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Lung emphysema treated successfully using volume reduction with lung sealant (AeriSeal®)

Case Report

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Abstract: Emphysema is a progressive and irreversible disease for which there is no cure to date. Endoscopic lung volume reduction with valve implantation or using lung sealant is a treatment option for patients with severe emphysema. A 60-year-old ex-smoker (80 pack years) referred to our center because of severe lung emphysema with progressive worsening of the obstructive ventilator pattern and clinical condition. By our patient we detected collateral channels by using the Chartis system®, which allow airflow into the target lobe and prevent atelectasis and significant lung volume reduction. Thus, we decided to treat the advanced emphysema of our patient with endoscopic volume reduction using lung sealant (AeriSeal®). The foam of lung sealant AeriSeal® is instilled into the peripheral airways and alveoli where it polymerizes and functions as tissue glue, forming a film of material on the lung surface that seals the target region to cause durable absorption atelectasis. Over a period of 16 weeks, the air within the sealed region was absorbed. The follow-up evaluation of this patient showed improved lung function (increased FEV 1, and a reduction of TLC and RV) with improved quality of life. Correlation between changes in primary and secondary outcome measures in the lung function parameters and 6- minute- walking test before and after the application of AeriSealant revealed significant reduction of hyperinflation and improvement both in the flow rates and physical capacity of our patient.

Keywords: *BLVR (Bronchoscopic lung volume reduction) • LVRS (Lung volume reduction surgery) • COPD (chronic obstructive pulmonary disease) • ELS (Emphysematous lung synthetic polymer sealant)*

1. Case report

A 60-year-old ex-smoker (80 pack years) was referred to our center because of severe lung emphysema with progressive worsening of the obstructive ventilatory pattern and clinical condition despite maximized treatment and supplemental oxygen support. Due to limited treatment options, the therapy of endoscopic lung volume reduction was evaluated in our center. The chest x ray (Figure 1 a) and CT- scan revealed severe heterogeneous centrilobular lung emphysema with predominant involvement of bilateral upper lobes (Figure 2 a,b).

Collateral flow within the targeted area was proven by using Chartis system®, therefore endobronchial valve treatment was not considered. Collateral channels can allow airflow into the target lobe and prevent atelectasis and significant lung volume reduction. Thus, we decided to treat the advanced emphysema with endoscopic volume reduction with lung sealant (AeriSeal®). Therapy was administered with the bronchoscope in wedge position at the airway subsegment. ELS foam sealant was delivered through a single lumen catheter with its tip positioned 2 cm beyond the bronchoscope. Wedge position was maintained throughout delivery to prevent backflow into the airway. The foam sealant was prepared at the bedside from aqueous polymer solution and cross-linker. Polymer solution contains 2% aminated polyvinylalcohol in phosphate buffer. Cross-linker consists of dilute, buffered pentane 1–5 dial. Cross-linker (0.5 ml) was added to the polymer substrate (4.5 ml) in a 20-ml syringe to initiate polymerization, which proceeds over approximately 3 min. The 5-ml solution was mixed with 15 ml of air to generate 20 ml of foam sealant by passing the material back and forth through a stopcock between the syringes 10 times. 20 ml of liquid foam sealant was

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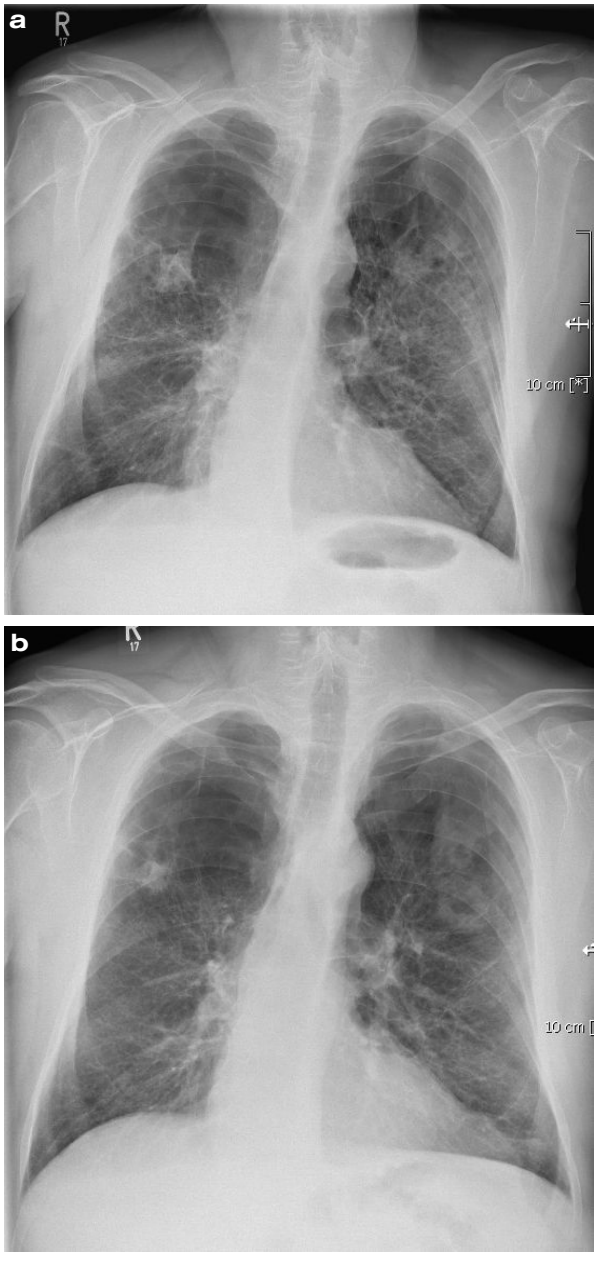

