

# Assessment of Ventilation Function and Airway Structure in Mesothelioma Using Hyperpolarized $^3\text{He}$ MRI

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## Introduction

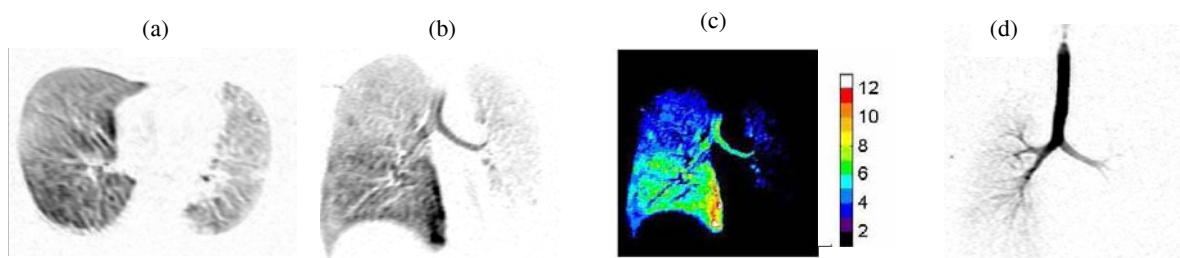
Mesothelioma is an asbestos-associated form of cancer that most commonly affects the mesothelial cells of the pleura, peritoneum, or the pericardium. Although it is a relatively rare cancer, the recent years have seen a steady rise in incidence rates, which are expected to continue increasing until the year 2020 [1]. We are particularly interested in the study of pleural mesothelioma, which affects the lining of the lung and thus significantly reduces ventilation to the diseased lung. Although conventional MRI visibly illustrates the spread of the tumor in the pleural cavities, it fails to provide functional information about the affected lung. Using hyperpolarized  $^3\text{He}$  MR imaging, we were able to visualize ventilation differences between the affected and non-affected lung in a mesothelioma patient.

## Materials and Methods

A 58 year old male patient diagnosed with mesothelioma was enrolled in this study. All procedures were approved by our Institutional Review Board. Chest x-ray of the patient showed circumferential left-sided pleural disease consistent with the patient's diagnosis of mesothelioma. All MR imaging experiments were performed using a 1.5 T GE Signa whole-body scanner outfitted with a heterodyne system. The subject's pulse rate and blood oxygen saturation were monitored using a pulse oximeter with a peripheral plethysmographic finger cuff. Following the proton localizer scans, both static and dynamic HP  $^3\text{He}$  MR scans were performed. For each  $^3\text{He}$  MR scan, the subject was instructed to inhale 300-500 mL of HP  $^3\text{He}$ , diluted to 1 L with inert  $\text{N}_2$ , from a Tedlar plastic bag. Multi-slice static imaging was performed during a 10 s breath-hold. The Fast Gradient-Echo (Fast GRE) pulse sequence was used with 13 mm slice thickness to cover the entire lung region. Imaging parameters were as follows: field-of-view 46 cm, matrix size 256 x 128, and TE/TR 4.6/50 ms. For the dynamic projection images, the subject inhaled the HP  $^3\text{He}$  gas over 5 – 8 seconds; the scan was started prior to the beginning of inspiration. The Fast GRE pulse sequence was used with the same FOV and matrix slice, but with TE/TR 1.2/4.4 ms. The  $^3\text{He}$  was hyperpolarized using a custom-built Rb spin-exchange polarizer with a polarization level of 10-20%.

## Results and Discussion

Figure 1 shows hyperpolarized helium MR images of static ventilation images in the axial and coronal planes, and dynamic projection of the airways. Figure 1a-b shows a substantially decreased ventilation of the entire left lung, corresponding to the lung affected from mesothelioma. In contrast, the right, healthy lung has a relatively uniform ventilation distribution. The ventilation map, shown in Figure 1C, also shows a deficient ventilation of up to 20% fractional ventilation in the left, affected lung, while the right lung displays a variation from 40-60% of fractional ventilation. The ventilation defects are also well appreciated on the dynamic projection scan, where the entire left lung is lacking in visible airways. In the right lung, up to 5-6 generations of airways can be observed. Mesothelioma results in a circumferential thickening of the lung pleura, which encases the entire left lung in this patient, and evidently results in a deficient ventilatory function. Ventilation distribution is a lung function also determined by airway structure, as is evident by the considerable disappearance of airways in the left lung, consistent with the dominant ventilation deficiency.



**Fig 1.** Hyperpolarized  $^3\text{He}$  lung images in axial (a) and coronal (b) views. Coronal ventilation map (c), and dynamic projection image of airways (d). For better visualization, the image negatives are displayed in (a,b,d).

## Conclusion

HP  $^3\text{He}$  MRI enables the tracking of airway and ventilation details not accessible with other non-radiation dependent imaging modalities. HP  $^3\text{He}$  MR imaging provides an important new technique for obtaining quantifiable structure-function properties of the lungs affected by mesothelioma, and can be used to stage treatment strategies.

## Acknowledgements

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## References

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