Time-resolved MR-angiography (TWIST) of the hand in comparison to digital substraction angiography (DSA)

K. Brauck[1], F. M. Vogt[1], S. Maderwald[1], S. C. Ladd[1], K. Kroeger[2], G. Laub[3], R. Kroeker[3], H. H. Quick[1], and J. Barkhausen[1]

[1]Department of Diagnostic and Interventional Radiology and Neuroradiology, University Hospital Essen, Essen, Germany, Germany, [2]Department of Angiology, University Hospital Essen, Essen, Germany, Germany, [3]Siemens Medical Solutions USA, United States

Introduction:

Contrast material-enhanced three dimensional (3D) magnetic resonance angiography (MRA) of the vessels of the lower extremity has become well established as a safe, reliable and accurate means for the evaluation of pathologies of this region. However, imaging of the small vessels of the wrist and hand is much more challenging and places special demands on the MRA sequences. Compared to other vascular territories the vessel diameters are much smaller and the delay between injection and delivery of contrast material to the target area is highly variable. Additionally, arterial and venous collaterals as well as vascular variants are more commonly making images difficult to interpret. Therefore, MRA of the hand requires high resolution to accurately depict the superficial and deep palmar arches and short scan times are mandatory to avoid venous contamination. Parallel acquisition (PAT) combined with k-space segmentation (TWIST) allow a substantial reduction of scan time and may be helpful to fulfil these contradictory requirements. Our study aimed to evaluate a dynamic contrast-enhanced MRA protocol combining high temporal and spatial resolution (TWIST) using digital subtraction angiography as the standard of reference.

Methods and Materials:

4 volunteers and 8 patients (5 men, 3 women, mean-age: 52 years) with vascular pathologies of the hand, which were referred for DSA of the hand, were enrolled into our study. All MRI examinations were performed on a 1.5T System (Magnetom Avanto, Siemens AG, Erlangen, Germany) using two multi-channel receiver coils. Following automatic injection (flow rate 3ml/s) of 0.1 mmol/kg Gadovist® (Schering, Berlin, Germany). 35 consecutive T1-w TWIST 3D-data sets were collected (TR: 2.92 ms, TE: 1.2 ms, FA: 25°, voxel size: 0.9x 0.7 x 1.2 mm^3. In comparison to the DSA the overall image quality, the visualization of vascular details and the diagnostic accuracy of the MR data sets were evaluated.

Results:

The two multi-channel surface coils combined with parallel acquisition and a recently developed k-space segmentation algorithm (TWIST) resulted in a true temporal resolution of 2.36 seconds, which was interpolated to an effective temporal resolution of 1.18 seconds, resulting in subsequent filling of the radial / ulnar artery, the metacarpal and digital arteries (Fig. 1) in volunteers. The high spatial and temporal resolution of this sequence allowed evaluation of the superficial and the deep palmar arches and the metacarpal vessels without venous overlay. All patients showed dysfunction of the arterial vessels of the forearm and/or the hand – occlusion of the ulnar or radial artery (n=4), occlusion of the palmar arches (n=5) and vascular malformation (n=2). The MRA showed an excellent agreement with DSA for the radial / ulnar and metacarpal arteries; however a diagnostic image quality for digital arteries could be obtained in 3 of 8 patients only.

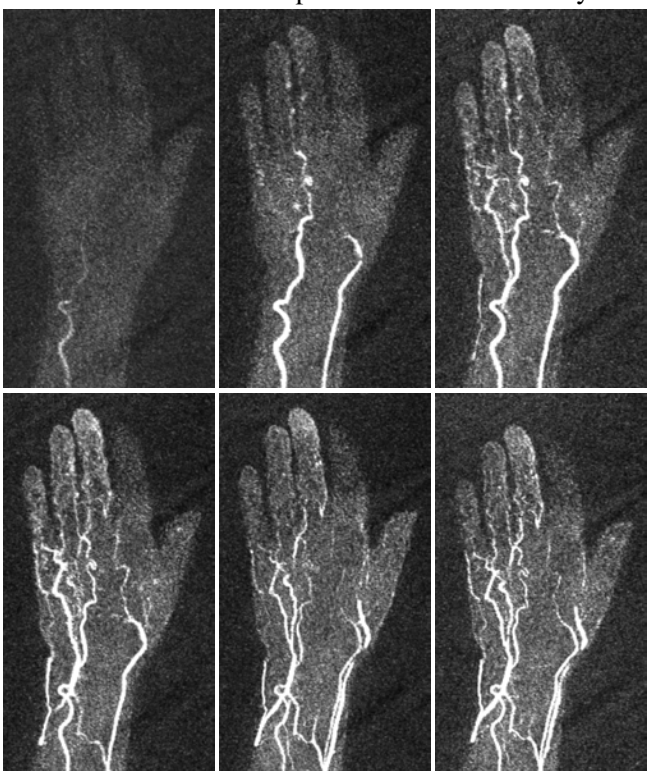

Fig. 1: Time-resolved MRA of the right hand. Occlusion of the digital arteries of digitus I and II.

Discussion:

The used dynamic TWIST MRA protocol delivers morphologic and functional information and can be considered as the imaging modality of first choice for vascular lesions of the hand. The time-resolved MRA protocol providing information about the arterial and venous vessels as well as soft tissues is advantageous especially in patients with arteriovenous malformations. However, the reliable assessment of the digital arteries still requires DSA in the majority of patients.