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Case Report

Endobronchial Valve as Salvage Lung-Sparing Treatment of Prolonged Air Leak Following Laser Assisted Metastasectomy

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Abstract

In the recent years employment of LASER for resection of lung metastasis demonstrated to be a valid surgi option to avoid major anatomical lung resections.

First experimental studies performed in the swine model [1] showed that at histological evaluation in the 0.5-c quadrants laying distant from the "center" of the LASER application, the tissue presented with cell vacuolizati and membrane destruction, while not signs of thermal damage was observed at 1-cm quadrants.

These data have several implications for daily clinical application; firstly, lung areas that are distant more thar cm apart do not entail the risk of heat accumulation; secondly, while resecting lung metastases that are clos than 1 cm to each other, the surgeon should either wait 3 to 5 minutes for spontaneous tissue cooling befo resecting the next metastasis to avoid applying the second LASER shot on a surface of pulmonary parenchyr already interested and potentially damaged by the first application; finally, the microscopic (not detectabl residual neoplastic cells (spreading from the metastatic lesion to the adjacent "healthy" parenchyma) cou potentially be eradicated until 1 cm far from resected area.

Therefore, LASER resection are considered radical even when a closer margin of resection (< 1 mm) is found histological examination of specimen. Moreover, through the high temperature reached in the tissue (>700°C LASER has an excellent sealing ability of small vessels and bronchi until 3-4 mm, minimizing the risk intraoperative and postoperative bleeding and air leakage.

Conversely, when such complications occur, especially delayed air leakage from bronchopleural fistula (BPI treatments may be very challenging since scar tissue could prevent healing. Therefore, surgical interventic pleurodesis, and prolonged chest tube drainage have several disadvantages in these patients. Many attempts ha been made to treat BPF through flexible bronchoscopy by submucosal injection of acrilic glue.

Endobronchial one-way valves (EBV), originally designed for lung volume reduction in pulmonary emphysem represent an emerging option for treatment of BPF. Insertion of EBV have less trauma, relatively short operati time, better safety than surgical intervention and is more likely to be accepted by patients.

In this paper we describe two case of delayed and prolonged air leak after LASER resection which finally receiv a successful treatment through placement of endobronchial valves.

Key Words: metastasectomy; emphysematous lung; lung LASER; endobronchial one-way valves (EBV)

Case Presentation

Case 1

A 55-yrs old patient with long history of IV stage thyroid cancer was scheduled for redo-metastesectomy of right lung after careful functional and oncological evaluation. A right lower lobectomy for large recurrent hilar metastasis and LASER assisted resection of a paramediastinal metastasis of right upper lobe and other two lesion of middle lobe was performed. Laser device used was Neodimium (Nd:YAG) 1,318 nm (LIMAX-120, Gebrüder

Martin GmbH & Co. KG, Tuttlingen, Germany) equipped with innovative characteristics (power up to 120 W; cut-line temperature up to 700°C). Postoperative course was uneventful until 5th day, when air leak and pneumothorax was observed (Figure.1). Due to increasing amount of air leakage and complete residual lung collapse (Figure.2), surgical repair was tempted. Intraoperatively BPF was found in right upper lobe. Direct suture, fibrin glue and pleural drape failed to stop air leak. Lung collapse prevented also blood patch. Therefore EBV were inserted first in upper segmental bronchus of right upper lobe (Figure.3) and, in a second-stage procedure, in middle lobe. Air leak stopped within 5 days, allowing to remove pleural drainages after 15 days. Despite the amount of lung parenchyma resected and the number of EBV inserted no significant residual pleural space was observed at follow-up (Figure.4).

