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Abstract

In the treatment of emphysema with an endobronchial valve, entire lobar treatment is important in achieving adequate atelectasis. This case illustrates that without treatment of the entire lobe, it can fail to collapse even after several years, leading to treatment failure. Intralobar collateral ventilation through the pores of Kohn is demonstrated in this case, as endobronchial valve blockage of the remaining patent anterior segment resulted in the desired atelectasis and significant improvements in pulmonary function.

Keywords

Lung, Prostheses and implants, Pulmonary alveoli, Pulmonary emphysema

Introduction

Endobronchial valve (EBV) placement is increasingly being recognized as an alternative approach for treating patients with severe heterogeneous emphysema.¹ The success of EBV therapy is dependent on the ability of the valves to cause the emphysematous areas of the lung to collapse. The presence of collateral ventilation between segments within the same lobe or even between lobes of the lung can impede this process. We describe a case that dramatically illustrates the importance of inter-segmental collateral ventilation in determining lung collapse following EBV placement, and how the previous failed treatment was rectified successfully with a single EBV.

Case report

A 76-year-old male ex-smoker, with known severe emphysema, was referred for further EBV placement. He had previously had bilateral EBV insertions in 2007 in another institute. High-resolution computed tomography confirmed the presence of 3 EBV distributed within the left upper lobe proper and lingular segmental bronchi, causing total left upper lobe collapse, and 2 EBV within the apical and posterior segments of the right upper lobe bronchi, but none in the anterior segment of the right upper lobe. There was no associated lobar or segmental collapse or consolidation of the

right upper lobe. The patient was apparently told in 2007 that the physician had failed to reach the right upper lobe anterior segmental bronchi to place the EBV. The current pulmonary function tests showed forced expiratory volume in 1 s was 0.53 L (19.6% of predicted) with no post-bronchodilator change, forced vital capacity was 1.5 L (40.2% of predicted), the residual volume was 3.07 L (192% of predicted), and the diffusing capacity of lung for carbon monoxide was 9.8 mL mm Hg⁻¹ min⁻¹ (39% of predicted). The patient underwent EBV (Pulmonx Zephyr, CA, USA) insertion into the right upper lobe anterior segmental bronchi. General anaesthesia was administered with single-lumen intubation but allowing for spontaneous breathing by the patient in order to perform Chartis Pulmonary Assessment System (Pulmonx, CA, USA) detection of collateral ventilation (Figure 1). Following sizing of the EBV with the measuring wings, a large size 5.5 valve was successfully deployed within the right upper lobe anterior segmental bronchi (Figure 2). Postoperative chest radiography showed

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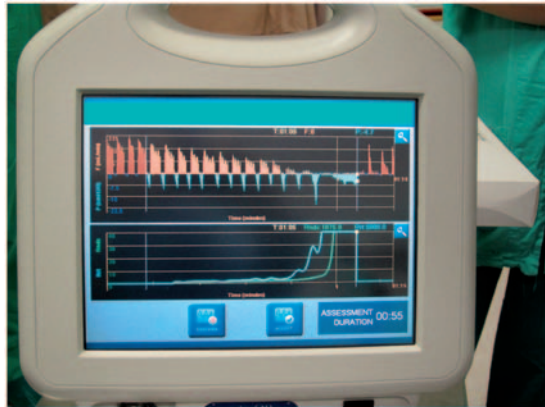


Figure 1. The Chartis Assessment System confirming no significant collateral ventilation in the right upper lobe following occlusion of the anterior segmental bronchus.



Figure 2. The endobronchial valve deployed in the anterior segmental bronchus, with the valve opening to allow collapse of the right upper lobe.

right upper lobe collapse (Figure 3). The patient made a good recovery and was discharged home on postoperative day 2. Pulmonary function tests at 6 months after the procedure showed forced expiratory volume in 1 s was 0.87 L (34% of predicted), forced vital capacity was 2.55 L (72% of predicted), the residual volume was 3.05 L (211% of predicted), and the diffusing capacity of lung for carbon monoxide was $9.7 \text{ mL mm Hg}^{-1} \text{ min}^{-1}$ (41% of predicted) with significant improvement in exercise tolerance.

Discussion

Endobronchial valve replacement is now an accepted therapy for selected patients with end-stage emphysema. By placement of EBV bronchoscopically into the most emphysematous areas of the lung, air is prevented from entering those segments, while the one-way valves allow expiration of air, the net result being atelectasis of the most emphysematous segments, redirection of air flow to the less emphysematous parts of the lung, reduced diaphragmatic splinting, and improved chest wall dynamics. The expected improvement in terms of forced expiratory volume in 1 s for single-lobar occlusion by EBV has been reported to be from around 10% to more than 40%.^{1,2} Furthermore, EBV therapy may allow sufficient improvement in lung function to reduce the risk of surgery or even allow patients previously denied surgery to undergo other forms of major surgical therapy.³

From early experience, it can be observed that the physiological and radiological improvements are more prominent in patients who have one entire lobe treated compared to those with 1 or 2 segments treated.²

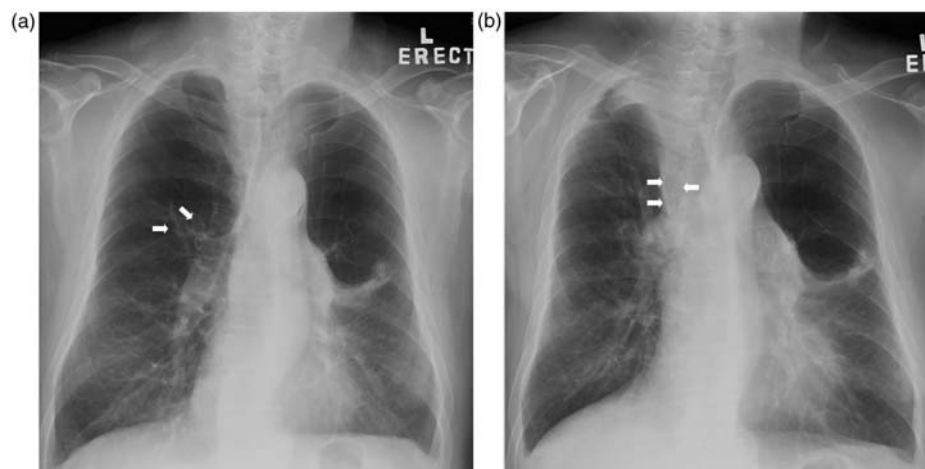


Figure 3. (a) Preoperative chest radiograph showing an inflated right upper lobe and positions of the 2 endobronchial valves (arrows) and (b) Chest radiograph on postoperative day 1, showing a totally collapsed right upper lobe with 3 endobronchial valves (arrows).

The failure of the most diseased lobe or area to develop atelectasis may be due to collateral ventilation through the pores of Kohn.⁴ These are microscopic channels that allow the passage of air between neighboring alveoli, segments, and even lobes of the lung, particularly in the presence of incomplete interlobar fissures. The development of the Chartis system has aided in identifying the presence of lobar collateral ventilation to improve outcome.⁵ Its use in this patient reassured us about the decision to deploy the EBV to block off the remaining segment of right upper lobe. This case demonstrated treatment failure in a patient who only received 2 EBV to 2 segments of the right upper lobe, and shows that even after several years, the right upper lobe failed to collapse due to inter-segmental collateral ventilation. Furthermore, placement of a single EBV to block off the remaining segmental bronchus in such circumstance can result in dramatic clinical benefits, even if performed after a long latent treatment period.

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Conflict of interest statement

None declared

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