CHAPTER 13

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Current Concepts in the Management of the Difficult Airway

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Current Concepts in the Management of the Difficult Airway

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The practice of airway management has seemingly become more complex with time, as evidenced by the introduction of a number of new airway devices, several of which have been included in the American Society of Anesthesiologists (ASA) Difficult Airway Management Algorithm.[1] Management of the difficult airway remains one of the most challenging tasks for anesthesia care providers. Claims involving airway management continue to comprise an important aspect of the ASA Closed Claims Project database.[2] This refresher course focuses on several of the available alternative airway management devices–techniques and their clinical applications, with particular emphasis on the difficult or failed airway.

Alternative Airway Devices

Endotracheal Tube Guides

The Eschmann Tracheal Introducer™ (Eschmann Health Care, Kent, United Kingdom, or SIMS Portex, Keene, NH), also known as the gum elastic bougie, is considered the first choice of intubation aides in the United Kingdom and is also popular in the United States. It is useful in patients with an "anterior larynx" and those with limited mouth opening. If only the epiglottis is visualized, the introducer can be guided under the epiglottis and into the trachea. Straight Eschmann tracheal tube guides are designed for endotracheal tube (ET) exchange.

The Frova Intubating Introducer™ (Cook Critical Care, Bloomington, IN; Fig. 1) was recently designed to facilitate endotracheal intubation and allow simple ET exchange. Its distal tip is angulated like the gum elastic bougie, but it has two side ports. It has a hollow lumen and is packaged with a stiffening cannula, which is not necessary for use, as well as a removable rapid-fit adapter that permits ventilation.

The Arndt Airway Exchange Catheter Set™ (Cook Critical Care) can be used to exchange a laryngeal mask airway (LMA) and ET using a fiberoptic bronchoscope (FOB). It has a tapered end, multiple side ports, and is packaged with a stiff wire guide, bronchoscopic port, and rapid-fit adapter.

The Aintree Airway Exchange Catheter™ (Cook Critical Care) (Fig. 2) can also be used to exchange LMAs and ETs using a FOB. Like the Supkis airway exchange catheter, its hollow lumen allows insertion of a FOB directly through the catheter.

The VETT System™ (PulmonX, Inc., Palo Alto, CA) involves integration of ultrathin FOB bundles into ETs, intubation stylets, and laryngoscope blades, and allows television monitor projection of the image seen from the end of the device. It may be a useful adjunct in the management of the difficult airway, because it enables fiberoptic visualization of all airway structures during intubation.[3] It affords a simpler and quicker

