Devices available for Lung isolation and Lung isolation techniques

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Lung isolation facilitates to perform advanced surgical procedures by providing better exposure of thoracic cavity. The anaesthesiologist should have in-depth knowledge regarding the anatomy of the tracheobronchial and bronchopulmonary segments. The physiological aspect of the ventilation and perfusion of the lungs would help us to manage one lung ventilation successfully. Commonly, lung separation is preferred for the surgical exposure. Also, it is needed it certain clinical conditions to protect the healthy lung from contamination with blood, pus or secretion from the diseased lung.

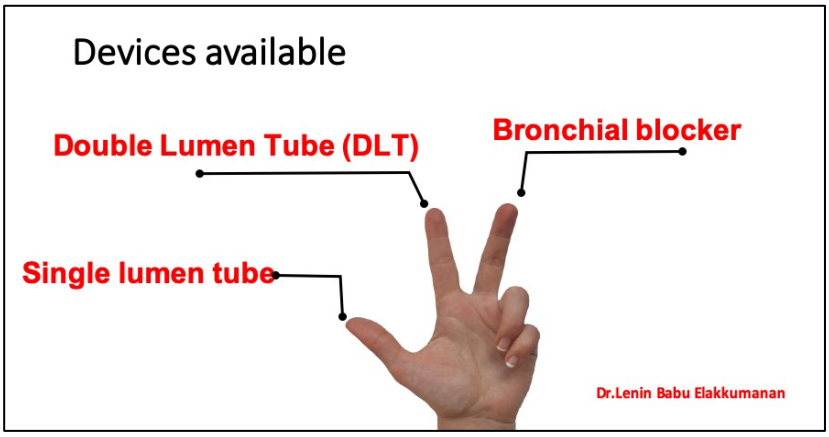
Indications for lung isolation

- Absolute indications:
    1. Patient related
        - Lung abscess
        - Pulmonary hemorrhage
        - Broncho pleural fistula
        - Bronchial disruption
        - Major Lung cyst/bulla
    2. Procedure related
        - VATS
        - Lung lavage

- Relative indications
    1. Thoracic aortic surgery
    2. Mediastinal surgery
    3. Esophageal surgery
    4. Open thoracotomy

