Hypermolalized $^3$He MR Lung Ventilation Imaging in Asthmatics:
Preliminary Findings


INTRODUCTION
Asthma is a disease characterized by chronic inflammation and reversible obstruction of the small airways resulting in impaired pulmonary ventilation. Current radiological techniques are of limited value in asthma. Hyperpolarized $^3$He magnetic resonance (MR) lung imaging is a new technology that provides high resolution visualization of lung ventilation (1-6).

METHODS and MATERIALS
Twenty subjects, 10 asthmatics and 10 healthy volunteers, underwent hyperpolarized $^3$He lung ventilation imaging. A single subject, an asthmatic, was imaged at a second time 3 weeks following the first imaging session to assess the time course of the ventilation defects. In the second session, this subject was evaluated twice: prior to and approximately 20 minutes after inhaled bronchodilator therapy.

$^3$He was polarized using a prototype commercial system (Magnetic Imaging Technologies, Durham, NC, USA). The details of the polarization process have been described previously (5). Imaging was performed on a broadband 1.5 T Magnetom Vision whole body MRI system (Siemens Medical Systems, Iselin, NJ, USA). Two transmit-receive coils were used for the helium imaging experiments: a tunable Helmholtz pair, and a quadrature flexible wrap coil (Medical Advances, Milwaukee, Wis). Coronal hyperpolarized $^3$He lung images were obtained using a gradient-echo, two-dimensional, fast low-angle shot (FLASH) sequence. Typical parameters were repetition time 9 ms, echo time 4 ms, flip angle 14°, field of view 30x50-55 cm$^2$, slice thickness 1-1.5 cm, and matrix 80-96x256. A single slice was acquired in 0.6 s and the entire lung was imaged during a 9-16 s breath hold.

RESULTS
Control subjects generally had uniform distribution of the gas throughout the lungs. Non-posterior ventilation defects were seen only in the asthmatic subjects. These defects were pleural based, frequently wedge-shaped and varied in size from tiny to segmental. Seven of the 10 asthmatic subjects had at least one non-posterior ventilation defect.

Two asthmatic subjects were mildly symptomatic at the time of imaging and had larger and more numerous defects than the asymptomatic asthmatics (Figure 1A). One of the symptomatic asthmatics was imaged a second time 3 weeks following the initial session and was again mildly symptomatic. There were multiple ventilation defects, but in different locations (Figure 1B). This subject was imaged again approximately thirty minutes later, following the use of an inhaled bronchodilator. The multiple ventilation defects completely resolved (Figure 1C).

CONCLUSION
With the ability to image small ventilation defects, hyperpolarized $^3$He lung imaging can detect the small reversible ventilation defects that characterize asthma. The ability to visualize lung ventilation offers a direct method of assessing asthma and the response to therapy.

REFERENCES

Figure 1. Coronal hyperpolarized $^3$He MR lung images of a mildly symptomatic asthmatic. A) There are multiple ventilation defects. B) The defects are in different locations 3 weeks later. C) The defects resolve following an inhaled bronchodilator.