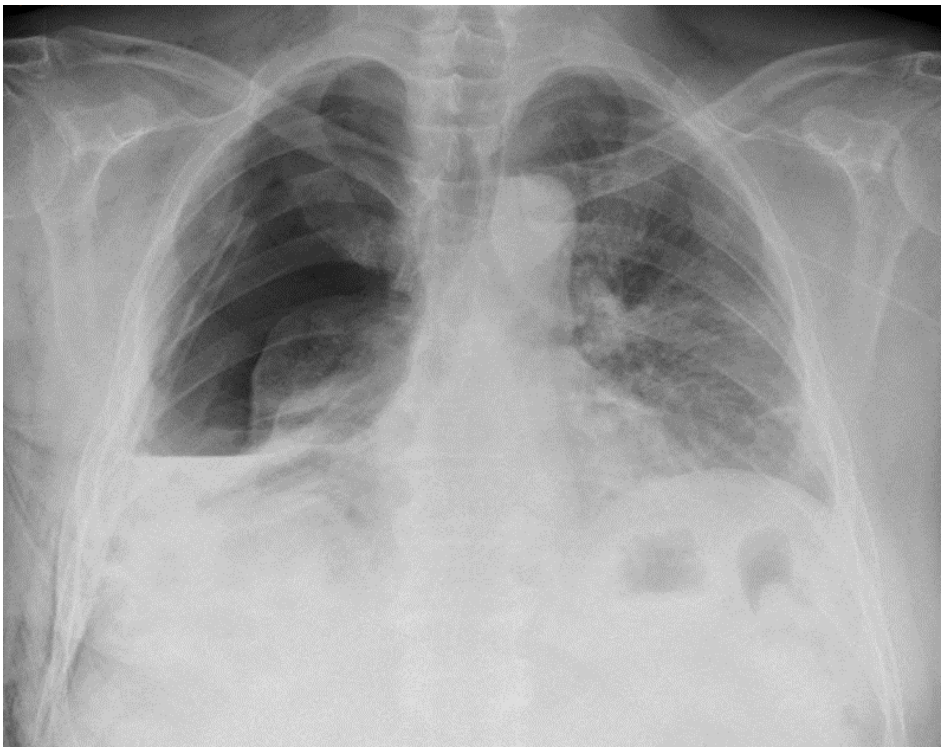

Figure 1: large hydro-pneumotorax despite large-bore chest tube and suction

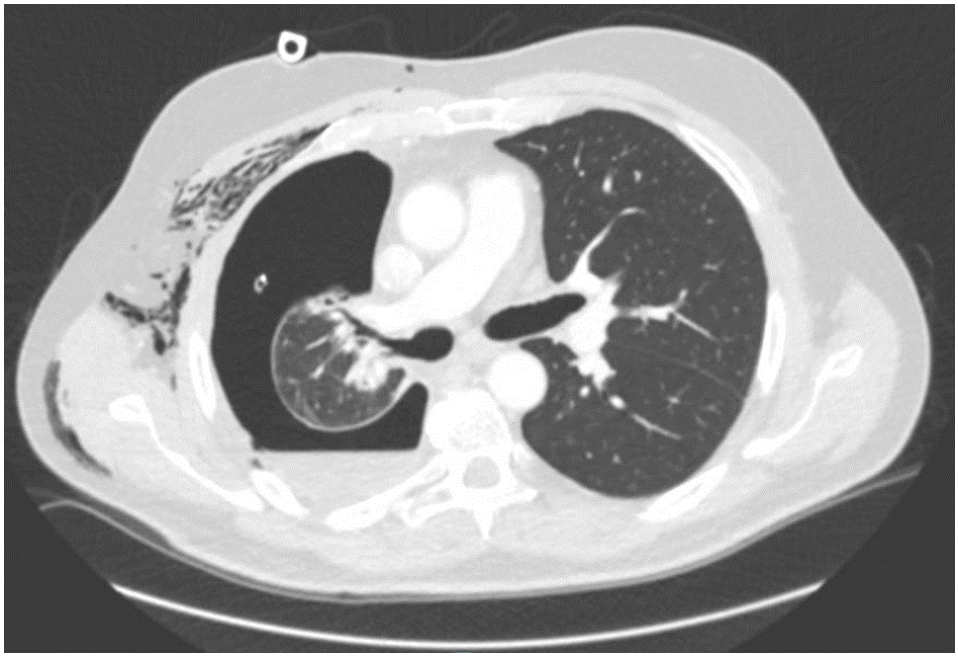

Figure 2: CT-scan showing large pneumothorax, pleural thickening and small BPF of RUL communicating with residual pleural space

