Intracranial Vessel Wall Imaging with MPIR-TSE at 7.0 Tesla in Ischemic Stroke and TIA Patients

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Introduction

Although post-mortem studies show a high prevalence of atherosclerotic changes in intracranial arteries[1], little is known about the contribution of intracranial atherosclerosis to cerebral ischemic stroke. With conventional angiography methods (X-ray or magnetic resonance angiography), an intracranial atheroma only becomes visible when it gives rise to luminal narrowing, which only occurs in a late stage of atherosclerosis, due to remodeling of the affected arteries[2]. We have used the 3D (volumetric) Magnetization Prepared Inversion Recovery Turbo Spin Echo (3D MPIR-TSE)[3] to image the intracranial vessel wall of patients with an increased chance of having intracranial atherosclerosis.

Methods

This study was approved by the institutional review board of the University Medical Center Utrecht. Nineteen patients presenting with transient ischemic attack (n=10) or ischemic stroke (n=9) were imaged after obtaining informed consent. Imaging was performed on a 7.0 Tesla whole body system (Philips Healthcare) with a 16 channel receive coil and volume transmit/receive coil for transmission (Nova Medical). All patients were scanned with the previously described MPIR-TSE sequence[3], with the following parameters: FOV 220 x 180 x 13 mm^3, transverse orientation, acquired resolution 0.8 x 0.8 x 0.8 mm^3 (0.5 μL), TSE factor = 60, TR/TI/TE 6050/1770/23 ms, magnetization preparation mixing time 250 ms, SENSE factor 2.0 in left-right direction, and NSA = 2, scan duration approx. 12 minutes. For possible depiction of atherosclerotic plaque 0.1mL/kg of a gadolinium-containing contrast agent (Gadobutrol) was administered. For confirmation of the observed vessels seen on the MPIR-TSE images, a TOF-MRA by means of fast field echo sequence was added, with the following parameters: FOV 180 x 180 x 110 mm^3 in transverse orientation, acquired resolution 0.4 x 0.5 x 0.6 mm^3, TR/TE 22/2.5 ms, scan duration approx. 10 minutes.

Results

In 3 patients MPIR-TSE exams were of insufficient quality for vessel wall assessment due to motion artifacts. In the 16 remaining patients, atherosclerotic lesions in major intracranial arteries were identified in 4 of the 10 TIA patients (40%) and 4 of the 6 stroke patients (67%). In all eight patients intracranial plaques were found at multiple locations, totaling 25 lesions. Most lesions consisted of small focal or more elongated thickening of the arterial vessel wall, sometimes of the whole vessel circumference, and causing luminal stenosis as seen on TOF-MRA images in only 3 of 25 lesions (Figure 1). Subtracted MPIR-TSE images (post- minus pre-contrast) showed enhancement in 7 of the 25 atherosclerotic lesions (Figure 1c). In 6 of the 8 patients with an intracranial lesion a lesion was present in an artery of the flow territory in which the ischemic event had occurred.

Conclusion

Intracranial vessel wall and its pathology can be depicted with MPIR-TSE imaging on 7.0 Tesla MRI in ischemic stroke patients and TIA patients. This allows studying the role of intracranial atherosclerosis in stroke and TIA in more detail.

Acknowledgements

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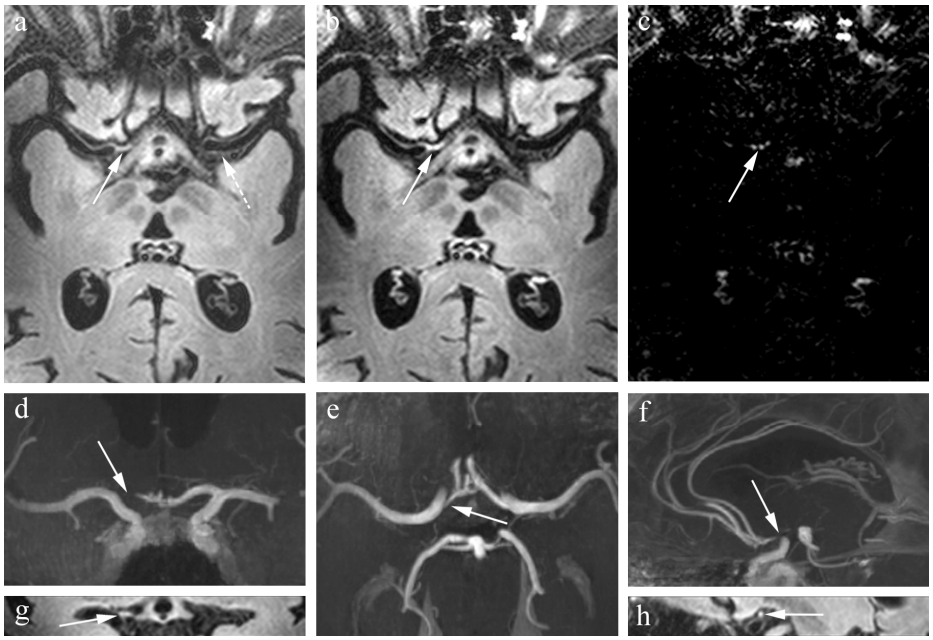

Figure 1: Female, 76 years old, with TIA of the left MCA territory. a-b, Transverse MPIR-TSE images showing normal MCA vessel wall (dashed arrow) and collapsed A1 segment (arrow), before and after contrast administration, respectively. Enhancement of collapsed proximal ACA was visible on subtracted image (c). d-f, Coronal, transverse and sagittal TOF-MRA images show corresponding absence of flow with no patent lumen in proximal part of the ACA (arrow). The collapsed ACA can also be seen on the coronal (g) and sagittal (h) MPIR-TSE reconstructions.