Evaluation of Serial Changes Over Time in Intracranial Aneurysms

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Abstract: There is considerable interest in being able to detect and quantitate time changes in lumenal contours in patients with aneurysms. This is difficult to achieve from 2D projection x-ray angiography studies. We have investigated the use of a 3D co-registration algorithm to compare vascular morphology in patients undergoing MR angiography at annual intervals. This algorithm provides clear delineation of changes in aneurysm size.

Introduction: This study was directed at providing a framework for analyzing changes in aneurysmal morphology in patients with fusiform basilar aneurysms. A post-processing co-registration algorithm was used to co-register contrast-enhanced MR angiography data sets using an automated algorithm. Patients were studied at annual intervals with the same image acquisition scheme and differences in anatomy were noted and quantitated.

Methods: Patients who were previously identified as having fusiform aneurysms of the basilar artery were scheduled for MRA studies. Six patients were imaged with multiple studies at annual intervals. Patients were imaged using contrast-enhanced MRA on a 1.5T system (Philips, Intera). High spatial resolution CE-MRA studies were acquired using SENSE with a factor of 2. For 3D CE-MRA, the parameters were: TR/TE = 5.0/1.7, flip = 30^0, FOV = 280mm, matrix = 512x256x36, BW = 255 Hz/pixel, SENSE factor = 2, centric ordered, acquisition time = 25s). Consecutive imaging data sets were co-registered using the custom-built program, R-VIEW which employs a minimization of joint histogram entropy algorithm[1]. The data set acquired at the second time point is then rigidly transformed into the same coordinate frame as that of the first time point with minimal user interaction. The initial data set is color coded with a blue scale and the later data set is color coded with a red scale. Changes in shape are then noted as mismatched color regions.

Results: CE-MRA studies provided excellent image quality and were helpful in determining whether changes occurred in geometric morphology over time, and were adequate to provide boundary conditions for co-registration. Fig. 1 shows an example of a patient who showed a reduced size of aneurysm when studied one year after her initial study. Fig. 1a is a Maximum Intensity Projection of a CE-MRA at the initial time point showing a bulbous aneurysm in the proximal basilar artery. At one year follow-up (Fig. 1b), the aneurysm shape is seen to change. The exact nature of the change is difficult to appreciate from non co-registered data. Fig. 1c shows the co-registered data showing (arrows) the large volume of aneurysm that is no longer patent. That region appears dark on the native MR images and presumably corresponds to deposited thrombus that has converted to hemosiderin. Fig.2 shows an example of a patient who displayed growth of the aneurysm (arrows) at one year follow up.

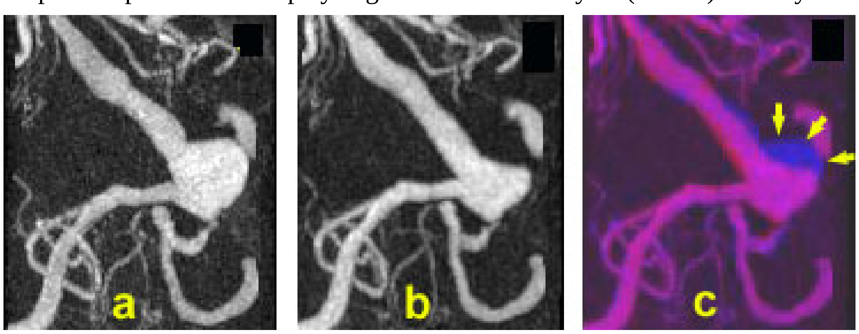

Fig. 1 MIP of CE-MRA at a) baseline and b) one year later. c) Shows an overlay of the two co-registered data sets. The region of volume reduction is indicated by arrows.

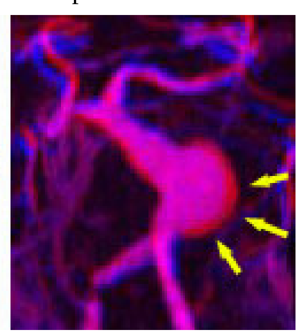

Fig. 2 Patient with growing aneurysm. Volume growth (arrows) is seen on overlay of co-registered data.

Conclusions: Co-registration of 3D CE-MRA data sets is effectively performed using R-VIEW. Serial data sets that are co-registered in this way are easily evaluated to determine whether there has been growth (or thrombus deposition). MR acquisitions have an inherent advantage over projection x-ray angiography where it is difficult to obtain comparable views of the vasculature in studies performed at different times. This method of analyzing morphology changes is also of value in studies that compare such changes to predictions of computational fluid dynamics programs, and could potentially be useful in guiding interventional procedures.

Reference: 1. C. Studholme, D. Hill, and D. Hawkes, Pattern Recognition, Vol 32(1), 71-86 (1999)