UniversitätsKlinikum Heidelberg

Ein-Lungen-Ventilation

Propädeutik und Neuerungen

Johann Motsch

Pathophysiologie des offenen Thorax unter Spontanatmung

Inspiration

Mediastinalshift

- **Verminderter venöser Rückstrom**
- **Sympathicusaktivierung**
- **Hypotension, Schock**

Paradoxe Atmung

Pendelluft

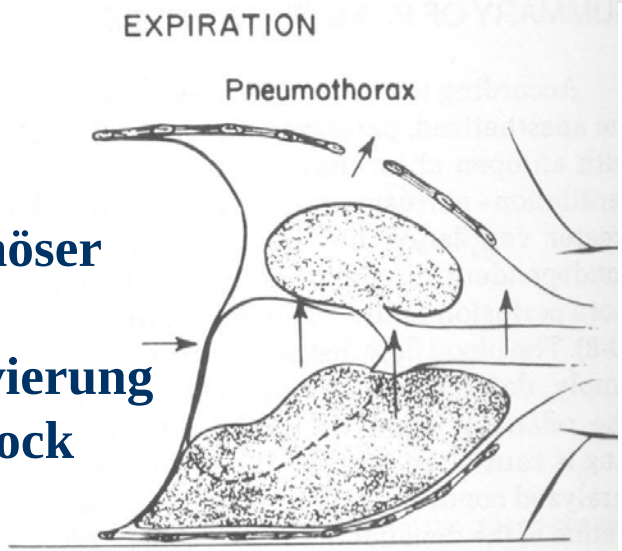
Expiration

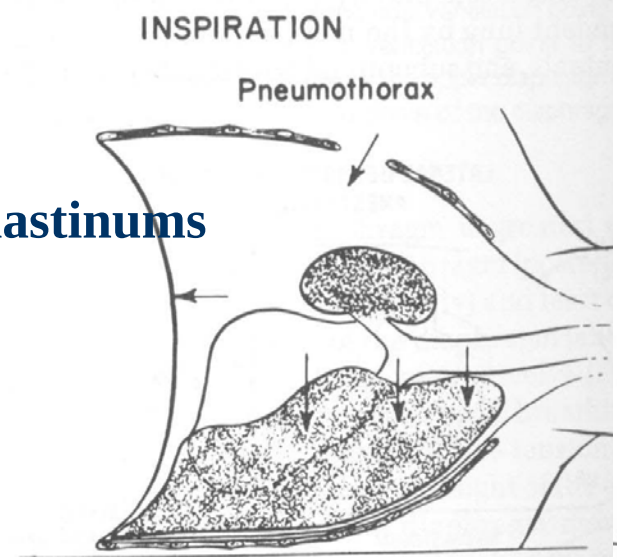
Verlagerung des Mediastinums

Paradoxe Atmung

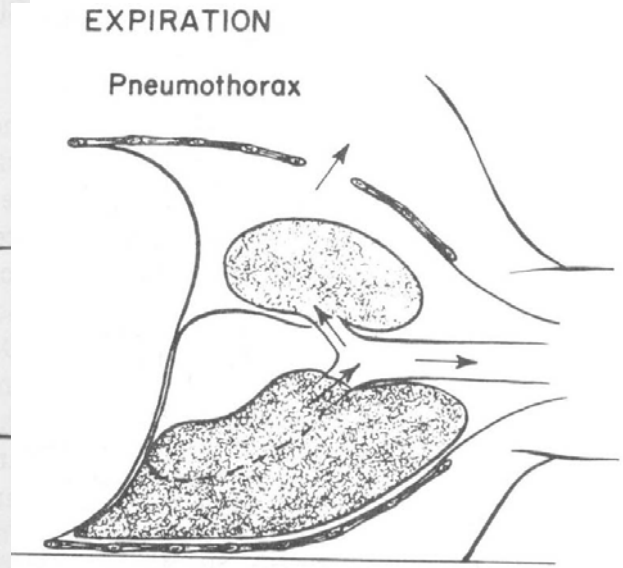
Pendelluft

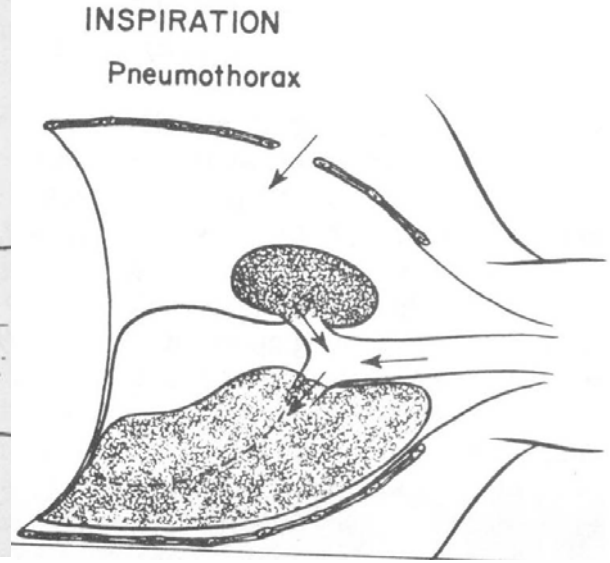
Mediastinalverlagerung





Paradoxe Atmung, Pendelluft





Pathophysiologie des eröffneten Thorax

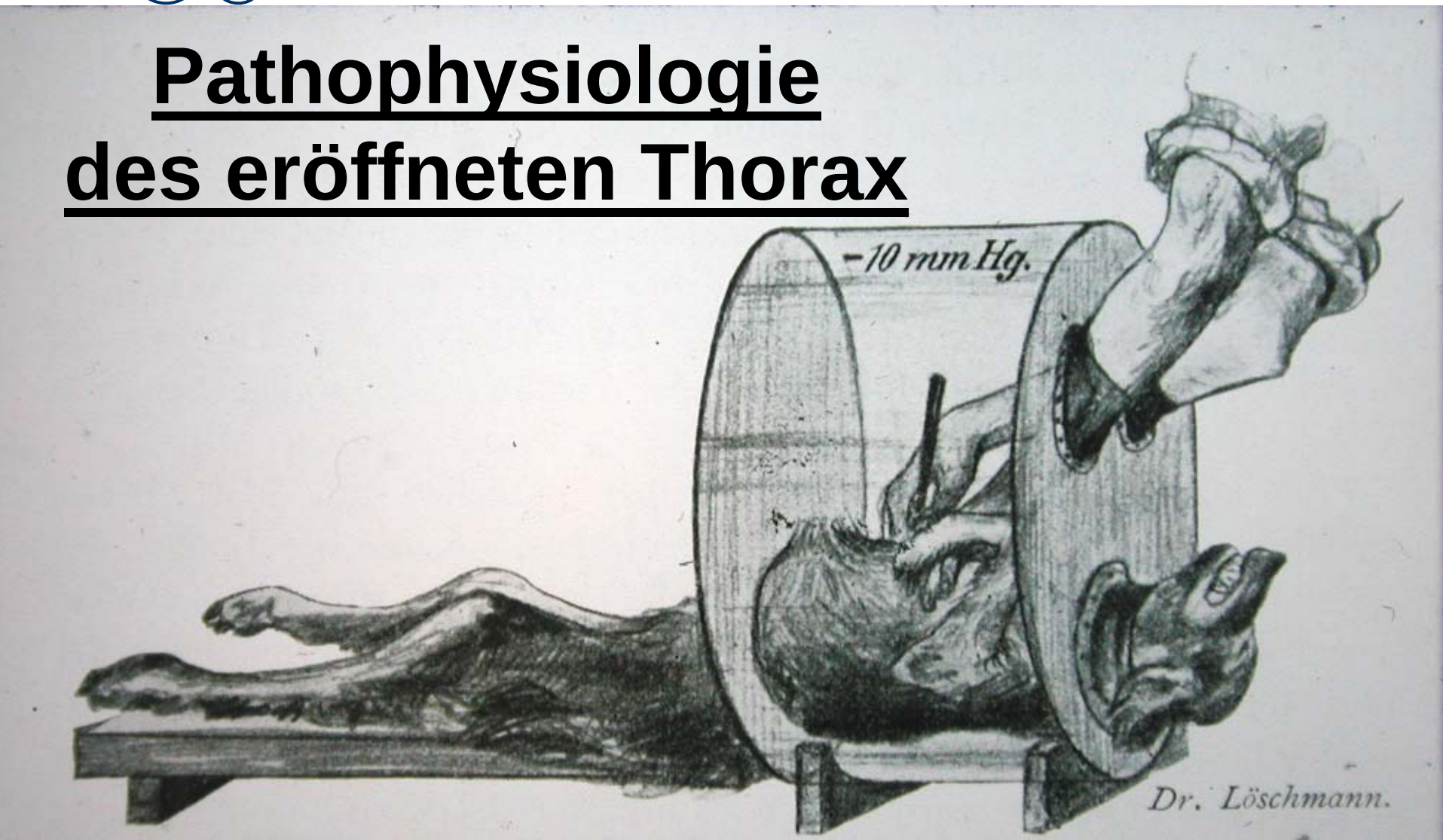


Fig. 2. Ursprünglicher Apparat zur Eröffnung der Brusthöhle. (Die Hände sind durch luftdicht schließende Manschetten in den Cylinder gesteckt; Kopf und Bauch des Tieres sind draußen; im Cylinder Luftdruck — 10 mm Hg.)

Sauerbruch´sche Unterdruckkammer

Offener Thorax

Vermeidung des Lungenkollaps

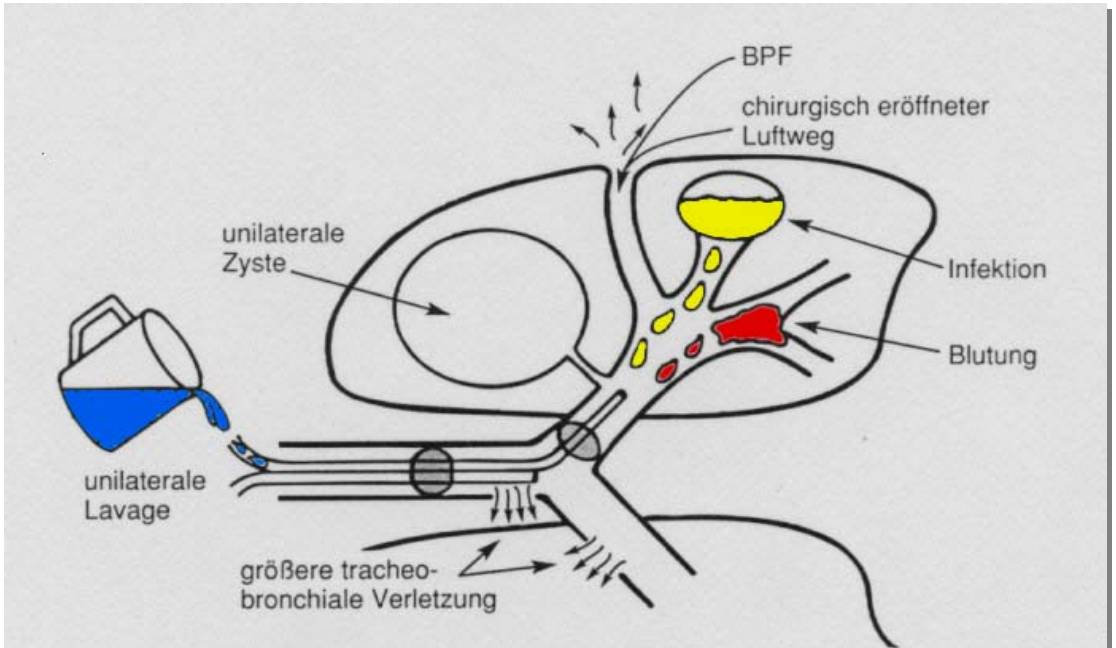
- Endotracheale Intubation
- Überdruckbeatmung

Anforderungen der modernen Thoraxchirurgie an die Anästhesie

- **Seitentrennung der Atemwege**
- **Ein-Lungen-Ventilation**

Seitentrennung der Atemwege

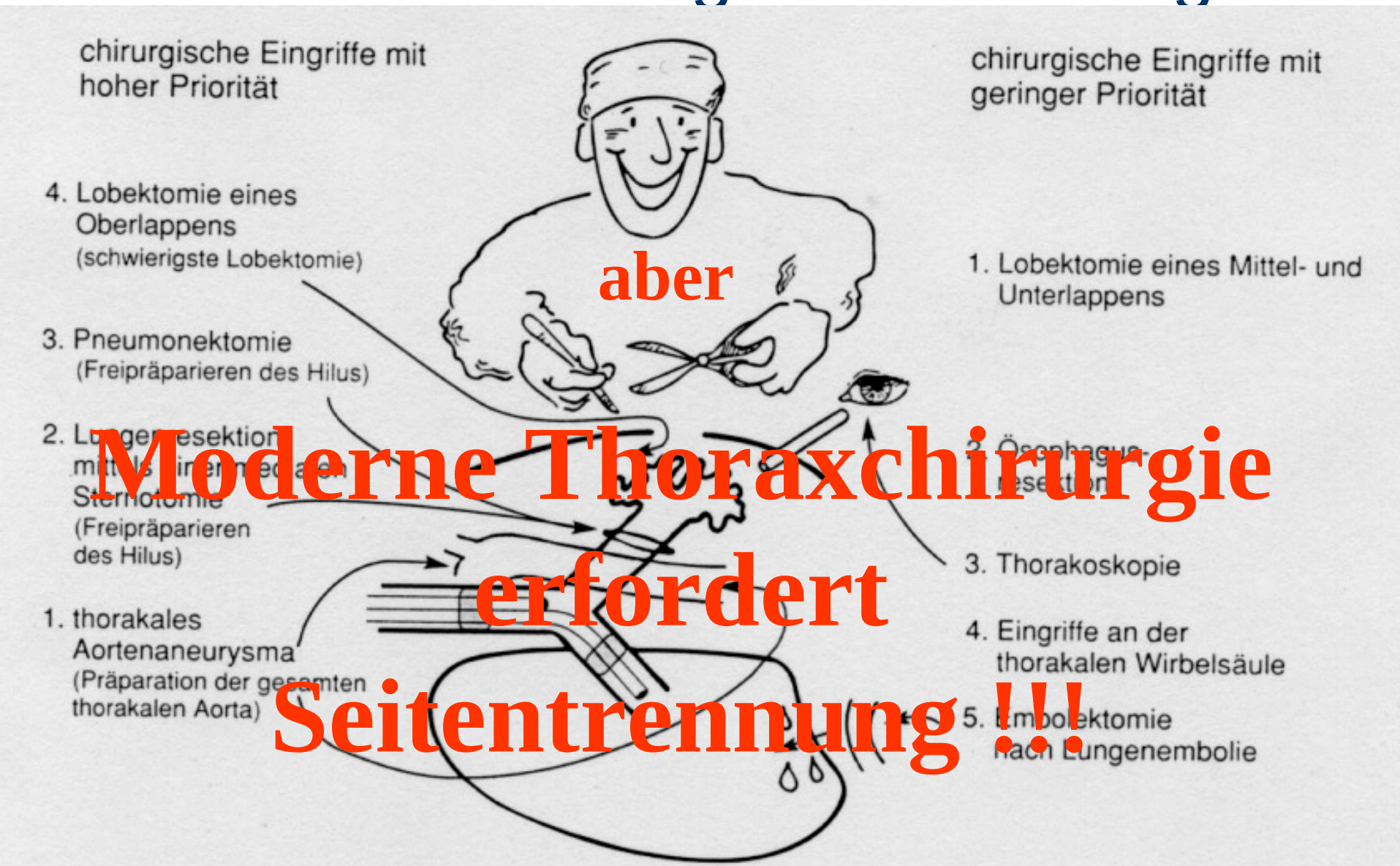
- Vermeidung von Sekretübertritt
- Vermeidung von Leckage
- Vermeidung von einseitiger Überblähung
- Vermeidung von alveolo-arterieller Gasembolie
- Schutz der anderen Lunge
- Optimierte Operationsbedingungen



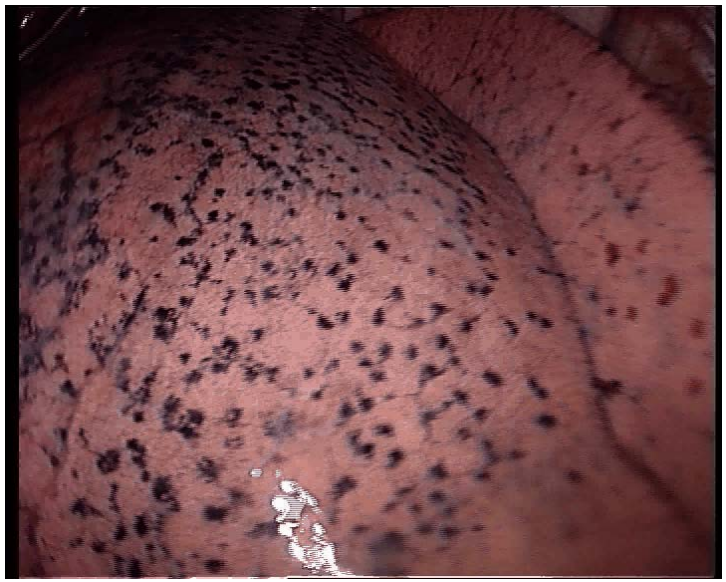
Absolute Indikation zur Seitentrennung

- **Haemoptyse**

Relative Indikationen zur Seitentrennung der Atemwege

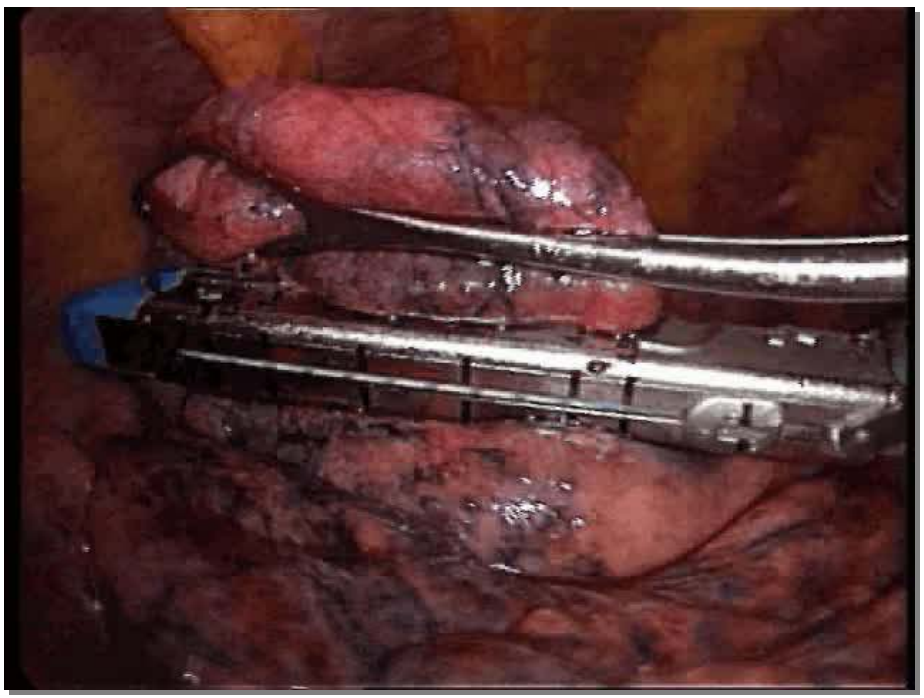


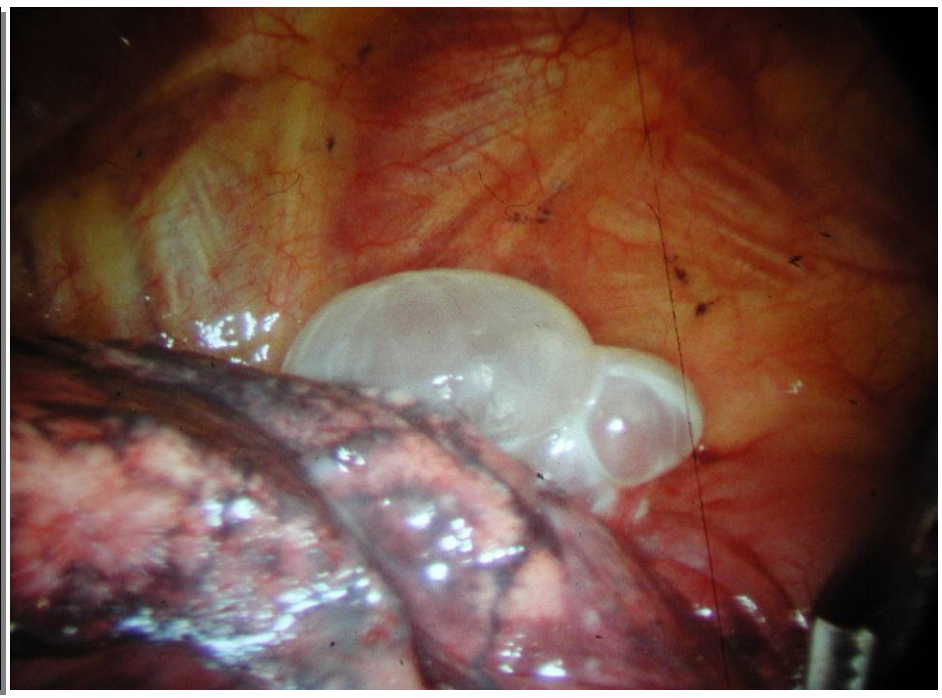
Thorakoskopische Operationen



VATS erfordert:

- **Ein-Lungen-Ventilation**
- **Atelektase**





Methoden zur Seitentrennung der Atemwege

- Doppellumentuben
- Univent-Tubus
- Bronchusblocker
- Arndt Endobronchialblocker
- Cohen Endobronchialblocker
- HFJV Hochfrequenzbeatmung

