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Editorial

The Utility of Post-Mortem 7.0 Tesla Magnetic Resonance Imaging of the Brain in Patients with Neurodegenerative and Cerebrovascular Diseases

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Though a definitive post-mortem diagnosis still needs to be confirmed by an extensive macroscopic and microscopic examination of the brain using validated neuropathological criteria [1], 7.0-tesla magnetic resonance imaging (MRI) can be used as an additional tool in patients with neurodegenerative and cerebrovascular diseases. The degree and the distribution of the cerebral atrophy and white matter changes can be demonstrated. It also detects lesions that can be selected for histological examination. Additional small cerebrovascular lesions can be quantified. The degree of iron load can be evaluated in different basal ganglia and brainstem structures [2].

We use a 7.0-tesla MRI Bruker BioSpin SA (Ettlingen, Germany). The samples are placed in an issuer-receiver cylinder coil with inner diameter of 72 mm. The examined brain sections are placed in a plastic box filled with salt-free water, the size of which does not allow significant tissue movements. Three MRI sequences are used: a positioning sequence, a T2 sequence and a T2* sequence. The positioning sequence allows determination of the three-directional position of the brain section inside the magnet. The thickness of the T2 images is 1 mm. The field of view is a 9-cm square slide that is coded by a 256 matrix. This spin echo sequence offers the opportunity to realize T2 images by using a long time of repetition (TR) and echo time (TE). In our studies, TR and TE are 2,500 and 33 ms, respectively. The acquisition time of this sequence is 80s. The field of view of the T2* sequence is coded by a 512 matrix. The slice thickness is 0.2 mm and corresponds to the upper part of the of the brain section. This sequence is a GRE sequence with a short TR of 60 ms and TE of 22 ms, a flip angle of 30° and number of excitation of 10. The acquisition time of the sequence is 10 minutes [3].

Six coronal sections of a cerebral hemisphere, a sagittal section of the brainstem and a horizontal section from a cerebellar hemisphere allow evaluation and quantification of all the cerebral lesions. The sections of the cerebral hemisphere consist of one at the prefrontal level in front of the frontal horn, one of the frontal lobe at the level of the head of the caudate nucleus, a central one near the mammillary body, a postcentral one, a parietal one at the level of the splenium corporis callosi and one at the level of the occipital lobe.

T2-tesla MRI allows a better differentiation between gray matter and white matter changes. It has the advantage, above the naked-eye examination, of a better differentiation between atrophy, due to cortical lesions and those due to white changes. Severe white matter changes are better demonstrated on MRI in several neurodegenerative and cerebrovascular diseases. The demonstration of lacunes is significantly increased on the T2 MRI sequence in patients with cerebrovascular disease due to a microangiopathy. The reliability to detect micro-bleeds in the cerebral cortex on T2* 7.0-tesla MRI is 96%, while much less reliable in the other cerebral regions. Cortical micro-infarcts are considered as the invisible lesions in clinical-radiological in vivo studies. In contrast, post-mortem 7.0-tesla MRI allows the demonstration of micro-infarcts of different sizes mainly in vascular dementia and Alzheimer brains with cerebral amyloid angiopathy, and also in Lewy body disease. Cortical superficial siderosis is defined as a characteristic curvilinear pattern of low signal on blood-sensitive T2* MRI sequences. It is due to blood residues in the subpial layers and reflects an underlying cortical hemorrhagic lesion. On post-mortem MRI a significant iron deposition is observed in the basal ganglia of brains with frontotemporal lobar degeneration and to a lesser degree in amyotrophic lateral sclerosis. A moderate increase of iron is only found in the caudate nucleus of Alzheimer brains. Iron content is significantly decreased in the substantia nigra and the red nucleus of brains with progressive supranuclear palsy.

7.0-tesla MRI of the brain is a useful additional tool for the neuropathological examination of patients who died after a neurodegenerative and/or vascular dementia. It has to be considered as a link between the naked eye and the microscopic examination of the brain. It has also the advantage to demonstrate some small lesions not seen on macroscopic examination of the brain. On serial sections cerebrovascular lesions can be quantified, allowing the determination of their additional impact on the severity of the dementia.

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