# 8

# The Role of Flexible Bronchoscopy

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## Introduction

Over the past 45 years flexible bronchoscopy has become the "gold standard" for managing the expected and unexpected difficult airway[1,2]. Unlike rigid laryngoscopy, intubation using a flexible bronchoscope does not require that an unobstructed straight view from the upper incisors to the larynx be created for intubation. Thus, patients with limited oral apertures, a mobile cervical spine, upper airway abnormalities (tumors, lingual tonsils, etc.), and redundant pharyngeal tissue are some of the classes of difficult airways that are better managed with fiberoptic intubations than with classic direct laryngoscopy.

The first fiberoptic intubation was performed by Murphy using a choledochoscope in 1967[3]. Though the technique was initially slow to be adopted, the flexible bronchoscope is now used routinely in airway management. Because of its flexible character and small diameter, the fiberoptic bronchoscope can be used for either nasal or oral intubations, and because it has been shown to cause less hemodynamic stimulation and moderately sedated patients find it less irritating than direct laryngoscopy, fiberoptic bronchoscopy has become the most widely used technique for awake intubations.

## Equipment Necessary for Fiberoptic Intubation

Preparing for fiberoptic intubations requires more equipment than most other intubating techniques. The bronchoscope itself is relatively complex compared to other intubating devices (Figure 8.1). It is composed of an eyepiece, a control section, a flexible insertion tube that is manipulated with an angulation controller, a universal cord containing the light fiber bundles and electrical wiring, and the light guide connector section. In addition to the camera and light fibers, the larger sized insertion tubes may also contain a channel for suctioning at the tip and/or a working channel that can be used to introduce catheters or instruments at the tip of the bronchoscope or to deliver fluids (e.g., saline flushes or local anesthesia) at the tip. The insertion tube used for adult intubations is usually about 4 mm in diameter. Larger diameter insertion tubes are available with larger working channels. Obviously, larger insertion tubes require that larger endotracheal tubes be used since the internal diameter of the endotracheal tube must be large enough to accommodate the bronchoscope (Table 8.1). One common example of the need to balance insertion tube size

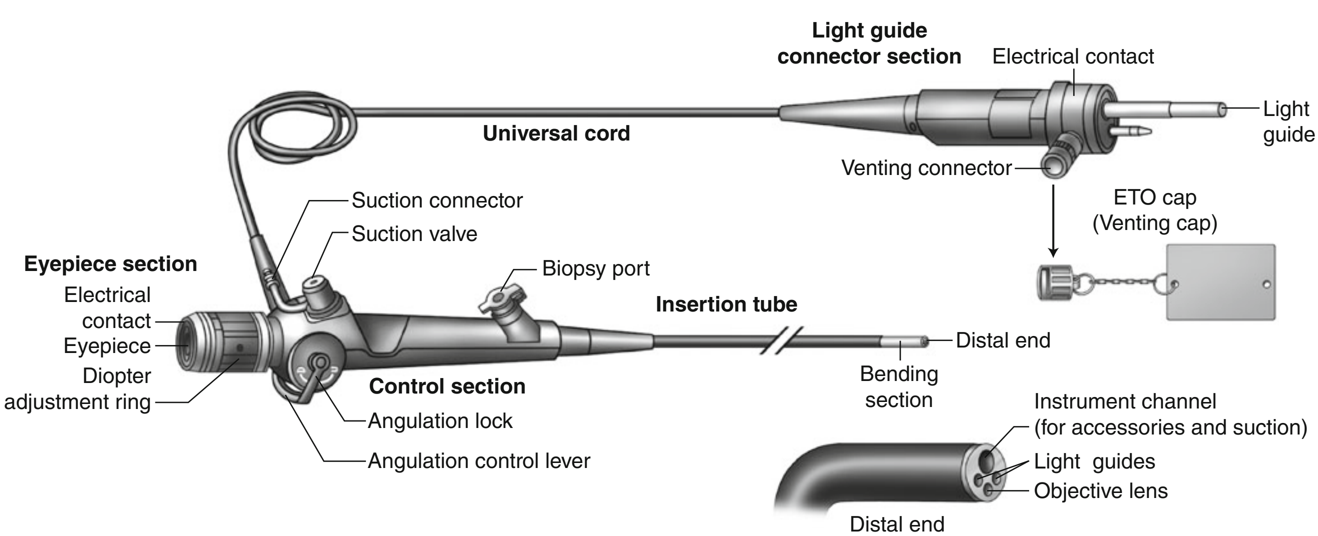


**Figure 8.1.** Schematic diagram of a flexible bronchoscope.

**Table 8.1. Insertion tube diameters, minimum ETT IDs, and lengths of commonly used bronchoscopes.**

| | Insertion tube size (mm) | Min size ETT ID (mm) | Length (mm) |
|---|---|---|---|
| Olympus | | | |
| BF-P160 | 4.9 | 6.0 | 600 |
| BF-P40 | 5.0 | 6.5 | 600 |
| BF-3C160 | 3.8 | 5.0 | 600 |
| LF-V | 4.0 | 5.0 | 600 |
| LF-GP | 4.1 | 5.0 | 600 |
| LF-TP | 5.2 | 6.5 | 600 |
| LF-2 | 4.0 | 5.0 | 600 |
| LF-P | 2.2 | 2.5 | 600 |
| LF-DP | 3.1 | 3.5 | 600 |
| Storz | | | |
| 11301-ABN1 | 2.8 | 3.5 | 500 |
| 11301-AB1 | 2.8 | 3.5 | 500 |
| 11302-BDN1 | 3.7 | 4.5 | 650 |
| 11302-BD1 | 3.7 | 4.5 | 650 |
| 1131-BNN1 | 5.2 | 6.0 | 650 |
| 1131-BN1 | 5.2 | 6.0 | 650 |
| Pentax | | | |
| FB-8V | 2.8 | 3.5 | 600 |
| FB-10V | 3.4 | 4.0 | 600 |
| FB-15V | 4.9 | 5.5 | 600 |
| EB-1570 | 5.1 | 6.0 | 600 |
| FI-13BS | 4.1 | 5.0 | 600 |
| EB-1170K | 3.8 | 4.5 | 600 |
| Ambu | | | |
| aScope2[a] | 5.4 | 6.0 | 630 |

[a]The Ambu aScope2 is a single use (disposable) intubating scope. ETT= endotracheal tube, ID = internal diameter

against the size of the endotracheal tube is in the pediatric patient. Thus, flexible bronchoscopes with very small insertion tubes are available (as small as 2.2 mm in diameter) to permit fiberoptic intubations in small children (including neonates). However, because the insertion tube is so small, it is not possible to accommodate a working channel or a suction channel in these scopes.

In addition to the bronchoscope itself, a light source is also required. Portable bronchoscopes are available that have a light source built into the control section; unfortunately, these light sources do not provide the same light intensity as the external light source units. The external light sources are quite large and, as a result, are usually placed on a cart to permit the user to push the light source around the operating room or to offsite locations. Additionally, a cart can be rigged to carry the fiberoptic scope and intubation supplies discussed below. A typical cart setup is shown in Figure 8.2.

Classically, the person performing a fiberoptic procedure looks through the eyepiece of the control section. Teaching adapters (Figure 8.3) were developed to allow a second person to watch the procedure with the same view as the individual performing the procedure. Now, many flexible bronchoscope carts include a video monitor to which the bronchoscope can be attached to allow the image to be displayed on a larger format, and one which the entire team can see. This allows the assistant to offer more useful help and allows an experienced bronchoscopist to better see and explain the technique to the novice/trainee. Many contemporary bronchoscopes have no eyepiece at all and require a video monitor for image display. These systems often allow for still and video image capture, as well.

**Figure 8.2.** A bronchoscope cart with a light source and video hook-up on the middle shelf, and trays with commonly used drugs and airway equipment on the bottom shelf. The video screen is attached to a pole at the back of the cart and there is a protective case containing clean scopes on the *left* of the cart (marked with a *solid black arrow*) and a protective tube (marked with a *black outlined arrow*) on the *right* for the safe storage of used/dirty scopes.

**Figure 8.3.** The teaching attachment allows a second person (e.g., a more experienced bronchoscopist) to see what the bronchoscopist is seeing to help guide the intubation.

## Additional Supplies Necessary for Flexible Bronchoscopy

In addition to the bronchoscope and light source, the cart often contains other useful drugs and supplies to facilitate intubations.

### The Intubating Airway

There are a number of intubating airways available. Unlike standard oral airways, these devices have open channels on top or along their sides to permit the midline introduction of the bronchoscope and endotracheal tube while allowing for passage of a relatively large caliber tube and easy removal of the airway after successful intubation. While the Ovassapian airway was developed specifically for use during fiberoptic intubations, many of the other devices were initially developed to facilitate blind oral intubations but worked effectively for fiberoptic intubations as well. Several of these devices are shown in Figure 8.4.

### Other Common Contents of the Cart

It is useful to have 4 × 4 gauze pads available both to facilitate the assistant's grasping of the tongue (when an intubating airway is not being used) and to apply surgical lubricant to the insertion tube to ease the passage of the endotracheal tube off of the scope and into the airway. The cart can also store surgical lubricant, local anesthetics (usually lidocaine 4 % liquid and 5 % jelly), an atomizer (or other aerosolizing device to spray the liquid lidocaine into the oropharynx), and tongue depressors to facilitate intubating airway placement and to apply 5 % lidocaine jelly to the base of the tongue.

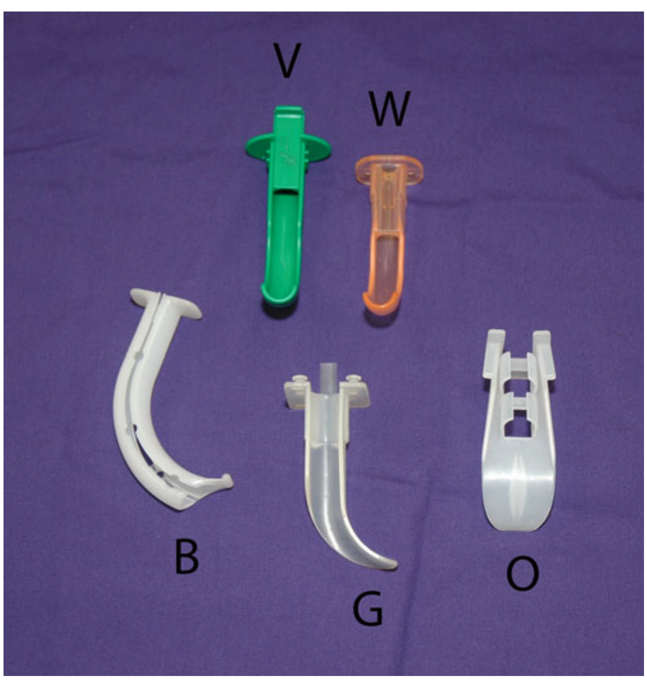


**Figure 8.4.** Several popular intubating airways are shown. *V* the VAMA (Valentin Andres Madrid airway) airway; *W* the Williams airway intubator; *B* the Berman airway; *G* the VBM Guedel airway; *O* the Ovassapian airway.

