Department of Anesthesia Techniques

Title of the lecture: - double lumen tube

Mohammed AbdulZahra Al_Mosawi

Ph.D., MSc. Anesthesia and ICU

TUMS, SUMS

Mohammed.abulzahra@oumus.edu.iq

(Double Lumen Tubes and Bronchial Blockers)

Lung isolation techniques are primarily designed to facilitate OLV in patients undergoing cardiac, thoracic, mediastinal, vascular, esophageal, or orthopedic procedures involving the chest cavity. Lung isolation is also used to protect the lung from soiling by the contralateral lung in such cases as bronchopleural fistula, pulmonary hemorrhage, and whole-lung lavage. In addition, lung isolation can be used to provide differential patterns of ventilation in cases of unilateral reperfusion injury (after lung transplantation or in unilateral lung trauma

The sharing of airway and lungs between the anesthetist and the surgeon, the lateral decubitus position, an open chest, and the requirement to collapse the non-dependent pathological lung that requires surgery and positive pressure ventilation of the normal dependent lung all pose a unique challenge to the anesthetist.

INDICATIONS FOR THE USE OF LUNG SEPARATION TECHNIQUES

Operation Room

• Before anesthetizing a patient with massive intrapulmonary bleed: open surgery or interventional radiologic procedures.

• Patients with bronchiectasis and lung abscess undergoing surgeries

• Surgeries for major bronchopleural or bronchoesophageal fistula repair

• Major bronchial disruption or trauma repair

• Unilateral lung lavage for pulmonary alveolar proteinosis

• Video-assisted thoracoscopic procedures: lung resections and esophageal surgeries

• Open thoracic surgeries of esophagus, spine surgeries those require transthoracic approach, and minimally invasive cardiac surgeries.

