Very Low Dose Time-resolved MR Angiography

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Introduction: Time resolved contrast-enhanced MR angiography has been increasingly used to evaluate the hemodynamic status of normal versus abnormal vasculatures. Fast imaging sequences, parallel imaging, and view-sharing techniques have been applied to provide the needed temporal and spatial resolution. The Gadolinium-based contrast agent is sometimes injected in double dose to enhance the image quality. In light of NSF and the desire to lower the amount of Gadolinium-based contrast agent to the patient, we have investigated the use of time resolved TWIST imaging (Time-resolved Imaging with Stochastic Trajectories) in combination with a small dose of diluted contrast agent for 4D imaging of the extracranial vasculature.

Methods: In this IRB approved study, we tested the feasibility of using an ultra low dose of contrast for time-resolved MRA in 10 patients referred to get a clinical MRA examination. For low dose dynamic MRA, 1 ml of Gd-DTPA (Magnevist, Bayer Healthcare, New Jersey), diluted to 4 ml, was injected at a rate of 2 ml/sec. This was compared to routine contrast-enhanced MRA using a single dose (0.1 mmol/kg) of contrast agent. All imaging was performed using a 3T whole body system (Magnetom Tim Trio, Siemens Medical Solutions, Erlangen, Germany), with fast gradients (45 mT/m, SR=200) and 32 channel RF system (simultaneously combining a 12-channel head array, 4-channel neck array, and 6-channel thorax array to extend the FOV to cover the entire aortic arch, the carotid arteries, and the intracranial arteries all dynamically). TR/TE = 1.9 ms/0.8 ms. Parallel imaging was used in two phase encode directions with a scan time of 5.3 sec. An additional acceleration factor of 3.8 was achieved using the TWIST dynamic mode. 3D imaging, with 100 slices (slice resolution = 2.5 mm), was acquired with an in-plane resolution of 1.3 mm x 2.2 mm and interpolated to isotropic voxels of 1.3 mm.

Results: Using only 1 ml of contrast agent, all time-resolved results were of similar image quality as routine studies with a single dose of contrast agent. In this preliminary study, there was good agreement between the very low dose, time-resolved MRA and the routine contrast-enhanced MRA. Fig. 1 shows an example of the time arrival of the contrast agent and fig. 2 shows the rotated MIPs during peak arterial enhancement. By using a combination of parallel imaging and the TWIST dynamic mode, the temporal update rate was 1.4 sec for each 3D volumetric data set.

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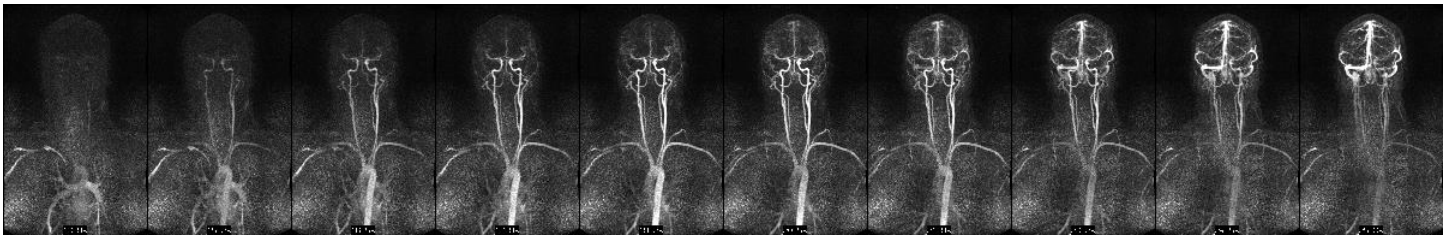

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Fig.1: Coronal MIP images following the arrival of 1 ml of diluted contrast agent. The in-plane resolution was acquired at 1.3 mm x 2.2 mm and interpolated to 1.3 mm x 1.3 mm.

Fig.2: Rotated MIP views at peak arterial enhancement (image “e” from above) following 1 ml of diluted contrast agent.

Conclusion: Time-resolved, three-dimensional MRA with near isotropic resolution and large coverage is feasible using as little a 1 ml of a Gadolinium-based contrast agent. Further studies involving larger number of patients are needed to determine whether very low dose time-resolved MRA would lead to any difference in clinical diagnosis.