

# Endobronchial valve to treat large bulla at right middle lobe in chronic obstructive pulmonary disease patients

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**Abstract:** We have used endobronchial valve (EBV) to treat large bulla at right middle lobe (RML) on three chronic obstructive pulmonary disease (COPD) patients and presented the clinical datum of three COPD patients with RML bulla. The improvement of lung function was significant on two patients, whose lung parenchyma was preserved well in lobes other than RML. On one patient, whose lung function did not show improvement after EBV treatment, the parenchyma of bilateral lungs was destructed heavily by chronic inflammation of COPD, and the RML bulla did not collapse because right major and/or minor fissures are incomplete. EBV may be used to treat large RML bulla in selected patients, whose parenchyma of other parts of the lung was conserved well and right major and minor fissures are complete.

**Keywords:** Endobronchial valve (EBV); bulla; chronic obstructive pulmonary disease (COPD)

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The large bulla is a complication of chronic obstructive pulmonary disease (COPD) that has been shown to have detrimental effects on lung function of COPD patients, such as decreased forced expiratory volume in 1 s (FEV<sub>1</sub>), increased total lung capacity (TLC) and functional residual capacity (FRC), and a reduction of diffusing capacity of the lung for carbon monoxide (DLCO) (1,2). Recently, in a prospective, non-randomised and single centre study, endobronchial treatment with one-way valve [Endobronchial valve (EBV), Zephyr<sup>®</sup>, Pulmonx, Inc., Palo Alto, Calif., USA] was showed to be a safe and effective alternative to treat severe bullous emphysema (3). However, in our previous case series of five COPD patients with bulla, only one had a right middle lobe (RML) bulla which showed sustained improvement in lung function up to six months after EBV treatment (4). To test the effectiveness of EBV to treat large RML bulla, we now present the clinical datum of three COPD patients with large RML bulla, who were treated using EBVs.

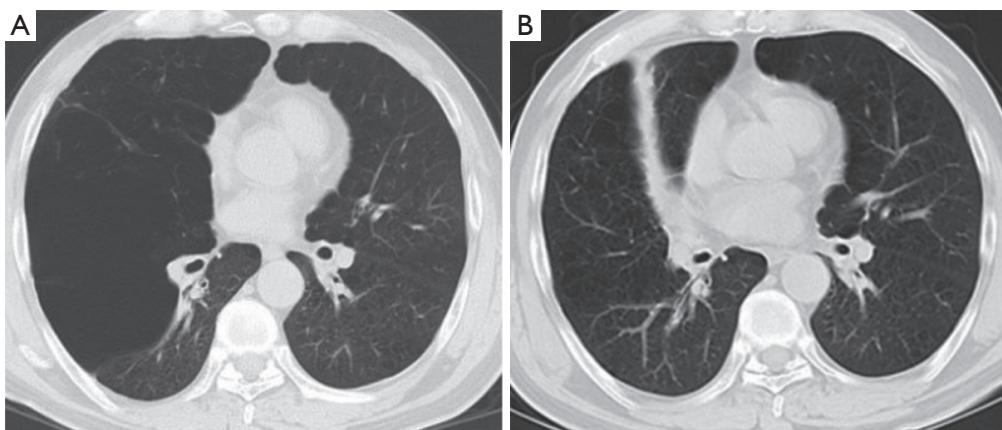
## Clinical summaries

### Patient 1

A 52-year-old male, who has a 35-pack-year smoking history, was presented to our respiratory department with worsening dyspnea for 5 years. He has compromised pulmonary function while FEV<sub>1</sub> was 1.07 L (35.4% predicted) and residual volume (RV) was 5.37 L (215.8% predicted). The chest computed tomography (CT) revealed a large RML bulla and complete left major and minor fissure. One EBV (size 5.5 mm) was inserted in the RML bronchus. One month and 6 months after the treatment, the lung function tests showed that FEV<sub>1</sub> improved to 1.27 L (38.9% predicted) and 1.75 L (57.7%), respectively. Chest CT revealed disappearance of the bulla and atelectasis of RML 6 months after EBV deployment (Figure 1).

### Patient 2

A 66-year-old female consulted at the COPD clinic because



**Figure 1** Chest CT before and after the EBV treatment in patient No. 1. (A) A giant bulla occupied the whole RML before EBV treatment; (B) the bulla disappeared and RML collapsed 6 months after EBV deployment. CT, computed tomography; EBV, endobronchial valve; RML, right middle lobe.

of shortness of breath with exertion for 6 years. She is an ex-smoker with a 20-pack-year smoking history. Her severe airflow limitation was manifested by reduced  $FEV_1$  (0.71 L, 38.3% predicted). CT of chest showed a large bulla and severe destruction of lung tissue associated with emphysema in RML. Airways leading to the RML were occluded using one valve (size 4.0 mm). At follow-up visits, lung function test revealed  $FEV_1$  rose to 1.01 L (54.0% predicted) 1 month after EBV treatment to 1.03 L (55.2% predicted) 6 months after EBV treatment. Chest CT showed disappearance of the bulla and atelectasis of RML (Figure 2).