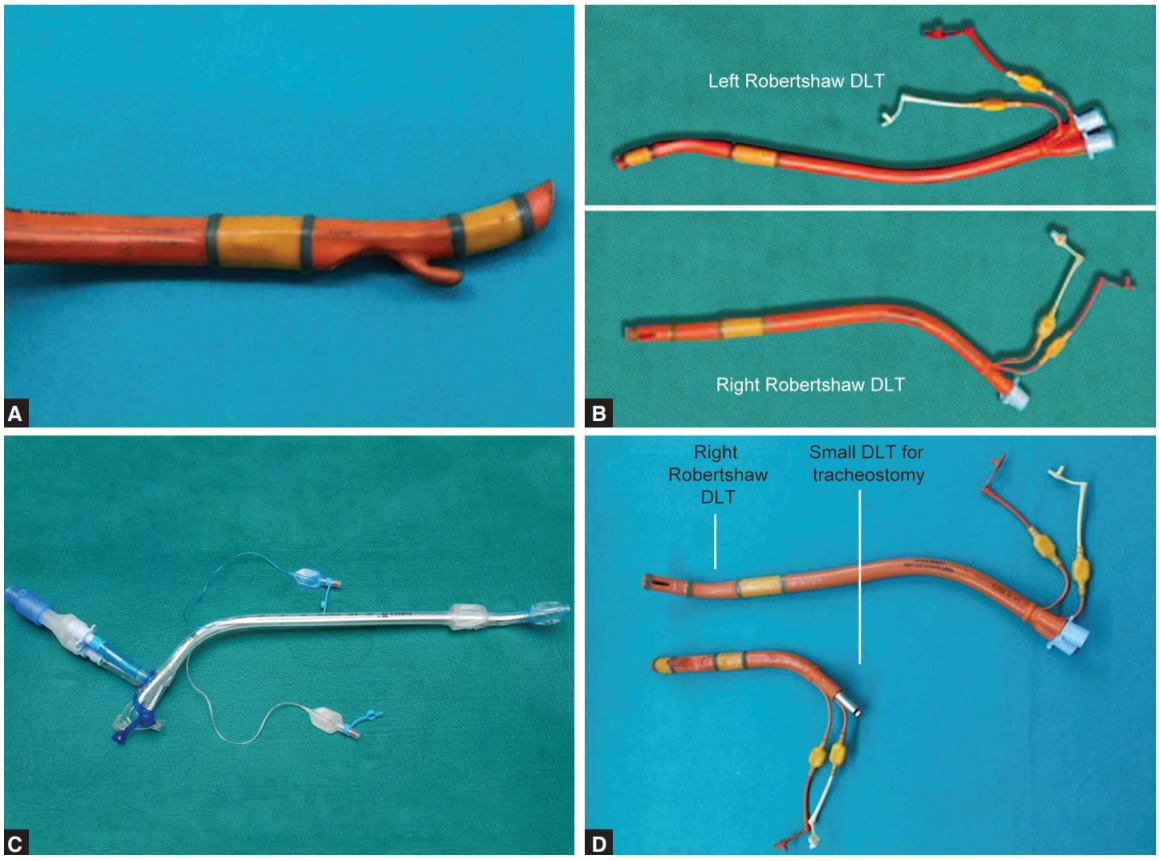
Intensive Care Unit

- Unilateral parenchymal injury

- Aspiration
- Pulmonary contusion
- Pneumonia
- Single lung transplant (postoperative complications)
- Bronchopleural fistula needing mechanical ventilation.

TABLE 66-4 **OPTIONS FOR LUNG ISOLATION**

Options	Advantages	Disadvantages
Double-lumen tube	Easy to place successfully	Size selection more difficult
1. Direct laryngoscopy	Repositioning rarely required	Difficult to place in patients with difficult airways or abnormal tracheas
2. Via tube exchanger	Bronchoscopy to isolated lung	
3. Fiberoptically	Suction to isolated lung	Not optimal for postoperative ventilation
	CPAP easily added	Potential laryngeal trauma
	Can alternate one-lung ventilation to either lung easily	Potential bronchial trauma
	Placement still possible if bronchoscopy not available	
	Best device for absolute lung isolation	
Bronchial blockers (BB)	Size selection rarely an issue	More time needed for positioning
1. Arndt	Easily added to regular ETT	Repositioning needed more often
2. Cohen	Allows ventilation during placement	Bronchoscope essential for positioning
3. Fuji	Easier placement in patients with difficult airways and in children	Limited right lung isolation due to RUL anatomy
4. EZ Blocker		Bronchoscopy to isolated lung impossible
	Postoperative two-lung ventilation by withdrawing blocker	Minimal suction to isolated lung
	Selective lobar lung isolation possible	Difficult to alternate one-lung ventilation to either lung
	CPAP to isolated lung possible	
Univent tube	Same as BBs	Same as for BBs
	Less repositioning compared with BBs	ETT portion has higher air flow resistance than regular ETT
	Rarely used	ETT portion has larger diameter than regular ETT
Endobronchial tube	Like regular ETTs, easier placement in patients with difficult airways	Bronchoscopy necessary for placement
		Does not allow for bronchoscopy, suctioning, or CPAP to isolated lung
	Longer than regular ETT	
	Short cuff designed for lung isolation	Difficult one-lung ventilation (right lung)
Endotracheal tube advanced into bronchus	Easier placement in patients with difficult airways	Does not allow for bronchoscopy, suctioning, or CPAP to isolated lung
		Cuff not designed for lung isolation
		Extremely difficult right one-lung ventilation



Double lumen bronchial tubes are either right- or left-sided but all modern day DLTs have:

• Longer bronchial lumen entering one of the bronchus with a cuff

• Shorter tracheal lumen with a cuff

• Preformed curve to facilitate entry in to the bronchus

• Malleable stylet

• Radiographic marker along the length of the tube.

SELECTING SIZE OF DOUBLE LUMEN BRONCHIAL TUBE

Based on sex and height of patients: Size 35 Fr is recommended for females of height less than 160 cm, 37 Fr for females of height more than 160 cm, 37 Fr for males of height less than 170 cm, and 41 Fr for males of height more than 170 cm.

One can also use a formula based on height to decide optimal depth of insertion for left sided DLTs. Depth of insertion in cm (at incisors) = 12 + patient height (cm)/10

Based on radiological studies

TABLE 66-5 **COMPARATIVE DIAMETERS OF SINGLE- AND DOUBLE-LUMEN TUBES**

Single-Lumen Tubes		Double-Lumen Tubes			
ID (mm)	ED (mm)	French Size (Fr)	Double-Lumen ED (mm)	Bronchial Lumen ID (mm)	FOB size (mm)
6.5	8.9	26	8.7	3.2	2.4
7.0	9.5	28	9.3	3.4	2.4
8.0	10.8	32	10.7	3.5	2.4
8.5	11.4	35	11.7	4.3	≥3.5
9.0	12.1	37	12.3	4.5	≥3.5
9.5	12.8	39	13.0	4.9	≥3.5
10.0	13.5	41	13.7	5.4	≥3.5

