Surface Morphometry of Subcortical Structures in Premature Neonates

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INTRODUCTION: Most surface morphometric work in neonates has been dedicated to studying the cerebral cortex. However, changes in surface morphometry of the corpus callosum and lateral ventricles are likely sensitive indicators of diffuse white matter injury and of the interrelated subcortical grey matter injury in preterm neonate. Using brain structural magnetic resonance (MR) images, we propose a novel pipeline for regional group comparisons of the surface anatomy of subcortical structures in neonates.

SUBJECTS AND METHODS: 5 premature neonates (post-conception ages 25-36 weeks, 43.43±7.72 weeks at scan time) and 5 term born infants (post-conception ages 44.88±3.25 weeks at scan time) with normal MRI scans were acquired on a 1.5T GE scanner with a neonatal head coil and high resolution Coronal T2 and SPGR protocol. Manual tracing of subcortical structures is performed using Insight Toolkit's SNAP program [1]. Tracings are done in the registered template space by an experienced pediatric neuroradiologist. We reconstruct subcortical surfaces with correct topologies and build a set of parametric meshes using holomorphic one-forms from which we compute a conformal parametrization of the surface [2]. After generating the conformal parameterization, a surface registration is done by computing a constrained harmonic map [2] to obtain corresponding locations between subjects for each subcortical structure. At each vertex on the grid, we statistically compare the premature and term-born neonates using a Hotelling's T^2 test. Then we run a permutation test to estimate the statistical significance of vertex-wise changes and the overall significance. **Fig. 1 (a)** illustrates the system pipeline.

RESULTS: We have manually traced 7 brain subcortical structures: the corpus collosum, lateral ventricle, thalamus, hippocampus, caudate nucleus, putamen and the 3rd ventricle. **Fig. 1 (b)** shows some processing results.

DISCUSSION: We have built a pipeline for surface based subcortical structure morphometry, which has been specifically adapted to process neonatal imaging using both T1 and T2 signal contrast to delineate subcortical structures. Future work is aimed at applying mTBM to study group difference between term and preterm groups.

REFERENCES: **1.** Yushkevich, P.A., et al. *User-guided 3D active contour segmentation of anatomical structures: Significantly improved efficiency and reliability,* NeuroImage, 2006, 31(3): p. 1116-1128 **2.** Wang, Y., et al., *Multivariate tensor-based morphometry on surfaces: Application to mapping ventricular abnormalities in HIV/AIDS,* NeuroImage, 2010, 49(3): p. 2141-2157

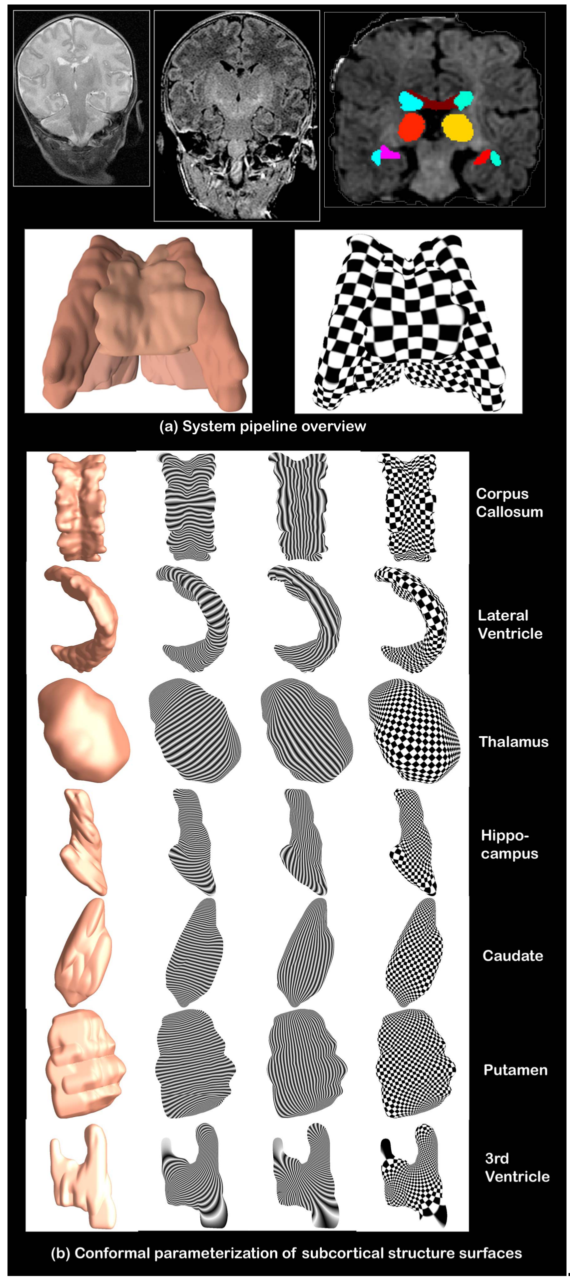

Fig. 1 (a) Diagram of the mTBM method. Insight Toolkit's SNAP program was applied to trace subcortical structure boundaries. Surface mTBM is applied to analyze morphometric changes. **(b)** Reconstructed subcortical structure surfaces (first column) and the procedure to compute their conformal grids by computing exact harmonic one-form (second column), its conjugate one-form (third column) and the resulting holomorphic one-form (last column). Here one-forms are shown by texture mapping of checkboard images. Note images are for illustration purpose only and are not in their correct size ratios.