CHAPTER 41
LARYNGOSCOPY, BRONCHOSCOPY, AND OESOPHAGOSCOPY

V. T. Joseph
Michael Laschat
Catharine Mngongo

Introduction

Endoscopic visualisation of the airway and digestive tract has made huge progress in the past decade due to the technological advances in light and image transmission. The early designs followed Nitze's method of providing illumination with an incandescent bulb. These have now been completely replaced with fibre-optic light systems and Hopkins rod lens telescopes. A further development has been the introduction of flexible fibre-optic endoscopes with high-definition videocameras providing real-time, high-quality images. At the same time, manufacturers have miniaturised endoscopic instruments so that a wide range of these are now available for use in infants and children.

Laryngoscopy

Examination of the larynx is carried out for both diagnostic and therapeutic indications.

Diagnostic

Diagnostic indications for laryngoscopy include:

- stridor, either congenital or acquired;
- subglottic stenosis;
- cysts or masses causing airway obstruction;
- vocal cord palsy; and
- foreign bodies.

Therapeutic

Therapeutic indications for laryngoscopy include:

- subglottic stenosis;
- aspiration/injection of mucous cysts, cystic hygromas;
- papillomas;
- lingual thyroid; and
- webs.

Instruments/Equipment

Laryngoscopy can be performed by using rigid or flexible instruments, each of which has certain specific advantages.

Rigid laryngoscopy

A rigid laryngoscopy may be done by using the indirect or direct method.

Indirect laryngoscopy

Indirect laryngoscopy is performed by using specially designed laryngeal mirrors in combination with a headlight. This enables the larynx and the nasopharynx to be visualised. This method is frequently used in adults, but in children it is often difficult to carry out this procedure.

Direct laryngscopy

Direct laryngoscopy is performed with handheld curved- or straight-blade instruments or by using the suspension laryngoscope, which leaves both hands free to manipulate instruments. The curved Macintosh blade and the straight Miller blade laryngoscopes are routinely used by anaesthetists to intubate patients (Figure 41.1).

Figure 41.1: Curved blade (Macintosh) and straight blade (Miller) laryngoscopes with locking handles.

Technique

Direct laryngoscopy

Curved-blade laryngoscope

The patient is placed supine with the neck slightly flexed and extension at the atlanto-occipital joint. The neck should not be extended fully, as this displaces the larynx anteriorly and moves it away from the line of vision. The curved blade is passed along the right side of the tongue, displacing it to the left. The tip of the blade is inserted into the vallecula, and the laryngoscope is lifted upward and forward so that the epiglottis is carried up and away from the laryngeal inlet to expose the vocal cords.

Straight-blade laryngoscope

The tip of the blade is passed under the epiglottis and is used to lift it up to expose the cords. This method is particularly useful in babies and young infants.

Note that direct laryngoscopy with the handheld laryngoscope is useful in providing rapid visualisation of the larynx, but because the surgeon has to hold the laryngoscope by hand, it is difficult to carry out therapeutic manoeuvers.

Suspension laryngoscope

Direct laryngoscopy performed by using the suspension laryngoscope (Figure 41.2) is frequently carried out by ear, nose, and throat (ENT) surgeons. The equipment consists of a short tubular laryngoscope that is locked to a supporting arm that rests on a base plate lying against the anterior chest wall. This arrangement leaves the surgeon's hands free to use instruments and even to position an operating microscope for precise surgery.

The surgical procedures that can be done with the suspension laryngoscope include aspiration/marsupialisation of cysts, excision of nodules, laser vaporisation of papillomas, and injection of bleomycin in cystic hygromas with laryngeal involvement.

Flexible laryngoscopy

The instruments used for flexible laryngoscopy include the ultrathin bronchoscope, the standard flexible bronchoscope, and the specially designed flexible nasopharyngoscope (Figure 14.3). The ultrathin

bronchoscope has no suction or instrument channel and is mostly used by anaesthetists for intubation in difficult head and neck cases. The standard bronchoscope has an instrument/suction channel and can be used for therapeutic indications, although the rigid instrument is greatly superior in this respect. Both the standard flexible bronchoscope and the nasopharyngoscope are used to evaluate laryngomalacia and vocal cord paralysis.

The image can be viewed directly through the eyepiece of the scope; in more advanced systems, it is displayed on a high-resolution monitor. The newer nasolaryngoscopes have the camera chip at the tip and can provide extremely high quality images. The ultrafine scopes have an outer diameter of 2.2 mm but do not incorporate a suction/irrigation channel. The instruments with a working channel are larger, with an outer diameter of 4.9 mm, and can be used to remove foreign bodies and to perform biopsies.