TABLE 66-6 **SELECTION OF DOUBLE-LUMEN TUBE SIZE BASED ON ADULT PATIENT'S SEX AND HEIGHT**

Sex	Height (cm)	Size of Double-Lumen Tube (Fr)
Female	<160 (63 in)*	35
Female	>160	37
Male	<170 (67 in)†	39
Male	>170	41

INSERTION TECHNIQUE:

1. The "blind" technique: Polyvinyl chloride DLTs are straight with curve at bronchial tube level.
   – The DLT is inserted with concavity facing anteriorly (tip directed upwards) and rotated by 90° towards the bronchus to be intubated after bronchial cuff (distal cuff) passes through vocal cords
   – After the tube passes through glottis, remove the stylet so as to avoid trauma to airway. Advance the tube while rotating by 90° towards the side to be intubated until moderate resistance is felt; this depth is usually 28–30 cm in a normal adult.
   Avoid using excess force while inserting the tube to prevent airway damage
   – Connect the DLT to the anesthesia circuit, inflate the tracheal cuff and auscultate chest for breath sounds as well as confirm presence of end-tidal CO2 on the capnogram – Take note of the peak airway pressures at this time.
   - Clamp the fresh gases to tracheal lumen and open the port of tracheal lumen. Inflate the bronchial cuff gradually until no air entry is detected on the contralateral lung and no air leak is felt at the tracheal opening during ventilation.

– Auscultate the lung to ensure that there is good air entry at the apex and base of the lung unilateral, and there is no air entry in the contralateral lung.
– Note peak airway pressures. In an adult, rise in peak airway pressure for same tidal volume should not be more than 8–12 cm H2O
– Ventilate both lungs again – Clamp fresh gas flow inlet of bronchial lumen and start tracheal ventilation. Confirm unilateral air entry by auscultation and unilateral chest expansion
– Note the peak airway pressures again. If there is larger airway pressure rise, or reduced air entry it suggests that either the bronchial cuff is causing obstruction by herniation across the carina or tube is far too in and tracheal lumen has entered the bronchus
– Deflate the bronchial cuff and auscultate. If there is no difference in air entry or if there is no change in airway pressures on deflation of the cuff, it suggests that the tracheal portion of the tube is endobronchial, and the tube should be slightly withdrawn. However, if on deflation of bronchial cuff, air entry improves and airway pressure comes down, it suggests probable herniation of bronchial cuff and tube needs to be pushed further into the bronchus.
– After clinical confirmation of placement of tube, insert fibreoptic bronchoscope (FOB) down the tracheal lumen and visualize carina. At this point, one should be able to see the carina in front and the blue cuff of endobronchial tube in the main bronchus.
Any malpositioning of the tube can be visualized and corrected under FOB guidance.

“Head Turn” maneuver: Another major problem while inserting left DLT by blind method is entry of tube in right main bronchus. If left DLT enters right main stem bronchus repeatedly; deflate both cuffs, withdraw the tube into the trachea. Turn patient’s jaw toward the left shoulder while bending the right ear to the right shoulder and then advance the tube.
– Insert the DLT through the glottis with direct laryngoscopy, rotate it 90° to the side of endobronchial tube, and advance it till the proximal edge of the tracheal cuff is just beyond the vocal cords so that the tip of the bronchial lumen is supracarinal

– With inflation of tracheal cuff, initiate ventilation of both lungs and confirm tube placement by auscultation and capnometry
– Place FOB through the bronchial lumen and advance until the carina and main stem bronchi are clearly identified.

Whether DLT is inserted blindly or under vision, precise monitoring of the position of tube is necessary when the patient's position is changed from supine to lateral decubitus because displacement can occur in up to 32% of cases. Distal displacements is more common than proximal displacement. Movements of 16–19 mm of a left double lumen tube and 8 mm of a right double lumen tube can compromise functional lung separation in an adult.

