# Endoskopische Ventilimplantation – eine Option bei persistierendem Airleak?

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OKL/ Elisabethinen LINZ

# Disclosure

- Vortragstätigkeit: ERBE, Medtronic, AstraZeneca, GSK

# Definition persistierendes „Air leak" (PAL)

- Persistent Air Leak (PAL) is generally defined as an air leak from the lung lasting more than 5–7 days despite chest tube drainage

- PALs are typically caused by bronchopleural fistula/ alveolopleural fistula.

- Alveolar-pleural fistula defines a communication between the pulmonary parenchyma distal to a segmental bronchus and the pleural space.

- Classification systems uses the traditional analog scale (Cerfolio G4/G5):



| Classification | Description |
| --- | --- |
| Grade 1 | Air leak observed only at forced expiration or cough |
| Grade 2 | Air leak observed with normal expiration |
| Grade 3 | Air leak observed with normal inspiration |
| Grade 4 | Air leak observed throughout the respiratory cycle but ceases momentarily |
| Grade 5 | Continuous air leak observed throughout the entire respiratory cycle without cessation |
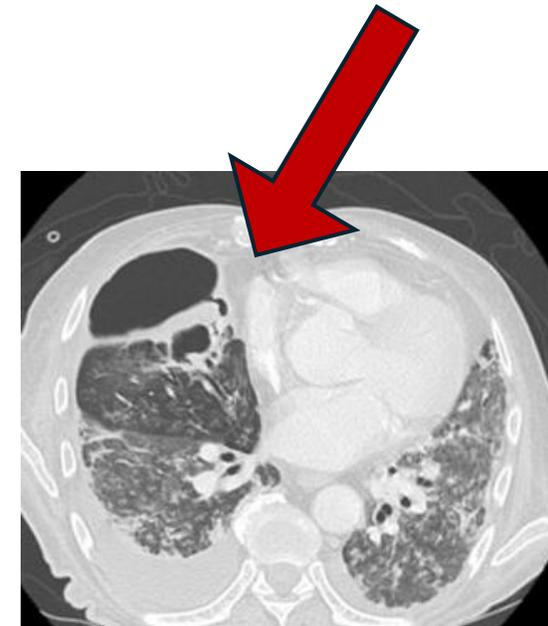
# Patient-Related Risk Factors

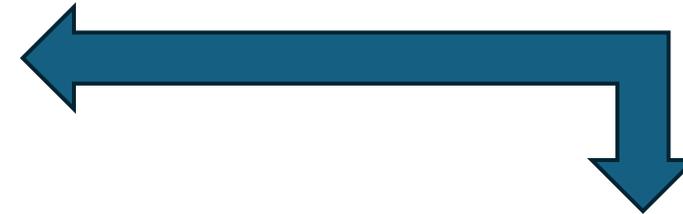| Risk Factor | Description |
|---|---|
| Chronic Lung Diseases | Conditions such as COPD, emphysema, or pulmonary fibrosis increase risk. |
| Smoking History | Smoking adversely affects the integrity of lung parenchyma. |
| Tumor Stage | Advanced stages often require more extensive surgical resections, potentially increasing the vulnerability of lung tissue. |
| Age and Nutritional Status | Elderly patients and those with poor nutritional status may have reduced tissue repair capabilities. |
| Obesity | Obesity can lead to increased surgical complications. |
| Genetic Predisposition | Genetic factors may influence lung tissue integrity and the ability to heal. |
| Preoperative Pulmonary Function | Lower preoperative lung function can indicate a higher risk of PAL. |
| Immunosuppression | Patients with weakened immune systems may have delayed healing. |
| Diabetes Mellitus | Diabetes can impair wound healing and lung recovery. |

# Surgical and Perioperative Risk Factors for PAL

| Risk Factor | Description |
|---|---|
| Type of Surgery | Certain procedures, like lung resections and lung volume reduction surgery for emphysema treatment, have a higher incidence of PAL. |
| Upper Lobe Resections | Upper lobe resections carry a higher risk of air leak due to their greater elastic recoil, sparser anastomotic blood supply, prevalence of emphysematous changes in the upper lobes, and the technical challenges associated with their proximity to major airways and vessels. |
| Pleural Adhesions | They complicate surgical dissection, potentially leading to inadvertent lung parenchyma injury and disruption of the lung surface integrity during surgery. |
| Surgical Technique | Use of certain instruments and techniques can affect tissue integrity. |
| Intraoperative Lung Manipulation | Excessive handling or manipulation of lung tissue can predispose to PAL. |
| Extended Operative Time | Longer surgeries may increase the risk of PAL due to prolonged exposure. |
| Anesthesia Type | Specific types of anesthesia may affect lung function. |
| Postoperative Pain Management | Inadequate pain management can prevent effective coughing and deep breathing. |
| Mechanical Ventilation Use | Use of mechanical ventilation can affect lung mechanics. |
| Experience of Surgical Team | Less experienced surgical teams may cause higher rates of PAL due to technique variability. |

