Lung Isolation with Bronchial Blockers

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Objectives:
1. To enable the learner to develop an organized plan to deal with lung isolation in patients with difficult airways.
2. To increase the knowledge-base of clinicians on the recent advances in bronchial blockers for lung isolation during thoracic surgery

Lung isolation can be achieved by three different methods: double-lumen endobronchial tubes, bronchial blockers or single-lumen endobronchial tubes. The commonest technique is with a double-lumen tube (DLT). The DLT is a bifurcated tube with both an endotracheal and an endobronchial lumen and can be used to achieve isolation of either the right or left lung. The second method involves blockade of a mainstem bronchus to allow lung collapse distal to the occlusion. These bronchial blockers can be used with a standard endotracheal tube or contained within a separate channel inside a modified single-lumen endotracheal tube such as the Univent tube. The final option for lung isolation is to use either a single-lumen endotracheal or endobronchial tube which is advanced into the contra-lateral mainstem bronchus protecting this lung while allowing collapse of the lung on the side of surgery. This technique is still used when needed in infants and small children: an un-cuffed uncut pediatric-size endotracheal tube is advanced into the mainstem bronchus under direct guidance with an infant bronchoscope.

A number of patients requiring one-lung ventilation (OLV) are identified during preoperative evaluation to have a potentially difficult airway, others present with unexpected difficulty to intubate after induction of anesthesia. Between 5 and 8% of patients with primary lung carcinoma also have a carcinoma of the pharynx, usually in the epiglottic area. Many of these patients have had previous radiation therapy of the neck or previous airway surgery such as hemi-mandibulectomy or hemiglossectomy, making intubation and achievement of OLV difficult due to distorted upper airway anatomy. Also, a patient who requires OLV might have distorted anatomy at or beyond the tracheal carina, such as descending thoracic aortic aneurysm compressing the entrance of the left mainstem bronchus or an intra- or extraluminal tumor near the tracheobronchial bifurcation that makes the insertion of a left-sided DLT relatively difficult or impossible. Such anomalies can be detected by reviewing the chest radiographs and CT scans of the chest. A flexible fiberoptic bronchoscopic exam is necessary to assess a distorted area of the airway prior to selection of a specific tube or blocker to achieve OLV.

In patients who require OLV and present with a difficult airway, the primary goal is to establish an airway with a single-lumen endotracheal tube placed orally with the aid of a flexible fiberoptic bronchoscope, after appropriate airway anesthesia is achieved. Once the single-lumen endotracheal tube is in place, an independent bronchial blocker can be passed. If the patient requires OLV and cannot be intubated orally, an awake naso-tracheal intubation can be performed with a single-lumen endotracheal tube and once the airway is established,
then a bronchial blocker can be passed. In selected patients who seem easy to bag-mask ventilate oral endotracheal intubation may be performed after induction of anesthesia with a bronchoscope or with a video-laryngoscope.

Another group of patients that may benefit from the use of bronchial blockers are those cancer patients who have undergone a previous contra-lateral pulmonary resection. In such cases selective lobar blockade with a bronchial blocker in the ipsilateral side improves oxygenation and facilitates surgical exposure. Bronchial blockers are most commonly used intra-lumenal (co-axial) with a single lumen tube. They can also be placed separately thorough the glottis or tracheostomy exterior to a single lumen tube. This allows the use of a smaller single lumen tube and is often useful in pediatrics. Another advantage of bronchial blockers is when postoperative mechanical ventilation is planned after prolonged thoracic or esophageal surgery. In many instances these patients have an edematous upper airway at the end of the procedure. If a bronchial blocker is used there is no need to change the single-lumen endotracheal tube. Table 2 describes the characteristics of current bronchial blockers. The smallest ID of ET tube that will allow passage of both a bronchial blocker and a fiberoptic bronchoscope depends on the diameters of the bronchoscope and blocker. For standard adult 9F blockers, an endotracheal tube ≥ 7.0 mm ID can be used with a bronchoscope < 4mm diameter. Larger bronchoscopes will require an endotracheal tube > 7.5 mm ID. All blockers need to be well lubricated prior to placement.

An alternative technique to achieve OLV in a patient with a difficult airway is to intubate the patient’s trachea with a single-lumen endotracheal tube, then a tube exchange technique can be used to replace the existing single-lumen endotracheal tube for a DLT after general anesthesia is induced. A tube exchange catheter should have a hollow center channel and universal adapters to insufflate oxygen or for jet ventilation if necessary. The exchange catheter should have markings on the outer surface to control the depth of insertion while in use. For a DLT the exchange catheter should be at least 83cm long. A 14F exchange catheter can be used for 41F and 39F DLTs, for 37F or 35F DLTs an 11F exchange catheter is used. Specially designed exchange catheters for DLTs are available with a softer distal tip to try to decrease the risk of distal airway trauma (e.g. Cook® Exchange Catheter, Cook Critical Care, Bloomington, IN).