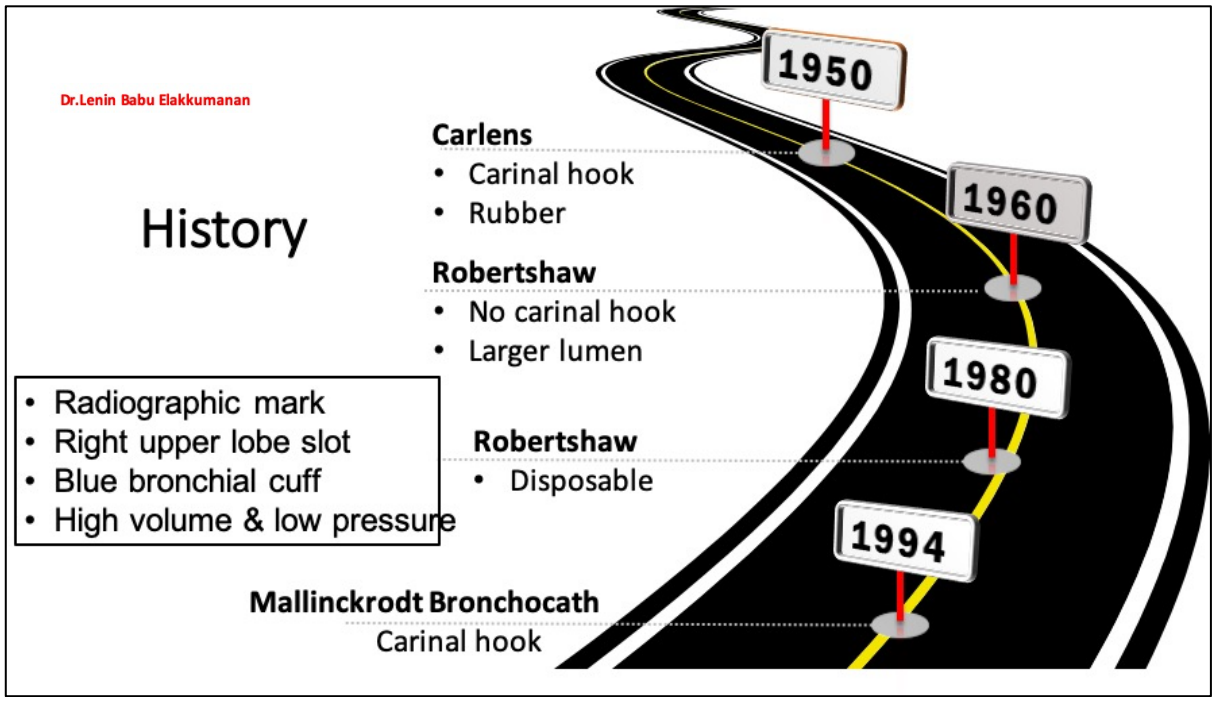
Available devices for lung isolation

This write up would primarily focus on the devices available for lung isolation and describes the several techniques for the same. Earlier, Anesthesiologists were using the single lumen endotracheal tube for lung isolation by endobronchial intubation. Later, with the invention of double lumen tube and the fibreoptic bronchoscope, it became relatively easy. The lung isolation is commonly achieved by the use of the double lumen tube or bronchial blockers. (figure.1)



Double lumen tubes (DLT)

The basic idea of double lumen was developed by the physician for spirometry. Carlen's tube was the oldest DLT which had the characteristic carinal hook. This was a left sided DLT made up of rubber. For the insertion, the carinal hook was tied using loose knot with the tube to facilitate