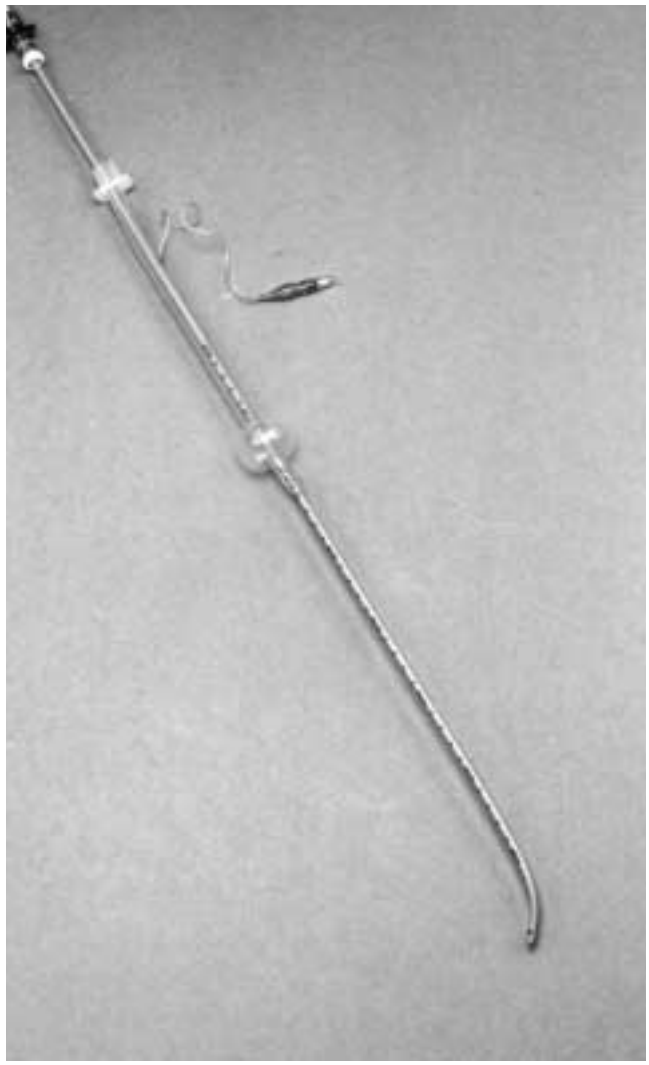

FIG. 1. The Frova Intubating Introducer from Cook Critical Care (Bloomington, IN).

approach to visualization intubation than does the standard fiberoptic approach. In addition, it may serve as an excellent teaching tool of intubation skills and monitor the amount of tracheobronchial secretions on line.

Lighted Stylets

The Trachlight™ (Laerdal Medical Corp., Long Beach, CA) consists of three parts: a reusable handle, a flexible wand, and a stiff, retractable stylet. It is especially useful in situations in which the FOB is unavailable (*e.g.*, in ambulances or emergency departments) or in which bronchoscopy is difficult to perform (*e.g.*, when an airway is obscured by blood or secretions or when the patient's head cannot be flexed or extended). However, as a blind technique, it should be avoided in patients with possible laryngeal fracture, pharyngeal masses, or with anatomic abnormalities of the upper airway. This device is provided with three stylets that are reusable and will accommodate tracheal tubes from

FIG. 2. The Aintree Airway Exchange Catheter™ from Cook Critical Care.

2.5 to 10 mm (ID).[4] It functions using the principle of transillumination. As the lighted stylet enters the trachea, transilluminated light remains bright and circumscribed. If the stylet enters the esophagus, the light is not easily seen as a translumination in the trachea. It is portable, easy to maintain, and relatively inexpensive.

The Ventus Seeing Eye Stylet System™ (American West Medical Co., Lenexa, KS) was recently developed to improve on the limitations of the standard flexible FOB. It has the simple form of a standard stylet plus the advantage of a fiberoptic view and maneuverability of its tip. Little time is needed for its preparation and use, and no special training is required. It can be used alone without difficulty and is especially useful for those unable to maintain skills with a bronchoscope.[5] For extremely difficult cases, the fiberoptic stylet can be used in combination with direct laryngoscopy or other airway devices and techniques.

The AeroView Endotracheal Scope System™ (Imagyn Medical Technologies, Newport Beach, CA) is a new portable fiberoptic management system that may be used for both difficult and routine airway management situations, as well as for teaching purposes. A lever controls its distal tip unidirectionally, and the view is projected to an endoview camera system. The scope is used with disposable sheaths, thus it does not

come into contact with the patient, and is considered to have lower maintenance costs than the more conventional flexible fiberoptic scopes.

Rigid Laryngoscopes

Modifications of traditional laryngoscope blades are primarily designed to overcome certain difficult airway problems, such as limited mouth opening, an "anterior larynx," sternal space restriction, a small intraoral cavity, and an immobile or unstable cervical spine.

The Flexibater Adjustable Laryngoscope™ (Arco Medic Ltd., Omar, Israel) is similar in shape to a MacIntosh laryngoscope, but the distal tip changes its shape according to the pressure that is placed on the trigger.

