Error in the Reproducibility of Volume Measurements in Patients with Stable Intracranial Aneurysms Imaged at 1.5T & 3T

Farshid Faraji[1], Donne Nieuwoudt[1], Alastair Martin[2], and David Saloner[1]

[1]Radiology & Biomedical Imaging, UCSF/VAMC, San Francisco, CA, United States, [2]Radiology & Biomedical Imaging, UCSF, San Francisco, CA, United States

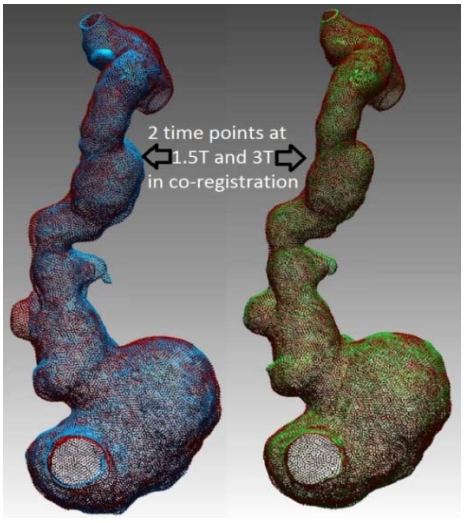
TARGET AUDIENCE Researchers interested in contrast-enhanced MR angiography in patients with vascular disease.

PURPOSE Intracranial aneurysms are localized dilations in the blood vessel wall, occurring in about 0.5% to 6% of the population. These vascular abnormalities can have devastating effects in the event of rupture or mass effect on adjoining brain regions. [1] There are treatment options available for some intracranial aneurysms, including surgical clipping of the aneurysm or endovascular treatments such as coil embolization. A number of patients with asymptomatic aneurysms choose not to receive treatment either because of size criteria or patient and clinician preference. [2] We have followed a cohort of more than 100 patients with serial MR imaging at 1.5T. We have now transitioned to studying these patients at 3T. Here, we assess the error in reproducibility of measurement of aneurysm volumes among patients with stable aneurysms who have had repeat MR imaging at both 1.5T and 3T.

MATERIALS & METHODS 9 patients with intracranial aneurysms had contrast-enhanced MR angiography (CE-MRA) performed at 6-month to 1-year intervals. Imaging was performed on a 1.5T Philips (Intera) and a 3T Siemens (Skyra). Both 3D-MRA sequences employ an elliptic-centric re-ordering scheme. Images from the 1.5T Philips were acquired with a resolution of 0.63/0.6/1.2mm, while the 3T Siemens acquired images at 0.7mm isotropic resolution A timing bolus (2cc Gadolinium at 2mL/s) followed by a saline flush (10cc at 2mL/s) was used to determine the appropriate scan delay for the full contrast bolus used in the 3D-CE-MRA (20cc Gadolinium at 2mL/s, followed by 20cc saline at 2mL/s). Acquired DICOM images were converted to VTK format with commercially available software (DICOM ToolBox) & VTK were subsequently imported into an in-house software (ClemSTL) for conversion to STL by thresholding & creation of an isosurface. Obtained surfaces were imported into 3D-modeling software (Rapidform) where they were tightly co-registered between time points. To account for differences between acquisitions, an intensity-based thresholding was used, where a healthy, non-aneurysmal, reference vessel was selected near the aneurysm, and its volume was matched between studies to within 2%. This ensured that any change seen in the volume of the aneurysm was indeed due to progression in disease, rather than technique or instrument adjustment variability. Volume of the aneurysm was calculated across time points using this reference vessel technique. Standard error was calculated relative to the aneurysm mean volume, for each patient at 1.5T & 3T.

RESULTS Results of the study are summarized in the table below. The mean measurement error across all studies was reduced from 3.21% at 1.5T to 2.01% at 3T.

Patient #	Studies at 1.5 T	Error at 1.5T	Studies at 3T	Error at 3T	Average Volume (mm^3)
1	2	6.64%	2	0.23%	88.9
2	4	2.87%	2	2.50%	1636.9
3	5	2.23%	2	2.15%	2147.5
4	2	2.15%	2	0.91%	503.5
5	3	2.56%	2	4.54%	41.9
6	3	3.36%	2	3.76%	69.8
7	5	4.26%	2	3.25%	313.9
8	5	4.54%	2	0.26%	107.6
9	2	0.24%	2	0.47%	89.7
		3.21%		2.01%	



DISCUSSION In this study, we observed that increasing field strength and spatial resolution resulted in a 33% reduction of the measurement error when calculating volumes of intracranial aneurysms. This reduced error can help us to determine with greater accuracy whether a patient's aneurysm is growing or stable, an important consideration when deciding whether to pursue surgical treatment options. Reduction of measurement error is also of great importance for longitudinal studies that may otherwise require very large patient numbers to obtain statistical significance. This error reduction permits detection of effects at 3T with a cohort half the size than would be needed at 1.5T. Additional studies must be acquired to further validate this finding.

REFERENCES [1] Stroke. 2002; 33: 2536-2544. **[2]** N Engl J Med. 1998 Dec 10; 339(24): 1725-33.