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Bronchoscopic thermal vapor ablation after unsuccessful lung volume reduction surgery: A case report

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ABSTRACT

Introduction: Compared to surgery there is no evidence on bronchoscopic lung volume reduction (LVR) in patients with fading benefit after LVR surgery. CASE REPORT: We present a case of 64-year old female patient who was successfully treated with bronchial thermal vapor ablation (BTVA) after previous ineffective lung volume reduction (LVR) surgery several months earlier. CONCLUSIONS: Bronchoscopic LVR, in particular BTVA, might be considered in patients with fading or missing effects after previous LVRS. At least, the safety profile of BTVA seems not be adversely affected by previous LVRS, when proper patient selection and procedure planning are ensured.

1. Introduction

Pulmonary function, dyspnea and quality of life have been shown to improve significantly after both surgical and bronchoscopic LVR in patients with severe emphysema and hyperinflation [1]. However, since chronic obstructive pulmonary disease (COPD) is a progressive disorder, the beneficial effects of all LVR procedures are only temporary and symptoms return to baseline levels after months to years [2–4]. Thus, neither lung volume reduction (LVR) procedure is able to alter the natural course of COPD with annual decline of pulmonary function and again increasing hyperinflation [5]. Unfortunately, only few COPD patients qualify for lung transplantation due to advanced age and co-morbidities. Attempts of repeated LVR surgery (Re-LVRS) have been published with promising results in highly selected patients, who increasingly deteriorate after initially successful LVRS [6,7]. Compared to surgery there is no evidence on bronchoscopic LVR in patients who had previous LVRS. Concerning BTVA, there is evidence on successful segmental treatment with acceptable safety profile in emphysema patients, who did not have a previous LVR [8]. To the best of our knowledge, this is the first report on a successful bronchoscopic LVR using BTVA after previous LVRS.

2. Case report

A 64-year old female patient was referred for evaluation of increasing dyspnea five months after bilateral thoracoscopic LVRS in her upper lobes. Immediately after LVRS she had noticed some improvement of her dyspnea, but this continued only for three months. Since then, her symptoms slowly returned to baseline. Compared to preoperative values, her FEV1 had slightly decreased, and residual volume (RV) had increased by 220 ml (Table 1). According to her recent bodyplethysmography with RV of 5.08 l (295% predicted) and RV/total lung capacity (TLC) of 0.77, symptomatic hyperinflation was suspected. Her drug treatment included inhalative tiotropium and fluticasone/salmeterol, and theophylline 1 × 200mg orally, which was unchanged to preoperative. Inhalation technique was checked and found to be accurate. Other causes of increasing dyspnea (e.g. congestive heart failure, pulmonary embolism, and pleural effusion) were excluded by computed tomography (CT) and echocardiography. Pulmonary hypertension seemed not causative for her symptoms, since peak systolic right ventricular pressure on echocardiography had decreased from 34 mmHg preoperatively to 31 mmHg. 6-minute walking distance (6-MWD) was 280 m, which was 70 m more compared to the preoperative value. Quantitative CT analysis using the software by Intervapor® (Uptake Medical® Technology Inc., Seattle WA, USA) revealed a slightly heterogeneous emphysema with interlobar fissure completeness between 69 and 92%. Due to upper lobe disease severity (proportion of voxels with density less than −950 HU) of 44% in LB1/2 with a heterogeneity index of 1.2 between segment and ipsilateral lobe, and an estimated target volume of 233 ml, bronchoscopic LVR using bronchial thermal vapor ablation (BTVA) was a possible treatment option, since the patient refused to undergo re-LVRS. Seven months after unsuccessful LVR surgery, LB1/2 was treated with BTVA in general anesthesia. Vapor was

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List of abbreviations

BTVA	bronchial thermal vapor ablation
COPD	chronic obstructive pulmonary disease
FEV1	forced expiratory volume in first second
LVR	lung volume reduction
LVRS	lung volume reduction surgery
6MWD	6-min walking distance
RV	residual volume
TLC	total lung capacity

Table 1
Pulmonary function tests and 6-min walking distance.

