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Endobronchial one-way valve for persistent air leak and lung volume reduction

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Abstract

There are randomized controlled study data showing that endobronchial one-way valves (EBV) are useful for bronchoscopic lung volume reduction (BLVR). There is also case series data showing EBV to be effective in stopping persistent air leaks complicating pneumothoraces. We describe a 66-year-old man with severe chronic obstructive pulmonary disease (COPD) who failed assessments for BLVR because of the inability to perform the carbon monoxide diffusion test but subsequently had EBV deployed to his right upper lobe bronchi for persistent air leak complicating a spontaneous pneumothorax. Afterwards, there was subjective improvement in breathlessness, exercise capacity, and reduced frequency of exacerbations requiring hospitalization. Lung function parameters showed marked improvement. This case suggests that patients with compatible spirometric lung volume and computed tomography findings should proceed with BLVR. In addition, one should be aware of the possibility of improved lung function in patients with pulmonary emphysema following implantation of EBV for persistent air leak.

Introduction

In the wake of the high perioperative morbidity and mortality associated with lung volume reduction surgery (LVRS) for severe pulmonary emphysema, bronchoscopic lung volume reduction (BLVR) using endobronchial one-way valves (EBV) was proposed as one of the safer means to achieve similar clinical benefits. A randomized controlled trial showed that EBV treatment was of modest benefits in terms of force expiratory volume in 1 second (FEV1) and 6-min walk distance [1]. A subsequent trial with patients having intact interlobar fissures and heterogeneous emphysema showed significant improvement in lung function and exercise capacity at 3 months post-procedure [2].

Another clinical use of EBV is treating prolonged air leak in the pneumothorax of various aetiologies. We have reported a retrospective case series on the use of EBV in treating prolonged air leak complicating spontaneous pneumothorax [3]. Only 22% of attempted cases had cessation of air leak within 72 h after EBV implantation, and intact interlobar fissures appear to be necessary for success [3].

Here, we report a patient with severe chronic obstructive pulmonary disease (COPD) and persistent air leak complicating spontaneous pneumothorax, who was successfully treated with EBV implantation and with subsequent marked improvement in lung function.

Case Report

The patient was a male smoker in his 60s who presented with acute exacerbation of COPD (AECOPD) in May 2012. Subsequently, he was started on inhaled corticosteroids, long-acting beta agonist, long-acting muscarinic agent, and pulmonary rehabilitation but still required frequent admission to hospital for AECOPD. On several such occasions, short periods of non-invasive ventilation were needed. In November 2013, he was found to have resting hypoxaemia in a stable clinical state and was put on long-term domiciliary oxygen therapy. Post-bronchodilator

FEV1 was 0.66 L (22% predicted); total lung capacity (TLC) was 10.32 L (182% predicted), and residual volume (RV) was 7.85 L (400% predicted). The 6-min walking distance was 240 m. In 2014, he underwent assessment for BLVR by EBV but was ineligible as he was unable to perform the carbon monoxide diffusion study.

In September 2015, he was admitted for severe shortness of breath, and chest radiograph (CXR) showed a right pneumothorax. In the previous 2 years, he was admitted eight times for AECOPD. A chest tube was inserted with subsequent satisfactory lung expansion. However, there was continuous bubbling observed in the chest drainage bottle. Sputum grew *Haemophilus influenzae* resistant to amoxycillin-clavulanate, and he was treated with levofloxacin. Meanwhile, air leak persisted despite talc pleurodesis performed thrice at intervals. Computed tomography (CT) of the thorax showed right pneumothorax with intact lung fissures bilaterally. CT thorax performed in 2014 during assessment for BLVR showed severe, non-bullous centrilobular emphysema, predominantly in both upper lobes (Fig. 1). Finally, in November 2015, 49 days after initial presentation, bronchoscopy was performed and showed air leak via the right upper lobe bronchus. Each of the three segmental bronchi had one EBV deployed, and air leak stopped immediately. Post-procedure CXR showed collapse of right upper lobe with no pneumothorax (Fig. 2A,B). The chest tube was removed the next day, and the patient was discharged from hospital after 2 weeks of inpatient rehabilitation.

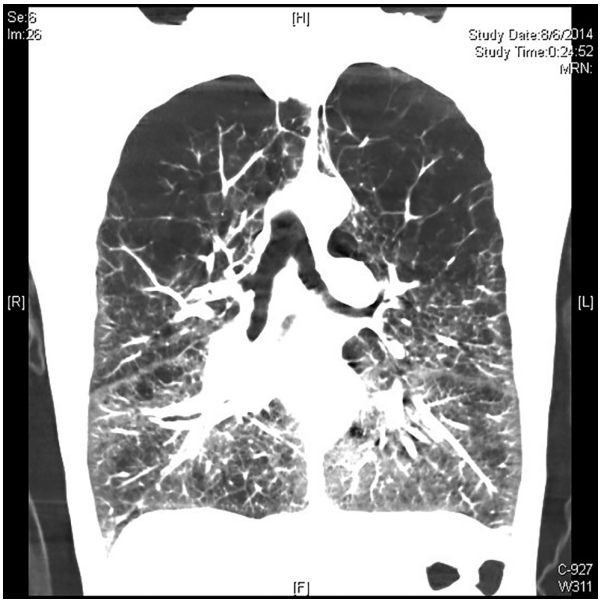

Figure 1. Frontal view of computed tomography (CT) thorax showing predominant upper lobe emphysema.