Flexible tip or levering laryngoscopes, such as CLM laryngoscopes™ (Mercury Medical, Clearwater FL; Fig. 3), are designed with a hinged tip controlled by a lever at the proximal end and are very useful in patients with a recessed mandible and decreased mouth opening. The risk of tooth damage caused by clinicians levering back with the laryngoscope on the teeth is decreased. A lever controls the tip angle through 70° during intubation to lift the epiglottis, if necessary, to improve laryngeal visualization.[6]

Straight laryngoscopes continue to be modified in design, and there has been a resurgence of interest in their routine use for tracheal intubation. The Henderson laryngoscope (Karl Stortz Gmb & Co., KG, Tuttlingen, Germany) has an improved tip and light, as well as a larger cross-sectional area, which facilitates passage of an 8-mm (ID) ET. When used with the paraglossal technique, a better view is obtained, yet at the expense of less space in which to manipulate an ET.[7] It is a very powerful device when combined with an intubation catheter.

The X-Lite Video Set™ (Rusch Inc., Duluth, GA) includes MAC laryngoscope blades, a handle with an integrated video camera and control unit with an LCD screen, and a xenon light source. The wide-angle camera allows excellent visualization and video documentation of laryngoscopy and intubation. Extreme positioning of the head is unnecessary.

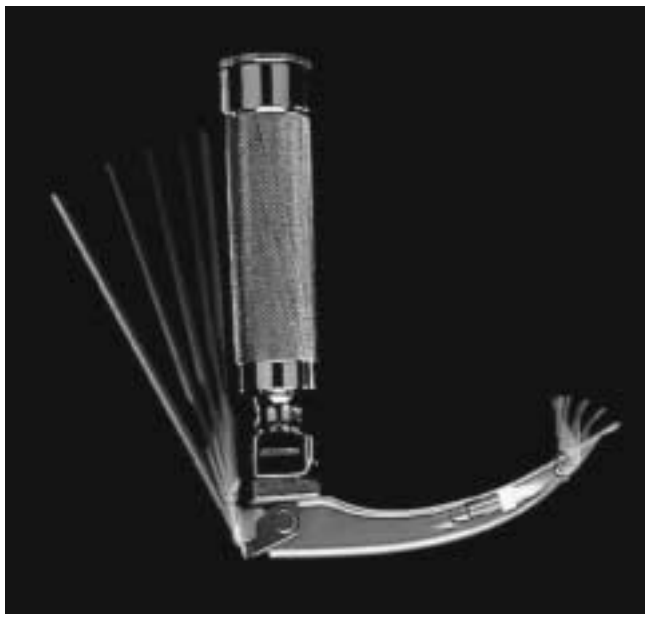

FIG. 3. The CLM Laryngoscope™ from Mercury Medical.

Indirect Rigid Fiberoptic Laryngoscopes

These laryngoscopes were designed to facilitate tracheal intubation in the same population as those considered for flexible fiberoptic bronchoscopy, such as patients with limited mouth opening or neck movement. Compared with the flexible FOBs, they are more rugged in design, control soft tissue better, allow for better management of secretions, are more portable (with the exception of the new portable FOBs), and are not as costly. Intubation can be performed *via* the nasal or oral route and can be accomplished in awake or anesthetized patients.

The Bullard Elite Laryngoscope™ (Circon, ACMI, Stamford, CT) is the most recent version of the Bullard laryngoscope and is the only indirect fiberoptic laryngoscope that incorporates attachable metal stylets for use. It can also be used with a conventional laryngoscope handle. It also has a working channel for oxygen insufflation, suction, and instillation of local anesthetics. It is available in both adult and pediatric sizes (newborn–infant and child). Six methods of intubation using it have been described.[8,9]

The UpsherScope™ (Mercury Medical, Clearwater, FL) is the simplest in design in this category.[10] Unlike the Bullard, there are no detachable stylets or extra ports, but rather a C-shaped delivery slot along the right side of the instrument. Although only an adult size is available, a pediatric version is being developed.

