Longitudinal TBSS study of preterm and at term newborns

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Target audience: Researchers and clinicians from a broad range of backgrounds interested in brain development.

Purpose: The prenatal period and the first months of life are characterized by important microstructural changes in the brain that are crucial for myelination process. Comparisons between groups of normal subjects and preterm newborns have been presented but few studies have been performed looking at changes along time. In this work, we show a comparative TBSS DTI study between a group of normal newborns and a group of preterm newborns these last acquired at three different stages of development which, in this early age of life, are particularly interesting for the comprehension of brain maturation and connectivity.

Materials and methods:
Two groups of subjects were studied: a) 30 control subjects, born at term; b) 20 preterm newborns (within 24-33 weeks of post menstrual age (PMA)), without any evident white matter injuries on conventional MR examinations. An MR acquisitions was performed for normal subjects within the first 4 days of life, while preterm infants were scanned three times (stage1, early after birth, stage2, 40th week PMA, and stage3, at 44th week PMA, start of the second month of life). During the examinations, infants were spontaneously asleep without sedation. MR acquisitions were performed on a 3 Tesla scanner (Philips, Intera) and included a clinical examination (T1, T2) and DTI acquisitions (DW-EPI, 21 directions for diffusion gradients, b-value=700s/mm2, voxel size=2x2x3.5mm3). Maps were created using FDT diffusion toolbox (FSL, www.fmrib.ox.ac.uk/fsl/): eddy current distortions were corrected and binary masks of the brain tissue were generated with BET software on 21 directions for diffusion gradients, b-value=700s/mm2, voxel size=2x2x3.5mm3). Maps were created using FDT diffusion toolbox (FSL, www.fmrib.ox.ac.uk/fsl/): eddy current distortions were corrected and binary masks of the brain tissue were generated with BET software on the b=0 images. Finally, tensor maps for FA and MD were calculated with DITfit. Analysis was performed optimising the preproccessing steps for newborn images: skull was removed by erosion with a 2D kernel and a 12 dof linear registration aligned all the images to a subject chosen as reference. Mean image and skeleton were derived after a non linear transformation, setting the subject best representing the group as target. Analysis was performed looking at changes along time. In this work, we show a comparative TBSS DTI study between a group of normal newborns and a group of preterm newborns these last acquired at three different stages of development which, in this early age of life, are particularly interesting for the comprehension of brain maturation and connectivity.

Results:
In Figure 1, results of the TBSS analysis between normal subjects and preterm at stage2 are shown. Significant differences in FA (on the left) and MD (on the right) are superimposed to the FA template. Figure 2 shows results of the FA TBSS analysis between preterm newborns at stage1 and stage2 on the left, and between preterm newborns at stage2 and stage3 on the right.

Discussion and conclusions:
As shown, controls have a significant higher FA with respect to newborns stage2 in specific areas: in the corona radiata with asimmetric representation (on the left in anterior central and posterior areas and in the right hemisphere only in its anterior area) in the bilateral anterior and superior thalamic radiations. MD is significantly higher in newborns at stage2 with respect to controls almost in the whole skeleton and bilaterally. The comparisons between stages always found a significant higher FA for older newborns (stage3 > stage2 > stage1) and a significant higher MD for the younger (stage1 > stage2 > stage3). These results are similar to those found by other groups with other kind of analysis. This demonstrates an advanced development of controls with respect to preterm newborns at the same PMA. The asymmetric difference in the FA comparison between controls and step2, with a left prevalence at the level of corona radiata maybe a pre-step index of lateralization in controls that may be still absent in preterm newborns. Furthermore the temporal evolution of FA and MD in the three stages describes the maturation of brain with the increasing of

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