

# Flexible Bronchoscopy 101 2.0

## CE Hours

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### Course Objectives:

1. Describe the anatomy of the trachea
2. List the indications for a flexible bronchoscopy.
3. List the contraindications for flexible bronchoscopy
4. Describe how flexible bronchoscopy is performed in an awake patient
5. Describe the potential complications of flexible bronchoscopy.

### Abstract

#### SUMMARY

The use of flexible fiberoptic bronchoscopy should be considered an art in thoracic anesthesia. To master this art, one must be able to recognize tracheobronchial anatomy and changes those occur upon age, understand the anatomical distances of the airway, recognize the take-off of the right upper bronchus, and have familiarity and expertise with the use of the flexible fiberoptic bronchoscope. These will lead to a successful placement of lung isolation devices in thoracic anesthesia and make prompt diagnosis of tracheobronchial ruptures. Also, a uniform training and competence should be included in a trainee's curriculum.

Bronchoscopy is not a new medical procedure by any means. A crude form of bronchoscopy was developed nearly a century ago for the removal of foreign bodies from the upper airways. Of course, the early instruments did not have light, nor were they flexible. Most were rigid short tubes with mirrors to image the back of the throat. During the early part of the

20th century, bronchoscopy was only utilized for removal of foreign bodies from the upper airways. It was not till the 1960s, when the first flexible bronchoscopes were developed for clinical use. Flexible bronchoscopy did not become a part of routine medical diagnostic until the 1970s. Over the years, flexible bronchoscopy has undergone many changes and the current instruments available are sophisticated, expensive and very versatile.

Fiberoptic bronchoscopy is deemed to be a safe procedure. It is a procedure that is widely used by pulmonologists, anesthesiologists, critical care specialists, thoracic surgeons and otolaryngologists. Close to half a million flexible bronchoscopies are done each year in the USA. Even though the bronchoscope is widely used in the operating room and ICU, there are no criteria as to what skill healthcare professionals need to have or what type of training is required before using a bronchoscope. At present, any physician can do the procedure if permitted by the healthcare facility where they work. Outside of hospital, there are no rules or regulations as to who can or cannot do this procedure.

At present, fiberoptic bronchoscopy is widely used both as a diagnostic and therapeutic tool for a variety of upper airway and lung lesions. In addition, flexible bronchoscopy can also be used to remove foreign bodies and collect samples following lung lavage. Flexible bronchoscopy can be performed at the bedside with minimal or no anesthesia. The latest instruments are easy to use, versatile and better tolerated by critically ill patients in the intensive care unit. Finally the newer scopes have exceptional control and allow the healthcare provider to explore the upper airways in detail and allow for obtaining of specimens for cytopathology.

## **Tracheal Anatomy**

The trachea is a long tubular structure made from cartilage

and fibromuscular tissues. The trachea originates in the neck at the cricoid cartilage and extends to the carina in the mediastinum. The length of the adult trachea is about 15 cm. The trachea is composed of 14-22 C-shaped rings. The anterior trachea is composed of cartilage whereas the posterior wall is composed of fibromuscular tissues. The average diameter of the trachea in adult men is 22 mm and in women it is 19 mm. The trachea is a slender structure with walls that measure 3 mm in diameter in both genders. The trachea is a midline structure but may deviate slightly to the left at the aortic arch in people with atherosclerotic aorta. Deviation of the trachea from the midline may also be seen in elderly people and in presence of COPD.

At the carina, the trachea bifurcates into the right and left mainstem bronchus. The tracheal bifurcation is located at the level of the sternal angle anteriorly and the 5th thoracic vertebra posteriorly. The right mainstem bronchus lies in a more vertical orientation relative to the trachea, whereas the left mainstem bronchus lies in a more horizontal plane. The one feature when looking at the right mainstem bronchus is the trifurcation of the right upper lobe. This is a very important landmark to identify while performing fiberoptic bronchoscopy in order to distinguish the right from the left mainstem bronchus. The left mainstem bronchus is slightly longer than the right mainstem bronchus, and it divides into the left upper and the left lower lobe bronchus.

