4D-MRA in combination with selective arterial spin labelling for functional characterization of arteriovenous malformations at 3 T

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Introduction: Arteriovenous malformations (AVMs) account for an increasingly recognized cause of death and long-term morbidity due to there lifelong risk of bleeding. MRI of AVMs should answer two major questions: first Spetzler-Martin-classification, which determines surgical outcome and second correct identification of feeding arteries and anatomic variants. It has recently been shown that 4D-MRA allows for the same Spetzler-Martin classification as digital subtraction angiography (DSA) [1]. However in identification of arterial feeders DSA still remains slightly superior, which is mainly due to its selectivity providing relevant functional information regarding the vascular supply of brain AVMs. To improve diagnostic accuracy of MRI, methods improving its selectivity are needed. Arterial spin labelling with selective labelling pulses [2] is a promising method providing selective and functional information regarding brain perfusion territories, regional cerebral vascular supply and functional collateral circulation [3, 4]. The first aim of this study was to prospectively evaluate 4D-MRA in combination with selective arterial spin labelling for preoperative assessment of cerebral AVMs. The second aim was the evaluation of 4D-MRA in combination with selective arterial spin labelling for postoperative imaging because the role of noninvasive imaging in postoperative assessment of AVMs still is a matter of discussion [5, 6].

Methods: In a prospective intraindividual comparative study 10 patients (6 female, 4 male; mean age 35.8 years ± 12.2; range 20-58 years) diagnosed with symptomatic cerebral AVMs underwent pre- and postoperative 4D-MRA, regional brain perfusion imaging using selective arterial spin labelling and DSA. Institutional ethics committee approval and written informed consent were obtained. 4D-MRA was performed using CENTRA keyhole [7] in combination with view sharing yielding a temporal resolution of 572 msec, a whole brain coverage and an isotropic voxel size of 1.1 x 1.1 x 1.1 mm³. Selective arterial spin labelling was performed using the PULSAR labelling sequence [2] for selective labelling of both carotid arteries and the vertebrobasilar complex. All images were pre- and postoperatively assessed by two radiologists in consensus regarding technical success rate, preoperative assessment (Spetzler-Martin classification, identification of arterial feeders, existence of anatomic variants / functional crossfilling) and completeness of resection. In all cases DSA served as the standard of reference.

Results: 4D-MRA was successfully performed in 20/20 exams and enabled the same Spetzler-Martin classification as DSA in all cases (100 %). 11/13 (85 %) feeding arteries were identified by 4D-MRA (Figure 1). Selective arterial spin labelling was successful in 16/20 (80 %) exams. Selective arterial spin labelling provided additional functional or anatomic information in 2/16 exams and enabled the diagnosis of a cross-filling feeding artery that was not identified by 4D-MRA but by DSA, thus improving the sensitivity of MRI in identification of arterial feeders from 11/13 (85 %) to 12/13 (92 %) (Figure 2). Postoperative assessment confirmed complete resection of all AVMs in 100 % yielding a 100 % concordance between 4D-MRA in combination with selective arterial spin labelling and DSA.

Conclusion: 4D-MRA in combination with selective arterial spin labelling is a promising tool for pre- and postoperative assessment of cerebral AVMs providing functional information that so far has been gained only with selective DSA.
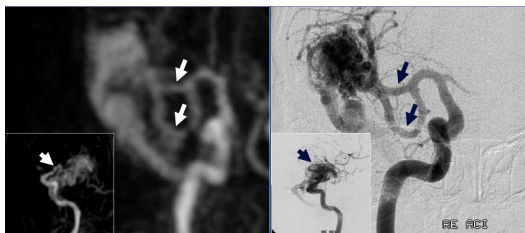

Figure 1: 45 year-old patient with right temporal AVM. Identification of arterial feeders arising from the right medial cerebral artery confirmed by DSA (right image)
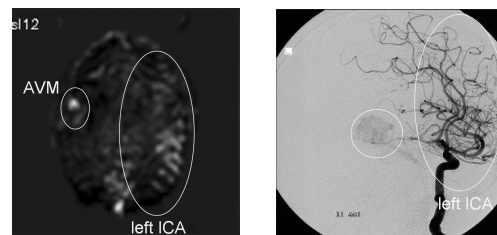

Figure 2: Same patient. Selective arterial spin labelling of the left internal carotid artery (ICA): Functional crossfilling of the right-sided AVM, confirmed by DSA (right image)

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