

# $^1\text{H}$ -MR spectroscopy for the pediatric brain

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In the developing brain, metabolites concentrations such as NAA, choline and myo-Inositol show dynamic change. We have used  $^1\text{H}$ -MRS routinely since 2009 and found very useful.

MRI and  $^1\text{H}$ -MRS were performed on 3T and 1.5T clinical scanners. The spectra were acquired using single voxel, PRESS sequence with water presaturation with TE/TR 30/5000 and 4 to 32 number of excitations. The acquisition time including simming scan estimated about 5 minutes in each. Spectral data processing including signal quantification was performed using LCModel.

We have published metabolites concentration changes in preterm neonates from corrected age of 30 weeks<sup>1</sup>, and relatively higher neonatal lactate concentration than those in children<sup>2</sup>, both are important for the precise evaluation of neonatal brain pathology, particularly in hypoxic-ischemic encephalopathy(HIE). In neonatal HIE, low absolute NAA, creatine, and high glutamine plus glutamate and lactate concentrations within 4 days revealed excellent prognostic biomarkers as well as lactate/NAA, lactate/choline and lactate/create. NAA and creatine concentrations decreased in 7-14 days in HIE neonate with poor outcome, whereas high lactate and glutamine plus glutamate tended to be transient<sup>3</sup>. These results suggest us the importance of early treatment.

In neuro-metabolic diseases, we could make diagnoses of several cases of Creatine transporter deficiency from deficient Creatine peaks<sup>4</sup>, and a Sojgren-Larsen disease from large elevation of 1.3 ppm lipid peak although they almost had no significant MRI abnormalities<sup>5</sup>. Quantification of metabolites using LCModel revealed abnormal elevation of GABA in an encephalopathic infant leading to the diagnosis of GABA transaminase deficiency<sup>6</sup>. A conspicuous peak of 0.9 ppm from branched amino acids confirmed the diagnosis of Maple syrup urine disease in two encephalopathic neonates<sup>7</sup>. In addition to the MR findings of cerebellar atrophy and lenticular calcification, reduced choline and myo-inositol peaks leads the diagnosis of Folate transporter deficiency in two siblings. In the latter 3 disorders, changes of their spectral abnormalities well-reflected disease condition from the treatments.

In conclusions,  $^1\text{H}$ -MRS is useful to understand and evaluate early brain development. It is also a powerful tool for the diagnosis, disease monitoring and prognostic assessment in pediatric neuro-metabolic disorders.

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Keywords :  $^1\text{H}$ -MRS, Brain development, Neonatal HIE, Neuro-metabolic disease

# Neuroimaging on neonatal hypoxic ischemic encephalopathy

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Neonatal encephalopathy is a clinical syndrome characterized by “a subnormal level of consciousness or seizures, and often accompanied by difficulty with initiating and maintaining respiration and depression of tone and reflexes,” in the earliest days of life of a term newborn. Neonatal encephalopathy remains a major cause of neurodevelopmental disability, with a spectrum of outcomes that are not limited to cerebral palsy and also include cognitive and behavioral disabilities and epilepsy.

Therapeutic hypothermia, using selective head cooling or whole-body cooling, is now considered the standard of care for infants born at 35 weeks of gestation or greater with moderate to severe hypoxic ischemic encephalopathy who meet inclusion criteria used in clinical trials. An initial meta-analysis done by Edwards and colleagues with an overall sample size of 767 participants from three randomized controlled trials clearly demonstrated that hypothermia is neuroprotective. Because of concerns that hypothermia may be less beneficial for infants with severe encephalopathy, further analysis showed benefits of hypothermia for both infants with moderate encephalopathy and those with severe encephalopathy. Survival without neurodevelopmental delay was increased.

Neonatal encephalopathy and seizures are the most overt manifestation of the severity of brain injury in the newborn period. The clinical signs and symptoms of neonatal brain injury depend on the severity, timing, and duration of the insult, and the newborn's maturity, even within ages considered full term. The investigation of term newborns with encephalopathy addresses three primary concerns: (1) identifying the underlying etiology, (2) determining the timing of the brain injury, and (3) predicting the neurodevelopmental outcome of the affected newborn. To assess the encephalopathic term newborn, diagnostic tools available to the clinician include clinical features and biochemical and electrophysiological tests. However, the severity of brain injury in term asphyxiated newborns is not reliably predicted by commonly used clinical indicators during the first days of life. Brain imaging has revealed patterns of brain injury following a hypoxic-ischemic insult that are unique to the immature brain and that depend on the age at which injury occurs and the severity and duration of the insult.

The choice of the neuroimaging technique must balance the risk of transport and sedation required to acquire an MRI with the risk of ionizing radiation with CT. With the development of monitoring equipment and improved capacity to scan newborns, MRI should be the modality of choice.

Keywords : Pediatric, Neuroimaging, Hypoxic ischemic encephalopathy, Hypothermia

# T2 Relaxometry MRI Predicts Cerebral Palsy in Preterm Infants

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With the improvement of intensive care in newborns, the patterns of periventricular leukomalacia (PVL) include microscopic necrosis and diffuse white matter (WM) injury replacing the macrocystic PVL. Microscopic necrosis and diffuse white matter injury are prone to be underestimated in conventional qualitative MR imaging.

T2 relaxometry can quantify tissue characteristics and provide an objective measurement of the watery contents of the brain. T2-relaxation values descended rapidly in the first few months due to the fast myelination process during the first year of life. This rapid decline of T2 relaxometry observed in normal brain maturation corresponded to the curvilinear decline in preterm infants with normal development.

The alternated T2 relaxometry patterns in the cerebral palsy (CP) group illustrated slower decline of T2 quantification, with relatively lower T2 values in the early stage of WM injury and higher T2 values in the later stage. Previous animal studies shown that T2WI hypointensity in the early stage of cerebral WM injury was related to pathologic microcysts and diffuse noncystic gliosis. The representative lower T2 values at the early stage of WM injury in infants with CP may reflect the pathologic changes.

T2-relaxometry brain MR imaging provides neuroimaging-outcome correlation among preterm infants.

Keywords : T2 Relaxometry, MRI, Cerebral palsy, Preterm