ADC values in the posterior limb of internal capsule are predictive of outcome following perinatal asphyxia

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Background: Cerebral injury following perinatal asphyxia leads to changes in water diffusion. These changes are detectable via MR diffusion weighted imaging (DWI), which currently provides the most sensitive early marker of cerebral injury. Abnormalities of the posterior limb of the internal capsule (PLIC) following asphyxia correlate with poor clinical outcome [1].

Objective: To determine whether or not objective measures of water diffusion in the PLIC correlate with changes evident on conventional imaging, and are predictive of clinical outcome.

Design/Methods: From January 2001 until September 2002, infants admitted to the Newborn intensive care units of the Royal Women's and Royal Children's Hospitals in Melbourne who had a clinical diagnosis of hypoxic-ischemic encephalopathy (HIE) were entered into this study. A clinical diagnosis of HIE was made where there was a postnatal clinical course consistent with encephalopathy, with or without a sentinel hypoxic event. All infants underwent an MRI protocol using a 1.5 Tesla magnet (GE systems) which included epi – DWI (b=1 s/μm^2, 3 orthogonal directions, TR/TE 10000/104, BW +/- 100kHz, FOV 25 cm, slice thickness 4.0 mm, 192 x 128 matrix, 2 averages). Timing of imaging was determined by clinical need. Apparent diffusion coefficients were then calculated using Functool for standardized regions of interest (10-20 mm^2) corresponding to the location of the middle third of the PLIC (Figure 1). The lower of the two ADC values from the right and left PLIC was used for analysis.

Three broad outcome categories were considered – normal, mild to moderate cerebral palsy, and severe cerebral palsy or death. Statistical analysis was performed using SPSS v 11.5.

Results: Thirty four infants were admitted to our unit with a diagnosis of HIE. Of these, two infants died prior to acquisition of an MRI scan, and a further four infants were found to have a diagnosis other than HIE [cerebral dysgenesis (n=2) or established *in-utero* injury (n=2)]. The remaining 28 infants had a mean birthweight of 3488 g (SD 461 g) and median gestation of 40 weeks (range 37 to 42 weeks). Patterns of injury on MRI scanning were as follows: 2 infants had a normal scan, 4 had isolated basal ganglia injury, 3 had isolated white matter injury, 2 had cortical and white matter injury only and 17 had evidence of injury in three or more anatomical structures. Infants were scanned at a median age of 6 days of age (range 1 to 12 days).There was no clear relationship between age at scan and ADC value in the PLIC amongst study infants. Of the 28 infants, 16 infants survived and 12 died in the perinatal period. The ADC value (mean ± sd) in the PLIC was significantly greater for those infants who survived (0.89 ± 0.17 μm^2/ms) compared to those who died (0.75 ± 0.17 μm^2/ms) (t=2.25, p=0.03). The average age at follow-up for survivors was 12.9 months. When ADC values for surviving infants were analyzed according to their neurodevelopmental outcome, a significant difference was found between the groups (figure 2). A receiver operator curve was generated to determine which ADC value had the greatest utility as a predictor of survival with or without severe neurodevelopmental impairment. At an ADC value of 0.74 μm^2/ms, this parameter predicted outcome with sensitivity of 80% and specificity of 100%. This relationship was statistically significant using the Fisher exact test (p = 0.01).

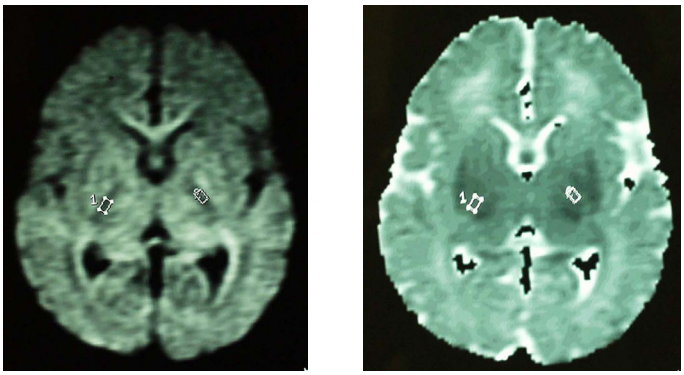

Figure 1: Placement of regions of interest over the PLIC on a diffusion weighted image (left). These regions of interest were then overlayed onto an ADC map (right) to measure ADC values in the PLIC using Functool (GEMS).

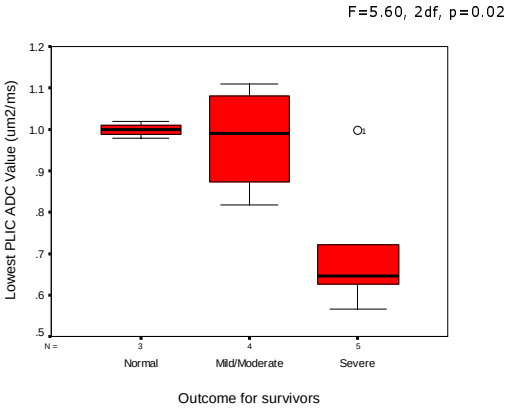

Figure 2: ADC value in the PLIC grouped according to neurodevelopmental outcome; the line in each box represents the median value, the upper and lower bounds of each box represent the 25th and 75th quartiles, the horizontal lines represent the maximum and minimum values.

Conclusions: ADC value in the PLIC is an objective measure of ischemic injury and may be of use as a prognostic marker for infants with HIE.

Reference: [1] Rutherford MA, Pennock JM, Counsell SJ et al. Pediatrics 1998; 102: 323-328.