Figure 1. a Chest x- rays before the endoscopic lung volume reduction.

b Shows atelectasis of both right and left upper lobe after endoscopic lung volume reduction.

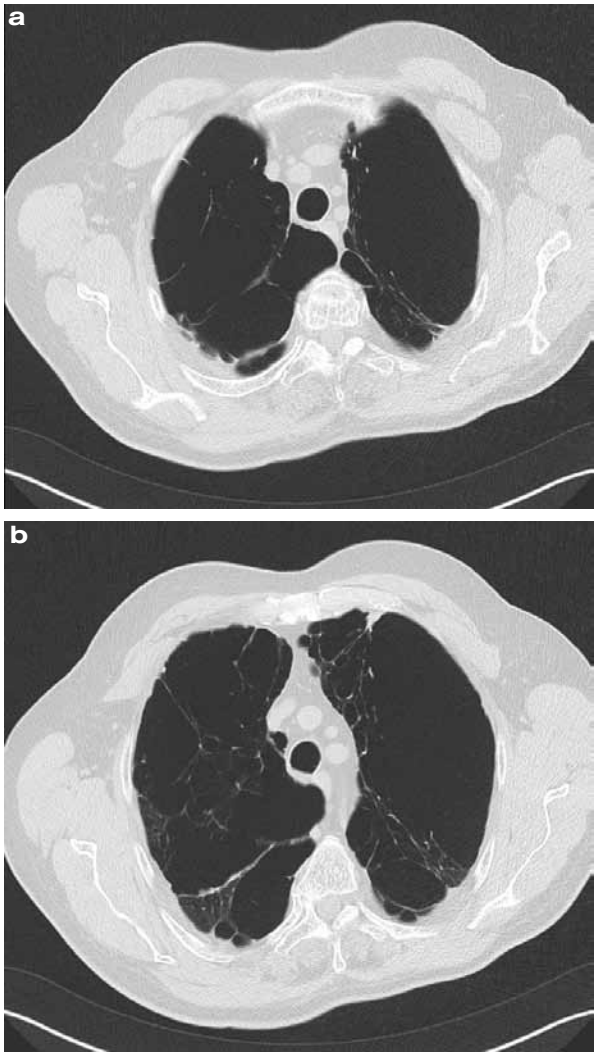

Figure 2. a CT- scan revealed severe heterogeneous centrilobular lung emphysema with bilateral involvement of the upper lobes.

b CT- scan revealed severe heterogeneous centrilobular lung emphysema with bilateral involvement of the upper lobes.

injected over 10–20 s. Wedge position was maintained for 1 min following delivery to allow complete in situ polymerization. The scope was then repositioned at the next treatment site, and the procedure repeated until all treatments were completed [1]. The bronchoscopic images (Figure 3 a,b) showed that AeriSeal foam Sealant fills the targeted diseased alveolar region right and left upper lobe segment 1, where it is intended to induce atelectasis and to block collateral air flow.

Sixteen weeks after the polymeric foam sealant application, the patient was clinically in a good condition, and reported improvement of general ability to manage daily life as well as an improvement of dyspnea. Follow-up evaluation with chest x- ray (Figure 1 b) sixteen weeks after the intervention showed atelectasis of both upper lobes. Pulmonary function test showed significant reduction of lung hyperinflation.

The parameter of the lung function examination also showed improvement of different parameters (Table 1).