### **The Bronchoscope Workings**

Flexible bronchoscopy can be performed at the bedside operating room, intensive care unit and even in the emergency department for management of any airway problem. The fiberoptic scope is a relatively simple instrument with 3 channels -one for visualization, one for light transmission and an open channel through which accessory instruments can be passed or it can be used for lavage, suctioning , obtain specimens, retrieve foreign bodies or administer oxygen. The

latest flexible bronchoscopes have a working channel which is 2 mm in diameter and a 1.2 mm suction port. There are pediatric scopes that do have variable diameter ranging from 1.8 mm to 3.4 mm. All the present day scopes have a moveable distal tip. All flexible bronchoscopes allow for aspiration of fluid from the airways via the suction port. In addition, instruments that can be passed through user port include a cup forcep, metal wire basket or claw forceps. Because the flexible scope allows for directional control of the tip, cultures can be identified from selective area of the lobe or segment.

## **Indications**

The fiberoptic bronchoscope is a versatile instrument and has many indications which include the following-

## **Diagnostic**

- Visualize any abnormalities in the airways.
- Perform bronchoalveolar lavage or endobronchial brushings to obtain specimen for culture or cytology
- Perform a biopsy of an unknown mass
- Assess a patient with hemoptysis
- Evaluate a patient with sarcoidosis, chronic cough
- Determine cause of lung collapse
- Investigate the origin of abnormal sputum cytology to rule out cancer
- Evaluation of a patient with tracheoesophageal fistula, vocal cord dysfunction, stenosis
- Evaluate a patient's airway after smoke inhalation injury
- Investigate a patient with recurrent laryngeal nerve injury
- In individuals who suddenly develop a wheeze, especially children to ensure that they have not inhaled a foreign body, or in patients who are unresponsive to conventional bronchodilator therapy

- Assessment of airway patency after head and neck trauma

## Therapeutic

- Remove secretions, blood, or mucus plugs lodged in the airway
- Remove foreign body from the airway
- In adults, the flexible bronchoscope has a large side port to allow for introduction of laser. The laser is sometimes used to remove foreign material or lyse endobronchial tissue and improve airway patency
- Stent insertion to palliate extrinsic compression of the tracheobronchial lumen from either malignant or benign disease processes
- Bronchoscopy is also employed in percutaneous tracheostomy
- The flexible bronchoscope is very useful in patients who are difficult to intubate. It may allow one to slide the endotracheal tube over the scope and then advance it over the vocal cords under direct vision
- Assess placement of a double lumen endotracheal tube

## Contraindications

Although bronchoscopy is a relatively safe procedure, complications are not uncommon when the procedure is done when it is not warranted and/or by inexperienced physicians. Bronchoscopy should not be done in the following conditions:

- Patients with hemodynamic instability (low blood pressure, shock). These patients should preferably be stabilized first. It is dangerous to bring such patients to the OR for a procedure. Instead, the procedure may be done at the patient's bedside (bronchoscopy is a portable procedure).
- Patients with respiratory distress and choking episodes. Patients who are in respiratory distress may be at great risk when sedated. The introduction of the scope may

also initiate wheezing or severe coughing. In such cases, the procedure should be cancelled until the patient is stable. If the procedure is emergent, then the patient should be informed about the possibility of being intubated.

- Patients who are unable to provide consent. These patients should not undergo the procedure unless there is a life-threatening emergency. In such scenarios, two physicians must clearly state the reasons for the procedure in the chart. The hospital administrator must also be informed to avoid any litigation issues later on.
- No monitoring equipment available.
- Unavailability of antidotes to the drugs for sedation, CPR kit or resuscitative equipment.
- Lack of properly trained staff dedicated to sedation of patient.

