
The Difficult Airway

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One of the most serious challenges in the care of patients is that presented by the difficult airway. Whether the difficult airway is recognized or not, the gravity of the failure to properly manage the situation is paralleled by few other clinical events. Consequences of such failure include hypoxemia, hypercapnia, resultant metabolic alteration, neurological sequelae, and death.

The difficult airway is defined as the clinical situation in which a conventionally trained anesthesiologist experiences difficulty with mask ventilation, difficulty with tracheal intubation, or both.¹ Although the majority of airway management, particularly in the hospital setting, is performed by anesthesiologists, the intent of this discussion is to present information for the guidance of all medical personnel that may be in the situation of managing a difficult airway.

Although the incidence of a difficult airway is estimated to be less than 10% of all cases of airway management,² it is apparent that the lack of anticipation of airway difficulty is most often the cause of compromised clinical outcomes.³ While there is no ideal method of airway evaluation, the ability to appreciate the issues impacting on the management of the airway will help anticipate potential problems and may help place the practitioner in the position of acting rather than reacting.

■ Airway Assessment

Techniques for endotracheal intubation have been presented in an earlier chapter in this issue (see chapter by Hurford). A brief review of upper airway anatomy will provide a basis to appreciate the manner by which physical and/or medical issues may serve as obstacles to intubation.

To maximize the potential exposure of the glottic opening, it is es-

essential that the oral axis, the pharyngeal axis, and the laryngeal axis approximate a straight line thereby affording the shortest distance from the teeth to the glottic opening (Fig. 1). This is best accomplished by placing the supine patient in the position described as the “sniffing” position. Elevating (using a blanket, folded towels, foam rest, etc) the occiput approximately 10 cm higher than the shoulder blades provides the necessary cervical flexion to better align the laryngeal and pharyngeal axes. Extension of the head on the atlanto-occipital joint by the practitioner’s free hand (or by an assistant) will serve to maximally align the oral axis with the laryngeal and pharyngeal axes. A significant number of difficult or failed intubations have been attributed to poor positioning.⁴

A difficult airway may be anticipated by review of the patient’s old records, when available. Pertinent information such as previous techniques employed, ease of mask airway, type of laryngoscope blade, use of stylet, use of muscle relaxant, appreciation of glottic opening, and number of attempts are often noted in the body of the patient’s chart. The preoperative interview may also serve to provide key information with regard to previous anesthetic experiences. Many institutions will provide the patient who has experienced difficulty in the process of intubation

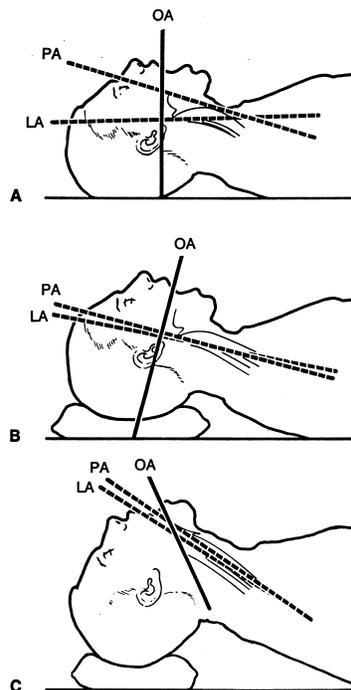


Figure 1. Schematic diagram demonstrating head position for intubation of the trachea. OA = oral axis; LA = laryngeal axis; PA = pharyngeal axis. (From Stoelting and Miller, *Basics of Anesthesiology*, 3rd ed. New York: Churchill-Livingston, 1994:148. With permission.)

with a copy of a letter for the record (a copy of which is also sent to the patient's primary care physician) outlining the difficulties and the methods used to overcome any obstacles to intubation. The patient is often aware that there were problems "getting the breathing tube in" and is sensitized to the issue. The individual may have a Medic Alert bracelet addressing the issue of a difficult airway.⁵ A thorough, focused history may provide relevant information regarding the patient's airway, and, possibly uncover medical issues that may potentially compromise access to the airway.

In an ideal situation, detailed records are available for review and the patient is able to provide an in-depth and insightful history. However, as is often the case in the setting of an urgent or emergent procedure, the records may not be available and the patient may not be able to provide any history.