## Setting up for Fiberoptic Intubation

Before beginning the procedure, it is important to be sure that all of the equipment is in good working order. The bronchoscope should be plugged into the light source and the video monitor (if one is being used) and powered up to be sure the light is shining at the bronchoscope's tip and that the image is focused and clear. The tip of the scope should then be placed in a container with warm water (not saline!) along with the endotracheal tube that is to be used (Figure 8.5). The bronchoscope is kept in the warm water to keep the lens from fogging when it is placed into the warm, moist atmosphere of the airway, and the endotracheal tube is placed in the water to soften it up so that it can pass more easily along the curved length of the insertion tube into the trachea. The presence of working suction and the availability of a reliable supply of oxygen should also be confirmed before starting.

Whether the patient is to be intubated awake or asleep a dose of glycopyrrolate, unless it is contraindicated, is given to dry the patient's airway. Standard premedicants including midazolam and fentanyl are also usually given as are famotidine, metoclopramide, and sodium citrate/citric acid (bicitra) if the patient is at risk for aspiration. The desired endotracheal tube is loaded on the lubricated insertion tube of the flexible bronchoscope before starting the procedure so that it is ready for use. To keep the tube from sliding down the insertion tube, the endotracheal tube can be secured by holding the pilot balloon with your fifth finger or the adapter end of the endotracheal tube can be taped to the control section (Figure 8.6).

## Techniques for Fiberoptic Intubation

### Asleep Oral Intubation

For oral intubations the bronchoscopist can stand either at the head of the bed in the traditional intubating position or to the patient's side looking towards the patient's chin. In either case, it is important that the insertion tube is kept as straight as possible. This can


**Figure 8.5.** The *arrow* indicates the endotracheal tube and the tip of the insertion tube in a bottle of warm water in a basket attached to the bronchoscope cart.

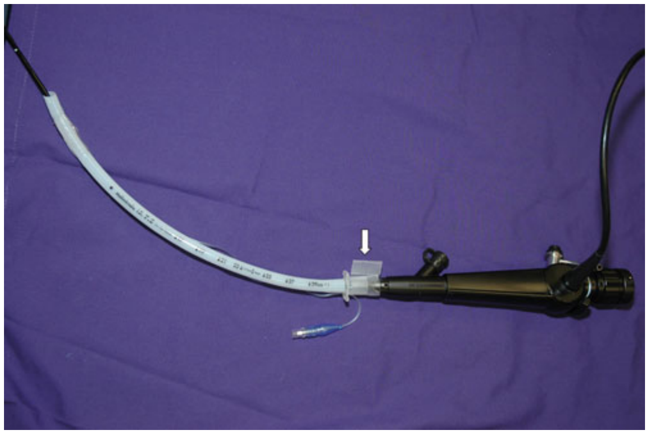

**Figure 8.6.** The endotracheal tube attached to the hub of the bronchoscope control section with a piece of tape.

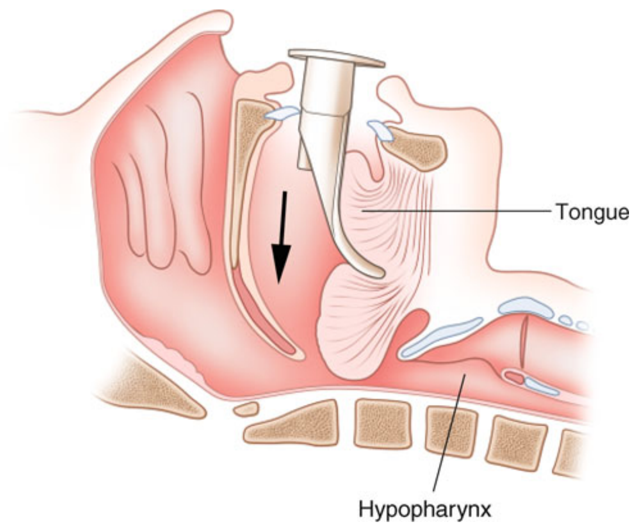


**Figure 8.7.** The phalange of the airway is caught along the superior surface of the tongue and posterior force on the plastic airway pushes the base of the tongue into the posterior oropharynx obstructing the channel to the hypopharynx.

often be facilitated by lowering the height of the operating room bed. Prior to induction, the patient is given glycopyrrolate, midazolam, and/or fentanyl as described above. Once the patient has been induced and the ability to bag-mask ventilate has been confirmed, the patient can be given a muscle relaxant (I usually prefer succinylcholine unless there is a contraindication to this drug because it's short duration of action allows the patient to resume spontaneous respirations in the rare instance when intubation proves impossible and bag-mask ventilation becomes ineffective). Oxygen via nasal cannula at 3–5 L/min can also be used to provide apneic oxygenation[4]. This can be especially useful in obese patients and others with diminished functional residual capacity.

Once the muscle relaxants have taken effect, an intubating airway is inserted over the tongue with the phalange running along the base of the tongue. The placement of the airway is extremely important because improper placement can actually make intubation much harder, or impossible. Specifically, improper placement of the intubating airway can lead to obstruction of the posterior oropharynx by either the base of the tongue or the airway itself. If the airway is placed with the tip of the phalange on the tongue and then pushed straight posteriorly, the tongue can get pushed back into the posterior oropharynx and block the inlet to the hypopharynx (Figure 8.7). On the other hand, if the airway is placed too far into the mouth, its distal phalange can narrow the posterior oropharynx

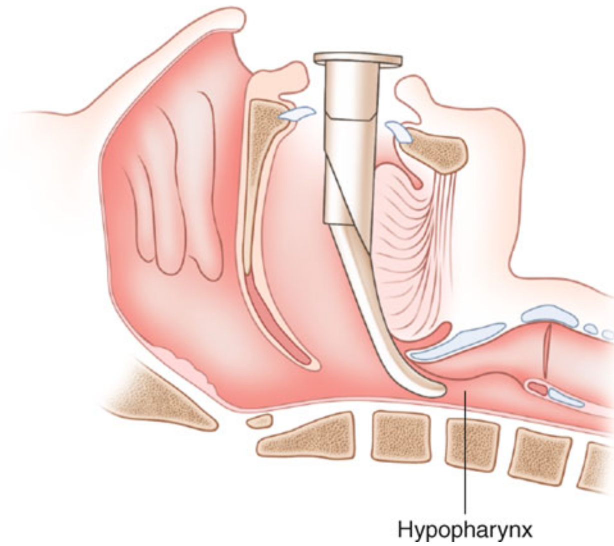


**Figure 8.8.** The airway is inserted too deeply into the mouth and the phalange obstructs the channel to the hypopharynx.

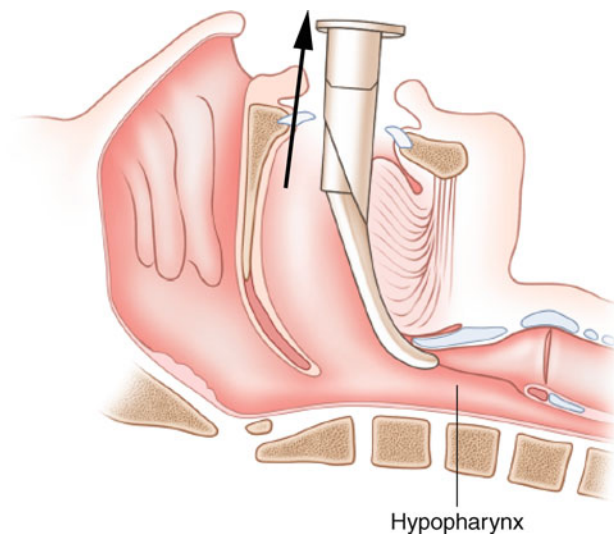


**Figure 8.9.** The airway is pulled back (outward) enough to bring it against the base of the tongue and open the channel to the hypopharynx.

(Figure 8.8). Either of these errors can make the bronchoscopic entry into the hypopharynx harder, or impossible.

To avoid this problem, either of two intubating airway placement techniques can be used. Either a tongue depressor can be used to flatten the tongue and allow the bronchoscopist to see directly into the posterior oropharynx and place the distal phalange along the base of the tongue without pushing the airway in too far or pushing the base of the tongue into the posterior oropharynx. Alternatively, the intubating airway can be placed about two thirds of the way into the mouth and then lower jaw thrust can be applied while pushing the airway in further. The jaw thrust maneuver opens the posterior oropharynx and allows the tip of the airway to drop into the now widely opened posterior space. Jaw thrust can then either be maintained by the assistant and fiberoptic bronchoscopy initiated or the airway can be pulled back gently until the phalange settles along the posterior aspect of the base of the tongue (Figure 8.9).

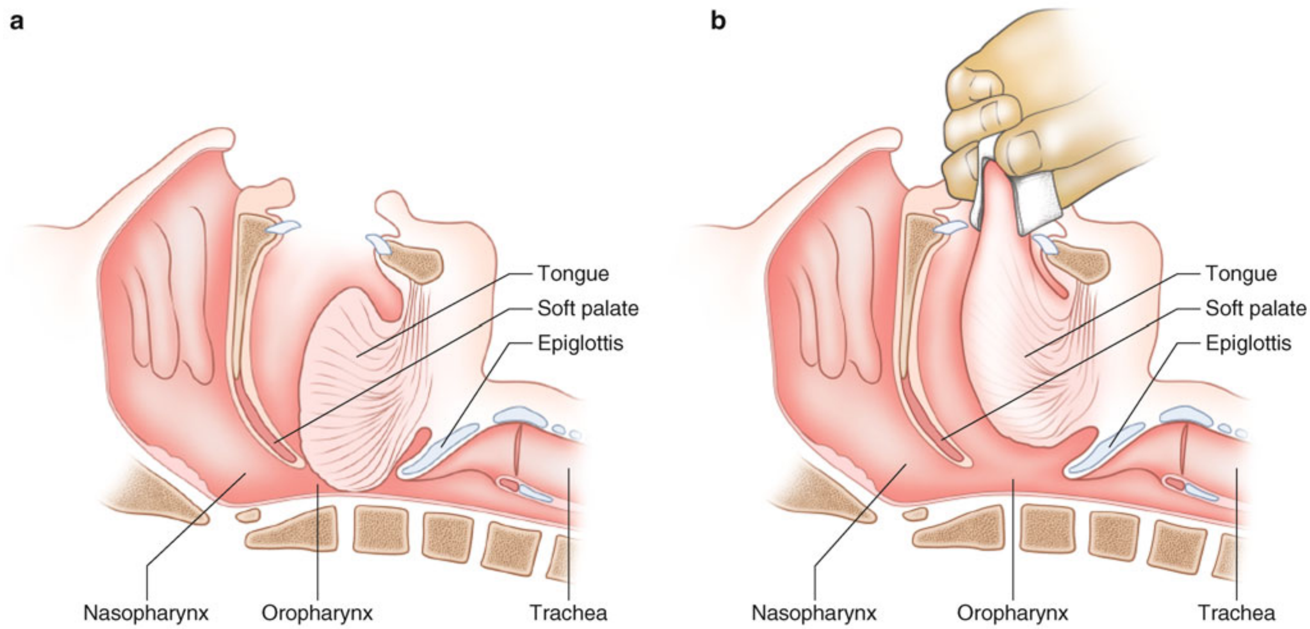


**Figure 8.10.** (**a**) The base of the tongue obstructs passage through the oropharynx. (**b**) An assistant grasps the tongue and exerts outward pressure to pull the base of the tongue forward out of the posterior oropharynx.

