Assessment of Peripheral Airways Development after Preterm Birth by Hyperpolarised 3He

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Introduction

Premature born children suffer from altered lung development and function. We compared (*in vivo)* measurements of acinar structure in children born preterm with healthy controls using the techniques of hyperpolarised ^{3}He MR (HPHe3MR) and Multiple Breath Nitrogen Washout (MBNW).

Methods

A group of 11 ex-preterm children (gestational age 24-32 weeks) with severe neonatal lung disease were compared to 20 term-born healthy subjects closely matched for age, height and weight, with respect to the Apparent Diffusion Coefficient (ADC) using HPHe3MR, and indices of ventilatory inhomogeneity (S_{cond} and S_{acin}) using MBNW. MRI Investigation: ADC was measured on a 0.15 T scanner using a modified RARE sequence to give a global value for both lungs (FOV =35 cm, TE=10 ms, BW=33 kHz, 64 echoes). We acquired a 1D image on the transverse plane. A set of 2 to 4 measurements were taken with the subject in the supine position. Subjects inhaled a mixture of 10 ml HP ^{3}He and 300 ml ^{4}He. The NMR spin echo peaks were plotted against time on a logarithmic scale. The ADC was then calculated from the slope of the exponential decay. For each data set we evaluated the global ADC and individual values for each lung. Lung Function: Standard lung function parameters were measured using spirometry. MBNW was performed using a commercial system and the Phase III slopes were analysed using software developed in-house to calculate S_{cond} and S_{acin} .

Results

ADC ranged from 0.104 to 0.16 cm^2s^{-1} (median 0.122) for all subjects (Figure 1). For both groups the inhomogeneity of ADC across the lungs was mainly below 15% but 5 girls (out of 15) showed a variation of between 15 and 40%. Preterms had few significant differences in lung function when compared to the term group. S_{acin} was significantly higher in preterms, showing increased inhomogeneity at acinar level, but S_{cond} and ADC were no different. (Table 1).

Conclusions

When compared to controls, children born preterm have a trend towards differences in spirometry but have markedly higher ventilatory inhomogeneity in their acinar airways. Lung damage at the alveolar level normally leads to higher ADC as the gas can diffuse more freely so we hypothesised that ADC would be higher in children born preterm. The lack of a difference between preterm and control groups suggests that the acinar changes are not related to abnormal structure at the alveolar level. The ADC sometimes exhibits an inhomogeneous distribution across the lungs, more commonly in girls. Extending the study to children of other age groups could clarify whether this inhomogeneity is related to puberty.

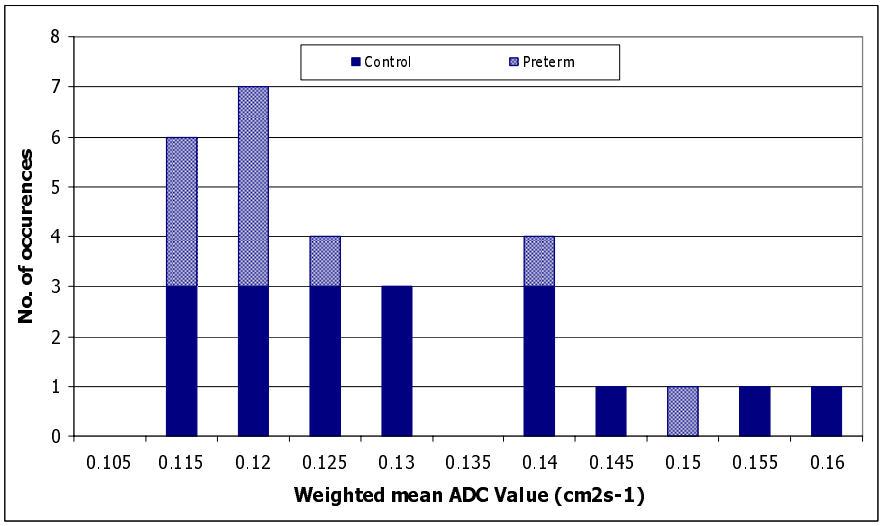

Figure 1: Distribution of ADC among the groups.

Table 1. Comparison of indices between preterm and term. Mean (SD)

	Preterm	Control	p
FEV1(z-score)	-0.42 (0.90)	0.22 (0.91)	0.07
FRC-MBNW (L)	1.5 (0.6)	1.15 (0.2)	0.05
S_{acin}	0.186 (0.088)	0.095 (0.045)	0.007
S_{cond}	0.056 (0.049)	0.036 (0.027)	0.24
ADC (cm^2s^{-1})	0.127 (0.014)	0.124 (0.013)	0.25