28 Poster Highlights Session

17:15 - 18:45 *Auditorium IV*

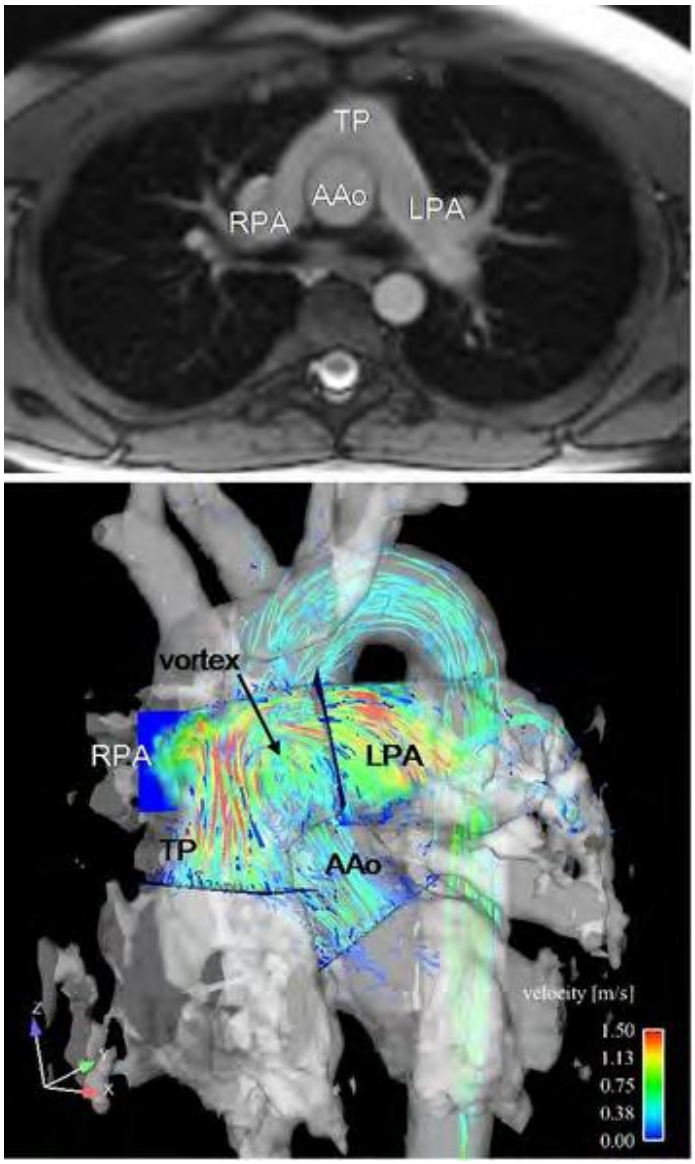
MRI and MRS in paediatric problem solving

146

Evaluation of postoperative hemodynamics in patients with transposition of the great arteries (D-TGA) by 4D MRI

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Purpose/Introduction: Postsurgical follow-up in patients with transposition of the great arteries (D-TGA) after arterial switch procedure is mandatory to evaluate long-term complications such as pulmonary artery stenoses or valve insufficiencies. 4D MRI was applied to characterize aortic and pulmonary hemodynamic changes and their correlation with postsurgical anatomy.
Subjects and Methods: 4D MRI with 3-directional velocity encoding (TE/TR=2.4/4.8ms, venc 200cm/s, spatial resolution~2.5mm^3, temporal resolution=38ms) was performed in 17 patients after repair of TGA and in 12 healthy controls (age=12±5.4 years vs. 23±1.6 years). Patients were divided into two groups according to the postoperative position of the pulmonary trunk (TP) in relation to the ascending aorta (AAo): anterior (n=10) and right anterior position (n=7). Aortic and pulmonary blood flow was visualized by time-resolved 3D particle traces emitted from planes at the level of the aortic and pulmonary valves. Analysis included visual grading (ranking 0-2) of pulmonary and aortic flow disturbances (vortices, helices) and increased pulmonary flow velocity (v>1.5m/s). Blood flow distribution to the right and left pulmonary artery (flow ratio RPA:LPA) and flow velocity was quantified at the valves and in the RPA and LPA.
Results: Increased vortex flow in the TP was detected in patients with anterior TP position (7/10, mean grade 1.6) compared with the patients with right anterior TP position (0/7). Increased helix flow was seen in the LPA of both patient groups (9/17 patients, grade 1.3) while helix flow was less frequent in the RPA and TP (4/17, 3/17). All patients had an enlarged aortic sinus normalized to BSA (diameter = 29mm±5mm) and 11 presented local increased helices in the AAo not encompassing the complete vessel lumen (grade 1.5). Systolic peak velocity in the TP was significantly higher in patients (1.74m/s±0.63m/s) than in volunteers (0.95m/s±0.12m/s), in the RPA 2.04m/s±0.43m/s vs. 0.98m/s±0.14m/s, in the LPA 1.78m/s±0.54m/s vs. 0.89m/s±0.13m/s. The flow ratio RPA:LPA was more heterogenous in patients with a predominant flow to the RPA (flow ratio RPA:LPA = 1.56±0.78) vs. RPA:LPA = 1.1±0.15 in volunteers.



