

# Successful Bronchoscopic Lung Volume Reduction Using Endobronchial Valve for Severe Right Lower Lobe Emphysema.

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## ABSTRACT

Chronic obstructive pulmonary disease is a common disease worldwide. Most patients with advanced chronic obstructive pulmonary disease will only receive maximum inhaler therapy plus other non-pharmacological treatments (vaccination, pulmonary rehabilitation, oxygen therapy). Bronchoscopic lung volume reduction by endobronchial valve insertion is an option available in interventional pulmonology centres for eligible patients. We report a 72-year-old man with severe airflow limitation plus hyperinflation and air trapping who received endobronchial valve insertion in the right lower lobe. His residual volume reduced remarkably from 14.1L (778%) to 5.57L (292%) following 1 year with symptomatic improvement which was sustained after 2 years follow-up. In conclusion, bronchoscopic lung volume reduction by endobronchial valve insertion is a treatment option for advanced chronic obstructive pulmonary disease patients on maximal medical therapy. It may achieve the same effect on respiratory function as lung volume reduction surgery, but without the added disadvantages of morbidity and mortality associated with surgery.

**Keywords :** Bronchoscopic lung volume reduction, chronic obstructive pulmonary disease, endobronchial valve, lung volume reduction surgery

## INTRODUCTION

Bronchoscopic lung volume reduction (BLVR) by endobronchial valve (EBV) insertion for severe emphysema was first published in 2003 by Toma et al.<sup>1</sup> EBV is placed in the most emphysematous part of the lung with the aim to induce partial atelectasis. Once deployed, the one-way valve allows trapped air in the diseased part to escape but prevents influx of airflow. Reduction of lung volume improves lung mechanics thus enabling better gaseous exchange. BLVR in predominant upper lobe emphysema is well estab-

lished, however its use in lower lobe emphysema is unclear.<sup>2</sup> Our patient had EBV placed in the right lower lobe (apical, medial, anterior, lateral and posterior segment) with successful result. Currently in Serdang Pulmonology Unit, symptomatic chronic obstructive pulmonary disease (COPD) patients with FEV1 of 15%-45% predicted and residual volume greater than 175% predicted are eligible for assessment of EBV insertion. As of June 2017, 14 patients with severe COPD had received EBV insertion. However, with further studies, we should consider changing our practice to offer EBV insertion to COPD patients whose residual volumes are greater than 150%.<sup>2-4</sup> This case highlights the service availability of managing advanced COPD cases whereby

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predominant lower lobe emphysema is not a contraindication for BLVR.

### Case Report

A 72-years-old man was diagnosed with COPD since the age of 65. He is an ex-smoker of 75 pack years and has been under our regular follow-up since 2011. He has persistent cough with phlegm and reduced effort tolerance. The Modified Medical Research Council (MMRC) dyspneic score was 3 and he could not climb more than 6 steps of stairs. Being a grocery shop owner, he could no longer drive his mini-lorry, as he was too weak to handle the steering wheel. During follow-up, he had received various inhalers in a step-wise pattern. His inhaler therapy prior to intervention includes salmeterol/fluticasone (50/250) twice daily and tiotropium spiriva respimat® 5mcg once daily where he was compliant and showed good inhaler technique. Newer inhaler combinations were not available back then.

The patient had 10 visits to the emergency department for nebulisations and 3 admissions for acute exacerbation of COPD between 2011 and 2013. The COPD assessment tool (CAT) score was persistently more than 20. He attended pulmonary rehabilitation which resulted in modest symptomatic improvement. He received pneumococcal vaccination and yearly influenza vaccinations. Physical examination revealed evidence of generalised muscle wasting with BMI of 17kg/m<sup>2</sup> and generalised reduced breath sounds bilaterally. There were no signs of heart failure.