### Patient 3

A 50-year-old male smoker was evaluated for chronic shortness of breath. He was diagnosed of COPD 15 years before, and in the last 2 years he has been hospitalized for 3 times to receive treatment for acute exacerbation of chronic obstructive pulmonary disease (AECOPD) and respiratory failure. Before the admission,  $FEV_1$  was 0.74 L (19.7% predicted). CT scan showed a large bulla at the position of RML. One valve was placed in RML attempting to close the bulla. The  $FEV_1$  has no significant alteration after EBV implantation, with  $FEV_1$  0.77 L (20.3%, predicted) and 0.83 L (21.9%, predicted), at 1 month and 6 months after EBV treatment, respectively. The volume of the bulla didn't change (Figure 3).

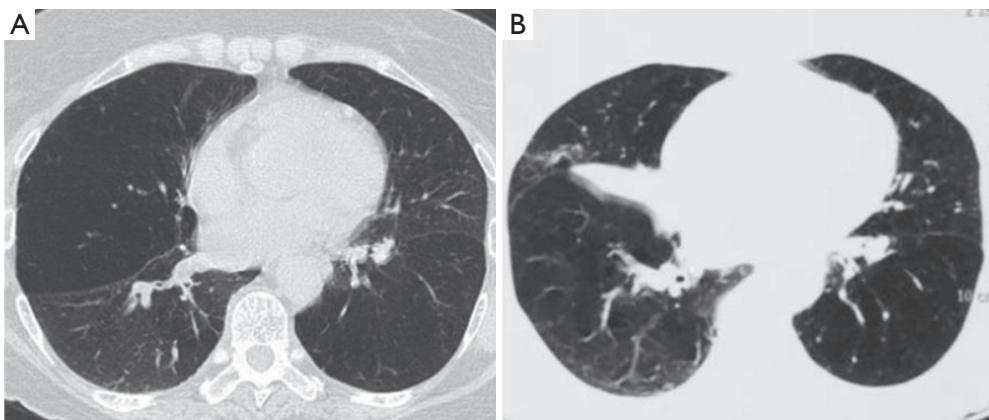
### Discussion

To our knowledge, this is the first report of usage of EBV

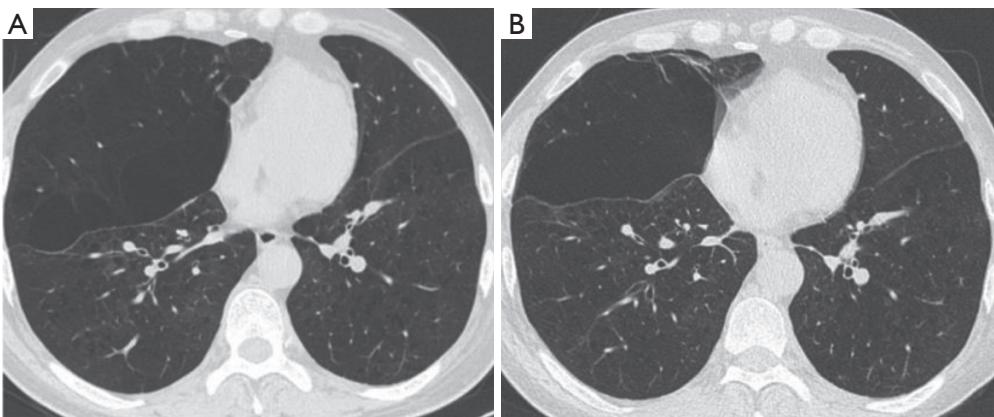
to treat large RML bulla, although there were several studies of EBV treatment of bulla in COPD patients (3,5,6). In this study, the improvement of lung function was significant on two patients, whose lung parenchyma was preserved well in lobes other than RML. At the same time, right major and minor fissures were intact on these two patients, which were evidenced by the RML atelectasis after EBV treatment. On the third patient, whose lung function did not show improvement after EBV treatment, the parenchyma of bilateral lungs was destructed heavily by chronic inflammation of COPD, and the bulla of RML did not collapse because right major and/or minor fissures are incomplete.

As illustrated by the first two cases, the isolated large bulla of RML can exist when rest part of lung parenchyma conserved well. This imbalance of lung destruction between RML and rest part of the lung could be explained by the anatomy of right middle bronchus and pathophysiology of COPD: for the right middle bronchus is slimmer and longer than other bronchus, it may experience narrowing even partial collapse at the expiration, meaning that small air trap may exist in the RML. As a consequence, bulla developed in the RML with long-term air trap.

It is obvious that this study has several limitations. Firstly, the patient population is too small to make definite conclusion whether EBV is efficient to treat large RML bulla. Secondly, more detailed clinical data, such as exercise capacity [e.g., 6 minutes walking test (6MWT)] and quality of life [e.g., COPD assessment test (CAT) or ST-George Respiratory Questionnaire (SGRQ)], are of absence in this study.



**Figure 2** Chest CT before and after the EBV treatment in patient No. 2. (A) A giant bulla located in the RML before EBV deployment; (B) the bulla vanished at 6 months after EBV treatment. CT, computed tomography; EBV, endobronchial valve; RML, right middle lobe.



**Figure 3** CT imaging before and after the EBV treatment in patient No. 3. (A) CT scan showed a bulla at the position of RML; (B) the volume of RML displayed a slight decrease at 6 months after EBV deployment. CT, computed tomography; EBV, endobronchial valve; RML, right middle lobe.

In conclusion, EBV may be used to treat large RML bulla in selected patients, whose parenchyma of other parts of the lung was conserved well and right major and minor fissures are complete.

#### Acknowledgements

None.

#### Footnote

*Conflicts of Interest:* The authors have no conflicts of interest to declare.

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