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Authors
Donna Dadkhoo, Yuan-Chiao Lu, Kushal Kapse, Nicole Andersen, Catherine Limperopoulos

Abstract Title
Volumetric Analysis of Preterm Newborn Brain with Normal, Mild Injury, and Moderate Injury

Background
In preterm newborns, brain development is very vulnerable because of their often complicated extra-uterine conditions. About 15 million preterm babies are born each year, and preterm birth complications are one of the leading causes of deaths in children under the age of five years old. Investigating preterm newborns and volumetric measures of their brain tissues is a step towards keeping maternal health, delivering a healthy baby, and preventing future cognitive impairments.

Objective
The goal of this study was to compare the volumes of brain tissues of preterm newborns between normal, mild injury, and moderate injury using high-resolution 3D brain models.

Methods
A total number of 145 preterm newborns were recruited in this study (no injury: 90, mild injury: 41, and moderate injury: 14), resulting a total number of 252 MR scans. Multi-plane multi-phase single-shot fast spin-echo T2-weighted images with a slice thickness of 2 mm were acquired on a GE Discovery MR450 1.5T MRI Scanner. High-resolution 3D models of the brain were reconstructed using slice-to-volume registration method, segmented by Draw-EM algorithm, and then manually corrected using ITK-SNAP. The brain volumes of 6 tissues, the cortical gray matter, white matter, lateral ventricles, brainstem, cerebellum, and deep gray matter, were determined based on the image voxel sizes. Generalized Estimating Equations (GEE) allowed for multiple measurements per subject were utilized for statistical analysis with the goal of comparing quantified volumetric measures between three injury levels, adjusting for gestational age and gender.

Results
The average gestational age of all scans was 25.69±2.85 weeks (range: 18.29-30). GEE analyses showed that brain volume decreased as injury severity increased from normal to moderate injury for all brain tissues except the ventricles (p-values<0.05). The volume of the ventricles increased as injury severity increased. In addition, for all 6 brain tissues, brain volume increased as gestational age increased (p-values<0.05). Furthermore, evidences pointed towards males having higher volumes of ventricles than females (p-values<0.05).

Conclusion
The current study conducted volumetric analyses of preterm newborns under various injury levels. Results indicated that increasing injury severity correlated with decreasing brain volume for all brain tissues except the ventricles. The results from the volumetric analysis will serve as a reference for future studies on shape alterations of the brain associated with preterm newborns in order to help finding treatments and preventions for babies and their mothers.