Prediction of clinical outcome of hypoxic-ischemic encephalopathy using diffusion tensor imaging assessed by a Reproducible Objective Quantification Scheme (ROQS) in the perinatal period

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Purpose:

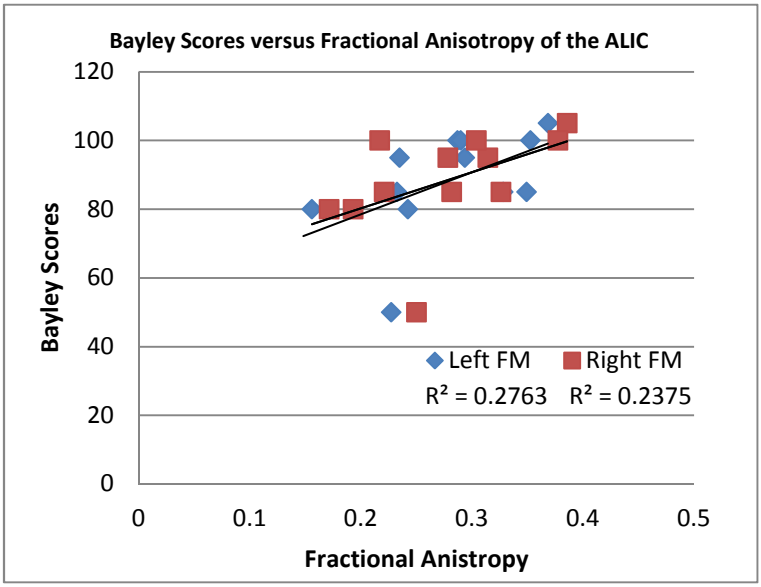
Perinatal hypoxic-ischemic encephalopathy causes significant disability in newborns and accounts for about 25% of children with cerebral palsy.[1,2] As of yet, there is no reliable biomarker to predict which of these infants will have poor outcome. Diffusion tensor imaging (DTI) is more sensitive to white matter changes than conventional clinical MRI and can possibly detect subtle variations in white matter in these infants which may better assess severity. In the current study, we use DTI to evaluate white matter integrity in a priori selected regions to predict clinical outcome.

Methods and Materials:

Subjects included 19 infants that were imaged between 6 and 9 days of age. Subjects underwent therapeutic hypothermia and were examined at 18-24 months to assess clinical outcome. Subjects were divided into good outcome (neurological normal) or poor outcome (death or motor/cognitive abnormalities). Subjects were scored with the Bayley Scale of Infant Development. DTI imaging was performed using a 1.5 T MRI GE Scanner using a 33 gradient direction sequence. A semi-automated region of interest (ROI) approach, the Reproducible Objective Quantification Scheme (ROQS),[3] was adopted to test 12 specific tracts selected in an a priori fashion based on prior studies.[1,2] As a post-hoc test, 3-D tractograms of these pathways were also created using home-grown software adopting a streamlined technique. Fractional anisotropy (FA) for the ROIs and tractograms of these tracts were correlated with the Bayley score and FA from subjects in good and poor outcome groups was compared using 2-tailed non-parametric statistics.

Results:

White matter integrity measured by FA of the anterior limb of the internal capsule (ALIC) bilaterally, the left posterior limb of the internal capsule (PLIC), and forceps major (FM) bilaterally predict clinical outcome from both 2D ROI and tractogram measurements (*Statistics from 2D ROIs:* right ALIC p=0.012, left ALIC p=0.014, left PLIC p=0.035, right FM p=0.009, left FM p=0.002). The FM tract bilaterally also correlated with Bayley Scores of development (right FM r=0.62, p=0.016, left FM r = 0.70, p=0.009).



Discussion:

Conventional clinical MRI and other clinical measures cannot adequately predict outcome in infants that have suffered hypoxic-ischemic encephalopathy. However, DTI is sensitive to subtle microstructural changes overlooked by conventional imaging. As shown in this study, variations in white matter integrity in specific pathways (the ALIC, PLIC, and FM) can predict clinical outcome after treatment with therapeutic hypothermia.

Conclusion:

DTI detects subtle variations in white matter and can be performed to possibly predict outcome following therapeutic hypothermia in infants suffering from hypoxic-ischemic encephalopathy, one of the predominate causes of cerebral palsy.

References:

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