	Pre-LVR surgery	5 months after LVR surgery/pre BTVA	6 weeks after BTVA	6 months after BTVA
FVC, liters (% predicted)	1.60 (78)	1.52 (74)	2.06 (83)	2.23 (110)
FEV1, liters (% predicted)	0.68 (40)	0.65 (39)	0.97 (50)	1.10 (66)
FEV1/FVC	0.38	0.42	0.47	0.48
TLC, liters (% predicted)	6.63 (164)	6.62 (164)	4.75 (117)	4.90 (121)
RV, liters (% predicted)	4.86 (282)	5.08 (295)	2.57 (148)	2.62 (151)
RV/TLC	0.73	0.77	0.54	0.54
TLCO, % predicted	20	20	34	30
6-MWD, meters	210	280	325	420

delivered during 7.2 seconds corresponding to 8.5 cal/g lung tissue using a segmentally wedged and properly positioned balloon catheter (InterVapor®) according to a recent best practice recommendation paper [9]. The patient tolerated BTVA treatment without any complaints and was discharged on the following day. Prophylactic medication with prednisone 20mg/d and amoxicillin-clavulanate (625mg tid) was given for seven days. At follow-up examinations six weeks and six months after BTVA, the patient refused any side effects like increased cough, fever, chills, or hemoptysis. However, her dyspnea already improved after six weeks persisting for at least six months, and 6-MWD increased to 325 and 420 m after six weeks and six months, respectively. Also, pulmonary function values improved impressively (Table 1). On CT follow-up after six months, there was evidence of new symmetric bilateral consolidations imitating round atelectasis in both lower lobes and faint reticular changes in LB1/1 (Figs. 1–2).

BTVA, bronchial thermal vapor ablation; FEV_1, forced expiratory volume in 1 s; FVC, forced vital capacity; LVR, lung volume reduction; RV, residual volume; TLC, total lung capacity; TLCO, transfer factor of the lung for carbon monoxide; 6-MWD, 6 min walking distance.

3. Discussion

Recurrent hyperinflation with deterioration of dyspnea and quality of life several months to years after LVR is not unusual. The beneficial effects on FEV1, hyperinflation and dyspnea after LVRS were persistent for up to three years in both homogeneous and heterogeneous emphysema [10]. Similar long-term results were found after bronchoscopic LVR using endobronchial valves with maintained success for up to five years [11], and after LVR coils with declining benefits after three years [3]. Since BTVA is a relatively new LVR technique, there are only 12-month efficacy and safety data available [12]. Retrospective data on Re-LVR after deteriorating effects after a previous successful LVRS are only available for surgery, showing improvements of dyspnea and lung

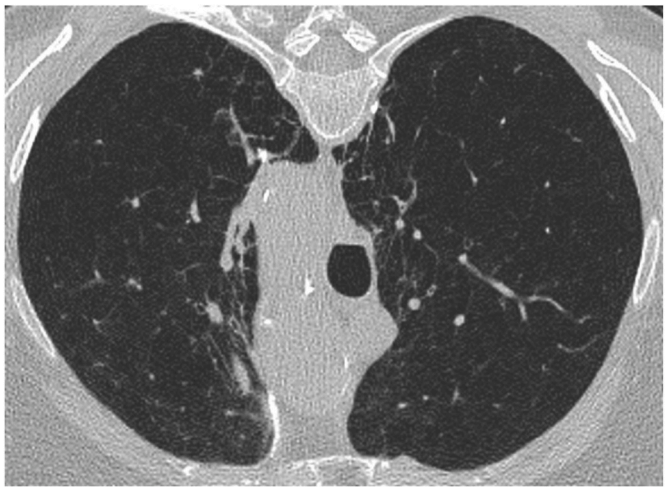

Fig. 1. Chest computed tomography after LVRS and BTVA (upper lobes).

