Targeted ROTational Magnetic Resonance Angiography(TROTA): 2D Projection Imaging with 3D Reconstruction

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Introduction:

Despite significant advances in the field of MR angiography, many diagnostic applications are still limited by the ability of current techniques to accurately determine the severity of stenosis. Trade-offs must always be made between spatial resolution, temporal resolution and examination field-of-view. A strategy will be presented where initial contrast injections (or even non- contrast time-of-flight scans) are done to locate vessel narrowings and further targeted studies are performed to confirm and more accurately depict suspect lesions.

Methods:

The TROTA (Targeted ROTational Magnetic Resonance Angiography) technique is a further development of 2D complex subtraction Gd-enhanced MRA[1]. Projection reconstruction techniques similar to those used in rotational catheter x-ray angiography [2] are employed. The method yields 2D time-resolved targeted projection angiograms around a vessel of interest using a rotating slice-selective acquisition (Figure 1). These projection angiograms can be reformatted with similar techniques used in rotational x-ray DSA yielding three-dimensional pixel data. The data can be displayed using MIP, 3D rendering and multi-planar slice reformatting to accurately depict vessel morphology.

Imaging was performed using a 1.5T clinical scanner (Magnetom Sonata, Siemens Medical Systems, Erlangen, Germany). A two-dimensional slice-selective snapshot FLASH sequences was used (TR=3.0, TE=1.8, FA=20, BW= 610 Hz/pixel, Voxel Size= 0.75mmx0.75mm; slice thickness=20mm, 12-20 angles, 380msec/projection). An example rotation of the 2D slice around a targeted vessel in the neck is depicted in Fig 1. TROTA acquisitions in the neck of the carotid right carotid artery were performed in four healthy volunteers. The right carotid artery was localized using 2D and 3D time-of-flight sequences and a targeted acquisition was obtained using a contrasted-enhanced (15ml gadiomide, Omniscan injected at 2ml/s) TROTA sequence. After Fourier transformation of the source projection images, reconstruction was performed using complex filtered-backprojection. Three-dimensional rendering and slice reformatting was performed using VolView (Kitware, Clifton Park, New York).

Results:

Representative source rotational 2D projection images are shown in Fig. 2. After backprojection, images were available in the coronal, axial and sagittal orientations. Using the available three-dimensional data, targeted MIP and three-dimensional rendering (Fig 3)was possible.

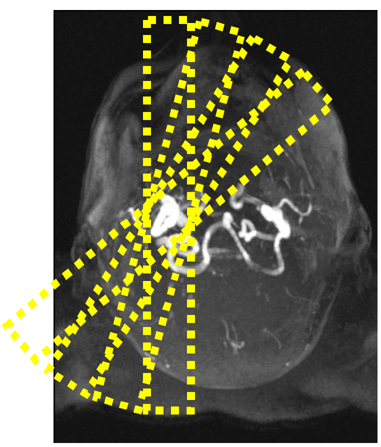

Figure 1: 2D Selective rotational angiograms are prescribed and collected during bolus gadolinium administration.

Figure 2: After complex subtraction from a precontrast acquisition, rotational projection angiograms over 180 degrees are available.

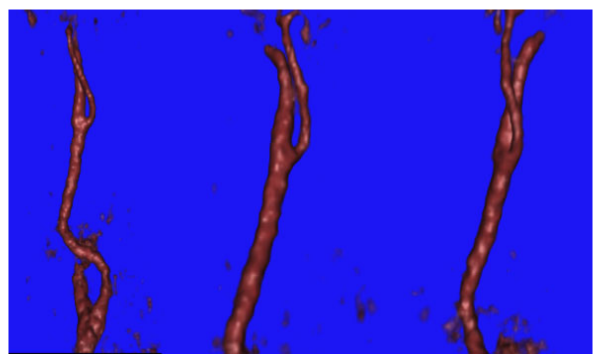

Figure 3: Thick 2D slices provide a summation (projection) across the targeted vessel. Complex filtered backprojection of the data in Figure 2 results in three-dimensional pixel data. Shown above are 3D renderings of the volumetric data.

Discussion:

Everyday clinical decisions depend on the accurate measurement of stenosis severity. TROTA aims to improve spatial resolution through a targeted rotating acquisition. TROTA further enhances the superior temporal resolution of 2D-MR-DSA with the addition of isotropic high-resolution 3D reformatting. In the future, TROTA may provide 3D targeted angiograms with spatial resolution equivalent to catheter angiography.

1. Wang Y, Johnston DL, et al. Magn Reson Med 1996;36(4):551-6.
2. Elgersma OE, Buijs PC, et al. Radiology 1999;213(3):777-83.