Substructural Topographic Map of the Interhemispheric-Cortices Connectivity in Neonate Boys And Girls.
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Purposes: The corpus callosum (CC) is the largest bundle of white matter fibers interconnecting the 2 hemispheres. The development starts at 14 weeks of gestation and there is a posterior (splenium) to anterior (genu) gradient of myelination, although the genu grows prior to the splenium. Abnormal CC development has been observed in preterm infants [1], low birth weight children [2], and neonates with congenital heart diseases [3]. Poor neuro-development outcomes has been correlated with altered CC microstructures in periventricular leukomalacia [4] and preterm infants [5]. Using fiber tracking we aim to draw a topographic map of the interhemispheric fibers in healthy neonates by segmenting the corpus callosum in 5 sub-structures: genu, rostrum, body, isthmus and splenium.

Material et Methods: DTI was performed on 3T scanner with 8-channel head coil and 35 non-collinear diffusion gradient directions plus one T2W volume and double refocusing pulses to reduce eddy-current artifacts. The diffusion sensitivity was set to b=700 (s/mm^2), pixel = 0.85x0.85 mm^2 and slice thickness = 2.5 mm. The CC was manually segmented in 5 substructures on diffusion color-encoded map by measuring the anterior-to-posterior length on sagittal view. The genu, most anterior substructure, was set to 1/6 of the entire length, followed by the rostrum 2/6 of the length, then the body which equals 4/6, then the isthmus which measures 4/5 and finally the splenium, the most posterior substructure (Figure 1). Twenty healthy term infants were recruited form the postnatal ward at the University Hospital of Zurich (Table 1). Fiber tracking was carried out on DTIStudio with FACT algorithm and the following criteria FA = 0.15, and angulation < 60°. Boys versus girls statistical analysis (multi-comparaison analysis of covariances) of fiber length (mm), anisotropy (FA), and mean (MD), radial (E23) and axial (E1) diffusions was performed with age at MRI as covariate.

Results: The regional interhemispheric connectivity through each substructure was successful in each subject (Figure 1). We can clearly identify each substructure connectivity: the splenium to the occipital and temporal-occipital, the isthmus links the superior temporal and posterior parietal, the body links the motor areas, the rostrum to the pre-motor and the genu to prefrontal cortex and supplementary motor areas. The age difference between the two groups (Ttest) was not significant. The length of fibers and the axial diffusion (E23) and mean diffusion (MD) were found in boys compared to girls in the genu, the rostrum, the body and the splenium. We also report a lower FA in the genu of boys compared to girls (Table 2). The isthmus was the only substructure that was not different between the 2 groups. Similar development pattern of E1, E23, MD and FA has been observed in both groups among all substructures.

Discussion: The connectivity through the genu to the premotor cortex is more developed in newborn girls than boys. This means more maturati on of the myelin sheath among girls. The isthmus connectivity to the superior temporal and posterior parietal is similar in both groups and is the last substructure to develop (lowest substructure anisotropy, and axial diffusion). The rostrum that links the 2 hemispheric premotor cortex is more developed than the body substructure, i.e. links to the motor cortex, in both groups at this age. We also notice faster development of the motor and premotor cortices among girls. The splenium connection to the occipital lobes and temporal occipital lobes is first to develop in these substructures (lowest mean diffusion and highest anisotropy) and shows faster development in neonate girls.