In an attempt to provide the best possible insight into the likelihood of a difficult airway, methods of evaluating the airway have been proposed, modified, and integrated into various approaches to airway assessment. Mallampati and colleagues⁶ proposed 3 classes of the airway based on the ability to view the structures of the oropharynx in the seated patient, with the mouth wide open, tongue protruded, and the neck extended. Samsoon and Young⁷ added a fourth category to provide the following description.

- Class I Faucial pillars, soft palate, and uvula visible
- Class II Uvula masked by base of tongue
- Class III Only soft palate visible
- Class IV Soft palate not visible

Cormack and Lehane⁸ described four grades of glottic exposure during direct laryngoscopy as follows:

- Grade I Full glottic exposure
- Grade II Only the posterior commissure of the glottis is visible
- Grade III No glottic exposure
- Grade IV No exposure of glottis or corniculate cartilage

These classification systems potentially offer an excellent tool in the evaluation of the airway. The Mallampati method, however, was only able to predict a difficult airway approximately 50% of the time, with the value of the system compromised by a high incidence of false positive assessments. Issues impacting the limited predictive value of the Mallampati assessment include a high degree of variability among observers, as well as the tendency for patients to phonate during the exam.⁹

In an effort to develop a more effective clinical predictor of the dif-

difficult airway, Wilson and associates¹⁰ examined a large group of patients, 50% of whom were studied retrospectively. A risk score was developed based on the evaluation of five variables. The patient's weight, head movement, neck and jaw movement, mandibular recession, and the presence of protruding incisors were each scored on a 0 to 2 ranking. A total score equal to 3 or more predicted a difficult airway only 75% of the time. Although an improvement over the predictive capability of the Mallampati classification, the Wilson system still failed to predict a significant portion of difficult intubations.

A comparison of these methods for prediction of the difficult intubation was made by Oates and colleagues.¹¹ This study demonstrated that both the Mallampati classification and the Wilson risk sum were only able to predict the difficult intubation in 50% of the cases. The Wilson risk-sum method of airway assessment was preferred only in view of the appreciable interobserver variation in performing the Mallampati classification.

Several other clinical findings have been offered as a means to predict the difficult intubation. The anterior tilt of the larynx has been quantified with a bubble inclinometer and a laryngeal indices caliper. The variation from the horizontal was found to correlate with increased difficulty in laryngoscopy.¹² The distance between the thyroid notch and the mental prominence, with the neck in full extension, has been reported as an indicator of the laryngeal angle.¹³ A distance less than 6 cm may predict difficulty with visualization of the larynx during direct laryngoscopy.

The degree of interobserver variability does contribute to the decreased specificity of some tests. Certain tests, such as mouth-opening capability and chin protrusion have excellent interobserver variability, while the Mallampati technique of assessing oropharyngeal view had poor reliability.¹⁴ The inability to address lower airway issues and mask ventilation difficulties are additional shortcomings of many predictive tests.¹⁵ A list of anatomical issues that may render intubation difficult is presented in Table 1.

When evaluating a patient for a possible difficult intubation, it is important to appreciate the mechanisms by which various conditions may contribute to difficulty in airway management. In general, these conditions can be grouped into 6 functional categories of conditions that (1) limit the head and neck mobility, (2) limit the mouth opening, (3) limit the mandibular subluxation, (4) decrease the airway open space, (5) fix the tissues of the airway, and (6) distort the airway anatomy and can individually or in combination contribute to an increased difficulty in intubation.¹⁶ Rather than relying on a single test or method of evaluation, it is critical that the patient be assessed with the purpose of appreciating any physical finding that may impact one or more of these functional categories.

A list of diseases and syndromes associated with difficult tracheal intubation and mask ventilation is presented in Table 2.

Table 1. *Abnormal Anatomy Leading to Difficult or Failed Intubation*

Head size	Laryngeal edema
Congenital syndromes	Infections
Neck mobility	Burn patients
Limited mouth opening	Small or narrowed trachea
Loose teeth	Tracheoesophageal fistula
Enlarged tongue	Esophageal achalasis
Enlarged tonsils	Goiter
Thyroglossal duct cyst	Tension pneumothorax
Epiglottitis	Hiatal hernia
Limited laryngeal opening	Tumors
Laryngeal polyposis	Radiation effects
Trauma	

Source: Roberts et al.¹² With permission.