the insertion of DLT into the glottis. The use of carinal hook was associated with trauma. Thereafter, White had designed similar tube for the right side without carinal hook. Later, Robertshaw who was an anaesthesiologist designed the DLT for both sides without carinal hooks. (figure.2) The internal lumen was 'D' shaped which had increased the lumen size and also the ventilatory parameters. Since then, many developments took place to provide the current DLT which is made up of PVC for single use.



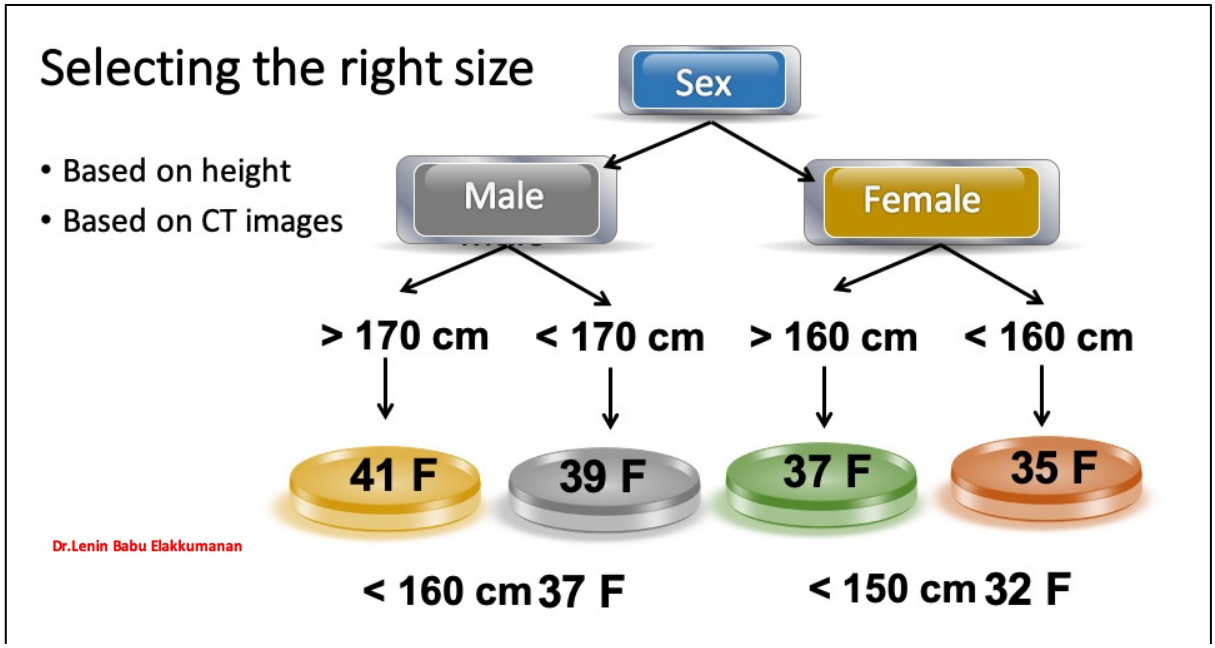
Selecting the right and left side DLT

While using the left sided DLT, one can effectively block either of the sides by blocking the lumens appropriately. Then the logical question arises, what is the indication for the right sided DLT? The distance between the secondary carina and the primary carina is relatively

