



Case report

Sequential unilateral lung volume reduction for emphysema - Stretching the benefit

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ABSTRACT

Bronchoscopic Lung Volume Reduction (BLVR) and Surgical Lung Volume Reduction (SLVR) are two different approaches used to remodel severely emphysematous lungs to improve lung function and quality-of-life. We present a case initially referred for lung transplantation, where sequential left upper lobe BLVR and 7 years later right upper lobe SLVR, providing enduring physiological and functional improvement. The potential for sustained benefit via sequential unilateral lung volume reduction is under-appreciated.

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1. Introduction

In appropriately selected patients with severe emphysema, Lung Transplantation, Surgical Lung Volume Reduction (SLVR) and Bronchoscopic Lung Volume Reduction (BLVR) can improve lung function, exercise capacity and quality of life [1–3]. The challenge is to achieve safety whilst achieving long-term efficacy [2]. Potentially, less invasive and repeated strategies such as unilateral BLVR [2,3] or SLVR [1] may be preferable to a single complex bilateral procedure.

2. Case report

A symptomatic 62 year old ex-smoker with severe emphysema, a modified Medical Research Council (MRC) dyspnea score of 4, a forced expiratory volume in 1 second (FEV₁) of 32% predicted, a gas transfer (TLCO) of 25% predicted and a 6 minute walk distance (6MWD) of 233m was initially referred for lung transplantation in 2008. With significant hyperinflation and a heterogeneous pattern of upper lobe predominant emphysema on Computed Tomography (CT) scan, BLVR and SLVR were considered suitable alternative therapies. BLVR was chosen using the then novel therapy of bronchoscopic instillation of heated water vapor (UptakeMedical Corp,

Tustin, CA) targeting the most affected left upper lobe (LUL) [3,4]. Discharged after 24hrs, the patient re-presented with pneumonitis secondary to a combination of expected thermal inflammation and potential bacterial secondary infection. This settled with intravenous antibiotics.

Subsequent reviews at 1,3, 6 months post-procedure revealed the efficacy of this treatment approach as reflected by significant improvement of MRC score from 4 to 1 and increase in 6MWD to 362m. These functional improvements mirrored significant changes in lung physiological measures (Fig. 1).

Serial chest x-rays as shown in Fig. 2, demonstrate significant mediastinal movement and volume change with BLVR. CT scans were performed at baseline, 3 and 6 months, as well as 5 years post BLVR. Software calculated lobar volume changes (Vida Diagnostics Inc, Coralville, IA) [3] are shown in Fig. 3. At 3 months, the LUL volume had reduced from 1647ml at baseline to 87ml. Subsequent CT analyses out to 5 years revealed a gradual increase in LUL volume to 522 ml. Conversely, the untreated right upper lobe (RUL) volume had continued to hyperinflate from a baseline of 1860ml–2127ml after 5 years. Notably, there was subtler, desirable expansion of the structurally better preserved denser left lower lobe (892ml–1234 ml) and potentially late compression of the right lower lobe (892ml–754ml) as the hyper-inflated low tissue density right upper lobe continued to expand.

With a slow recurrence of exercise limitation, consistent physiological measures (FEV₁ 31% predicted, 6MWD 230m, increasing hyperinflation) (Fig. 3) and an untouched potential obvious

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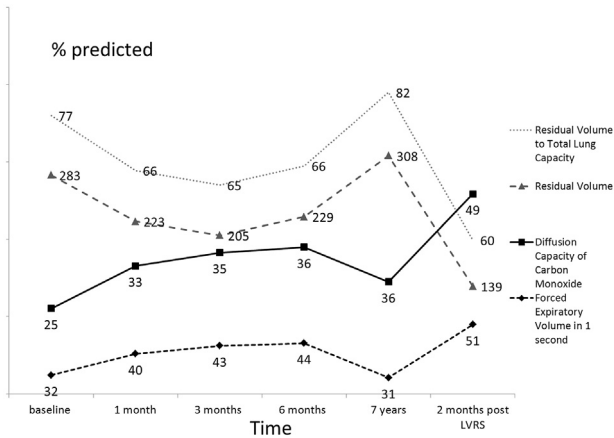


Fig. 1. Lung function versus time.

3. Discussion

To our knowledge this is the first case where sequential unilateral BLVR and then SLVR has been performed. This started with a patient initially considered potentially for lung transplantation, buying quality years with a less invasive BLVR approach, while improving robustness sufficiently to eventually enable the more extensive SLVR approach—achieving favorable outcomes from both procedures.

BLVR has been recognized to have an acceptable safety profile, whether via the application of valves, glues, coils or water vapor [2], but each of these approaches are still finding their feet in terms of reproducibly achieving symptom control and improvement in physiological efficacy. Key predictors of efficacy include the degree of heterogeneity between the targeted treated and un-treated lung segments and the degree of hyperinflation. Valves have the disadvantage of requiring the absence of inter-lobar collateral

