High resolution diffusion tensor imaging of the corpus callosum in the preterm brain at 3 Tesla

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Introduction

The corpus callosum is the largest of the commissures linking the cerebral hemispheres. Previous magnetic resonance imaging (MRI) studies have demonstrated thinning of the body of the corpus callosum in adolescents who were born preterm[1,2] and an association between callosal volume and verbal and motor performance in preterm born children has recently been identified.[3,4] Diffusion tensor imaging (DTI) has been used to assess the cerebral white matter in this group of infants.[5-9] Investigating the nature of diffusion parallel (axial) and perpendicular (radial) to callosal fibres may provide further information regarding the microstructure of the corpus callosum in the preterm brain.

Aim

Our aim was to assess axial and radial diffusivity in the corpus callosum in preterm infants who had no evidence of abnormality on MRI at term equivalent age and in healthy term control infants in order to test the hypothesis that radial diffusivity in the corpus callosum is increased in the preterm brain.

Methods

Ethical permission approval for this study was granted by the local Research Ethics Committee and written parental consent was obtained prior to scanning. We studied 15 preterm infants of median [range] gestational age at birth = 31 [25.14 – 34.43] weeks, at term equivalent age (postmenstrual age at scanning = 40.72 [39.14 - 44] weeks) and 5 healthy term control infants (age at scanning = 42 [41 - 44] weeks). MRI was performed on a Philips 3 Tesla system. 3D MPRAGE and T2 weighted imaging were obtained prior to DTI. Single shot EPI DTI was acquired in 15 non-collinear directions using the following parameters; TR 9000ms, TE 79ms, slice thickness 2mm, field of view 224mm, matrix 128 x 128 (voxel size = 1.75 x 1.75 x 2 mm^3), 2 NSA, *b* value = 750 s/mm^2. The data were acquired with a SENSE factor of 2 and the scanning time for this sequence was ~5 minutes. Distortions due to eddy currents were minimized by registering the DT images to the b0 image using affine transformations. DTI analysis was performed off-line using DTI Studio version 2.1.[9] Values for axial ($\lambda 1$) and radial ($(\lambda 2 + \lambda 3)/2$) diffusivity were obtained from regions of interest (ROI)s in the genu, splenium, and anterior, central and posterior portions of the body of the corpus callosum. The data were not normally distributed and so values for axial and radial diffusivity in the 2 groups of infants were compared using a Mann-Whitney U test.

Results

There was no significant difference in the age at scanning between the 2 groups of infants ($p = 0.18$).
Table 1 shows the results for axial and radial diffusivity (mean ± sd x 10^{-3} mm^2/s) in the corpus callosum.

	Genu		Splenium		Anterior body		Middle body		Posterior body	
	axial	radial	axial	radial	axial	radial	axial	radial	axial	radial
Term controls (n = 5)	1.84 ±0.16	0.729 ±0.12	1.89 ±0.17	0.624 ±0.07	1.96 ±0.43	1.19 ±0.26	1.95 ±0.26	1.27 ±0.30	2.05 ±0.17	1.20 ±0.13
Preterm infants at term corrected age (n = 16)	2.23 ±0.45	0.923 ±0.22	1.98 ±0.58	0.686 ±0.20	2.16 ±0.55	1.31 ±0.34	2.02 ±0.49	1.27 ±0.74	2.32 ±0.60	1.53 ±0.32
p value	0.14	0.09	0.23	0.31	0.20	0.35	0.80	0.99	0.61	**0.01**

Table 1

Discussion

Detailed DTI studies of the corpus callosum in the neonatal period are hindered by the thinness of this structure and the relatively coarse resolution of single shot EPI DTI. The high signal to noise ratio afforded by imaging at 3 Tesla allowed higher resolution DTI to be obtained and thereby enabled us to examine this region in more detail. In addition, the near isotropic voxel dimensions allowed multi-planar reformatting of the DT images, enabling ROIs to be positioned in the sagittal plane in order to assess the body of the corpus callosum. Focal thinning affecting the posterior portion of the body of the corpus callosum is frequently noted on MRI scans of preterm infants.[3] The increased radial diffusivity in this region in preterm infants without overt focal lesions suggests that, in addition to the previously reported macrostructural abnormalities identified beyond the neonatal period, microstructural abnormalities are prevalent in the posterior portion of the body of the corpus callosum as early as term equivalent age in the preterm population.

References

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