longer in the left side. As the margin of safety is more on the left side, most of the anaesthesiologist prefer to use the left sided DLT. However, the presence of any intraluminal and/or extraluminal obstruction of the left main stem bronchus will narrow the lumen which mandates the use of right sided DLT. Few of the anaesthesiologist use right DLT for the sleeve resection of left main bronchus to avoid the DLT to get caught in the suture lines. Still, some of the anaesthesiologist use the left sided DLT for left main bronchus sleeve resection and they withdraw the tube just before suturing and reinsert.

Selecting the correct size

Choosing the appropriate size of the DLT is essential to avoid many complications. Too small tube may lead to endobronchial intubation with the tracheal lumen. Too large tube may lead to trauma to the glottis and the bronchus. The most appropriate size DLT may be selected based on the sex and the height of the patient. (Figure.3) Also the tracheal and bronchial measurements based on the CT images may be used to select the tube size. (Figure.4)



Selecting the correct size

Tracheal width	Left bronchial width	DLT Size
14 mm	9.5 mm	35 F
15 mm	10.2 mm	37 F
16 mm	10.9 mm	39 F
18 mm	12.2 mm	41 F

Identifying the side of DLT

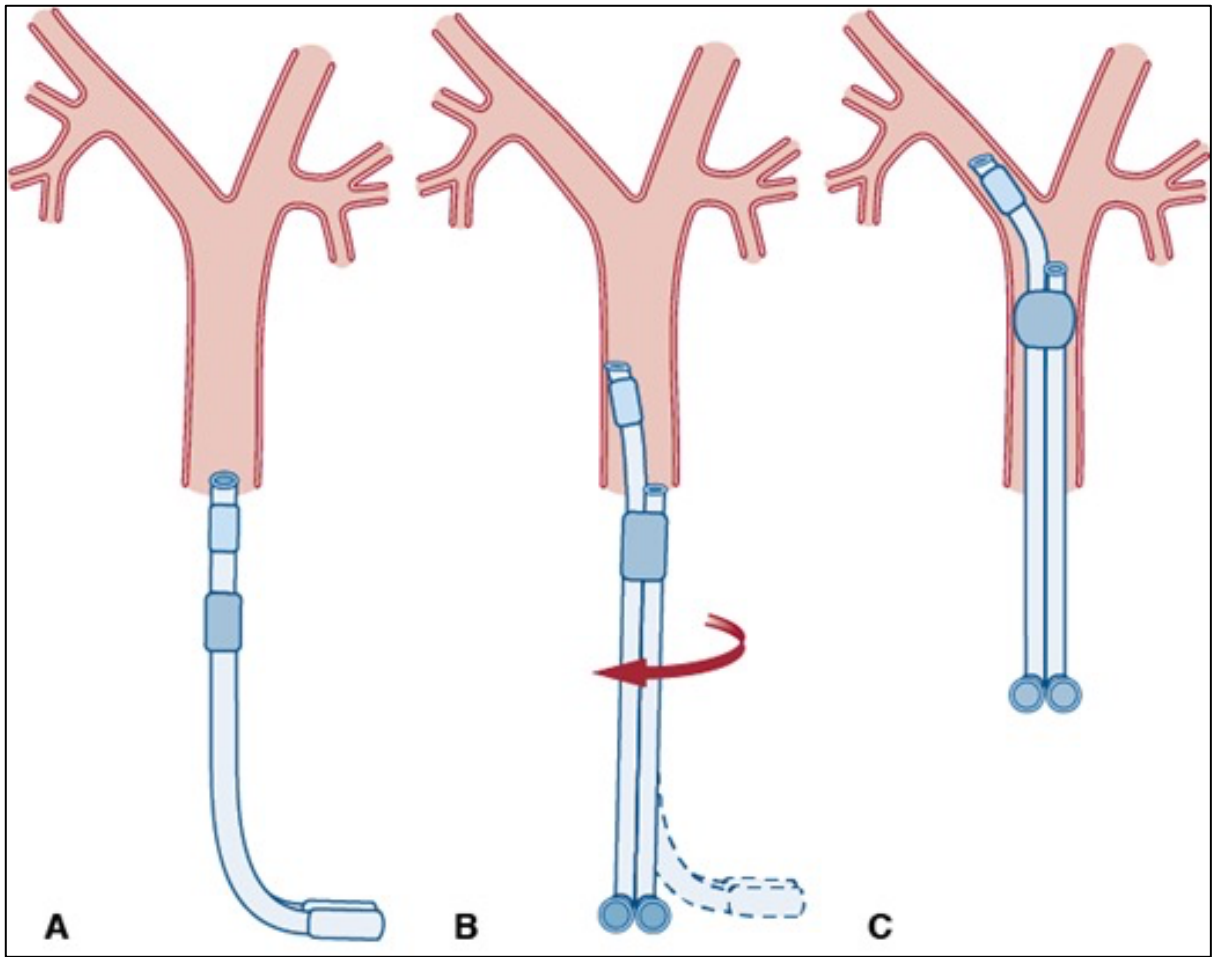
The common question which is asked in the exam is to identify the DLT whether it is right or left sided. The machine end of the DLT should be hold in the hand in such a way that the concavity of proximal curvature is facing upwards. Then one has to observe the direction of the distal curvature. If the tube curves to left, then it is left sided tube. Apart from the curvature, the right side DLT will have a ventilation slot for the right upper lobe bronchus. Also, the bronchial cuff may have a different design. (figure.5)