Initial respiratory function test (Table 1) in September 2013 showed severe airflow limitation (FEV1 0.67L / 30% predicted, FEV1/FVC ratio 56%). There was also hyperinflation (total lung capacity 16.1L / 341% predicted) and air trapping (residual volume - 14.7L / 778% predicted). The gas transfer

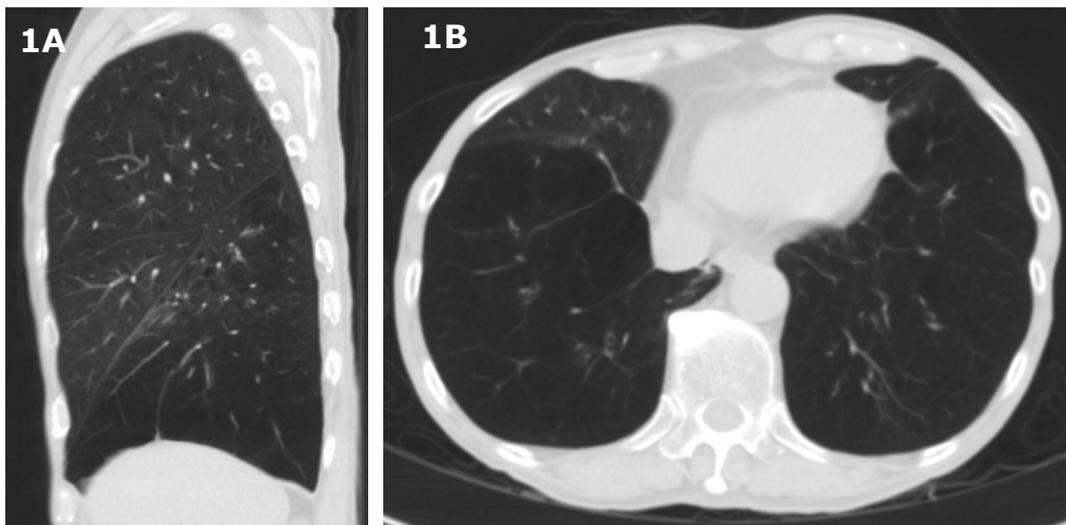
**Table 1: Serial general respiratory function test pre and post EBV insertion.**

	Pre EBV insertion (Sept 2013)	11 months post EBV insertion (Feb 2015)	15 months post EBV insertion (Jun 2015)
<b>FEV1 (L)</b>	0.67 (30%)	1.19 (52%)	1.2 (54%)
<b>FVC (L)</b>	1.19 (67%)	2.40 (73%)	2.35 (72%)
<b>TLC (L)</b>	16.2 (341%)	6.36 (134%)	7.95 (168%)
<b>RV (L)</b>	14.73 (778%)	3.95 (209%)	5.57 (292%)
<b>DLCO Adj</b>	7.9 (67%)	9.9 (83%)	8.2 (69%)

FEV1 : Forced expiratory flow at 1 second, FVC : Forced vital capacity, TLC : Total lung capacity, RV : Residual volume, DLCO Adj : Corrected gas transfer for haemoglobin.

coefficient is reduced consistent with emphysemasema. Chest x-ray (CXR) revealed hyperinflated lungs with flattening of both hemidiaphragms. High resolution computed tomography (HRCT) of the chest showed heterogeneous emphysema predominantly in the lower lobes with complete fissures bilaterally (Figure 1). Alpha-1 anti-trypsin levels were normal.

A decision was made for BLVR by EBV insertion targeted towards the right lower lobe. This procedure was performed in March 2014. Airway was secured via rigid intubation and no collateral ventilation detected using the Chartis system. Three zephyr® EBVs; 2 units size 4, 1 unit size 5.5 (Figure 2A) were deployed at the right lower lobe at subsegment apical (RB6), medial (RB7), anterior (RB8), lateral (RB9) and posterior (RB10) using the zephyr® endobronchial delivery catheter (Figure 2B). In comparison with pre-procedural chest X-ray (Figure 3A), immediate CXR post procedure (Figure 3B) showed doming of the right hemidiaphragm indicating successful BLVR. Patient was observed for 72 hours before discharge and did not develop any complications particularly pneumothorax. On review 1 month later, he showed remarkable improvement of his symptoms. Gradually he regained his strength. He is able to drive, leave his house confidently and is able to



**Figure 1: HRCT Thorax right sagittal view (Figure 1A) and axial view (Figure 1B) showing heterogenous emphysema with lower lobe predominance and complete fissures. (Please click on image to enlarge)**

climb 15 steps of stairs. His CAT score was 8. He had no visits to the emergency department or admissions for COPD in 2014. Eleven months later, repeat general respiratory function test showed significant improvement of airflow limitation, hyperinflation and air trapping (Table 1). Residual volume had improved by 62% and FEV1 had improved by 79% during his current review with sustainable symptomatic improvement.