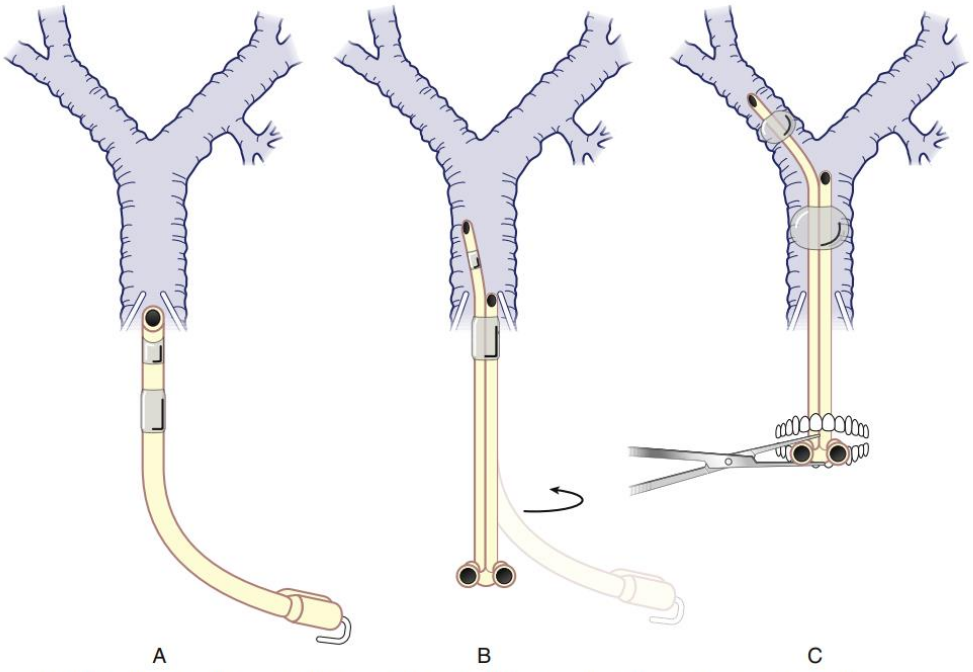
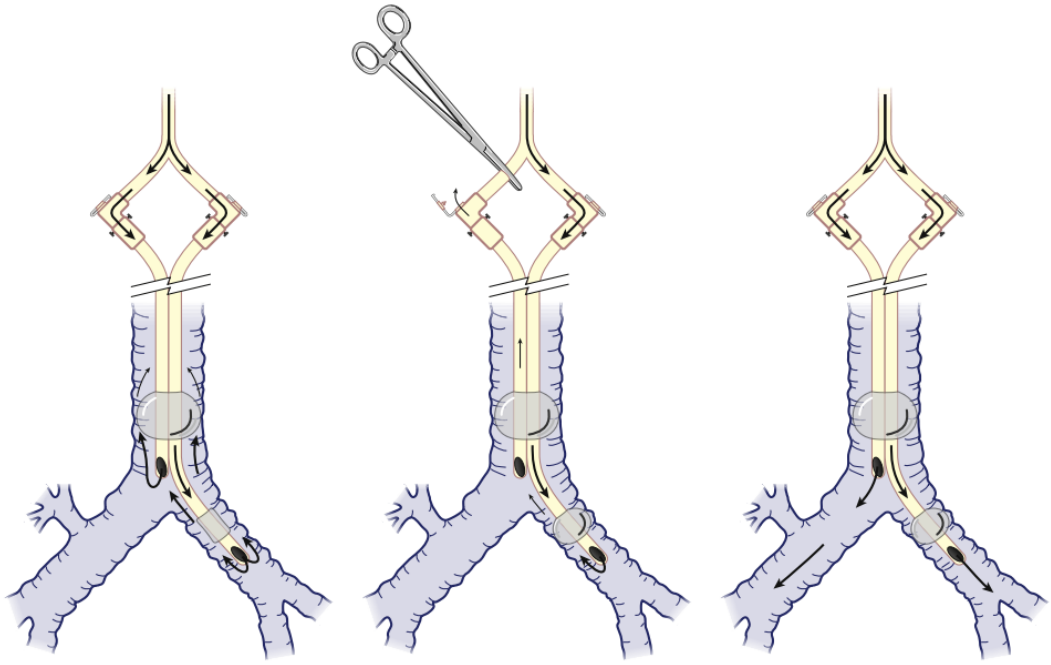


