Bilateral time-resolved contrast-enhanced MR angiography of the hands at 3.0 Tesla

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Introduction

Due to the small caliber of the target vessels, great interindividual variety of vascular anatomy and contrast agent dynamics, contrast enhanced (ce)-MRA of the hand still is challenging. The purpose of this study was to evaluate the diagnostic quality and feasibility of highly accelerated time-resolved ce-3D MRA at 3.0 Tesla compared (tr-MRA) with an established single-acquisition first-pass high-resolution 3D MRA technique (st-MRA). Time-resolved and standard bilateral ce-MRA was performed subsequently in the same subject in a study with 22 healthy volunteers.

Materials and Methods

22 healthy volunteers were examined with an eight-channel head coil at a 3.0T-scanner (MRT Trio, Siemens, Germany). Gadolinium-BOPTA-enhanced tr-MRA was performed applying a highly spatially and temporally accelerated spoiled GRE-sequence (rf-spoiled FLASH) featuring parallel imaging (GRAPPA [1]), and view sharing along the temporal dimension (TREAT [2]). A series of 32 3D-sets was acquired within 2 min providing an effective temporal resolution of 3.6s/data set and spatial resolution of 0.9x0.9x2.0 mm^3. In the same subject, a timed single-acquisition high-resolution 3D ce-MRA (spatial resolution = 1.1 x 1.0 x 1.0 mm^3) served as intraindividual standard of reference for comparing the diagnostic image quality and onset of artefacts. All measurements were performed bilaterally, i.e. covering both hands at the same time, using a home-built hand fixation device. Signal-time-curves within the hand artery tree were determined by ROI measurements in the time-resolved ce MRA data sets.

Results

In all subjects tr-MRA provided a clear separation of the arterio-venous contrast bolus transit phases. The bolus arrival time greatly varied among the volunteers ranging from 26s to 60s seconds (mean: 41s, standard deviation: 9s). In 5 out of 22 subjects (23%) significant left to right side differences of bolus arrival times were measured, (Fig. 1). The bolus propagation time from the inflow arteries to the proper digital arteries was between 8 s and 26 s. The maximum intraindividual left to right side difference of bolus propagation time was 11 s. Compared with st-MRA overall image quality of artery depiction in tr-MRA was inferior. Whereas image quality of the palmar arches and greater vessels was diagnostic, the delineation of the digital segments at P2/P3 level suffered from false-positive findings presenting as pseudostenoses. This finding particularly emerged in those regions were the vessel course left the coronal axis and progressed through-plane, e.g. at the origin of the proper digital from the common digital arteries. In all cases, time resolution in tr-MRA reliably prevented venous contamination which was casually encountered in st-MRA, particularly in those cases where complex hemodynamics and side-different bolus arrival were present.

Discussion

Applying tr-MRA with high image acceleration at 3.0 T provided reliable separation of the arterio-venous contrast agent transit phases. In 23% of the subjects, different time frames had to be selected to compensate for marked contrast dynamics differences between left and right hand. In these cases, arteriography with st-MRA was optimal merely on one side whereas contra lateral misregistration either with venous contamination or incomplete arterial contrast-enhancement occurred. Although depiction of the greater arteries, the palm arch and arising branches was acceptable or good with tr-MRA, compared with single acquisition high-resolution ce-MRA, spatial resolution and SNR constraints impeded the delineation of the middle and distal finger arteries. Particularly, false-positive findings appearing as "pseudostenoses" had to be encountered in the through-plane course of the fine digital vessels most likely due to partial volume effects on basis of the limited resolution in z-axis. Future studies are necessary to further refine time-resolved ce-MRA and define optimal trade-offs between spatial resolution and acceptable temporal resolution for reliable artery-vein separation

Conclusion:

Highly accelerated bilateral ce-3D MRA of the hand at 3.0 T is easy-to-handle and reliably separates the arterio-venous contrast agent transit phases. Although diagnostic imaging of the greater arteries, the palm arch and arising branches is possible, due to spatial resolution and SNR constraints the depiction of the digital vessels still is suboptimal with typically false-positive findings appearing as pseudostenoses.

References:
1. Griswold MA, et al. Magn Reson Med, 47, 1202-10.
2. Fink C, et al. Eur Radiol, 15, 2070-4.

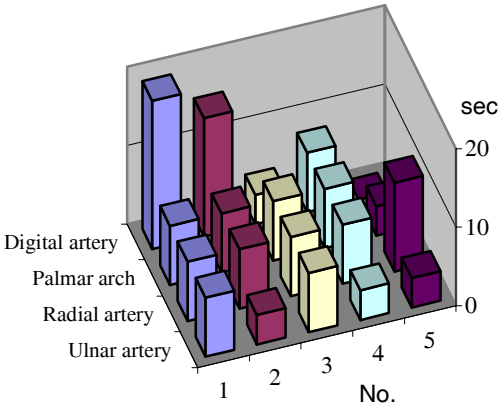

Fig. 1. Differences of contrast bolus arrival time corresponding to the vessel segments in 5 subjects with side-different contrast dynamics of the hand (n=22).

Fig. 2. (A) Bilateral ce-MRA of the hand in a healthy volunteer. Tr-MRA demonstrates non-simultaneous arterial filling in different time frames. (B) On st-MRA selective arteriography is shown only on the right side whereas venous contamination is found contra laterally.