Relationship between heterogeneous bronchoconstriction and impulse oscillometry resistance: a simulation study

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Rationale

Impulse oscillometry (IOS) is a common clinical technique to probe airway structure. The IOS parameter R5-R20 is believed to be a measure of heterogeneous small airways constriction (Gonem et al. ERJ 2012, Gonem et al. CEA 2013). We test this hypothesis using a computational model.

Methods

A complete airway model was created by first segmenting the lobes and central airways (to generation 8) from CT data of a healthy adult male (25yo, 27.7 BMI). A volume filling branching algorithm was applied to extrapolate the remaining airway tree to generation 24. Random airway constriction patterns of varying severity and heterogeneity were applied to three groups of airways: the large conducting airways (generations 4-7), the small conducting airways (8-15) and the intra-acinar airways (16-24). An acoustic impedance model was used to simulate IOS resistance parameters using the resulting models.

Results

Mean R5-R20 showed little change over baseline after severe constriction of the large conducting airways (+10% homogenous, -15% heterogeneous). Mean R5-R20 increased with homogeneous
constriction of both the small conducting airways (+186%) and the intra-acinar airways (+197%). Mean R5-R20 increased further with heterogeneous constriction of the small conducting airways (+270%) and increased markedly after heterogeneous constriction of the intra-acinar region (+440%).

**Conclusions**

Simulations support the hypothesis that increased R5-R20 is a measure of airways constriction in the small conducting and intra-acinar airways. Further, R5-R20 is seen to depend strongly on increasing constriction heterogeneity in the intra-acinar region.