Figure 66-12. Blind method for placement of a left-sided DLT. **A,** The DLT is passed with direct laryngoscopy beyond the vocal cords. **B,** The DLT is rotated 90 degrees to the left (counter-clockwise). **C,** The DLT is advanced to an appropriate depth (in general 27-29 cm marking at the level of the teeth). *(Reproduced with permission from Slinger P:* Principles and practice of anesthesia for thoracic surgery, *New York, Springer, 2011.)*



Advantages of Double Lumen Tubes

- Easier to position
- Can be positioned without bronchoscopy
- Less time is required to position as compared with EBB
- More rapid lung collapse as compared with EBB
- Less likely to be displaced as compared with EBB
- Allows either lung to be ventilated, collapsed, and re-expanded
- Each lung can be suctioned adequately
- Each lung can be inspected with a bronchoscope
- Continuous positive airway pressure (CPAP) can be easily applied to operated lung
- Enables independent lung ventilation in ICU.

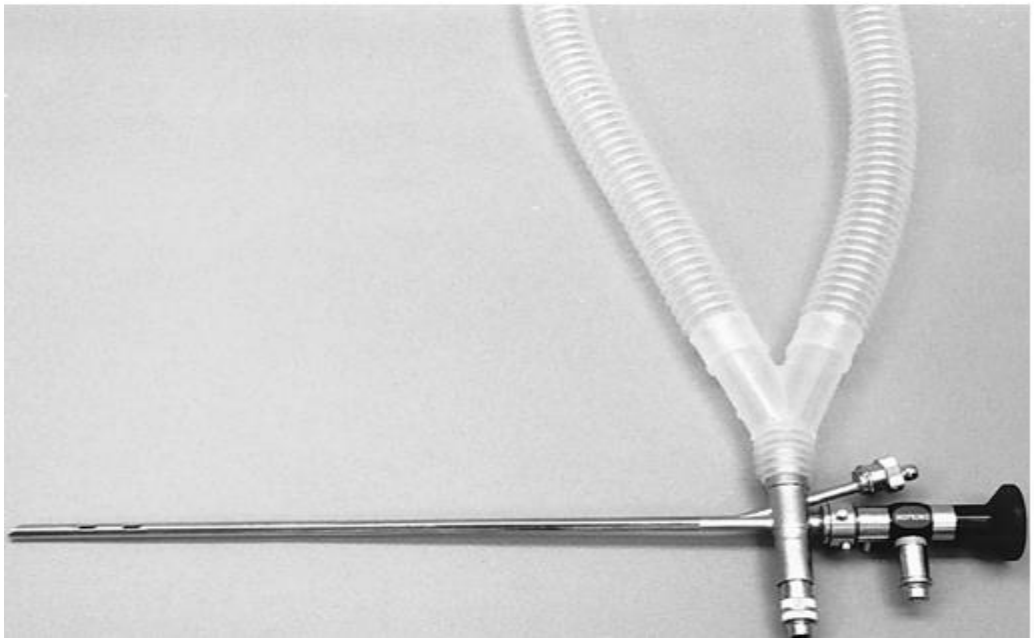
Disadvantages of Double Lumen Tubes

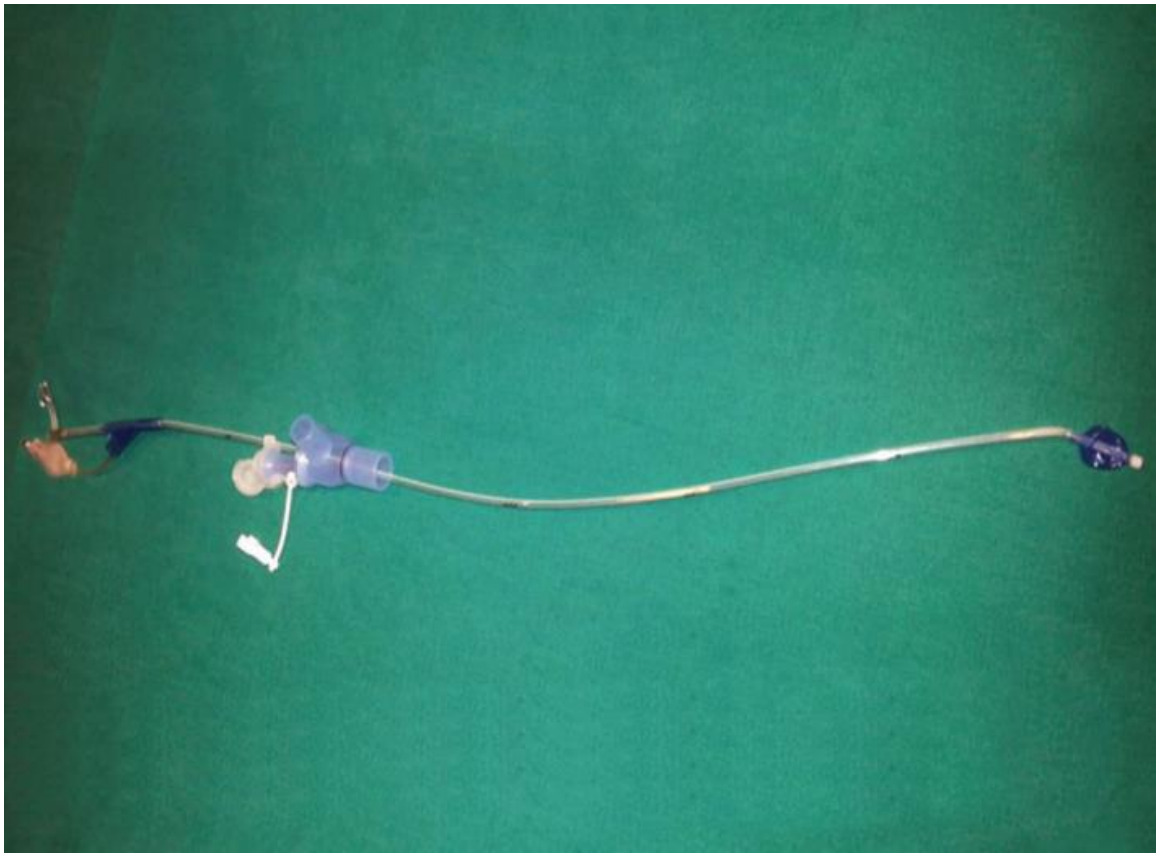