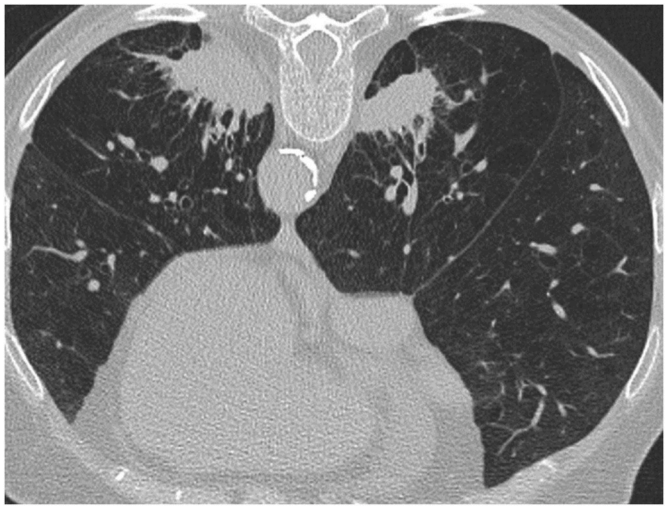

Fig. 2. Chest computed tomography after LVRS and BTVA (lower lobes).

function for up to one year [7]. In this publication, there was usually a period of maintained success between initial LVRS and Re-LVRS of five years. However, the situation is different in the presented case, since the patient had never shown any benefit after LVRS, and the period between LVRS and Re-LVR was only six months. Therefore, the presented case is a non-responder after LVRS rather than secondary decliner.

Analogously to the STEP-UP trial, a target energy dose of 8.5 calories per gram of lung tissue was delivered [8,12]. The choice of the dose is the result of several previous studies with different vapor doses ranging between 5 and 10 cal/g [9]. The dose chosen in the presented patient is a trade-off between optimal benefit and acceptable risk, since adverse events (e.g. pneumonitis) are associated with the volume of the treated lobe [13]. Therefore, segmental (sequential) rather than lobar vapor treatment is recommended [9]. However, in our patient, the second BTVA treatment was withheld due to the successful first application.

Despite the ongoing favorable outcome of BTVA after previous LVRS, the mechanism is not obvious in the presented case. In particular, the cause and effect of the new bilateral consolidations in both lower lobes, where neither LVRS nor BTVA had been performed, remain unexplained. Compared to this finding, the BTVA target zone in LB1/2 showed relatively faint reticular changes. In addition, it is unusual that patients treated with BTVA show improved pulmonary function and dyspnea after only six weeks, since vapor-induced inflammation and scarring may take several months. Possibly, there was an alternative,

unknown mechanism, which eventually led to the favorable outcome.

4. Conclusion

Bronchoscopic LVR, in particular BTVA, might be considered in patients with fading effects after previous successful LVRS. At least, the safety profile of BTVA seems not be adversely affected by previous LVRS, when proper patient selection and procedure planning are ensured.

Ethics approval and consent to participate

Ethics approval was waived by Ethics committee of Canton Zurich, since this is only a retrospective case report.

Consent for publication

The patient has given her written informed consent to publish this case report and allied images.

Availability of data and material

Not applicable.

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Author contributions

All authors contributed equally to this report, and have read and approved this final version of the manuscript.

Fig. 1 show representative transverse sections in prone position of upper lobes 6 months after BTVA and 12 months after initial LVRS, respectively. In the upper left lobe (LB1/2), there are faint reticular changes, which might be attributable to scarring after LVRS or BTVA.

Fig. 2 show representative transverse sections in prone position of lower lobes 6 months after BTVA and 12 months after initial LVRS, respectively. In both lower lobes, where neither LVRS nor BTVA had been performed, there are symmetrical consolidations of unknown cause imitating round atelectasis.

Declaration of competing interest

DF has received scientific grants from Uptake Medical® Technology Inc., Seattle WA, USA for participation in a postmarket surveillance study. However, the presented patient was not included in this study. GS and CS do not have potential conflicts of interest.

