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REVIEW ARTICLE

Management of the difficult airway

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Airway management is the cornerstone of Emergency Medicine. The Emergency Physician (EP) must be able to protect the airway, oxygenate, and ventilate patients of all ages and sizes including those possessing multiple markers of potential difficult intubation. In many situations there will not be available backup for the EP and no possibility of deferring the procedure ("cancelling the case") due to the patient's extremis. Fortunately, experienced and trained EP's are able to achieve control of the airway in the vast majority of cases with sedation or rapid sequence intubation (RSI) with paralysis and direct laryngoscopy (DL). In this Review/Point of View report we will outline a method of preparation, approach, and use of equipment that should reduce the chance of an adverse or even catastrophic outcome in your practice. [Emergencias 2011;23:479-485]

Key words: Airway difficult. Emergency Medicine.

Introduction

Basic preparedness dictates that each Emergency Department (ED) is equipped for routine and difficult intubations in a room or rooms, or with moveable carts, that contain the necessary medications, equipment, oxygen, and suction and that appropriate personnel are immediately available when a patient presents unexpectedly needing airway intervention. There are a number of markers that can be used to predict a difficult airway and/or difficulty in ventilation via bag-valve-mask (BVM). These include the Mallampati classification; measurements of thyromental and interincisor distances; obesity; cervical spine immobility; large tongue; pregnancy; beard; etc. Unfortunately many ED patients present with the sudden need for an airway regardless of difficulty. Knowledge of adverse markers can at times suggest changes in intubating technique or equipment such as performing the intubation with sedation rather than RSI if the EP is concerned that BVM ventilation might not be possible.

An organized approach to the patient with a potentially difficult airway helps translate knowledge into practice and helps optimize the airway plan for each particular patient scenario. One simplified approach used by the authors is to first consider the list of "airway concerns" or factors determined by history or on exam to predict difficulty with airway management in the particular case. The impact of each airway concern is then considered in relation to the case and is used to develop the optimal primary, backup and rescue approach (PBR). Presence of a cervical collar/immobilization for example, can be considered as an "airway concern" because it prevents the optimal alignment of the airway axes, leading to potential difficulty with direct laryngoscopy. This concern may then translate into the early usage (primary attempt) of a video laryngoscope. The intent of this approach is to provide the highest chance for success on the "primary" attempt. This "PBR" approach is felt by the authors to be more practical and easier to remember than some of the complicated airway algorithms.

Although this paper reviews the management of the difficult airway we will mention a few simple tricks. Resuscitation rooms are very bright; reducing the ambient lighting lets the intubating physician's eyes adjust to the lower level of light in the hypopharynx during DL. In cases when the vocal cords are not visualized, attempting to first identify the epiglottis then position the blade tip

appropriately can help with orientation. Manipulation of the thyroid cartilage is best accomplished by the intubator placing his or her hand over the assistants so that when visualization is obtained position can be maintained. This technique is sometimes referred to as "bimanual", in contrast to the "BURP" (Backwards, Upwards, Rightward, Pressure) or Sellicks maneuvers. Albert Einstein said "insanity is doing the same thing over and over and expecting different results". When the EP's first attempt is not successful a natural tendency is to use the method that is historically best for the physician and try even harder to make it successful. It is preferable to remember change something before the next attempt—perhaps positioning the patient differently, using a different blade, or using an airway adjunct. This concept relates to the "PBR" plan described above and fits within the "backup" step, attempting to improve the likelihood of success on the second attempt. Each intubation attempt makes the next more difficult and increases the risk that edema or bleeding could make even bag-valve-mask ventilation difficult and intubation impossible.

It has long been recognized that positioning of the patient is instrumental in securing the airway (within the constraints of cervical spine immobilization and other special circumstances). EP's are accustomed to intubating immobilized trauma patients and usually secure the airway without great attention to position. Morbidly obese patients, however, mandate appropriate positioning. These patients' airway axes when supine constitute a near impossible visualization of the glottis but when "ramped" the axes often align producing a reasonably easy intubation as shown in Figures 1 and 2. This method, taught at our figure originally by Thomas Mort, MD has proven tremendously useful. Its importance cannot be overemphasized as a maneuver that can permit intubations which would otherwise not be successful.