Discussion/Conclusion: Visualization and quantification of postsurgical blood flow in TGA-patients after switch repair using 4D MRI revealed to date unknown postoperative flow disturbances. Asymmetric flow to the right and left lung, increased flow velocity in the pulmonary arteries without the presence of vessel stenosis, enhanced pulmonary vortex flow for the anterior TP position and frequent helices in the LPA and AAo were the main findings.

147

Metabolic feature selection for differentiating fetuses with congenital diaphragmatic hernia from normal pregnancies using high-resolution ^{1}H NMR spectroscopy

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Purpose/Introduction: This study analyzes the effect of feature extraction methods prior to classification of ^{1}H NMR spectroscopy from human amniotic fluid (AF). The aim was to identify metabolic markers specific to fetuses with congenital diaphragmatic hernia (CDH). Severe lung hypoplasia in CDH is a prenatal condition that can be targeted in utero by tracheal occlusion (TO)

and its subsequent reversal (rTO), hence, precise information on the condition of the respective (CDH) fetus is warranted.
Subjects and Methods: 84 ^{1}H NMR spectra of AF from 54 healthy fetuses, 20 CDH cases measured before TO and 10 at rTO were acquired using an Avance 400 MHz Bruker Biospin NMR spectrometer. The gestational age range was 15-38 weeks, 21-35 weeks and 31-35 weeks in healthy fetuses, CDH before TO and CDH at rTO, respectively. NMR spectra were phase and baseline corrected, frequency aligned and normalized to the total spectral area. Data matrices were built using the full spectrum range (-1.2 - 10 ppm) excluding the water resonance region (4.2 - 5.0 ppm). To obtain relevant CDH disease biomarkers, automated feature selection methods were applied. Four filter models: T-test, Kruskal-Wallis test, Fisher discriminant criterion and Relief-F algorithm were considered in combination with discriminant analyses. The spectral regions found most relevant for differentiating CDH from healthy fetuses were integrated and considered for subsequent classification by excluding those metabolites whose behavior is potentially age related.

Results: Results show that 30 spectral regions account for 80% variability between fetuses with CDH and healthy pregnancies (see Fig.1), providing 86% accurate classification. Within these regions Isoleucine, Leucine, Valine, Pyruvate, Gaba, Glutamate, Glutamine, Citrate, Creatine, Creatinine and Glucose were identified. Moreover, Pyruvate, Glutamate and Citrate were selected as main disease biomarkers (see Fig.2) since they exhibit alterations that have significantly different trends than the age related metabolic changes reported in [1]. Small metabolite changes were also observed between CDH subjects at TO and rTO.

