MRI/A in the evaluation of changes over time in untreated aneuryms

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INTRODUCTION: Intracranial aneurysms pose a substantial risk for subsequent neurological events either from hemorrhagic stroke subsequent to aneurysm rupture, or from mass effect generated by the enlarging aneurysm pressing on critical brain structures. Little is known about the natural progression of untreated aneurysms over time and this provides a challenge for determining the appropriate therapeutic intervention in patients with known aneurysms. We report here on the use of 3D MRA/I methods that were used to evaluate the progression of disease in patients with intracranial aneurysms where no intervention was planned, either because of size, unfavorable treatment options, or because of patient choice. This presentation expands on our previous report [1] on this topic with studies on additional subjects and over longer time periods. The use of MRI provides a non-invasive option to evaluate serial changes over time and to potentially identify subjects at increased risk for rapid progression.

METHODS: 78 patients with 88 aneurysms of the intracranial circulation were recruited for serial imaging using an IRB-approved protocol. Of these 14 aneurysms had intralumenal thrombus and were excluded from analysis in this review. This left 64 patients with 74 aneurysms in this analysis. Patients were imaged at baseline and then in intervals that ranged between 6 months and 1 year. Of the 74 aneurysms, 3 had 8 follow-up studies, 4 had 7 follow-up studies, 4 had 6 follow-up studies, 4 had 5 follow-up studies, 7 had 4 follow-up studies, 12 had 4 follow-up studies, 13 had 3 follow-up studies, 16 had 3 follow-up studies, 18 had 2 follow-up studies, and the remaining 18 had one follow-up study. This results in a total of 300 imaging studies with 226 interval measurements. At each imaging session MRA and MRI studies were conducted at 1.5T to assess lumenal volume and whether there was any thrombus present in these aneurysms [2,3]. A contrast enhanced 3D MRA study used was acquired with a parallel acceleration factor of 2 resulting in high-resolution (0.6 x 0.63 x 1.2 mm) 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.

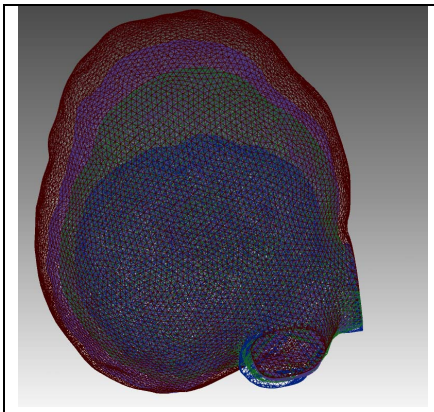

Fig. 1: Saccular anterior communicating artery aneurysm showing growth on repeated CE-MRA studies from baseline (blue) to 12 months follow-up (green), 18 months (purple) and 24 months (red)

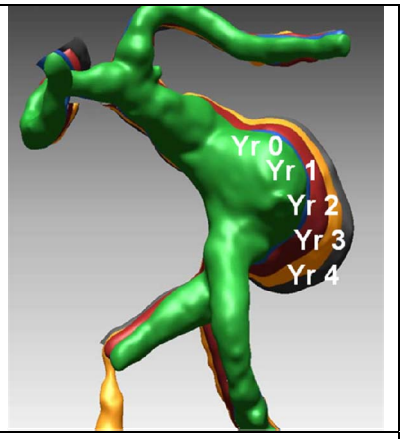

Fig 2: Fusiform basilar artery aneurysm showing growth on repeated CE-MRA studies from baseline (Year 0 - green).

Serial MR studies were co-registered using internal fiducial markers. Consistent thresh-holding was imposed by requiring that a reference segment of undiseased vessel maintained the same lumenal volume over time. The lumenal volume of the aneurysmal segment was then assessed on the CE-MRA studies for regional and global changes (Fig 1). Changes in volume of the aneurysmal segment were calculated as a percentage of the baseline volume and were normalized on an annualized basis. A statistical analysis of measurement error was conducted using a mixed effects maximum residual likelihood model.

RESULTS: Of the 74 aneurysms, 55% were on the internal carotid artery, 25% were vertebro-basilar, 12% were of the anterior communicating aneurysm, and 8% of the middle cerebral artery. 62% of the aneurysms were saccular and the remaining 38% were fusiform. Averaged over all locations, types, and sizes of aneurysm the standard error of measurement was found to be 4.9%. Of the aneurysms that were followed, 11 of 74 showed growth that was significant beyond measurement error.

DISCUSSION: MR provides a minimally invasive means to monitor intracranial aneurysms affording the opportunity to determine their natural history in ways that are not possible with other imaging modalities. In particular, 3D analyses remove the limitations of traditional methods that utilize measurements of linear dimensions: This study indicates that the great majority of aneuryms remain stable – a significant number of them display no morphology changes over many years. We continue to recruit subjects to expand our statistical power, and to permit more definitive statements on the relationship of hemodynamics to aneurysm evolution in general, and as a function of other variables, such as size and location of the aneurysms. We have also begun to implement these studies at 3T with voxels that are 30% smaller than those at 1.5T.

REFERENCES: [1] Saloner et al ISMRM 2012; [2] Dispensa et al *JMRI* 2007; 26:177–183 [3]; Boussel et al. JVIR 2011; 22: 1007-11