During medical follow up, the patient reported significant improvement of breathlessness and exercise tolerance compared to before the pneumothorax episode. The EBVs were hence allowed to remain in situ. Post-bronchodilator FEV1 in August 2016 was 1.14 L (42% predicted); TLC was 7.96 L (145% predicted), and RV was 4.51 L (235% predicted). A repeat of 6-min walking distance was not performed. Subsequent CXR showed further collapse of the right upper lobe (Fig. 2C,D). At the time of writing, the patient is attending regular follow up at our clinic and was admitted four times for AECOPD since EBV insertion (over a period of 3.5 years, an average of 1.14 admissions per year).

Discussion

Our patient had an unintentional lung volume reduction brought about by deployment of EBV for a different indication. This was followed by marked subjective improvement in breathlessness, exercise tolerance, general well-being, and sustained reduction of hospital admission for AECOPD. Lung function assessed 9 months after the procedure showed improvement in FEV1 of 0.48 L (73%), reduction in TLC of 2.36 L (22.9%), and reduction in RV of 3.34 L (42.5%). These rather marked improvements are probably the result of the almost-complete lobar atelectasis achieved and are consistent with the findings of Hopkinson et al., who showed superior improvement in lung function parameters in patients with radiological atelectasis following BLVR with EBV [4].

During screening for BLVR using EBV for this patient in 2014, we adopted the exclusion criteria of a carbon monoxide diffusing capacity of less than 20% by Sciurba et al. [1]. As our patient failed the test, he was unable to proceed. Incidentally, this exclusion criterion appears to originate from the National Emphysema Treatment Trial Research Group report showing that such patients are at significantly higher risk of mortality following LVRS [5]. However, BLVR has a much lower peri-procedure mortality and morbidity rate, and whether the safety data for LVRS are appropriate for BLVR is questionable. Indeed, in the subsequent trial by Davey et al. published in 2015, specific lower limits of lung function as exclusion criteria were abolished [2].

This case suggests that, if spirometric lung volumes and CT indices are favourable for BLVR using EBV, unavailability of diffusion study data should not prevent the patient from proceeding with it. Furthermore, physicians should look for clinical and lung function improvement in COPD patients successfully treated with EBV for persistent air leak and should withhold removal of the EBVs if such is found.

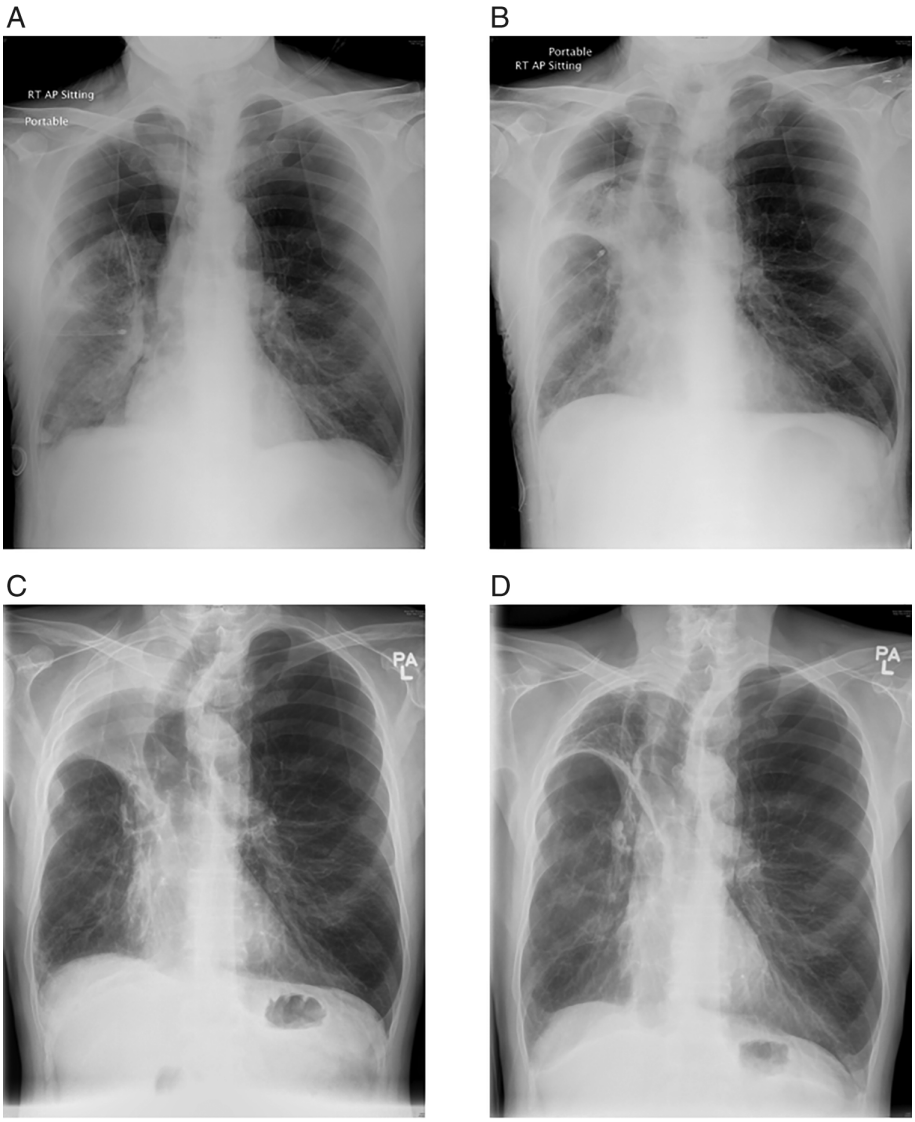

Figure 2. Chest radiograph at different time points. (A) immediately before endobronchial one-way valves (EBV) insertion. (B) immediately after EBV insertion. (C) 5 weeks after EBV insertion. (D) 40 months after EBV insertion.

Disclosure Statement

Appropriate written informed consent was obtained for publication of this case report and accompanying images.

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