Brain Alterations Detected by Ultrasound Radiomics in Neonates and Infants Born HIV-Exposed Uninfected

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Purpose: To evaluate whether ultrasound-based radiomics can detect differences in brain tissue organization at birth and persistence over time in infants born HIV-exposed uninfected (HEU) compared to infants born HIV-unexposed (HU).

Methods: In this prospective study, nested within the Botswana-based FLOURISH study, cranial ultrasound was performed at birth and at 5-6 months in infants HEU and HU full-term (≥ 37 weeks gestation) using fixed imaging settings. The caudate nuclei and periventricular white matter were segmented, and radiomic features reflecting tissue heterogeneity and texture were extracted using radiomics software. Mean values were calculated and group comparisons were performed at each time point using the Mann-Whitney test between the two groups (Significance set at $p<0.05$).

Results: At birth, in the white matter the HEU group (n=24) had lower heterogeneity (193.01 vs 221.49, p=0.11), entropy (1.27 vs 1.33, p=0.05), RLNonUni (2001.21 vs 2443.01, p=0.03), and GLevNonU (293.17 vs 398.00, p=0.01) compared to HU (n=18). At 5-6 months, lower means were also noted in infants HEU compared to infants HU for heterogeneity (154.8 vs 180.9, p=0.2), entropy (1.9 vs 1.9, p=0.2), RLNonUni (1672.4 vs 2267.9, p<0.001), and GLevNonU (316.3 vs 410.2, p<0.001).

The caudate showed similar findings in infants HEU. Heterogeneity (176.61 vs 191.96, p=0.15), entropy (1.27 vs 1.52, p<0.001), RLNonUni (2009.53 vs 2962.58, p<0.001), and GLevNonU (310.04 vs 481.45, p<0.001) were lower in infants HEU. At 5-6 months, this pattern persisted, with lower heterogeneity (113.42 vs 161.88, p=0.13), entropy (1.460 vs 1.540, p=0.322), and RLNonUni (1922.09 vs 2451.36, p=0.24).

Conclusion: Ultrasound radiomics detects early and persistent alterations in brain tissue organization more frequently observed in infants HEU, suggesting an in utero insult associated with altered brain maturation beyond the neonatal period. Radiomics may provide a noninvasive imaging biomarker for early detection, risk stratification, and longitudinal monitoring of children at risk for neurodevelopmental delay. Future studies are warranted to correlate these preliminary findings with neurodevelopmental outcomes.