Methoden zur Seitentrennung der Atemwege

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  - Bronchusblocker
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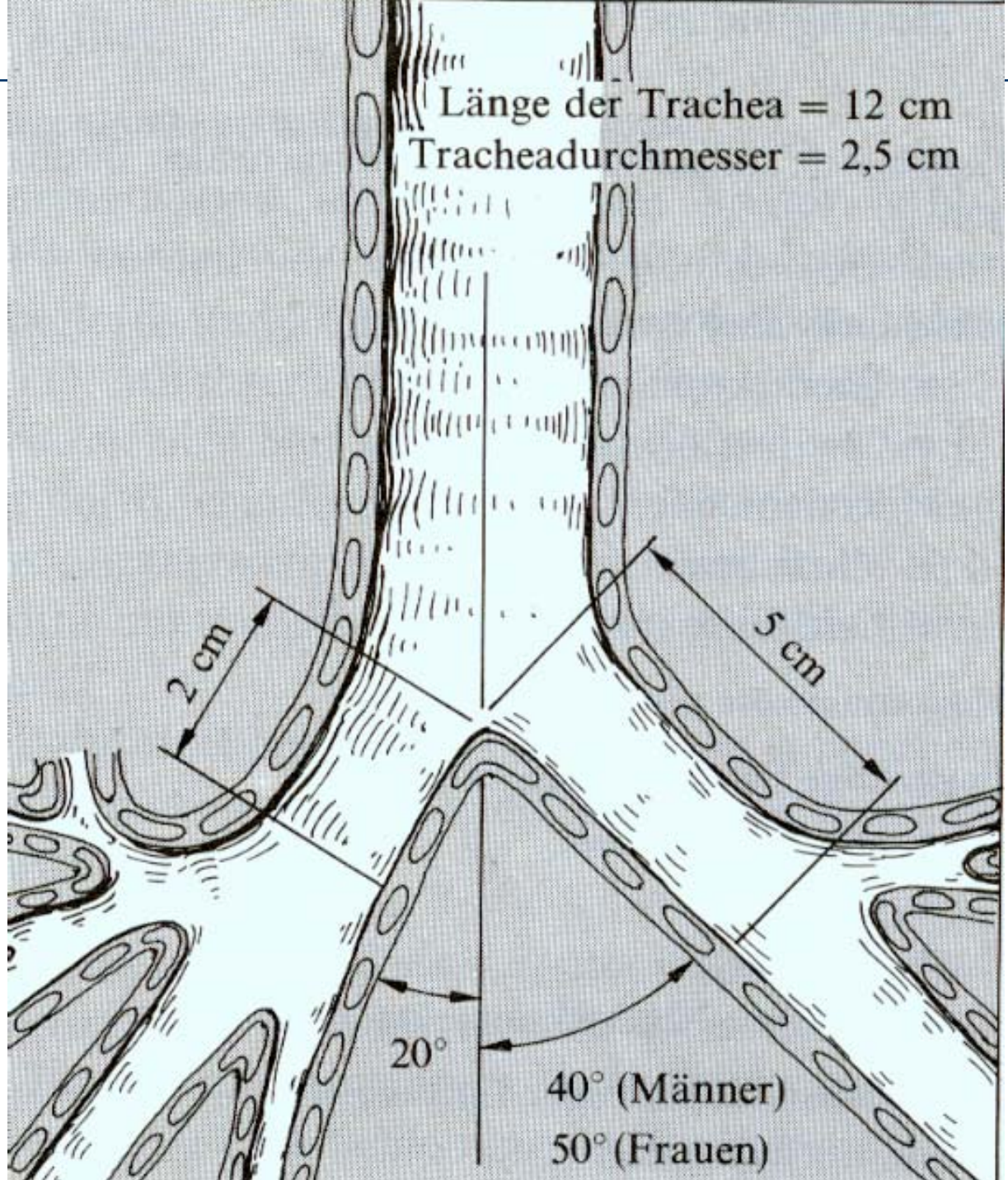
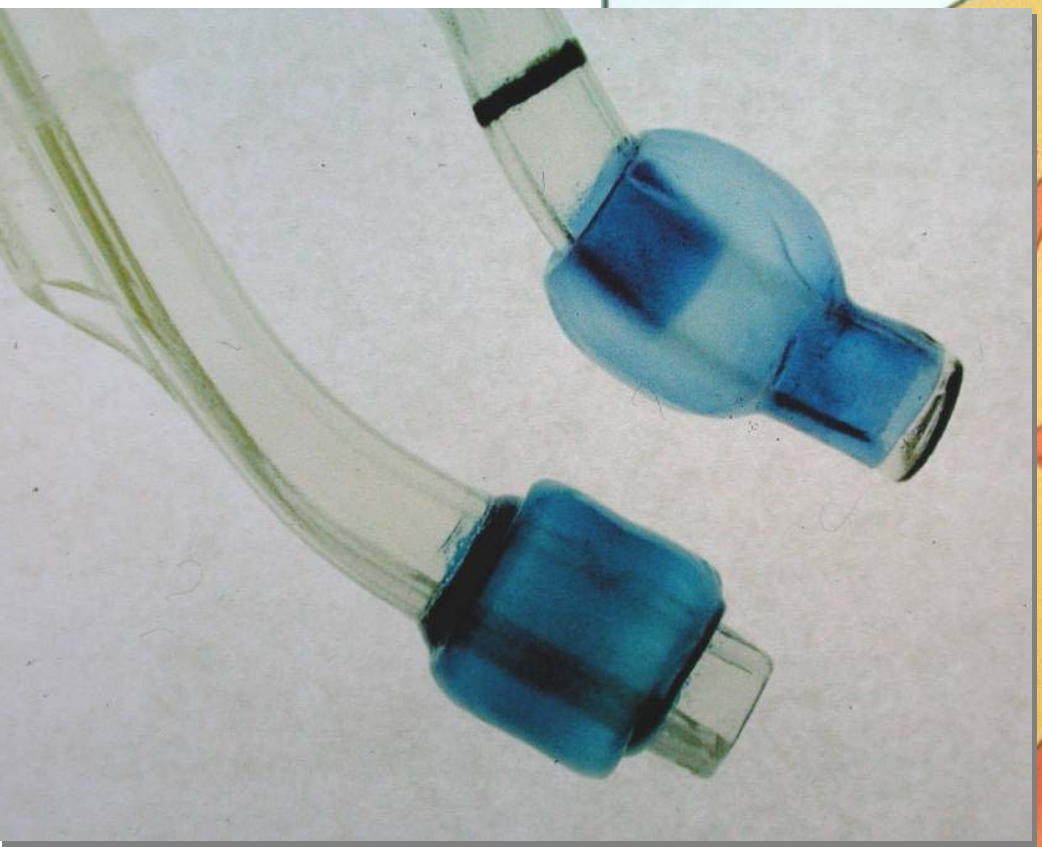
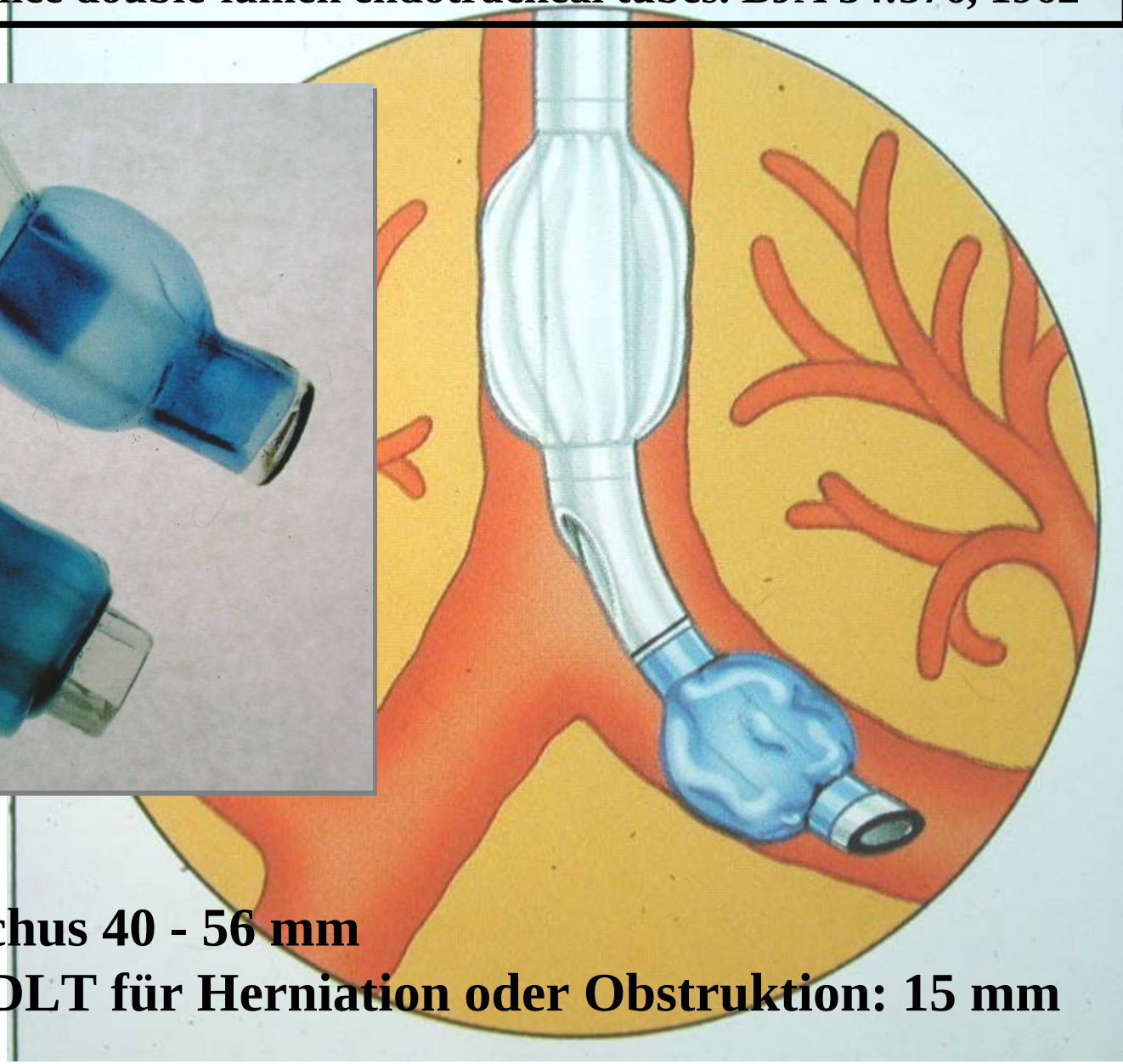
  - HFJV Hochfrequenzbeatmung

Bjork, Carlens: J Thorac Surg 20:151;1950
White GMJ: BJA 32:232; 1960


Länge der Trachea = 12 cm
Tracheadurchmesser = 2,5 cm
2 cm
5 cm
20°
40° (Männer)
50° (Frauen)

Robertshaw: Low resistance double-lumen endotracheal tubes. BJA 34:576, 1962

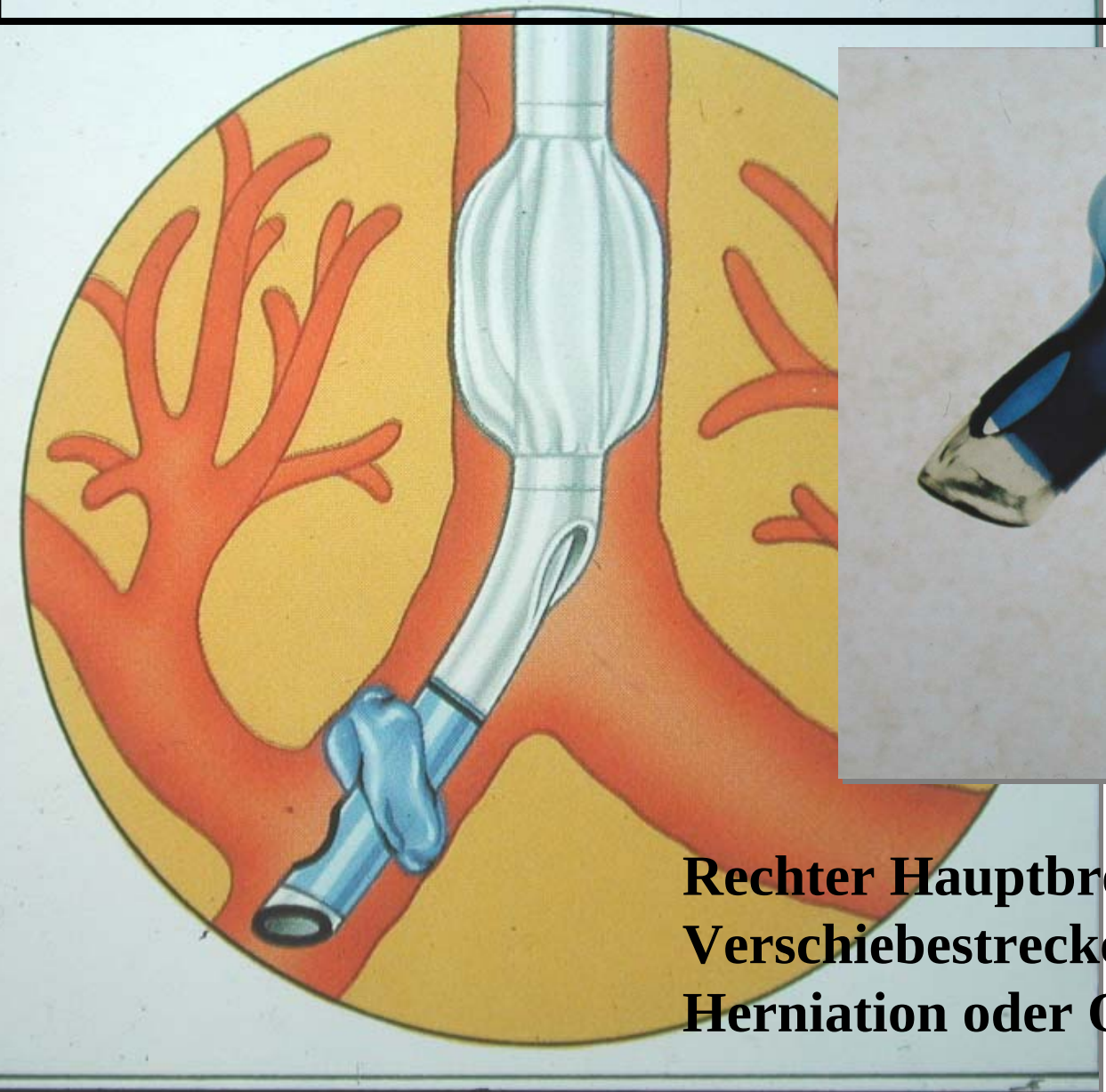


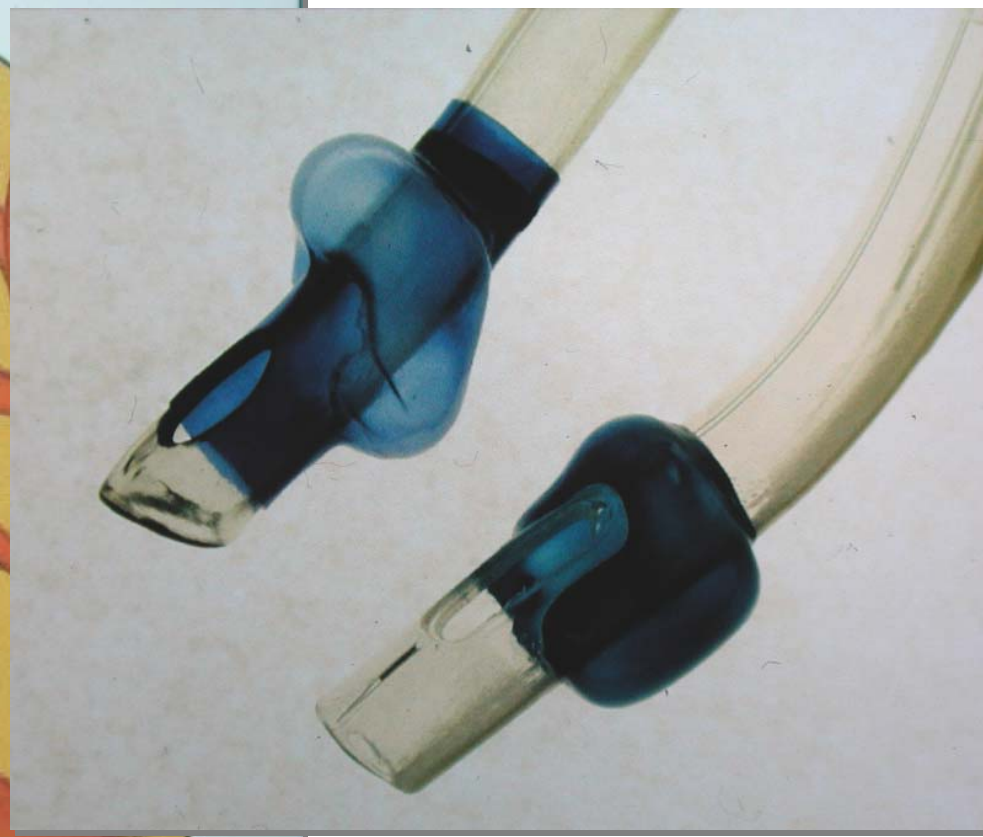


Linker Hauptbronchus 40 - 56 mm

Verschiebestrecke DLT für Herniation oder Obstruktion: 15 mm

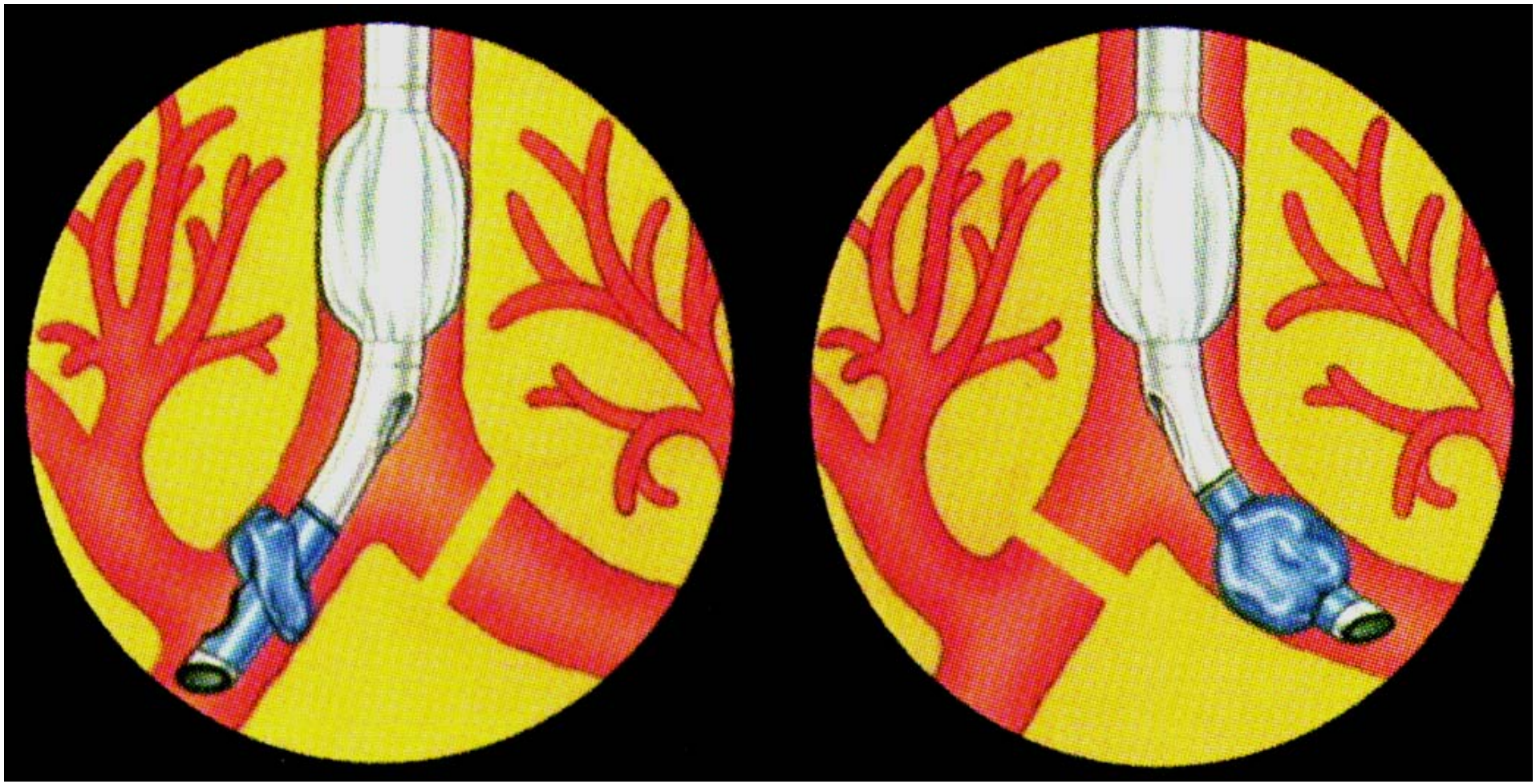
Robertshaw: Low resistance double-lumen endotracheal tubes. BJA 34:576, 1962





Rechter Hauptbronchus 9 - 25 mm
Verschiebestrecke DLT für
Herniation oder Obstruktion: 8 mm

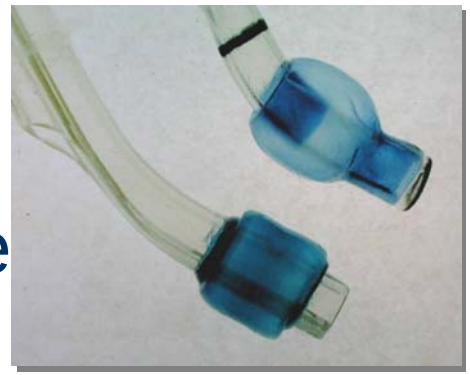
Seitenwahl des Doppellumentubus



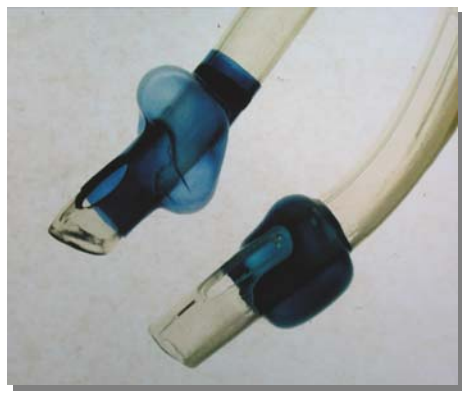
Bloß fort vom Chirurgen !

Auswahl des DLT

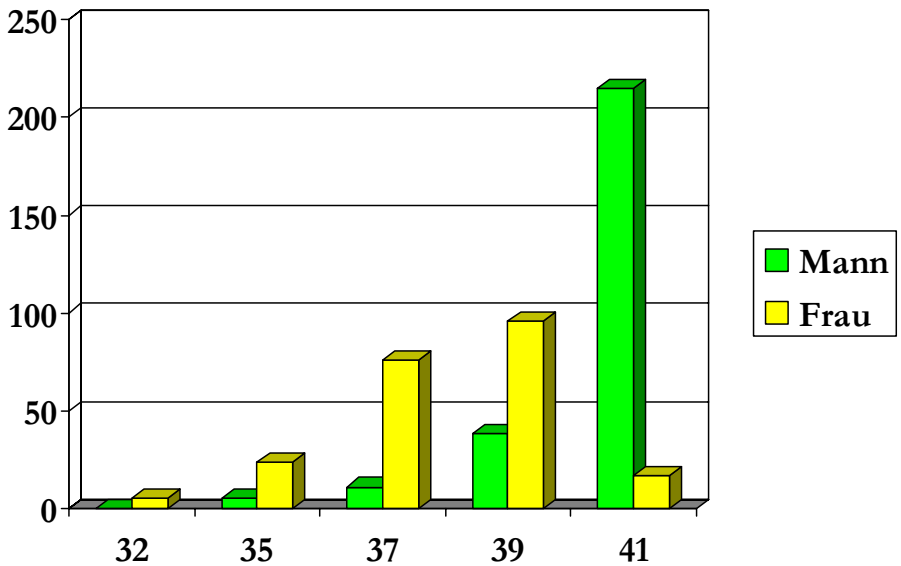
- Robertshaw links DLT
  - Standard
  - Thorakotomie rechts oder links ohne Parenchymresektion (Standard)
  - Lungenresektion rechts



- Robertshaw rechts DLT
  - Lungenresektion links
  - Spezielle Indikation
    - Lageveränderung li. Hauptbronchus:
      - TAA, Tumor



Doppellumentubus: Welche Größe?