■ **Special Considerations**

The management of a child with a potentially difficult airway can be particularly challenging. Proper management is dependent upon the skill of the practitioner, as well as the ability of the practitioner to appreciate the manner(s) by which the pediatric airway differs from the adult. Hall¹⁷ describes four general categories of the pediatric airway. Children with congenital abnormalities such as laryngomalacia, glottic webs, and hemangiomas may present with varying degrees of obstruction. Infections of the airway such as epiglottitis and croup may produce progressive airway obstruction. Sudden airway obstruction is often seen in trauma or foreign body aspiration. The final category is that of the child who offers no findings suggestive of a difficult intubation, however, is nonetheless difficult to visualize for intubation. As in the adult, a course of action is determined in light of the clinical assessment of the child, bearing in

Table 2. *Diseases and Syndromes that Are Likely to Render Mask Ventilation and Tracheal Intubation Difficult*

Acromegaly	Ankylosing spondylitis
Stylohyoid ligament calcification	Fetal alcohol syndrome
Severe cervical osteoarthritis	Mucopolysaccharidoses
Cockayne’s syndrome	Pierre Robin syndrome
Cystic hygroma	Pseudoxanthoma “protein”
Cherubism	Rheumatoid arthritis
Goldenhar’s syndrome	Temporomandibular joint dysfunction
Still’s disease	Tracheal agenesis
Klippel-Feil syndrome	Treacher Collins syndrome

Source: Capan.¹⁸ With permission.

mind that the pediatric patient may lack the physiological reserve of an adult. Teaching suggests that cases of epiglottitis (supraglottitis) should be treated in an operating room should intubation be considered. Combined evaluation by anesthetic and surgical teams is mandated. If intubation is to be performed, fiberoptic and rigid bronchoscopes should be available in the room and immediate support from an otolaryngologist is desirable.

Trauma to the head and neck also demands special consideration. The absence of marked signs of external trauma cannot be relied upon to predict a patent, uncompromised airway. It is therefore essential that the preoperative assessment in the traumatized patient be performed with special consideration of the possibility of damage to structures not easily visible from the exterior. Blunt trauma to the airway, laceration of the tongue or other elements of the oral cavity, fractures to the mandible and maxilla, as well as multiple injuries, may compromise the management of the airway yet may not be readily appreciated during initial examination of the patient.

The pregnant patient also presents particular challenges. Upper airway edema associated with pregnancy may limit the view of the glottic opening in a patient who may have been described as having a class I view (Mallampati) while undergoing direct laryngoscopy for a surgical procedure while not pregnant. Additionally, tissues of the upper airway in the parturient are more likely to become edematous or bleed during direct laryngoscopy.

■ Approach to Airway Management

Capan¹⁸ has reviewed many of the common pitfalls that may complicate management of the airway in the setting of the trauma patient. While separate chapters address the issues of airway trauma (see chapter by Peralta and Hurford) and airway management of the parturient (see chapter by Dennehey and Pian-Smith), these special situations still present commonalties in the evaluation and approach to the potentially difficult airway. Many problems may not be recognized until intubation is attempted.

In the emergency setting, there may be little time to perform an adequate assessment of the airway. Patients may be unconscious, in respiratory distress, or cyanotic. Injuries may limit or preclude the establishment of a mask airway. In these settings, the individual most experienced in tracheal intubation should perform direct laryngoscopy to evaluate the airway and attempt the intubation. Even in the case of cervical injury, where in-line traction for stabilization of the neck must be performed by an assistant, the technique of direct laryngoscopy is most likely the quickest method to secure the airway. However, even in the most urgent of clinical situations, back-up plans, including fiberoptic bronchoscopy and the process of establishing a surgical airway, must be considered.

The patient with a full stomach presents special challenges in securing an airway. Here the risk of aspiration of stomach contents is weighed against the urgency of establishing an artificial airway. While a rapid sequence induction with cricoid pressure may be a viable solution in the patient with a known history of easy mask ventilation and a class I view (Mallampati) of the vocal cords, the approach to the unknown patient with a receding chin, protruding incisors, and a small mouth opening will be quite different. Here, the possibility of an awake intubation must be considered. In the most dire of circumstances, the issue of treating aspiration versus hypoxic neurological damage must play a role in the decision-making process.