# Risikostratifizierung: Wie tun??

# Aggregate Prolonged Air Leak (PAL) : Brunelli Score for a Patient Undergoing Lobectomy

| Parameter | Finding | Points |
|---|---|---|
| age in years | <= 65 years of age | 0 |
| | > 65 years of age | 1 |
| BMI | >= 25.5 kg per sq meter | 0 |
| | < 25.5 kg per square meter | 2 |
| FEV1 | >= 80% of predicted | 0 |
| | < 80% of predicted | 1.5 |
| dense pleural adhesions | absent | 0 |
| | present | 1 |

| Score | Class | Prolonged Air Leak |
|---|---|---|
| 0 | A | < 1.5% |
| 1 | B | 5–7% |
| 1.5 to 3 | C | 11–13% |
| 3.5 to 5.5 | D | 26–29% |

**ORIGINAL ARTICLE**

# Performance of prolonged air leak scoring systems in patients undergoing video-assisted thoracoscopic surgery segmentectomy

Michel Gonzalez [ID] [a,e,*], Wolfram Karenovics[b,e], Benoît Bédat [ID] [a,e], Celine Forster[a,e], Marc-Olivier Sauvain[c,e], Frédéric Triponez [ID] [b,e], Michel Christodoulou[d,e], Thorsten Krueger[a,e], and Jean Yannis Perentes[a,e]

**Table 3:** Multivariable analysis of risk factors for PAL > 5 days

| Risk factors | Odds ratio | 95% Confidence interval | P-value |
|---|---|---|---|
| Gender (female) | 0.616 | 0.34 to 1.11 | 0.110 |
| BMI > 30 | 0.166 | 0.04 to 0.73 | 0.018 |
| Pleural adhesions | 2.115 | 1.07 to 4.17 | 0.031 |
| ASA score > 2 | 1.392 | 0.75 to 2.57 | 0.290 |
| Tobacco use | 3.112 | 1.05 to 9.25 | 0.041 |
| Diabetes mellitus | 0.278 | 0.09 to 0.84 | 0.024 |
| FEV1 < 80% | 1.441 | 0.77 to 2.67 | 0.251 |
| DLCO < 80% | 2.400 | 1.11 to 5.14 | 0.025 |

**Table 1:** Patient characteristics and postoperative outcomes

| Patient characteristics | Total (%) | No PAL | PAL >5 days | p-value |
|---|---|---|---|---|
| Patients (n.b.) | 453 | 389 (85.9) | 64 (14.1) | |
| Sex | | | | |
| Female | 226 (49.8) | 200 (51.4) | 26 (40.6) | 0.109 |
| Male | 227 (50.2) | 189 (48.6) | 38 (59.4) | |
| Age, mean (SD), years | 66.5 (10.2) | 66.5 (10.3) | 66.4 (8.9) | 0.966 |
| Age > 70 years | 188 (41.5) | 162 (41.6) | 26 (40.6) | 0.877 |
| BMI, mean (SD) | 25.2 (4.6) | 25.4 (4.6) | 23.3 (3.9) | <0.001 |
| BMI < 18 (%) | 26 (5.7) | 19 (4.9) | 7 (10.9) | 0.061 |
| BMI > 30 (%) | 74 (16.3) | 71 (18.3) | 3 (4.7) | 0.002 |
| Pleural adhesions (%) | 74 (16.3) | 56 (14.4) | 18 (28.1) | 0.009 |
| Dyspnoea score (%) | | | | |
| 0 | 272 (60) | 248 (63.7) | 24 (37.5) | 0.006 |
| 1 | 119 (26.3) | 92 (23.7) | 27 (42.2) | |
| 2 | 51 (11.2) | 42 (10.8) | 9 (14.1) | |
| 3 | 11 (2.4) | 7 (1.8) | 4 (6.3) | |
| Comorbidities (%) | | | | |
| Hypertension | 217 (47.9) | 184 (47.3) | 33 (51.6) | 0.527 |
| Cardiopathy | 76 (16.8) | 63 (16.2) | 13 (20.3) | 0.42 |
| Tobacco | 357 (78.8) | 297 (76.3) | 60 (93.8) | <0.001 |
| Diabetes mellitus | 60 (13.2) | 56 (14.4) | 4 (6.3) | 0.053 |
| ASA score >2 | 235 (51.9) | 194 (49.9) | 41 (64) | 0.034 |
| PFTs | | | | |
| FEV1, mean (SD) | 85.8 (22.5) | 87.5 (22.3) | 75.9 (21.1) | <0.001 |
| FEV1 < 80% (%) | 170 (37.5) | 133 (34.2) | 34 (53.1) | <0.001 |
| DLCO, mean (SD) | 73.7 (21.7) | 75.5 (21.8) | 63.2 (17.4) | <0.001 |
| DLCO < 80% (%) | 263 (58.1) | 212 (54.5) | 51 (79.7) | <0.001 |