Pre use preparation

The DLT has to be prepared before insertion. Both cuff should be checked for any leak and observe for the symmetrical inflation of the cuff. The FOB, Stylet and the DLT cuff should be lubricated. The connectors should be assembled and kept ready for immediate connection after inserting DLT. After general anaesthesia, good laryngoscopy should be performed for insertion. While introducing the DLT in the oropharynx, one has to be careful to avoid contact of the tracheal cuff with the upper incisor.

Insertion technique of DLT

There are two techniques of insertion for the DLT which includes blind insertion and the FOB guided insertion. For the blind insertion, the DLT is inserted into the glottis while the concavity of the distal curvature facing upwards. Once the DLT crosses the glottis, the stylet should be removed to avoid tracheo bronchial injuries. Then, the DLT is rotated 90 anticlockwise so that the concavity of the proximal curvature is facing upwards and advanced till there is resistance. (figure.6)



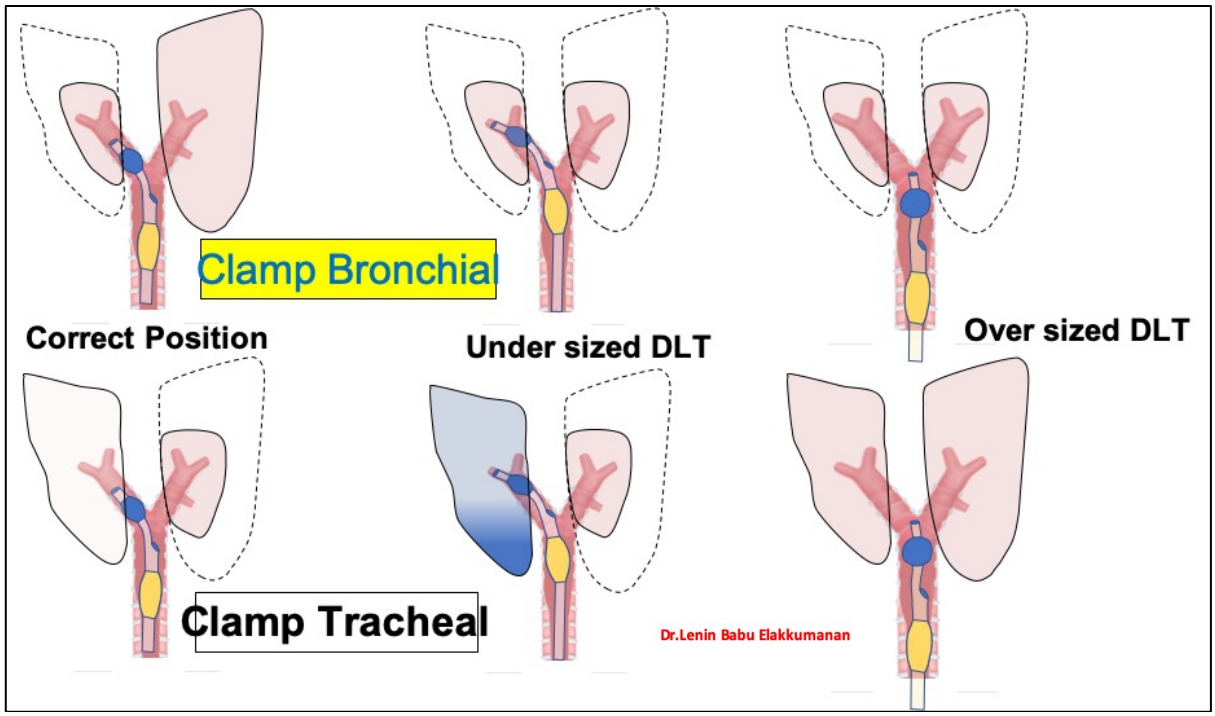
In the FOB guided technique, the similar procedure is done till the DLT is advanced. However, here the DLT is advanced under FOB guidance. Once, the tracheal cuff is inside the glottis, FOB is inserted through the bronchial lumen. The tip of the FOB is kept just beyond the bronchial lumen and both the DLT and the FOB is advanced while observing the entry of the DLT into the desired side. Alternatively, after inserting the FOB into bronchial lumen, only the FOB is advanced. The primary carina is identified, and the FOB is placed in the desired bronchus. Later the DLT is rail roaded slowly over the FOB. One has to be gentle to avoid damage to the FOB while railroading. Hence, if any difficulty is encountered, the further pushing of the tube should be avoided.

Confirmation of DLT

The final position of DLT is confirmed by either auscultation or by FOB assessment. Even for the experienced anaesthesiologist, some of situations will be very difficult to confirm by auscultation. One has to have better understanding of the anatomy of the bronchopulmonary segments. After insertion of the DLT, first the tracheal cuff is inflated to confirm the tracheal intubation and bilateral equal air entry. Then the bronchial cuff is inflated with 2-3 ml of air. To avoid damage to the bronchus and the bronchial mucosa, the bronchial cuff is inflated as minimum volume required to occlude the bronchus. Usually, it would need 2-3 ml.

After inflating both tracheal and bronchial cuff with appropriate volume, then the operative side lumen is clamped. For example, in case of left sided procedures, the bronchial lumen is clamped and ventilation is continued through the tracheal lumen. If the DLT is

correctly positioned, the air entry would be only on right side with absent breath sound on the left side. (figure 7)



In the above example, the malposition of DLT can occur in three scenarios. If the DLT is too small, the bronchial lumen may go beyond the secondary carina. And the tracheal lumen will be beyond primary carina. In this case, the right sided air entry would be absent during ventilation through tracheal lumen. If the DLT is too big, the bronchial lumen may not enter the left main stem bronchus. Both the tracheal and bronchial cuff will be positioned in the trachea only. As the bronchial lumen is above the primary carina, the ventilation through the bronchial lumen would ventilate both the lungs (after clamping the tracheal lumen). The ventilation through the tracheal lumen would be difficult as most of the lumen is obstructed by the bronchial lumen.