Intoxicated patients are considered to have a full stomach. These patients may also be uncooperative and/or combative. This may be as a result of injury, intoxication, or hypoxemia. Such patients may require sedation prior to airway evaluation. Use of sedation must be approached with caution in consideration of the possibility of respiratory compromise. Oversedation is an easy, lethal complication.

Injury to the chest and thorax may limit the positioning of the patient and may compromise the mechanics of oxygenation and ventilation. Consideration must be given to the possibility of trauma to the tracheobronchial tree. A pneumothorax or an injury to a main-stem bronchus may require a different approach to airway management, including the use of different airway devices.

Injuries to the head and neck, including facial burns and maxillofacial injuries, may severely limit the ability to examine the upper airway (see chapter by Sheridan). Damage to facial structures may compromise the mask fit and cause swelling that may impinge on the upper airway. Injuries to the eye often limit access to the nose and mouth region. Additionally, injuries to the globe may necessitate avoidance of increased intracranial pressure that may often accompany laryngoscopy and intubation.

In patients with suspected injuries of the neck and/or cervical spine, special precautions must be utilized to ensure that management of the airway causes no further damage. Although direct laryngoscopy is possible, Fuchs and colleagues¹⁹ demonstrated that fiberoptic intubation was a useful alternative.

■ Airway Impairments

Abnormal airway anatomy is often responsible for difficult or failed intubations. Table 2¹⁸ lists conditions that may compromise airway management. Congenital syndromes such as Hurler, Pierre Robin, and Sjögren's syndromes involve abnormalities that may lead to a difficult intubation. Watson²⁰ has compiled a detailed list of congenital and acquired abnormalities that may contribute to a difficult or failed intubation.

Neck mobility may be particularly limited in patients with rheumatoid

arthritis or ankylosing spondylitis. An enlarged tongue and tonsils may limit glottic exposure. These structures may also be at risk for injury during intubation attempts. Tumors of the larynx, thyroglossal duct cysts, and thyroid enlargement may distort the anatomy of the upper airway. A tension pneumothorax or the effects of preoperative radiation to the head and neck may exert a traction on tissues of the head and neck sufficient to distort or obliterate normal airway anatomy.

■ Methods of Securing the Airway

A list of suggested contents of a portable storage unit for difficult airway management is provided in Table 3.

From above the Glottis

Direct Laryngoscopy This is the most common approach to securing the airway. The general principles of intubation utilizing direct laryngoscopy have been discussed in an earlier chapter (by Hurford). There are three basic types of laryngoscope blades.

The curved blade is typified by the MacIntosh blade. It is a large blade with a side flange that assists in sweeping the tongue out of the practitioner's field of view. Advantages include the reduced likelihood of damage to the teeth, more room for the passage of the endotracheal tube, and less potential for trauma to the epiglottis, as the tip of the blade is placed above the epiglottis at the base of the tongue (vallecula). Since the blade tip normally does not come in contact with the inferior surface of the epiglottis, the incidence of laryngospasm may be lessened. Disadvantages

Table 3. *Suggested Contents of the Portable Storage Unit for Difficult Airway Management*

Rigid laryngoscope blades of alternate design and size from those routinely used
Endotracheal tubes of assorted sizes
Endotracheal tube guides (e.g., semirigid stylets with or without hollow core for jet ventilation, light wands and forceps designed to manipulate the distal portion of the endotracheal tube)
Fiberoptic intubation equipment
Retrograde intubation equipment
At least one device suitable for emergency nonsurgical airway (e.g., a transtracheal jet ventilator, a hollow jet ventilation stylet, the laryngeal mask, and the esophageal-tracheal combitube)
Equipment suitable for emergency surgical airway access
An exhaled carbon dioxide detector

Source: ASA practice guidelines for difficult airway management. *Anesthesiology* 1993;78(3). With permission.

include difficulty in small oral cavities. The McCoy blade, a modification of the curved blade, offers a hinged tip that may be remotely manipulated to further elevate the epiglottis.

The straight blade is typified by the Jackson-Wisconsin blade, while the straight blade with the curved tip is typified by the Miller blade. Considered more effective in patients with anterior angulation of the laryngeal cartilage or limited neck mobility, the straight blades offer a better view of the glottic opening, as they are placed beneath the laryngeal surface of the epiglottis. Additionally, straight blades are felt to be more effective in patients with smaller oral cavities and are usually recommended for small children, given the less rigid, U-shaped epiglottis found in these patients. The incidence of laryngospasm may be elevated with the stimulation of the posterior surface of the epiglottis.

