Introduction

COPD exacerbations are characterized by increased dyspnea and decreased pulmonary function. The differences in both the level and the course of breathlessness during an exacerbation of COPD do not correlate well with classical parameters such as blood oxygen saturation or lung function. In exacerbations an increase in airway resistance and/or hyperinflation is often observed although very difficult to measure by lung function. Functional respiratory imaging (FRI), a novel technique which calculates volumes and resistances by computational fluid dynamics on a regional level from high resolution computed tomography (CT) scans has been demonstrated to be feasible in stable COPD, but not yet during exacerbations.

Aims

Recovering from a COPD exacerbation is typically associated with an improvement in FEV1. The common perception is that FEV1 is determined by the characteristics of the larger airways (generations 2-6). We investigated the relationship between changes in FEV1, airway volume and lung hyperinflation in patients recovering from an acute COPD exacerbation.

Methods

In 3 centers in Europe, a total of 53 patients presenting with an acute exacerbation of COPD were recruited:

- Exacerbation was defined by an increase in symptoms lasting at least 2 days and necessitating a change in therapy
- Inclusion criteria were age > 40 years, post-bronchodilator FEV1/FVC < 0.70 and < 80%pred as documented in the last 5 years, and at least 10 pack years
- Exclusion of patients with pneumonia, concomitant asthma, and when pregnant or lactating
- Post-bronchodilator CT and spirometry measurements were performed < 5 days from presentation with the exacerbation and at day 43 (±7 days)

Airway volumes (until generation 6-10) and hyperinflation were assessed using FRI during both visits. Data of both upper and lower lobes were extracted. The change in FEV1 was modelled using multiple regression.

Results

In total, 45 patients were evaluated (6 dropouts, 2 bad scans). The main patient characteristics at inclusion are presented in Table 1.

| Table 1. Patient characteristics at inclusion |
|-----------------|-----------------|
| Patients        | 45              |
| Gender          | 19M/26F         |
| Age (years)     | 57.5±9.6        |
| FEV1 (%pred)    | 45.9±15.16      |
| FEV1/FVC (%)    | 2.35±2.46       |
| TLC (%pred)     | 106.4±18.18     |
| RVC (%pred)     | 180.8±15.97     |

- FEV1 increased after recovery with 159ml ([144] = 4.11; p < 0.001)
- Both an increase in airway volume and a decrease in hyperinflation were observed
- However, recovery from exacerbation turns out to be extremely heterogeneous by nature (see Figure 1)
- A significant correlation was found between the change in FEV1 and the changes in both airway volume and hyperinflation in the upper and lower lobes (adjusted R² = 0.28, p = 0.002)
- Increase in FEV1 is mainly driven by a decrease in hyperinflation in the lower lobes (semipartial correlation coefficient squared ΔR² = 0.17, p = 0.002). The effect from the upper lobe is much smaller (ΔR² = 0.08, p = 0.038)
- Increase in FEV1 is also determined by an increase in volume of the airways going to the lower lobe (ΔR² = 0.11, p = 0.014). No relation was found with this value in the upper lobes (p = 0.04)

Conclusions

Changes in FEV1 after exacerbation appear to be driven more by changes in the smaller airways than by changes in the proximal airways. It also seems that regionalization is a very important aspect. Our hypothesis is that, while the manifestation of COPD in stable patients is more present in the upper lobes, acute exacerbation mainly affects the lower lobes. We believe that it's important to know which lung zones drive changes in FEV1 in different pathologies as this can lead to earlier disease detection and more targeted treatments. In the next step, we want to differentiate the exacerbations of patients with predominant emphysema from those with predominant conductive airway disease, as different types of exacerbations may need different treatments.

Research supported by GSK