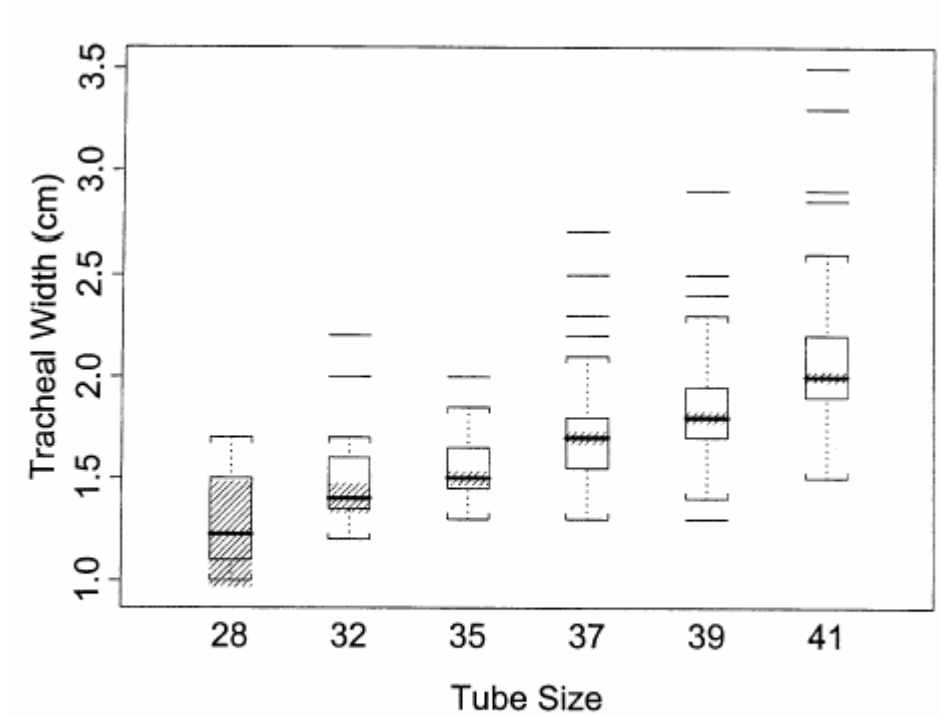


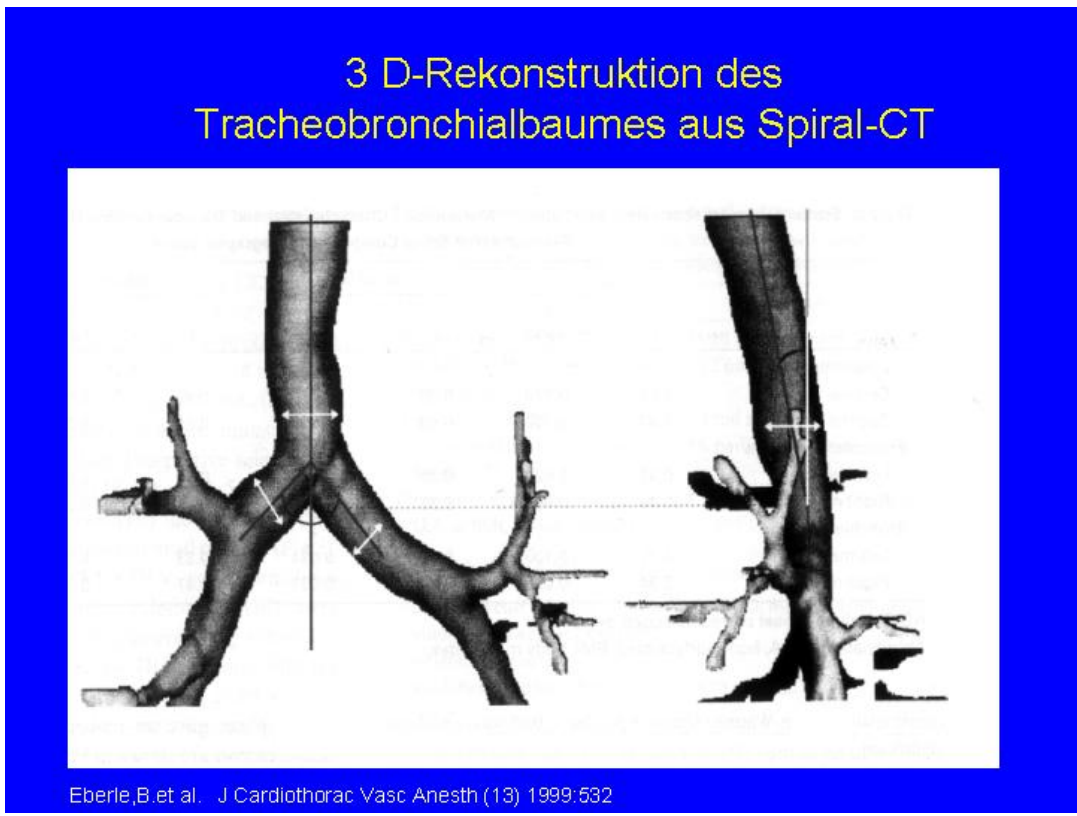
Fig 1. The optimal size left DLT is the largest tube whose bronchial lumen fits the left main bronchus with only a small air leak when its bronchial cuff is not inflated. If LB-W is known, then a left

Brodsky JB et al J Cardiothorac Vasc Anesth 1997:11:924

Ermittlung des passenden DLT

1. **Klinik:**
   - **Alter, Größe, Geschlecht, Gewicht**
2. **Thoraxbild a.p.**
   - **∅ Hauptbronchus links = ∅ Trachea x 0,68**
     (Brodsky et al. 1996)
3. **3D - Rekonstruktion**

Superposition von DLT scans
(Eberle et al. 1999)



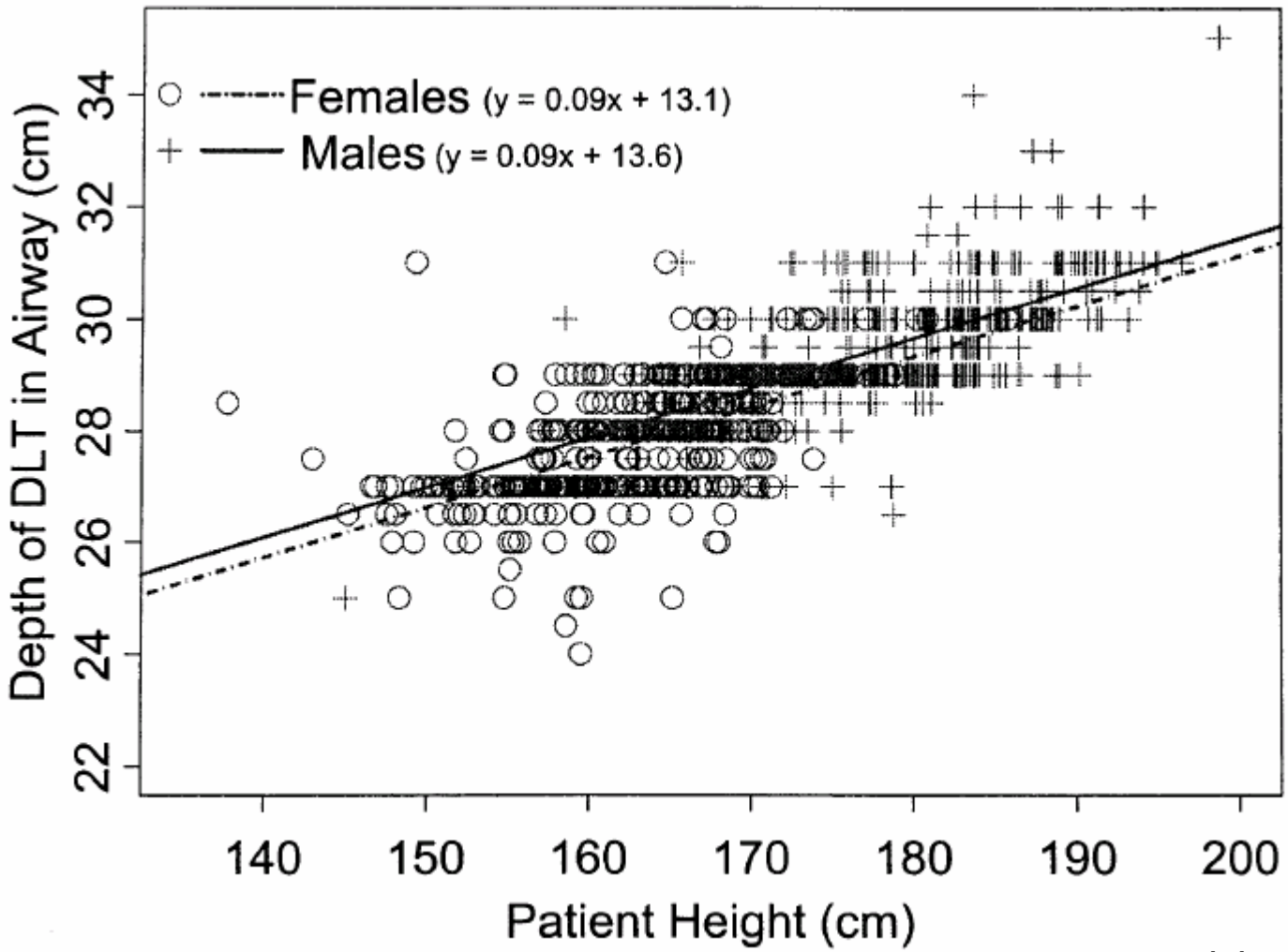
Wahl der Größe des DLT

Trachealdurch-messer [mm]	Errechneter linker Hauptbronchus-durchmesser [mm]	Primär empfohlene DLT-Größe [Fr]	Äußerer DLT-Durchmesser [mm]	
			Tracheales Lumen	Linkes Lumen
≥18	≥12,2	41	14–15	10,6
≥16	≥10,9	39	13–14	10,1
≥15	≥10,2	37	13–14	10,0
≥14	≥9,5	35	12–13	9,5
≥12,5	≥8,5	32	10–11	8,3
≥11	≥7,5	28	9,4	7,4

Wahl der Tubusgröße bei Kindern

Alter [Jahre]	Tubusgröße [mm]	Bronchusblocker [Fr]	UNIVENT	DLT [Fr]
0,5–1	3,5–4,0	5		
1–2	4,0–4,5	5		
2–4	4,5–5,0	5		
4–6	5,0–5,5	5		
6–8	5,5–6,0	5	3,5	
8–10	6,0	6	3,5	26
10–12	6,5	6	4,5	26–28
12–14	6,5–7,0	6	4,5	32
14–16	7,0	7	6,0	35
16–18	7,0–8,0	7	7,0	35

Einführtiefe DLT links



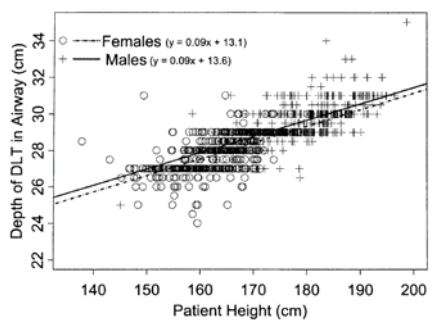
Brodsky, Takita

Einführtiefe DLT

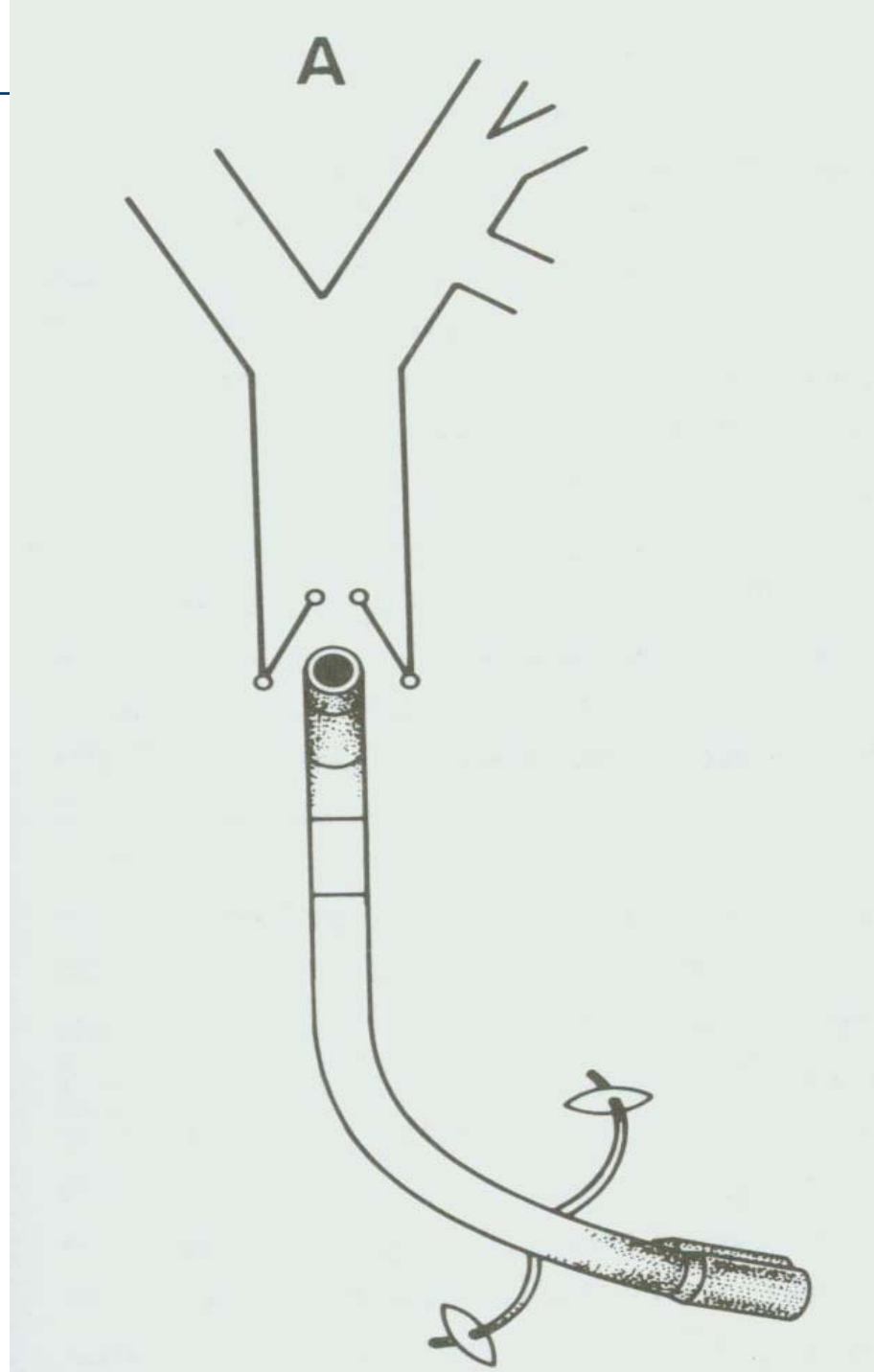
- **Korrelation**
  - **Körpergröße / Länge der Trachea**

- **170 cm KG 29 cm ab Zahnreihe**
- **170 cm -10 cm 28 cm**
- **170 cm +10 cm 30 cm**
  - **Pro 10 cm Anpassung um jeweils 1 cm**

- **DLT (cm) = 12,5 + (0,1) x KG cm [Takita 2001]**



Tricks bei Intubation mit DLT



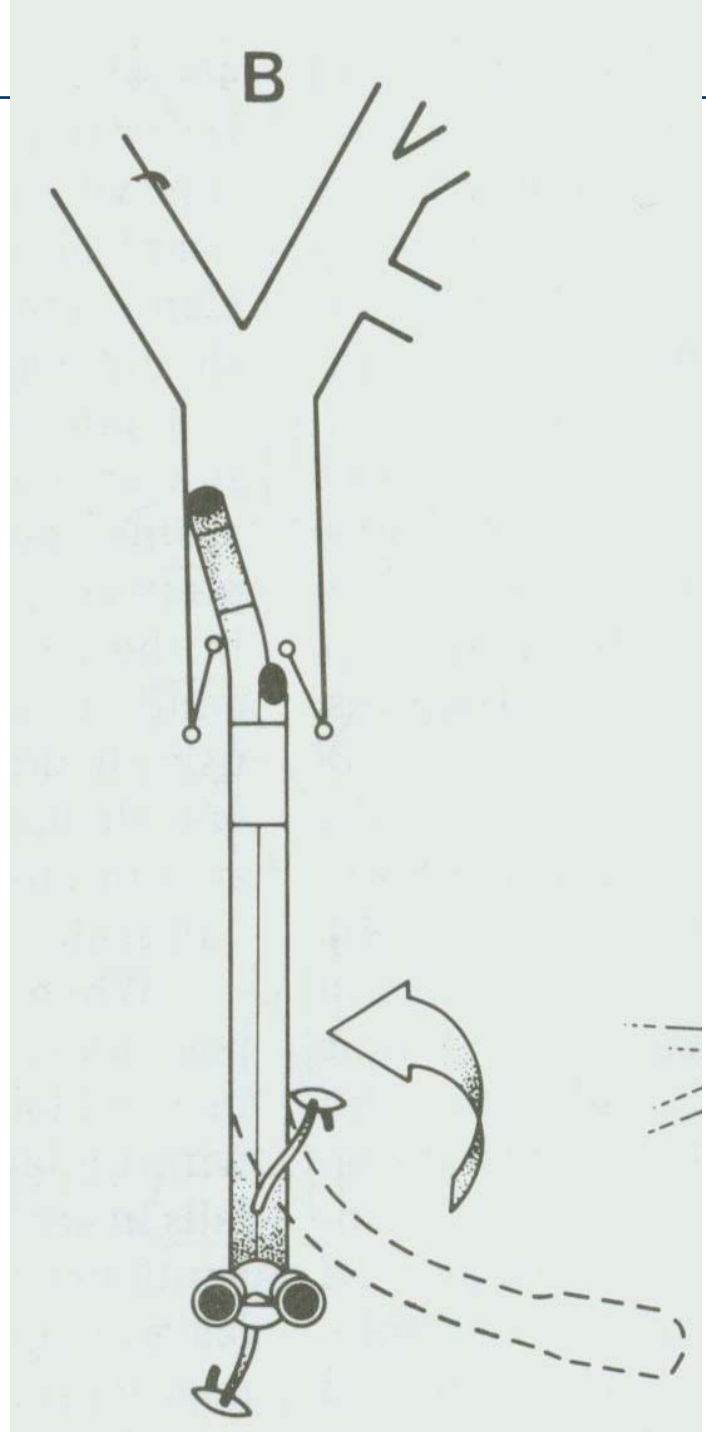
Tricks bei Intubation mit DLT

- Kopfposition
  - Verbesserte Jackson Position - Cave Cuff
  - Kopfüberstreckung - retromolar
- Tubusform - Führungsstab
  - wie vorgegeben
  - halbkreisförmige Biegung
    - immer: bei schwieriger Laryngoskopie!

Tricks bei Intubation mit DLT

Nach Passage der Stimmritze:

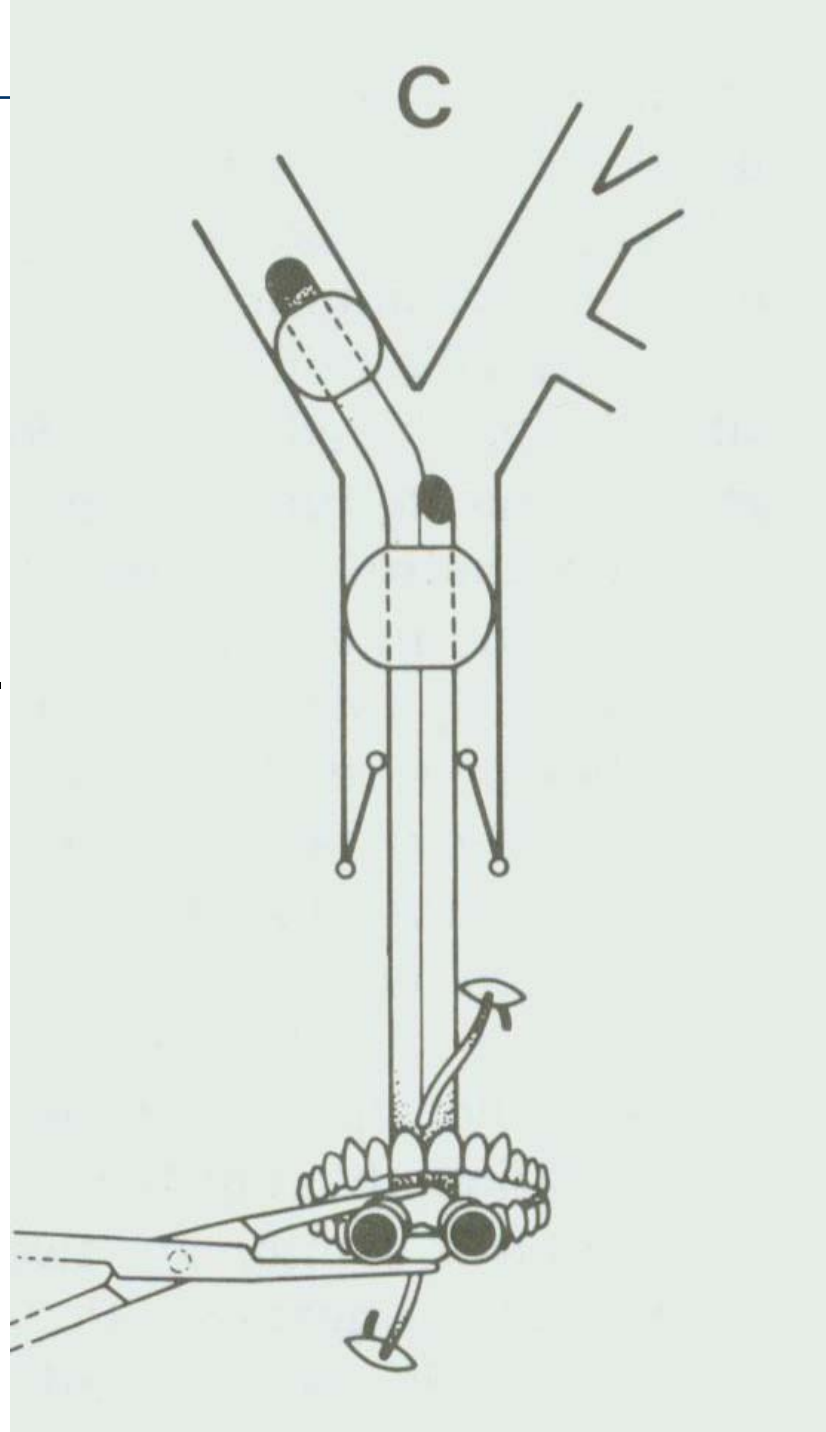
- **Zurückziehen des Mandrins**
- **Rotation um 90°**
- **Vorsichtiges Vorschieben bis zum errechneten Abstand**



Tricks bei Intubation mit DLT

Beim Vorschieben in der Trachea:

- **Unterkiefer ipsilateral**
- **„Ohr auf Schulter“ kontralateral**
- **90 ° Drehung**
- **niemals federnder Widerstand**
- **klinische Kontrolle**



Lagekontrolle Doppellumentubus?

SPECIAL ARTICLE

Left Double-Lumen Tubes: Clinical Experience With 1,170 Patients

Jay B. Brodsky, MD, and Harry J.M. Lemmens, MD, PhD

MODERN DISPOSABLE plastic double-lumen tubes (DLTs) are generally safe and easy to use.[1,2] However, a misplaced or improperly used DLT can jeopardize any procedure and even injure the patient. This article reviews considerations for the selection and placement of left-sided DLTs based on data collected from a large series of patients undergoing thoracic procedures requiring one-lung ventilation (OLV) at this institution. Although the information presented represents the authors' experience at a single center, others can apply many of the lessons in their own practices.

With the permission of the Human Subjects Committee at Stanford University Medical Center, over an 8-year period from 1993 and 2001, 1,170 consecutive patients undergoing anesthesia for noncardiac, general thoracic surgical procedures were studied. All patients were anesthetized by anesthesia residents under the supervision of one of the authors (JBB).

should be closely examined to identify an early takeoff of the right upper-lobe bronchus.

A left DLT was chosen for 1,166 of the 1,170 patients. The DLT was successfully used for lung separation in 1,145 (98.2%). A left DLT was used in 451 left-sided procedures, 534 right-sided procedures, and 99 procedures involving sequential collapse of both lungs (Table 1).