Relative contraindications to bronchoscopy include the following:

- Patients who have a coagulopathy. Dilation or biopsy in such cases can lead to uncontrolled bleeding. The coagulopathy must be corrected prior to the procedure.
- Patients who have neck trauma or recent head and neck surgery
- Similarly, patients with a neck brace or C-spine collar
- Patient with a known history of not tolerating the procedure

## **Preprocedure Preparation**

Although bronchoscopy is a minor procedure, it should be treated like any other surgical procedure. The patient's history and physical exam must be documented in the medical chart. A list of medications and patient allergies must be listed. A thorough exam of the head and neck area, including the oral cavity, must be done prior to the procedure and

documented. The neck should be palpated for presence of swollen lymph nodes when a lung cancer is suspected. If dentition is poor, it should be mentioned in the chart. Preoperative blood work should include a total blood count, electrolytes and coagulation profile. Most physicians will also obtain an ECG and a chest X-ray. Other blood work may depend on patient comorbidity.

A valid consent must be in the chart. The doctor or nurse must explain the benefits, risks and potential complications and alternatives to the patient. There is no need for preoperative antibiotics.

Prior to the procedure, the patient should preferably have nothing to eat for at least 4-6 hours. In awake patients, there is a real risk of aspiration. In intubated patients, any nasogastric feed should be on hold for several hours prior to the procedure

### **Equipment for Bronchoscopy**

- Biopsy forceps
- Camera to obtain images
- Dental protection device
- Bronchoscope with video monitor
- Gauze
- Gloves
- Gown
- Irrigation fluid (saline or water)
- Lidocaine gel
- Lubricating gel
- Sterile container for specimen
- Suction
- Topical lidocaine
- Mask

### **Anesthesia**

In some hospitals in the United States, bronchoscopy is

performed under some type of sedation. Moderate sedation is required because the procedure can be discomforting. The sedation is usually achieved by administering a combination of a fast-acting narcotic such as fentanyl (Sublimaze) and a benzodiazepine such as midazolam (Versed). In countries outside of the U.S., the procedure is commonly done without the use of sedation. In such cases, topical anesthesia is used to numb the oral cavity, although the results are not desirable or comfortable for the patient. Although general anesthesia is rarely required in adult patients, children and anxious patients may benefit from it. It is vital that one member of the staff be dedicated to administering anesthesia and monitoring the patient. In most cases, a combination of IV fentanyl and midazolam will suffice. Antidotes to these drugs must be present in the room. Prior to initiating the procedure, an IV line must be placed and fluids started. The patient must be attached to a pulse oximeter. Blood pressure should be measured every three to five minutes and the patient's GCS must be monitored as protocol established in the OR. The anesthesia staff must speak to the patient every few minutes to assess the degree of sedation. If the oxygen saturation at room air is less than 95%, nasal oxygen may be provided. In many cases, complications result not from the actual procedure but from the anesthesia.

## **Monitoring**

Flexible bronchoscopy may be an elective or emergent procedure. Irrespective of the case status, it is important to have some type of monitoring of the patient. In all awake patients, the patient should have pulse oximetry monitoring. Oxygen may be provided via a nasal cannula if the patient has borderline saturations. If the patient has any type of heart disease, an ECG monitor should also be hooked up. A suction device should be set up. Failure to monitor is often the most common cause respiratory or cardiac arrest and frequently leads to litigation.



## Position of Patient

For bronchoscopy in an awake patient, the patient should be dressed in a hospital gown. The procedure is best done in the patient's bed, which has side railings (the OR bed does not offer this protection). The head of the bed should be elevated to 45 degrees (Simms position). Place the patient's hands at his or her sides. The operator usually stands on the patient's left side. The anesthesia staff stands on the patient's right side. The respiratory therapist delivering the equipment stands next to the operator.

## Technique

The flexible bronchoscope can be inserted via the:

- Nasal passage
- Using a LMA
- Endotracheal tube
- Tracheostomy tube

Flexible bronchoscopy can be performed in an awake patient on the medical floor, in the operating room or in the ICU in patients who are already intubated. A size 8 mm endotracheal tube is usually necessary for insertion of a 5 mm fiberoptic bronchoscope. Use of a smaller endotracheal tube in the presence of fiberoptic bronchoscope can lead to inadequate ventilation and even impaction of the scope. In some cases, the bronchoscope may even be damaged by the narrow endotracheal tube. There are also accessories like the swivel adapter with a self-sealing valve that can be used to facilitate ventilation and manipulation of the bronchoscope at the same time. The channel suction part of the bronchoscope should be attached to suction aspirated secretions. A video screen monitor should be used whenever possible to enhance the views. Another alternative to perform fiberoptic bronchoscopy is with the use of a laryngeal mask airway (LMA). This technique allows visualization of the vocal cords and

subglottic structures with lower resistance than a single-lumen endotracheal tube when the bronchoscope is inserted.

