Intracranial 4D MRA: Evaluation of Additional View Sharing for Improved Temporal and Isotropic Spatial Resolution at 3.0 T

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Aim of the study

To evaluate the feasibility and clinical application of view-sharing in 4D contrast-enhanced MRA (CEMRA)

Introduction

High spatial resolution 3D CEMRA is the first-line diagnostic tool in the assessment of supraaortic steno-occlusive disease in many centers. However, for adequate diagnosis and treatment of cerebral arteriovenous malformations (cAVMs), detailled characterization of both angioarchitecture and hemodynamics is required[1,2]. In previous studies, the combination of CENTRA[3], Keyhole[4,5], parallel imaging (SENSE[6]) and partial Fourier allowed for the acquisition of whole head 4D CEMRA at a spatial resolution of (1.1 x 1.4 x 1.1) mm³ and a temporal resolution of 608 ms/dynamic scan[7]. The addition of view sharing to this acquisition scheme holds promise to further accelerate and/or increase spatial resolution of 4D CEMRA.

Methods

4D CEMRA of the head with randomly segmented central k-space ordering (CENTRA), keyhole, parallel imaging (SENSE) and view sharing (Fig.1) was performed in 7 volunteers and 4 patients on a clinical whole body 3.0T MR system (Achieva X series, Philips Medical Systems, Best, NL) using an 8-element head coil (Philips Medical Systems, Best, NL). DSA correlation was available in 2 patients with cerebral arteriovenous malformations (cAVM). 4D CEMRA with view sharing was acquired using the following parameters: TR, 2.2ms; TE, 0.9ms; flip angle, 15°; SENSE, acceleration in phase-encoding 4x and in slice-encoding 2x; FOV, 256mm; 140 slices with a true voxel size of isotropic (1.1x1.1x1.1)mm³ at a temporal resolution of 572 ms/dynamic scan (50 dynamics). A biphasic injection protocol was used in all subjects: 5 ml of Gadobutrol (Gadovist, Bayer Health Care, Leverkusen, Germany) at a flow rate of 2 ml/s followed by 5 ml of Gadobutrol at a flow rate of 1 ml/s and 36 ml of saline at 3 ml/s. Data acquisition started 10 s after beginning of the first injection of contrast medium. Images were analyzed with respect to image quality and the appearance of artefacts.

Results

4D CEMRA with additional view sharing at 3.0T was successfully performed in 11/11 subjects. The increase in temporal and spatial resolution by the addition of view-sharing to the combined protocol with CENTRA-keyhole, parallel imaging and partial Fourier did not result in additional artefacts or decline in image quality. The protocol allowed for the clear depiction of arterial and venous phases (Fig.2) and a diagnostic image quality as compared to DSA in patients with cAVM (Fig.3).

Conclusion

The addition of view-sharing to keyhole imaging improves the performance of 4D CEMRA by allowing to simultaneously increase temporal as well as spatial resolution..

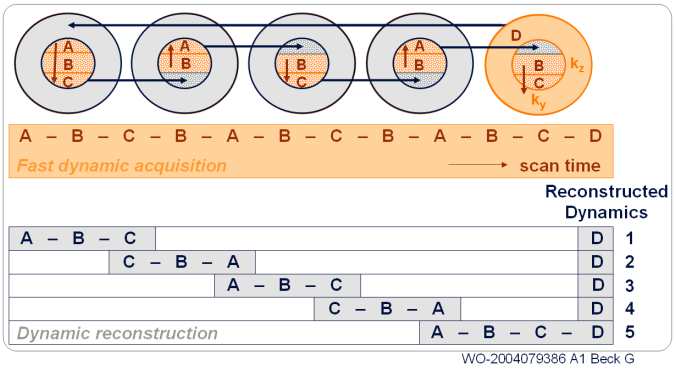

Fig. 1: Acquisition scheme for the combination of Keyhole and View Sharing in highly accelerated 4D CEMRA.

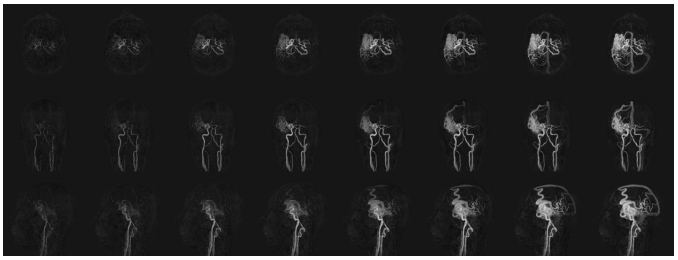

Fig. 2: Right temporal parasagittal AVM in a 38 year-old female patient. Please note the clear separation of arterial and venous phases due to high temporal resolution (572 ms/dynamic scan).

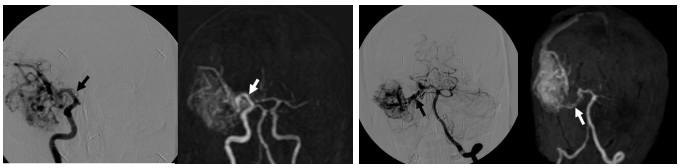

Fig. 3: Same patient as in Fig.2. Arterial feeders (arrows) are correctly diagnosed due to high temporal resolution (arterial phase) and high spatial resolution (voxel size 1.1x 1.1x 1.1 mm³)

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