The only DLT used was the BronchoCath DLT (Mallinckrodt Medical, Inc, St. Louis, MO). During the study 3 versions of the BronchoCath left DLT were commercially available. The original BronchoCath tube was modified in 1994. The major change was elimination of the bevel at the tip of the bronchial lumen.[17] This was done to decrease the chance of obstruction to gas flow from adherence of a beveled tip to the bronchial wall, when the patient was in the lateral position and the DLT was in the bronchus of the nonoperated lung.[18] Other modifications at

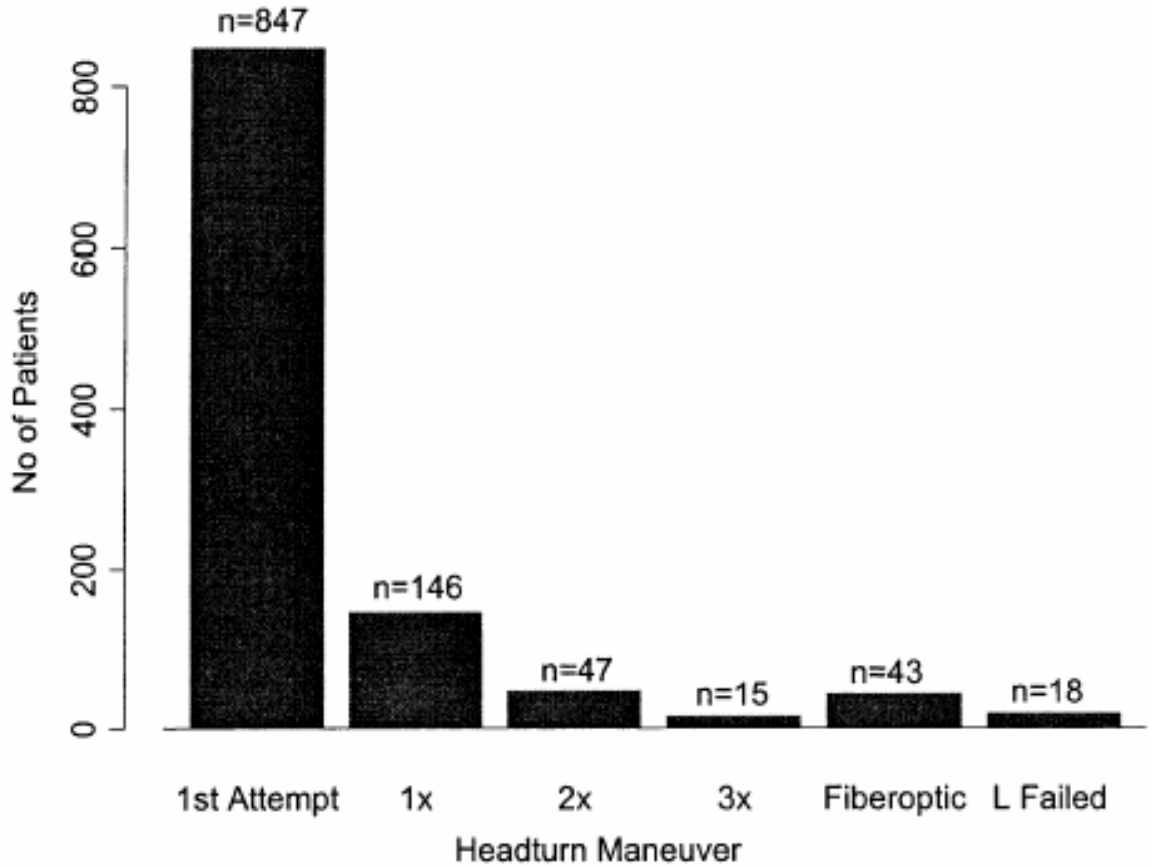


Fig 3. In 847 of 1,116 (75.9%) patients, the left bronchus was intubated directly on the first attempt. When the left DLT inadvertently entered the right bronchus the tube was withdrawn into the trachea. The patient's jaw was turned toward the left shoulder while the right ear was bent to the right shoulder ("headturn" maneuver) and the tube was readvanced. This maneuver enabled successful intubation of the left bronchus in 208 of the 269 patients (77.4%) in whom a right bronchial intubation initially occurred. If the "headturn" maneuver failed after 3 attempts, an FOB was placed down the bronchial lumen and used to visually guide the DLT into the left bronchus. Bronchoscopic assistance was successful in 43 of 61 pa-

Lagekontrolle DLT

Fiberoptic bronchoscopy need not be a routine part of double-lumen tube placement

Jay B. Brodsky

Purpose of review

The debate continues as to whether a fiberoptic bronchoscope must be used to position a double-lumen tube. This review supports the argument that although bronchoscopy is extremely helpful, it is not always needed for the routine placement of left double-lumen tubes.

Recent findings

Several recent clinical reports have demonstrated that an experienced anesthesiologist can safely and consistently position double-lumen tubes without bronchoscopic assistance. In order to do so several important factors must be considered. These include the appropriate choice of tube (left or right), size of tube, and endpoint for the depth of insertion.

Summary

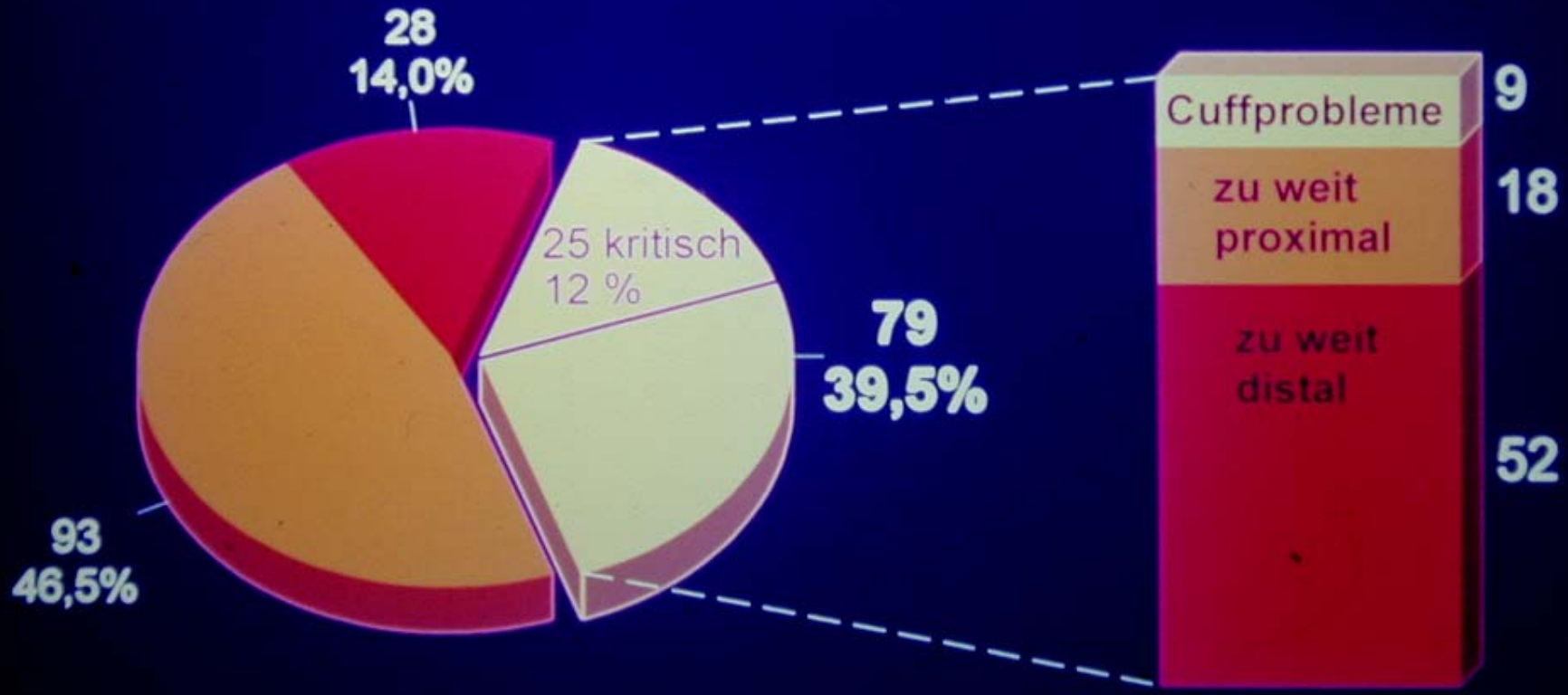
Introduction

Double-lumen tubes (DLTs) are used to isolate and collapse the lungs selectively during thoracic procedures. It is imperative that a DLT be safely and accurately positioned because a misplaced or improperly used tube can jeopardize any operation or injure the patient. Although bronchoscopy has been used for over 20 years as an aid for positioning DLTs, there continues to be a debate as to whether a fiberoptic bronchoscope (FOB) is essential for tube placement. An experienced anesthesiologist can and should be able to place left DLTs safely and consistently without depending on an FOB.

'Blind' versus fiberoptic positioning

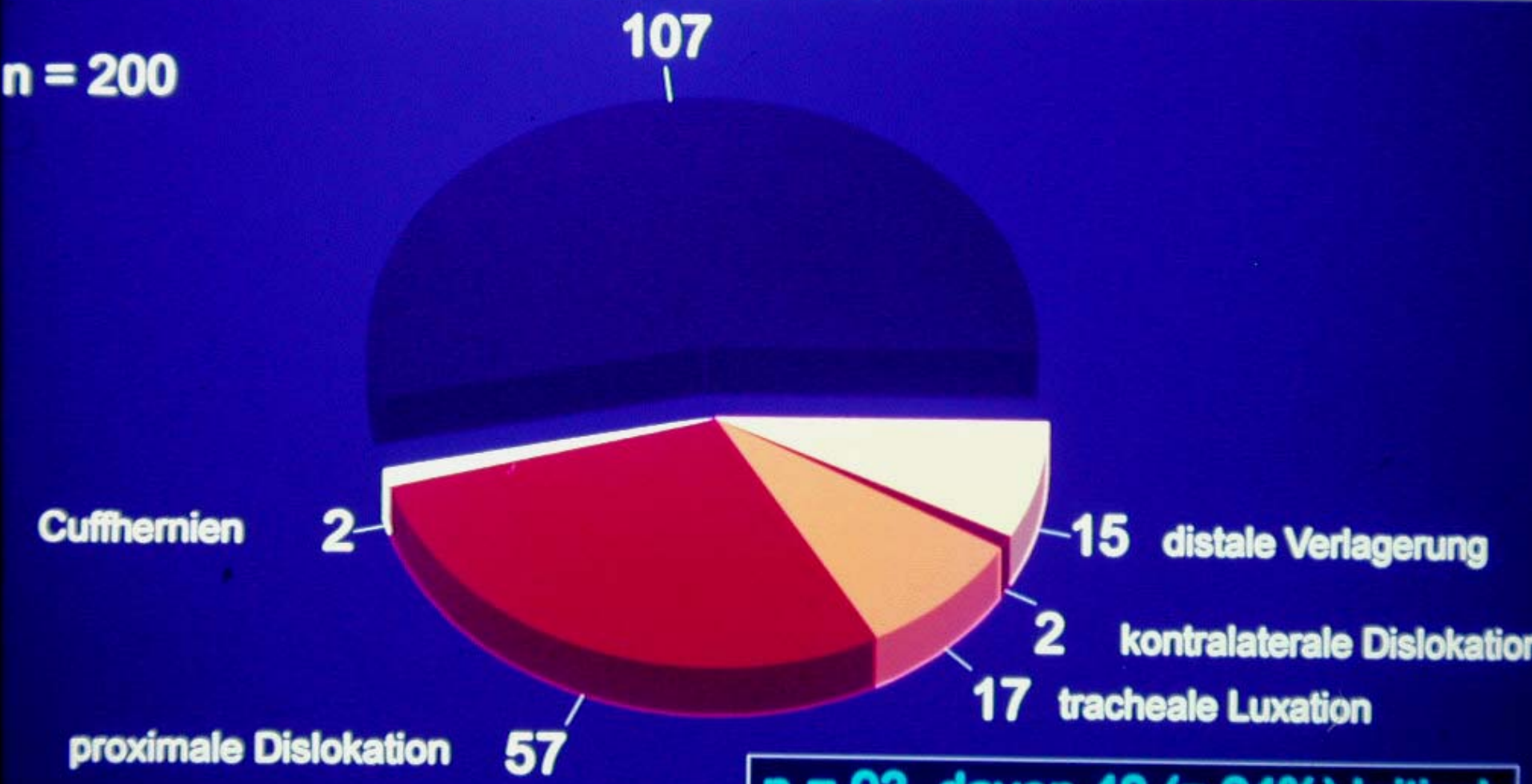
Fiberskopien nach klinischer Lagekontrolle
regulärer Auskultationsbefund

n = 200



Klein U, Karzai W, Bloos F et al: Anesthesiology 1998, 88: 346-35

Fiberskopien nach Umlagerung
korrekturbedürftige Befunde



n = 93, davon 48 (= 24%) kritisch

Klein U, Karzai W, Bloos F et al: Anesthesiology 1998, 88: 346-350

Lagekontrolle DLT

Double-lumen tube position should be confirmed by fiberoptic bronchoscopy

Edmond Cohen

Purpose of review

This review is part of Pro and Contra use of fiberoptic bronchoscopy to confirm the position of a double lumen tube. The purpose of this review is to highlight the circumstances where fiberoptic bronchoscopy should be used in conjunction with lung separation, right sided double-lumen tube positioning, and to identify fine malposition for generally missed by clinical signs.

Recent findings

Until several years ago, confirmation of a double-lumen tube (DLT) position was limited to inspection and auscultation. Fiberoptic bronchoscopes were usually only available in the bronchoscope suite for the exclusive use of the pulmonary personnel. Today, in most institutions, fiberoptic bronchoscopes

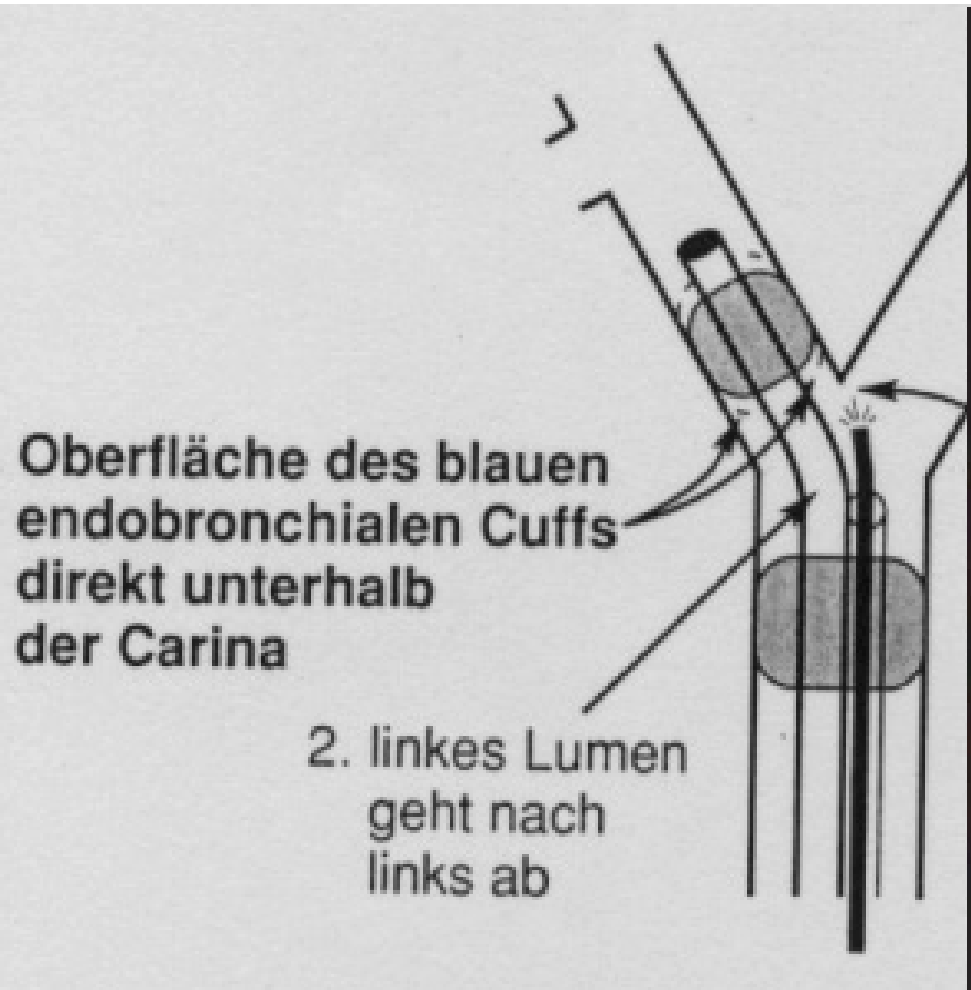
Introduction

Until several years ago, confirmation of a double-lumen tube (DLT) position was limited to inspection and auscultation. Fiberoptic bronchoscopes were usually only available in the bronchoscopy suite for the exclusive use of the pulmonary personnel. Today, in most institutions, fiberoptic bronchoscopes of different diameters are available in the operating room for use by the anesthesia personnel. Advances in technology and improved quality of the endoscopic image make the technique easy to use with a relatively simple learning curve. In fact, fiberoptic workshops, thoracic workshops and difficult airway workshops are offered in nearly all important anes-

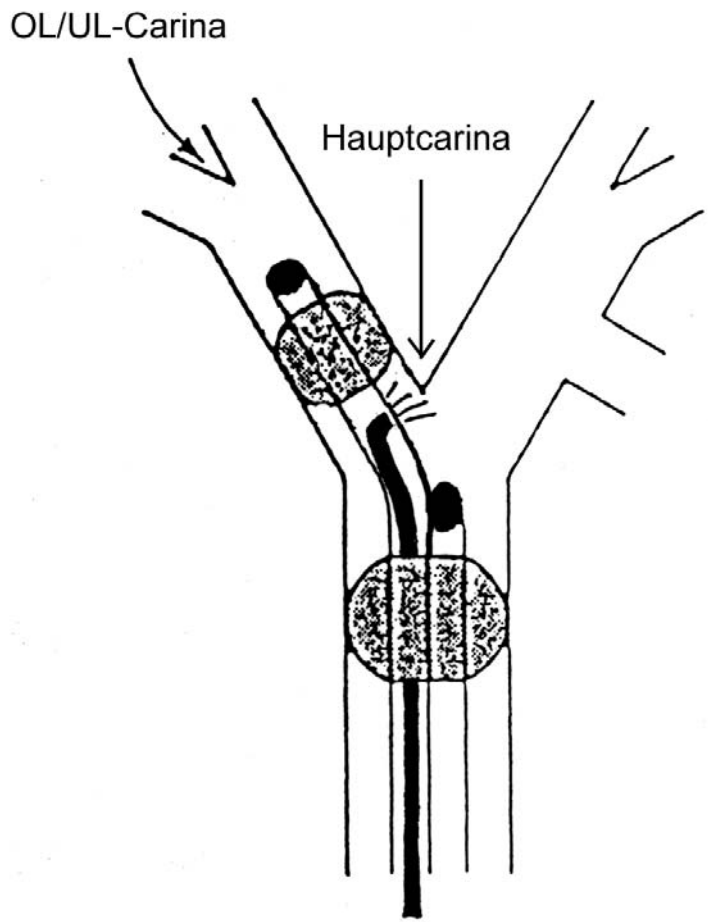
- **Heute**
  - **Bronchoskopie = Standard**

Linksendobronchiale Intubation

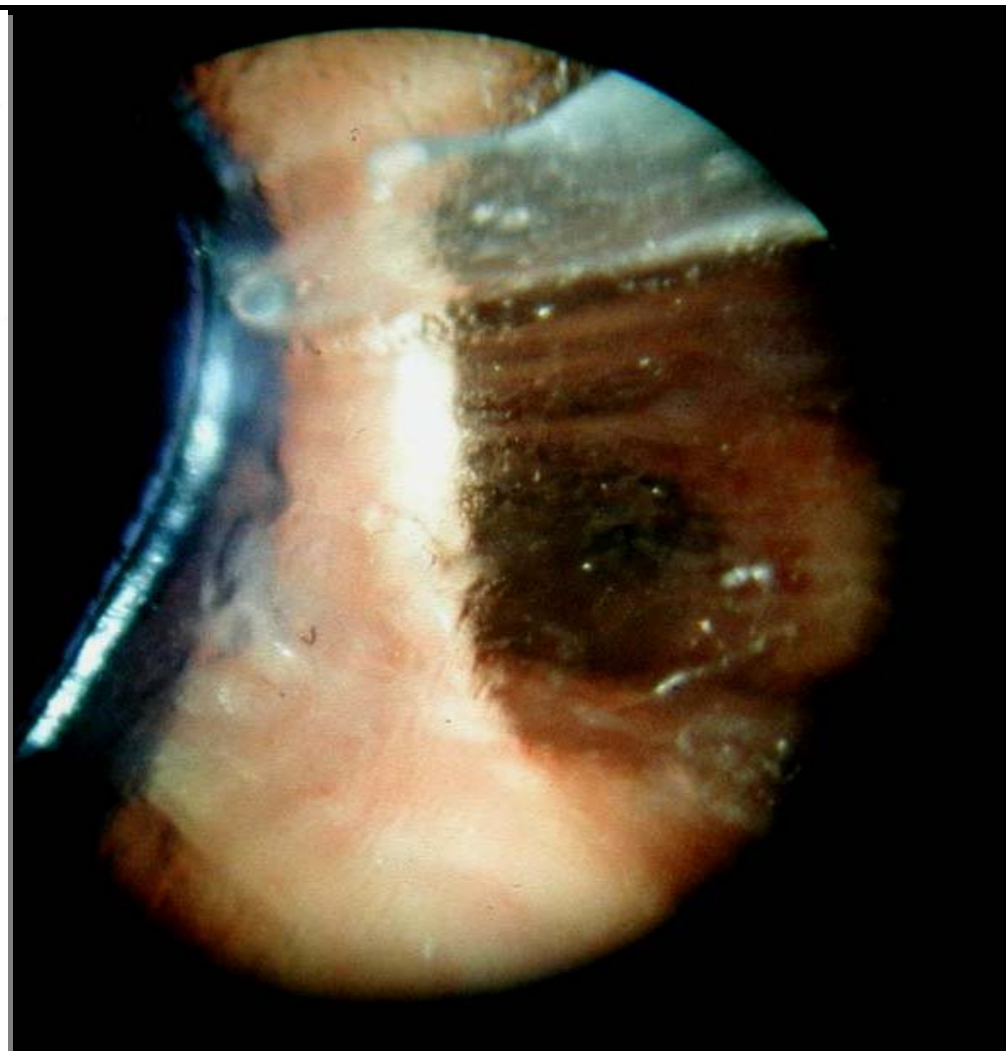
Linksendobronchiale Intubation: FOB - Kontrolle



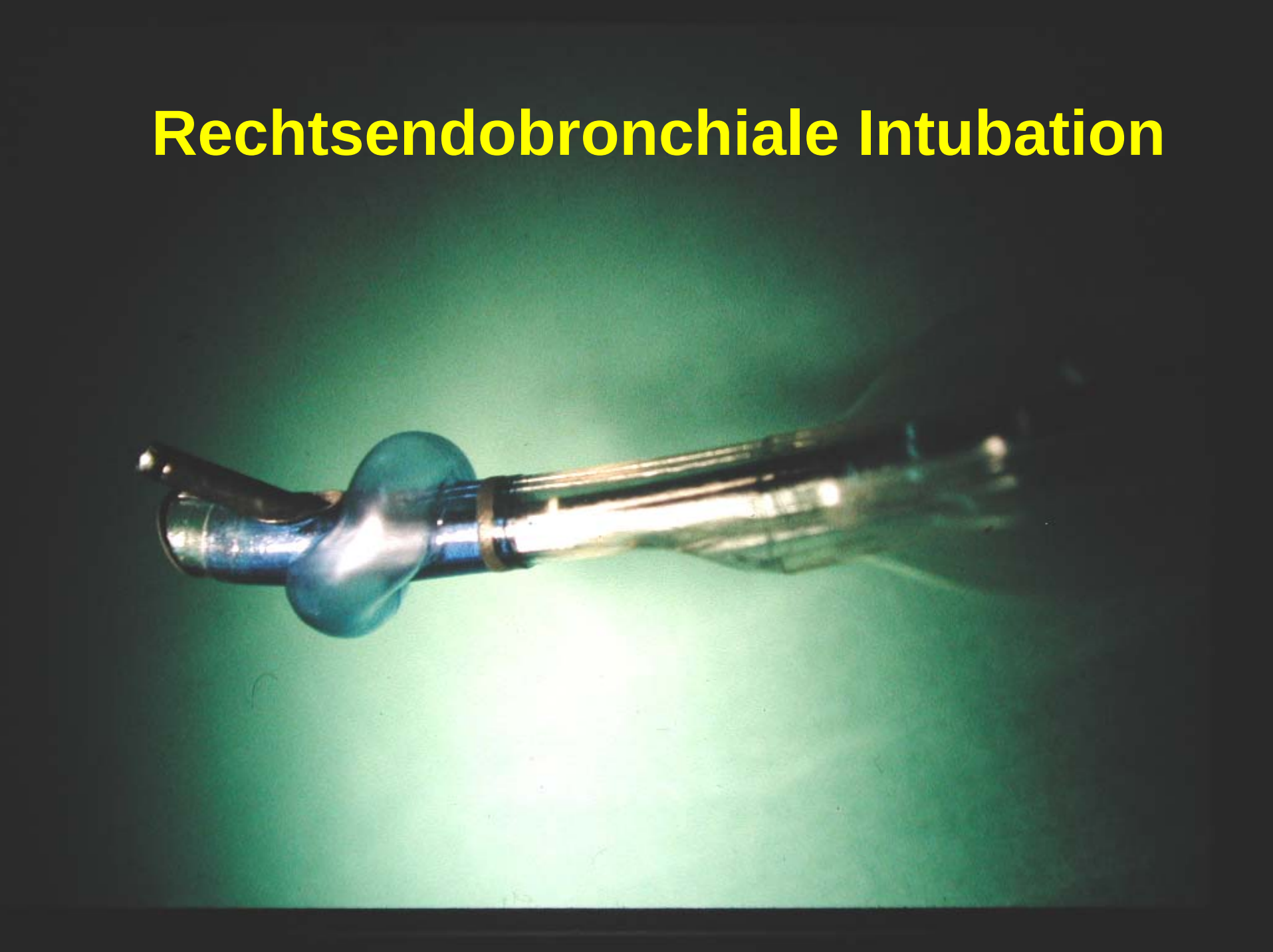
Endobronchiale FOB-Kontrolle: Heidelberg View



