Evaluation of Intracranial Aneurysms with 7T versus 1.5T MR Angiography

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Background and Purpose: Three-dimensional time-of-flight (TOF) magnetic resonance angiography (MRA) has proven to be a reliable, non-invasive technique for the detection and pre-treatment assessment of intracranial aneurysms. The approximately 4.7 times higher signal at 7T compared to 1.5T may improve image quality of MR angiograms and should therefore provide a superior visualization of intracranial arteries and aneurysms. The purpose of this study was to determine whether 7T TOF MRA is superior to 1.5T TOF MRA in the detection and evaluation of intracranial aneurysms.

Methods: Ten patients with intracranial aneurysms underwent 7T TOF MRA (Magnetom 7T, Siemens, Erlangen, Germany), 1.5T TOF MRA (Magnetom Espree or Sonata; Siemens, Erlangen, Germany) and digital subtraction angiography (DSA, Infinix NB, Toshiba, Tochigi, Japan). 7T images were performed by using a CP head coil (InVivo Corp., Gainesville, FL) or an 8-channel head coil (Rapid, Wuerzburg, Germany), which was individually tuned on the patient´s head. For 1.5T imaging a CP head coil or an 8-channel head coil (Siemens, Erlangen Germany) was used. The interval between all three examinations was not longer than two days. Image analysis of source images and maximum intensity projections was performed by two neuroradiologists blinded to clinical data and results of previous angiograms. They compared the image quality of aneurysms (dome, neck, origin) and 12 different vessel segments (C 6-7, A 1-2, M 1-3, P 1-3, AICA, PICA) in both TOF MR angiographies by using a four-point scale. DSA served as a reference standard. Wilcoxon rank test was used to compare the mean values of image quality determined by both readers.

Results: Twelve intracranial aneurysms in ten patients depicted by conventional angiography were correctly identified in 7T and 1.5T TOF MRA by both readers. Seven of ten intracranial aneurysms were located in the anterior circulation and the remaining three aneurysms were detected in the posterior circulation. Intracranial 3D TOF MRA at 7T revealed superior image quality of the aneurysmal dome (58% of 12 aneurysms), the aneurysmal neck (50% of 12 aneurysms), the A1- (60% of 10 patients) and A2-segment of the anterior cerebral artery (50% of 10 patients). However, four vessel segments (PICA, C6, M2, P3) were graded better at 1.5T, which may be attributed to the inferior coverage of 7T head coils and a 20 ms longer TR of the 7T TOF MRA protocol.

Conclusions: Our preliminary results indicate that 7T TOF MRA provides superior image quality of the aneurysmal dome and neck compared with that of a standard 1.5 T TOF MRA. Improved head coils and optimized scan protocols are needed to convert the signal gain of ultrahigh field MRI into a further improvement of the overall image quality of TOF MR angiographies and possibly depiction of very small aneurysms.

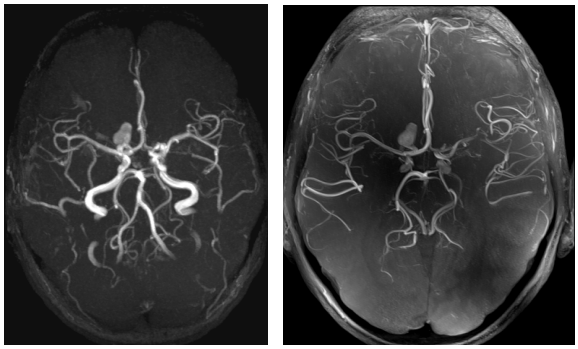

Figure: Axial TOF MRA collapse images of a 45-year-old female patient with an asymptomatic, saccular aneurysm of the right internal carotid artery. The temporal branches of the middle cerebral artery are better depicted on the 7T TOF MRA image (A), whereas the caudal segments of the internal carotid arteries are only revealed on the 1.5T TOF MRA image (B) probably due to the reduced coverage of the 8-channel head coil at 7T.