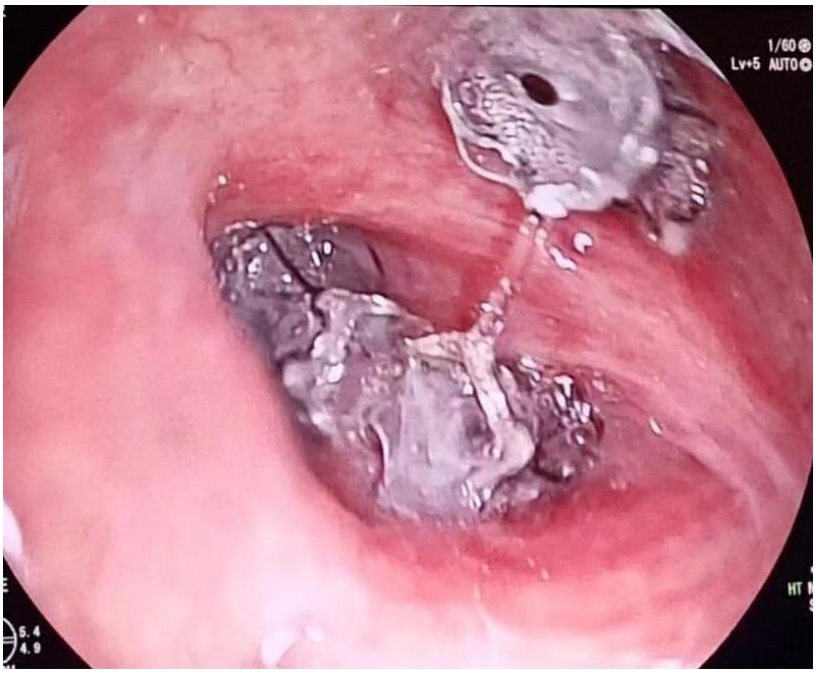

Figure 3: complete RUL exclusion with EBV placed in each of 3 segmental bronchi

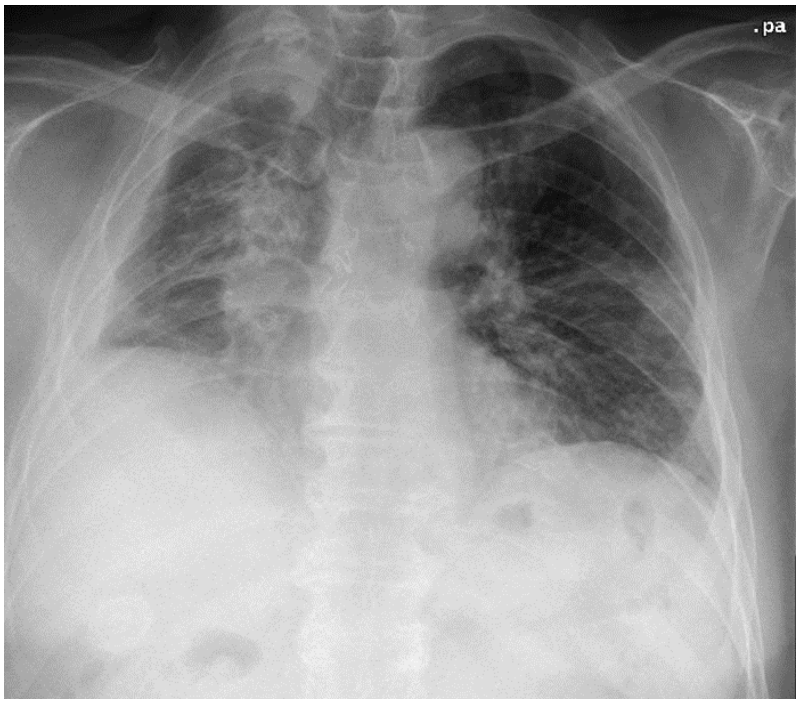

Figure 4: long-term result at 12 months follow-up (after 12 months?)