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References

[1] P.L. Shah, F.J. Herth, W.H. van Geffen, G. Deslee, D.J. Slebos, Lung volume reduction for emphysema, Lancet Respir. Med. 5 (2) (2017) 147–156.
[2] K.E. Bloch, C.L. Georgescu, E.W. Russi, W. Weder, Gain and subsequent loss of lung function after lung volume reduction surgery in cases of severe emphysema with different morphologic patterns, J. Thorac. Cardiovasc. Surg. 123 (5) (2002) 845–854.
[3] J.E. Hartman, K. Klooster, K. Gortzak, N.H. ten Hacken, D.J. Slebos, Long-term follow-up after bronchoscopic lung volume reduction treatment with coils in patients with severe emphysema, Respirology 20 (2) (2015) 319–326.
[4] J.M. Travaline, J.P. Gaughan, S. Furukawa, G.J. Criner, Effect of bilateral lung volume reduction surgery on FEV1 decline in severe emphysema, COPD 2 (2) (2005) 203–208.
[5] O.A. Minai, J. Benditt, F.J. Martinez, Natural history of emphysema, Proc. Am. Thorac. Soc. 5 (4) (2008) 468–474.
[6] F. Tacconi, E. Pompeo, D. Forcella, M. Marino, D. Varvaras, T.C. Mineo, Lung volume reduction reoperations, Ann. Thorac. Surg. 85 (4) (2008) 1171–1177.
[7] A. Kostron, M. Horn-Tutic, D. Franzen, P. Kestenholz, D. Schneiter, I. Opitz, M. Kohler, W. Weder, Repeated lung volume reduction surgery is successful in selected patients, Eur. J. Cardio. Thorac. Surg. 48 (5) (2015) 710–715.
[8] F.J. Herth, A. Valipour, P.L. Shah, R. Eberhardt, C. Grah, J. Egan, J.H. Ficker, M. Wagner, C. Witt, U. Liebers, P. Hopkins, W. Gesierich, M. Phillips, F. Stanzel, W. H. McNulty, C. Petermann, G. Snell, D. Gompelmann, Segmental volume reduction using thermal vapour ablation in patients with severe emphysema: 6-month results of the multicentre, parallel-group, open-label, randomised controlled STEP-UP trial, Lancet Respir. Med. 4 (3) (2016) 185–193.
[9] D. Gompelmann, P.L. Shah, A. Valipour, F.J.F. Herth, Bronchoscopic thermal vapor ablation: best practice recommendations from an expert panel on endoscopic lung volume reduction, Respiration 95 (6) (2018) 392–400.
[10] W. Weder, M. Tutic, D. Lardinois, W. Jungraithmayr, S. Hillinger, E.W. Russi, K. E. Bloch, Persistent benefit from lung volume reduction surgery in patients with homogeneous emphysema, Ann. Thorac. Surg. 87 (1) (2009) 229–236, discussion 236-7.
[11] A. Fiorelli, C. Santoriello, A. De Felice, F. Ferrigno, A. Carlucci, E. De Ruberto, R. Mastromarino, L. Occhiati, G. Messina, E. Santoriello, G. Vicidomini, M. Polverino, M. Santini, Bronchoscopic lung volume reduction with endobronchial valves for heterogeneous emphysema: long-term results, J. Vis. Surg. 3 (2017) 170.
[12] D. Gompelmann, R. Eberhardt, M. Schuhmann, A. Valipour, P.L. Shah, F.J. Herth, K. Kontogianni, Lung volume reduction with vapor ablation in the presence of incomplete fissures: 12-month results from the STEP-UP randomized controlled study, Respiration 92 (6) (2016) 397–403.
[13] D. Gompelmann, R. Eberhardt, A. Ernst, P. Hopkins, J. Egan, F. Stanzel, A. Valipour, M. Wagner, C. Witt, K.M. Baker, M.H. Gotfried, S. Kesten, G. Snell, F. J. Herth, The localized inflammatory response to bronchoscopic thermal vapor ablation, Respiration 86 (4) (2013) 324–331.