**Table 4:** Distribution of patients and incidence of PAL by different scoring systems

| Scoring systems | Expected incidence of PAL (%) | Incidence of PAL of VATS segmentectomy | Percentage of PAL (%) |
|---|---|---|---|
| Brunelli score (PAL > 5 days) | | | |
| Class A | 1.4 | 3/45 | 6.8 |
| Class B | 5 | 2/62 | 3.2 |
| Class C | 12.5 | 24/222 | 10.8 |
| Class D | 29 | 35/124 | 28.2 |
| Epithor score (PAL > 5 days) | | | |
| Very low | 2.1 | 0/13 | 0 |
| Low | 3.9 | 0/50 | 0 |
| Moderate | 5.6 | 2/40 | 5 |
| High | 8.2 | 5/79 | 6.3 |
| Very high | 14.7 | 57/271 | 21 |
| ESTS score (PAL >5 days) | | | |
| Class A | 6.3 | 10/142 | 7 |
| Class B | 9.9 | 26/197 | 13.2 |
| Class C | 13 | 23/96 | 24 |
| Class D | 25 | 5/18 | 27.8 |

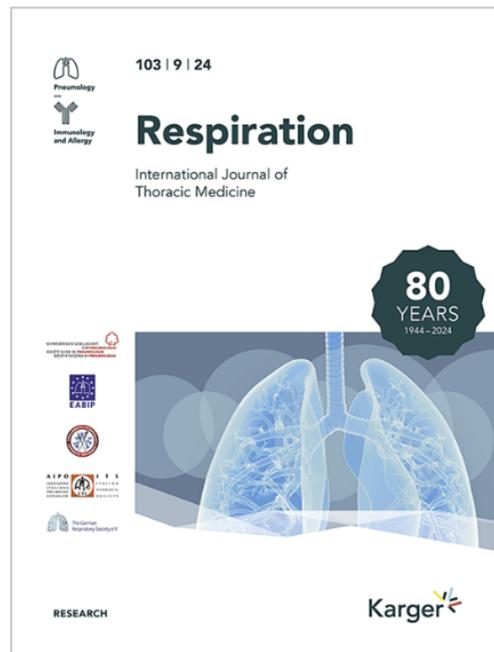ESTS: European Society of Thoracic Surgeons; PAL: prolonged air leak.

# Air leak: Was nun?

# Indikation: Endobronchial Valves in PAL

- Patients with severe PAL or leaks refractory to other methods of control may benefit from bronchoscopic placement of a unidirectional endobronchial valve (EBV) in the segmental bronchi, occluding distal airflow

# Endobronchial Valves in Treatment of Persistent Air Leak: European Case-Series Study and Best Practice Recommendations – From an Expert Panel

Special Collection:  Karger e-Journal Backfile Collection 2024

Subject Area: Pneumology

Illaa Smesseim; Louis-Vincent Morin-Thibault; Felix J.F. Herth; James Tonkin; Pallav L. Shah ; Dirk-Jan Slebos; David T. Koster; Chris Dickhoff; Johannes Marlene Andreas Daniels; Jouke Annema; Peter Bonta

**Article Contents**

# EBV in PAL: Results

- 66 patients, male (66.7%), median age 59.5 years.
- The most common underlying lung disease: COPD (39.4%) and lung cancer (33.3%).
- The median time between pneumothorax and valve placement was 24.5 days (interquartile range: 14.0–54.3).
- Air leak resolved in 40/66 patients (60.6%) within 30 days after EBV treatment.
- Concerning safety outcome, no procedure-related mortality was reported and complication rate was low (6.1%). Five patients (7.6%) died in the first 30 days after intervention.