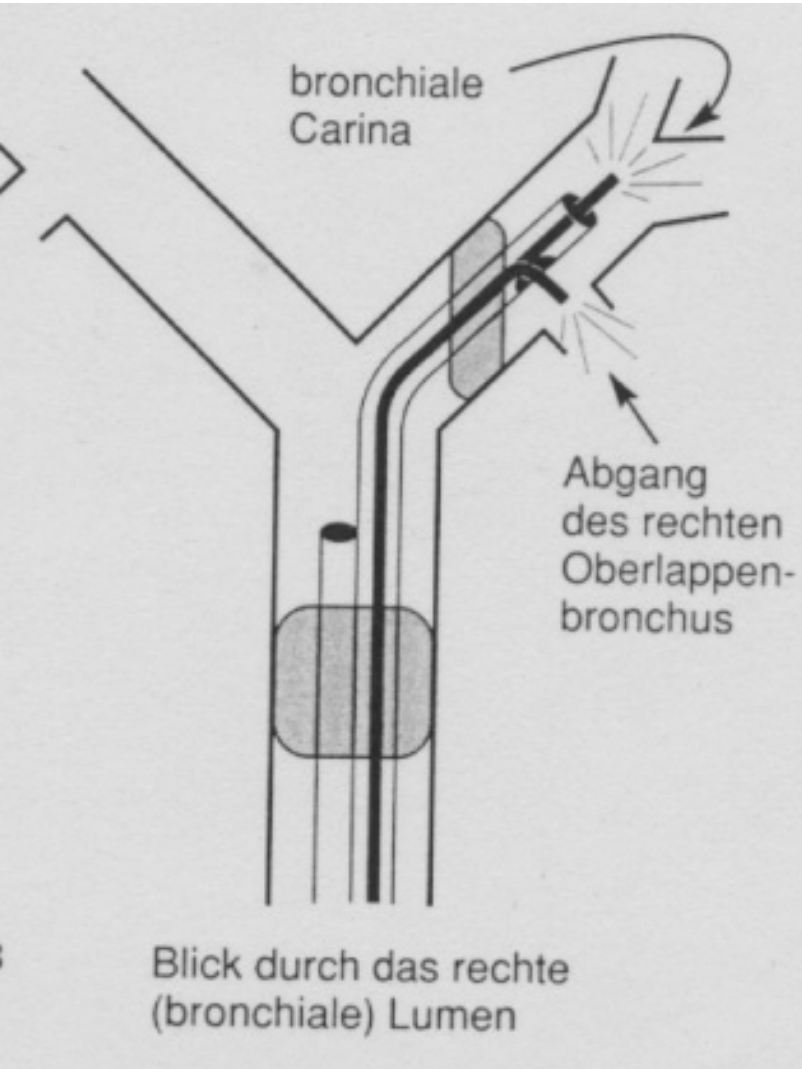
Blick durch das linke (bronchiale) Lumen



Rechtsendobronchiale Intubation

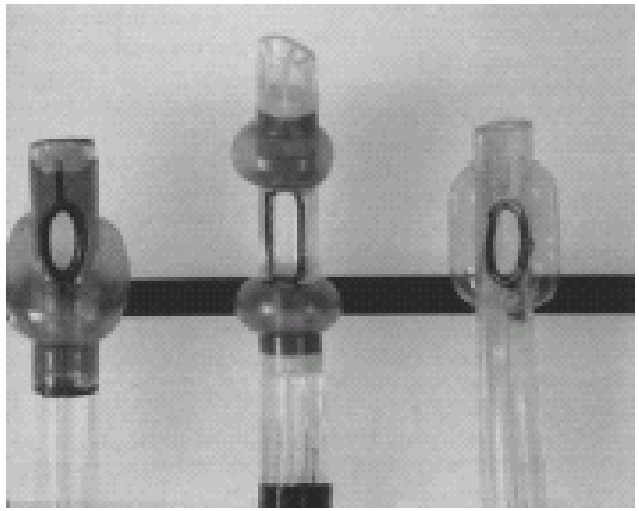


Rechtsendobronchiale Intubation : FOB - Kontrolle

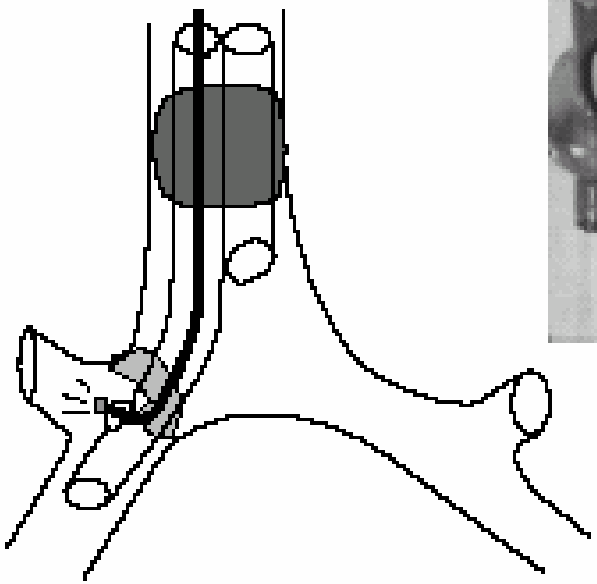


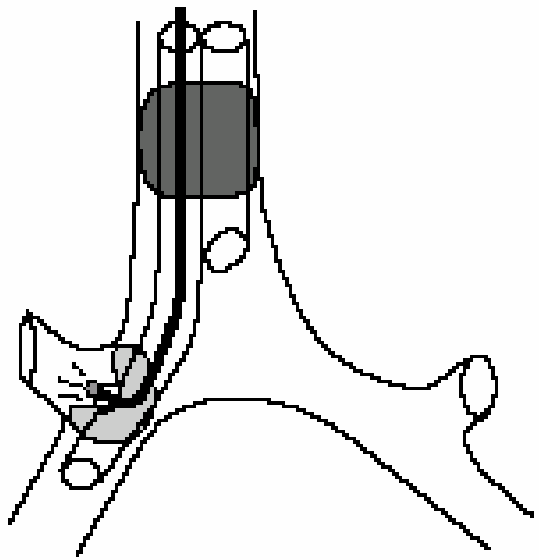
Fiberoptic bronchoscopy: right sided DLT

Mallinkrodt

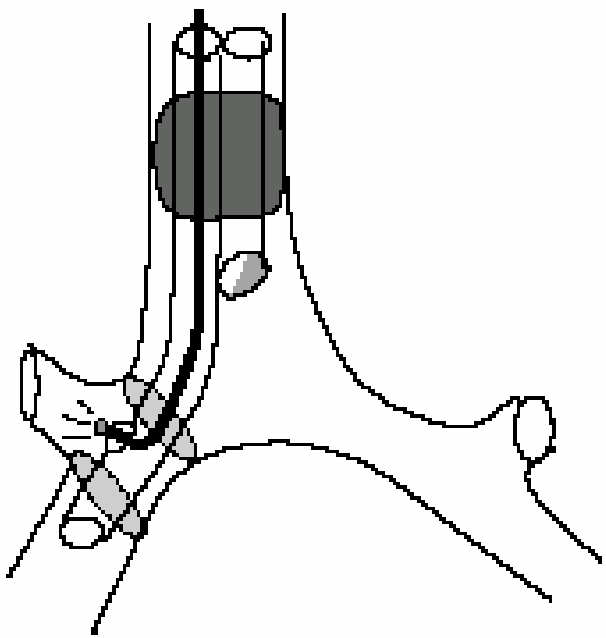


Rusch





Sheridan



DLT: typische Fehlpositionen

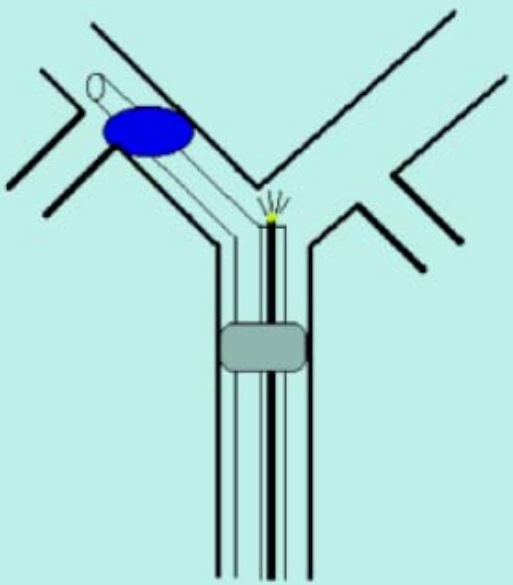


Abb. 12 ▲ **Obstruktion des linken Oberlappen-bronchus**

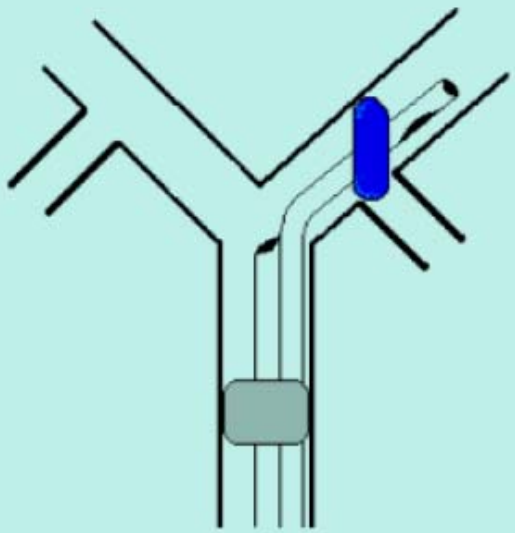


Abb. 13 ▲ **Obstruktion des rechten Oberlappenbronchus**

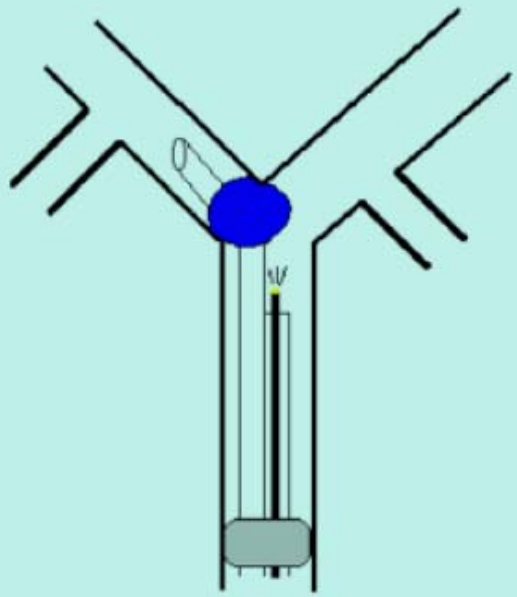


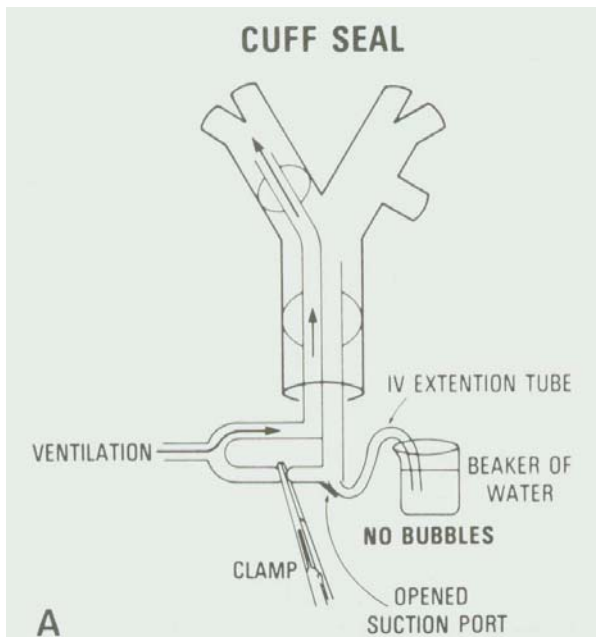
Abb. 14 ▲ **Herniation des bronchialen Cuffs über die Karina**

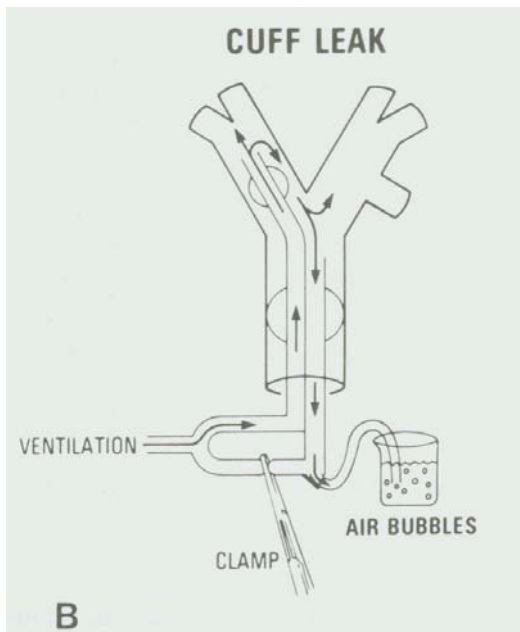
Überprüfen der Tubuslage bei DLT

- Auskultation
- Inspektion
- Bronchoskopie
  - nach Intubation
  - nach Umlagerung
  - bei Hypoxämie
  - bei Anstieg Beatmungsdruck
- Seitentrennung
- Immer Cuffdruckmesser bronchialer Schenkel

Überprüfung der Seitentrennung

- Bronchoskop - Lagekontrolle DLT
- Blockung bronchialer Cuff 0,5 - 2ml
  - max. 3ml -> Tubuswechsel !
- Cuffdruckmesser
- Bubble-Test





Vorteile Doppellumentubus

- Zugriff immer auf beide Lungen
- Bronchoskopie
- Geringer Beatmungswiderstand
- Schnelle Lungendeflation
- Endobronchiales Absaugung, CPAP, PEEP
- Sequenzieller Kollaps beider Lungen

Nachteile/Kontraindikationen DLT

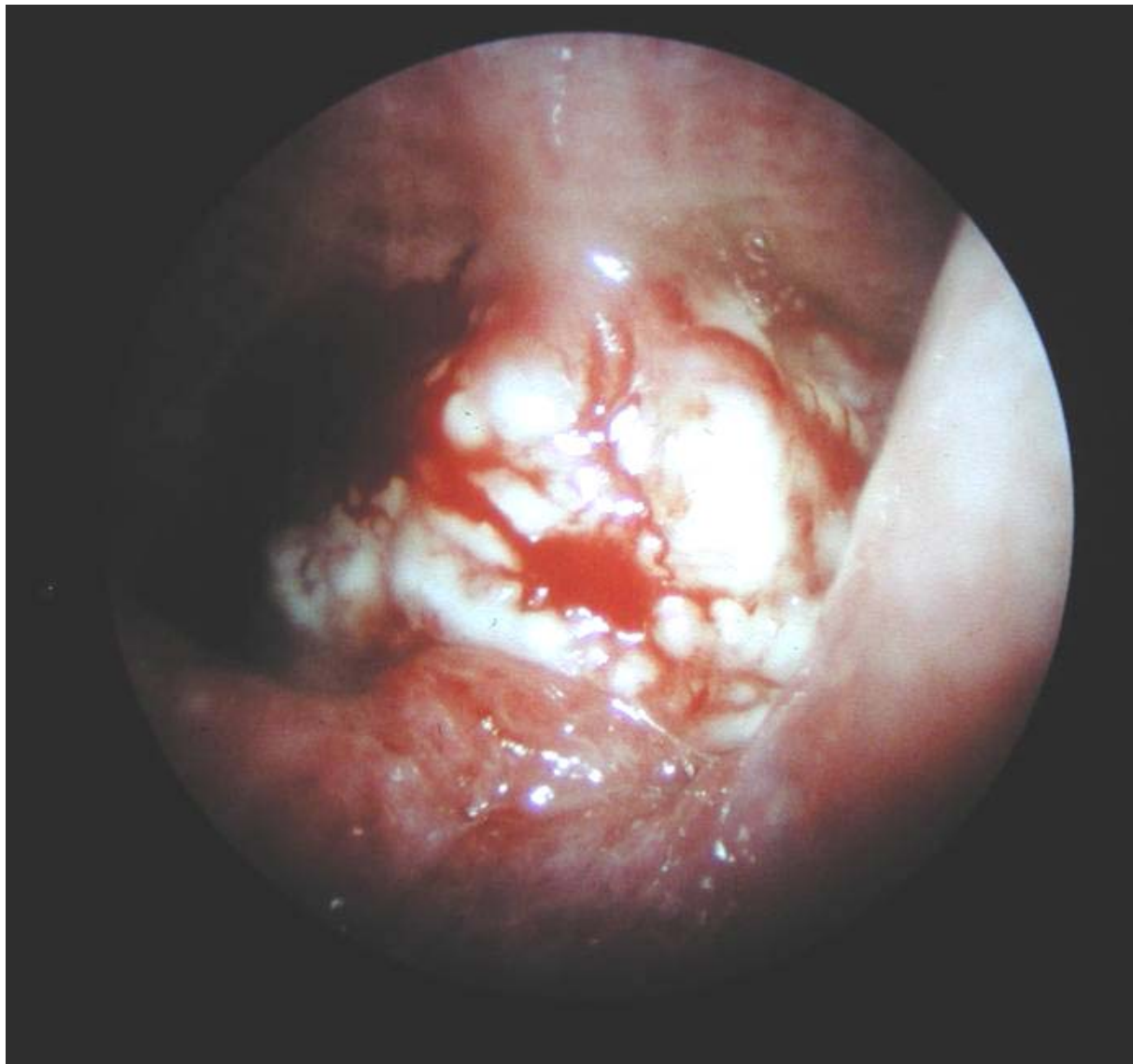
- Obligatorische Fiberoptische Kontrolle
- Aspirationsgefährdeter Patient
- Schwierige Intubation
- Trachealstenosen/Verlagerungen
- Vaskularisierte endotracheale Tumoren
- Kinder < 8-10J, kleinwüchsige Erwachsene
- Postoperative Umintubation empfohlen

Kontraindikationen für DLT

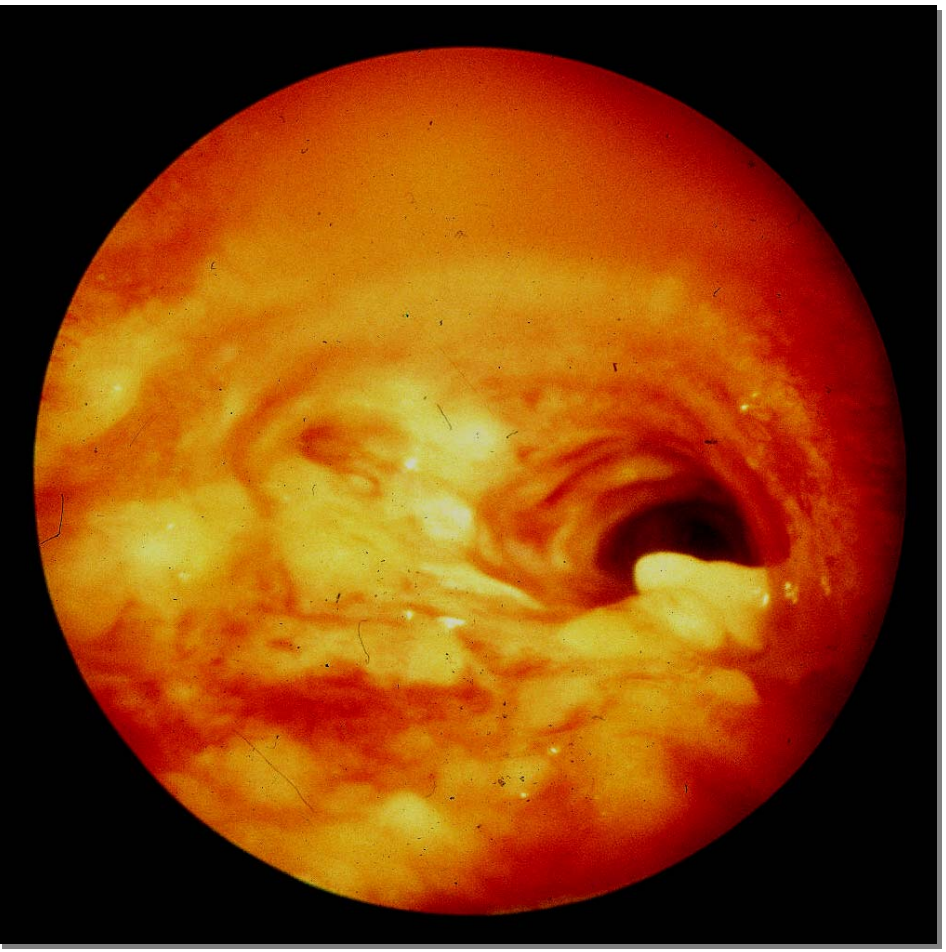
- Aspirationsrisiko hoch
- Hindernisse: Tumor, Trauma
- Mißbildungen: Stenosen
- Verformungen: Skoliose, Mediastinaltumor
- Schwieriger Atemweg:
  - Glottisdarstellung erschwert, unmöglich
- Hypoxierisiko bei Wechsel ETT/DLT

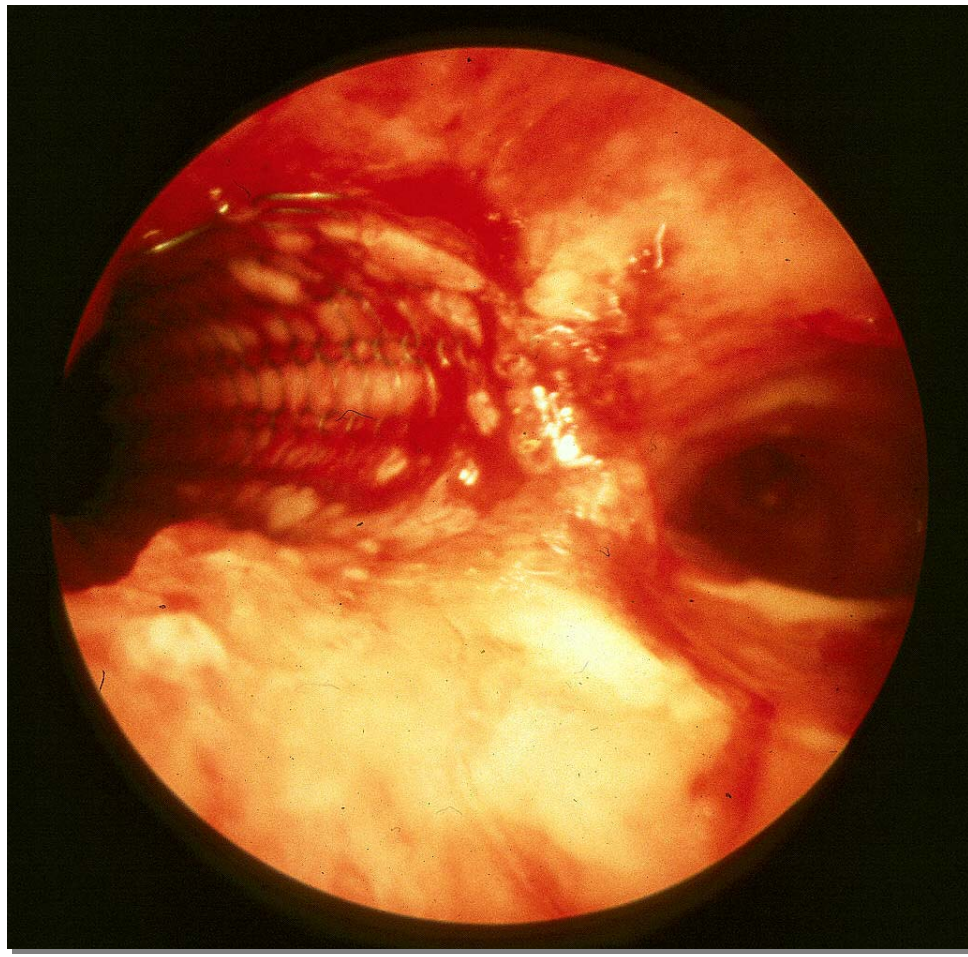
Kontraindikation für DLT

- Tumor
  - Hauptcarina



Trauma durch PVC-DLT





DLT 35 Ch für Patientin von 150 cm Größe

Anesthesiology 2006; 105:471–7

Airway Injuries after One-lung Ventilation: A Comparison between Double-lumen Tube and Endobronchial Blocker

