Advanced Diffusion Acquisition

Reduced FOV

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TARGET AUDIENCE: Scientists and clinicians who are interested in quantitative diffusion imaging measurements in localised areas.

OUTCOME/OBJECTIVES: In this talk the problems linked to imaging small areas for quantitative measurements exploiting the water diffusion process will be explained. In particular differences between gradient and radiofrequency (RF) pulse based techniques will be explained. Applications to a number of areas including parts of the central nervous system and the body will be shown.

PURPOSE: Diffusion imaging needs fast acquisition methods such as echo planar imaging (EPI) in order to encode signal which decays due to the diffusion of water molecules, limiting artefacts due to macroscopic and physiological motion. Images artefacts are introduced because of magnetic susceptibility differences between air and tissue and bone and tissue and are exacerbated by long EPI echo train lengths, for a fixed acquisition bandwidth. Small structures in the central nervous system (CNS) and in the body are particularly affected by image quality and diffusion imaging becomes a challenge. Tackling image quality, reducing geometrical distortions and wrap around artefacts as well as responding to the need of increasing image resolution have all led to the development of dedicated reduced FOV techniques.

METHODS: The first proposal of a reduced FOV method came with the ZOnally Oblique Multislice (ZOOM)-EPI technique, which used magnetic field gradients modifications of standard pulse sequences to excite a reduced FOV to improve image quality for diffusion tensor imaging (DTI) of the spinal cord and optic nerve[1,2]. The ZOOM-EPI method was a 2D extension of line scanning[3] to speed up acquisition and increase signal to noise ratio (SNR). Subsequently a number of implementations have been proposed. An alternative to gradient-based approaches is the use of 2D RF pulses that are designed to excite just the desired area[4]. Strategies to increase the slice coverage with reduced FOV methods is to combine it with the use of multi-band RF pulses[5].

RESULTS: Examples of studies performing reduced FOV acquisition strategies in a number of applications will be presented (e.g. pancreas[6], thyroid gland[7], spinal cord[8]), including a thorough comparison of reduced FOV method applied at 7T[9].

DISCUSSION & CONCLUSION: Over 10 years after the first indication that reduced FOV strategies are very useful for specific diffusion imaging studies, there are a number of possible approaches available to the research community and the field is recognizing the importance of continuously improving these methods.

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