Specially modified blades include the Bullard,²¹ Wu,²² and Upsher.²³ Containing fiberoptic bundles, these blades permit direct vision of the larynx while an endotracheal tube is advanced from the side. These designs permit direct visualization of the glottis in the absence of optimal alignment of the oral, pharyngeal, and tracheal axes. Disadvantages include the relatively high cost of purchase and the time required to develop proficiency in their use.

Flexible Fiberoptic Bronchoscopy The flexible fiberoptic bronchoscope is considered perhaps the most useful instrument in dealing with a difficult airway. The flexibility of the fiberoptic scope permits the practitioner to conform the instrument to the anatomy of the airway. It may be employed intraorally or intranasally, requiring minimal mouth opening. Additionally, it provides the ability to insufflate oxygen and permits inspection of the airway below the glottic opening. Liabilities are in the areas of relatively high cost and the extent of experience needed to develop proficiency. The fiberoptic scope may also be used for retrograde intubation techniques from below the larynx. The use of a Patil mask with a fiberoptic scope permits ventilation while the endoscopy is performed. However, it is generally of limited use when blood is found in the oropharynx.

Light Wand As the stylet is blindly advanced, the appreciation of light through the tissues anterior to the larynx suggest that the stylet is positioned in the airway. Preferably done in a darkened room, the disadvantages include the risk to airway structures caused by blunt trauma.

Blind Nasal Intubation This technique may be performed in the conscious or unconscious patient. Preparation of the nasal mucosa with an appropriate vasoconstrictor is critical, as is the use of local anesthetic in the conscious patient. In the spontaneously breathing patient, as the endotracheal tube is advanced to the oropharynx, sounds of air moving at the distal tip of the tube serve as a target as the tube is advanced through

the glottis. The head position may be flexed, extended, or rotated to modify the position of the tip of the tube relative to the glottis. Additionally, the cuff of the tube may be inflated in the oropharynx to permit the elevation of the tip to facilitate passage of the tip through the vocal cords. A pair of forceps may also be used to guide the tube through the glottis using distal pressure on the tube to slowly advance through the vocal cords.

Gum Elastic Bougie Less commonly employed, the elastic bougie, either hollow or solid, may be blindly advanced into the trachea after laryngoscopy. Although a blind technique, the hollow bougie permits the attachment of a capnograph. Thus, as the tube is advanced, the cessation of a tracing on the capnograph suggests entry into the esophagus. The bougie may also be advanced into the trachea through a laryngeal mask airway (LMA).

Esophageal Obturator Airways Devices such as the LMA will be discussed in a separate chapter (see chapter by Campo and Denman). While relatively easy to use and inexpensive, no protection from aspiration is provided. However, with the exclusion of airway blockage below the vocal cords, these devices should be prioritized for employment in the setting of a difficult airway.

From below the Glottis

Transtracheal Jet Ventilation (TTJV) This technique permits delivery of oxygen most commonly through a catheter introduced into the trachea through the cricothyroid membrane. The airway is accessed with a 14-gauge intravenous catheter. When air is aspirated from the tracheal lumen, the stylet is removed. A coupling device comprised of a 3-ml Luer-Lok syringe and a connector to an 8-mm endotracheal tube is used to attach the jet ventilator to the cannula. Exhalation occurs passively through the glottic opening. Disadvantages include the cost of the apparatus, the risk of bleeding, the inability to adequately ventilate the patient, and the required time to develop proficiency. Additionally, there is the risk of barotrauma to the lungs, either by inflation at too great a rate or the absence of a route for exhaled gas. The technique, when properly utilized, will provide additional time to consider implementation of alternative plans for airway management. However, it is imperative that the operator not underestimate the difficulty of this procedure. It is, by definition, temporary and requires emergent/urgent formal cricothyrotomy or tracheostomy. A study in cadavers²⁴ suggested that in the hands of an inexperienced clinician, emergency cricothyrotomy by either surgical or Seldinger methods yielded equally poor results.