Case 2

A 54-yrs old patient with medical history of previously resected bladder urothelial tumour underwent LASER assisted resection of 1.3 cm nodular lesion in right lower lobe. Resection was performed by LASER Limax 120. Postoperative course was uneventful with discharge on 5th postoperative day. At 6 months follow-up chest CT-scan moderate right pneumothorax was observed necessitating chest-tube insertion. A small area of subpleural cavitation with thickened walls in the area of previous LASER resection was observed at chest CT scan (Figure.5). After 6 days, with apparently no air leakage, chest-tube was removed but the patients experienced early recurrent pneumothorax at 1-week chest X-rays. Considering the radiological findings, the timing and the kind of air leak, EBV placement was considered as the first option. EBV was inserted in segmental apical bronchus of right lower lobe (Figure. 6), leading to cessation of air leak and chest tube removal within 1 week. No recurrences and no significant pulmonary atelectasis were reported (Figure. 7).

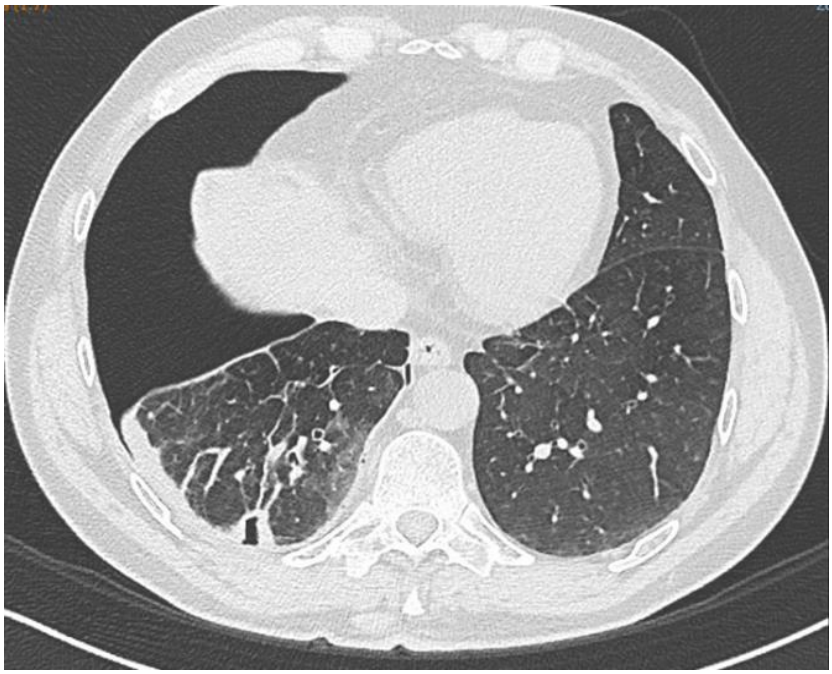

Figure 5: Chest CT-scan demonstrating (demonstrates) right pneumothorax with pleural thickening and dense scar tissue surrounding pulmonary breach in the area of resected metastasis

