Estimation of internal airflow redistribution in function of PEEP in NIV

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Rationale
It has been shown that NIV causes internal airflow redistribution in COPD patients recovering after exacerbation [Int J COPD, 2011;6 615-24]. This work tries to use functional respiratory imaging (FRI) to develop a method to predict the amount of redistribution that can be achieved in a patient specific manner.

Methods
10 persistent hypercapnic COPD GOLD III patients underwent a HRCT scan at FRC and TLC. From these scans airway tree and initial internal flow distribution (IFD) were obtained. Using computation fluid dynamics (CFD), and by setting tracheal pressure $p_{trach} = 0$, this data was used to calculate lobar pressure ($p_{lobe}$). Different PEEP levels ($p'_{trach}$) were simulated by adapting lobe ($p'_{lobe}$) using the formula below:

$$p'_{lobe} = \frac{\sum_{lobe=LL}^{LLL} (p'_{trach} - p_{lobe})A_{lobe}}{\sum_{lobe=RR}^{LL} (p_{trach} - p_{lobe})A_{lobe}} p_{lobe}$$

Using this new lobar pressure in the CFD calculations resulted in values for IFD in function of the PEEP level.
Results

It was observed that in some patients increasing PEEP levels did not result in a change in IFD, whereas in other patients a complete shift from predominant upper lobe breathing to lower lobe breathing was seen. The shift in IFD happened for all patients in the PEEP range [0-10]cmH₂O.

Conclusions

FRI predicts PEEP to have an influence on IFD. This influence is observed in a range of PEEP that is clinical achievable. These findings have to be confirmed in a prospective clinical trial.

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Figure

Figure 1 Different response of IFD as PEEP levels increase