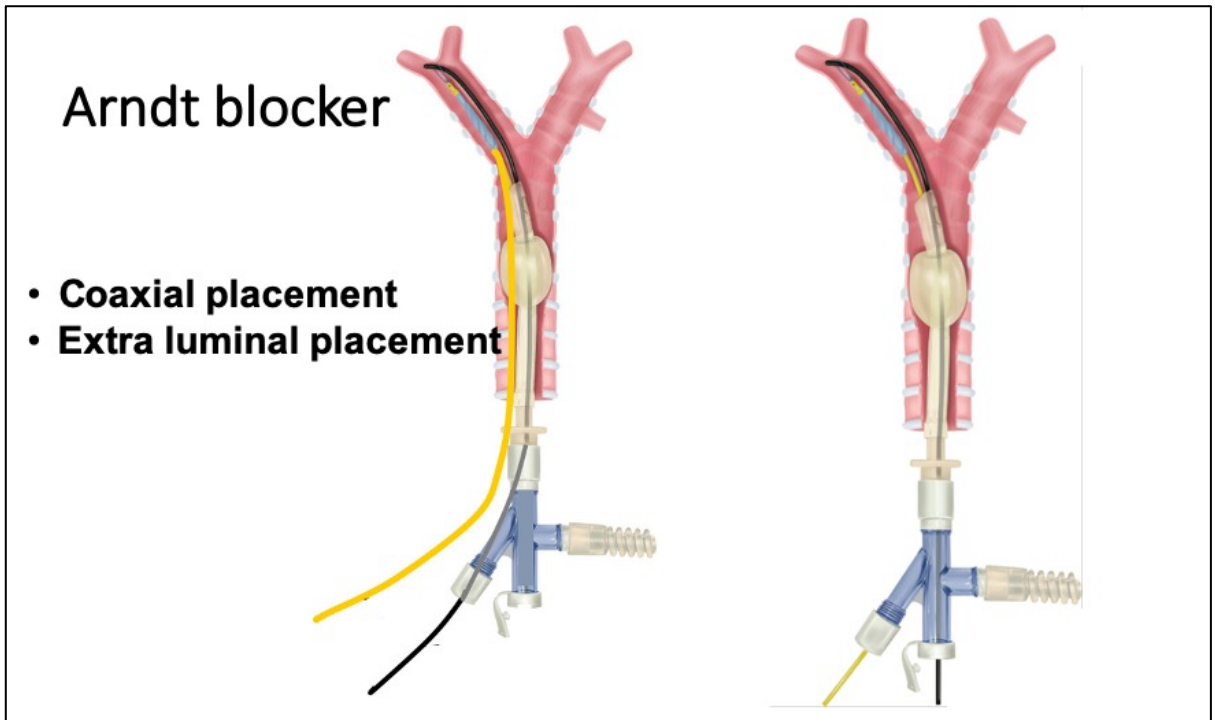
In case of the right sided DLT, the small size DLT may enter into the right main stem bronchus too much. The right upper lobe bronchus is obstructed as the ventilation slot is not correctly positioned. Hence, the ventilation through the bronchial lumen (tracheal lumen clamped) would result in reduced air entry in the upper chest. The lower chest breath sounds will be audible.

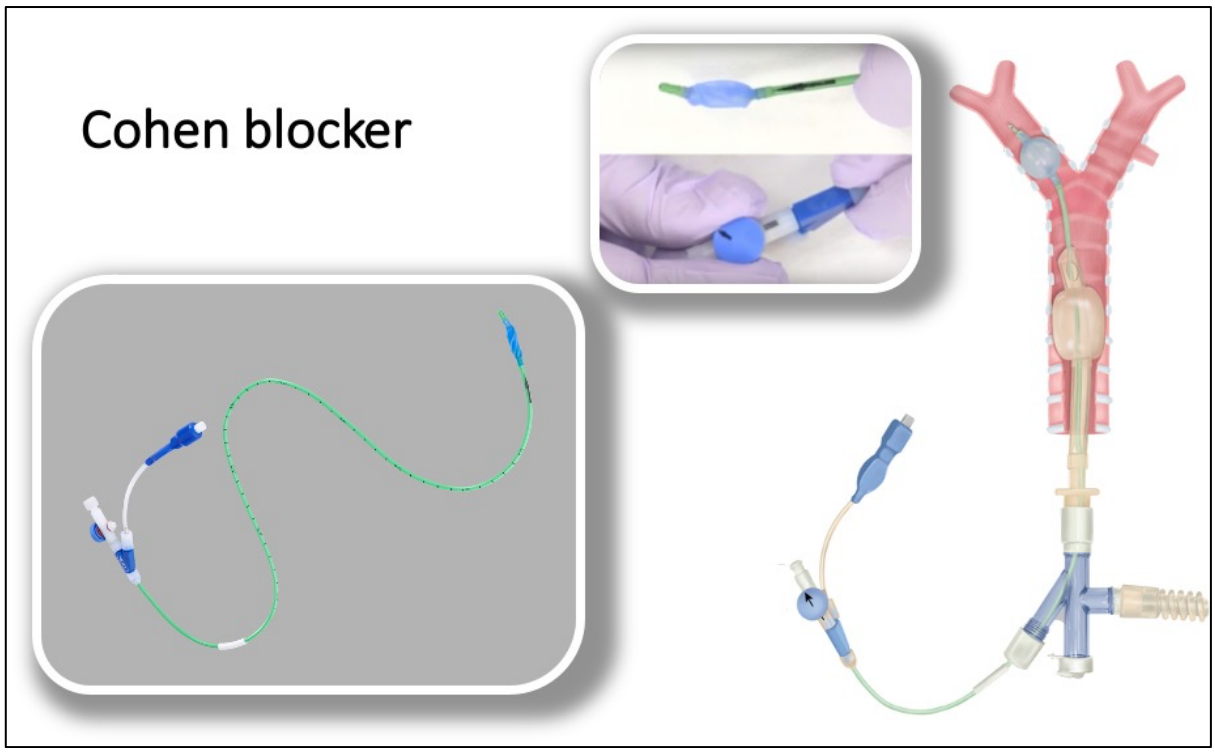
The FOB assessment is performed primarily through the tracheal lumen to see the rim of bronchial cuff as the DLT enters the desired bronchus. Then the FOB is performed through the bronchial lumen to observe the secondary carina in left sided tubes and origin of right upper lobe bronchus in case of right sided DLTs.

