

Response to Deep Inspirations in Reactive and Non-Reactive Asthmatic Subjects Using Hyperpolarized ^3He MRI

Y-S. Tzeng^{1,2}, N. Shah¹, J. Mansour¹, J. Gereige¹, G. Washko³, M. Cho³, E. Stepp³, K. Lutchen², and M. Albert¹

¹Radiology, Brigham & Women's Hospital, Boston, MA, United States, ²Biomedical Engineering, Boston University, Boston, MA, United States, ³Division of Pulmonary and Critical Care Medicine, Brigham & Women's Hospital, Boston, MA, United States

Introduction

Algorithms have been developed to quantify the heterogeneity of ventilation imaged using Hyperpolarized (HP) ^3He MRI. These can be used to study airway reactivity and the associated ventilation distribution of asthmatics versus normal controls.

Approach

HP ^3He MRI was performed before Methacholine challenge (Mch), after Mch, and after deep inspirations (DI) on reactive asthmatics (RA, $\text{PC}_{20} < 8$ mg/ml, n=8), non-reactive asthmatics (NRA, $\text{PC}_{20} > 8$ mg/ml, n=8) and normal healthy controls (HC, n=6). Subjects were instructed not to take DI's after Mch. Heterogeneity was mapped by plotting the MR images' local pixel intensity coefficient-of-variation. Changes in overall heterogeneity (ΔH) due to Mch and DI were computed, and recovery (Q) was quantified from their ratio. Scans were conducted on a 1.5T GE Signa LX scanner, and ^3He polarization achieved was between 10-20%.

Results

Representative postMch and postDI images from each of the 3 subject groups are presented in Figure 1.

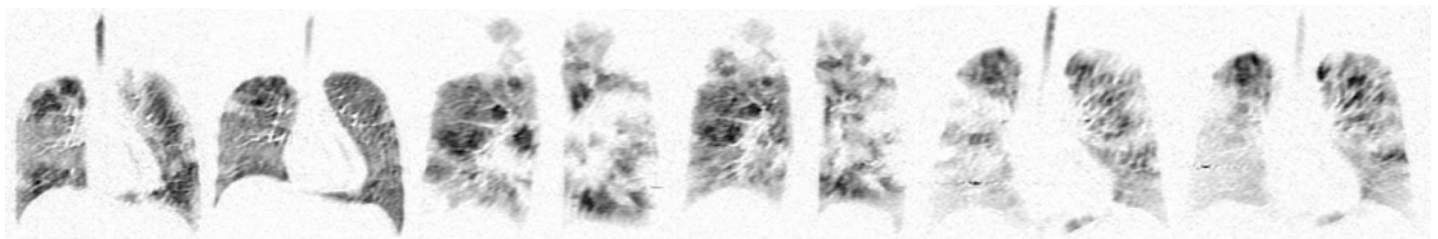


Figure 1. PostMch and postDI images from 3 representative subjects.

Figure 2 shows that all 3 subject groups had significant heterogeneity increases following Mch. However, non-reactive asthmatics and healthy controls had significant heterogeneity decreases going from postMch to postDI while the reactive asthmatics did not.

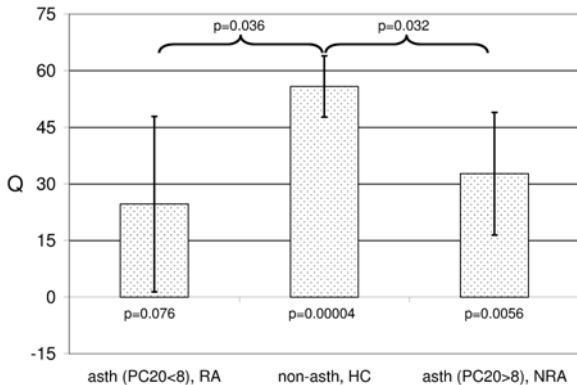


Figure 3. Recovery: Percentage of Mch-induced Heterogeneity negated by DI's.

healthy controls, this was statistically different from the healthy controls when the DI-induced dilations were normalized by the Mch-induced constrictions.

Conclusion

The reaction of the non-reactive asthmatics to DI suggests that although they do not seem hyper-reactive based on PFT's, permanent airway remodeling may exist such that once bronchoconstriction is initiated, their ability to bronchodilate is impaired in a fashion similar to reactive asthmatics.

Sponsors

NIH grants EB-001689-02 and HL62269-02

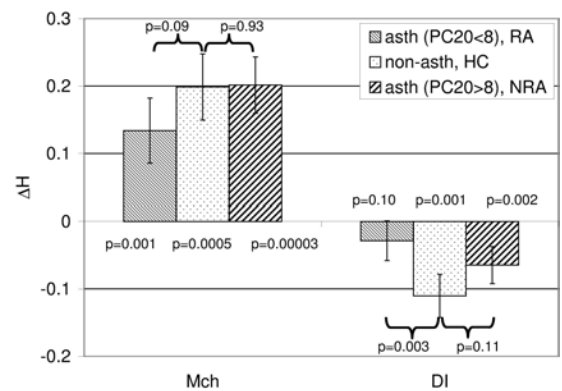


Figure 2. Heterogeneity changes in response to Mch and DI's.

The reaction of the reactive asthmatics was statistically different from the healthy controls while that of the non-reactive asthmatics was not. Figure 3 shows that non-reactive asthmatics and healthy controls had significant recoveries, while the reactive asthmatics did not. However, the recoveries of both asthmatics groups were statistically different from that of the healthy controls. In all 3 metrics, there was no difference between the 2 asthmatic groups (p=0.06 for Mch, p=0.10 for DI, p=0.59 for recovery).

Despite that the non-reactive asthmatics had a reaction to DI similar to that of