Tortuosity and diameter differences of neonatal cerebral vasculature between term and preterm infants at term:an MRA study at 3 Tesla

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Background:
Recent studies have highlighted differences in brain development in preterm infants at term equivalent age when compared to term born infants[1]. These occur in the absence of focal pathology. The third trimester of fetal development is a period of excessive growth and very high metabolic demands. About 70% of the energy is used on brain and vessel development. To our knowledge no other previous qualitative or quantitative systematic MRI studies of the morphology and patterning of neonatal cerebral macrocirculation have been carried out so far.

Purpose:
The aim of the study is to identify any differences in the development of neonatal cerebral vasculature in- and ex utero, and to test the null hypothesis that there is no difference in the morphology and patterning of the major cerebral arteries of neonatal brain between term infants and preterm infants imaged at term equivalent age.

Methods:
The study was approved by the Hammersmith Hospitals Trust Ethics Committee and informed consent was obtained for all of these infants. The study group consisted of 24 infants, 12 term born (GA: 40.3 ± 1.0weeks) scanned for different clinical reasons and 12 preterm (GA: 29.5 ± 2.5 weeks) imaged at term equivalent age. There was no significant difference in the age at scan between the 2 groups (p=0.21). Infants were scanned on a 3 Tesla Philips Intera scanner (Best, Netherlands). 3D Time of Flight Magnetic Resonance Angiography (3D TOF MRA) images were obtained with the following imaging parameters, optimised for neonatal cerebral vasculature imaging [2]: TR:18ms, TE:3.5ms, Flip Angle: 16 degrees, FOV:160, Acquired Matrix size: 288X288. All images were acquired with the same anatomic coverage and angulation of the imaging slab, with the stack being perpendicular to the internal carotid artery. Maximum Intensity projections in 3 planes were created in order to visualise the vessels. Cine views of MIPs from multiple angles were used to ensure that analysis was always performed on a projection taken in a standard orientation. Images were assessed by 2 observers (CM, MAR). In addition vessel tortuosity and diameter were measured for both the middle cerebral arteries (MCAs) in the transverse plane for each infant. Tortuosity was quantified using the distance factor (DF)[3] defined as the ratio of the distance measured along the vessel between 2 points to the straight line distance between the same points. For this study the start point was the origin of the MCA at the internal carotids and the end point was the first MCA trunk bifurcation after the genu. Vessel diameters were determined by measuring full width at half maximum[4] (FWHM) from signal intensity profiles across the relevant vessels. Measurements were made using the v1.32 Image J medical image analysis software (http://rsb.info.nih.gov/ij). Data were tested for normality and compared using a one way ANOVA test.

Results:
Visual analysis of the 2 dimensional MIP angiography images revealed a characteristic pattern of decreased tortuosity of the vasculature of the preterm infants imaged at term equivalent age (fig.1) compared to their term born counterparts (fig.2). This was most evident in the middle cerebral artery viewed in the transverse MIPs. Quantitative measurements showed that tortuosity in both the right and left MCAs was significantly decreased in the preterm infants (1.17±0.05 and 1.16±0.06) compared to term infants (1.45±0.08 and 1.48±0.16, $p<0.001$). There was no significant difference in the diameters of the MCA between the preterm and term infants measuring 1.04±0.08 and 1.07±0.05 respectively.

Discussion:
Premature delivery appears to have a marked effect on the development of cerebral vessels. We have shown that preterm infants have less tortuous vessels. The clinical significance of this finding remains unknown and subject to future studies. Measurements in a larger group of infants will be required to study the relationships between tortuosity, postnatal age and other biometric indices .The preterm infant is relatively hyperoxic compared to the fetus and fatty acids deficient[5] compared to the full term infant. These two facts may switch off the normal vasogenic/ angiogenic factors and be responsible for the observed tortuosity difference.

References:
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Fig.1

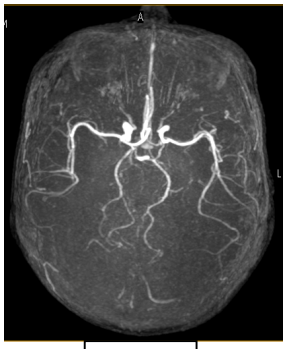

Fig.2