***Conclusion:*** EBV placement is a treatment option in patients with PAL. In this multicenter case-series of high-risk patients **<span style="color:red">not eligible for lung surgery</span>**, EBV placement resulted in air leak resolution in 6 out of 10 patients with a low complication rate.

Considering the minimally invasive nature of EBV to treat PAL as opposed to surgery, further research should investigate if EBV treatment should be expanded in low to intermediate risk PAL patients.

# EBV für PAL

## Endobronchial valves for emphysema and persistent air-leak: 10-year experience in an Asian country

Jin-Young Huh[1], Byeong-Ho Jeong[2], Ho il Yoon[3], Hojoong Kim[2], Young-Jae Cho[3], Changhwan Kim[4,5], Seung Jun Lee[6], Hwan hee Kim[7], Seung Won Ra[8], Ye Jin Lee[3], Beong Ki Kim[9], Sung Kyoung Kim[10], Ki Hyun Seo[11] and Sei Won Lee[12]*

**Within the subset of 18 patients with PAL, the predominant causes of air-leak included:**

spontaneous secondary pneumothorax (44.0%), parapneumonic effusion/empyema (22.2%), post-lung resection surgery (16.7%).

Follow up: 77.8% successfully had their chest tubes removed. Post-procedural complications were minimal, with two incidences of hemoptysis and one of empyema, all of which were effectively managed.
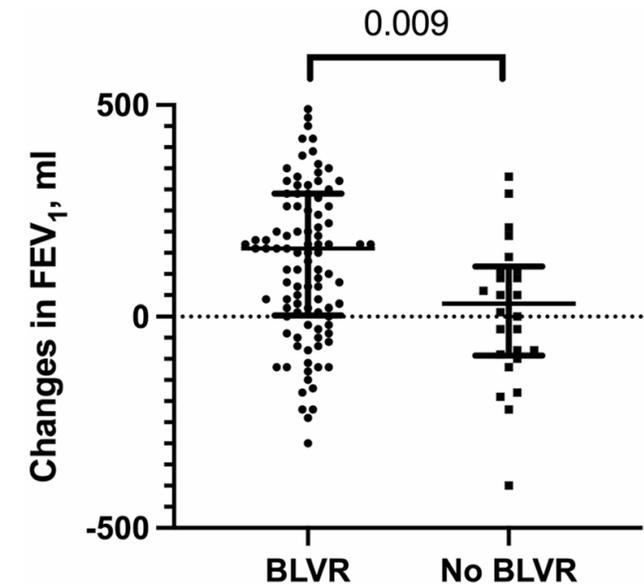


**Fig. 3** Changes in FEV$_1$ 3 months after evaluation for BLVR. Abbreviations: FEV$_1$, forced expiratory volume in 1 s, BVLR, bronchoscopic lung volume reduction

Huh et al. BMC Pulmonary Medicine :2024

# A single-institution out... ...ment for persistent air leak

Kaity H. Tung, MD,[a,b] Sujay Sreen... ...ra Gupta, MD,[b]
Nathaniel M. Ivanick, MD, FCCP,[b...]

Check for updates

**TABLE 2. Outcomes of patients who underwent bronchial valve placement for persiste...**

| Lung resection | Open thoracotomy | VAT... |
|---|---|---|
| n | 5 | 39 |
| FEV$_1$ (% predicted) | 62 ± 12 [59] | 76 ± 19 |
| DLCO (% predicted) | 58 ± 13 [55] | 74 ± 20 |
| Cancer resection | 4 | 34 |
| Noncancerous resection | 1 | 5 |
| Air leak duration pre-BV, d | 9 ± 3 [8] | 11 ± 9 |
| BV to CT discontinuation, d | 10 ± 6 [13] | 9 ± 7 |
| Discharged with air leak, n (%) | 4 (80) | 23 (5... |
| Number of valves per patient | 2 ± 1 [2] | 3 ± 1 |
| Location of valves | RUL: 4 RLL: 7 | RUL: 30 RML: 10 ... RLL: 37 |
| Number of patients with air leak resolution, n (%) | 5 (100) | 37 (9... |
| Repeat bronchoscopy with additional valves placed, n (%) | 0 (0) | 6 (15... |
| Pleurodesis pre-BV, n (%) | 0 (0) | 16 (4... |
| Pleurodesis post-BV, n (%) | 0 (0) | 5 (13... |
| Number of patients with BV removed, n (%) | 3 (60) | 35 (9... |
| Interval to valve removal, d | 40 ± 2 [40] | 50 ± 45 |
| 90-d all-cause mortality rate post-BV | 0 (0) | 3 (8... |