It is important to note that it is not as easy to perform bag-mask ventilation when the intubating airway is in place. Thus, if the patient desaturates and positive pressure ventilation becomes necessary during the procedure, it is often best to remove the intubating airway and replace it with a standard airway until the patient's hypoxia has been corrected and you are ready to resume efforts at intubation.

Once the intubating airway is in place (or, alternatively, if your assistant is providing direct outward pressure on the tongue to open up the oropharyngeal space—Figure 8.10), you are ready to start the procedure. First the eyepiece must be oriented so that the triangular reference marker is at the 12 o'clock position. Prior to inserting the bronchoscope into the mouth, it is very important to have your assistant provide firm lower jaw thrust to facilitate the passage of the tip of the bronchoscope through the oropharynx. The tip of the bronchoscope should be tilted at 45° (upward if you are intubating from the head of the bed, or downward if you are intubating from the side of the bed) as shown in Figure 8.11. Then, using the hand you will be using to control the insertion tube, hold the insertion tube 6–8 in. from the tip firmly between your thumb and index finger. The tip of the insertion tube can then be introduced into the mouth under direct vision (Figure 8.12). Hold the insertion tube so that the tip is looking directly over the phalange of the intubating airway and down towards the larynx (Figure 8.13). In this way you can avoid the struggle of finding your way from the teeth to the posterior oropharynx, and your first view through the scope is often looking directly onto the laryngeal structures.

Once the tip of the scope has passed the intubating airway, the tip can be directed toward the cords. Normally, the tip of the insertion tube must be directed slightly downward to get under the tip of the epiglottis (this is facilitated by the jaw thrust or tongue pulling of your assistant) and then up over the arytenoid cartilages and through the cords into the trachea where the cartilaginous rings become apparent anteriorly (Figure 8.14). If it is necessary to steer the tip to the left or right (e.g., to avoid tumors or to navigate an airway that deviates from the midline due to previous external beam radiation or surgical scarring), the scope tip is tilted slightly up or down and small wrist movements of the hand holding the control section into mild pronation or supination permit fine adjustments in direction at the scope tip to steer the scope towards and through the vocal cords. This part of the procedure undoubtedly requires the most practice as the direction of tip movement

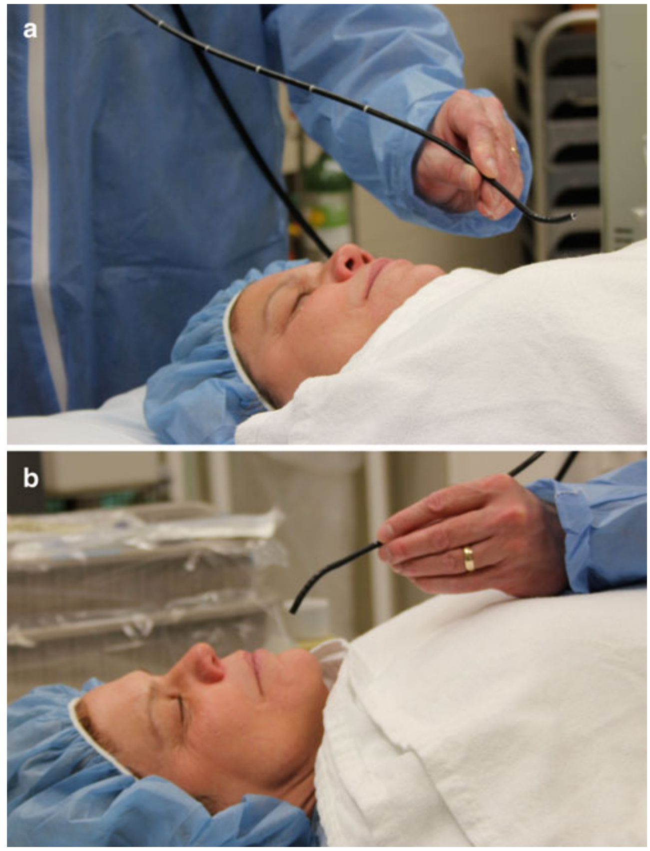

**Figure 8.11.** (**a**) When intubating from the head of the bed the tip of the bronchoscope is tilted *up* at a 45° angle, and the insertion tube is held firmly approximately 7 in. from the tip. (**b**) When intubating from the side of the bed the scope is tipped *down* at a 45° angle prior to insertion into the mouth.

with elevation or depression of the lever and pronation and supination of the wrist takes time to get used to since significant angular motion occurs even with small changes in wrist orientation.

Once the tip of the scope enters the trachea, it is advanced into the level of the mid-trachea. It is important not to push the scope in too far because contact of the scope tip with the carina can cause significant irritation of the airway leading to tachycardia, hypertension, and severe laryngospasm. When the tip of the scope reaches the level of the mid-trachea, the bronchoscopist can look away from the eyepiece (or video screen) and use the insertion tube to "blindly" guide the endotracheal tube into the trachea. First the tape (or fifth finger) holding the hub of the endotracheal tube in place is released. Then the tube is passed down the lubricated insertion tube. Often passage of the endotracheal tube through the oral cavity is easier if the intubating airway is removed first. If the tip of the endotracheal tube becomes stuck as it passes the base of the tongue, the jaw thrust maneuver by the assistant used earlier can open the passage into the larynx. If the tip seems to be getting stuck at the level of the larynx, the endotracheal tube can be turned gently clockwise or counterclockwise to free the tip from the epiglottis or the arytenoid cartilages and then advanced into the trachea. The likelihood of the endotracheal tube getting hung up on the laryngeal structures is markedly decreased if the internal diameter of the endotracheal tube is close in size to the diameter of the insertion tube. A snugger fit of the endotracheal tube on the insertion tube allows less freedom for the endotracheal tube tip to become caught on the epiglottis or at the arytenoid cartilages (Figure 8.15). Obviously, if the diameter of the endotracheal tube is too small, it will not pass smoothly onto or off of the insertion tube and the airway established will be smaller with a higher resistance to

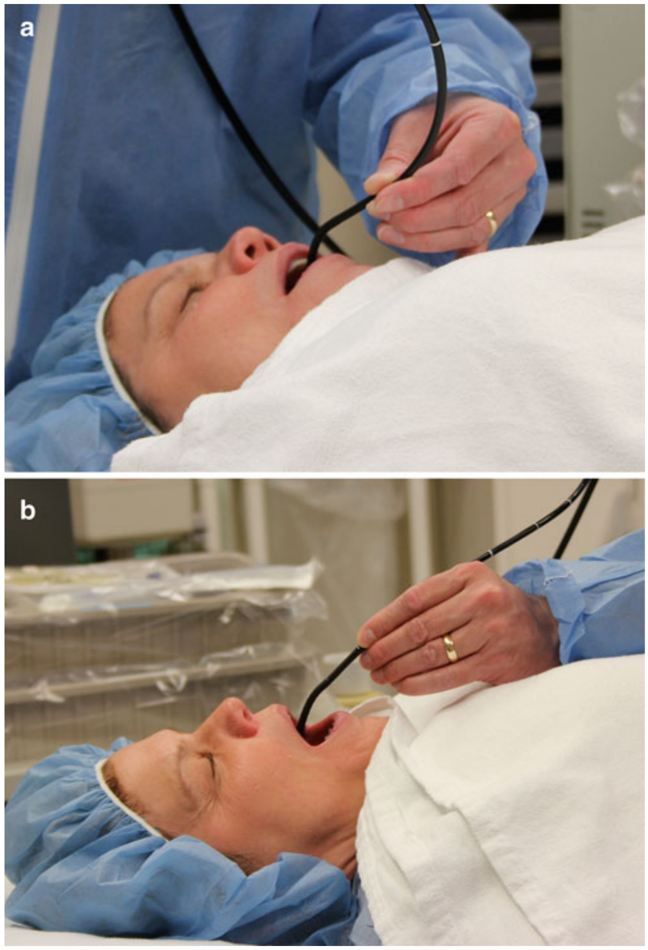

**Figure 8.12** While looking directly into the mouth (not through the scope), the tip of the bronchoscope is introduced into the mouth and advanced until it is beyond the base of the tongue. (**a**) From the head of the bed, (**b**) from the side of the bed.

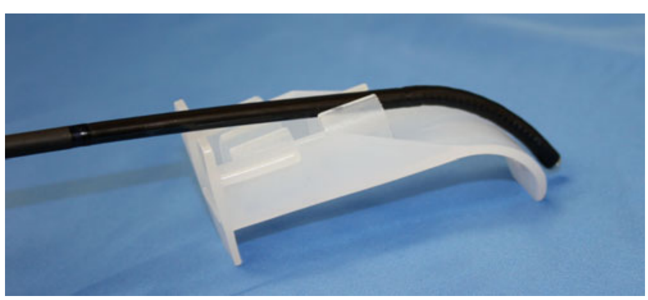

**Figure 8.13.** The tip of the scope is shown as it would follow the curve of the plastic airway into the hypopharynx.

airflow. So, a balance between endotracheal tube size and the challenge caused by play along the insertion tube must be reached for each patient.

