A Comparison of Hyperpolarized ^{3}He MR Imaging and Krypton Scintigraphy in Healthy Volunteers and COPD Patients

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Introduction: Hyperpolarised ^{3}He MR imaging of the lung provides information of regional ventilation. Routinely this is evaluated by scintigraphy with different nuclear agents (1). With the introduction of hyperpolarized ^{3}He MR imaging (HP-MRI) comparison with nuclear techniques showed reproducibility of ventilation defects (2,3,4), although the spatial resolution of MR is superior. However, systematic comparison between the two imaging modalities has not yet been performed. In this study we visually compare hyperpolarized ^{3}He imaging with ^{81m} Krypton (^{81m}Kr) scintigraphy in 21 subjects (Chronic Obstructive Pulmonary Disease (COPD) patients and lung healthy volunteers).

Methods: 15 COPD patients (FEV1<70% predicted) and 6 lung healthy volunteers were imaged with HP-MRI and ^{81m}Kr scintigraphy. The two examinations were carried out within 2 weeks. The ^{3}He gas was polarized in Mainz and shipped to Copenhagen by air transport (5). A Siemens Vision scanner 1.5 T equipped with a ^{3}He/^{1}H birdcage coil (Fraunhofer Institute, St. Ingbert, Germany) was used for imaging. After inhalation of 300 ml hyperpolarized ^{3}He coronal images were acquired during a 12 s breath hold with a 2D FLASH sequence (TR/TE 11ms/4.2ms, flip angle < 10 deg, FOV 340 mm, slice thickness 10 mm, matrix 81x128 interpolated to 256x256). Four planar ^{81m}Kr scintigrams were acquired at tidal breathing: anterior-posterior, right posterior oblique and left posterior oblique (Millenium MG, GE; matrix 256x256, pixel size 2.26 mm x 2.26 mm).
The HP-MR and ^{81m}Kr scintigraphy images were scored visually in consensus by two experts who were blinded to the patients' identity. In each scanning modality the severity of ventilation defects in both lungs (right and left) was scored in four groups (normal (0), mild (1), moderate (2), and severe (3) ventilation defects, se table 1). In addition, the percentage of non-ventilated lung was estimated.

Results: The correlation between the percentage of non-ventilated lung in the two methods is 0.63 ($p<0.05$). Table 1 shows the scoring for the 21 subjects. The kappa value is 0.22. One-sample sign test was calculated, for the right lung HP-MRI scored higher than ^{81m}Kr ($p<0.05$), whereas no significantly difference was observed in the left lung.

Table 1		^{81m}Kr scintigraphy			
		0	**1**	**2**	**3**
HP-MRI	**0**	8	1		
	1	6	3	5	
	2		4	2	1
	3		2	6	4

Discussion:

In this study we found a fair agreement in the scoring of the severity of ventilation defects in HP-MRI and ^{81m}Kr scintigraphy (κ=0,22). The HP-MRI scoring of defects in the right lung was significantly higher than the ^{81m}Kr scintigraphy score. Although both techniques represent ventilation distribution, the breathing technique during acquisition is different for the two methods, thus the HP-MRI is obtained at breath hold at maximal inspiration (TLC), while ^{81m}Kr scintigraphy is performed during continuous tidal breathing at functional residual capacity (FRC). Whereas HP-MRI is obtained in coronal slices, the ^{81m}Kr scintigraphy is here represented in only four planar projections (se figure 1 and 2).
In conclusion, ventilation defects seem to be most pronounced when diagnosed with HP-MRI. However, there are different explanations for this: superior resolution of HP-MRI, the sensitivity of HP-MRI could reveal non-pathological transient defects, the different measurement set-up (breathing techniques and projections). Further studies are required before the clinical value of HP-MRI is established.

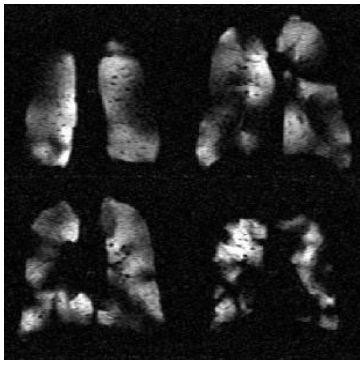

Figure 1 Four coronal slices going from posterior (upper left) to anterior (lower right) acquired with HP-MRI in a COPD patient. Multiple wedge shaped defects are scattered throughout the lung.

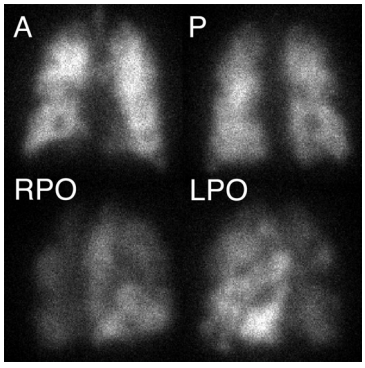

Figure 2 Krypton scintigrams (A: anterior, P: posterior, RPO: right posterior oblique, LPO: left posterior oblique) for the same COPD patient also showing multiple defects.

References

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