Once the patient is sedated, the bronchoscope is then gently inserted via the nasal passageway under vision. The scope is advanced by visualizing the epiglottis and vocal cords. There is usually some resistance as the scope passes through the upper pharynx. However, if resistance persists, the scope should never be advanced blindly. Once the scope is above the vocal cord, a tiny amount of local anesthetic is sprayed to allow passage of the scope past the vocal cords. As the bronchoscope is passed down the trachea, both the anterior and posterior walls of the trachea are visualized.

A systematic and complete fiberoptic bronchoscopy examination includes a clear view of the anterior wall (tracheal cartilage) and posterior wall (membranous portion) of the trachea below the vocal cords and of the tracheal carina. When advancing the bronchoscope through the right mainstem bronchus, a clear view of the bronchus intermedius should be seen, and at 3 o'clock the orifice of the right upper lobe bronchus should also be seen. As the bronchoscope is advanced inside the take-off of the right upper bronchus, a clear view of the orifices is found: apical, anterior, and posterior segments. This is the only structure in the tracheobronchial tree that has three orifices.

To obtain cultures one needs to use a sterile protected brush technique. A telescoping double sheath with a polyethylene glycol plug protects the catheter brush. This is important as this can help bypass areas of the tracheal bronchial tree where are normally found and do not play a role on pathology. Unfortunately, because of the small size of pediatric scopes, it is not possible to use protective sheath when obtaining specimen in infants and small children.

Once the airway has been thoroughly visualized, the scope is removed. On the way out, the mucosa and all biopsy sites are

visualized to ensure that there is complete hemostasis. Sedative drug infusions are stopped and the patient is allowed to recover.

## **Post procedure**

After the procedure, the patient is kept upright and sent to the recovery room. If the patient had any type of biopsy, a chest x-ray is performed in the recovery room to ensure that the patient has not developed a pneumothorax. Patients are kept in the recovery room for 45-120 minutes depending on their alertness and recovery from anesthesia.

Individuals who had the procedure under general anesthesia are often observed in the recovery room until they are fully awake. Flexible bronchoscopy is a painless procedure but some patients may complain of a sore throat for a few hours or a vague ache around the back of the throat. This can be relieved with ice chips.

Most patients require observation for a few hours in the post-anesthesia recovery unit. If bronchoscopy was an outpatient procedure, the patient is discharged home. However, if the patient received moderate sedation, it is important that someone drive the patient home.

There is no pain after the procedure. Patients are told to rest for the first day and can resume all their activities within the next 12 to 24 hours. When patients are discharged, they are told to watch out for difficulty swallowing, dry cough, fever and unusual chest pain.

Antibiotics are usually not prescribed at discharge, and the patient is usually seen in the clinic in 5 to 7 days. Patients with coagulopathy or low platelet counts are usually not discharged for fear of delayed bleeding. When bed rest is prescribed, deep vein thrombosis precautions are undertaken with the use of sequential compression devices and/or compression stockings.

## Follow-Up

After outpatient bronchoscopy, patients are usually followed up by their regular healthcare providers. If biopsies were obtained, the results usually take five to seven days. If the bronchoscopy was normal, the patient and the family are usually notified after the procedure so there is no need for follow-up. Patients who underwent bronchoscopy for atelectasis usually require a chest x-ray to ensure that the lung is inflated.

## Complications

Bronchoscopy is a relatively safe procedure. However, complications occur in one in every 1,000 procedures. (This is a gross underestimate; many complications are not reported because the procedure is often performed outside of hospital premises.) The mortality after bronchoscopy is unknown but does occur. The most common cause of mortality is unrecognized or delayed recognition of tracheal perforation. Common complications of bronchoscopy include the following:

Overall, the most common complications of bronchoscopy include pneumothorax, aspiration, hypoventilation, hypotension, over sedation and airway obstruction. These complications account for more than 50% of all major complications. All are preventable if due caution is exercised during the procedure.

