Assessment of cystic fibrosis in children using hyperpolarized 3-Helium MRI: comparison with Shwachman score, Chrispin-Norman score and spirometry.

E. J. van Beek[1], C. Hill[1], N. Woodhouse[1], S. Fichele[1], S. Fleming[1], B. Howe[2], S. Bott[2], C. J. Taylor[2], J. M. Wild[1]

[1]Unit of Academic Radiology, University of Sheffield, Sheffield, South Yorkshire, United Kingdom, [2]Academic Unit of Child Health, University of Sheffield, Sheffield, South Yorkshire, United Kingdom

Objective: Hyperpolarized 3-Helium MRI has been investigated in a variety of settings. However, in children with lung diseases the technique has, to our knowledge, not been tested. Nevertheless, it is likely that the technique will be particularly useful in children with congenital lung diseases, as standard radiological investigation is often limited due to ionising radiation constraints. In this pilot study, we investigated the feasibility of hyperpolarized 3-Helium MRI and the correlations with routine clinical parameters in children with cystic fibrosis.

Materials & Methods: Eight children with cystic fibrosis were studied after ethics approval and following informed consent of children and parents. All children underwent routine clinical investigation, including spirometry (FEV_1 and FVC) within 6 weeks, and also had chest radiography performed for Shwachmann and Chrispin-Norman scoring. 3-Helium was polarized to 30% using rubidium exchange apparatus (Amersham Health), delivery of a 300ml ^3He / 700 ml N_2 mixture took place from a Tedlar bag followed by continued inhalation of room air. Imaging was performed at 1.5 T on a whole body system. A low flip angle 3D gradient echo sequence (24 slices, 9 mm thick, 96 views, TE 4.5 ms, TR 9 ms, BW 31kHz, 256 samples, FOV 43 cm) was used to image ventilation distribution. A radial projection sequence (1) was used for dynamic imaging of the ventilation cycle. The Donnelly score was used for assessment of 3-He MR images (2). Correlations were calculated and regression analysis was performed with application of the F-statistic using the Microsoft Excel software (Microsoft Office 2000).

Results: The children ranged in age from 6 – 15 years (median 12 years), and they all tolerated the imaging well. Vital signs monitoring did not reveal any desaturation during the Helium breath-hold or dynamic scans. Two children were excluded from the analysis: a 15-year old boy had developed pneumonia since his previous clinical assessment and completed his antibiotics on the day of MR imaging; a 7-year old boy had spirometry results which did not correlate with clinical findings and deviated from previous assessments (therefore spirometric data were deemed unreliable). For the remaining 6 subjects, the following correlations and F-scores were found (Table). A significant correlation was found between Donnelly score and spirometry, while a trend was seen for the correlation between Donnelly score and Shwachman score.

Donnelly score vs FEV1/FVC	r =-0.87	F = 12.07 (p=0.025)
Donnelly score vs Shwachman score	r = -0.74	F = 4.81 (p=0.09)
Donnelly score vs Chrispin-Norman score	r = 0.1	N.S.
Shwachman score vs FEV1/FVC	r = 0.42	N.S.
Chrispin-Norman score vs FEV1/FVC	r = -0.17	N.S.

The figures demonstrate two examples of subjects studied, with a 15-year old boy with minor symptoms (Figure 1 A) and in a 12-year old asymptomatic child (Figure 1 B), respectively.

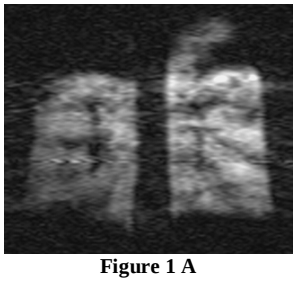

Figure 1 A

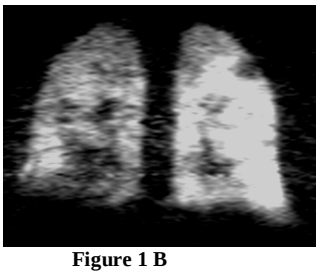

Figure 1 B

Discussion: This study demonstrates the feasibility of hyperpolarized 3-He MR imaging in children with cystic fibrosis. The initial results suggest that the technique is safe, but larger numbers will be required to confirm this. Hyperpolarized 3-Helium MRI correlated closely with spirometry data. Furthermore, it is shown that MRI is more closely related to lung function test results than either the Shwachman or the Chrispin-Norman scores, suggesting that these latter tests do not predict for lung function in this patient population. Hyperpolarized 3-He MRI could prove to be a useful test in the monitoring of children with cystic fibrosis.

References

1) Wild JM et al. MRM 2003;49:991-7; 2) Donnelly LF et al. Radiology 1999;212:885-9.