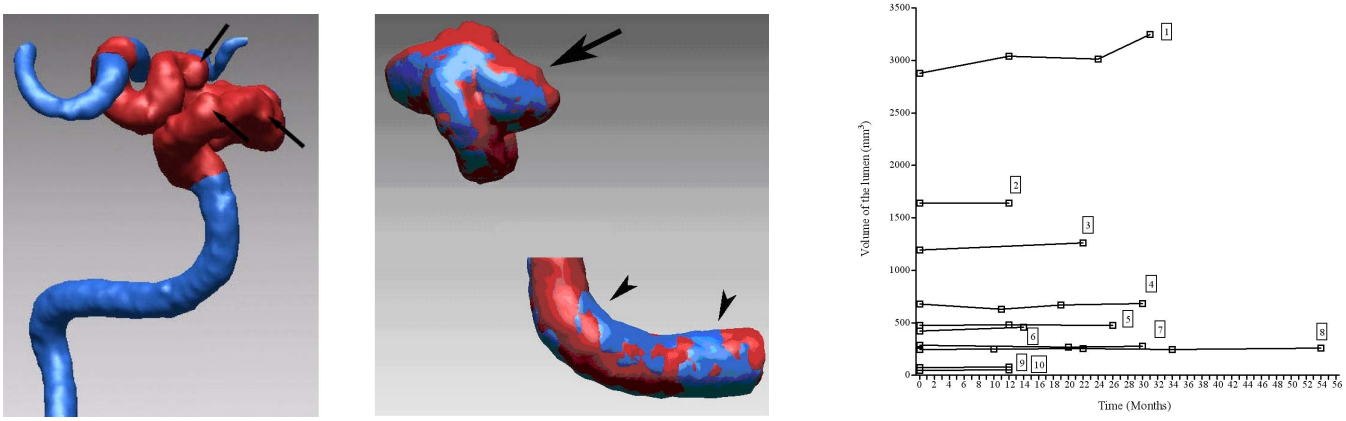

Figure 1 Left: Representative dysmorphic, fusiform aneurysm of the distal ICA showing baseline (blue) and follow-up lumenal volumes following co-registration; **Center**: Reference undisease vessel with threshhold selected to conserve volume (arrowheads) is shown together with aneurysmal distal vessel; **Right:** The volume of the aneurysmal segments of vessel are shown as measured over multiple time points for the ten different patients.

Results

All ten patients were found to have aneurysmal segments that were free of thrombus. Excellent co-registration of CE-MRA studies of the lumens of complex vascular anatomy measured at multiple time points was attained. Nine of the ten patients had changes in lumenal volume that were less than the error of measurement. Only one subject had any appreciable volume change (Patient 1 in the figure) who showed a relatively modest growth of 4.8%/year.

Conclusions

This study underscores the value of MRA as a non-invasive method for monitoring patients with aneurysms over time. The methods permit accurate estimates of volume changes in aneurysm geometries where the conventional method of using linear dimensions to assess aneurysm size are difficult if not impossible to implement. Importantly, the study shows that patients who are currently subjected to interventions that are associated with relatively high risk would better be followed by “watchful waiting” as these aneurysms have relatively slow rates of growth.

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