Complications

Diagnostic laryngoscopy is generally a very safe procedure. The patient needs to be carefully monitored throughout the endoscopy to ensure that the airway and ventilation are not compromised. Facilities for intubation should always be at hand, and in cases where a difficult airway is anticipated (see Figure 41.4), tracheostomy instruments must be kept in the operating theatre next to the patient. The surgical team must be prepared to carry out a tracheostomy if the anaesthetist fails to intubate the patient.

Therapeutic interventions are potentially at risk of compromising the airway, due to either oedema or collapse of the larynx/trachea following removal of large neck masses. The complications that may occur include laryngeal oedema, haemorrhage, and perforation. The surgeon must decide whether the patient should be left intubated with postoperative intensive care support until the airway is stable.

Bronchoscopy

Paediatric bronchoscopy is indicated for a wide variety of diseases. It allows an assessment of the anatomy and function of the complete upper airway from the nasal passage, pharynx, and larynx to the segment bronchi. Diagnostic procedures such as bronchoalveolar lavage, as well as interventional procedures such as extraction of foreign bodies, can be performed with special instruments.

Diagnostic Bronchoscopy

Stridor is a clinical sign for obstruction of the upper airway. Inspiratory stridor usually indicates an obstruction of the extrathoracic part of the airway. Expiratory stridor indicates an obstruction of the intrathoracic part of the airway.

In most cases, congenital inspiratory stridor is caused by laryngomalacia. It should be investigated endoscopically when it is progressive or causes apnoea, feeding difficulties and growth retardation, or when symptoms point to a diagnosis other than laryngomalacia. In these cases, one may find bilateral vocal cord paralysis, subglottic hemangioma, or laryngeal cysts. Proper diagnosis of congenital inspiratory stridor can be done only with the child breathing spontaneously.

Acquired inspiratory stridor may originate from subglottic scar tissue, ductal cysts, or laryngeal papillomas. Expiratory stridor may be caused by asthma but also may be due to inhaled foreign bodies and tracheomalacia as a result of tracheobronchial or vascular malformations.

Recurrent aspiration with bronchopneumonias can be caused by broncho-oesophageal fistulas or laryngeal clefts. H-type broncho-oesophageal fistula takes an oblique course from the cephalad opening on the posterior wall of the upper trachea to a more caudal position on the anterior wall of the oesophagus. Diagnosis can be very difficult due to the small diameter of some fistulas, but usually can be achieved with combined bronchoscopy and oesophagoscopy. The tracheal aspect of the fistula usually appears as a small prominence in the midline of the posterior membranous wall of the cervical trachea. A fine catheter can be passed through a ventilation bronchoscope into the tracheal opening

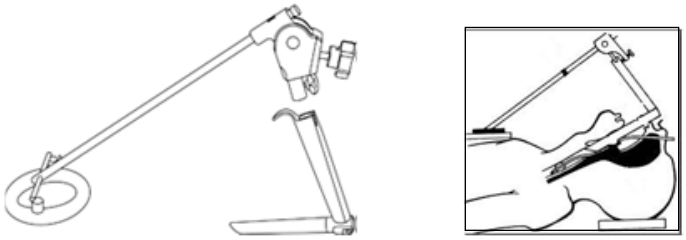

Figure 41.2: Rigid suspension laryngoscope for surgical procedures in the upper airway

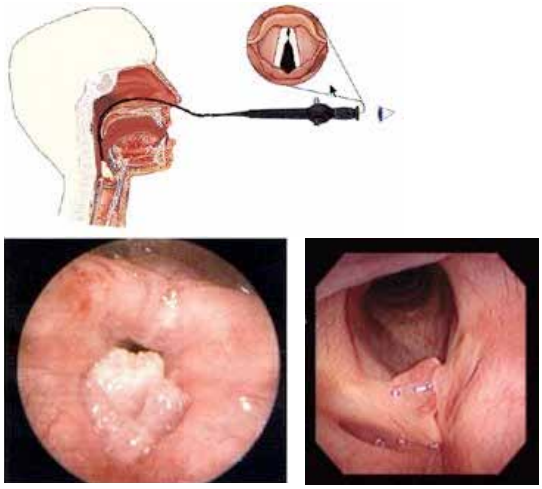

Figure 41.3: Flexible fibre-optic nasopharyngoscope (left) showing normal view (centre) and laryngeal papilloma (right).

