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 endarterctomy[1,2]. For adequate diagnosis and treatment of cAVM, however, a detailed characterization of angioarchitecture and hemodynamics including arterial feeding, dimension of nidus and draining veins[3] and correct classification according to the grading system of Spetzler and Martin[4] 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 Keyhole[6] 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.

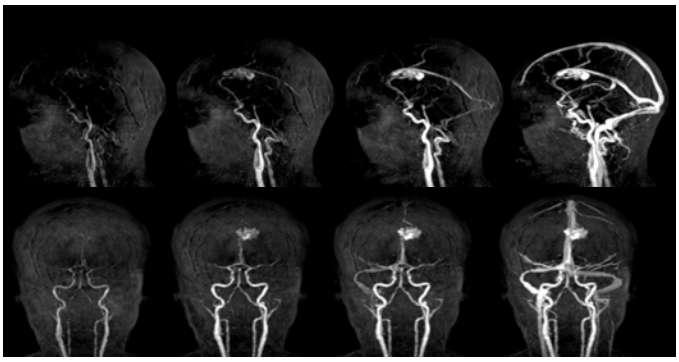

Fig. 1: Sample of a large left frontal parasagittal AVM in a 23 years-old patient. Please note the depiction of arterial feeders as well as the venous drainage due to the high temporal resolution (608 msec./dynamic scan) and the high spatial resolution (acquired voxel size: (1.1 x 1.4 x 1.1) mm³)

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