Bleeding is rare but can occur. Bleeding may be due to damage to the oral cavity or dentition or may occur after a biopsy. Although bleeding in most cases is mild, if it is due to a biopsy of a vascular lesion, the patient may suddenly develop hypoxia.

Infection is a very rare complication of bronchoscopy. This is more likely in patients on long-term steroids or those whose immune systems are compromised. These patients may need antibiotics, depending on the type of organism involved.

Perforation of the trachea or bronchus is a serious complication. The trachea is most commonly perforated on the posterior wall where it has fibromuscular tissues. The perforation usually presents with vague signs and symptoms. The patient may complain of difficulty swallowing, have a fever or may experience neck pain. In such cases, it is important to perform a repeat bronchoscopy as soon as possible. If the diagnosis is delayed, a CT scan of the neck and chest area is useful to determine the extent of mediastinitis. The treatment of the perforation depends on the location, patient age, and comorbidity. For perforations in the neck area, clinical judgment is required. Small perforations with no major air leak can be managed conservatively with antibiotics and total parenteral nutrition for a few weeks. Some larger neck perforations may require drainage of the neck. If the perforation is in the chest, it must be surgically repaired. Patients too ill for surgery may undergo stent placement. It is important to remember that tracheal perforations, if missed, carry a very high morbidity and mortality. Consultation from a thoracic surgeon is prudent.

Cardiopulmonary complications can occur in patients with a prior history of heart or lung problems. Both heart attacks and respiratory failure have been reported after bronchoscopy. Patients should be optimized and cleared by the internist prior to the procedure.

Adverse reactions to medications have been reported. Although some patients may develop an allergic reaction, the most common adverse reactions to medications include hypotension and hypoxia. Patients must be closely monitored and antidotes to both fentanyl and midazolam must be available in the room.

Anytime a biopsy is performed, a potential pneumothorax can occur. Hence a chest x-ray should always be done to rule out this complication.

Laryngospasm may occur in patients with asthma, COPD or emphysema. It can be severe enough to require endotracheal intubation.

Hypoxia can occur if excessive suctioning is done for prolonged periods.

Complications from conscious sedation can occur such as excess sedation, aspiration and even cardiac arrest.

Damage can occur to vocal cords.

In general women tend to be more prone to iatrogenic injuries from the scope, most likely due to the small tracheal size.

### **Recent Advances**

In the last two decades, advances in endoscopy have led to the development of thinner and more flexible instruments. There are now ultrathin flexible scopes that can be inserted via the nasal passages to view the upper airways. These versatile scopes are well tolerated and very safe. It has been marketed for use outside the hospital and in doctors' offices. However, there is one major limitation of this scope: it has very small side ports and the small caliber does not allow for larger instruments to be passed for any type of therapeutic procedures (e.g., biopsy). At the moment, it is only useful for diagnosis of visible lesions. Its inability to perform biopsy is a major drawback.

### **Certification in Bronchoscopy**

For the past 30 years, flexible bronchoscopy has been performed by a variety of healthcare professionals in differing specialties. Because these procedures have high reimbursements, the procedure is often performed for trivial reasons. Despite the widespread practice of diagnostic flexible bronchoscopy, there are no firm guidelines that assure a uniform acquisition of basic skills and competency in

this procedure, nor are there guidelines to ensure uniform training and competency in advanced diagnostic flexible bronchoscopy techniques. Some hospitals only give bronchoscopic privileges to those who have already performed at least 50 procedures in their training. However, there are no guidelines for many other healthcare professionals who perform bronchoscopy in the ED, operating room or in outpatient settings

There are now plans to establish national criteria, indications, limitations, contraindications and alternatives for bronchoscopic procedures. Moreover, because of the potential for cardiac arrest from anesthesia, knowing the principles of conscious sedation and use of trained personnel are necessary. In order to correctly interpret bronchoscopic findings, there is an urgent need to develop competency training in endoscopic procedures.

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