Retrograde Intubation Using a cricotracheal membrane approach, a needle is advanced into the tracheal lumen. Aspiration of air, or in the

case of attachment of a fluid-filled syringe, the appearance of bubbles verifies the tracheal lumen. A wire is then advanced until either is seen in the oropharynx or in the nares. This serves as a guidewire to advance the endotracheal tube into the airway. A variant of this procedure uses a fiberoptic scope. When the guidewire is passed into the oral or nasal cavity, it can be inserted into the air/suction lumen of the scope. This permits the scope to be advanced over the wire into the trachea.

Surgical Airway A surgical airway may be the result of an unanticipated difficult airway. It may also be planned in anticipation of a known difficult airway and performed under local anesthetic, with minimal, if any, sedation.

■ Management of the Difficult Airway

The American Society of Anesthesiologists (ASA) has prepared guidelines and algorithms¹ in the management of the difficult airway. Current recommendations (Fig. 2) represent a combination of earlier guidance. In an effort to optimize evaluation and management of the potentially difficult airway, Benumof⁴ has offered a list of 11 acceptable physical findings regarding teeth, neck, and jaw characteristics and oropharyngeal category. One should be warned it is seldom that one airway finding is so abnormal as to constitute a difficult airway. It is the combination/integration of findings that determines the index of suspicion of a difficult airway.

The ASA approach to a difficult airway is comprised of two basic limbs. One dealing with the recognized or anticipated difficult airway and the other addressing the unrecognized condition. The inability to intubate when the patient cannot be ventilated by mask is also addressed as a special category. It should also be emphasized that calling for help whenever airway difficulty is noted is always recommended.

Recognized

In the case of the recognized difficult airway, an awake intubation should be considered. The preparation of the patient is critical. Both physical and psychological factors play an important role in a successful awake intubation. The patient must receive adequate local anesthetic to the upper airway and sufficient sedation to facilitate relaxation yet preserve airway reflexes. Vasoconstrictors should be applied to the mucosa over the turbinates and a drying agent such as glycopyrrolate may be administered when feasible. Careful attention must be paid to proper patient positioning as well as preoxygenation. Once the patient is properly prepared, tracheal intubation may proceed by several different methods.

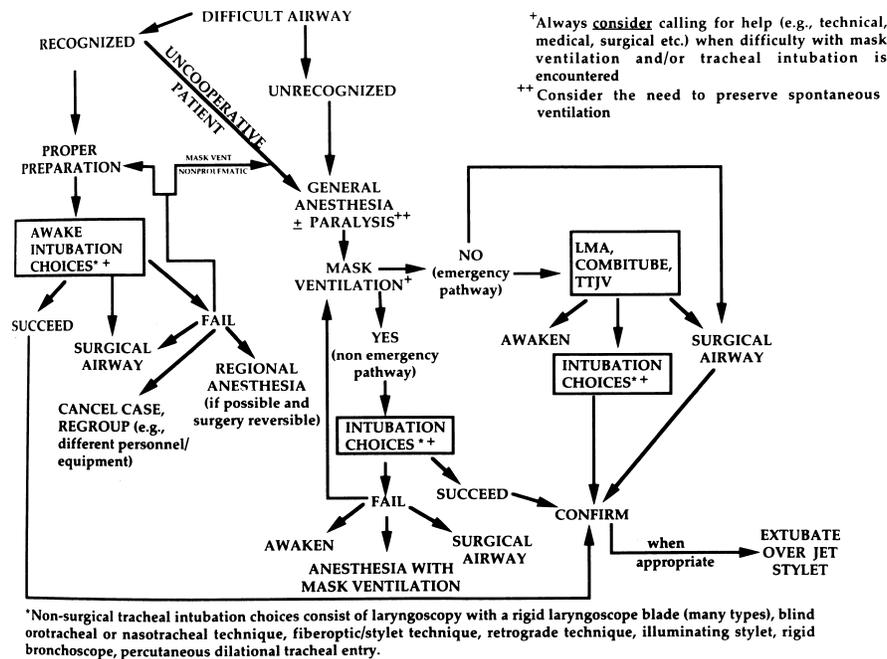


Figure 2. Flow chart shows the American Society of Anesthesiologists Difficult Airway Algorithm. (From Benumof JL. Laryngeal mask airway and the ASA difficult airway algorithm. *Anesthesiology* 1996;84:686–99. With permission.)

