Karolinska Institutet

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High-resolution diffusion-weighted brain MRI under motion

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av

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ABSTRACT

Magnetic resonance imaging is one of the fastest developing medical imaging techniques. It provides excellent soft tissue contrast and has been a leading tool for neuroradiology and neuroscience research over the last decades. One of the possible MR imaging contrasts is the ability to visualize diffusion processes. The method, referred to as diffusion-weighted imaging, is one of the most common clinical contrasts but is prone to artifacts and is challenging to acquire at high resolutions.

This thesis aimed to improve the resolution of diffusion weighted imaging, both in a clinical and in a research context. While diffusion-weighted imaging traditionally has been considered a 2D technique the manuscripts and methods presented here explore 3D diffusion acquisitions with isotropic resolution. Acquiring multiple small 3D volumes, or slabs, which are combined into one full volume has been the method of choice in this work.

The first paper presented explores a parallel imaging driven multi-echo EPI readout to enable high resolution with reduced geometric distortions. The work performed on diffusion phase correction lead to an understanding that was used for the subsequent multi-slab papers.

The second and third papers introduce the diffusion-weighted 3D multi-slab echo-planar imaging technique and explore its advantages and performance. As the method requires a slightly increased acquisition time the need for prospective motion correction became apparent.

The forth paper suggests a new motion navigator using the subcutaneous fat surrounding the skull for rigid body head motion estimation, dubbed FatNav. The spatially sparse representation of the fat signal allowed for high parallel imaging acceleration factors, short acquisition times, and reduced geometric distortions of the navigator.

The fifth manuscript presents a combination of the high-resolution 3D multi-slab technique and a modified FatNav module. Unlike our first FatNav implementation, using a single sagittal slab, this modified navigator acquired orthogonal projections of the head using the fat signal alone.

The combined use of both presented methods provides a promising start for a fully motion corrected high-resolution diffusion acquisition in a clinical setting.