Evaluation of 3D Fast SPGR and TRICKS for Distal Extremity CE-MRA

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Background

MRA of the distal extremities (hand and foot) presents significant challenges due to variability in blood flow, early venous return and complex anatomy in a small region. In order to diagnose diseases involving these small vessels and to assist in microsurgical planning both precise bolus timing and the highest possible spatial and temporal resolution are required. Conventional MRA has been of limited value in these regions due to the inherent problems with bolus tracking and the rapid venous return. TRICKS (time-resolved imaging of contrast kinetics) allows for multiple acquisition volumes in a rapid time frame due to less frequent sampling of k-space and sharing of views, minimizing imaging time and maximizing contrast and spatial resolution. We evaluated the feasibility of TRICKS in the distal extremities in 5 patients with comparison to conventional contrast enhanced MRA.

Methods

Images were acquired using a 1.5T MR scanner (Signa, General Electric Medical Systems, Milwaukee, Wisconsin, version 11.0). Conventional MRA consisted of a 3D fast SPGR sequence with the following parameters: TR/TE 6.3/1.4 msec, flip angle 35, bandwidth 31.2 kHz, 18 cm FOV, 256x160 matrix, 1 NEX, 0.75 phase FOV, 2.8 mm section thickness, 30-40 sections in a time acquisition of 34 seconds. Timing delay was determined using the Fluoro Trigger option, which uses a real-time method to demonstrate the arrival of the contrast agent. The TRICKS MRA was performed approximately 5-8 minutes following the conventional MRA sequence using 15-18 ml of contrast injected at a rate of 3 ml/s. A mask acquisition was acquired (16 s), and after a brief pause, 10 temporally resolved 3D volumes were obtained following the administration of contrast. The following parameters used for the TRICKS acquisition: TR/TE 4.1/1.7msec, flip angle 30, bandwidth 62.5 kHz, 18 cm FOV, 256x224 matrix, 0.50 NEX. 0.8 phase FOV, 1.8 mm section thickness, and 28-40 sections in a time acquisition of 70 seconds. The effective temporal resolution of the sequence was 4.8 seconds. The collapsed image from each frame was review and the optimal frame was selected and compared with the conventional sequence. Dedicated transmit/receive extremity coils were used for all imaging.

Results

Images were diagnostic in all cases, with TRICKS images showing superior temporal and spatial resolution (figure 1), allowing for easy separation of the arterial and venous phases for both the reconstructed planar and projection images in the distal extremities. TRICKS images were deemed more useful for surgical planning purposes than the conventional MRA with better visualization of small segmental arterial branches. The TRICKS images of the foot also confirmed patent trifurcation flow which could not be assessed with the single acquisition conventional MRA.

Discussion and Conclusion

In this small feasibility study, we have shown TRICKS to be a viable technique for evaluating detailed vascular anatomy of the distal extremities with improved vessel visualization when compared with conventional MRA. The excellent temporal resolution combined with high spatial resolution and rapid image acquisition makes this an ideal technique for diagnosis and surgical planning in the extremities.

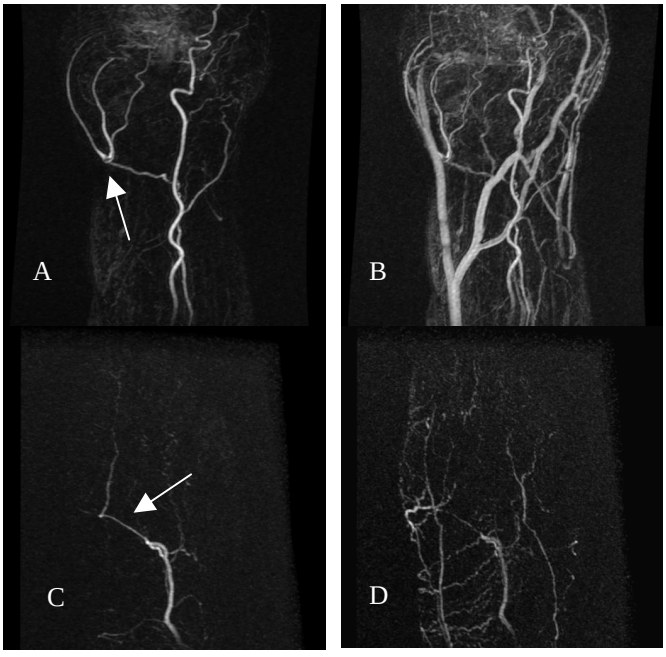

Figure 1. Examples of TRICKS used in the hand and foot. Image (A) demonstrates the arterial phase in the hand showing occlusion of the proximal radial artery with reconstitution distally by a branch of the ulnar artery; image (B) demonstrates the venous phase. Images (C) and (D) are of the early and slightly later arterial phases of the foot showing flow in the first dorsal metatarsal branch arising from the anterior tibial artery (arrow) and slightly delayed flow in the branches of the posterior tibial and peroneal artery branches.