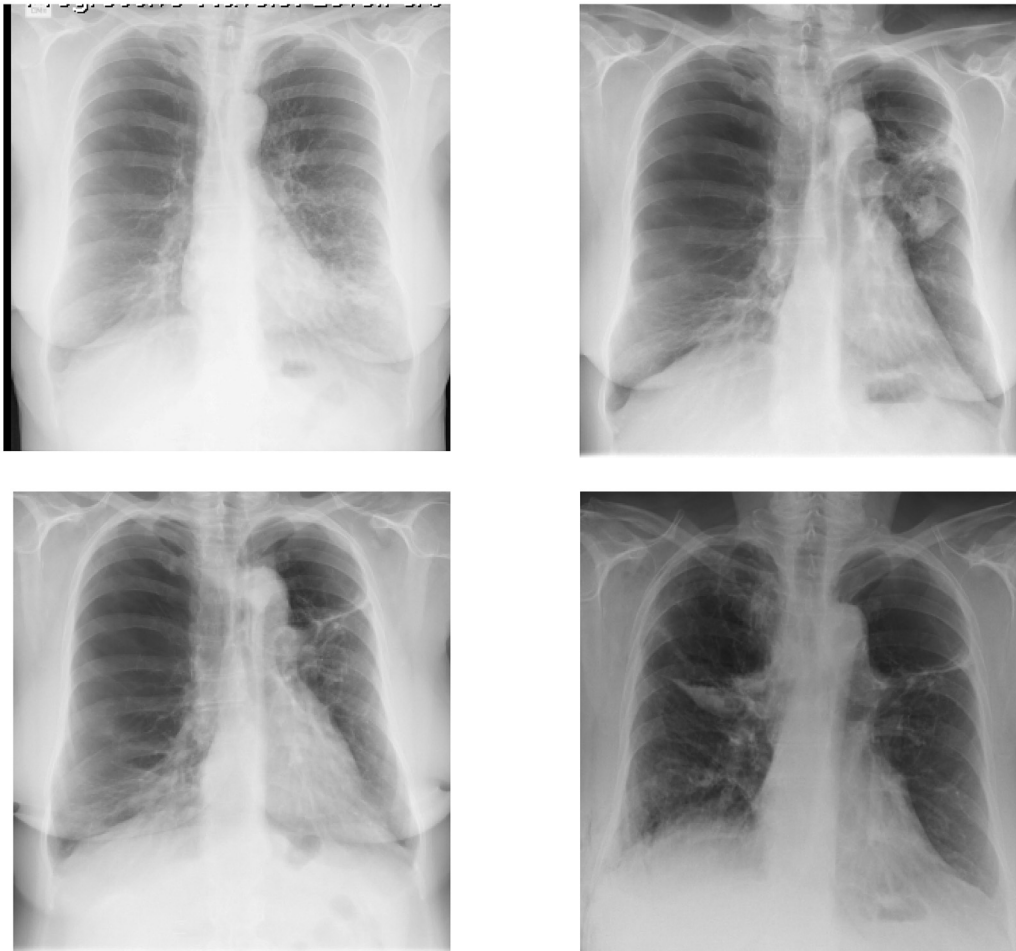


Fig. 2. Serial chest X-rays. A) Pre-all procedures. B) Early post-left upper lobe bronchoscopic lung reduction. C) Late post-left upper lobe bronchoscopic lung reduction. D) Early post-right upper lobe surgical lung reduction. Note movement of mediastinum and changing volume of lower lobes.

unilateral RUL target, a second procedure was considered 7 years after the first. Notably, the patient was less frail than at her first assessment and SLVR was considered the most appropriate strategy. Surgery was uncomplicated; the patient was discharged after 7 days, and has remained well with again a useful improvement in lung function (Figs. 1 and 3).

ventilation and complete lobar application for efficacy, whereas glues, coils and vapor can be applied at a complete lobar or segmental level while still achieving efficacy [2–5]. Vapor BLVR therapy as applied here in 2008 fitted these criteria.

SLVR has a peri-operative mortality of 5–10% with significant morbidity and a guaranteed longer hospital stay than BLVR [5,6]. However, in the most heterogeneous, hyper-inflated lungs, clinical

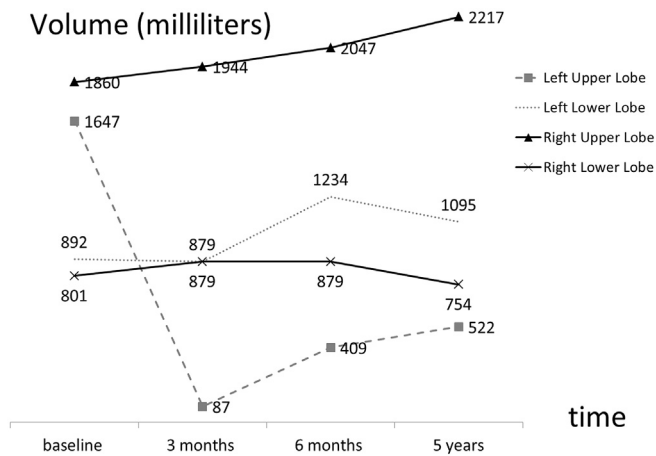


Fig. 3. Changes in lobar volumes versus time.

results are usually significantly better than those seen following BLVR. The challenge for the surgeon is to select out ideal surgical target zone, severely affected individuals who are robust enough to move safely through the post-operative period and remain in sufficient condition to enjoy the long-term benefit.

A unilateral lung volume reduction approach was suggested for SLVR in the 90's, noting unilateral surgery got 75% of the benefit of the bilateral approach (not 50%) and could be repeated on the second side at a later date, prolonging overall efficacy [6]. However, it was perceived a bilateral approach at one sitting had a similar mortality and morbidity risk and achieved greater short term efficacy (notably not twice that of unilateral surgery). The superior

safety profile of BLVR has seen several successful trials of glues and vapor where sequential treatments attempt to serially target the most affected emphysematous segments [4,5].

In general, emphysema remains a common burdensome condition with historically limited therapeutic options. Lung volume reduction techniques, via either SLVR or BLVR, can provide an enduring benefit to many affected individuals. Sequential combinations of the different rapidly evolving techniques, based on an increasing understanding of the anatomy (CT software), and physiology (collateral ventilation measures and 4 dimensional CT) is the way of the future.

Conflict of interest

None.

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