Non-Contrast MRA using magnetization transfer (MT) preparation with a zero echo-time (ZTE) acquisition

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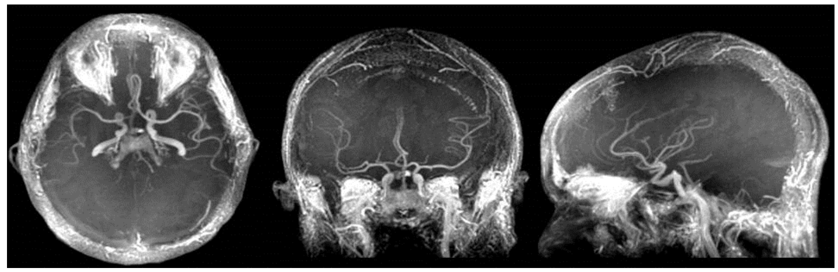
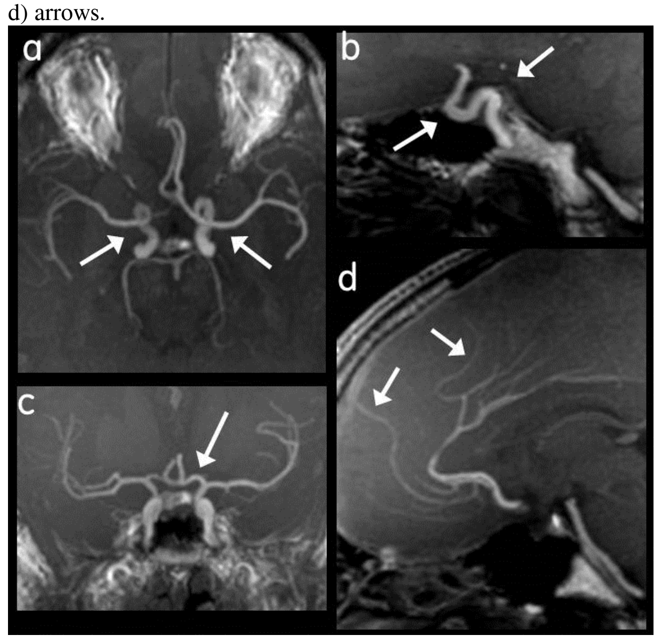
Introduction: Non-contrast neurovascular imaging is essential for the evaluation of a vast array of neurovascular diseases, for which time-of-flight (TOF) MRA is the current gold standard. However, there has been recent interest in both more robust non-contrast enhanced MRA (NCE-MRA) and imaging strategies which reduce patient anxiety and improve comfort. Magnetization Transfer (MT) provides a means suppress brain tissue based on the macromolecular content and is a well-established improvement to standard angiographic techniques [1,2]. Unlike alternative magnetization preparation and inflow based strategies, MT saturation is not dependent on blood flow allowing imaging without significant effect on fast or slow flowing blood. In this work, we investigate the use of MT prepared zero echo time imaging (ZTE) imaging technique for NCE-MRA. This sequence provides echo times (TE) times on the order microseconds for natural flow compensation and reduced signal loss of turbulent or accelerating spins [3,4]. Additionally, the quiet nature of ZTE leads to a more tolerable image session.

Figure 1. Thick section MIP reformats from a normal volunteer showing good visualization of the intracranial arteries.



Methods: Imaging was performed on 3T clinical MRI (MR750w, GE Healthcare, Waukesha, WI) using 8-channel receive array head coil (Invivo Corporation, Orlando, FL). A silent 20 ms sinc shaped RF MT preparation pulse at 1000 Hz off resonance was periodically played-out followed by data acquisition using a single-slab ZTE radial readout. Acquisition parameters included a preparation pulse rate of 1 pulse per 155 ms, ±30kHz BW, 5 degree imaging flip angle, 1.1 mm isotropic acquired voxel size, 24 cm FOV, angular sampling density of twice the Nyquist rate at the outer edge of k-space. Total acquisition time was 4:50 (min:sec). MT preparation was achieved utilizing a 30ms, 3000° hamming windowed sinc pulse played at 1000 Hz off-resonance.

Figure 2. Limited MIPs showing no signal loss visible in the carotid siphon a) and b) arrows. Excellent delineation of the anterior communicating artery in the coronal plane c) arrow. The distal middle cerebral arteries are well visualized in the axial view d) arrows.



Results: The periodic preparation pulse included no gradient waveforms and when combined with the ZTE image acquisition provided very low acoustic noise. Thick section limited-MIP images of reformats provide good depiction of the major intracranial arteries and demonstrate the high isotropic resolution and whole head coverage (Figure 1). Superficial vessels are also visible at the edges of the head. No signal loss due to dephasing is visible in the tortuous path of the carotid siphon (Figure 2 a-b, arrows). The method allowed good visualization of the intracranial arteries including the anterior communicating artery (Figure 2c, arrow) and distal arteries (Figure 2d, arrows).

Discussion and Conclusions: The combination of an MT preparation pulse with a ZTE data acquisition shows potential for providing NCE-MRA that is extremely quiet. An MT based approach shows potential in settings of slow blood flow where inflow and tagging methods may be challenged. This is despite the lack of inflow contrast normally dominant in TOF application. Further, the ZTE data readout minimizes the total echo time thereby reducing the sensitivity to dephasing in turbulent flow. The combination of these features make it an attractive method for imaging of patients post-intervention where interventional devices can dramatically shorten T_2* and create undesired flow disturbance.

References:[1] Pike et al. MRM 1992 ;25 :372-379. [2] Edelman et al. Radiology 1992 ;184 :395-399. [3] Hafner MRM, 1994.17 :1047-1051. [4] Madio et al. MRM 34 :525-529.

Acknowledgements: NIH5R01NS066982