Bronchoscopic Lung Volume Reduction

Javier Flandes, MD, PhD[a,*], Francisco J. Soto, MD, MS[b], Rosa Cordovilla, MD[c], Enrique Cases, MD[d], Javier Alfayate, MD[a]

KEYWORDS

• COPD • Emphysema • Bronchoscopic lung volume reduction • Endobronchial valves • Coils

KEY POINTS

- Bronchoscopic lung volume reduction (BLVR) has been shown to be an effective and safe nonsurgical alternative for a select group of emphysema patients.
- Careful evaluation and selection of candidates at centers with expertise in BLVR and interventional pulmonology are key factors in obtaining better clinical outcomes.
- Currently, coils and unidirectional endobronchial valves (EBVs) are the devices more widely used for BLVR. The choice of each specific device depends on the emphysema characteristics (homogeneous vs heterogeneous), presence or absence of lobar collateral ventilation (CV), and underlying comorbidities.
- These interventions are designed to add to the overall care of advanced emphysema patients and contribute to a comprehensive and multidisciplinary approach to the management of chronic obstructive pulmonary disease.

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) usually presents as either chronic bronchitis or emphysema and it affects quality of life, leading to disability and early death.[1] It is one of the main causes of death in the world.[2]

Emphysema is defined as the progressive and irreversible destruction of alveolar sacs leading to a loss of lung recoil, early airway collapse, and loss of alveolar gas exchange surface area.[3] Airway collapse leads to air trapping and its presence has correlated with an increase in mortality.[4] In addition to static air trapping, patients develop dynamic hyperinflation, which leads to exercise intolerance and physical deconditioning.[5]

Standard treatment of COPD involves smoking cessation, therapies, such as long-acting bronchodilators and anticholinergic agents, oxygen therapy, and pulmonary rehabilitation programs.[6] Unfortunately, many patients continue to decline despite such comprehensive approach and experience an increase in exacerbations and worsening in exercise tolerance. Such irreversible decline prompted the need to identify additional therapeutic interventions for this specific high-risk patient population.[7]

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[a] Bronchology and Interventional Pulmonology Unit, IIS-Fundación Jiménez Díaz, CIBERES, Avenida Reyes Catolicos No 2, Madrid 28040, Spain; [b] Pulmonary and Critical Care, Department of Medicine, University of Tennessee Medical Center, 1940 Alcoa Hwy e, Knoxville, TN 37920, USA; [c] Bronchology and Interventional Pulmonology Unit, Salamanca University Hospital, Paseo de San Vicente 58, Salamanca 37007, Spain; [d] Bronchology and Interventional Pulmonology Unit, La Fe University Hospital, Avenida Fernando Abril Martorell 106, Valencia 46026, Spain

* Corresponding author.

E-mail address: jflandes@quironsalud.es

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EARLY LUNG VOLUME REDUCTION TECHNIQUES

The National Emphysema Treatment Trial (NETT),[7] a multicenter, prospective, randomized study, evaluated the efficacy of surgical lung volume reduction (LVR) compared with standard emphysema management. The study revealed an improvement in exercise tolerance and survival benefit in patients who had upper lobe-predominant emphysema (heterogeneous emphysema pattern) and a poor baseline exercise capacity. It also, however, showed a higher mortality rate and postoperative complications in the treatment group.

Given the potential clinical benefit of volume reduction shown by NETT but with a high surgical risk, less-invasive interventions have been studied and developed, especially in the field of bronchoscopic LVR (BLVR). Most of the BLVR studies have adopted inclusion and exclusion criteria as well as outcome measures from NETT design.[7]

CLINICAL OUTCOMES

Since the NETT design and its clinical outcomes, several variables have been identified to evaluate a functional response to BLVR. They typically include forced expiratory volume in 1 second (FEV_1), residual volume (RV), and total lung capacity (TLC) as determined by plethysmography; 6-minute walk test (6MWT) distance; modified Medical Research Council (mMRC) scale; and quality-of-life scale as determined by St George's Respiratory Questionnaire (SGRQ).

Previous studies have suggested a minimal clinically important difference (MCID) for the main parameters.

- FEV_1 (improvement by 0.10 L or $\geq$12%)[8]
- 6MWT (improvement by $\geq$26 m)[9]
- SGRQ (improvement by $\geq$4 points)[10]
- RV (improvement of at least 0.31–0.43 L, or decrease in RV% from baseline of 6.1%–8.6%)[11]

EARLY LUNG VOLUME REDUCTION ENDOSCOPIC APPROACHES

Early attempts to achieve volume reduction included Watanabe's Spigots (Novatech, La Ciotat, France), which are silicone devices used to occlude the lung segments that are more severely affected by emphysema. The results only showed a minimal benefit for BLVR and its current use focuses on management of bronchopleural fistula and persistent air leak.[12,13]

A technique of Airway Bypass (Broncus Technologies, San Jose, California) was designed to create extra-anatomic passages between the hyperinflated lung parenchyma and larger airways with the goal of decreasing air trapping.[14] This was evaluated in the EASE (Exale Airway Stents for Emphysema) trial,[15] which only showed short-term benefit and the technique is no longer used.

CURRENT TECHNIQUES

The more promising and clinically beneficial techniques in current use include unidirectional intrabronchial valves (IBVs), EBVs, and endobronchial coils. Both types of devices (valves and coils) are discussed in detail later.

Table 1 compares relevant clinical and functional characteristics of both main BLVR techniques.

UNIDIRECTIONAL VALVES

The main purpose of unidirectional valves is to occlude the targeted lobe and through a unidirectional valve-like effect cause atelectasis and volume reduction in the treated area.[16] There are 2 types of valves available and both are made of silicone and nitinol, a metal alloy of nickel and titanium. Both valves are introduced through the working channel of a greater than or equal to 2.8-mm therapeutic bronchoscope. The intervention is usually unilateral. Its main advantage compared with other endobronchial devices is that the valves can be removed if there is no clear clinical benefit, or in case of complications. An average of 3 to 4 valves is usually placed per

Table 1
Practical comparison between coils and endobronchial valves

	Coils	Endobronchial Valves
Treatment	Bilateral	Unilateral
Sedation	General anesthesia	Conscious sedation
Procedure reversibility	No	Yes
Average number of devices per lobe	10–14 coils	3–4 valves
Airway bleeding risk	Mild to moderate	Low
Pneumothorax risk	Yes	Yes
Safe in patients with PH	No	Unclear