Once the tube is in place, a quick look through the bronchoscope should allow you to establish how far above the carina the tip of the endotracheal tube lies (2–3 cm is usually optimal in an adult patient), and then the insertion tube is removed. The distance from the carina to the tip of the endotracheal tube can be determined by advancing the bronchoscope to just above the carina, marking the position on the bronchoscope with

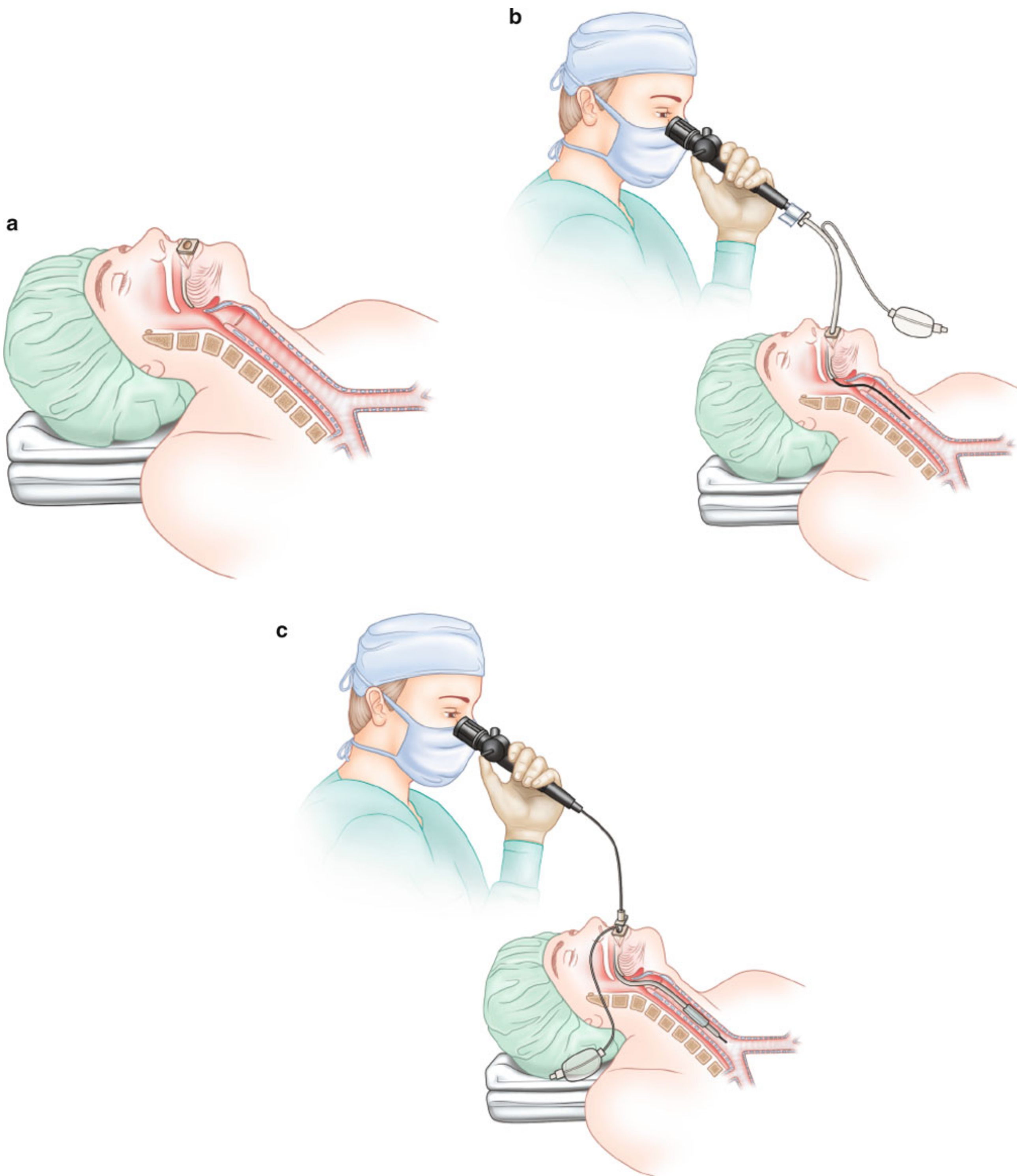


**Figure 8.14.** Standard technique for bronchoscopic orotracheal intubation. (**a**) The Ovassapian airway in place. (**b**) The bronchoscope with the endotracheal tube loaded on it is advanced into the mid-trachea. (**c**) The endotracheal tube is advanced over the bronchoscope into the trachea.

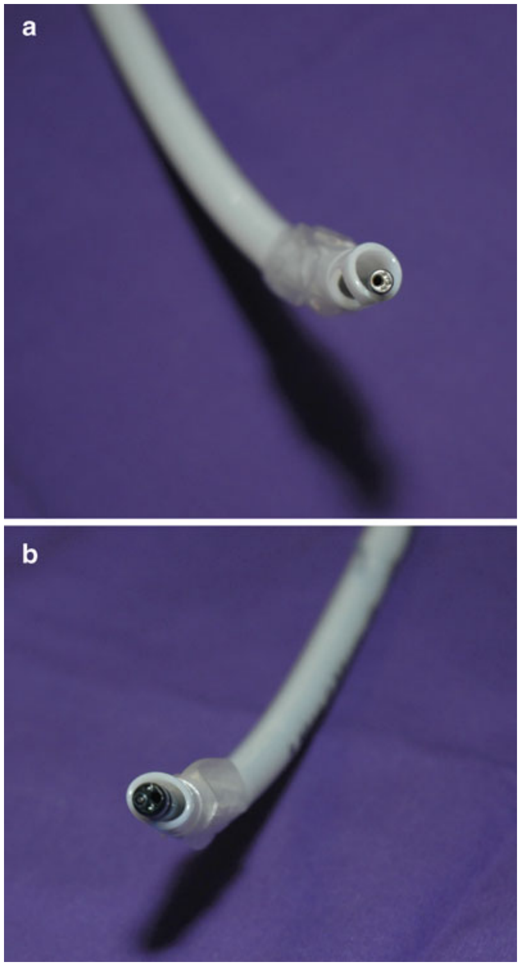


**Figure 8.15.** (**a**) Poor size match between the bronchoscope and the endotracheal tube is shown. The amount of play between scope and tube this permits increases the risk that the leading edge of the endotracheal tube will become caught on glottic structures as the endotracheal tube is passed towards the trachea over the bronchoscope. (**b**) Here there is better size-matching between the scope and the endotracheal tube so there is less risk of entrapment of the endotracheal tube tip at the level of the glottis.

the thumb and forefinger, withdrawing the scope to the tip of the bevel of the endotracheal tube, and measuring the difference between these[5] (Figure 8.16). The endotracheal tube is then attached to the anesthesia circuit, and the endotracheal tube is secured. Auscultation for breath sounds bilaterally is prudent to be sure that the left or right mainstem bronchus has not been intubated (as the lobar bronchial divisions can be mistaken for the carina).

## Asleep Nasal Intubation

The preparatory setup for an asleep nasal fiberoptic intubation is the same as listed above in the section titled "Setting up for Fiberoptic Intubation." Once the equipment has been checked and the premedicants administered, an assessment of the nares is made and a determination as to whether one or the other nare is more widely patent is made. Generally, the nostril with greater patency should be selected. This can be established prior to induction by asking the patient to occlude each nostril in turn and sniff rapidly; however, it is wise to prepare both nostrils with a vasoconstrictor to shrink the nasal mucosal vasculature (this increases the size of the nasal channels to make passage of the endotracheal tube

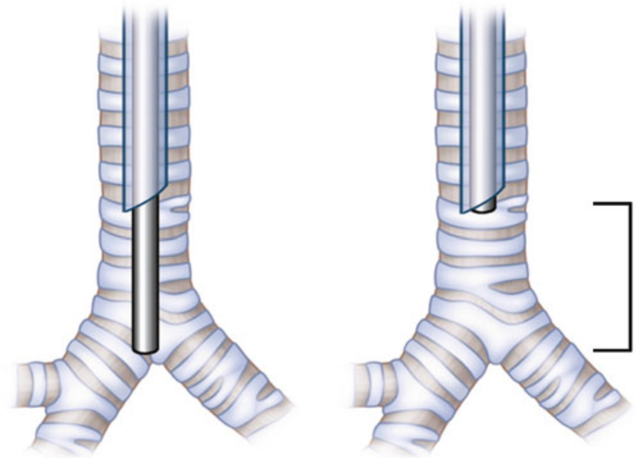

**Figure 8.16.** Using a bronchoscope to measure the distance from the carina to the tip of the endotracheal tube.

easier and decreases the blood flow through the nares thereby decreasing the risk of bleeding). General anesthesia is then induced as outlined above, ensuring that bag-mask ventilation is possible prior to giving the muscle relaxant.

A well-lubricated appropriately sized endotracheal tube (usually a size 7.0 or smaller) is then placed into the preferred nostril and pushed gently medially and posteriorly (as if placing a nasogastric tube). The endotracheal tube should be inserted approximately 2 1/2 to 3 in. (6–8 cm) into the nostril. The objective is to place the tip of the tube into the posterior oropharynx. It is important to recognize increased resistance to the advancement of the nasotracheal tube as it is advanced. (If this is a problem with both nares, the bronchoscope may be introduced prior to the nasotracheal tube in an effort to navigate around the turbinates.) The assistant then applies a firm lower jaw thrust (Figure 8.17) that is intended to draw the base of the tongue forward and open up the inlet to the larynx. Alternatively, the tip of the tongue can be grasped and pulled forward to drag the base of the tongue out of the oropharynx. A lubricated bronchoscope is then passed through the end of the endotracheal tube protruding from the nostril and advanced through the tube. Upon emerging from the endotracheal tube, the bronchoscopist should be looking directly onto the vocal cords. The bronchoscope is then advanced past the cords to the level of the mid-trachea and the endotracheal tube is gently advanced over the insertion tube of the bronchoscope into the trachea. To reach the mid-tracheal level, the endotracheal tube normally needs to be pushed all the way into the nostril such that the adapter at the end of the endotracheal tube is flush with the nostril (Figure 8.18). Alternatively, a pre-formed nasal RAE tube (Covidien) can be used for nasal intubations. These longer tubes are shaped in a way that permits placement of the endotracheal tube tip into the mid-trachea while leaving the bent segment of the tube outside the nostril. This makes it possible to connect the anesthesia circuit to the endotracheal tube above the patient's head instead of across their face (Figure 8.19). This arrangement is particularly helpful when the surgery is taking place below the level of the nose. Fiberoptic insertion of a nasal RAE tube is slightly more difficult than insertion of a standard endotracheal tube because the nasal RAE tube is longer and has a severe bend midway along its length. As with a standard tube, warming the nasal RAE tube can make it easier to slide it along the insertion tube. In addition, it is often necessary to hold the bent segment straight during the initial insertion of the bronchoscope into the nasal RAE tube to permit the passage of the insertion tube past the bend (Figure 8.20). Prior to removing the bronchoscope the distance to the carina can be noted, and then the scope is removed and the endotracheal tube is connected to the anesthesia circuit and end-tidal $CO_2$ is documented as are bilateral breath sounds. When securing the nasotracheal tube, it is very important to avoid any pressure on the nasal ala as this can result in very painful ulcers.

