Very Low Dose Time-resolved MR Angiography

G. Laub1, R. Kroeker2, D. Lohan3, and P. Finn3

1Siemens Medical Solutions USA, Los Angeles, CA, United States, 2Siemens Medical Solutions, Canada, 3David Geffen School of Medicine, UCLA

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.

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.