Newer forms of equipment serving as adjuncts to intubation are becoming widely used in ED's. Each EP should be familiar with several devices whose use should be optimally learned and practiced in the Simulation Laboratory or the Operating Room prior to use in the clinical setting. The adjuncts should be used in routine intubations if possible and not reserved only for failures of DL when familiarity with methods and equipment is most crucial. Before any intubation is attempted the EP should formulate a plan with a primary approach, a back-up plan, and a rescue method that incorporates familiar devices. In order for the plan to be effective, it is vital that the appropriate

Figure 1. Morbidly obese patient supine on gurney. Note malalignment of airway axes.

Figura 2. Patient "ramped" with wedge of blankets below torso from pelvic brim to shoulders with head further placed in sniffing position. External auditory meatus is now nearly at level of sternum indicating appropriate position. Note greatly improved alignment of airway axes.(Photos courtesy of Thomas Mort, MD).

equipment readily at hand and not locked up or remotely stored. When difficulty is expected or occurs suddenly the assistance of another EP, anesthesiologist, or surgeon should be requested if available.

Beyond the standard laryngoscope we now consider a bougie (or gum elastic bougie, or tracheal tube introducer [TTI]) to be a necessary component of every ED's intubating supplies. Figures 3 to 6 show several bougies and demonstrate its use. We feel that the bougie is one of the most significant advances in emergency intubation since RSI. Equipment and skill to perform a cricothyrotomy is also necessary by either an open (preferred) or percutaneous method for any physician providing advanced airway manage-

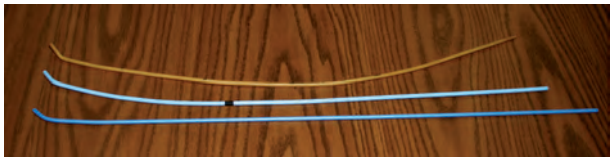

Figura 3. Three styles/brands of bougies.

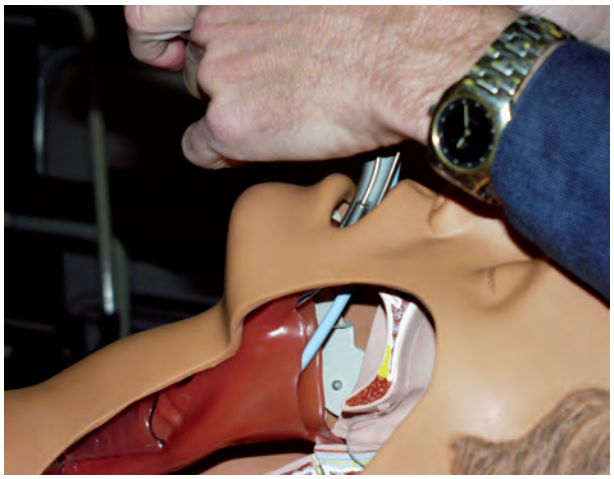

Figura 4. Laryngoscope in hypopharynx and bougie being passed through cords.

ment, particularly when using paralytics. While cricothyroidotomy may be considered the most definitive "rescue" airway, this category also includes the Combitube© or King LT© supraglottic devices. Also considered a "rescue" device and gaining widespread use in at least larger ED's is the intubating LMA (laryngeal mask airway).

The bougie was introduced to EM by Moscati, Jehle, and others[1]. It is an inexpensive, non-electronic, unbreakable adjunct that can convert a very difficult intubation into a successful procedure via a Seldinger-like technique. As shown in Figure 3, the bougie is slightly flexible with an angled-tip. If one can visualize even a portion of the arytenoids the bougie is relatively easily passed through the cords and in cases where only the epiglottis is seen intubation will be successful 85 percent of the time versus 44% when the ETT (ETT) is passed blindly[2]. Proper passage down the trachea is typically associated with a very recognizable "washboard sensation" produced as the tip passes over the rings of the trachea. The ETT is then loaded onto and passed over the bougie into the trachea. The tip of the ETT may be obstructed on structures such as the epiglottis, arytenoids or vocal cords. Because of this, there are four "tricks" which can be used to ease the passage of the ETT along the bougie and through the glottis. First, lubrication can decrease the resistance of the contact between the bougie and