A Randomized, Prospective, Controlled Trial

Heike Knoll, M.D., Stephan Ziegeler, M.D.,* Jan-Uwe Schreiber, M.D.,* Heiko Buchinger, M.D.,* Patric Bialas, M.D.,* Kirill Semyonov, M.D.,* Thomas Graeter, M.D.,† Thomas Mencke, M.D.‡*

Background: **Vocal cord injuries, postoperative hoarseness, and sore throat are common complications after general anesthesia. One-lung ventilation can be achieved *via* two techniques: double-lumen endotracheal tube or endobronchial blocker such as the Arndt blocker. The current study was designed to assess the impact of these techniques for one-lung ventilation on the incidence and severity of postoperative hoarseness, vocal cord lesions, and sore throat.**

bation, and technical factors such as endotracheal tube size.[1,2,6,7–9]

One-lung ventilation during thoracotomy can be achieved *via* two basic techniques[10–12]: (1) use of a double-lumen endotracheal tube (DLT) consisting of an endotracheal and an endobronchial lumen allowing independent single-lung ventilation[13]; or (2) use of an

Table 1. Classification of Airway Injuries

Type	Classification	Definition
Bronchial injuries	Redness	
	Edema	Swollen mucosa
	Hematoma	Bleeding into mucosa
Vocal cord injuries	Thickening of the vocal cords	Localized swelling at the vocal process of the arytenoids cartilage
	Redness	
	Edema	Swollen mucosa at the vocal folds
	Erythema	Redness of the mucosa with surrounding inflammatory swelling
	Hematoma	Bleeding into vocal cord
	Granuloma	Granulation tissue remains as a chronic, localized, rounded tissue

Anesthesiology 2006; 105:471–7

Airway Injuries after One-lung Ventilation: A Comparison between Double-lumen Tube and Endobronchial Blocker

A Randomized, Prospective, Controlled Trial

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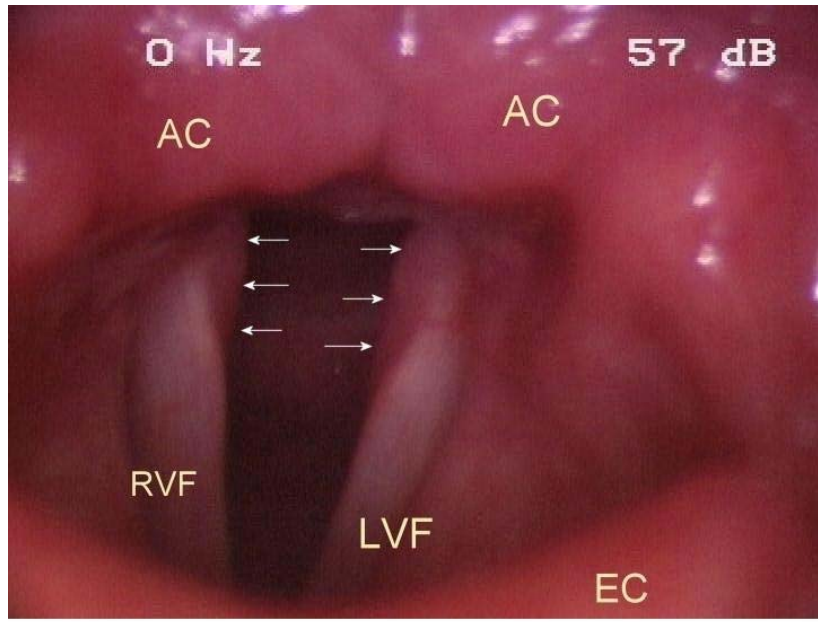
Table 4. Incidence and Bronchoscopic Findings of Bronchus Injuries and Vocal Cord Injuries

	Blocker (n = 29)	Double Lumen (n = 27)	*P* Value
Bronchus injuries			
Patients*	6	8	0.540
Morphology			
Redness	6	5	1.000
Edema	0	3	0.237
Hematoma	0	2	0.492
Vocal cord injuries			
Patients*	5	12	0.046
Morphology			
Redness	2	6	0.137
Edema	3	5	0.462
Hematoma	0	1	1.000

Values are numbers (n).

* Number of patients with bronchus injuries or vocal cord injuries.

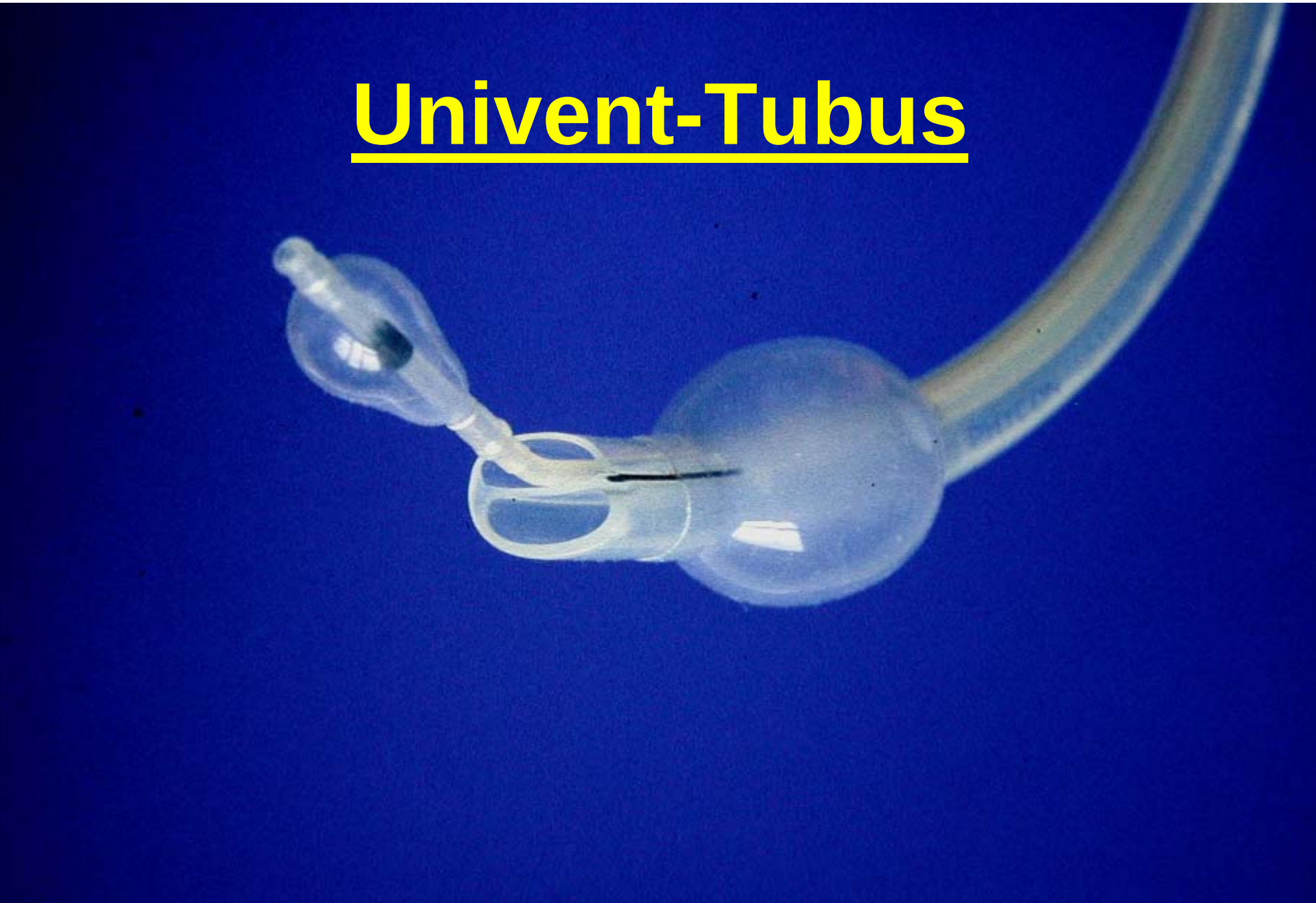


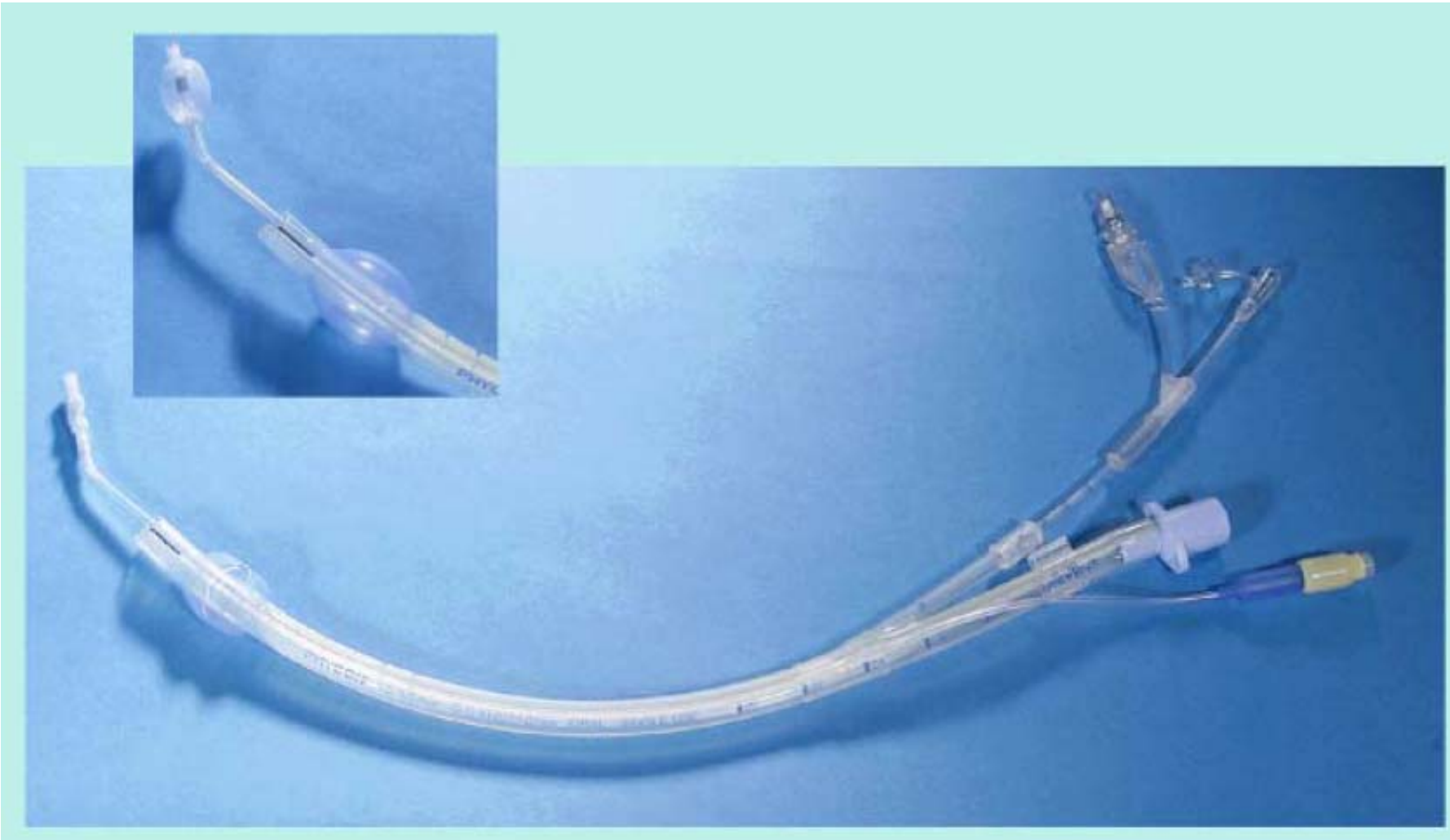
Swollen mucosa (arrows) at both arytenoid catilages 24 hours after intubation
AC = arytenoid catilages ; EC = epiglottis ; LVF = left vocal fold ; RVF : right vocal fold

Methoden zur Seitentrennung der Atemwege

- Doppellumentuben
- **Univent-Tubus**
- Bronchusblocker
- Arndt Endobronchialblocker
- Cohen Endobronchialblocker
- HFJV Hochfrequenzbeatmung

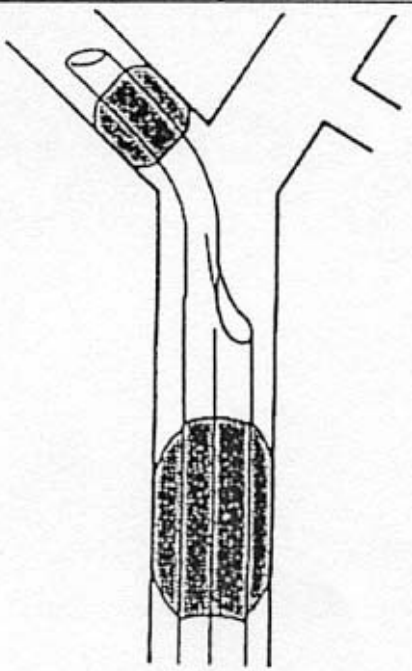
Univent-Tubus





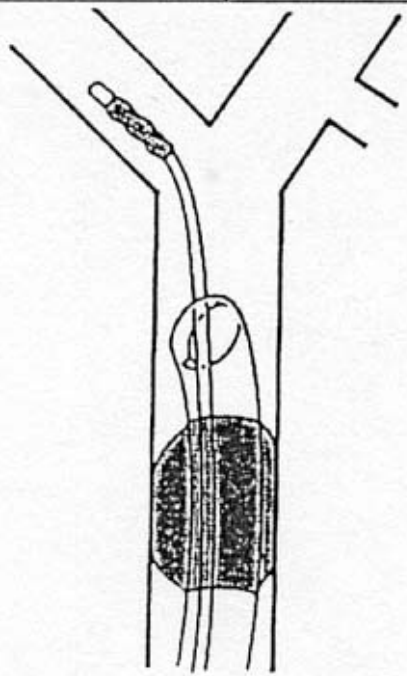
DLT *vs* Univent

Einseitig	Einseitig
Kollaps IPPV Blähung CPAP HFJV Absaugen PEEP	Kollaps IPPV Blähung CPAP HFJV Absaugen PEEP
OP-Lunge	freie Lunge



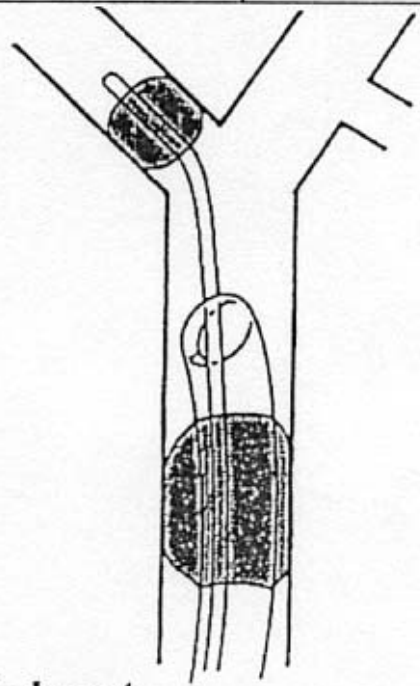
Doppel-Lumen

Beidseitig	
---- IPPV Blähung ---- ---- ---- PEEP	
OP-Lunge	freie Lunge



Univent
Bronchusblocker entlüftet

Einseitig	Einseitig
Kollaps --- Blähung CPAP HFJV --- ---	--- IPPV Blähung CPAP HFJV Absaugen PEEP
OP-Lunge	freie Lunge



Univent
Bronchusblocker gebläht

Vorteile UNIVENT-Tubus

- Kein postoperativer Tubuswechsel nötig
- Endobronchiale Absaugung
- CPAP und O2-Insufflation eingeschränkt möglich
- Blockung einzelner Lungensegmente möglich

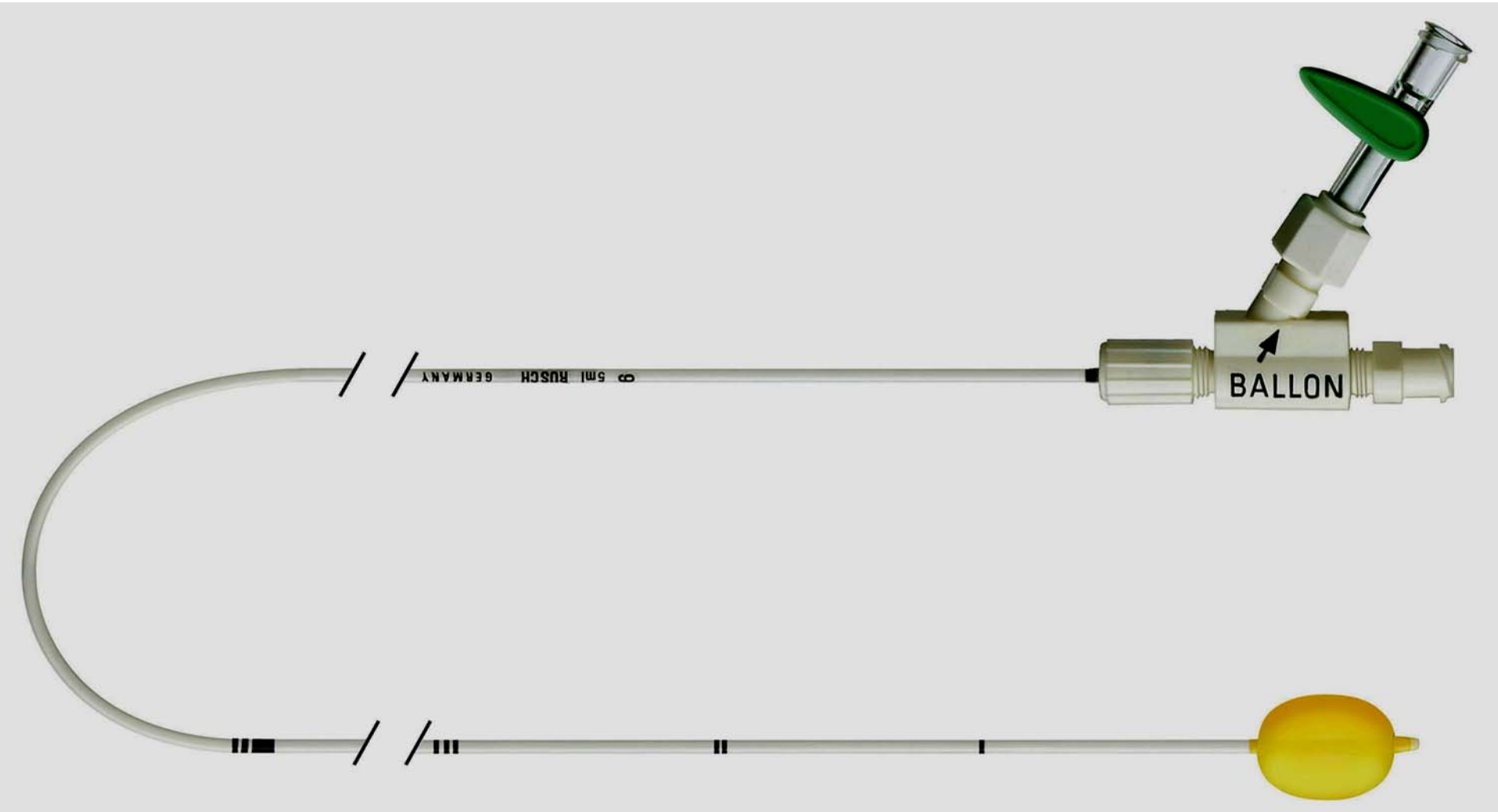
Nachteile/Kontraindikationen UNIVENT

- Obligatorische Fiberoptische Kontrolle
- Oft schwierige Positionierung im linken Hauptbronchus
- Großer Außendurchmesser
- Risiko Bronchusperforation durch starren Bronchusblocker
- Gefahr der versehentlichen postoperativen Blockung mit Obstruktion

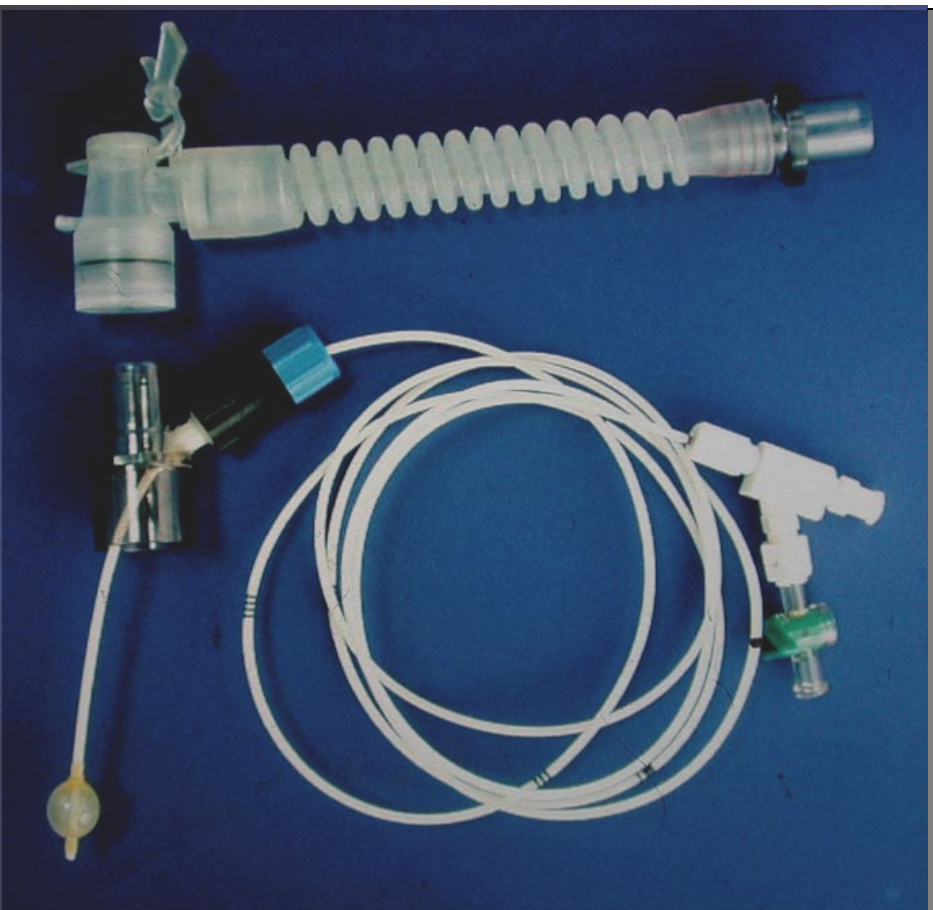
Methoden zur Seitentrennung der Atemwege

- Doppellumentuben
- Univent-Tubus
- **Bronchusblocker**
- Arndt Endobronchialblocker
- Cohen Endobronchialblocker
- HFJV Hochfrequenzbeatmung

