

Prognostic predictive value of diffusion-weighted magnetic resonance imaging of the brain in small for gestational age fetuses

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Objective

Diffusion-weighted MR imaging (DWI) is a sensitive method to detect early changes that may precede brain lesions on conventional MRI. DWI allows objective quantitative measurement of apparent diffusion coefficient (ADC) based on water diffusion on a cellular scale. DWI is widely used in the neonates in clinical conditions at risk of cerebral hypoxia. Very few studies using DWI in the prenatal assessment of IUGR fetuses have been reported so far. We aimed to prospectively measure ADC value between 28 and 32 weeks of gestation (WG) in different cerebral territories of SGA fetuses with estimated fetal weight (EFW) < 5th centile. Our main objective was to compare ADC values in the frontal white matter (FWM) in two groups of fetuses according to their perinatal outcome.

Methods

A prospective non-interventional multicentric study involving 6 tertiary Parisian centres was conducted. Inclusion criteria were: (i) singleton pregnancies with SGA fetuses (EFW < 5th centile) between 28 and 32 WG whatever the results of umbilical and maternal uterine Doppler explorations, (ii) no fetal anomalies, (iii) exclusion of congenital CMV infection and (iv) normal karyotype. MRI examination with DWI sequences using a standardized protocol was scheduled within 14 days following inclusion and clinicians were blinded to these results. As part of this protocol, US examination was performed within one week prior to MRI examination. Umbilical artery Doppler were classified as normal (RI ≤ 95th centile) or abnormal (RI > 95th centile or end diastolic or reverse flow). All the data of pregnancy monitoring for both fetuses and their mother were prospectively recorded. Primary outcome was a composite adverse perinatal outcome and defined if any of the following were observed: perinatal death, admission to NICU with mechanical ventilation > 48 h, necrotising enterocolitis, grade III-IV intraventricular haemorrhage or periventricular leucomalacia. Univariate comparison of mean ADC values in FWM and other cerebral territories between fetuses with adverse perinatal outcome and those without was performed. ROC curves were designed when a significant difference was found to determine the most discriminating threshold to predict adverse perinatal outcome. Association between ADC values and adverse perinatal outcome was then studied using multilevel logistic regression models to adjust for other common prognostic factors for IUGR fetuses.

Results

MRI with DWI was performed in 64 patients. In five cases MRI was not useful owing to fetal movements (7.8%). Two terminations of pregnancies were performed with no link with IUGR. Among the 57 remaining cases, one case of IUD occurred. There were 56 live born neonates delivered at median GA of 33 weeks (31-35.5 weeks) with a median birth weight of 1340g (1015-1655g). Overall, there were 7 cases with adverse perinatal outcome (12.3%). Maternal characteristics and pregnancy-associated complications were similar between the two groups. Abnormal umbilical artery Doppler was more frequently observed in the adverse perinatal outcome group (5/7 vs 15/50, p=0.09). The neonates in the adverse perinatal outcome group were delivered significantly earlier (31 vs 33 WG) with a lower birthweight (990 vs 1105 g). The ADC values in FWM were significantly lower in fetuses in the adverse perinatal group (1.68 vs 1.78 10⁻³ mm²/s, p=0.04). No significant differences were observed in the other cerebral territories. ROC curves allowed calculating a cut-off value of ADC in FWM of 1.7 10⁻³ mm²/s that was associated with a sensitivity and specificity of 57%, 78% and PPV and NPV of 27% and 93%, respectively for the prediction of adverse perinatal outcome. A mean ADC value in FWM < 1.7 10⁻³ mm²/s was associated to a significant increased risk of adverse perinatal outcome when adjusting for GA at MRI and fetal sex (OR=6.06), but not when adjusting with umbilical artery Doppler.

Conclusion

DWI could represent an additional tool in the characterization of SGA fetuses at risk of poor perinatal outcome. A standardized evaluation of the live neonates included in our series is scheduled at 2 years of age as the major goal of prenatal management of IUGR fetuses is to prevent long term neuro-developmental impairment.