Mean ± standard deviation [median]. *VATS*, Video-assisted thoracoscopic surgery; *RATS*, robot-assisted tho... volume in 1 second; *DLCO*, diffusing capacity of the lungs for carbon monoxide; *BV*, bronchial valve; *CT*, ... middle lobe; *LUL*, left upper lobe; *LLL*, left lower lobe.

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**[1]Standard Chest Tube Maneuvers**
- Increase or decrease suction
- Add or reposition tube
- Bronchodilators
- Incentive spirometry
- Pulmonary toilet
- Consider chest computed tomography (Round 2)

**[2]Advanced Techniques**

**FIRST ROUND**

*Bronchial Valves*
- Iatrogenic pneumothorax
- Lung resection

*Chemical Pleurodesis*
- Pleural malignancy
- Secondary spontaneous pneumothorax

*Surgery*
- Bronchopleural fistula

**SECOND ROUND**

*Bronchial Valves*
- Pleural malignancy
- Secondary spontaneous pneumothorax
- Bronchopleural fistula

*Chemical Pleurodesis*
- Iatrogenic pneumothorax
- Lung resection

**≥ THIRD ROUND(S)**

*Repeat Chemical Pleurodesis or Revise Bronchial Valves*
- All air leak etiology in study

*Surgery*
- All air leak etiology in study

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...7 cases of BV placement for PAL after lung resection (n =49), iatrogenic or spontaneous pneumothorax, pleural malignancy, bronchopleural fistula or exploratory thoracotomy (n = 18)
Air leak resolution was at least 95% across all categories, except for the spontaneous pneumothorax cohort (80%).
Only 7% of all patients underwent post-BV pleurodesis. Rate of BV removal for lung resection patients was 86% and 72% for other etiologies. 61% of patients were discharged safely with a chest tube
90-day all-cause mortality rate was 9%

# Empfehlung des Vorgehens:

# EBV in PSP

## Joint ERS/EACTS/ESTS clinical practice guidelines on adults with spontaneous pneumothorax

*PICO 6: Should bronchial valves be used for management of persistent air leak in spontaneous pneumothorax (compared to chest drain alone)?*

Recommendation

- The panel could make no recommendation for or against bronchial valves in patients with PSP who are not fit for surgery due to lack of evidence.
- The panel could make no recommendation for or against bronchial valves in patients with SSP who are not fit for surgery due to lack of conclusive evidence. *(No recommendation, very low quality of evidence)*

