ASSESSMENT OF FEV$_1$ DECLINE AFTER LUNG TRANSPLANTATION USING FUNCTIONAL RESPIRATORY IMAGING

Eduardo Barbosa, Jr.\(^1\), Francisca Ferreira\(^2\), Wim Vo\(^2\), Cedric Van Holsbeke\(^2\), Lieven Nuyttens\(^2\), Wilfried De Backer\(^2\), Jan De Backer\(^2\), James Lee\(^3\)

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Introduction

- Chronic lung allograft dysfunction (CLAD) is the major limitation to long-term survival after lung transplantation (LTx).
- Bronchiolitis obliterans syndrome (BOS) is the obstructive phenotype of CLAD, defined as a sustained decline in FEV$_1$, not associated with other potential reversible causes.
- HRT has shown potential in the management of post-LTx patients, but its role in the early detection of BOS has not been established.
- Early diagnosis of BOS might increase the probability of successful treatment with novel therapeutic agents.

Aim of the study

- To show that Functional Respiratory Imaging (FRI) can assess post LTx changes in lung structure and function that correlate with onset of BOS.
- To identify which lung zones are key drivers for the decline in FEV$_1$, in BOS patients. Characterizing key areas in the lung affected in early BOS could lead to earlier diagnosis of this condition and potential for improved outcomes using novel treatments.

Functional Respiratory Imaging

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<tr>
<th>FRI parameters</th>
<th>Imaging lobar volume</th>
<th>Imaging specific airway volume</th>
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FRI parameters

- Time to BOS diagnosis: 4.4±2.9 years (averages±stdev) after transplant, ranging from 1 to 11 years.
- BOS Grade: 0–p.
- Number of Scans / Patient: 8 scans (averages±stdev), ranging from 2 to 8.
- Time Elapsed from LTx to CT scan: 1.4±1.3 years (averages±stdev) after transplant, ranging from 23 days to 13 years.

Methods

- Paired inspiratory-expiratory CT scans of 38 LTx recipients were analyzed retrospectively.
- The BOS cohort experienced a reduction in FEV$_1$<10% compared to baseline (BOS 0–p).
- The PFTs performed closest to each scan were examined to evaluate if the patient met the criteria for BOS 0–p.
- FRI yielded regional parameters (at lobar level): lung volumes (iVlobe), airway volumes (iVaw) and airway resistance (iRaw).
- Airway volumes and resistance were made specific by correcting for the lung volume (siVaw and siRaw).
- Multivariate regression modeling was performed to determine the most relevant image metrics to predict FEV$_1$ decline in the BOS cohort.
- Lung function and FRI parameters were analyzed and compared between the 2 groups.

Results and discussion

The FEV$_1$ decline in the BOS cohort could be accurately described with a conditional R$^2$ of 0.99. Key drivers for the decline were changes in iVlobe (p < 0.001) and siVaw (p = 0.001) as derived from the expiratory HRCT scans and changes in iRaw (p < 0.005), iVaw (p = 0.001) and siRaw (p < 0.05) based on the inspiratory HRCT scans.

When comparing the two cohorts, a significant increase in transplanted lung volume derived from the expiratory HRCT scans was observed in the subjects diagnosed with BOS compared to the non-BOS patients. On the other hand, the FEV$_1$ change between the two groups was not statistically different.

Conclusion

FRI parameters, based on volumetric inspiratory and expiratory scans, can determine with great accuracy the regional key drivers for FEV$_1$ decline in BOS patients. FRI could also differentiate early BOS from non-BOS in LTx patients, whereas FEV$_1$ could not. An increase in FRI volume of the transplanted lung in the BOS group is likely a consequence of progressive airflow obstruction leading to an increase in air trapping extent, characteristic of the disease. These results illustrate the potential of FRI as a biomarker to assist in early BOS diagnosis, and may be more sensitive than FEV$_1$. As future research, the influence of single and double lung transplantation on the onset of BOS will be assessed.

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