Bronchus-Blocker-Katheter



Seitentrennung der Luftwege : Bronchusblocker



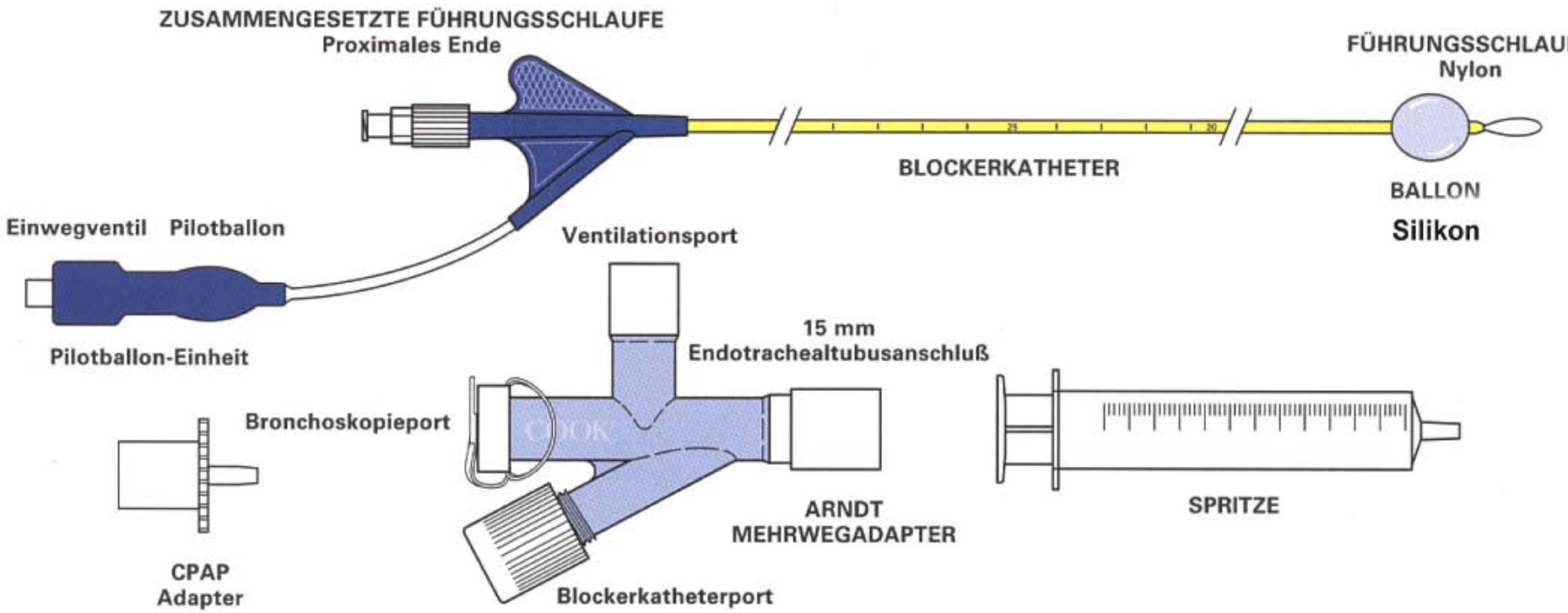
Methoden zur Seitentrennung der Atemwege

- Doppellumentuben
- Univent-Tubus
- Bronchusblocker

- **Arndt Endobronchialblocker**

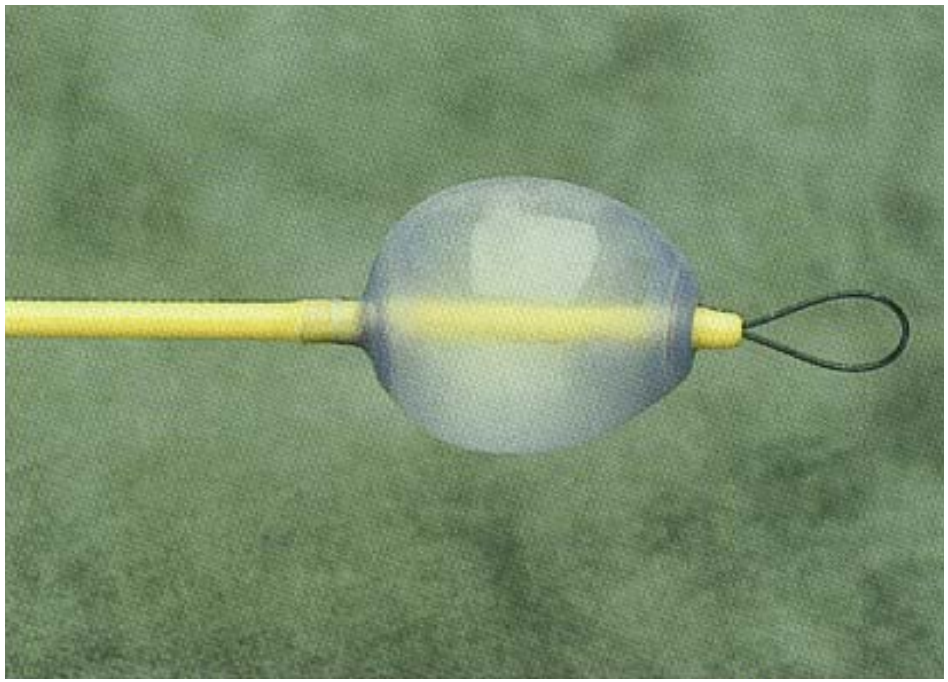
- Cohen Endobronchialblocker
- HFJV Hochfrequenzbeatmung

Arndt® - Bronchusblocker

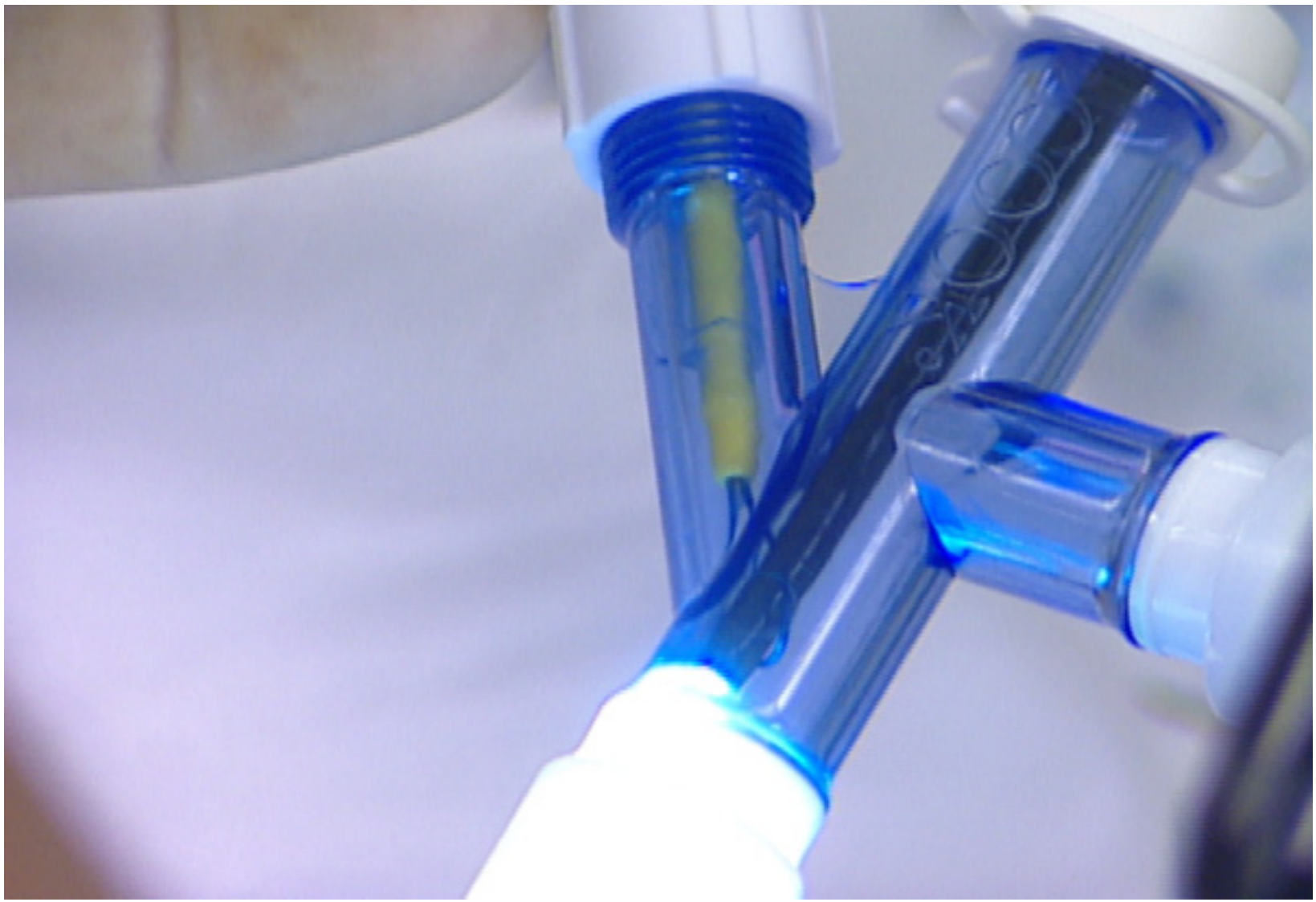


→ Sphärischer (rechts) oder elliptischer „high-volume-low pressure“ Cuff
→ Länge 50-78cm, ø 5-9 French, Innenlumen 1,4 mm

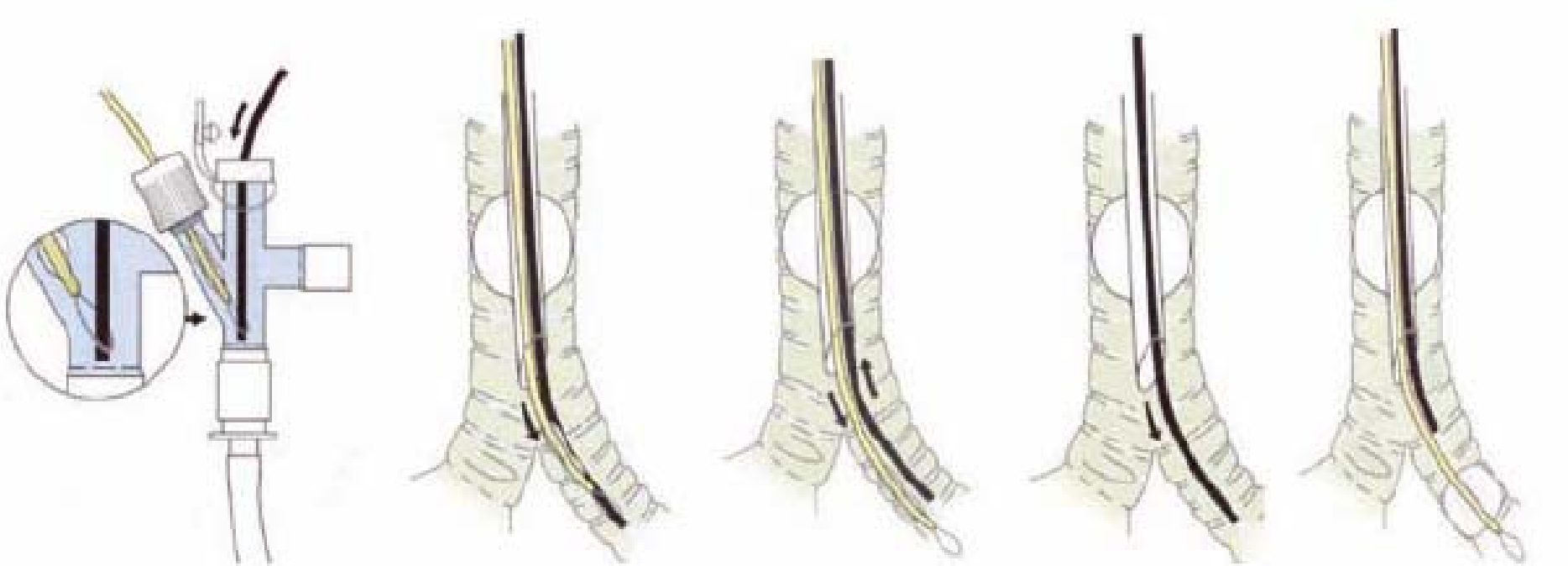
Arndt-Bronchus-Blocker



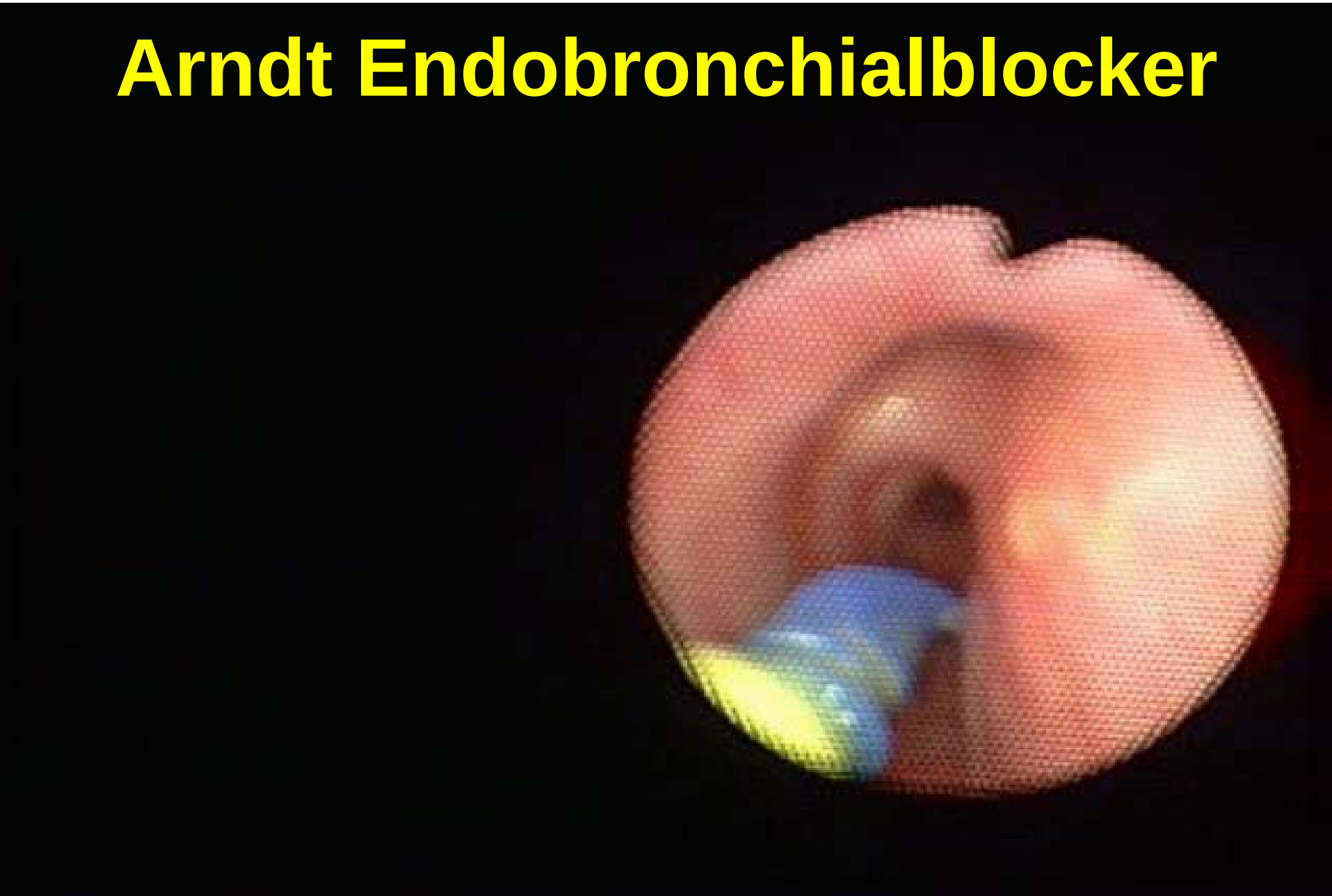
Arndt-Blocker beim Kind



Positionierung eines Arndt Bronchus-Blockers



Arndt Endobronchialblocker



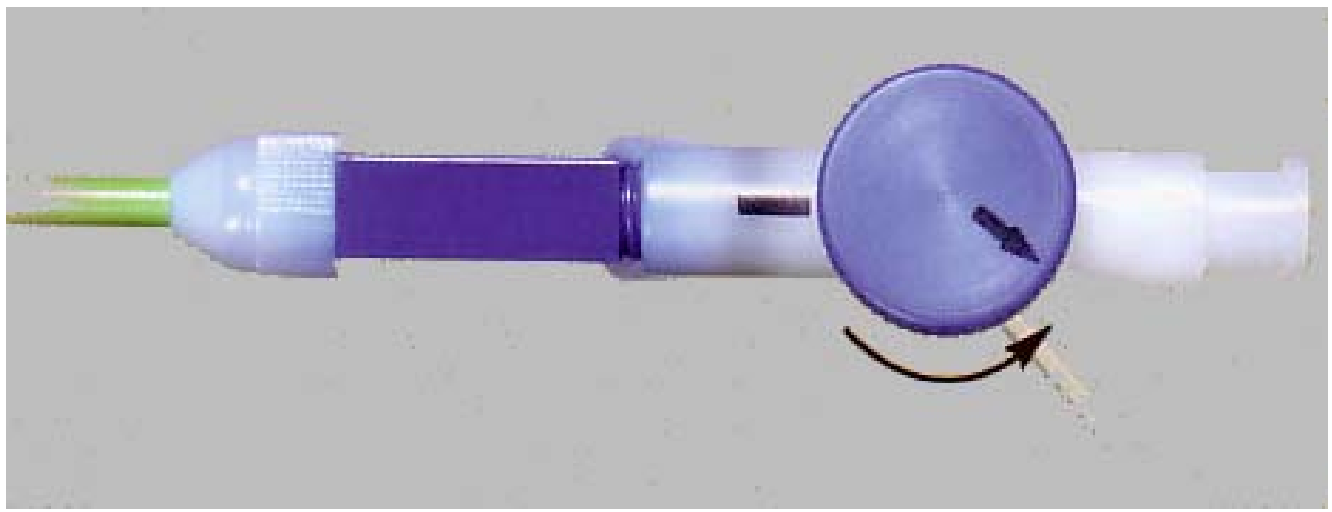
Arndt Endobronchialblocker

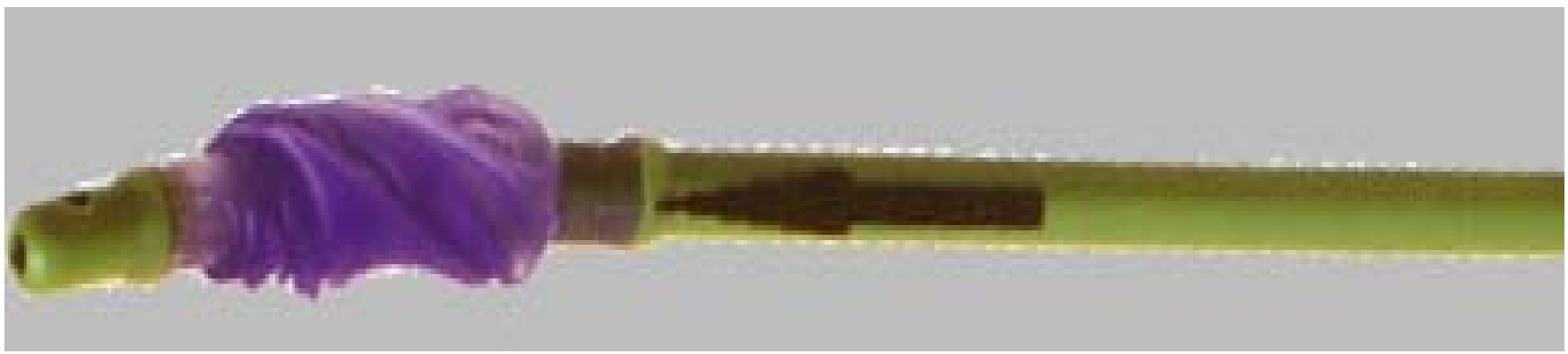
Grösse (F)	kleinster SLT ID koaxial (mm)	Länge (cm)	Cuff	Cuff Füll-volumen (cm3)
9	7,5	78 & 65	Elliptisch sphärisch	6-12 4-8
7	6,0	65	sphärisch	2-6
5	4,5	65 & 50	sphärisch	0,5-2,0

Methoden zur Seitentrennung der Atemwege

- Doppellumentuben
- Univent-Tubus
- Bronchusblocker
- Arndt Endobronchialblocker
- **Cohen Endobronchialblocker**
- HFJV Hochfrequenzbeatmung

Cohen Endobronchialblocker





Vorteile Bronchusblocker

- Intubation mit konventionellem Tubus möglich
- Kein postoperativer Tubuswechsel nötig
- Absaugung und O2-Insufflation eingeschränkt möglich
- Blockung einzelner Lungensegmente möglich

Nachteile / Kontraind. Bronchusblocker

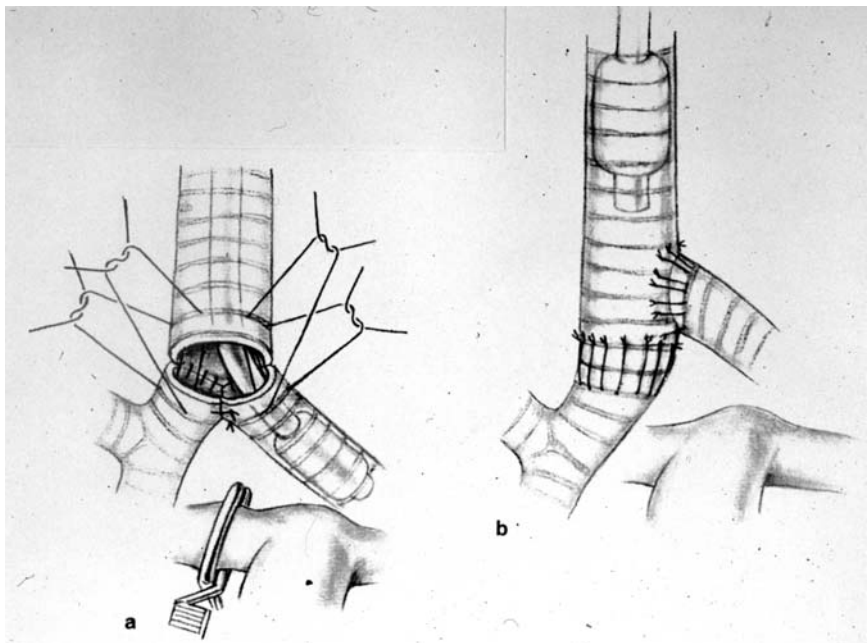
- Obligatorische Fiberoptische Kontrolle
- Hohes Dislokationsrisiko
- Erschwerte Absaugung
- Verzögerter Lungenkollaps
- Nur für linke Lunge empfohlen
- Reduktion des verfügbaren Tubuslumen
- Obstruktion der Trachea bei Dislokation

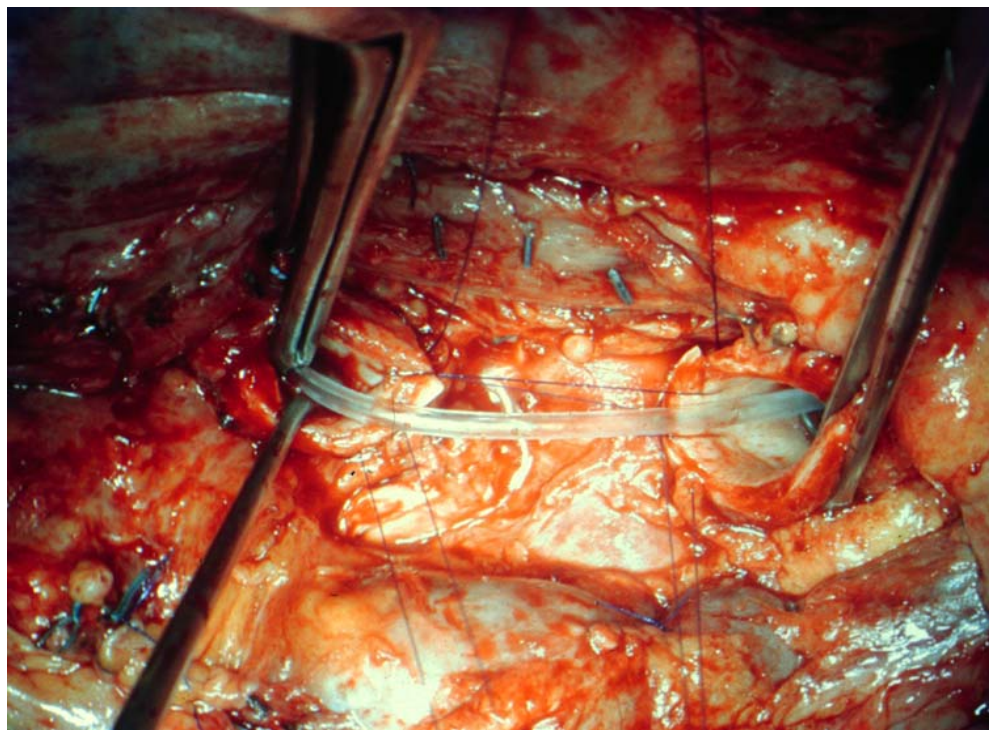
Methoden zur Seitentrennung der Atemwege

- Doppellumentuben
- Univent-Tubus
- Bronchusblocker
- Arndt Endobronchialblocker
- Cohen Endobronchialblocker

