Diffusion Kurtosis Magnetic Resonance Imaging: a New Method of Brain Microstructure Characterization (Preliminary Results in Healthy Volunteers)

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Abstract

Advances in magnetic resonance in medicine during the last decade have opened up new opportunities for application of diffusion-weighted magnetic resonance imaging in brain microstructure assessment. Conventional diffusion-tensor magnetic resonance imaging is based on the Gaussian diffusion model. However, presence of multiple cells, cell membranes and organelles, membrane ion pumps, crossing neural bundles, makes water molecule diffusion hindered and restricted. Such a diffusion is characterized as non-Gaussian. Thus, diffusion-tensor magnetic resonance imaging does not allow an accurate and comprehensive assessment of brain tissue microstructure. There are several new non-Gaussian models of brain tissue molecule diffusion, which have currently been recommended and developed. The subject of this article is application of one of these models – a diffusion kurtosis model. The technique allows us to simultaneously evaluate both Gaussian and non-Gaussian diffusion components, including a diffusion-tensor magnetic resonance imaging. The aim of this work is to analyze several quantitative parameters of diffusion kurtosis imaging in different brain regions in 5 healthy young volunteers. An attempt was made to interpret the obtained diffusion data concerning histologic microstructure of the brain and physics. We have also analyzed the differences between diffusion tensor and diffusion kurtosis imaging from the point of view of radiologists. According to the study results, mean, axial and radial kurtosis, fractional anisotropy and kurtosis anisotropy were significantly higher in brain white matter, compared to the deep gray matter. Mean diffusivity values were higher in the deep gray matter in comparison to the white matter, but without statistical significance.

Key words: Diffusion Weighted Magnetic Resonance Imaging, Diffusion Tensor Magnetic Resonance Imaging, Diffusion Kurtosis Magnetic Resonance Imaging, Neuroimaging.

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