Need for bronchial blockers

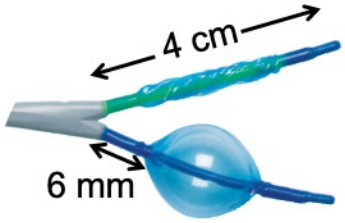
DLTs are the most commonly used devices for lung isolation. However, patients with difficult airway, already intubated patients, patients with poor pulmonary reserve, need for segmental lobar blockade would necessitate the use of bronchial blocker. Here the trachea is intubated with single lumen ETT followed by the co-axial insertion of bronchial blockers.

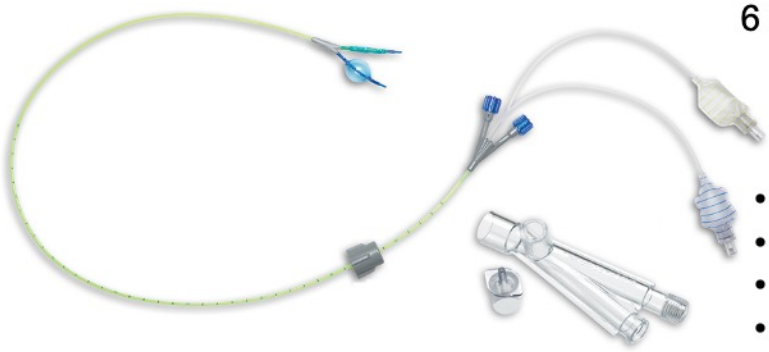
Alternatively, the bronchial blocker may be inserted first into position followed by the ETT insertion. The bronchial blockers are positioned into the desired bronchus using blind insertion or through the FOB assistance. (figure 8-12). Though the insertion principle is almost similar among the available bronchial blockers, they are different based on several factors as listed in the table. (figure.13)





