4D Time-resolved angiography with CENTRA Keyhole (4D-TRAK) and SENSE using a total acceleration factor of 60 as compared with catheter angiography in patients with cerebral arteriovenous malformations at 3.0T

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Aim of the study
To evaluate and compare time-resolved contrast-enhanced 4D MR angiography with CENTRA Keyhole (4D-TRAK) and parallel imaging (SENSE) at 3.0 T with catheter angiography as the standard of reference in patients with cerebral arteriovenous malformations (cAVM).

Introduction
3D contrast-enhanced MR angiography (3D-CE-MRA) already is the first-line diagnostic tool in the preoperative work-up of patients with carotid stenosis and in the evaluation of patients for endarterectomy1,2. For adequate diagnosis and treatment of cAVM, however, a detailed characterization of angioarchitecture and hemodynamics including arterial feeding, dimension of nidus and draining veins3 and correct classification according to the grading system of Spetzler and Martin4 are required. Catheter angiography is still considered the standard of reference due to its high temporal and high spatial resolution. 4D-TRAK is a new method combining randomly segmented central k-space ordering (CENTRA)5 with Keyhole6 and half fourier imaging. This study was carried out to evaluate the performance and clinical usefulness of 4D-TRAK compared to digital subtraction angiography (DSA).

Methods
In a prospective, intra-individual comparative study, 10 patients with cAVM were examined by both 4D-TRAK and DSA. 4D-TRAK was acquired with CENTRA Keyhole (keyhole diameter 16%, i.e. acceleration factor (AF) of 6), SENSE (AF = 8) and half Fourier imaging (25% acceleration, i.e. AF = 1.25) yielding a total acceleration of 6 x 8 x 1.25 = 60 on a 3.0 T whole body MRI (Achieva, Philips Medical Systems, Best, NL). 150 dynamic scans were acquired at a temporal resolution of 608 msec./dynamic scan. Each scan included 140 slices with an acquired voxel size of (1.1 x 1.4 x 1.1) mm³. 4D TRAK and DSA were independently review by one neuroradiologist (NR) and one neurosurgeon (NS) according to the Spetzler-Martin classification taking into account nidus size, arterial feeders and venous drainage.

Results
4D TRAK with an acceleration factor of 60 was successfully performed in 10/10 patients. Classification of cAVM on 4D TRAK and DSA matched in 10/10 patients (100%) according to Spetzler and Martin (Grade I: 2; II: 5; III: 2; IV: 1) for both readers (NS, NR) yielding a 100% inter-observer agreement (kappa = 1). Selective DSA was superior to 4D TRAK in depicting arterial feeder branches allowing the identification of three small arterial feeders that were only retrospectively depictable on 4D-TRAK.

Conclusion
4D-TRAK is feasible at 3.0 T using an acceleration factor of 60 yielding a temporal resolution of 608 msec / dynamic scan. 4D TRAK allows for a reliable classification of cAVM according to the clinically relevant classification of Spetzler and Martin.

Fig. 1: Sample of a large left frontal parasagittal AVM in a 23 years-old patient. Please note the depiction of arterial feeders as well as the venous drainage due to the high temporal resolution (608 msec/dynamic scan) and the high spatial resolution (acquired voxel size: (1.1 x 1.4 x 1.1) mm³)

References