The exchange catheter, single-lumen endotracheal tube and the DLT combination should be tested in vitro before the exchange. A sniffing position facilitates tube exchange. After the exchange catheter is lubricated, it is advanced through a single-lumen endotracheal tube. The catheter should not be inserted deeper than 24cm at the lips to avoid accidental rupture or laceration of the trachea or bronchi. After cuff deflation, the single-lumen endotracheal tube is withdrawn. Then the endobronchial lumen of the DLT is advanced over the exchange catheter. It is optimal to use a video-laryngoscope during the tube exchange to guide the DLT thorough the glottis under direct vision. If a video-laryngoscope is not available, having an assistant perform standard laryngoscopy during tube exchange partially straightens out the alignment of the oropharynx and glottis and facilitates the exchange. Proper final position of the DLT is then achieved with auscultation and bronchoscopy.

Another group of patients with problematic airways who can present for thoracic surgery are patients with tracheostomies or laryngectomies. A DLT placed through a tracheostomy stoma may be prone to malposition because the upper airway has been shortened and the conventional DLT may be too long. Before placing any lung isolation devices through a tracheostomy stoma it is important to consider whether it is a fresh stoma (i.e. few days old,
when the airway can be lost immediately on decannulation) versus a chronic tracheostomy. The alternatives to achieve OLV in a tracheostomized patient include: 1) Insertion of a single-lumen endotracheal tube with an independent bronchial blocker, coaxially or extra-lumenal, 2) The use of a disposable cuffed tracheostomy cannula with an independent bronchial blocker, 3) Replacement of the tracheostomy cannula with a specially designed short DLT such as the Naruke DLT which is made for use in tracheostomized patients, 4) Placement of a small DLT through the tracheostomy stoma, or 5) If possible, oral access to the airway for standard placement of a DLT or blocker (this is occasionally an option in patients on prolonged mechanical ventilation for respiratory failure or postoperative complications).

In summary, the optimal method of lung isolation will depend on a number of factors including the patient’s airway anatomy, the indication for lung isolation, the available equipment and the training of the anesthesiologist. Whatever method of lung isolation is used the “ABCs” of lung isolation are:

**Anatomy.** Know the tracheo-bronchial anatomy. One of the major problems that many anesthesiologists have achieving satisfactory lung isolation is due to lack of familiarity with distal airway anatomy.

**Bronchoscopy.** Whenever possible use a fiberoptic bronchoscope to position endobronchial tubes and blockers. The ability to perform fiberoptic bronchoscopy is now a fundamental skill needed by all anesthesiologists providing anesthesia for thoracic surgery. An online bronchoscopy simulator has been developed to help train anesthesiologists in positioning double-lumen tubes and blockers. This simulator, which uses real-time video, is available without cost at [www.thoracicanesthesia.com](http://www.thoracicanesthesia.com).

**Chest imaging.** The anesthesiologist should always look at the chest imaging prior to placement of a double-lumen tube or blocker. Abnormalities of the lower airway can often be identified in advance and this will have an impact on the selection of the optimal method of lung isolation for a specific case.

### Table 1: Characteristics of the Cohen, Arndt, and Fuji Bronchial Blockers

<table>
<thead>
<tr>
<th></th>
<th>Cohen Blocker</th>
<th>Arndt Blocker</th>
<th>Fuji Uniblocker</th>
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<tbody>
<tr>
<td><strong>Size</strong></td>
<td>9F</td>
<td>5F, 7F, and 9F</td>
<td>5F, 9F</td>
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<tr>
<td><strong>Balloon shape</strong></td>
<td>Spherical</td>
<td>Spherical or elliptical</td>
<td>Spherical</td>
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<tr>
<td><strong>Guidance mechanism</strong></td>
<td>Wheel device to deflect the tip</td>
<td>Nylon wire loop that is coupled with the fiberoptic bronchoscope</td>
<td>None, preshaped tip</td>
</tr>
<tr>
<td>Smallest recommended *ETT for coaxial use</td>
<td>9F (8.0 ETT)</td>
<td>5F (4.5 ETT), 7F (7.0 ETT), 9F (8.0 ETT)</td>
<td>9F (8.0 ETT)</td>
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<tr>
<td>Murphy eye</td>
<td>Present</td>
<td>Present in 9F</td>
<td>Not Present</td>
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<tr>
<td>Center Channel</td>
<td>1.6 mm internal diameter</td>
<td>1.4 mm internal diameter</td>
<td>2.0 mm internal diameter</td>
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*Single endotracheal tube = ETT

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