Diffusion Tensor Imaging using SENSE in Prenatal Studies

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Introduction

Prenatal MRI is a valuable tool for clinical [1] and research [2] studies of intra-uterine life *in vivo*. Diffusion-weighted MRI (DWI) of fetal brain has been recently demonstrated to be feasible [3], but it has been limited to only three axis diffusion sensitized gradients acquisition, in order to be compatible with breath-hold acquisition time (< 20 seconds). However, to obtain true rotational insensitive Mean Diffusivity (D) and Fractional Anisotropy (FA) maps, Diffusion Tensor Imaging (DTI) protocol is needed, which involves the acquisitions of at least 6 orientations of diffusion gradients. Until recently, the long scan time has limited DTI application in prenatal MRI. Parallel acquisition (SENSE) is a valuable technique for the reduction of susceptibility artefacts and acquisition time [4]. SENSE can provide acquisition times compatible with breath-hold imaging, and thus appears to be a promising tool for prenatal DTI studies. In this preliminary study, results obtained by combination of DTI and SENSE technique in prenatal imaging are presented.

Materials and methods

Foetuses (from 21st to 34th weeks gestational age (GA)) referred for clinical prenatal MRI because of body abnormalities suspected at US were investigated. Mothers signed the prenatal MRI consent form in use at our Institution. MR imaging was performed on a 1.5 Tesla Philips Gyroscan Intera (Explorer 60mT/m gradients) scanner and a 6-channels SENSE body coil. First, a reference scan was acquired in free breath to calculate sensitivity maps. DTI was acquired in breath-hold with a Reduction Factor = 2. Acquisition parameters were: TR=1159 msec, TE=58 msec, Matrix size=128x128, FOV= 280x280 mm^2, 10 slices, slice thickness = 5 mm, diffusion sensitization along 6 non-collinear directions, 2 b-value = 0-700s/mm^2, acquisition time = 14 sec. Tensor maps were calculated using BrainVisa software[5]. Quantification of D and FA values was performed collecting ROIs in various brain regions (e.g. frontal and occipital white matter, genu of corpus callosum, basal ganglia grey matter).

Results

The possibility of acquiring DTI during breath-hold has improved the quality of DW images. The 14 seconds breath-hold acquisition DTI was well tolerated by the mothers. The artefacts due to foetus movements between measurements along different diffusion orientations were also reduced, but are still a problem especially for the younger foetuses. Figure 1 reports an exemplificative D and FA maps for a 32nd weeks GA foetus. D values are 1.7 and 1.3 μm^2/msec for white and grey matter ROIs respectively. A clear increase in FA is visible in the genu of corpus callosum (arrow) which is compatible with premyelination anisotropy [6]. Figure 2 shows the D map of a 21 weeks GA foetus. The measurements of D in the different ROIs are compatible with the values reported in the literature regarding pre-term children.

Discussion and Conclusion

Breath-hold scans of SENSE-DTI reduced the problems related to mother's movement and enabled the feasibility of prenatal DTI which appears to be a promising tool for clinical and for research studies of brain development.

References

[1] Huppi et al., *Semin. Neonatol*.,2001;6(2):195-210; [2] Scifo et al., *Neuroimage* 2003, (19): S1589; [3] Righini et al; *AJNR Am J Neuroradiol*, 2003 24: 799-804. [4] KP Pruessmann et al., *MRM*, 42: 952-962 (1999); [5] Y.Cointepas et al, *Neuroimage* 2003, (19): S810; [6] Wimberger et al.. *JCAT* 1995; 19: 28 - 33.

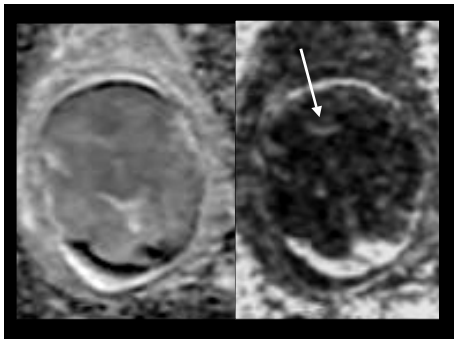

Figure 1: D (left) and FA (right) of a 32nd weeks GA foetus

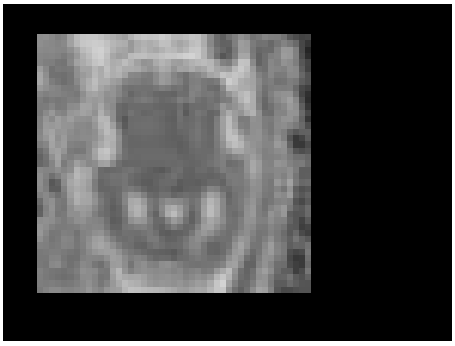

Figure 2: D of a 21st week GA foetus