The WuScope™ (Pentax Precision Instrument Corp., Orangeburg, NY) is conceptually similar to both the Bullard laryngoscope and UpsherScope.[11] It has a handle, an anatomically designed blade, a fiberoptic view port, and a port for oxygen insufflation. The blade portion has three detachable stainless steel ports that require assembly. The fiberoptic mechanism consists of a fiberoptic rhinolaryngoscope Achi LA-SI. This feature accounts for its better visualization capacity and higher cost compared with the two aforementioned scopes.

Supraglottic Ventilatory Devices

The Cuffed Oropharyngeal Airway™ (COPA, Mallinkrodt Medical, St. Louis, MO) is an inexpensive, disposable device that combines a Guedel airway with an inflatable distal high-volume, low-pressure cuff and a 15-mm proximal adapter. Choosing the appropriate size beforehand and attaching the rubber head straps before cuff inflation are essential to successful use of the device. The correctly sized COPA is usually one or two sizes larger than a regular Guedel-type oral airway. It is designed to create an effective airway without stimulating the larynx and can be used when facemask ventilation has proved difficult,[12] as an adjunct to fiberoptic intubation,[13] and with positive-pressure ventilation.[14] Because the COPA does not protect the airway from regurgitation and aspiration, it is contraindicated in nonfasting patients and those who may have a full stomach or history of reflux. In addition, like the LMA, it can be used as a "bridge to extubation" at the end of surgery.

The Laryngeal Mask Airway™ (LMA; LMA North America, San Diego, CA) is the single most important development in airway devices in the past 20 years. Since its introduction into clinical practice, it has been used in more than 100 million patients worldwide with no reported deaths.[15] Although originally developed for airway management of routine cases with spontaneous ventilation, it is now listed in the ASA Difficult Airway Algorithm in five different places as an airway (ventilatory device) or a conduit for endotracheal intubation.[16] It can be used in both pediatric and adult patients in whom ventilation with a facemask or intubation is difficult or impossible. It also can be used as a bridge to extubation[17] and with pressure support or positive pressure ventilation.[18] Several new variants of the LMA Classic (standard LMA) are available, including the LMA Flexible (wire reinforced flexible LMA), LMA Unique (disposable LMA), LMA Fastrach

FIG. 4. The LMA Proseal from LMA North America.

(intubating LMA), and, most recently, the LMA Proseal (gastric LMA; Fig. 4). The Proseal[19] was designed with a modified posterior cuff to improve the laryngeal seal. It incorporates a second tube to provide a channel for gastric tube placement or passage of regurgitated fluid. It is postulated that the Proseal will replace the Classic LMA, because it is designed to provide a better seal and to protect the airway against aspiration.

The Esophageal Tracheal Combitube™ (Tyco-Kendall, Mansfield, MA) is a disposable double-lumen tube that combines the features of a conventional ET and that of an esophageal obturator airway. It has a large proximal latex oropharyngeal balloon and a distal esophageal low-pressure cuff with eight ventilatory holes in between. Ventilation is possible with either tracheal or esophageal intubation. Although the Combitube

can be inserted blindly, laryngoscopy may be performed to enhance placement of the device. It can be used in patients taller than 4 feet in elective or emergent situations, both in and out of the hospital environment.[20,21] Like the Proseal, the Combitube should protect against aspiration.[22] It is especially useful for patients in whom direct visualization of the vocal cords is not possible, as in patients with massive airway bleeding or regurgitation, limited access to the airway, and in patients in whom neck movement is contraindicated. Two adult sizes are available, and a pediatric version is being developed.

The Laryngeal Tube™ (LT, VBM Medizintechnik GmbH, Sulz, Germany) is a newly developed, multiuse, latex-free, single-lumen silicon tube with oropharyngeal and esophageal low-pressure cuffs, a ventilation outlet in between, and a blind distal tip (almost like a single-lumen, shortened Combitube). Ventilation and oxygenation capabilities are similar to the LMA and Combitube.[23] Simple handling and possible aspiration protection are considered to be the advantages of this airway device.