Figure 41.4: Massive tumour (teratoma) occupying whole oral cavity. Intubation could be done only by using a flexible fibre-optic scope to guide placement of the endotracheal tube.

of the fistula into the oesophagus. Diagnosis is then affirmed by oesophagoscopy, demonstrating the catheter entering the oesophagus. Surgical identification is facilitated with a catheter or a wire in the fistula during the operative repair.

Laryngeal clefts are easy to overlook because redundant mucosa fills the cleft. Careful inspection of the interarytenoid and posterior glottis region with a Hopkins rod telescope is mandatory.

Interventional Bronchoscopy

Foreign body inhalation

Symptoms of foreign body inhalation vary. There can be complete obstruction with hypoxia, bradycardia, and cardiac arrest, but if the object is small and passes beyond the main bronchi, the child may quickly become asymptomatic and be presented only when symptoms of distal obstruction occur.

The majority of inhaled foreign bodies are radiolucent. A chest x-ray may show unilateral hyperinflation of the affected side as well as

collapse and consolidation distal to the obstruction, but it may also be without pathologic findings.

Indication for bronchoscopy is a positive history and clinical signs of aspiration.

Usually a rigid technique is used for the removal of foreign bodies. With the patient deeply anaesthetised, a rigid ventilation bronchoscope is introduced under direct view into the trachea. The foreign body is extracted with special grasping forceps. In most cases, the foreign body is too large to be removed through the bronchoscope, so the object, forceps, and the bronchoscope have to be removed together as a single unit.

Great danger ensues when the foreign body is lost in the trachea or in the subglottic space obstructing the airway. If the object cannot be removed quickly, it should be pushed down into a main stem bronchus to allow oxygenation. Then a second attempt at removal can be made. After removal of the foreign body, the presence of a second foreign body should be excluded.

Airway stenosis

An important indication for interventional bronchoscopy is treatment of airway stenoses. Laser therapy of subglottic haemangiomas is favoured by some, whereas others use application of intralesional steroids followed by intubation. Subglottic granulation tissue and viral papillomas can be treated with the intralesional injection of drugs (corticosteroids and chemotherapeutic agents). Subglottic cysts, which can develop after intubation, can be resected with a laser or with special forceps. These interventions require the availability of an intensive care unit because many children need to remain intubated due to secondary swelling of the subglottic area.

Technique

In many parts of the world, the use of flexible endoscopes for diagnostic purposes is regarded as a standard, but in many other locations, the availability and cost of flexible bronchoscopes limit the use of these expensive and fragile instruments. Adequate assessment of the supraglottis, subglottis, and the trachea is possible in most cases, however, by using a telescopic rod alone with the patient breathing spontaneously with 100% oxygen and a volatile agent, usually halothane or sevoflurane. Rigid endoscopy is ideal for therapeutic interventions such as foreign body extraction or laser surgery. The main disadvantage of the rigid technique is that it can be used only under anaesthesia, whereas flexible bronchoscopes can be used under sedation and local anaesthesia.

Rigid bronchoscopes

Rigid ventilation bronchoscopes consist of a light metal tube. A port at the distal end allows the attachment of an anaesthetic T-piece for ventilation. Light is transmitted over a prism at the distal end of the tube. The ventilation scope can be used with spontaneous or controlled breathing. The scope can be used with the Hopkins rod telescope for diagnostic procedures (Figure 41.5). With the telescope in place, ventilation and examination are possible under excellent visual conditions. However, the telescope narrows the lumen of the bronchoscope, increasing airflow resistance and making breathing difficult. This is particular a problem with the smallest bronchoscopes. For therapeutic procedures the ventilation bronchoscope is used with special equipment, such as grasping forceps, for extraction of foreign bodies.

The Hopkins rod telescope is an endoscopic telescope in which the air-containing spaces between the conventional series of lenses are replaced with glass rods with polished ends separated by small air lenses. This system transmits more light, yields greater magnification, and provides greater depth and breadth of field than conventional lens systems. The instrument is inserted under direct laryngoscopy with a standard laryngoscope through the mouth under general anaesthesia, with the patient lying in a supine position. The smallest available telescope has a diameter of less than 2 mm. With this instrument, diagnostic bronchoscopy is possible even in very small newborns. In this case the Hopkins rod telescope alone can be inserted either by using an apnoeic technique or alternatively with the newborn breathing spontaneously.