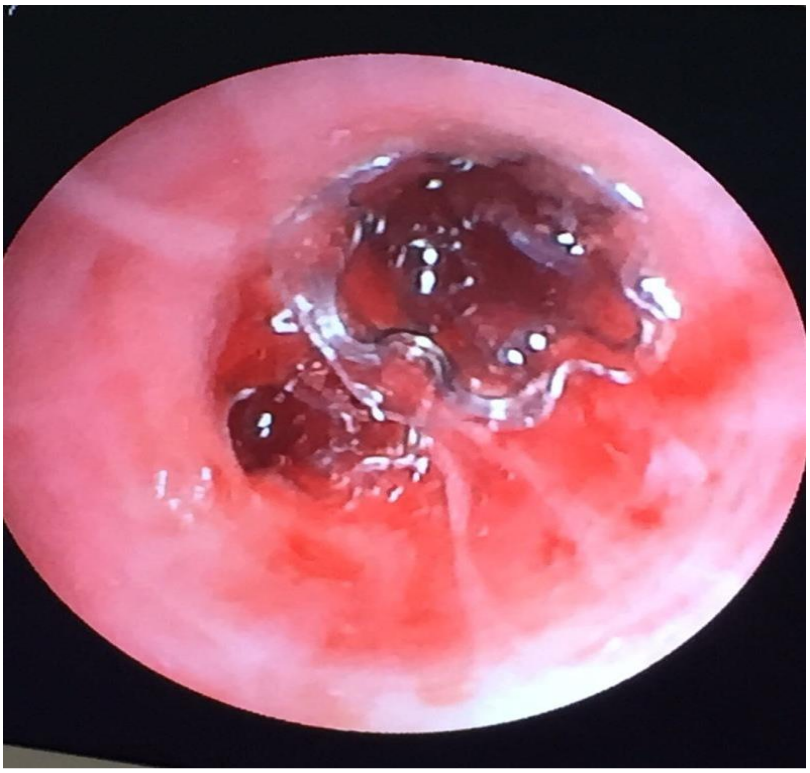

Figure 6: EBV placed in two segmental bronchi of basal pyramid of RLL

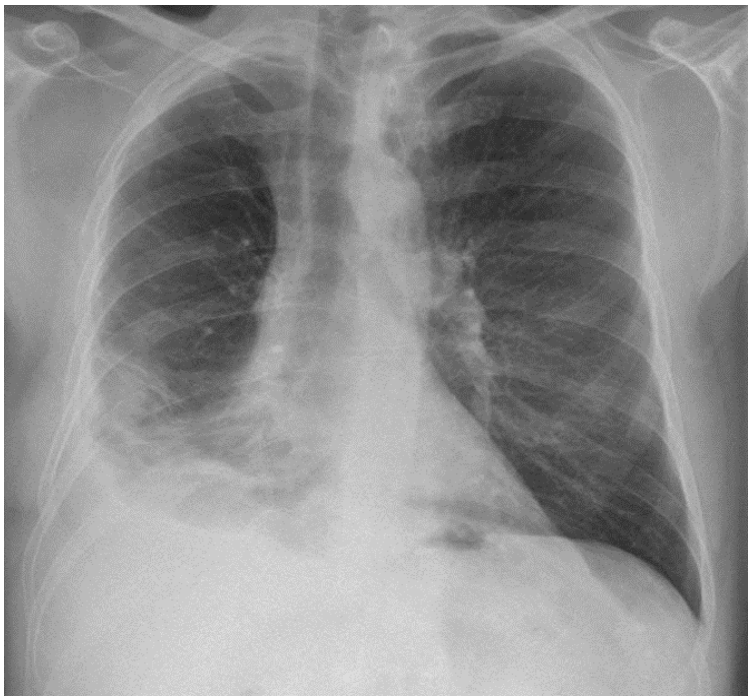

Figure 7: 6 months result prior to EBV removal

Discussion

Air leak is the most common postoperative complication after lung surgery and it is defined prolonged (PAL) when persisting 5 or more days after intervention. The incidence varies from 10% (Society of Thoracic Surgeons (STS) General Thoracic Surgery Database (GTSD)) to 25% in other reports [2,3]. PAL significantly affects postoperative outcome (pain, ateletactasis, pneumonia, venous thromboembolism), increases in-hospital lenght of stay and consenquently costs by an average 30% [4,5,6,7]. Moreover, PAL also is associated with increased in-hospital mortality, with 3.4 times greater risk of death than those without (95% confidence interval [CI], 1.9–6.2) [4].

