Efficacy of detection of significant carotid artery stenosis with TREAT imaging at 1.5T and 3.0T

H. J. Michaely[1], H. Kramer[1], K. Bauner[1], K. Nael[2], M. F. Reiser[1], S. O. Schoenberg[1]

[1]Institute of Clinical Radiology, University of Munich, Munich, Bavaria, Germany, [2]Radiological Sciences, UCLA, Los Angeles, California, United States

Background

In western countries, ischemic stroke is a major reason of morbidity and mortality. High-grade carotid artery stenosis (CAS) is a main risk factor for the development of stroke. Surgical treatment of high-grade CAS was proven to significantly reduce the risk of stroke in the NASCET and ECST trials [1]. Currently, conventional intra-arterial angiography is still considered to be the gold-standard exam for detection and grading of CAS. State-of-the-art high-spatial resolution MR-angiography (MRA) reaches a very good sensitivity and specificity for detection and grading of CAS. However, in contrast to conventional angiography, high-spatial resolution MRA does not allow to assess the hemodynamic impact of a CAS. Recently introduced MRA techniques like TREAT (time-resolved echo-shared angiographic technique) allow to monitor the passage of a contrast agent bolus with high spatial and temporal resolution. The aim of this study was therefore to evaluate the efficacy of TREAT in the detection of hemodynamically significant CAS.

Material and Methods

40 patients (18 female /22 male, age 69.7 ± 9.2) with suspected CAS underwent high resolution (HR)-MRA of the supraaortic vessels. HR-MRA was performed on a 1.5T MR-system (30 patients, Sonata, Siemens Medical Solution) or a 3.0T MR-system (10 patients, Tim Trio, Siemens Medical Solution) using a fast 3D-GRE sequence with parallel imaging (Voxel size 0.9x0.7x0.9mm³, parallel imaging GRAPPA factor 2, acquisition time 24s at 1.5T, 0.8x0.7x0.8 mm³, GRAPPA factor 3, acquisition time 16s at 3.0T) after injection 15ml of gadobutrol (Gadovist, Schering) at 1.5ml/s. After injection of a 10ml bolus of gadobutrol, time-resolved TREAT-MRA was performed with a 3D-TREAT sequence which combines view sharing [2] and parallel imaging with a spiral-radial k-space reordering. The temporal resolution was 2.3s/3D-Volume (1.5T), 1.2s/3D-Volume (3.0T) respectively. The voxel size of TREAT was 2.0x1.4x2.0mm³ at 1.5T and 1.6x1.5x1.5mm³ at 3.0T.

The presence of CAS and the vessel area within and 2cm after the CAS was determined on multiplanar reconstructions of the high-spatial resolution MRA and the degree of stenosis (%) was measured. CAS>75% were considered hemodynamically significant. For assessment of delayed flow, signal-intensity-time curves were generated from the TREAT data on an offline workstation (Siemens Leonardo). The contralateral side served as reference for the determination of delayed flow in the stenotic vessel.

Results

All TREAT measurements were diagnostic. In the 11 patients without CAS no flow delay was seen. 14 patients had CAS<75% and 15 patients had CAS >75%. Flow delay was identified in 3/14 patients with CAS<75% and in 12/15 patients (p=0.014) with CAS>75%. At 1.5T, mean flow delay with CAS<75% was 0.3 frames whereas with CAS>75% the mean flow delay was 1.6 frames. With the higher temporal resolution at 3.0T, no flow delay was seen for CAS<75% and mean flow delay of 1 frame for CAS>75% (see figure 1 for two examples of high-grade CAS (arrowheads in A) with delayed flow of the affected side (arrow). C and D demonstrate the corresponding high-spatial resolution MRAs; A/C – 3.0T, B/D – 1.5T)

Conclusion

TREAT is an easily applicable and effective tool to monitor flow delay in stenotic carotid arteries. The identification of delayed flow on TREAT imaging is highly indicative of a hemodynamically significant CAS. The higher temporal resolution at 3.0T also allows detection of minor flow delay.

References

1. ***Stroke*. 1991** **2.** **Korosec FR, Frayne R, Grist TM, et al. *Magn Reson Med*. 1996**

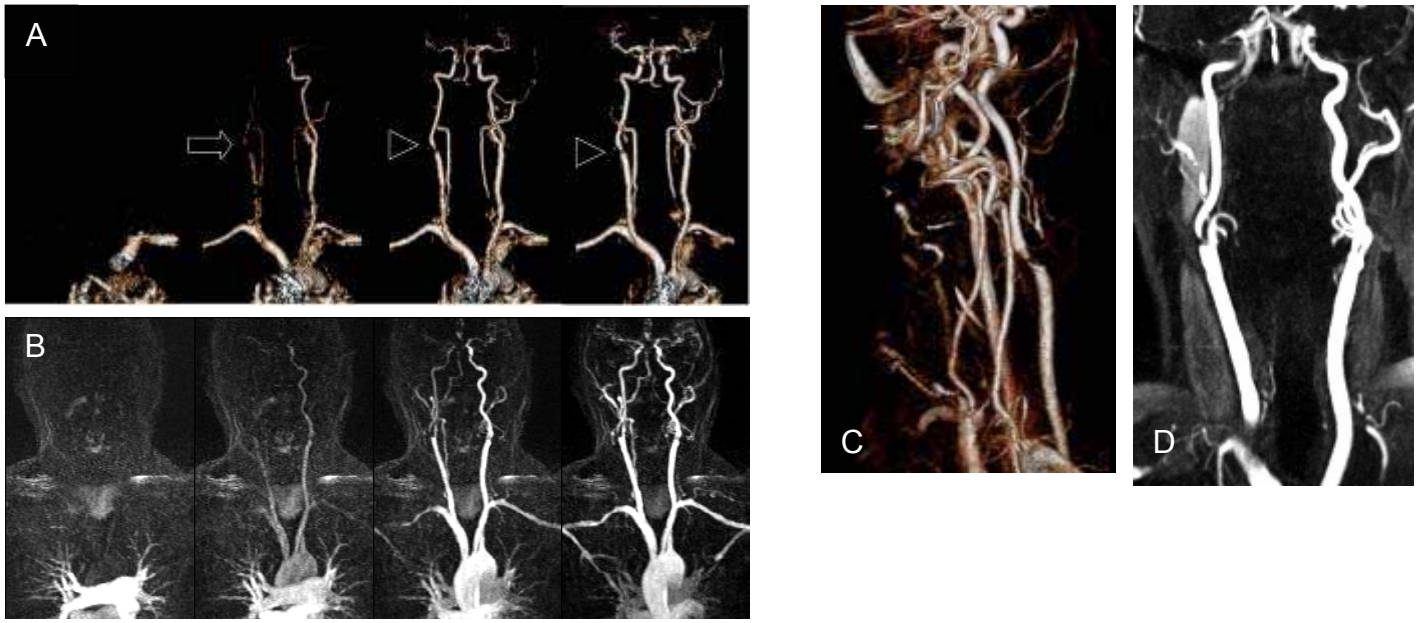

Figure 1 - Example of TREAT and high-spatial resolution MRA at 1.5T (B/D) and 3.0T (A/C).