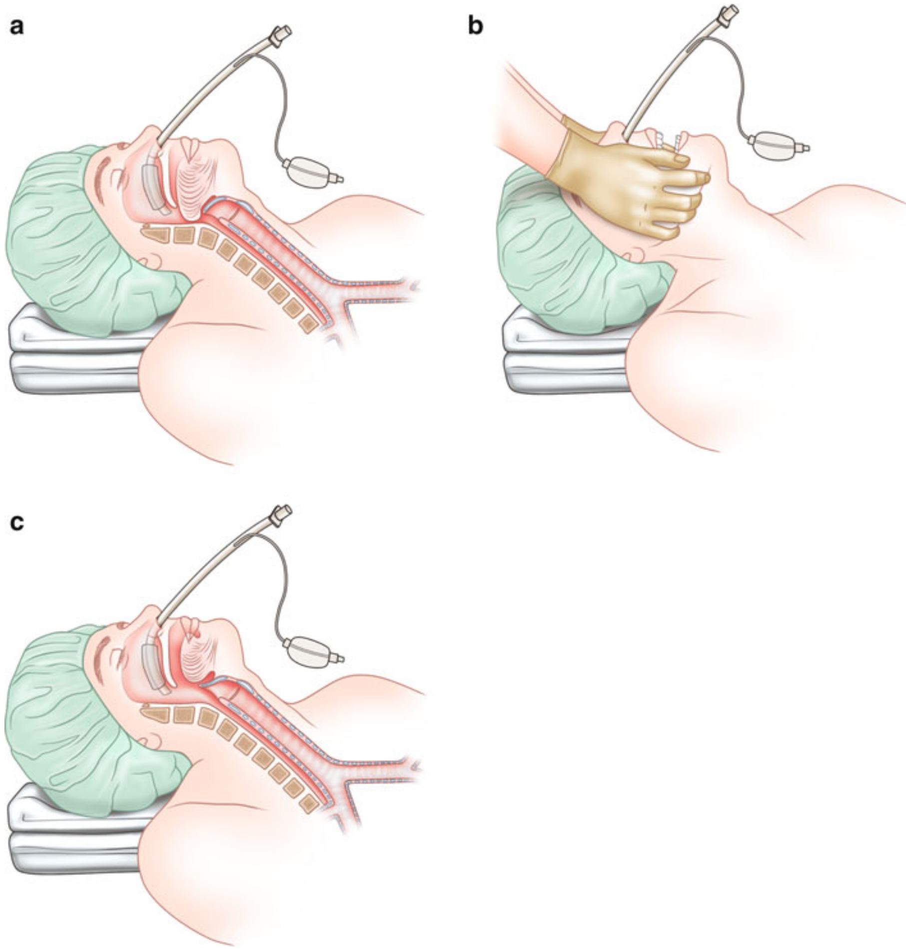


**Figure 8.17.** The jaw thrust maneuver is used to move the base of the tongue out of the posterior oropharynx and ease passage of the endotracheal tube into the hypopharynx during a bronchoscopic-assisted nasal intubation. (**a**) the base of the tongue obstructs the view to the larnyx (**b**) jaw thrust is applied by an assistant (**c**) while jaw thrust is applied the base of the tongue moves anteriorly allowing visualization of the larnyx.

**Figure 8.18.** The standard endotracheal tube is inserted all the way to the adapter hub at the completion of a nasal intubation.

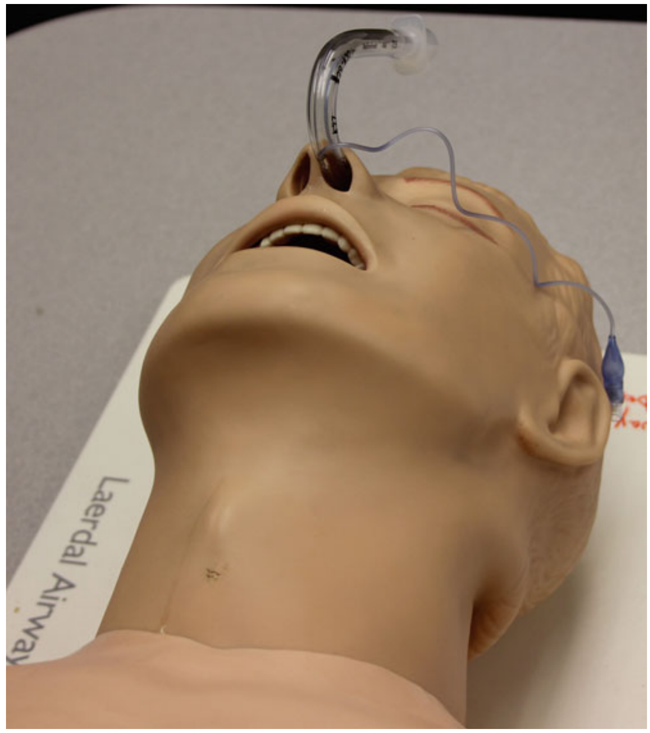


**Figure 8.19.** A nasal RAE tube in place leaving the face below the nostrils free of airway connections.

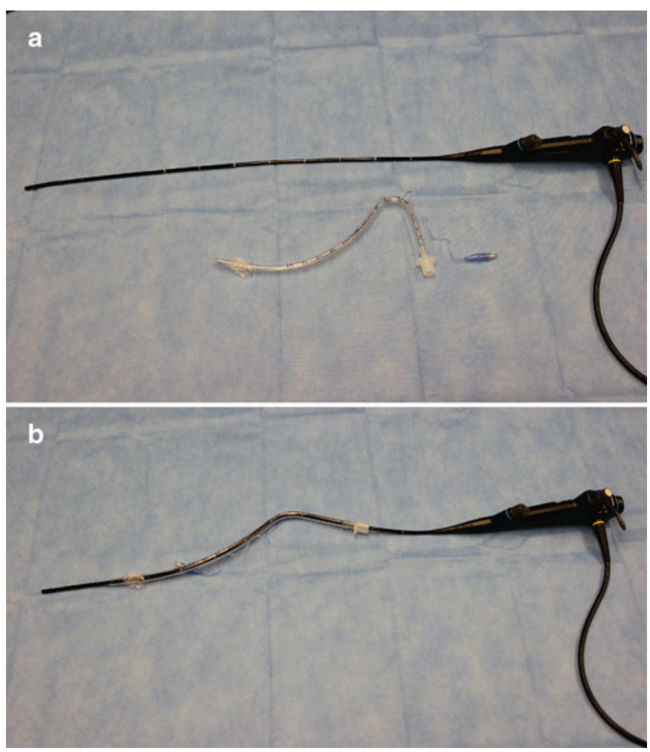


**Figure 8.20.** (**a**) The nasal RAE tube has a severe curve and requires firm straightening pressure applied at both ends to allow passage of the bronchoscope's insertion tube through it (**b**).

There are three significant advantages to inserting the endotracheal tube into the nostril prior to introducing the bronchoscope (the "tube first" technique). First, passing the relatively large and stiff endotracheal tube through the nostril into the oropharynx avoids the potential challenge of navigating the nasal passage with the relatively floppy insertion tube of the bronchoscope (this is especially beneficial for the novice bronchoscopist whose steering skills are still relatively limited). Second, prior insertion of the endotracheal tube avoids a situation where the bronchoscope has been successfully directed into the mid-trachea, but the endotracheal tube loaded on the insertion tube is too large to pass through the nasal canal requiring that the scope be removed and the procedure started anew. Finally, placing the tip of the nasotracheal tube into the oropharynx prior to performing bronchoscopy keeps the scope midline upon insertion and generally permits the first view to be a straight shot along the posterior wall of the oropharynx onto the cords. If the endotracheal tube cannot be advanced blindly from the nostril into the oropharynx, then the bronchoscope can be inserted through the tube and the scope can be used to direct the tip of the endotracheal tube into and through the oropharynx (the "scope first technique").

## Awake Fiberoptic Intubation

The indications and basic setup for awake intubations are discussed in Chap. 3. Here we will concentrate on issues with awake intubations that are unique to the fiberoptic approach.

In addition to the high quality optics and maneuverability of the bronchoscope, another advantage of this device for awake intubations is the ability to "spray-as-you-go" to provide topical anesthesia to the airway all the way to the cords (or even below). As previously noted, the larger insertion tubes have suction ports and/or working channels. Epidural catheters can be inserted through either of these ports and advanced to the tip of the insertion tube. Lidocaine can then be sprayed over the airway and directed evenly over the cords (Figure 8.21). This technique allows the bronchoscopist to avoid the translaryngeal approach to the cords and more reliably delivers the local anesthetic to the laryngeal structures.

## Awake Oral Fiberoptic Intubation

As always, the patient is given glycopyrrolate if it is not contraindicated. Then the patient can either be seated up in the bed (if they are not able to lie flat and/or to help open the channel through the oropharynx) or can be laid down, usually with a blanket ramp (Figure 4.9) to optimize the view. If possible, a surgical towel is placed over the patient's eyes to keep local anesthetic and other secretions from spraying into the eyes. Sedation and topical anesthesia as discussed in Chap. 3 can then proceed. Once the patient is adequately sedated and topical anesthesia has been achieved intubation can be performed. If the patient is sitting up or requires a very steep blanket ramp, it is usually easiest to approach the patient from the side of the bed looking up towards the patient's chin (Figure 8.22). If the patient can comfortably lie flat, intubating from the head of the bed is also possible. Nasal cannula oxygen is delivered at 4–5 L/min to decrease the risk of hypoxia during sedation and intubation. The oral airway is inserted as previously described making sure that neither the base of the tongue nor the phalange of the airway obstruct the route through the posterior oropharynx. A gentle jaw thrust is then provided by an assistant and the insertion tube with the endotracheal tube loaded on it is introduced with a 45° bend at the tip to the back of the oral cavity (Figure 8.11). If the view is clear, advance the insertion tube into the trachea and then pass the tube into the trachea. If the view is obstructed by redundant airway tissue, ask the patient to take a deep breath (this is why it is important to titrate the sedation to a level that still permits the patient to follow commands). With deep inspiration the epiglottis and laryngeal structures should become apparent and the insertion tube can be advanced into the trachea. Whether the initial view was clear or

