Effects of Targeted Lobar Volume Reduction by Endobronchial Valve Treatment on Non-Targeted Lobar Volume and Pulmonary Blood Volume

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Introduction

One-way endobronchial valve (EBV) placement is an established technique to treat advanced heterogeneous emphysema by collapsing targeted lobes. While successful lobar collapse (reduction of 350cc) has been shown to improve forced expiratory volume and 6-minute walk distance [Herth 2013, Roodenburg 2023], little data exists on the impact of targeted lobar volume reduction on non-targeted lobar blood volume. [Brown 2012, Rahaghi 2015].

Objective

The aim of this study is to quantify and examine the changes of lobar volume and blood volume post targeted lobar volume reduction by EBV treatment.

Methods

From the Endobronchial Valve for Emphysema Palliation Trial (VENT), subjects who underwent baseline pulmonary function test (PFT) and chest computed tomography scans (<=1.5mm slice thickness) at total lung capacity (TLC) pre and 6-month post treatment were selected (see Fig 1 for subject selection). A deep learning based automated lobar segmentation was performed to obtain lobar volume,[Wang 2018]. Total pulmonary blood volume (TBV) and blood volume at vascular cross-sectional area < 5mm^2 (BV5) were quantified using vessel segmentation obtained from an open-source deep learning model, TotalSegmentator.[Wasserthal 2023] Linear regression was used to study the effects of targeted lobar volume percent change (%Δ) from baseline on the %Δ of non-targeted lobar volume, TBV and BV5.

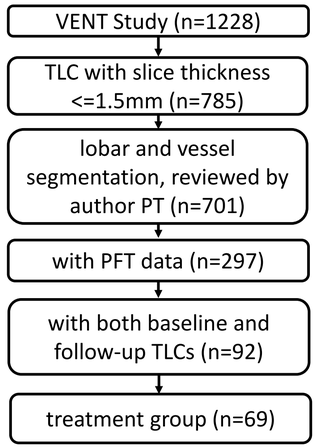

Figure 1. Subject selection flow chart.

Results

Table 1. Linear regression of percent change from baseline (%Δ) between targeted lobar volume versus non-targeted lobar volume, TBV (Figure 2) and BV5. In the non-targeted ipsilateral lobes, lobar volume, TBV and BV5 increased with reduced targeted lobar volume. Visualization of lobes and vessels at baseline and 6-month post treatment for 2 subjects are shown in Figure 3 and 4.

	variable	R^2	slope	p	n
ipsilateral	%Δ volume	0.35	-0.42	<0.001	103
	%Δ TBV	0.21	-0.36	<0.001	
	%Δ BV5	0.26	-0.41	<0.001	
contralateral	%Δ volume	0.13	-0.04	0.14	173
	%Δ TBV	0.06	-0.12	<0.01	
	%Δ BV5	0.07	-0.13	<0.01	

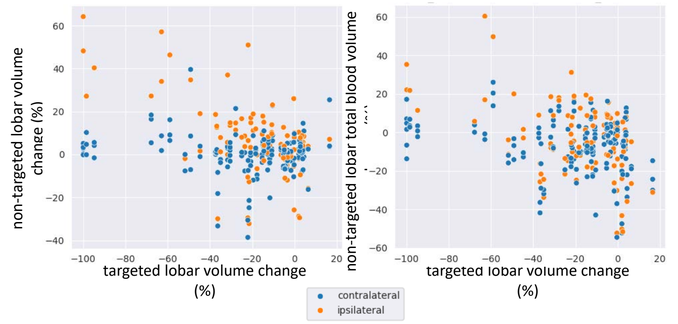

Figure 2. Targeted lobar volume percent changes at 6-month post treatment plotted against ipsilateral (orange) and contralateral (blue) lobar volume (left) and total blood volume (right) percent changes in subjects that underwent Endobronchial valve treatment.

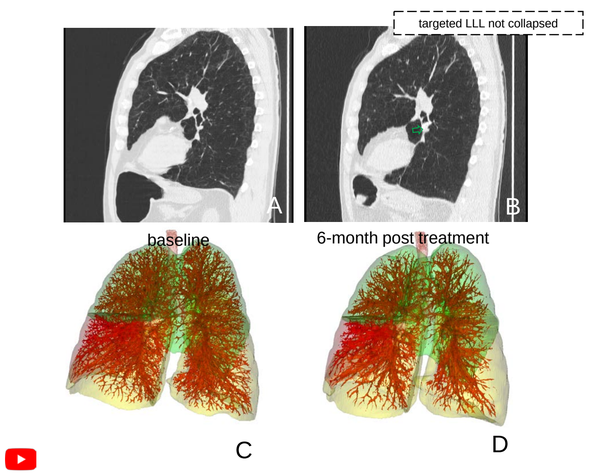

Figure 3. Sagittal view of left lung at baseline (A) and 6-month post treatment (B) with corresponding lobar and vascular segmentation rendering (C,D). Targeted left lower lobe (LLL) did not collapse at follow-up scan, due to incomplete fissure. EBV visible in sagittal view (green arrow).

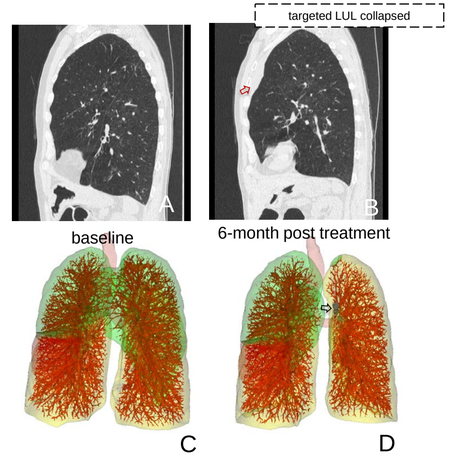

Figure 4. Sagittal view of left lung at baseline (A) and 6-month post treatment (B) with corresponding lobar and vascular segmentation rendering (C,D). Targeted left upper lobe (LUL) collapsed at follow-up (red arrow). EBV visible in rendering (black arrow).

Conclusion

Our results suggest within the treatment group, a 1% targeted lobar volume reduction leads to 0.4% and 0.3% increase in ipsilateral non-targeted lobar volume and blood volume, respectively. These findings underscore the benefits of EBV treatment in enhancing both ventilation and perfusion in the treated lungs.

References

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lobar and vascular volume, and animation available via top right QR code.