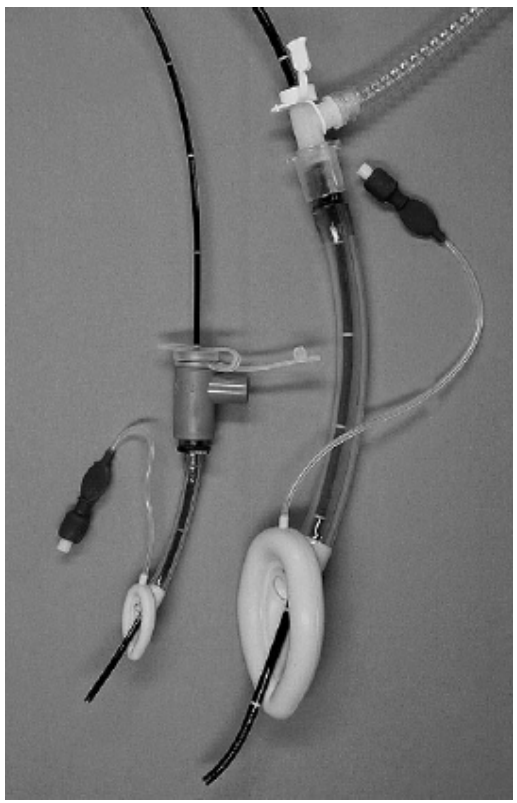
- **HFJV Hochfrequenzbeatmung**

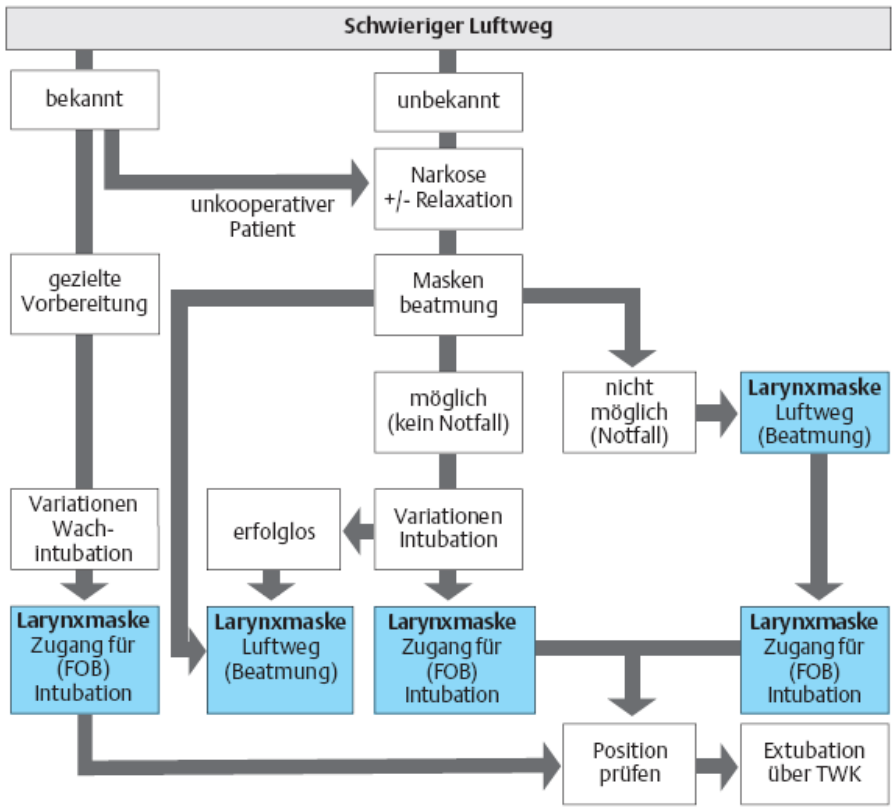
Manschetten-Pneumonektomie
Bifurkationsresektion

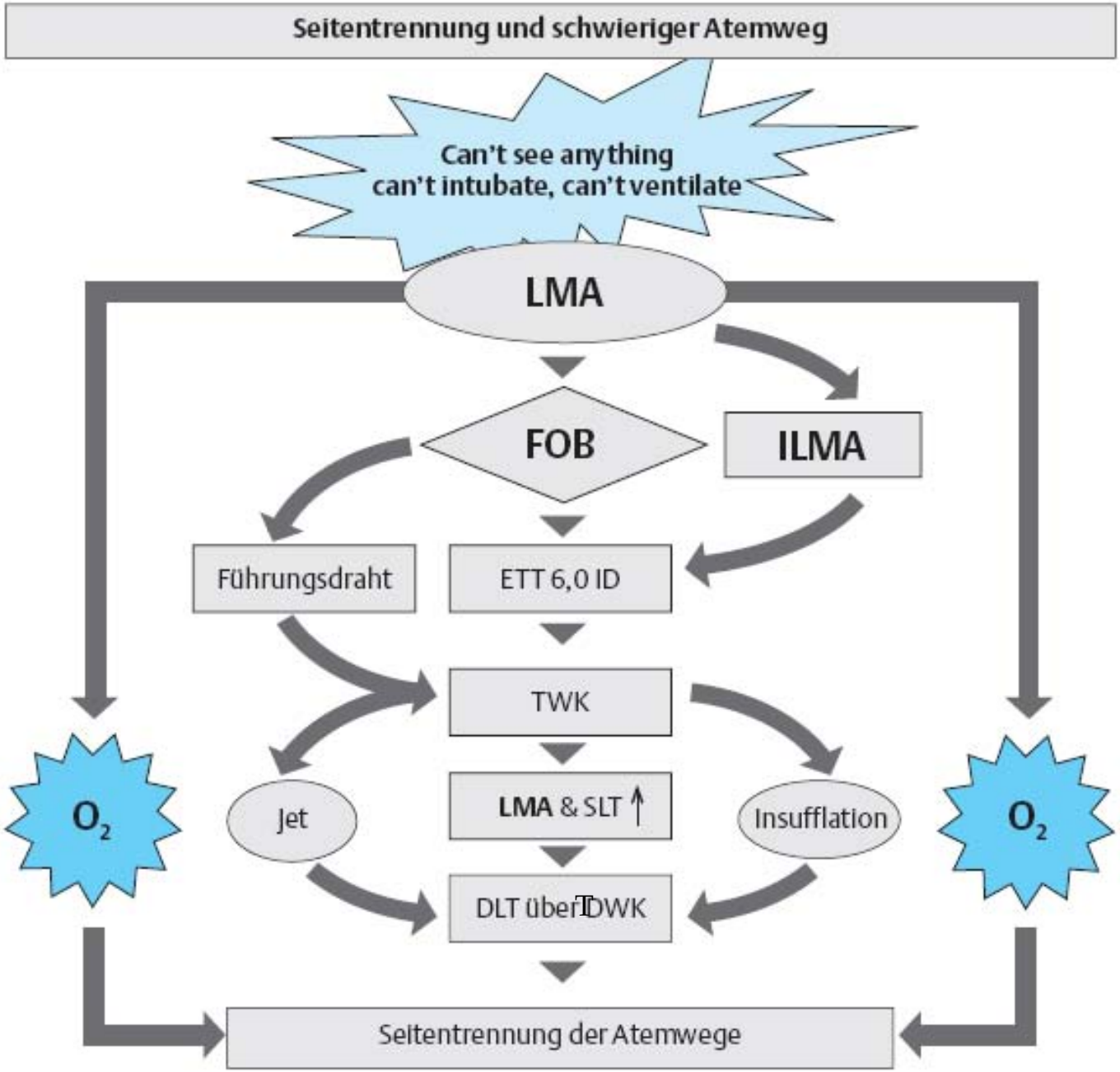




Ein-Lungen-Ventilation bei schwierigem Atemweg







Wiedemann K, Limberg D. Die Larynxmaske beim schwierigen Atemweg... Anästhesiol Intensivmed Notfalli

2004;39:501-6

Tubuswechselkatheter (Cook-Wechselkatheter)

Postoperative Umintubation - schwierige Intubatíon

Wie erhalte ich rasch eine Atelektase mit DLT z.B. für VATS

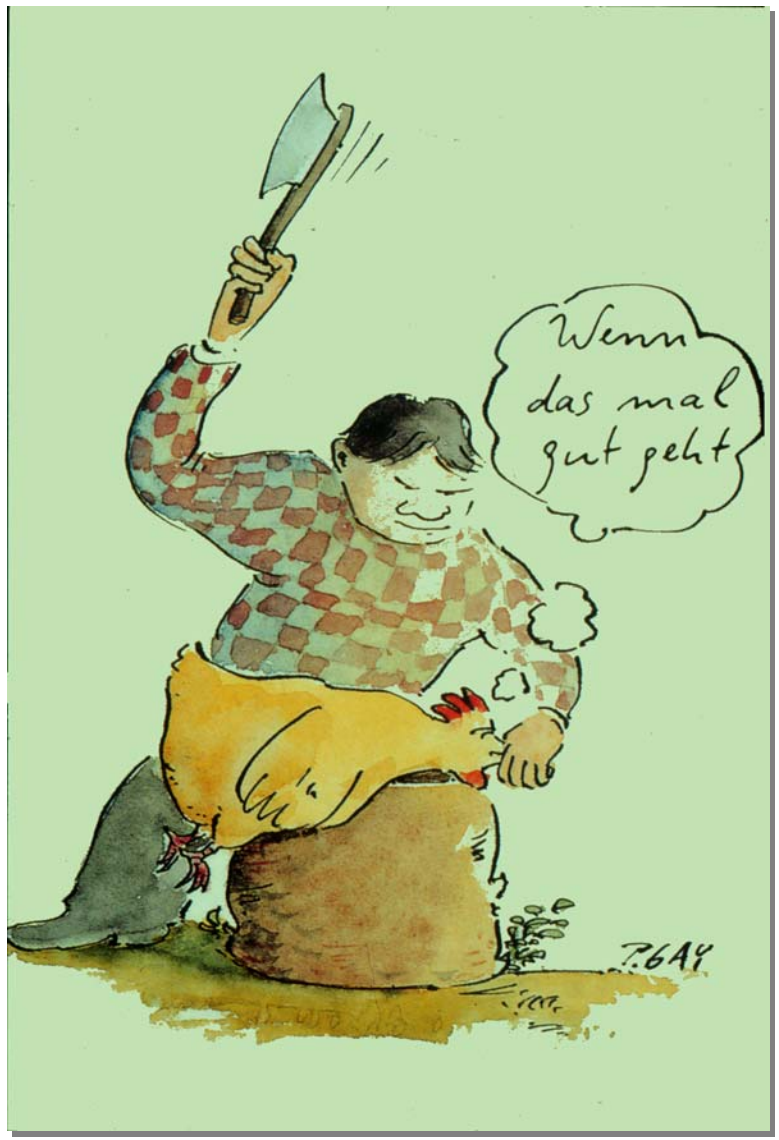
- Sichere Positionierung und Seitentrennung
  - Bubble-Test
  - Cuffdruckmesser am bronchialen Cuff
- kein CPAP auf abgehängte, nicht-ventilierte Lunge
- vor Seitentrennung Beatmung mit 1,0 FiO_2
- Abklemmen in End-Expiration
- Passive Mitbeatmung der abgehängten Lunge

Praktische Durchführung der Ein-Lungen-Ventilation

Klassisches Konzept ELV n. Benumof

- **DLV solange als möglich**
  - **evtl. bis zur Eröffnung der Pleura**

- **Beatmung**
  - **FiO2 = 1,0**
  - **TV = 10 ml/kg**
  - **AF = Normokapnie**
    - **pCO2 40 mmHg**
  - **PEEP = 0 (5) mm Hg**



Klassisches Konzept ELV n. Benumof

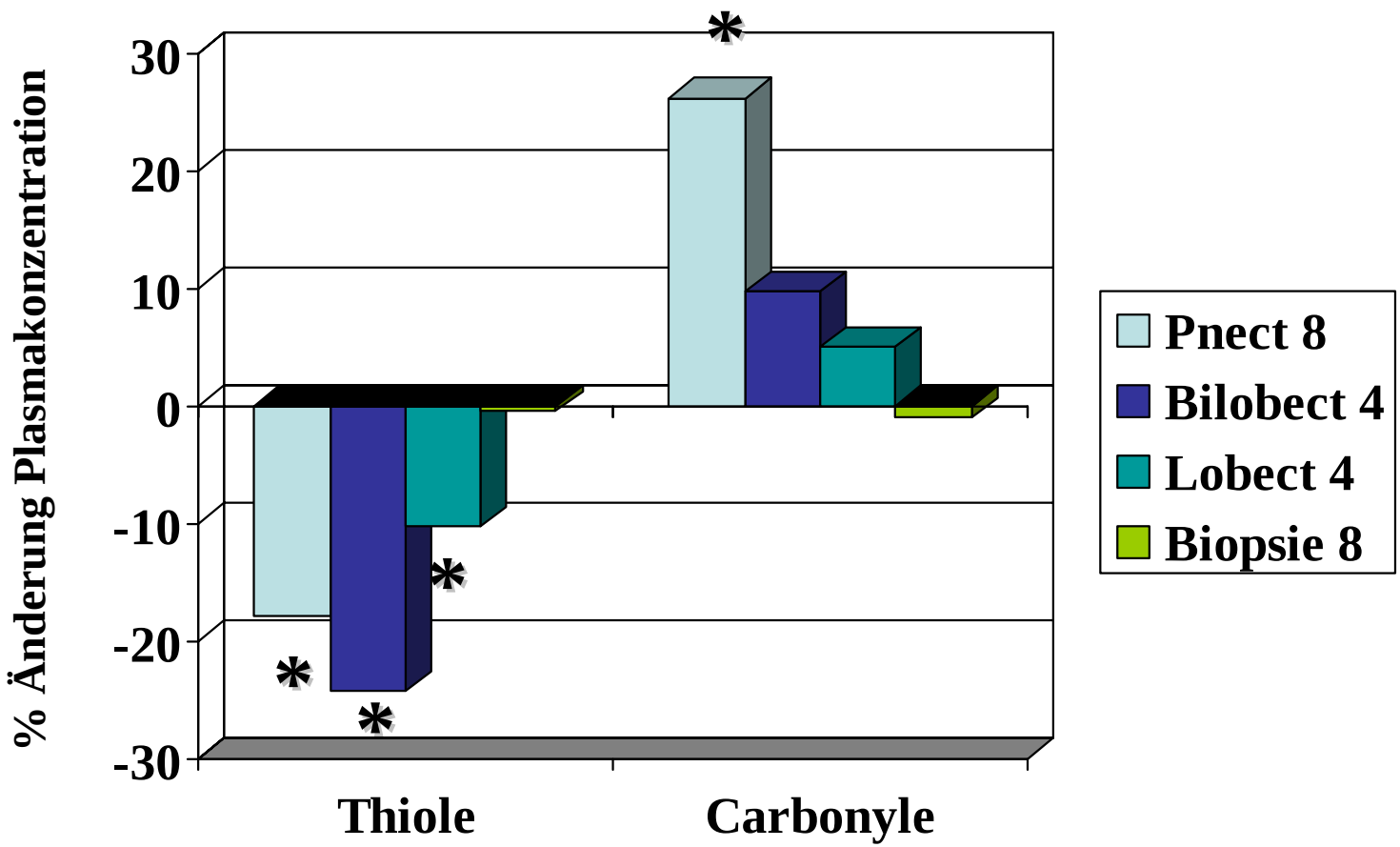
- DLV bis zur Eröffnung der Pleura
- Beatmung
  - FiO2 = 1,0
  - TV = 10 ml/kg
  - AF = Normokapnie pCO2 40 mmHg
  - PEEP = 0 (5) mm Hg
- **Bei Hypoxie**
  - **Positionskontrolle DLT**
  - **CPAP 5 – 10 cm H2O nichtabhängige Lunge**
  - **PEEP (≤ CPAP) 5 – 10 cm abhängige Lunge**
  - **Zweilungenventilation FiO2 1,0**
  - **Abklemmen Pulmonalarterie (Pneumonektomie)**

Acute lung injury following lung resection: is one lung anaesthesia to blame?

„ During one lung anaesthesia relative ischaemia of the ipsilateral lung is followed by re-expansion and reperfusion of the remaining lung tissue following lobectomy,and by hyperperfusion of the contralateral lung following pneumonectomy.“

Williams EA,Evans TW,Goldstraw P;Thorax 1996;51:114

ELV:Lungenschaden & oxidativer Stress



Williams EA et al.Eur Respir J 1998;11:1028

Editorial

Pro: Low Tidal Volume Is Indicated During One-Lung Ventilation

Peter Slinger, MD, FRCPC

Since the introduction of one-lung ventilation (OLV) as a standard practice during thoracic surgery in the first half of the last century, anesthesiologists have had to deal with the problem of maintaining adequate intraoperative arterial oxygenation while ventilating only one of the patient's lungs. Evolution in this management has been one of the great success stories in the practice of anesthesiology, as the incidence of hypoxemia during OLV has declined from 20%–25% in the 1970s (1) to <1% today (2). This can be attributed to several advances, including the use of fiberoptic bronchoscopy for double-lumen endobronchial tubes and bronchial blocker positioning and the use of newer volatile anesthetics that cause less inhibition of hypoxic pulmonary vasoconstriction and less shunt during OLV than older volatile anesthetics (3). Oxygenation with ≤1 MAC

Con: Low Tidal Volumes Are Indicated During One-Lung Ventilation

Thomas J. Gal, MD

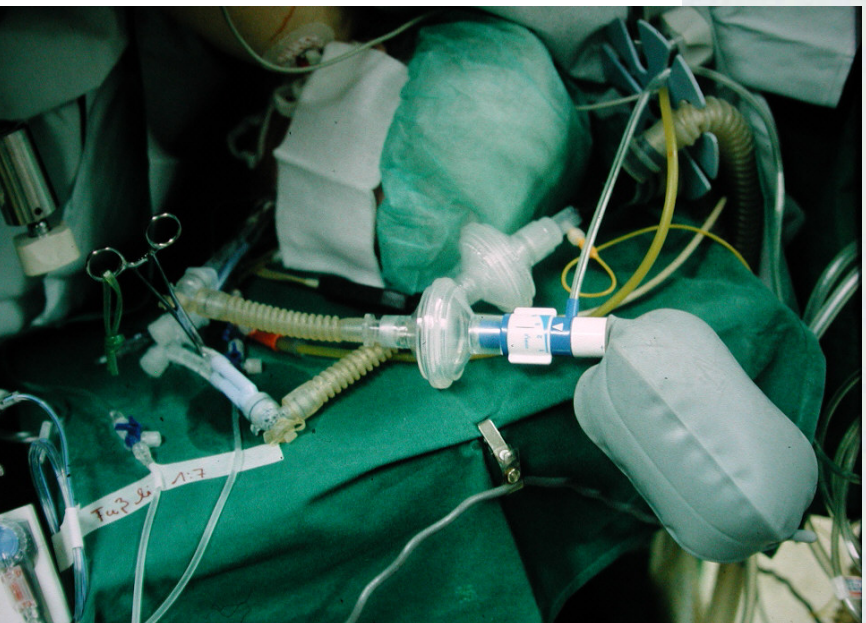
The management of one-lung ventilation is aimed at prevention of arterial hypoxemia. Generous inspired oxygen concentrations and adequate tidal volumes are usually deemed the most important components. Most textbooks advise retaining the same tidal volumes of 10–12 mL/kg (1) as with normal two-lung ventilation. This choice is based on the notion that tidal ventilation less than 8 mL/kg predisposes to atelectasis, whereas larger tidal volumes (15 mL/kg) may produce alveolar over-distension, compress alveolar vessels, and increase pulmonary vascular resistance in the ventilated dependent lung. The latter may, in turn, adversely divert some blood flow to the collapsed nondependent lung.

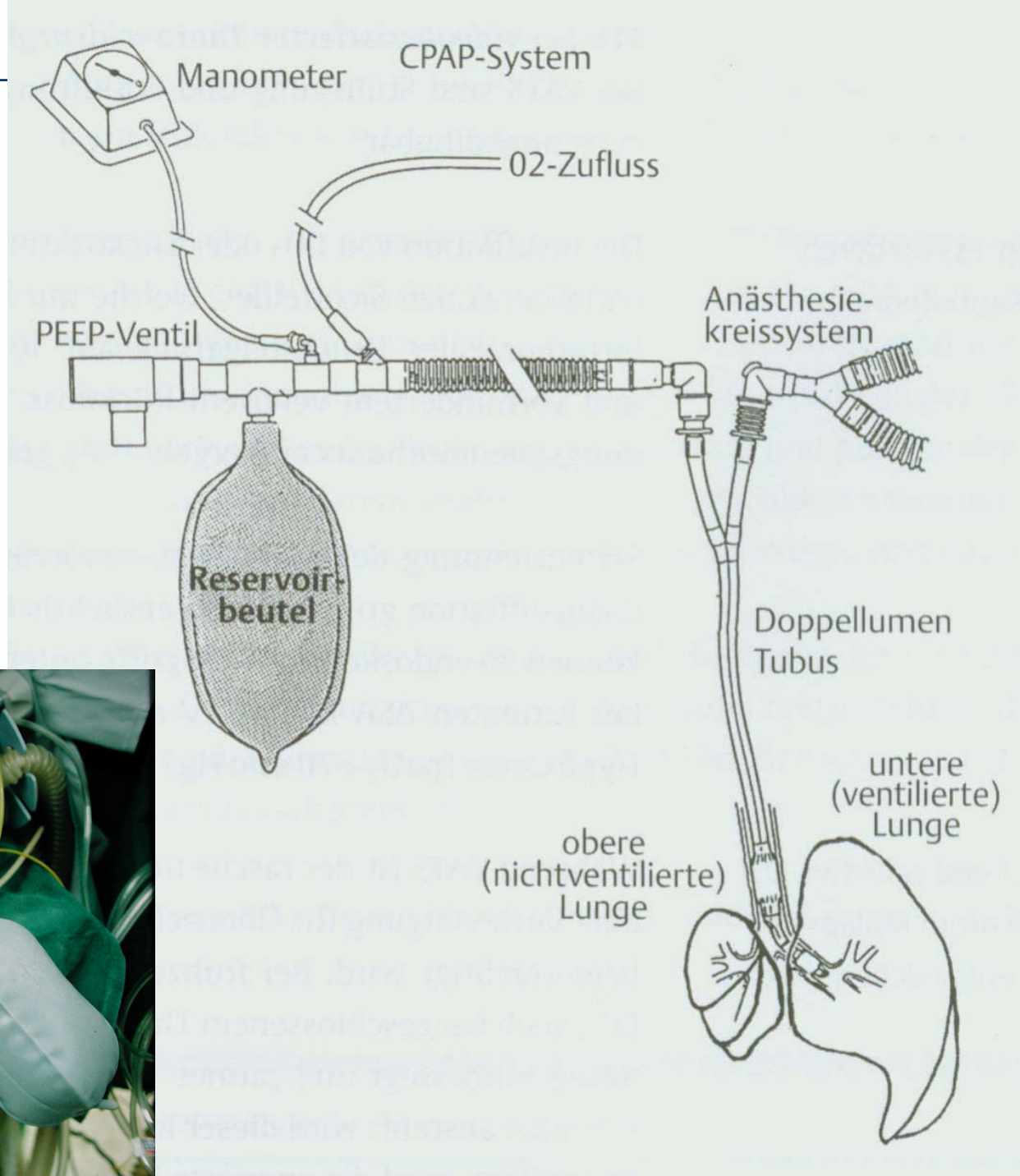
Neue lungenprotektive ELV

- **DLV solange möglich, evtl. bis zur Eröffnung der Pleura**

- **<u>Immer Bronchoskopie</u>**
  - **nach Intubation und DLT Platzierung**
  - **nach Umlagerung**
  - **bei Hypoxaemie**
  - **bei Anstieg des Atemwegsdruck**

CPAP – System für ELV





Neue lungenprotektive ELV

- **Beatmung**
  - FiO2 < 0,6 wenn möglich FiO2 < 1,0
  - PCV < 30-35 mmHg
    - Vermeidung hoher Atemwegsdrucke
  - Routine niedriger PEEP (5 cm H2O)
    - Vermeidung alveolarer Kollaps
  - Routine CPAP (4-5 cmH2O) außer VATS
  - Niedriges TV 6 ml/kg
    - permissive Hyperkapnie
  - Thorakale PDA

Neue lungenprotektive ELV

- **Bei Hypoxämie**
  - Recruitment der abhängigen Lunge
  - Neueinstellung PEEP und/oder CPAP
  - Kurze Episoden von ZLV
  - Verschluss der Pulmonalarterie
    - Chirurgisch
    - Katheter