Air leak originates from an alveolar-pleural fistula or a broncho-pleural fistula (BPF): the first is defined as a communication between the alveoli of the pulmonary parenchyma distal to a segmental bronchus with the pleural space, conversely, broncho-pleural fistula is when the communication exists between main stem, lobar of sublobar bronchus [8]. BPF is less common than alveolar-pleural fistula, with an incidence less or equal to 1% after lobectomy and sublobar resections (anatomical and non-anatomical segmentectomy) and 4-20% after pneumonectomy [9,10], but is a major complication with much greater mortality rate (11% to 18% for early BPF, within 30 days of surgery) and 0% to 7% for late BPF (beyond 30 days of surgery) [11,12].

Among risk factors for alveolar-pleural fistula there are demographic factors (advanced age), clinical factors (BMI<25 kg/m2, FEV1<80%, lower DLCO, pulmonary emphysema, infectious agents like Mycobacteria and Aspergillus) and intraoperative factors (large wedge resections for deeper nodules, longer stapling lines, incomplete fissure approached through non fissureless techniques, presence of pleural adhesions and resection of upper lobes). Regarding BPF, diabetic microangiopathy is the main clinical factor since bronchial stump healing is particularly affected by small vessel ischemia. Neoadjuvant therapies and infectious diseases also significantly worsen the incidence of BPF. Finally, postoperative prolonged positive-pressure mechanical ventilation is a risk factor for PAL, both from alveolar than bronchial origin.

However, lung surgery is not the only cause of this heterogeneous challenging entity: various other procedures (including radiofrequency ablation or simple thoracentesis) and also structural lung disease (emphysema, bronchiectasis, or any form of cavitary lung disorders) can lead to spontaneous alveolar-pleural fistula (APF) or BPF.

Radiofrequency ablation and especially lung LASER-assisted resections both induce cavitary lesion in lung parenchyma with remarkable peri-lesional fibrotic reaction due to heat damage. Scar tissue may prevent spontaneous closure of a BPF complicating lung LASER resection, leading to prolonged air leak. Therefore, usual treatment of this complication (insertion and maintaining of chest tube) may be ineffective despite suction or procedures to stop air leakage (as autologus blood patch). Redo-surgery by VATS or toracotomy has an high rate of success in fixing fistulae through several techniques (re-resection, surgical sealant, pleural curtain) but it may have some contraindications/technical issues (severely ill patients unfit for surgery, emphysematous lung, diffuse pleural adhesions with risk of causing other pulmonary breaches preventing air leak resolution). Moreover, as in Case 1, extended resections (e.g. bilobectomy or lobectomy and wedge resection) with low amount of residual parenchyma usually contraindicates further resections and may be associated to remarkable residual pleural space. Surgery in case 1 was uneffective as in other case resported in literature [13,14], having different etiology (infectious diseases, cavitary lung diseases), with or without concomitant pleural empyema.

In this limited experience, one of EBV employment advantage was the poor/absent pulmonary atelectasis of segments afferent to bronchi which EBV were placed in, allowing near complete pleural cavity occupancy once air leak stopped. In another case reported in literature, EBV were used to complete right upper lobe exclusion (after balloon occlusion test) in a patients who had undergone lower lobectomy with persistent air leak [15]. Absence of atelectasis after lobar exclusion for persistent air leak in our case was highly suggested by chest x-ray and CT scan, and it is indicative of collateral ventilation, a common phenomenon in emphysematous patients with incomplete fissures. At the same time, collateral ventilation does not seem to allow significant airflow enough to prevent quick leak closure.

Conclusion

EBV represents a valid and safe therapeutic option in complex APF or BPF when some factors (scar tissue surrounding air leak site, residual pleural space, previous extended lung resection, pleural thickening and pulmonary coartaction) may prevent success of surgical (re)intervention or in patients unfit for surgery. Infectious diseases, atelectasis, respiratory failure and migration are not frequent complications [16].

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