# Surface Morphometry of Subcortical Structures in Premature Neonates

Yalin Wang[1], Ashok Panigrahy[2,4], Rafael Ceschin[2], Songling Liu[1], Paul M. Thompson[3], Natasha Leporé[4]

[1]Computer Science and Engineering, Arizona State University; [2]Radiology, Childrens Hospital of Pittsburgh of UPMC; [3]Laboratory of Neuro Imaging, UCLA; [4]Radiology, University of Southern California and Childrens Hospital, Los Angeles

## ABSTRACT

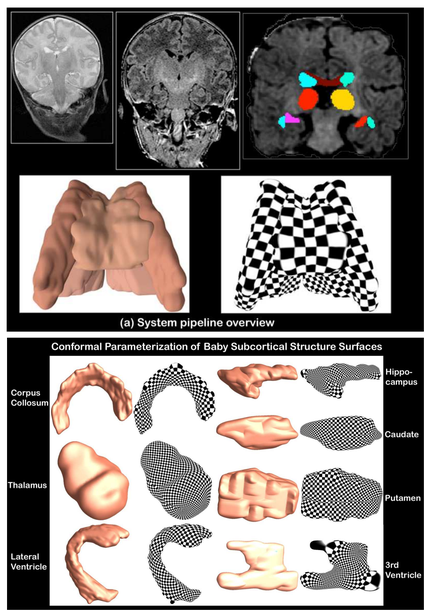
Neurocognitive and neurosensory deficits in preterm neonates are likely related to abnormal development and injury of subcortical structures including the corpus callosum, thalamus, basal ganglia and hippocampus. Most surface morphometric work in neonates has been dedicated to studying the cerebral cortex. 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. Our analysis is applied to compare MR data of premature neonates to those of healthy term born neonatal controls.

## 2. PREMATURITY DATA

- 10 premature neonates (25-36 weeks) and 10 term born controls
- 43.43 ± 7.72 and 44.88 ± 3.25 weeks at scan time, respectively
- No sign of white matter injury on MRI as visually assessed by radiologist
- 1.5T GE scanner, high resolution coronal T2 and SPGR protocol
- Subcortical structures manually segmented by experts

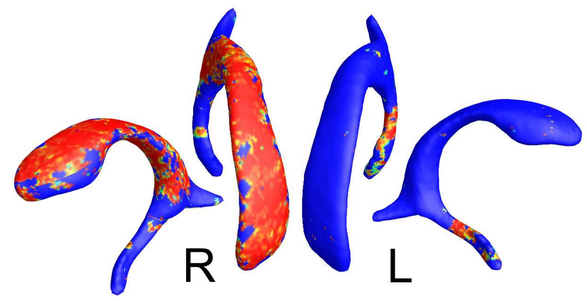
## 3. SUMMARY OF SURFACE MTBM [1] ANALYSIS PIPELINE

1. ITK-SNAP [2] is applied to manually trace subcortical structures boundaries
2. We build parametric meshes on subcortical surfaces using holomorphic 1-forms, from which we compute a conformal parametrization of the surface
3. We register the surfaces using a constrained harmonic map to obtain corresponding locations between subjects
4. At each vertex, we compare the premature and term born groups using a Hotelling's $T^2$-test on the multivariate deformation tensors $\sqrt{JJ^T}$. $J$ is the Jacobian of the deformation
5. We use permutation tests to determine statistical significance at each vertex, and to correct for multiple comparisons



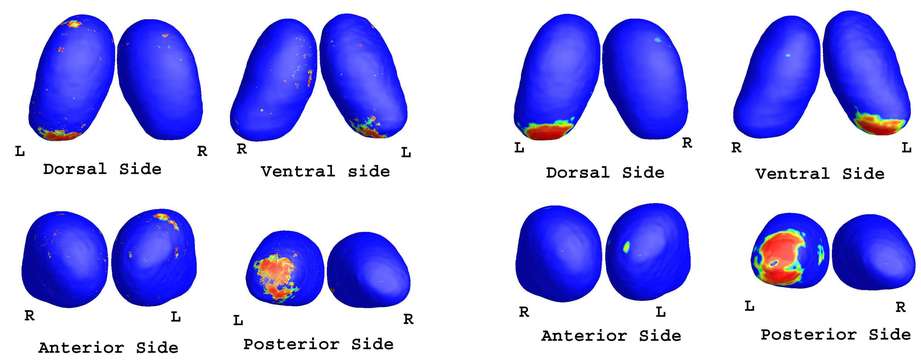

**Top** Illustration of steps 1 and 2
**Bottom** Examples of parametrizations for each of the subcortical structures

## 5. VENTRICLES RESULTS




MTBM results of comparing the lateral ventricles of premature and term-born neonates. Regions in red are statistically significant. The right lateral ventricle is significant at an overall level of p=0.0006, and the left is not significant.

## 6. THALAMUS RESULTS




MTBM results of comparing the thalami of premature and term-born neonates. Regions in red are statistically significant. The left panel uses the MTBM method described above, while the right one uses the more standard medial axis method (MAD). Overall values p-values for the left thalamus are p=0.010 for MTBM, and p=0.056 for MAD.

## 7. DISCUSSION

- First vertex based surface comparison of subcortical structures in premature neonates
- MAD and MTBM gave consistent results. While regions found with MTBM appear noisier, the method gives lower p-values than MAD
- Thalamic results are consistent with those found by our group in [3] using thalami volumes
- We will apply mTBM to larger samples, and to premature neonates with abnormal scans

## References

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