UNENHANCED FOUR DIMENSIONAL MAGNETIC RESONANCE ANGIOGRAPHY: PRELIMINARY EXPERIENCE IN PATIENTS WITH CEREBROVASCULAR DISORDERS

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Introduction

Invasive digital substraction angiography (DSA) remains to be the reference imaging method for the visualization of cerebral vasculature. Magnetic resonance angiography (MRA) has emerged in the past years as a non-invasive, radiation-free alternative. Conventional MRA techniques including time-of-flight and phase-contrast methods delineate vascular geometry but in general lack of temporal information including dynamic blood flow. Contrast-enhanced MRA allows for time-resolved acquisition of 3D imaging volume. However, such method is not suited for patients with impaired renal function. Furthermore, the spatial and temporal resolution has to be traded in order to synchronize data acquisition with the contrast media first passage.

An unenhanced four-dimensional (4D) MRA technique has recently been developed for intracranial MRA with high spatial and temporal resolution (1). Promising results have been reported from healthy subjects. The purpose of this work is to assess the clinical feasibility of using unenhanced 4D MRA for the diagnosis of cerebral vascular steno-occlusive disease and vascular malformations using DSA images as reference.

Methods

Three stroke patients, two arteriovenous malformation (AVM) and three moyamoya disease patients were enrolled for this study. All subjects were examed on 3T MAGNETOM Trio/Verio scanners (Siemens Healthcare, Germany). Unenhanced MRA measurement was performed employing a previously developed 4D sequence (1) with flow-sensitive alternating inversion recovery (FAIR) scheme (2) for blood labeling. Imaging parameters included: temporal resolution = 84 msec, voxel size = $1.0 \times 1.0 \times 1.0 mm^3$, 60 slices per slab, 25 degree flip angle with TrueFISP readout and pulse trigger. Subtraction of 4D images with nonselective and selective labeling, as well as MIP images of subtracted images in three orthogonal directions were performed inline as part of the reconstruction routine. One AVM patients and two moyamoya patients were undergone cerebrovascular DSA. 4D MRA images and DSA images were evaluated by two radiologists.

Results

4D MRA images were successfully acquired in all patients. The delineation of intracranial vessels was confirmed by DSA images in three patients. In one patient with unilateral stroke, 4D MRA depicted different inflow speed and lumen thickness of bilateral middle cerebral artery (MCA) (Fig. 1). In AVM patients, dynamic filling of the feeding arteries, nidus, and draining veins of AVM lesions are clearly delineated (Fig.2). In moyamoya disease patients, besides the occlusion at the proximal portion of the MCA, the rising of abnormal vascular network in the vicinity of the occlusive areas is depicted, just like the "puff of the smoke" (Fig. 3).

Conclusion

Our findings suggest that it is feasible to use unenhanced 4D MRA for the evaluation of anatomical and hemodynamic information in patients with cerebral vascular steno-occlusive disease and vascular malformations. Unenhanced 4D MRA provides a safe, radiation-free alternative without complications resulting from invasive catheterization procedure and contrast media. Further evaluation is warranted to determine the clinical efficacy of this technique in a larger patient population.
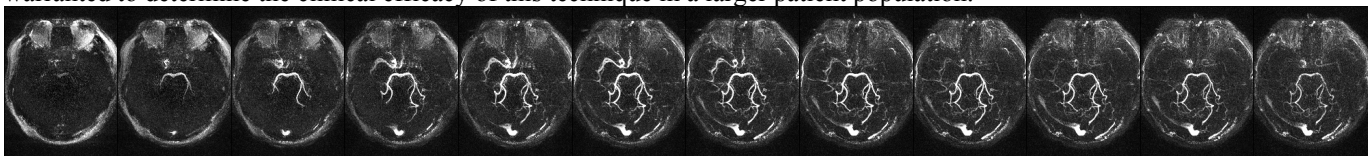

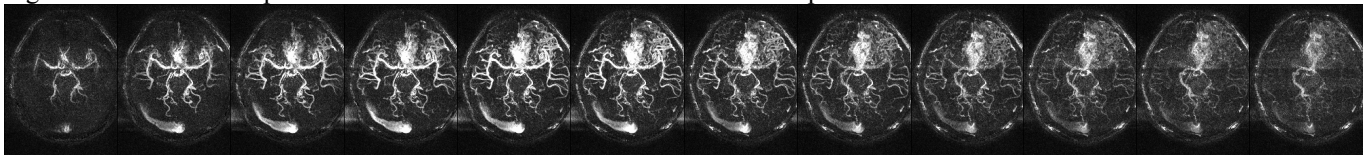Fig. 1 Different inflow speed and lumen thickness of bilateral MCA in one patient with stroke

Fig.2 Unenhanced 4D MRA images from a patient with AVM near the anterior cerebral artery. The filling arteries, nidus and draining veins were clearly depicted.
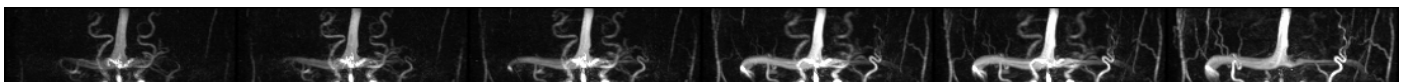

Fig. 3 Unenhanced 4D MRA images from a patient with moyamoya disease. The rising of abnormal compensatory vasculature was well delineated.

Reference: 1. Bi X et al, MRM 63: 835-841, 2010   2. Kim SG. MRM 34: 293-301, 1995