Direct laryngoscopy, blind nasal or oral tracheal, fiberoptic, stylet, illuminated stylet, or retrograde techniques have all been employed. The choice is driven in part by the clinical presentation and in part by the experience and knowledge of the practitioner. Rosenblatt and coworkers²⁵ reported that in the management of the difficult airway, anesthesiologists older than 55 years of age and those with greater than 10 years of clinical experience preferred direct laryngoscopy with apnea. While the availability of alternative techniques is commonplace, most anesthesiologists rely on direct laryngoscopy and fiberoptic-guided intubation. Should the clinical situation merit, the airway may even be secured surgically, under local anesthetic.

Failing intubation, several options may be entertained. If feasible, the procedure may be performed under a regional technique. However, the practitioner must consider the likelihood of the need for intubation during the surgery. This may impact the choice of regional anesthesia. The patient may be supported while additional equipment and/or personnel are brought in for another attempt. If elective, the procedure may be canceled. In the course of attempting to perform an awake intubation, if the patient can be adequately ventilated by mask or if the patient becomes

uncooperative, general anesthesia may be induced prior to intubation. Here the practitioner must be confident of being able to support the airway in the apneic patient. Failing this, the patient must be fully awakened.

An alternative has been reported in the case of an airway compromised by a large thyroid mass. In this instance, the initiation of femoral-femoral cardiopulmonary bypass, under local anesthetic, allowed a controlled tracheostomy to be performed.²⁶

Unrecognized

It is still relatively uncommon to attempt an intubation after induction of general anesthesia only to discover a difficult airway. This may occur in the case of an uncooperative patient initially planned for an awake intubation or simply an unrecognized difficult airway. If mask ventilation can be maintained, the option to proceed with tracheal intubation still exists. The presence of muscle relaxants only prevents immediate awakening of the patient. As described by Benumof,⁴ the practitioner should attempt to optimize intubating conditions. In the hands of an experienced endoscopist, the sniffing position must be optimized (unless contraindicated secondary to concerns about neck/spinal cord trauma), muscle tone should be absent (either by deep sedation or relaxant), and a different laryngoscope blade(s) may be used. Optimal external manipulation of the larynx should be employed by the practitioner or an assistant. By pressing over the thyroid, hyoid, and cricoid cartilages in a cephalad and posterior direction, the view of the glottis can often be improved. Attempts to intubate should be limited to no more than three to avoid the risk of airway edema/trauma. The option may exist to perform the surgery under general anesthesia by mask ventilation or by obtaining a surgical airway. Alternatively, the surgery may be postponed, if possible, and the patient awakened.

Cannot Intubate—Cannot Ventilate

This situation demands the initiation of immediate life-saving rescue strategies. Initial attempts should focus on two-person mask ventilation. The primary practitioner should employ two hands for mask fit and jaw thrust with an assistant squeezing the bag. If the assistant is capable of providing jaw thrust, this permits the primary practitioner to focus on mask fit. Appropriately sized oropharyngeal or nasopharyngeal airways should also be employed. In the absence of mask ventilation, the option to wait for the patient to awaken is reduced, especially in the presence of any muscle relaxant.

The algorithm suggests the use of esophageal obturator airways (EOA) such as the LMA or TTJV. The LMA additionally offers the advan-

tage of acting as a conduit for a fiberoptic scope. With a self-sealing sidearm, ventilation may be maintained while an attempt to pass a scope through the glottis is made. The intubating LMA permits direct passage of an endotracheal tube. Although these devices are readily available in the setting of an operating room, Levitan and colleagues²⁷ report that only 25% of responding emergency medicine residency programs reported having immediate access to either type of EOA. The true shortcoming of the EOA lies in the inability of these devices to rectify airway issues occurring at or beneath the glottis. Ventilation difficulties emanating from the glottic and subglottic region may only be remedied by endotracheal intubation, TTJV, or a surgical airway. TTJV does present the risk of barotrauma and is easily dislodged. Ultimately, a surgical airway may offer the only successful resolution of this life-threatening situation. Teams able to establish surgical airways emergently are usually available in larger centers. However, in smaller institutions, provisions to obtain a surgical airway must be considered as part of an overall plan to manage the difficult airway.