# Successful Endobronchial Valve Placement in the Treatment of Persistent Bronchopleural Fistula and Empyema Allows the Avoidance of Right Completion Pneumonectomy
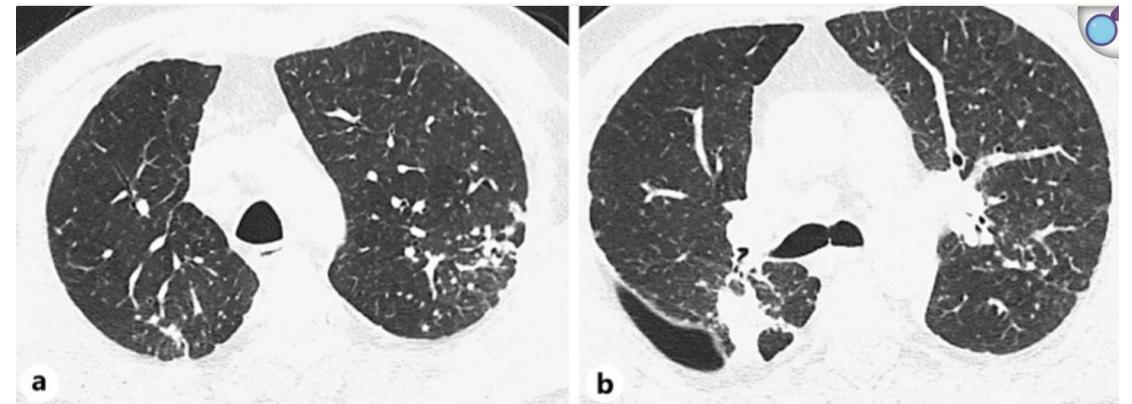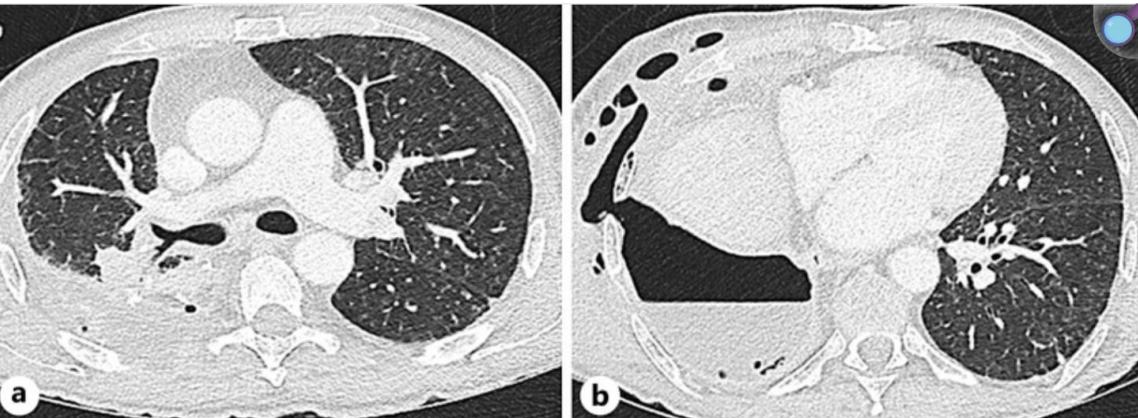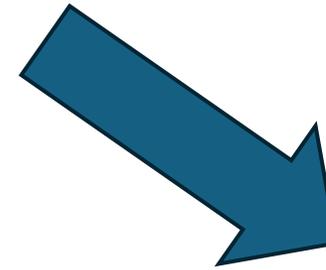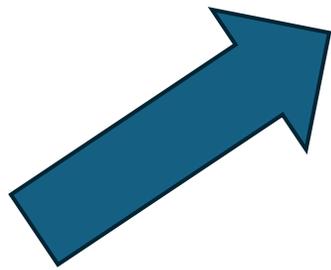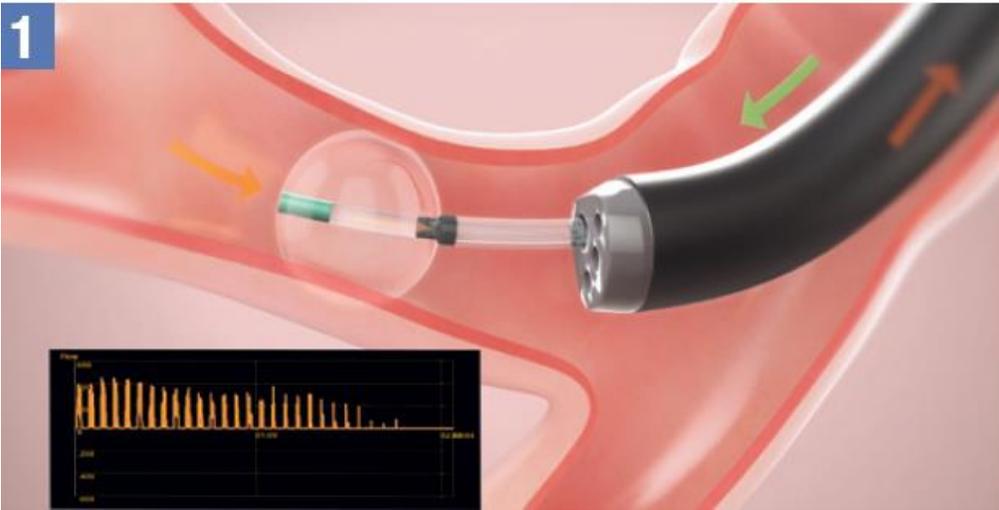
**Platzierung von Endobronchialventilen**
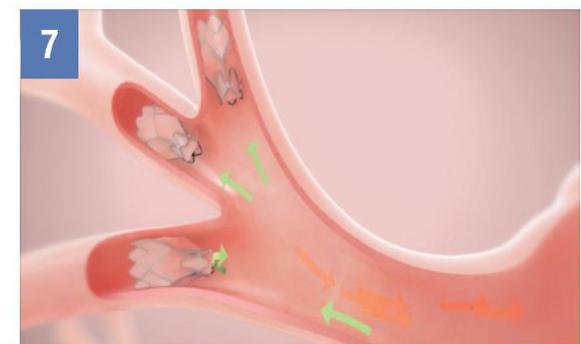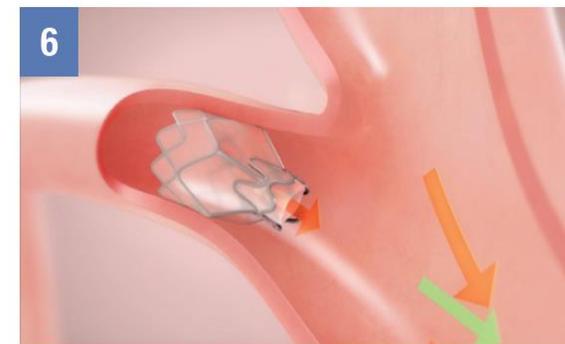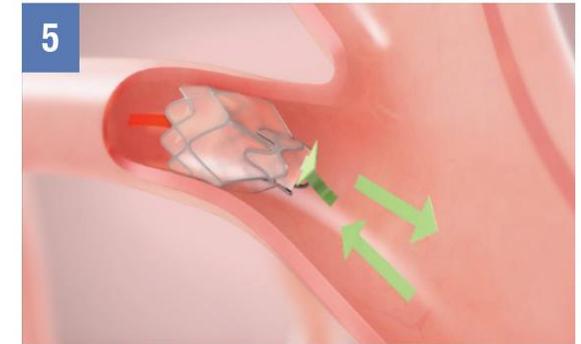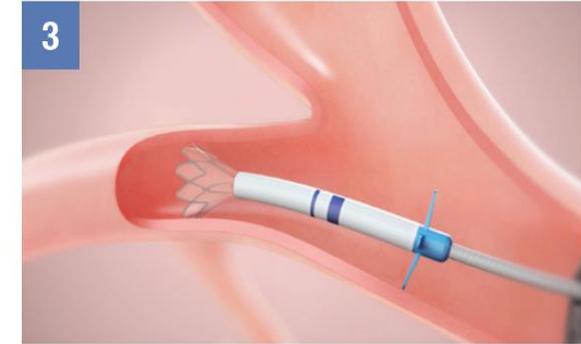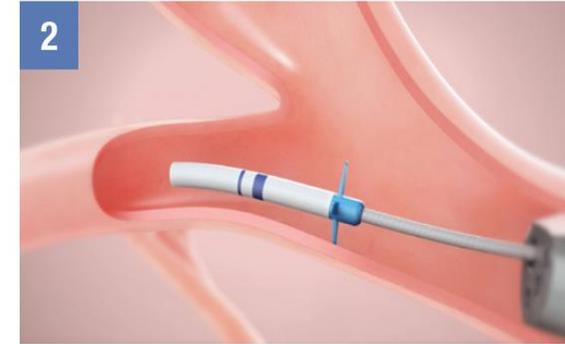
- (i) Identifizieren des spezifischen (Sub-): Ballon-Technik/ Chartis bei liegender Drainage bis Airleak endet
- (ii) Auswahl der Richtigen EBV Größe (Sizers)
- (iii) Platzieren des EBV

Kontrolle/ Entfernung des EBV planen

# Zusammenfassung:

Persistierende Air Leaks (PAL) stellen ein Problem, grade im p.o. Bereich dar

EBV sind zugelassen für die Therapie des PAL (Pulmonx JA, Olympus ?)

Datenlage: Keine großen prospektiven RCT, aber meist retrospektive Fall Serien

Implantation technisch: a) Identifizierung des Segmentes (Ballon/Chartis) b) Richtige Größe c) Implantation d) Entfernung planen

Zu wenig Daten über SAE derzeit

# VIELEN DANK !