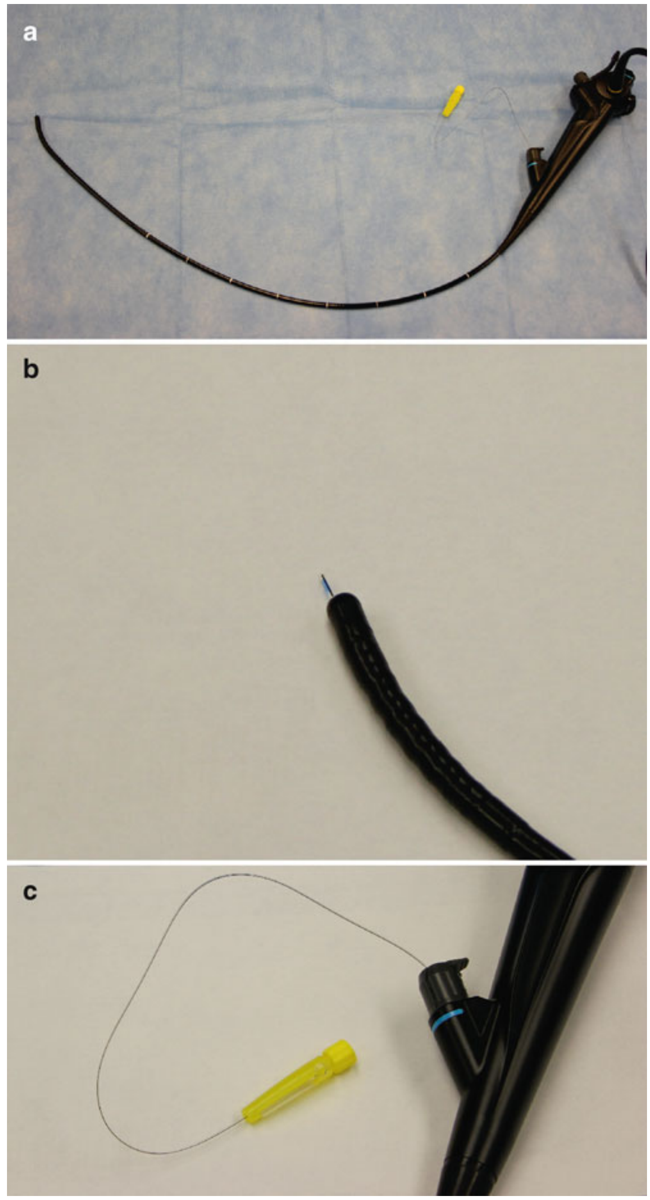

**Figure 8.21.** (**a**) An epidural catheter is shown entering the working channel port on the control section and exiting the tip of the insertion tube. (**b**) The epidural catheter is seen extending only a centimeter or so beyond the tip of the insertion tube. (**c**) Detail of the epidural catheter entering the port of the working channel.

obstructed, once the insertion tube is in the trachea, if the endotracheal tube does not pass easily over the insertion tube and into the trachea, another deep breath by the patient usually facilitates the passage of the endotracheal tube. Alternatively, gentle jaw thrust or tongue pulling by the assistant can also make endotracheal tube passage easier.

Once the endotracheal tube is in the trachea, a quick look through the bronchoscope to confirm the location is prudent (to be sure the bronchoscope had not become dislodged and delivered the endotracheal tube into the esophagus) prior to administering any intravenous sedative/hypnotic. If the intubation was difficult, it is reasonable to keep the bronchoscope nearby in case there are problems with the endotracheal tube during the case or in case the patient needs to be urgently reintubated after extubation at the end of the case.

**Figure 8.22.** Bronchoscopic intubation from the side of the patient's bed.

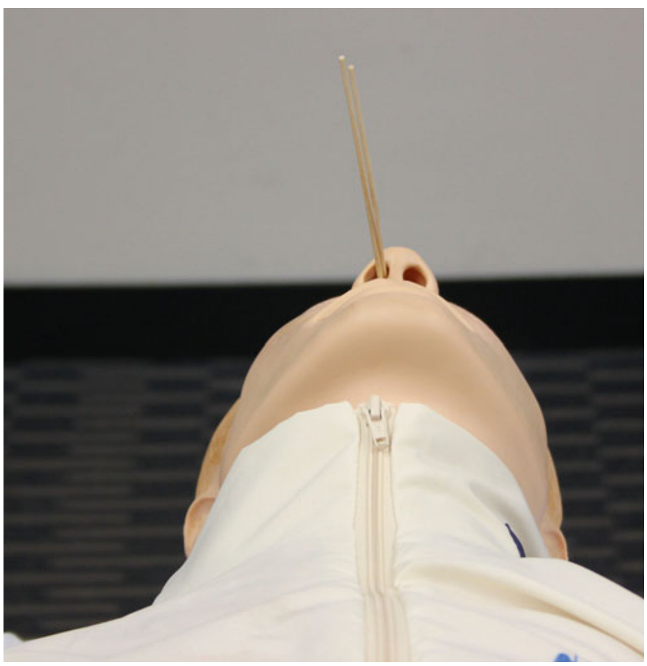

**Figure 8.23.** Cotton-tipped swabs coated with lidocaine jelly are placed into the nostril to anesthetize the nostril prior to awake nasal intubation.

## Awake Nasal Fiberoptic Intubation

The most significant difference between awake and asleep nasal intubations is the need for topicalization of the nares prior to awake nasal intubation. This can be achieved using lidocaine jelly on cotton-tipped swaps gently placed into the nostrils (Figure 8.23). Alternatively, a nasal trumpet coated with lidocaine jelly can be inserted into the nostrils to spread the local anesthesia over the mucosal surfaces. As for the asleep nasal intubations, phenylephrine (or cocaine 4 %) should be applied to the nostrils to open the nasal canals and shrink the mucosal vasculature. Once the patient is sedated and sufficient topical anesthesia has been provided, the endotracheal tube is inserted into the nostril and intubation proceeds just as in an asleep nasal fiberoptic intubation. Often the laryngeal structures come immediately into view upon passing the insertion tube beyond the tip of the endotra-

**Figure 8.24.** A laryngoscope is used to displace the tongue and facilitate bronchoscopic orotracheal intubation.

cheal tube, if not, a deep breath by the patient can open the glottis and permit passage of the insertion tube and the endotracheal tube into the trachea. Once the position of the endotracheal tube tip in the trachea is confirmed, a general anesthetic can be induced.

## Fiberoptic Bronchoscopy in Combination with Other Airway Management Techniques

### Fiberoptic Bronchoscopy Facilitated with Direct or Video Laryngoscopy

If the tongue cannot be adequately kept out of the way by an intubating airway or traction on the tip of the tongue, an assistant can insert a laryngoscope (either a direct laryngoscope[6] or a video laryngoscope like the GlideScope) into the mouth to retract the base of the tongue (Figure 8.24). The insertion tube of the bronchoscope can then be directed beyond the tip of the laryngoscope towards the glottic structures. Using this combination of techniques, the video laryngoscope helps retract the tongue and also permits indirect viewing of the endotracheal tube as it passes between the vocal cords.

## *Retrograde-Assisted Fiberoptic Intubation (Figure 8.25)*

When tumor, redundant airway tissue, or scarring make it difficult to steer the tip of the bronchoscope to and through the larynx, it is sometimes useful to pass a wire through the cricothyroid membrane into the oropharynx over which the bronchoscope can be advanced[7]. For details of the retrograde technique see Chap. 11. When using the retrograde technique to facilitate fiberoptic intubation, there are three unique and important considerations. First, the insertion tube must have an open channel (suction or working) at the tip that runs up to the control handle. Second, the wire passed through the cricothyroid membrane and directed cephalad to the mouth must be long enough to pass all the way through the insertion tube with room to spare since it will have to reach from the insertion site in the airway all the way through the insertion tube. Finally, the wire must be small enough to fit through the open channel at the tip of the insertion tube yet sufficiently stiff to provide it with guidance (e.g. Amplatz wire, Cook Medical).

To perform retrograde-assisted intubations, after the patient is induced (or sedated and adequate topical anesthesia provided if an awake intubation is to be performed) a needle or catheter large enough to accommodate the guidewire is inserted through the cricothyroid cartilage and angled cephalad. The guidewire is then passed through the needle or catheter until it is identified at the back of the mouth. The wire can then be grasped and pulled out of the mouth and secured at the insertion site with a clamp.

