Benefits of 3 Tesla vs. 1.5 Tesla Contrast-Enhanced MR Angiography of the Hands Using Parallel Imaging

O. Moske-Eick[1], J. T. Winterer[1], K. Elsner[2], J. Leupold[2], R. Strecker[2], M. Langer[1]

[1]Department of Diagnostic Radiology, University of Freiburg, Freiburg i. Br., BW, Germany, [2]Department of Radiology, MR Physics, University Hospital, Freiburg i. Br., BW, Germany

Introduction

Due to the small-sized target vessels, early venous contamination and variety of possible pathologic conditions, arteriography of the hand vasculature is still a challenge for MR-Angiography. The purpose of this study was on the one hand to determine the benefit of CE-MRA at 3.0 Tesla to signal-to-noise (SNR), contrast-to-noise (CNR) in healthy volunteers and on the other hand to investigate the diagnostic imaging quality in patients with severe ischemic hand disease, compared with standard 1.5 Tesla technique.

Materials and Methods

All MRI measurements were done on a 3T (SIEMENS Magnetom Trio) and 1.5 T (SIEMENS Magnetom Sonata) whole body system using an eight channel phased-array head coil. Examinations were performed in prone position with stretched arms in a superman shape. A custom-built pad with a 30 degree angle to the horizontal was used in order to allow the subjects a comfortable positioning of their hands and to avoid motion during the examinations. Identical Imaging protocols were used on both MR systems equipped with identical gradient systems (40mT/m and 200 T/m/s).

After the scout measurement the individual circulation time was determined via a testbolus measurement (2ml Gd-BOPTA, 20ml NaCl @ 2ml/sec.) using a 2D FLASH projection sequence with complex subtraction and a temporal resolution of 1s.

First Pass MR Angiography was performed using a RF-spoiled multiphasic elliptically reordered 3D fast low angle shot (FLASH) sequence with the following parameters: TE/TR = 1.4/3.7 ms, BW = 545Hz/Px, FA=22°. Partially sampling a k-space volume of 512x512x52 data points, an in-plane image resolution of 0.4 x 0.4 mm and a slice resolution of 1.2mm could be realized. Parallel imaging with a GRAPPA factor of 2 was applied in phase-encoding direction sampling 24 reference lines in the k-space center resulting in a total measurement time of 20 sec. For mask subtraction, a pre-contrast 3D FLASH measurement was performed.

A volume of 15ml Gd-BOPTA (Multihance®, Bracco-Altana-Pharma, Germany) followed by 20 ml of physiological saline solution was applied via the cubital vein. Automatic injection with a flow of 2ml/sec using a power injector (Spectris at Sonata resp. Solaris at Trio, Medrad) guaranteed standardized conditions for contrast agent application.

Postprocessing included image subtraction, overlapping thin-slice MIPs and angulated targeted MIPs. Differences between 1.5T and 3T were evaluated intraindividually with a) ROI measurements of vessel SNR and CNR, b) multi-observer rating of diagnostic image quality c) assessment of artefacts and venous contamination.

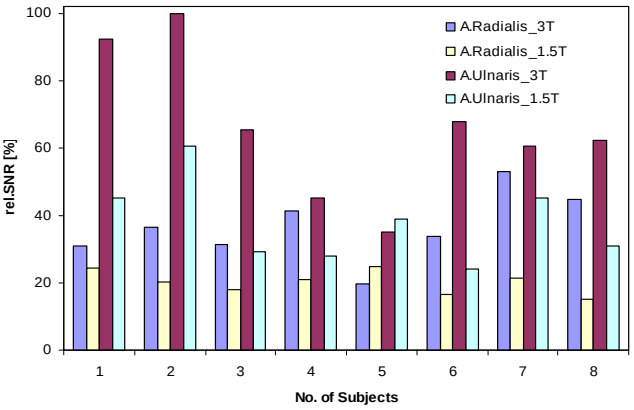
Patients / Volunteers: The ongoing study is separated in two parts: a) examination of 10 volunteers on the 1.5T and 3T system in subjects without known pathologies of the vessels of the hands in order to assess comparative SNR and CNR ratio b) examination of 10 patients with severe ischemic hand disease in order to investigate the diagnostic benefit of MRA of the hands at 3T vs. 1.5T. The two measurements were done on different days as defined by the study protocol.

Results

Multiphasic centric reordered acquisition provided high-resolution arterial-phase images with sufficient suppression of venous contamination and low incidence of artefacts. 5 Patients and 3 volunteers have been investigated so far.

The benefit from 3T vs 1.5 T CE-MRA is an increase in SNR of 102,3% and in CNR of 120,8% resulting in a significant improvement of vessel delineation and diagnostic image quality as shown in Fig.1 and Fig.2.

The summary of measured SNR values of all subjects is displayed in Fig. 3.



Discussion

CE-MRA is a generally robust and fast non-invasive technique with reproducible findings.

CE-MRA of the hands using parallel imaging at 3T is clearly improved providing a twofold increase of SNR/CNR and a better delineation of the small-sized arterial hand vessels in microvascular diseases. Further investigations will be performed to assess the clinical benefit of CE-MRA of the hands at 3T.

Figure 1. Patient with severe ischemic hand disease (Morbus Raynaud). Left 1,5T, right 3T (MIPs).

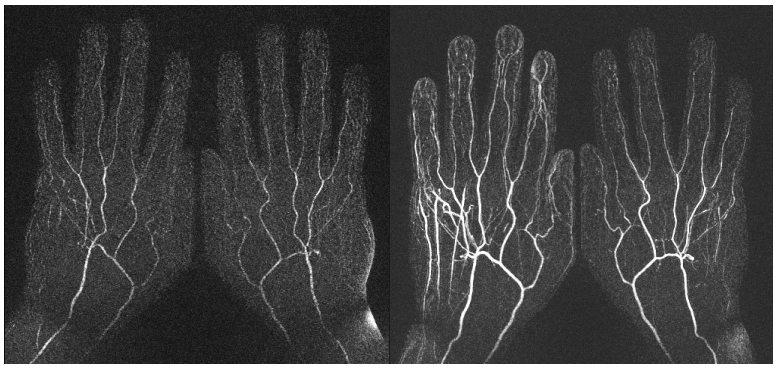


Figure 2. Healthy volunteer. Left 1,5T, right 3T (MIPs).

References

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3) Bilecen D, et. al. *AJR* 2004; **182**:180-182.