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Perioperative cerebral growth is associated with neurodevelopmental outcome in newborns operated for congenital heart disease

Knirsch W. (1,2), Meuwly E. (1,3), Von Rhein M. (1,3), Dave H. (1,4), Tuura R. (1,5), Scheer I. (1,5), Latal B. (1,3), Jakab A.(1,5)
Children's Research Center (1), Pediatric Cardiology, Pediatric Heart Center (2), Child Development Center (3), Congenital Cardiovascular Surgery, Pediatric Heart Center (4), Diagnostic Imaging, MR-Center (5), University Children's Hospital, Zurich, Switzerland

Objectives: We aimed to characterise global and local cerebral growth trajectories in neonates suffering from severe congenital heart disease (CHD), and compare against normal development and neurodevelopmental outcome at one year of age.

Methods: 47 neonates with CHD and 44 term controls were included (CHD, gestational age (GA) at the time of first MRI: 40.7 (37.6-51.6) weeks, controls, GA: 42.4 (40.2-45.7)). Diagnostic 3.0T MRI comprised T2-weighted tri-orthogonal sequences, which were combined and re-sampled to isotropic 0.5 mm voxel space. Global brain volume and lobar volumes were determined by non-linearly aligning a gestational week specific neonatal brain atlas. Growth rate was given as a volumetric change between the second and first MRI scan per week (pre- and post-operative, respectively), while regional growth rate maps were calculated by implementing the deformation-based morphometry approach. We correlated growth rate with the 1-year Bayley Scales of Infant Development using a general linear model approach in the FSL image analysis package, correcting for MRI software version, gender and socio-economic status.

Results: The rate of the global brain volume increase was lower in CHD infants (11 cm3/week) compared to the normal population (22.3 cm3/week). The lag behind normal development was most pronounced in the frontal and parietal lobes (2.72 and 1.81 cm3/week, respectively), where growth rate was greatly under the norm (6.13 cm3/week and 4.48 cm3/week, respectively). Regional growth rate in the left posterior superior temporal gyrus and left planum temporale correlated significantly ($p_{corrected}<0.02$) with the 1-year language development score in CHD infants.

Conclusion: Our findings not only confirmed the global reduction of cerebral volume in CHD infants, but also imply a further-reaching impairment consisting of reduced brain growth after corrective surgery and the potential of local brain growth rate to predict neurodevelopmental outcomes.