Endoscopic volume reduction before or after lung transplantation

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Abstract

Endobronchial valve therapy in patients with severe emphysema achieves similar clinical benefits to lung volume reduction surgery without the potential morbidity. We report successful endobronchial valve treatments in two patients with severe emphysema. Valves were placed in the first patient 5 months before lung transplantation and in the second patient 10 years after lung transplantation, using a flexible bronchoscope under local anaesthesia. The objective was to reduce pulmonary hyperinflation and improve lung function. The potential benefit of this procedure was anticipated by lobar collateral ventilation measurements. Two months later, forced expiratory volume in 1 s, forced vital capacity and dyspnoea improved in both cases.

Keywords: Emphysema • Bronchoscopic volume reduction • Lung transplantation • Collateral ventilation • Computed tomography scan

INTRODUCTION

Severe emphysema is a progressive disease with no curative treatment. At an advanced stage, lung volume reduction by surgery \cite{1} or single lung transplantation (SLT) are options in selected cases. After SLT for emphysema, static and dynamic hyperinflation of the native lung was regarded as a risk until initial encouraging reports. A less invasive and safer procedure than surgery is the use of unidirectional endobronchial valves (EBVs), which have shown some effectiveness either before or after lung transplantation \cite{2,3}. These one-way valves prevent air from entering the blocked emphysematous segment, while allowing the venting of expired gas and secretions, leading to atelectasis with subsequent reduction in lung volume, thereby allowing healthier regions to function more efficiently \cite{3}. Here, we report the successful use of EBVs in two patients with emphysema, one before lung transplantation and one after. The benefit was predicted by measurement of collateral ventilation by bronchial blocking with balloons \cite{4}.

CASE REPORT 1

A 63-year-old man with a history of smoking-related emphysema, currently non-smoking, had New York Heart Association (NYHA) class IV breathlessness. Body mass index (BMI) was 19 kg/m\textsuperscript{2}, with a forced expiratory volume in 1 s (FEV\textsubscript{1}) of 0.77 l (30\% of predicted), resulting in a severe chronic respiratory failure. In January 2010, using dedicated software (Myriam\textsuperscript{2}; Intrasens, Paris, France), measurement of left upper lobe volume was 2461 cm\textsuperscript{3}, of which 67\% was below -950 Hounsfield units on computed tomography scanning and was considered as emphysematous lung. No collateral ventilation in the left upper lobe was demonstrated using Chartis\textsuperscript{5} balloon occlusion (Pulmonx, Redwood City, A, USA). Therefore, two valves (Zephyr\textsuperscript{5.5}; Pulmonx) were placed using flexible endoscopy into both culmen and lingula bronchi after sedation and under local anaesthesia. No complications, such as pneumothorax, haemoptysis or infection, occurred after the procedure.

The volume reduction was achieved, because atelectasis was observed on X-rays (Fig. 1a and b). Two months later, BMI had increased from 19 to 22 kg/m\textsuperscript{2}, FEV\textsubscript{1} had increased by 0.3 l to reach 1.17 l (48\% predicted), forced expiratory vital capacity had increased by 1 l to reach 2.86 l (91\% of predicted) and total lung capacity had decreased from 8.81 (148\% of predicted) to 6.39 l (108\% of predicted) without any clinical benefit in dyspnoea. Five months later, due to low arterial partial pressure of O\textsubscript{2} with no clear relief in dyspnoea, we decided to offer lung transplantation. The transplant was done the right side because SLT is easier on the right side and the risk of native lung hyperinflation was avoided using the left EBV. At 1 year post-transplantation, the patient was evaluated as NYHA class I and was walking 6 km per day, and the FEV\textsubscript{1} was 2.36 l.

CASE REPORT 2

A 67-year-old man with respiratory failure due to smoking-related emphysema benefited from left SLT in 2001. Ten years

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later, he was again dyspnoeic at NYHA class IV, the BODE index (BMI, airflow Obstruction (FEV1), Dyspnoea (Modified Medical Research Council Dyspnea scale), Exercise capacity (6-min Walk Distance)) was 8, FEV1 0.73 l (31% of predicted) and forced expiratory vital capacity 1.21 l (39% of predicted), owing to moderate bronchiolitis obliterans syndrome stage 2 complicated by right native lung hyperinflation with an anterior transmediastinal hernia from the upper right lobe, with destruction of 54 and 72% of the upper and middle lobes, respectively. Collateral ventilation was present in the right upper lobe, as a consequence of an incomplete minor fissure. Consequently, it was decided to place one valve (Zephyr® 5.5; Pulmonx) into the right upper lobe bronchus and one into the right middle lobe bronchus using flexible endoscopy under sedation and local anaesthesia. No complication occurred.

After 2 months, NYHA dyspnoea score was II, BMI 23 kg/m², and BODE decreased from 8 to 5. There was an improvement of 0.63 l in forced expiratory vital capacity to reach 1.84 l (56% of predicted) and of 0.29 l in FEV1 to reach 1.02 l (41% of predicted), with reduced right upper and middle lobe volumes on radiography post-procedure (Fig. 1c and d). Unfortunately, the patient died 7 months later as a result of left lung graft infection without evidence of infection in the native lung where insertion of EBVs was performed.

**DISCUSSION**

In both cases presented, EBVs were placed in two patients using bronchoscopy under local anaesthesia. The clinical benefits were an improvement in lung volumes for both patients, as shown by an increase in forced expiratory vital capacity 2 months later, without any complication. Favourable results of EBV placement were predicted by measurement of heterogeneity and collateral ventilation [4]. Indeed, results of an update in 2010 suggest that the bronchoscopic strategies achieve results similar to lung volume reduction by surgery, with lower mortality and lower costs [3]. EBVs may have a role in emphysema, either before or after lung transplantation. First, EBVs may improve functional status and help patients with end-stage emphysema to reach transplantation in the best possible condition in terms of BMI, physical activity and lung function [5]. Second, EBVs play a role in the treatment of native lung hyperinflation after an SLT [3].

Assessment of collateral ventilation and/or the presence of complete interlobar fissures by computed tomography are essential prerequisites to ensure the occurrence of atelectasis after EBVs, with 90% correlation between pre- and post-procedure findings [4]. As used in these cases, the bronchial occlusion balloon system, described by Gompelmann et al., was used with success [4]. In addition, the following characteristics predictive of success have been described to enable selection of patients with the highest probability of functional responses: greater heterogeneity of emphysema between lobes on computed tomography quantification; low baseline exercise capacity; and predominantly upper lobe emphysema [3].

In conclusion, these observations suggest that EBVs have a role in the treatment of patients with severe emphysema before or after transplantation and that imaging and functional criteria predictive of success may be useful [4].

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**REFERENCES**