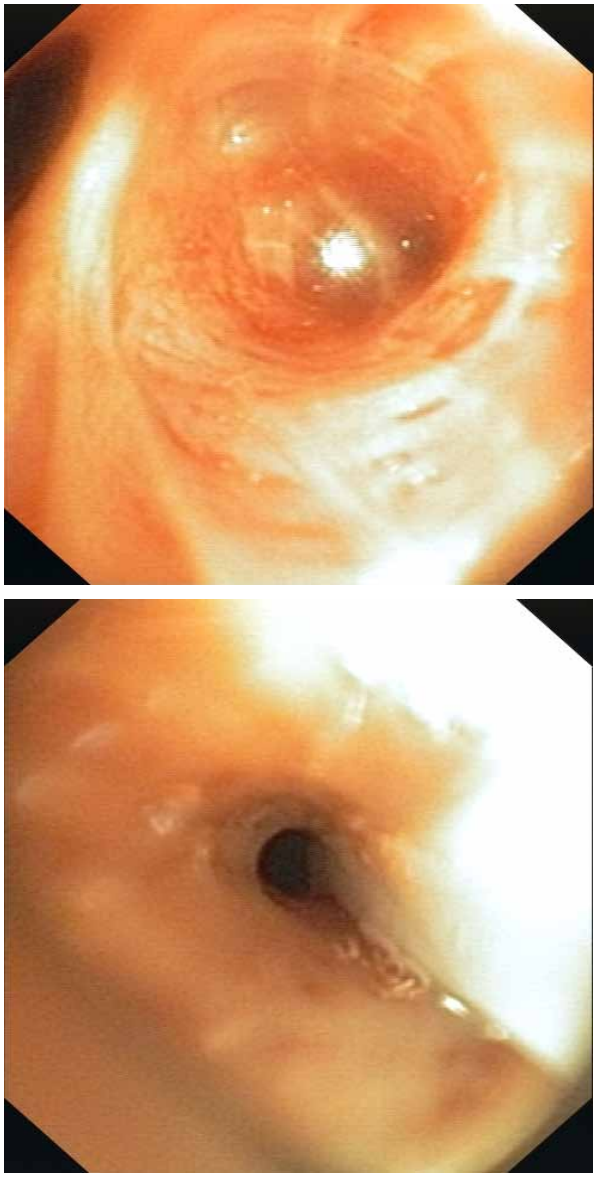

Figure 3. AeriSeal foam Sealants fills the targeted region of right upper lobe segment 1 and left upper lobe segment 1.

Table 1. Comparisons of the lung function parameters and 6-minute- walking test before and after endoscopic lung volume reduction.

Lung function parameter	Before application of AeriSeal	16 weeks after application of AeriSeal
FEV 1 L (% pred)	1.16 (28)	1.6 (38)
Forced vital capacity (FVC) L (% pred)	2.58 (46)	4.3 (76)
TLCOc SB mmol/min/kPa	28.2%	48%
TLCOc /VA mmol/min/kPa	51%	70%
Residual volume L (%pred)	5.5 (209)	4.5 (179)
6-Minute-Walking test (m)	130	240

2. Discussion

Four bronchoscopic lung volume reduction (BLVR) approaches have shown promise and led into later-stage clinical trials. These include the following: firstly, placement of endobronchial one-way valves designed to promote atelectasis by blocking inspiratory flow; secondly, Formation of airway bypass tracts using a radiofrequency catheter designed to facilitate emptying of damaged lung regions with long expiratory times; thirdly, Instillation of biological adhesives designed to collapse and remodel hyperinflated lung; and fourthly, Airway implants of nitinol coils of 10 to 20 cm in length designed for use in patients with either homogeneous or heterogeneous emphysema. These implants coil up on deployment and tether the lung.

Lung volume reduction surgery (LVRS) reduces hyperinflation and improves lung function by removal of emphysematous lung tissue. However, LVRS is also associated with significant short term morbidity and mortality [2]. Results from recently published Endobronchial Valve for Emphysema palliation Trail (VENT) and Exhale Airway Stents for Emphysema (EASE) trial showed that treatment was substantially less effective and did not consistently reduce hyperinflation or improve lung function mostly likely due to collateral ventilation present in majority of patients [3,4].

Bronchoscopic lung volume reduction (BLVR) is a general term that refers to any of several recently developed endobronchial procedures for treating hyperinflation in advanced emphysema [5].

Bronchoscopic lung volume reduction system with biological sealant/remodeling system is an alternative treatment option especially for patients with significant collateral flow which can easily measured by Chartis system®. Like valve-based systems, it is designed to reduce lung volume directly by collapsing and sealing damaged areas of hyperinflated lung in patients with heterogeneous emphysema to reduce hyperinflation and to improve pulmonary function and quality of life in patients with advanced emphysema and collateral flow [6]. Treatment by a biological sealant produces an irreversible change in emphysematours tissue. Biological sealant is delivered to the alveolar compartment as separate liquid components via a dual lumen catheter passed through the instrument channel of a flexible bronchoscope [7].

A common side effect is a systemic flu- like inflammatory reaction after foam sealant application accompanied by transient fever, cough, bronchospasm, chest pain, leukocytosis, malaise and elevated C- reactive protein levels. This side effect is generally self- limited

and resolves within 24-96 h spontaneously. Other serious pulmonary side effects within 6 months after the procedure include repetitive COPD exacerbations, pneumonia, bronchitis and hemoptysis. Over a period of several weeks, the treated lung region will start to shrink, reducing lung volume by atelectasis [8].

In our case report, bronchoscopic lung volume reduction by a lung sealant showed significant improvement in both clinical status and lung function parameters. Future studies are still necessary in order to identify the long- term effects of this innovative procedure.

Conflicts of interest

The author(s) indicated no potential conflicts of interest.

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