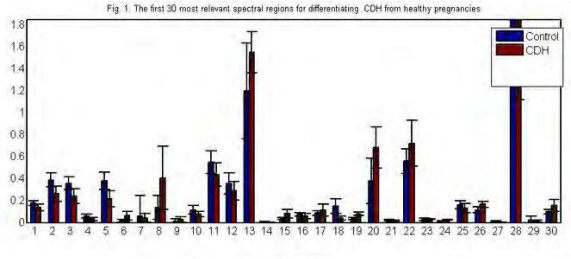
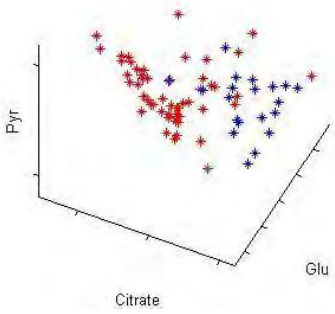


Fig.2. CDH vs Control



Discussion/Conclusion: The proposed feature extraction methods in combination with automated classifiers when analyzing 1H NMR spectra of human AF can represent an attractive tool in identifying CDH. Moreover, it could be combined in the future with routine fetal magnetic resonance imaging and thus help to obtain a more detailed picture of the fetal status.
References:
[1] B.R.Cohn et al., Magn Reson Mater Phy, 2009, 22: 343–352.

148

Temporal versus spatial resolution in quantitative pulmonary perfusion imaging of 2-year old children after congenital diaphragmatic hernia (CDH) repair

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Purpose/Introduction: Congenital diaphragmatic hernia (CDH) occurs in approximately one in 2000 to one in 4000 live births with lung hypoplasia and secondary pulmonary hypertension are the major causes of death. Recently, DCE-MRI of the lung in these patients was demonstrated [1,2]. Pulmonary blood flow (PBF) could discriminate healthy from hypolastic lung tissue. However, calculating PBF is dependent of the SNR achieved by MR sequence [3]. Therefore, we analysed how higher temporal and lower spatial resolution will influence the results reported in [1,2].
Subjects and Methods: 12 children after CDH-repair underwent DCE-MRI at 3T. 6 children were examined using the high spatial resolution protocol (protocol A) whereas the rest was examined with the high temporal resolution protocol (protocol B).
DCE-MRI was performed using a 3D TWIST sequence with TR/TE=2.55 ms/ 0.95 ms, FA=20°, FOV 320 x 260 mm² and GRAPPA 3. The two protocols only differ in spatial and temporal resolution (see Tab. 1). 0.05 mmol/kg body weight of contrast agent (Dotarem, Guerbet, France) was administered after the fifth volume acquired.

Tab.1

protocol	matrix	nominal temporal resolution	voxel resolution
A	256 x 256 x 96	3.0 sec	1.25 x 1.25 x 1.25 mm^3
B	192 x 162 x 56	1.5 sec	2.00 x 2.00 x 2.00 mm^3

Data analysis was performed as in [1]. Image quality was accessed by peak SNR (PSNR) during the first pass. Quantification of lung perfusion was performed using a pixel-by-pixel deconvolution approach. To access differences between left and right lung, ROIs were placed in one slice on the calculated pulmonary blood flow (PBF) maps and average PBF (PBF) was extracted.
Results: For all patients lung perfusion measurements could be obtained. Average PSNR values for protocol A were 15±7 and for protocol B 35±18. Mean PBF for protocol A was 37±11 ml/100ml/min (hypoplastic) and 63±16 ml/100ml/min (normal). Mean PBF for protocol B was 64±20 ml/100ml/min (hypoplastic) and 87±23 ml/100ml/min (normal) (see Fig. 1). Side differences for both protocols were significant (two-sampled t-test, P<0.05).

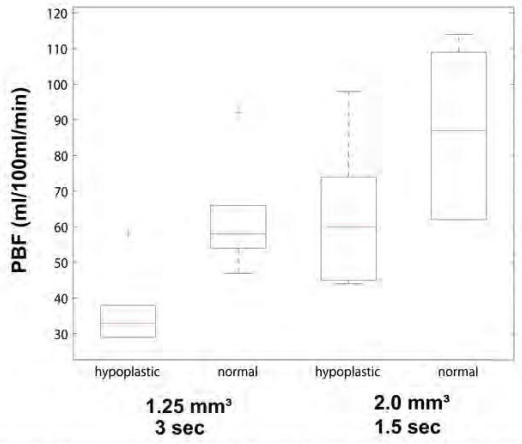


Fig.1 : Boxplot of pulmonary blood flow of the hypolastic and normal lung for protocol A and protocol B.