

MR QUANTITATIVE PULMONARY PERFUSION IMAGING IN 2-YEAR OLD CHILDREN AFTER CONGENITAL DIAPHRAGMATIC HERNIA REPAIR -COMPARISON BETWEEN HIGH TEMPORAL AND HIGH SPATIAL RESOLUTION-

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Purpose: Congenital diaphragmatic hernia (CDH) leads to lung hypoplasia which is associated to both, a malformed broncho-alveolar system and a hypoplastic microvascular structure. It has been shown that children after CDH repair show reduced MR lung perfusion values on the hypoplastic, ipsilateral side ¹. It has also been demonstrated by Monte Carlo simulation, that MR quantitative perfusion values depend on the MR protocol scheme, associated to an underestimation of pulmonary blood flow (PBF) with lower temporal resolution ². We therefore compared two MR protocols –one with a high spatial and one with a high temporal resolution- to investigate if impaired lung perfusion after CDH is measurable with both protocols, if simulation results can be confirmed and which protocol should be preferred.

Methods: DCE-MRI was performed in 36 children after CDH repair using a 3D time-resolved angiography with stochastic trajectories (TWIST) sequence on a 3T MR system (Magnetom Trio, Siemens Healthcare Sector, Erlangen, Germany). TWIST view sharing was set to 15% in the central and 20% sampling density in the outer region. Generalized autocalibrating partially parallel acquisition (GRAPPA) of factor 3 was used (Figure 1). Two MR protocols were applied - protocol A (n=18) based on a high spatial (3.0 sec; voxel size: 1.25x1.25x1.25 mm³) and protocol B (n=18) on a high temporal resolution (1.5 sec ; voxel size: 2x2x2 mm³). 0.05 mmol/kg body weight of contrast agent (Dotarem, Guerbet, France) was administered. Pulmonary blood flow (PBF), pulmonary blood volume (PBV) and mean transit time (MTT) were calculated for both lung sides by placing 6 cylindrical regions of interest (ROI), apical, middle and basal, in the ventral and the dorsal lung, respectively. The calculations were performed using the OsiriX plug-in UMMperfusion ³, which is based on an adapted version of the pixel-by-pixel approach of Ostergaard et al. ^{4,5}. Peak contrast to noise ratio (PCNR) was calculated

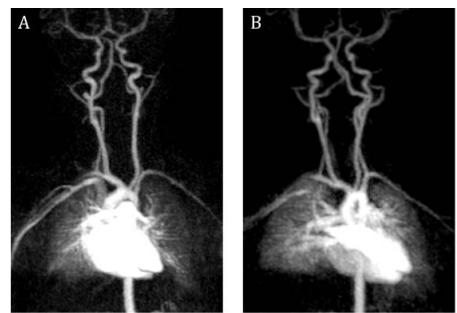


Figure 1 Sample images for reconstructed maximum intensity projection of pulmonary perfusion of two 2-year old children after CDH.

Image A was examined according to protocol A and image B according to protocol B.

	Protocol A			Protocol B		
	ipsilateral	contralateral	p-value	ipsilateral	contralateral	p-value
PBF Mean Ventral	44.5±25.6	63.3±28.2	0.0016*	62.4±24.1	84.7±30.4	0.0034*
PBF Mean Dorsal	60.6±38.6	103.4±56.2	0.0013*	81.9±33.3	130.9±43.9	<0.0001*
PBV Mean Ventral	4.5±2.2	6.0±2.7	0.0182*	6.3±2.5	8.2±3.4	0.0208*
PBV Mean Dorsal	6.5±3.9	11.5±7.1	0.0010*	9.1±4.8	14.5±5.2	0.0001*
MTT Mean Ventral	6.8±2.5	5.8±2.1	0.0090*	6.7±2.1	6.0±1.5	0.0861 (n.s.)
MTT Mean Dorsal	6.5±2.4	6.3±2.1	0.2837 (n.s.)	6.8±1.5	6.9±1.8	0.5944 (n.s.)

Results: With both protocols statistically significant side-differences could be measured for the PBF and the PBV (table 1). Protocol B resulted in a significantly raised PCNR (30±18 vs. 19±9; p=0.03). PBF was significantly higher with protocol B in comparison to protocol A (p always <0.05). PBV was also significantly increased by protocol B (p<0.05) except for the comparison of the ipsilateral, dorsal lungs (p=0.07). The MTT was independent of the protocol used (p always >0.05).

Discussion: In 2-year old children after CDH repair ipsilateral lung perfusion is statistically significantly reduced, which can be measured with both protocols. Higher temporal resolution and increased voxel size show a gain of PCNR and significantly decrease the underestimation of PBF. Differences between both protocols were measured between two different patient cohorts, but as interindividual variations are present within both patient cohorts, those differences can be attributed to the different MR protocol scheme.

Conclusion: A larger voxel size and a lower temporal resolution are associated to a gain of PCNR and higher values of pulmonary perfusion parameters. As an isotropic voxel size of 2 mm³ is still a sufficient spatial resolution, image parameters as chosen in protocol B should be applied for routine follow-up MR investigations of children after CDH repair.

References:

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