Maturation of the Corpus Callosum from Birth to Adulthood: Evaluation with Fractional Anisotropy and Diffusion Tensor Tractography

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Introduction: The corpus callosum (CC) is a heterogeneous white matter tract that connects the cerebral hemispheres as the largest inter-hemispheric commissural fiber network, and is reported to exhibit age-dependences [1, 2]. The purpose of this study was to evaluate white matter maturation of CC from birth (infancy) to adulthood by using fractional anisotropy (FA) and diffusion tensor tractography (DTT).

Methods: This study includes 63 patients from 34 weeks gestational age (GA) neonate up to 48 years old adult without evidence of intracranial organic lesions. DTI was performed on a 1.5T MR scanner (Excelart; Toshiba) using a single-shot SE-EPI sequence that acquires 7 images (b=0 and b=1000 sec/mm2 in 6 directions) to calculate FA maps. DTT of CC was generated by using PC-based software (Volume-One™ and VizDT II+™, available at http://www.volume-one.org/ and http://www.ut-radiology.umin.jp/people/masutani/dTV.htm/, respectively). For seeding ROI settings of DTT, whole contour of CC was plotted in the mid-sagittal image.

Results: Tab.1 shows FA values of CC in various ages. These FA values tended to increase with ages in all regions of CC, suggesting maturation of white matter tracts. Fig.1 illustrates DTT of CC in various ages in threshold FA value of 0.18. In neonatal period and early infancy (before 1 year old), CC is relatively well delineated with DTT, but the fibers are not extended to the adjacent white matter. Extension of the fibers to the adjacent white matter is revealed after 1 year old, and further extension of the tracts is demonstrated with ages. Fig.2 shows DTT of CC in various threshold FA values in 5 months old male. With the lower threshold FA values, the longer extension of the fibers is recognized, but has simultaneous risk of creating crossing fibers. With the higher threshold FA values, the shorter extension of the fibers is delineated.

Discussion: FA provides useful scalar information in the white matter maturation of CC. DTT can illustrate additional information of developing individual axonal tracts of CC when compared in the same seeding ROI settings and in the same threshold FA values. But special attention should be required for the threshold FA values that can greatly affect delineation of the fibers on DTT.

References: [1] Aboitiz et al, Neuroreport 1996; 7: 1761. [2] Hasan KM, et al, Proc of ISMRM, 338, 2004.

Region	34-38w GA (N=14)	39-43w GA (N=18)	1m-3y (N=17)	4y-48y (N=14)
Rostrum of CC	0.39±0.13	0.51±0.08	0.67±0.07	0.72±0.05
Genu of CC	0.43±0.12	0.55±0.11	0.72±0.04	0.79±0.06
Body of CC	0.41±0.09	0.50±0.07	0.69±0.05	0.73±0.08
Splenium of CC	0.49±0.08	0.59±0.09	0.75±0.10	0.84±0.06

Tab.1 FA values of CC (mean±SD) in various anatomical regions and in various ages.

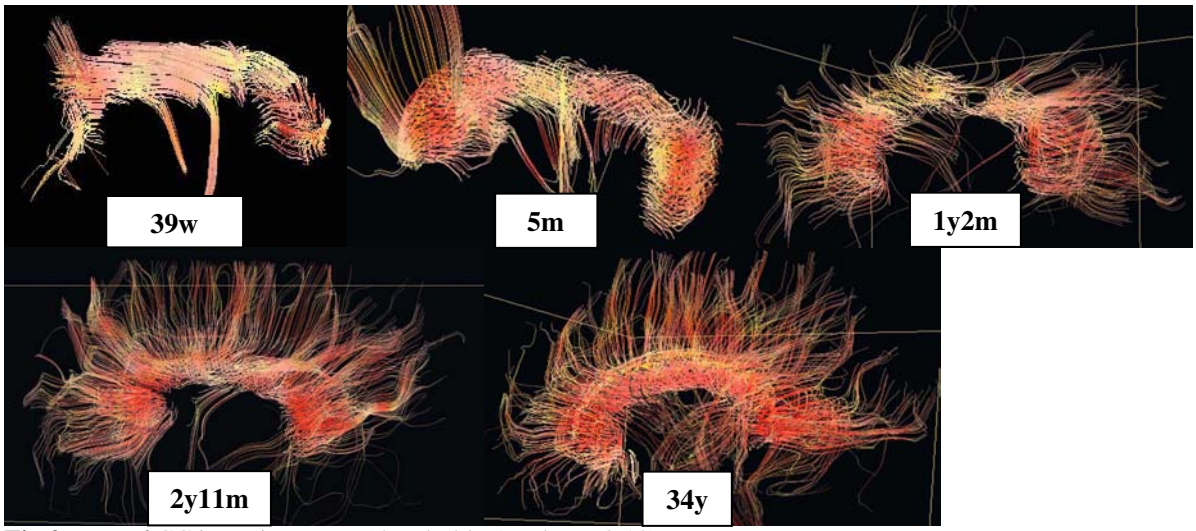

Fig.2 DTT of CC in various ages (threshold FA value = 0.18).

Fig.2 DTT of CC in various threshold FA values (5 months old male).

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