The Pharyngeal Airway Xpress™ (PA_X,Vital Signs Inc., Totowa, NJ; Fig. 5) is a sterile, latex-free, single-use airway device intended for use during routine anesthesia procedures. It is curved tube designed with an anatomically shaped gilled distal tip, a large oropharyngeal cuff, and an open "hooded window" that allows ventilation in between. This airway is placed blindly, without the aid of any instrument, and when positioned correctly should provide a more effective seal than the LMA.

The GO_2® Glottic Aperature Seal Airway™ (Augustine Medical, Eden Prairie, MN; Fig. 6) is a newly developed, disposable, single-lumen airway that can achieve a highly effective seal against and within the laryngeal inlet.[24] It is inserted with the aide of a stainless steel insertion blade. The tip of the blade lifts the epiglottis to expose the glottic opening, and the blade's track guides the GO_2 airway into position. The GO_2 airway itself is a curved tube that incorporates a flexible plastic frame at its distal end, which is covered with a soft, compressible foam pad. A cuff lies beneath the pad, which can be inflated to improve the seal. A tab at the distal end of the GO_2 airway engages the blade track during insertion. Thus far, two adult sizes have been developed, and pediatric sizes are under consideration.

Special Airway Techniques

Flexible Fiberoptic Intubation

Flexible fiberoptic intubation is a very reliable approach to difficult airway management and airway assessment. It has more universal application than any other technique. It can be used orally or nasally for both upper and lower airway problems and when access to the airway is limited. It can be used in patients of any age and in any position. Technological advances, including improved optics, battery-powered light sources, better aspiration capabilities, increased angulation capabilities, and improved reprocessing procedures, have been developed.

Rescue techniques, such as placing a retrograde guide wire through the suction channel,[25] may be used if the glottic opening cannot be located with the scope or if blood or secretions are present. Insufflation of oxygen or jet ventilation through the suction channel may provide additional time when difficulty arises in passing the ET into the trachea.[26]

Retrograde Intubation

Retrograde intubation is an excellent technique for securing a difficult airway alone or in conjunction with other alternative airway techniques.[27] The technique is simple,

FIG. 5. The Pharyngeal Airway Xpress (PA_x) from Vital Signs.

straightforward, and should be a skill of every anesthesia care provider. It is especially useful in patients with cervical spine injuries, abnormal anatomy, or who have suffered airway trauma. Because the technique is performed blindly, it is important to exercise caution to avoid worsening any preexisting conditions. Unless the practitioner is experienced in this technique, it should not be considered in the "cannot intubate, cannot ventilate" situation. Recent advances in the technique include the introduction of the Arndt Airway Exchange Catheter™ (Cook Critical Care) and needle holder to the pre-

FIG. 6. The Glottic Aperature Seal Airway (GO_2)™ from Augustine Medical.

existing retrograde intubation set. The Arndt catheter will allow patient oxygenation if necessary during the procedure and is recommended for use with ETs 5.0 mm or larger.[28]

Transtracheal Jet Ventilation

Transtracheal jet ventilation is a well accepted method of ventilation during rigid and interventional bronchoscopy.[29] It is applied in rigid bronchoscopy with a specially designed jet valve and in fiberscopes in which the jet injector is attached to the suction channel without intervening tubing. It may also be used to prophylactically secure a difficult airway by placing a cricothyrotomy catheter or an airway exchange catheter into the trachea to establish effective ventilation before induction of anesthesia.[30] Jet ventilation should begin with 5 psi and is increased in increments of 5 psi until adequate chest excursion occurs. The Enk Oxygen Flow Modulator™ (Cook Critical Care; Fig. 7) is a new device that is recommended for use when jet ventilation is appropriate but a jet ventilator is not available.[31] The device consists of a short, noncompliant tube with several openings located at opposite sites in front of a syringe connecter, which is connected between a transtracheal needle or intravenous catheter and an oxygen delivery system flowing at a rate of at least 15 l/min. It allows manually controlled oxygen flow by performing intermittent occlusion of the openings.

FIG. 7. The Enk Oxygen Flow Modulator from Cook Critical Care.