- It may be impossible to place a DLT in a patient with a difficult airway
- The large size and design of DLTs can cause airway damage during insertion, prolonged use, and removal
- There can be a problem in proper placement especially if the tracheal or bronchial anatomy is severely distorted
- Lesions within the trachea, like tumors, are relative contraindications to DLT placement
- If patient's condition necessitates mechanical ventilation postoperatively, changing a DLT to a single-lumen ETT at the end of surgery can be hazardous.

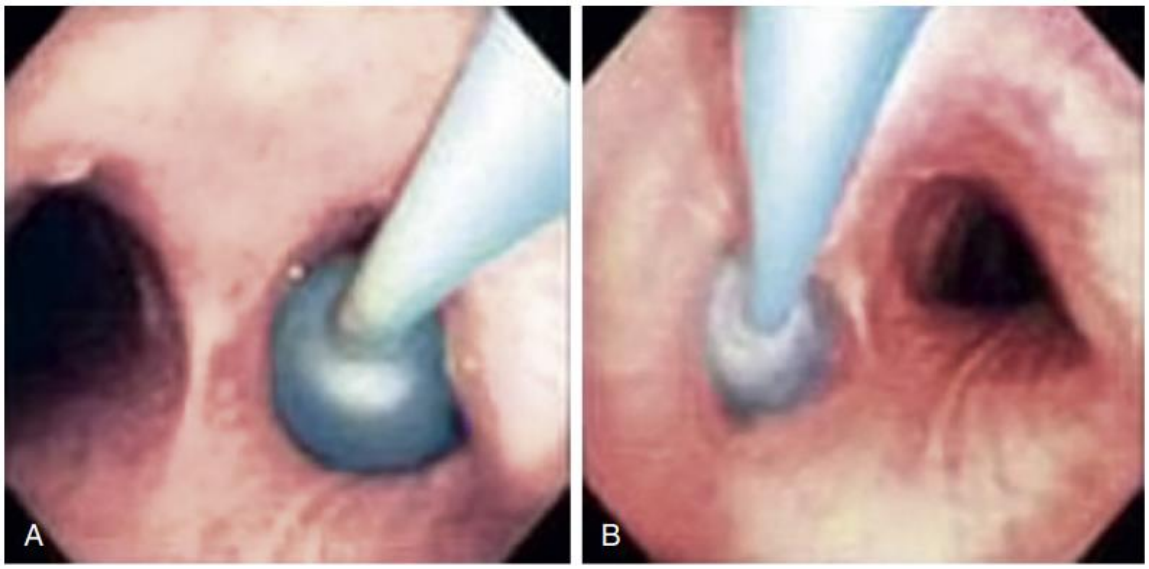
• Intubated patient from ICU coming for a surgery requiring lung isolation would require change of single-lumen ETT to a DLT, which can be dangerous in patients who are fluid resuscitated and have airway edema, those with cervical spine injuries, difficult airways, and in those that cannot tolerate periods of apnea
• DLTs are manufactured in limited sizes 28, 35, 37, 39, and 41 French and are often too big for the majority of pediatric patients
• Lumens of DLTs are narrow as compared to single lumen tubes.

