

Introduction

The Forced Oscillation Technique (FOT) is experiencing increased uptake as a clinical measure of lung function and airway constriction. However, due to the complex nature of test outputs, there is still uncertainty about exactly how test indices from the FOT respond to specific types of lung disease, such as bronchoconstriction and tissue breakdown. By comparing correlations of clinical and simulated data, we provide evidence of the nature of these responses.

Methods

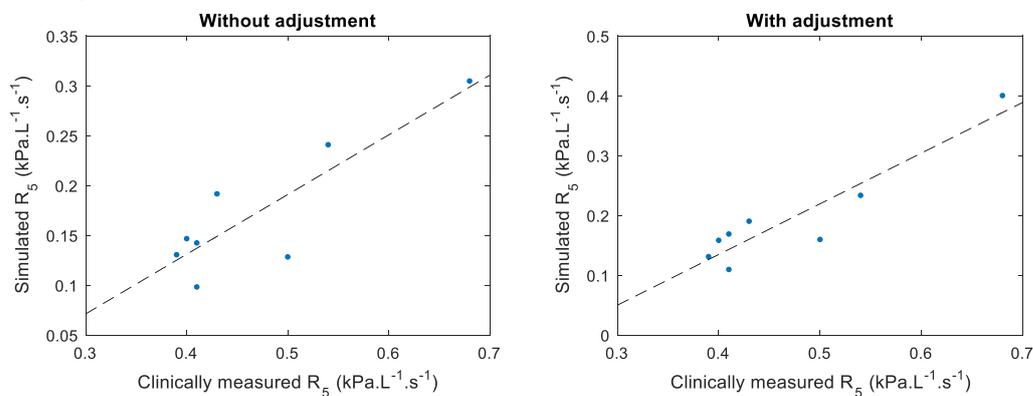
FOT measured resistance at 5Hz (R_5) was collected for 2 healthy patients, and 6 asthmatic subjects CITE. Each patient also underwent a CT scan (inspiratory/expiratory volumetric CT at TLC/FRC), which was used to generate a patient-specific virtual conducting zone structure (accurate to approximately generation 6-10). The FOT was then simulated on each structure using an electrical circuit analogous model, with flow-driven branch impedances, and a constant-phase and evenly dispersed viscoelastic model for the acinar regions (unadjusted group). Following this, ventilation of each lobe was approximated using the CT scan data, and used to rescale the small airway (generations 10-16) sizes in the virtual structures accordingly. These adjustments were made completely independently, and blind to the simulated and clinical FOT values. The FOT was then re-simulated on each structure with the updated model (adjusted group).

Results

The correlation of clinical resistance at 5Hz (R_5) and simulated R_5 (without adjustment) is shown in Fig 1a. While there is a correlation between simulated and clinical values, there is also a high degree of noise. After accounting for small airway sizes (Fig 1b), this correlation significantly improves, with a noticeable reduction in noise. The improvement is both visual and statistical, with the p-value for the linear fit decreasing by a factor of 5, and the R^2 value increasing by 15% (from 0.71 to 0.86).

Conclusions

The incorporation of imaging-derived, small airways information significantly improved the ability of the virtual model to recreate clinical data. This suggests that the response R_5 , while clearly global (due to Fig 1a still somewhat recreating clinical values) is still quite sensitive to small airway size, and should not be interpreted solely as a global parameter, as is often the case in the literature.



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