## Discussion

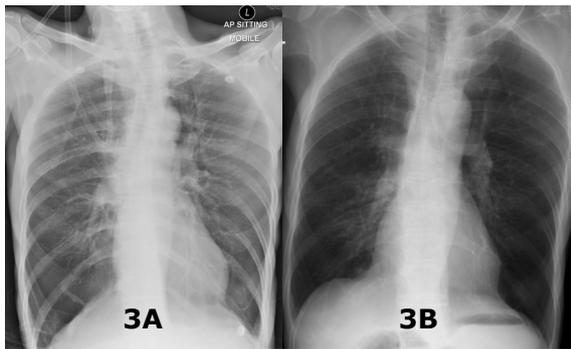
BLVR by EBV insertion is one of the emerging interventional pulmonology treatment modalities available for advanced COPD apart from insertion of endobronchial coils. However, there are limitations which include lack of specialised skills and exorbitant costs resulting in eligible patients denied of this procedure. Prior to the availability of EBV insertion, eligible patients based on NETT protocol

would have had the option for LVRS. However, clinicians would find EBV insertion more desirable than surgical LVRS as the latter is associated with longer length of hospital stay and increased perioperative mortality despite absence of comparable trials between the two. In the latest Global Initiative for Chronic Obstructive Lung Disease (GOLD) 2017 guideline, the updated recommendation have included usage of EBV as a treatment option for advanced emphysema without collateral ventilation. These interventions improve exercise tolerance, health-status, lung function 6-12 months following treatment and reduce end-expiratory lung volume.<sup>5</sup>

At present, inclusion criteria for EBV insertion in Serdang Pulmonology Unit are FEV1 of 15-45% predicted, residual volume greater than 175% predicted and HRCT scan showing heterogenous emphysema with complete fissure. Fifteen patients in our hospital were excluded despite meeting respiratory function criteria as they had incomplete fissure on HRCT. Our inclusion criteria using residual volume greater than 175% is almost similar to a study carried out by Herth et al.<sup>6</sup> However, there are other trials such as NETT, BeLieVeR-HiFi and STELVIO that enrolled pa-



**Figure 2: Endobronchial valves of different sizes used for the bronchoscope lung volume reduction (Figure 2A) deployed using the endobronchial delivery catheter (Figure 2B). (Please click on image to enlarge)**



**Figure 3: CXR pre EBV insertion showing hyperinflation of the lung with flattening of both hemidiaphragm (Figure 3A). CXR 2 hours post EBV showing doming of the right hemidiaphragm (Figure 3B). (Click on the image to enlarge)**

tients with residual volumes of greater than 150% predicted.<sup>2-4</sup>

EBV will be deployed once fissure integrity is determined using signals by the Chartis system.<sup>7</sup> It can be deployed either by conscious local sedation or through rigid bronchoscopy following general anesthesia. We prefer to do it via rigid bronchoscopy as one could not predict the anatomical variation that a patient may have. Coughing as a result of irritation to the bronchial wall during procedure complicates the matter and this can be overcome by performing it in a relaxed controlled situation under general anaesthesia. Nevertheless, mode of the EBV deployment depends on the bronchoscopist's preference.

Following the procedure, patients need to be observed as pneumothorax is an expected complication due to rapid total lung reduction. The median time of the onset of pneumothorax to EBV insertion is 2 days.<sup>6</sup> It is believed that pneumothorax may be an indicator of successful EBV therapy as patients experienced clinically significant improvement once the air leak stopped.<sup>8</sup> In our practice, patients are allowed to be discharged after 3 days if they do not develop any complications.

Our patient had a remarkable improvement of FEV1 by 77.6% (table 1) and residual volume by 73.2% following EBV insertion. What is more impressive is that the EBV was inserted in the right lower lobe which is a relative contraindication based on NETT protocol. Furthermore, from being a home-bound person, he is now back to his usual daily routine activity and able to drive his mini-lorry.

In conclusion, BLVR by EBV insertion is available in Malaysia for advanced COPD patients on maximal medical therapy. It may achieve similar improvement of respiratory function with lung volume reduction surgery without the added perioperative morbidity and mortality.

#### Consent

Written informed consent was obtained from the patient for publication of this case report.

#### Competing interests

The authors declare that they have no competing interests.

#### Authors' contributions

MFAH is the main author and corresponding author for this article. MZ and JAR edited and approved the final version of the case report. All authors approved the final manuscript as submitted.

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