TABLE 66-8 SUGGESTED METHODS OF LUNG ISOLATION FOR SPECIFIC INDICATIONS

Indication for Lung Isolation	Preferred Methods	Possible Alternatives
Pulmonary resection right side	Left DLT	BB/Left EBT
Pulmonary resection left side		
Pneumonectomy unlikely	Left DLT	BB/Right DLT
Pneumonectomy	Right DLT	Left DLT/BB
Thoracoscopy (either side)	Left DLT	BB/Right DLT
Pulmonary hemorrhage	Left DLT	BB/contralateral EBT
Bronchopleural fistula		
Left mainstem bronchus	Right DLT	EBT
All other sites	Left DLT	Right DLT/BB/EBT
Purulent secretions (e.g., abscess, cyst)	Left DLT	Right DLT/BB/EBT
Bullae, blebs	Left DLT	Right DLT/BB
Nonpulmonary surgery (e.g., thoracic aorta, esophagus)	Left DLT/ BB	Right DLT/EBT
Bronchial surgery (e.g., tumor, trauma)		
Left side	Right DLT	EBT
Right side	Left DLT	EBT
Upper airway abnormalities	BB	Left DLT/EBT
Lung transplantation		
Bilateral	Left DLT	BB/EBT
Single right lung	Left DLT	BB/EBT
Single left lung	Right DLT	BB/Left DLT/EBT
Whole lung lavage	Left DLT	—
Independent lung ventilation	Left DLT	Right DLT







VENTILATION STRATEGIES DURING ONE-LUNG VENTILATION

The strategy used to manage the ventilated lung during OLV plays an important part in the distribution of pulmonary blood flow between the lungs. It has been the practice of many anesthesiologists to use the same large tidal volume (e.g., 10 mL/kg ideal body weight) during OLV as during TLV. This strategy probably decreases hypoxemia by recurrently recruiting atelectasis regions in the dependent lung and may result in higher PaO2 values during OLV compared with smaller tidal volumes. However, there is a trend to use smaller tidal volumes with PEEP during OLV for several reasons. First, the incidence of hypoxemia during OLV is much lower than it was 20 to 30 years ago. Second, there is a risk of causing acute injury to the ventilated lung with prolonged use of large tidal volumes. And finally, third, a ventilation pattern that allows recurrent atelectasis and recruitment of lung parenchyma seem to be injurious. The ventilation technique needs to be individualized depending on the patient's underlying lung mechanics.

TABLE 66-9 SUGGESTED VENTILATION PARAMETERS FOR ONE-LUNG VENTILATION

Parameter	Suggested	Guidelines/Exceptions
Tidal volume	5-6 mL/kg	Maintain: Peak airway pressure <35 cm H_2O Plateau airway pressure <25 cm H_2O
Positive end-expiratory pressure	5 cm H_2O	Patients with COPD, no added PEEP
Respiratory rate	12 breaths/min	Maintain normal $Paco_2$, Pa-etCO_2 will usually increase 1-3 mm Hg during one-lung ventilation
Mode	Volume or pressure controlled	Pressure control for patients at risk of lung injury (e.g., bullae, pneumonectomy, post lung transplantation)

TREATMENT OF HYPOXEMIA DURING ONE-LUNG VENTILATION

1. Resume two-lung ventilation
2. Increase FiO2.
3. Check to be sure there has been no decrease in cardiac output.
4. Perform a recruitment maneuver of the ventilated lung
5. Apply PEEP to the ventilated lung
6. Continuous positive airway pressure (CPAP) with oxygen to the non-ventilated lung

Thank you