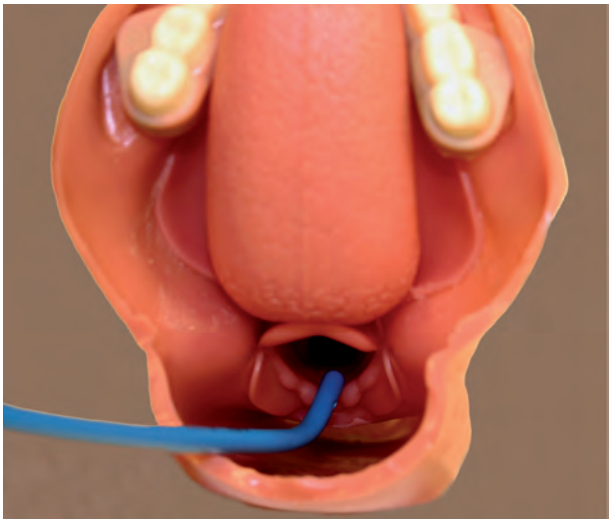

Figura 5. Intubator's view with laryngoscope removed to show bougie passing through vocal cords.

Figura 6. Endotracheal tube being passed over bougie through cords.

the ETT. Second, elevation of the mandible and tongue with the laryngoscope or manually can open the airway and facilitate easy passage of the tube through the cords (Figure 6). Straightening the bougie allows the force applied to the ETT to move it smoothly to the glottis rather than kinking the bougie when it is held with a 90 degree bend in the patients mouth. Finally, it is important to note that if resistance is met and the tube does not pass easily it is typically because the tip of the ETT is caught on one of the anatomic structures and it should be withdrawn several centimeters, rotated 90 degrees counterclockwise, and then passed again.

Blind nasotracheal intubation was once the mainstay of intubation in the field and in the ED, successful about 80% of the time in the spontaneously breathing patient. Nasotracheal intuba-

tion augmented with the use of a fiberoptic intubating scope has supplanted the older technique and is much more successful. To maximize first look passage the patient's nasal mucosa should be anesthetized and vasoconstricted; nebulized lidocaine administered; and most importantly the nasotracheal tube should be pre-positioned by passing it blindly "around the corner" so that it rests 2-3 cm above the cords before introducing the fiber-optic scope. Remember the contraindications of coagulopathy and midface and basal skull fracture.

The Combitube© or King© supraglottic devices are ideal "rescue" devices in situations where the EP is not an experienced intubator, where the patient is hypoxic and cannot be quickly intubated, and where the EP wishes to avoid cricothyrotomy. These devices were designed to be learned by paramedics in a mannequin laboratory and used in patients. The few steps in the procedure are rote and straightforward and result in a patent airway with normal oxygenation and ventilation in most cases. Aspiration is also limited. The resultant airway is stable for several hours but must be eventually replaced either by a surgical airway or by a more experienced operator intubating from above.

The ability to perform a surgical airway should be learned in the Simulation and Animal Laboratories and is beyond the scope of this review. Our recommendation for an emergent cricothyrotomy is the open surgical technique. The percutaneous methods are excellent if the anatomy is not distorted. However, emergency department patients requiring cricothyrotomy often have anatomical features that make both intubation and cricothyrotomy difficult such as obesity, short neck, and at times distorted anatomy due to injury and/or hematoma. In these patients finding the tracheal lumen percutaneously is difficult but much easier once the neck incision has been made, favoring the open surgical approach. In addition, percutaneous methods can actually be slower[3]. A recent change in our technique that facilitates the procedure is using the tracheal hook to penetrate the cricothyroid membrane before (previously it was done after) it is incised. The hook is used to bring the membrane closer to the surface and stabilizes it for incision, dilation, and tube passage. Another recent addition to percutaneous cricothyrotomy is the use of the bougie used as an introducer after the cricothyroid membrane is incised and dilated. This facilitates passage of an ETT particularly but also is helpful with a tracheotomy tube.