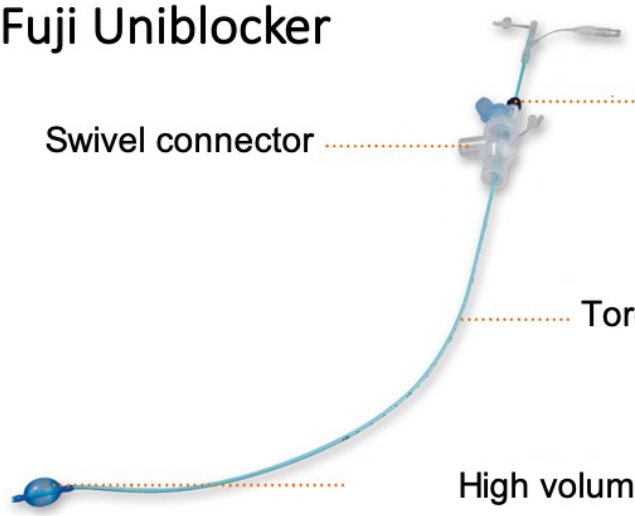
EZ blocker

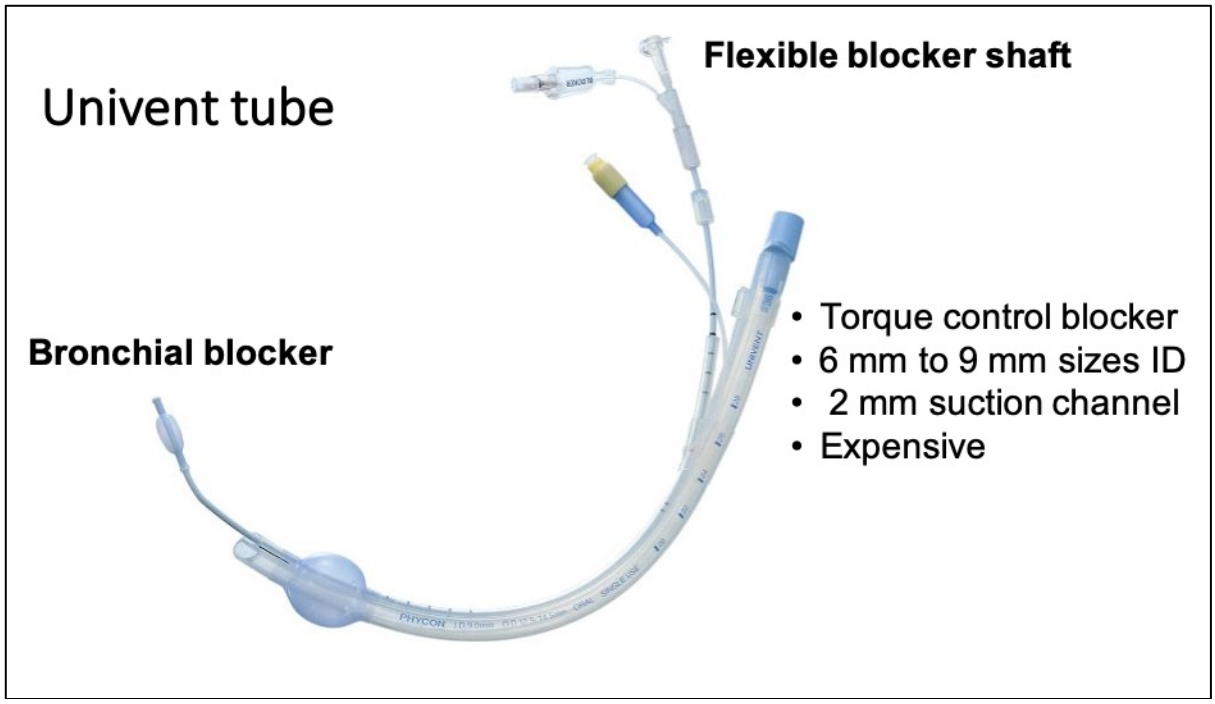




- 7 F size
- 75 cm Long
- 2 lumen for inflating cuff
- 2 lumen for oxygen
- Blue and yellow cuff

Fuji Uniblocker





Properties of bronchial blockers

	Cohen blocker	Arndt blocker	Fuji blocker	EZ blocker
Size	9 F	5 F, 7 F, 9 F	5 F, 9 F	7 F
Balloon shape	Spherical	Spherical /Elliptical	Spherical	Spherical
Insertion technique	Wheel device	Wire loop / FOB	Pre shaped tip / Blind	Blind
ETT size for coaxial use	9 F – 8.0 ETT	5 F – 4.5 ETT 7 F– 7.0 ETT 9 F – 8.0 ETT	9 F - 8.0 ETT	7.5
Suction channel	1.6 mm ID	1.4 mm ID	2.0 mm ID	1.4 mm ID

The ideal bronchial blocker is chosen based on the availability, size, patient characteristics, patient pathology, surgical condition and need for suction. The confirmation of the position is similar to the DLT placement.

Summary

The decision to use DLT or the bronchial blocker should be based on the patient pathology, surgical procedure, need for rapid sequence intubation, difficult airway and tracheobronchial anatomy. The availability of FOB and experience of the anaesthesiologist also plays an important role in selecting the device for lung separation.