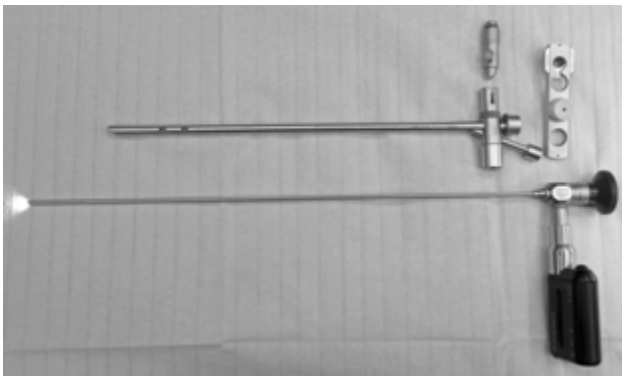

Figure 41.5: Storz ventilation bronchoscope with Hopkins rod telescope. A battery-powered light source is connected to the telescope.

Flexible bronchoscopes

The flexible fiberscope consists of a flexible tube that contains a fibre-optic system that transmits an image from the tip of the instrument to an eyepiece (Figures 41.6 and 41.7). Another technical advance is the video scope. In these instruments, a video chip positioned at the tip of the bronchoscope replaces the glass fibre bundle. This design avoids the inherent susceptibility of a fibre bundle to damage. Digital processing of the image is also possible. Using Bowden cables connected to a lever at the handpiece, the tip of the instrument can be oriented, allowing the practitioner to navigate the instrument into individual lobe or segment bronchi. Small fibre-optic endoscopes down to 2.2 mm in external diameter are available, but these very small instruments lack a channel for suctioning and instrumentation. The fiberscope can be inserted through the nose or the mouth under local anaesthesia with or without sedation. Very young children often need deep sedation or anaesthesia. Otherwise, only suboptimal information can be obtained due to movement, coughing, and obstructed view.

Complications

Complications include hypoxia, hypoventilation, and hypercapnia for many reasons, including obstruction of the airway or deep sedation.

Figure 41.6: Small flexible fibreoptic bronchoscope with suction/irrigation and biopsy channel.

Figure 41.7: Standard flexible fibre-optic bronchoscope with full deflection, suction/irrigation channel, and biopsy channel for instruments.

Trauma to lips, teeth, epiglottis, and larynx with subsequent airway oedema, especially subglottic oedema, are complications associated mainly with rigid bronchoscopes. If stridor is present in recovery, nebulised epinephrine should be administered. Intravenous administered dexamethasone also produces relief of stridor but takes 1 to 2 hours to act.

Damage to the tracheobronchial tree with pneumothorax or pneumomediastinum is rare. Pneumothorax or pneumomediastinum can also be the consequence of air trapping, as passive expiration cannot overcome the resistance in the airway obstructed by the instrument. Air trapping can also lead to diminished venous return and reduced cardiac output.

Local anaesthetic overdose may cause serious bradycardia and even death.

Infections are a problem, especially in flexible bronchoscopy. A major problem is proper disinfection of the suction channel and valves. Leak detection should be performed regularly because bacteria may penetrate into fissures around the optic fibres and cables.

Haemorrhage from granulations or haemangiomas is usually a minor problem and settles spontaneously.

Oesophagoscopy

In the earliest endoscopic procedures to visualise the oesophagus, only rigid instruments were available. These instruments are similar to rigid bronchoscopes except they lack side holes at the distal end and the ventilation channel is not required (Figure 41.8). The fibre-optic light is connected to a light prism, giving proximal illumination, or to a light rod, which is inserted through the lumen of the scope and locks into place to provide distal illumination.

The great advance in endoscopy came with the introduction of fibre-optic technology, which resulted in the development of flexible endoscopes for examination and therapeutic procedures in both the upper and lower gastrointestinal tracts.

Examination of the oesophagus is carried out for both diagnostic and therapeutic indications.

Diagnostic

Diagnostic indications for oesophagoscopy include:

- gastro-oesophageal reflux;
- dysphagia;
- corrosive ingestion;
- upper gastro-intestinal bleeding;
- trauma; and
- strictures.

Therapeutic

Therapeutic indications for oesophagoscopy include:

- balloon dilatation of strictures;
- percutaneous endoscopic gastrostomy (PEG) insertion;
- foreign body removal; and
- injection sclerotherapy.

Technique

Rigid endoscopes

Rigid endoscopes are most useful for removal of foreign bodies because instruments can easily be inserted through the lumen for retrieval. The procedure is done under general anaesthesia with endotracheal intubation. It is important that the endotracheal tube be slightly smaller than what would normally be used and the balloon be deflated; otherwise, it may be difficult to pass the scope down the oesophagus.