Cricothyrotomy

Cricothyrotomy is a life-saving procedure, which is the final "cannot ventilate, cannot intubate" option in all airway algorithms, whether they concern prehospital, emergency department, intensive care unit, or operating room patients.

Needle cricothyrotomy should be performed with catheters at least 4 cm long and up to 14 cm in adults. The possibility of kinking of standard plastic catheters has led to the production of special 6-French emergency transtracheal airway catheters (Cook Critical Care).

Percutaneous cricothyrotomy involves using the Seldinger technique to gain access to the cricothyroid membrane. There are a number of commercial kits available. The Melker Emergency Cricothyrotomy Catheter Sets™ (Cook Critical Care) are very user friendly and soon will be produced with a durable, elastic, high-volume, low-pressure cuff in a 5-mm airway catheter.

Surgical cricothyrotomy is performed by making an incision through the cricothyroid membrane using a scalpel, after which an ET is inserted. This is the most rapid technique and should be used when equipment for the less-invasive techniques is unavailable and speed is of the essence.

Tracheostomy

Tracheostomy establishes transcutaneous access to the trachea below the level of the cricoid cartilage.[32] Emergency tracheostomy may be necessary when acute airway loss occurs in children younger than 6 years or children whose cricothyroid space is considered too small for cannulation, as well as in persons whose laryngeal anatomy has been distorted by the presence of pathologic lesions or infection.

Percutaneous dilatational tracheostomy is the most commonly performed tracheostomy technique, yet it is still considered invasive and can cause trauma to the tracheal wall. The Ciaglia Blue Rhino™ (Cook Critical Care) was recently developed to minimize this trauma, as its special coating facilitates dilation of the trachea entrance site and allows controlled percutaneous introduction of tracheostomy tubes. The device is recommended for use in conjunction with a Shiley PERC Tracheostomy Tube With A Tapered Distal Tip™ (Mallinkrodt Medical). This technique is not recommended for emergency tube placement in patients with an enlarged thyroid gland.

Translaryngeal tracheostomy is a newer tracheostomy technique that is also considered to be safe and cost-effective and can be performed at the bedside.[33] It may be beneficial in patients who are coagulopathic. The Fantoni translaryngeal tracheostomy technique is a less invasive technique and has few complications compared with the percutaneous dilatational tracheostomy technique because the stoma is performed outward and the tracheal rings are simply divaricated.[34] The stoma is made by a tracheal tube inserted into the mouth and pulled retrograde outside the neck through the larynx using a guidewire introduced into the trachea. Modified Fantoni technique involves the use of a FOB in place of the rigid tracheoscope, the insertion of a J-shaped wire, and the use of a small-diameter ET positioned coaxially to the original airway, to ventilate the patient during introduction of the tracheostomy tube.[33] Thus, there is no need for neck movement or periods of apnea. This technique may be advantageous in patients with serious hypoxemia, considered difficult to intubate, or who have cervical spine injuries.

Surgical tracheostomy is more invasive and should be performed in an elective manner and in a sterile environment. Nonemergent tracheostomies are performed for several reasons: inability to intubate patients with stable airways through a transoral or transnasal route, patients in whom prolonged intubation *(e.g.*, >2 weeks) is anticipated, and patients who have been intubated translaryngeally for more than 3 days.[32] Absolute contraindications to a tracheostomy do not exist because this is a lifesaving procedure; however, patients who may have an adverse outcome include those with a coagulopathy, an infection involving the fascial planes of the neck or paratracheal regions, and inability to extend their necks.[32]

Conclusions

Most airway problems can be solved with relatively simple devices and techniques, but clinical judgment born of experience is crucial to their application. As with any intubation technique, practice and routine use will improve performance and may reduce the likelihood of complications. Each airway device has unique properties that may be advantageous in certain situations yet limiting in others. Specific airway management techniques are greatly influenced by individual patient disease and anatomy, and successful management may require combinations of devices and techniques.

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