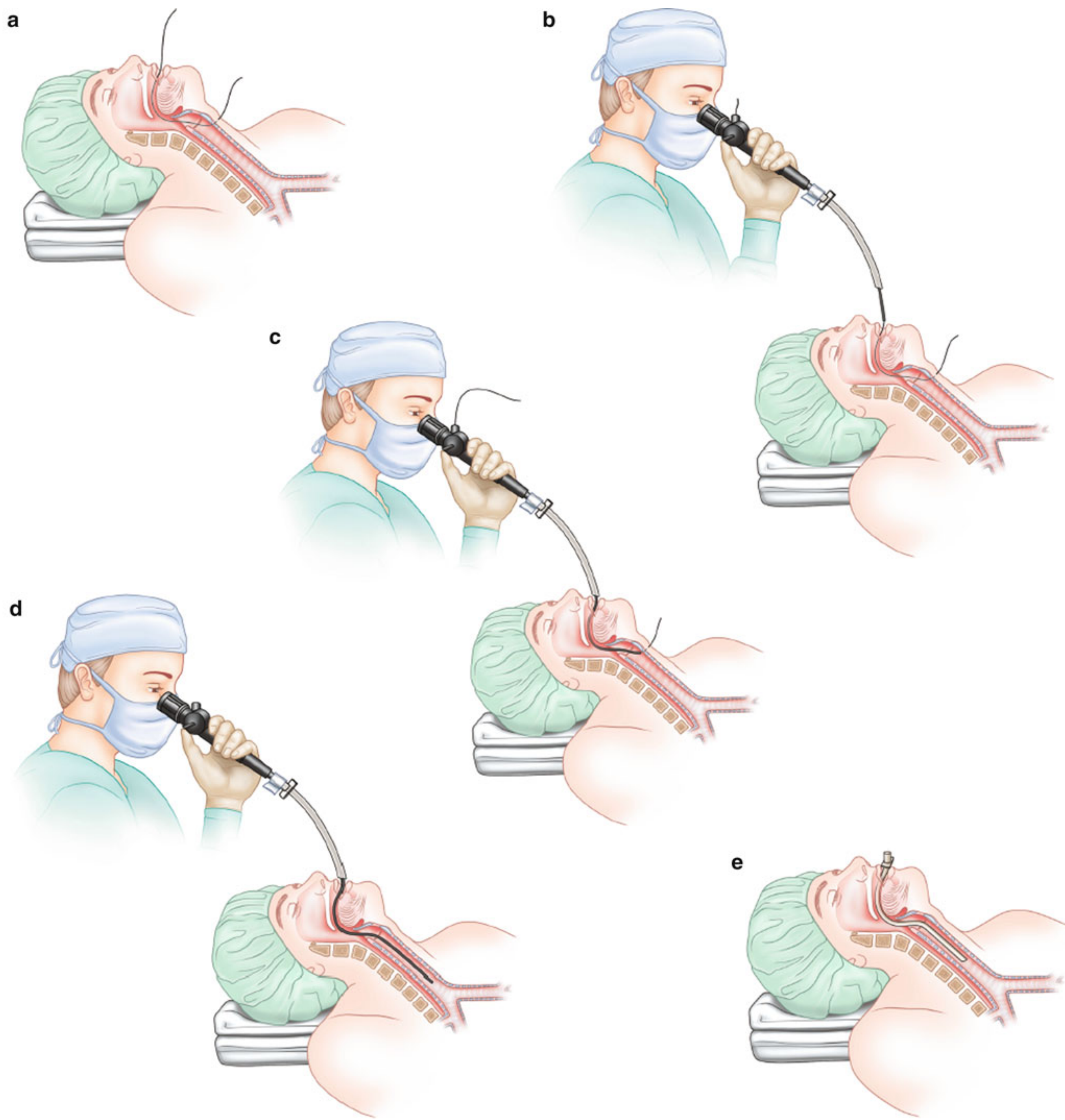


**Figure 8.25.** Retrograde-assisted fiberoptic intubation. (**a**) The guidewire is placed through the cricothyroid membrane and directed up the trachea and out the mouth. (**b**) The guidewire is inserted through the suction channel at the tip of the insertion tube of a bronchoscope with an endotracheal tube mounted on it. (**c**) The bronchoscope is advanced over the guidewire into the larynx. (**d**) The guidewire is released at the insertion site in the neck and pulled out through the proximal port of the suction channel, and the bronchoscope is advanced into the trachea. (**e**) The endotracheal tube is then passed over the bronchoscope's insertion tube into the trachea and the scope is removed.

The end of the wire protruding from the mouth is then introduced into the open channel at the tip of a bronchoscope with an endotracheal tube loaded on it (a size-appropriate Fastrach type tube might work best here because its floppy composition makes it easier to pass the tube around tight curves). The wire is then advanced through the insertion tube and out the port on the control handle (Figure 8.26). Gentle traction is applied to both

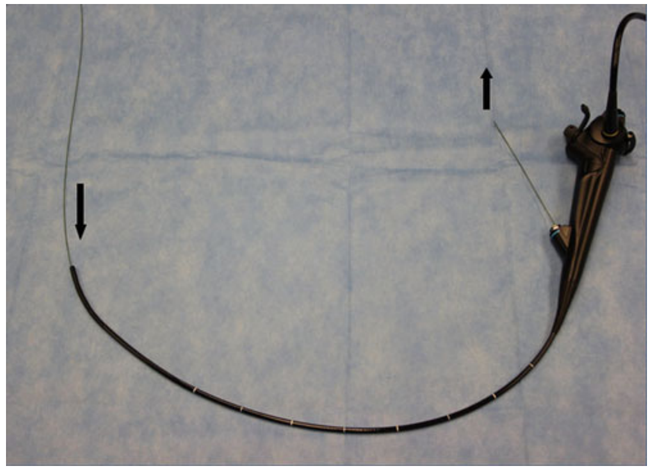

**Figure 8.26.** The guidewire is shown entering the tip of the insertion tube and exiting the working channel port on the control section.

ends of the wire by assistants, and the bronchoscope is carefully run along the guidewire into the trachea. Once the tracheal rings come into view and the scope tip meets the wire at its insertion point, the clamp at the insertion site can be released and the wire removed through the proximal port site. Then the insertion tube can be advanced to the mid-trachea and the endotracheal tube can be run over the insertion tube into the trachea.

## Fiberoptic Intubation Through the Laryngeal Mask Airways

Fiberoptic bronchoscopy can be used to convert an LMA™ (Classic or Unique) managed airway to an endotracheal tube or to facilitate the placement of the endotracheal tube through an intubating supraglottic airway such as the Fastrach™ (LMA North America).

### *Converting a Classic/Unique LMA to an Endotracheal Tube*

As discussed in Chap. 7, the laryngeal mask airway (LMA) can be used as an emergency airway device when other techniques fail. Thus, it may be necessary to convert an LMA to an endotracheal tube in a patient who has a challenging airway. In these circumstances, the bronchoscope can be used to exchange an endotracheal tube for the LMA.

With the LMA in place, an endotracheal tube small enough to fit through the tube of the LMA is selected[8]. The endotracheal tube is then loaded onto the bronchoscope and the well-lubricated bronchoscope is then directed through the LMA, under the epiglottis and between the cords (Figure 8.27). The endotracheal tube is then passed off the bronchoscope and through the LMA. The location of the endotracheal tube tip in the mid-trachea is confirmed, and then the cuff on the endotracheal tube is inflated. Depending on the plans for the patient going forward, the LMA can either be left in place and used to facilitate extubation or it can be removed. Removing the LMA requires that the adapter on the endotracheal tube be disconnected. Then a second endotracheal tube (usually one size smaller than the endotracheal tube in the airway) with its adapter removed is placed tip first into the tube in the airway and the LMA is removed over the tubes[9]. In this way the second tube keeps the first tube in the airway during the removing of the LMA (Figure 8.28).

A new device called an Aintree catheter (Cook Medical, Bloomington IN) has been developed to facilitate the fiberoptic-guided exchange of an endotracheal tube for an LMA already in the airway. The Aintree catheter is a 56-cm long plastic tube exchanger with a 4.8-mm inner diameter. The larger inner diameter permits the passage of an appropriately sized bronchoscope's insertion tube through the catheter (Figure 8.29). To perform the exchange from LMA to endotracheal tube, the Aintree catheter is loaded on a

**Figure 8.27.** The bronchoscope is inserted through an endotracheal tube placed into the tube section of an LMA.

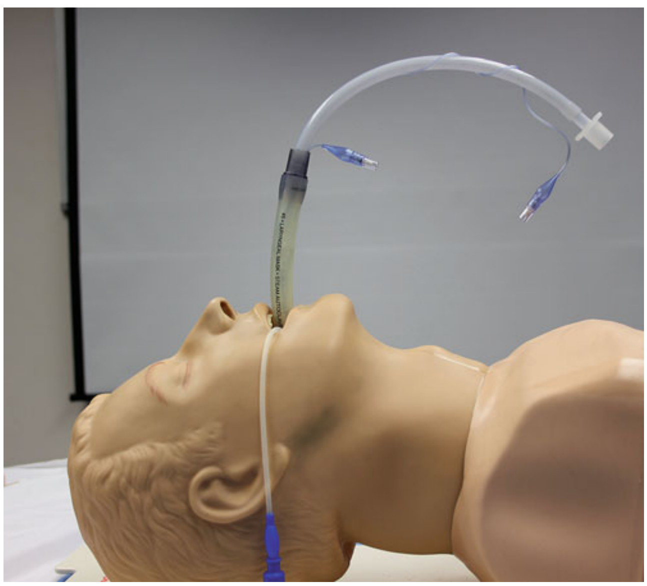

**Figure 8.28.** A second endotracheal tube is used to hold the first tube securely in place as the LMA is removed over the tubes.

well-lubricated bronchoscope and the insertion tube is then passed through the LMA into the trachea. The bronchoscope is then removed, leaving the Aintree catheter in place in the LMA (Figure 8.30). The Aintree catheter is then held in place while the LMA is removed (Figure 8.31). An endotracheal tube is then passed over the Aintree catheter into the trachea. The catheter is then removed from the endotracheal tube, and the location of the endotracheal tube's tip in the mid-trachea can be confirmed.

### *Fiberoptic-Assisted Use of the Fastrach (ILMA)*

The Fastrach (Intubating LMA—ILMA, LMA North America, San Diego CA) was developed to permit blind passage of a flexible endotracheal tube through a customized supraglottic airway device and into the trachea. There are times that blind passage of the endotracheal tube through this device is either risky (e.g., when friable tumors or fresh suture lines lie along the path to the trachea) or impossible. In these situations, fiberoptic-assisted placement of the endotracheal tube might be desirable.

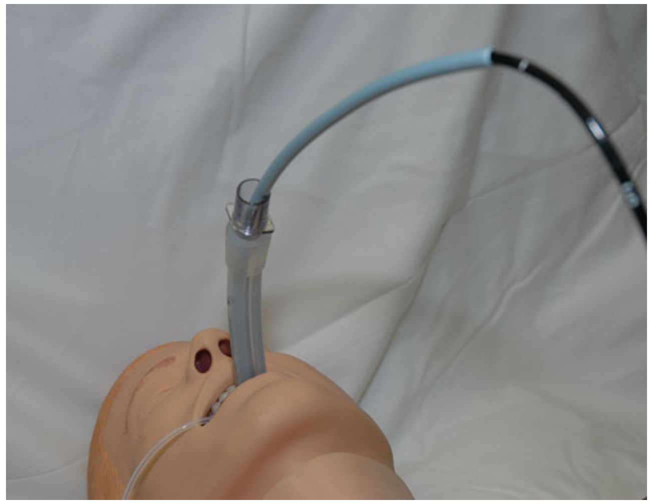

**Figure 8.29.** An Aintree catheter is passed off the insertion tube, through the LMA, and into the trachea.

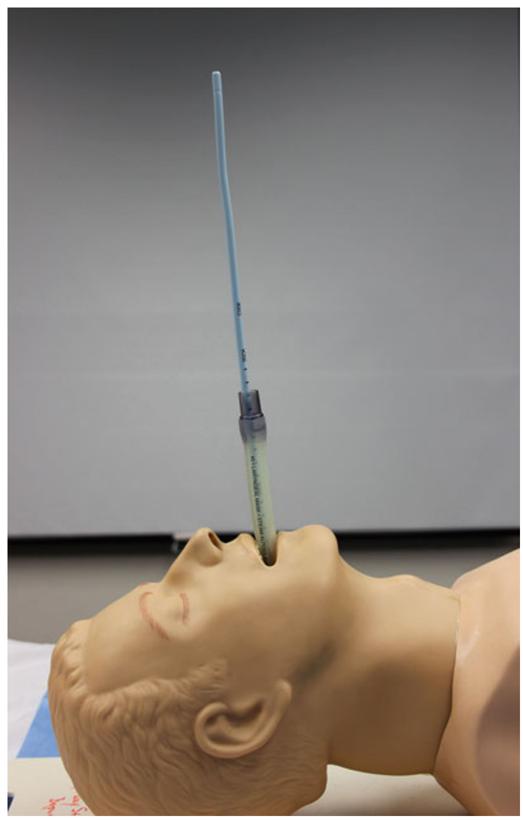

**Figure 8.30.** The Aintree catheter is left in place in the trachea after the bronchoscope is removed.

The Fastrach device is placed into the airway in the usual fashion (see Chap. 7). Once easy ventilation through the Fastrach has been confirmed, the specialized endotracheal tube is well-lubricated and introduced into the hub of the Fastrach without attaching the adapter to the tube (Figure 8.32). A well-lubricated insertion tube is then run through the endotracheal tube and out the heal of the Fastrach past the epiglottic elevator bar (Figure 8.33). The insertion tube is then steered into the trachea. If the larynx is not

