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Thorax Editorial - Imaging pathophysiological changes in the lungs in IPF with xenon MRI

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Although FVC is validated as a tool for assessment of idiopathic pulmonary fibrosis (IPF) progression and prediction of mortality, the need for tests that are more sensitive to patho-physiological change in the lungs in IPF is well recognised for earlier diagnosis, longitudinal assessment, and for better markers of therapy and prognosis [1].

Imaging in IPF in clinical radiological practice currently resides with structural CT. The structural changes seen in IPF on CT are regionally heterogeneous and represent different aspects of the pathology and lung disease evolution [2]. CT is now being used more quantitatively with image segmentation and texture analysis to classify the different structural changes. These algorithms show prognostic promise [3], but it remains to be seen how sensitive they are to disease progression. There is a possibility that manifestation of structural changes on CT is too late in the disease process for effective treatment in IPF.

MRI is a modality best associated with soft tissue imaging and at it does not feature in the regular diagnostic toolbox for clinical assessment of lung disease. MR imaging with inhaled hyperpolarized inert gases, (such as ^{3}He and ^{129}Xe which are magnetically sensitive) can provide novel and diverse functional and structural information from the lungs. These methods have been brewing in MRI labs for some time and a solid body of clinical research evidence now exists in a variety of different lung diseases. In a recent Editorial in Thorax [4], the sensitivity of hyperpolarized gas ventilation MRI to early obstructive airways disease in paediatric cystic fibrosis was highlighted.

In this paper from the Duke group [5] we now see the potential for hyperpolarized ^{129}Xe MRI, for assessing gas exchange and interstitial disease in the lungs in IPF. Xenon (Greek *xenos - strange*) is a noble gas atom, whose MR signal, can be boosted with hyperpolarisation to levels where it can be imaged in the lungs. Unlike ^{3}He, ^{129}Xe is cheaper and readily available so has wider clinical potential. Xenon's solubility and unique spectral signature from its environment, either as gas in the alveoli, when dissolved in the interstitial tissue, or taken up by the red blood cells in the capillaries, make it particularly interesting for measuring diffusion limitation. Previous studies with ^{129}Xe MR spectroscopy have focused on whole lung measurements of the dynamics of the xenon signals from the tissue, blood and airspaces [6], in order to estimate the interstitial barrier thickness and have shown differences between healthy and IPF lungs.

These approaches are extended here with a regional spectroscopic imaging technique giving us simultaneous structural and functional information on fibrotic change and gas exchange. Of particular interest is the increased ratio of the signal from the interstitial tissue to that from the red blood cells in the capillaries, which indicates diffusion limitation. In IPF lungs we see a basal and peripheral distribution of the tissue-to- blood signal ratio, which is consistent with the known anatomical heterogeneity of the disease. What is also really interesting is the fact that the tissue and red blood cell signals when averaged over the whole lungs showed weak correlation with the qualitative CT scores used. Furthermore, there was no clear matching of the MR maps with structural changes on CT in the patients with early fibrotic change. The method is clearly measuring different, but related aspects of the patho-physiology to structural CT, in that the size of the xenon signal is weighted by

combination of interstitial thickening, delayed gas diffusion plus perfusion deficit. The correlation of the xenon indices with the carbon monoxide diffusion factor (D_{LCO}) measured from the whole lungs corroborates this added physiological sensitivity.

The next step is to see how the regional pathophysiological sensitivity of xenon MRI compares with D_{LCO}, K_{CO}, FVC and quantitative CT analysis for monitoring disease progression. We could envisage an ionizing radiation free imaging exam with xenon MRI used alongside promising proton MRI methods [7] for the longitudinal assessment of structural and functional changes in interstitial lung diseases.

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