Entry into the oesophagus is guided by the use of a laryngoscope with the neck in the flexed position. Once the scope has entered the oesophagus, the neck is extended by placing a roll under the shoulders. This brings the axis of the scope into a straight line with the oesophagus and it is advanced under direct vision to the cardia. It is sometimes helpful to use a 0-degree telescope to view the distal lumen as the scope is advanced. In this case, the videocamera can be attached to the eyepiece to provide an image on the monitor (Figure 41.9).

Flexible endoscopes

Currently, most of the diagnostic and therapeutic procedures are performed with flexible endoscopes. Although it is possible to insert the flexible scope in an awake patient under sedation, most children will require general anaesthesia for this procedure. The patient is generally placed in the lateral position lying on the left side, although some surgeons prefer the supine position. The tip of the scope is angulated into a curve to follow the back of the tongue. On insertion, the phar-

Figure 41.8: Rigid oesophagoscopes for infants to older children.

Figure 41.9: Paediatric flexible fibre-optic gastroscope with videocamera head. The image is viewed on a high-resolution monitor.

Figure 41.10: Extraction of a lodged coin from the oesophagus with a grasp forceps inserted through the instrument channel of a flexible gastroscope

ynx is seen. Secretions are sucked out and the scope is guided behind the endotracheal tube to the cricopharyngeal inlet, where it enters the oesophagus. Further passage of the scope is assisted by gently insufflating air to distend the lumen and by aspirating any secretions along the way. The scope is passed all the way down into the stomach; Then, on withdrawal, a careful note is made of any pathology that has been noted previously. Any procedures that need to be carried out are then done with the scope positioned at the appropriate site. Many devices, such as forceps, needles, and electrosurgical knives, among others, available for therapeutic and diagnostic purposes can be inserted through an instrument channel (Figure 41.10).

Dilatation of strictures (Figures 41.11 and 41.12) can be done either with the direct endoscopic view or with radiological screening. For this purpose, contrast is used to fill the balloon, and the procedure is observed on the x-ray screen.

Complications

Complications are rare and include minor haemorrhage, injury to the larynx and hypopharynx and infections. Perforation can occur especially following deep biopsy, forceful dilation of strictures, or during removal of foreign bodies.

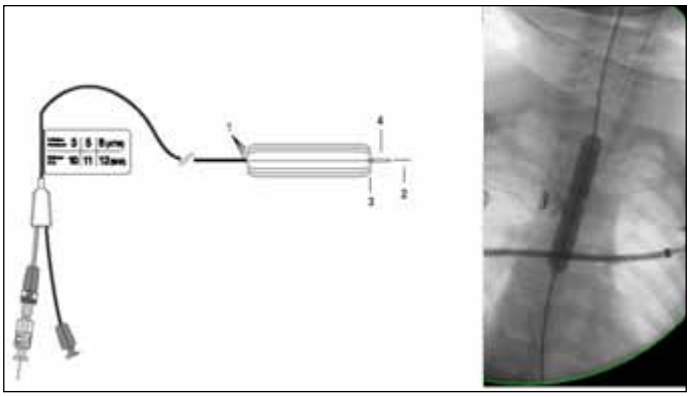

Figure 41.11: Oesophageal balloon (left) for dilatation of stricture (right) – accurate placement of the balloon and monitoring of the pressure used are essential.

Figure 41.12: Direct endoscopic view to a stricture after repair of oesophageal atresia with a flexible fibre-optic gastroscope. The diameter of this stricture is about 3 mm.

Key Summary Points

1. Rigid bronchoscopes and oesophagoscopes are used for foreign body removal and biopsy. For all other cases, use flexible fibre-optic instruments.
2. The appropriate size of scope must be used in keeping with the age and physical size of the patient.
3. Use video systems whenever possible because the image is magnified and much clearer. Also, the anaesthetist and other team members can see what is being done.
4. Before starting the procedure, always assemble the equipment and make sure that every component is working exactly as intended.
5. It is always helpful to use a laryngoscope to guide passage of the bronchoscope or oesophagoscope. The anaesthetist will be able to do this to display to the surgeon the exact anatomical structures at the upper end of the aerodigestive tract.
6. An emergency tracheostomy set must be ready in the operating theatre in case of airway problems or difficult intubation.
7. During the procedure, careful monitoring of the patient is mandatory. If any problems are noted, the endoscopy must be suspended. If necessary, the instruments must be removed and the anaesthetist allowed to re-establish satisfactory ventilation.

Suggested Reading

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