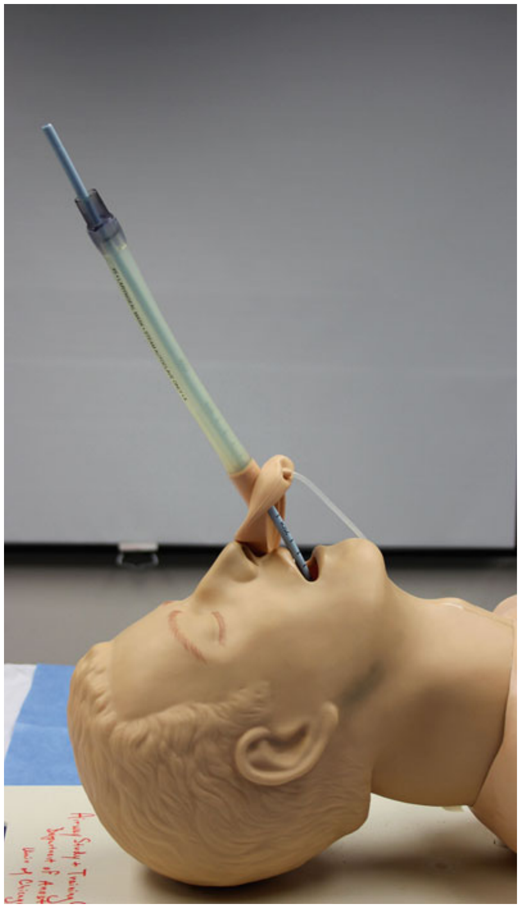

**Figure 8.31.** The LMA is removed over the Aintree catheter.

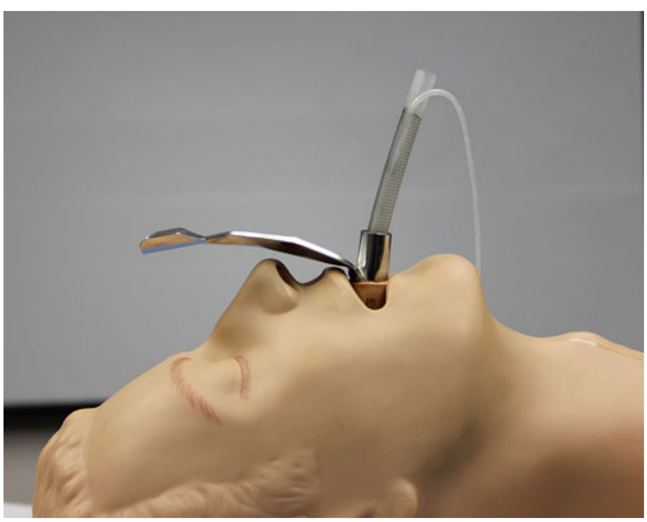

**Figure 8.32.** A flexible, specialized Fastrach endotracheal tube is inserted into the Fastrach LMA. The adapter hub of the endotracheal tube has been removed to allow the tube's passage through the Fastrach LMA.

visualized upon exiting the Fastrach, posterior rocking of the Fastrach (the Chandy maneuver, see Chap. 7) may align the heel of the Fastrach with the glottic inlet. The endotracheal tube can then be gently advanced over the insertion tube into the trachea and secured in the usual fashion.

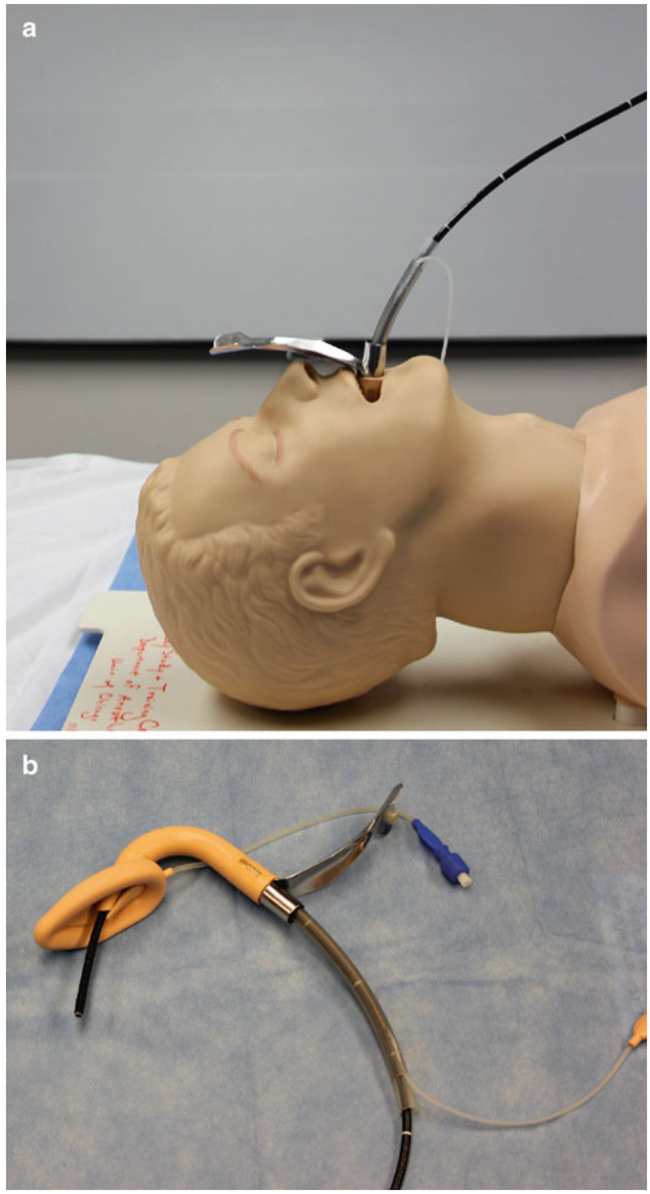

**Figure 8.33.** (**a**) The bronchoscope is inserted through the endotracheal tube in the Fastrach LMA. (**b**) The bronchoscope's insertion tube tip passes under the Fastrach's epiglottic elevator into the trachea. The endotracheal tube can then be advanced over the insertion tube and into the trachea.

## Complications Associated with Fiberoptic Intubations

Because the actual placement of the endotracheal tube is blind (that is, the endotracheal tube is run over the insertion tube and there is no visualization of the endotracheal tube as it passes through the posterior oropharynx or through the cords), it is possible that the endotracheal tube could injure the larynx or that the cuff could end up in the larynx instead of the trachea. Intralaryngeal placement of the cuff can cause recurrent laryngeal nerve injury if the placement is not corrected.

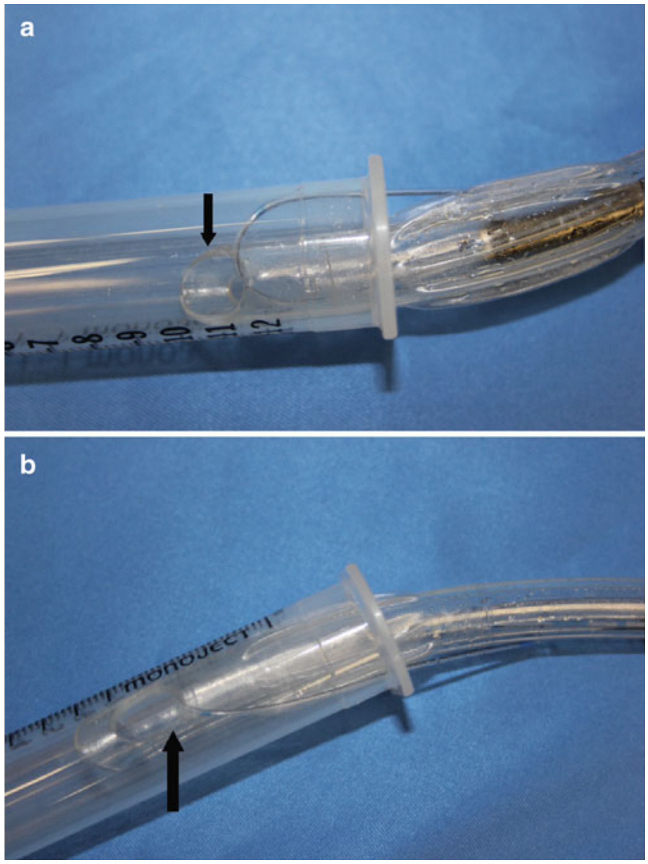

**Figure 8.34.** (**a**) The epidural catheter is seen extending well beyond the tip of the bronchoscope and emerging at the tip of the endotracheal tube. It then becomes trapped between the outer wall of the endotracheal tube and the surrounding tubular structure (a syringe barrel used to simulate the trachea), making it impossible to withdraw the catheter without pulling the endotracheal tube back. (**b**) The same situation as in (**a**) except the epidural catheter exits the endotracheal tube through the Murphy's eye hole instead of the tip of the endotracheal tube.

In addition, if the insertion tube is too large to fit through the endotracheal tube or it is inadequately lubricated, the outer covering of the insertion tube can be sheered off and obstruct either the endotracheal tube or the airway beyond the tip of the endotracheal tube.

If the bronchoscope is advanced through the Murphy eye of the endotracheal tube (instead of out the tip), it can become stuck. Then the bronchoscope cannot be removed and the endotracheal tube must be removed with the insertion tube in place and the entire procedure started over.

Finally, care must be taken when administering local anesthesia through a catheter inserted through the suction/working port of the bronchoscope. If the tip of the catheter protrudes beyond the tip of the insertion tube, it is possible for it to get drawn down by the tip of the endotracheal tube as it is advanced off of the insertion tube. When this happens, the catheter can become pinched between the tip of the endotracheal tube and the tracheal wall (Figure 8.34) and it becomes difficult or impossible to remove the catheter without manipulating the endotracheal tube[10].

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