Injury as a Result of Difficult Intubation

Airway injury during general anesthesia has always been a source of patient morbidity and liability for anesthesiologists. In a recent review of closed-claim analysis, Domino and colleagues²⁸ report that the most frequent sites of injury were the larynx, pharynx, and esophagus. Injuries to the esophagus and trachea were more frequent in difficult intubations. Injuries included pharyngoesophageal perforation with sequelae ranging from pneumothorax and subcutaneous emphysema to retropharyngeal abscess and mediastinitis. It is suggested that patients in whom tracheal intubation has been difficult should be observed for and told to watch for the development of signs and symptoms of these sequelae. A list of suggested approaches to difficult airway patients is presented in Table 4.¹²

■ Extubation

Mechanical problems associated with extubations have been generally attributed to one of three basic mechanisms: (1) failure to deflate the cuff, (2) a large cuff catching on the vocal cords, and (3) adhesion of the tube to the tracheal wall, either by inadequate lubrication or inadvertent fixation by a surgical suture.²⁹ Criteria for extubation involve several issues to ensure the patient's ability to adequately breathe spontaneously and possess the needed reflexes to protect the airway. Breathing spontaneously, the following of commands, purposeful gestures, and head lift have all been employed as extubation criteria. Although good indicators, these criteria are not foolproof and may occasionally result in a patient being

Table 4. *Suggested Approaches to Difficult Airway Patients*

Potential Airway Problems	Endoscopist Instrument Training	Proper Patient Positioning	Modifying the Patient's Airway Reflexes	Approach (oral, nasal, via the neck)
Obesity	Ideal for flexible fiberoptic	Cerv and A-O extension	Awake; topical or regional airway anesthesia	Oral or nasal
Potentially Unstable Neck	Ideal for flexible fiberoptic	Keep head neutral	Awake; topical or regional airway anesthesia	Usually oral or nasal, maybe neck
Blood in the Oropharynx	Try rigid nonfiberoptic blade	Keep head in sniffing position	Awake; topical or regional airway anesthesia	Oral, nasal, or neck approach
Airway Trauma	Rigid blades usually preferred	Keep head in sniffing position	Awake; topical or regional airway before gen. anes.	Neck may be the approach of choice
Limited Mouth Opening	Ideal for flexible fiberoptic orally or nasally	Cerv and A-O extension	Awake; topical or regional airway anesthesia	Oral, nasal, or neck approach
Full Stomach	Avoid flexible fiberoptic	Sniffing position with cricoid press	Cautious topical anesthesia of the airway	Usually oral
Copious Oral Secretions	May want to avoid flexible fiberoptic	Keep head in sniffing position	Antisialagogues; top. anesthesia and sedation	Oral or nasal
Agitated Patient	Common rigid laryngoscope blades	Sniffing; supine	Sedate; general anes. or topical regional anes.	Oral
Epiglottitis	Rigid laryngoscope blade	In parent's arms	General anesthesia prior to airway manipulation or IV	Oral

Cerv = cervical; AO = atlanto-occipital; gen. anes. = general anesthesia; top. = topical.

prematurely extubated, resulting in a period of assisted ventilation or reintubation.

These issues take on profound importance in the case of a patient who was found difficult to intubate. In the extreme case of the patient who could not be easily intubated or ventilated, the price of premature extubation may be grave. In any case, where resecuring an airway may be difficult, extra precautions are warranted before extubation. A common practice is extubation over a fiberoptic scope or a ventilating tube changer. While neither guarantees a secure airway, both afford the opportunity for some degree of oxygenation while further steps are considered.

■ Summary

The difficult airway, although rare, still occurs with a frequency sufficient to require that all personnel associated with airway management be familiar with methods to use when confronted with a challenging airway. Methods of airway assessment are helpful but lack adequate sensitivity and specificity. The most effective means of anticipating a difficult airway lies in an integrated approach utilizing the history, physical exam, and the patient's medical record. The most effective manner of dealing with a difficult airway involves proper anticipation, patient preparation, and the development of practical, well thought out contingency plans.

Most importantly, extubation must only occur after a plan has been designed to ensure that the patient may be adequately supported in the event of a premature extubation. Certain injuries to the airway and esophagus are more common in patients in whom intubation was difficult. Such patients should be closely watched and informed about the signs and symptoms of tracheal and esophageal injury.

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