The intubating LMA (ILMA) is an excellent airway device that can serve as a "backup" or "rescue" device providing both ventilation and as a conduit to endotracheal intubation. In the paralyzed patient it protects against passive regurgitation and aspiration moderately well. When properly seated in the hypopharynx blind intubation can be achieved more than 80% of the time with the supplied reinforced ETT and with an even higher success rate when combined with the use of a fiber-optic scope. The steps must be learned and practiced in the Simulation Laboratory and if possible in the Operating Room.

Technologic advances over the past decade have led to the development of many new airway devices including the modern video/optical laryngoscope (VL). These devices use various methods including fiberoptics, prism/lens systems and camera technology to essentially move the practitioner's eye to the tip of the laryngoscope. These devices have been very successful in overcoming the challenge of visualization with a direct laryngoscope when the tongue and soft tissue limit the direct line of sight experienced in some difficult airway situations.

One method of categorizing video laryngoscopes is to consider the technique by which the ETT is advanced through the vocal cords. The first category includes those devices depending on the "free hand" passage of the ETT through the glottis as practiced during traditional intubation with a direct laryngoscope. The Glidescope, Storz Video Mac and McGrath Video Laryngoscope are examples of devices in this category. The second category includes devices that are designed with some type of "guiding track", channel, or wire, to help navigate the ETT through the vocal cords. The Airtaq, Bullard Scope and Pentax AWS are examples of devices in this group. It cannot be stressed enough that these devices have their own unique design characteristics leading to the need for specific initial training and ongoing skill maintenance in order to safely and effectively use them.

The "free hand devices" are often intuitive for experienced clinicians because of their similarity to DL with respect to passing the ETT. Insertion technique, head position and device maneuvering do differ from traditional technique. Proper use of the "guiding track" category of devices require understanding that the device must be properly positioned relative to the glottis prior to advancing the ETT through the vocal cords. In this group, the device is what directs the ETT and therefore the device must be in proper position. The "guiding track" device differs from both tradi-

tional DL and the "free hand" devices because the ETT is guided by the hand controlling the device independent from the tube.

Video laryngoscopes can also differ with respect to the design of their blade architecture. Some video/optical laryngoscopes such as the Storz Video Mac are very similar to traditional Macintosh or Miller architecture. Other VL's such as the Glidescope utilize hyper-angulated blades and others have shorter 900 blades such as the Airtraq. Hyperangulated blade angles are designed to allow better visualization of the "anterior airway". Visualization can often be improved when compared to traditional DL; however a matching stylet angle or specialized stylet may be necessary to allow the clinician to navigate the ETT to the glottis.

High cost may limit access to modern video laryngoscopes in the emergency department. Fortunately some are produced as less expensive single use devices such as the Airtraq Optical Laryngoscope amongst others. Cost therefore can impact the way these devices are incorporated into EM airway algorithms. Teaching institutions often use these devices with a large connected video screen to allow students/residents to share the operator's view with instructors or observers. This method can allow "real time" corrective maneuvers by the instructor rather than having to depend on verbal descriptions of the laryngoscopic view and "taking over" the case. Beyond teaching, these video laryngoscopes are demonstrated to increase intubation success in some difficult airway cases.

Video laryngoscopes are becoming more prevalent and serve as a step forward when managing the difficult airway. A few specific design differences and considerations are discussed, however the proper selection and implementation into a clinical setting requires consideration of several variables including teaching use, operator preference and cost. The authors' institution has chosen to use a combined approach with two of the video laryngoscopes mentioned previously, one from the "free hand" category – the Storz Video Laryngoscope (or Video Mac) and one device from the "guiding track" category – the Airtraq Optical Laryngoscope. We will discuss a few of the considerations when using these particular devices.

The Storz Video Laryngoscope utilizes similar blade designs to the standard Macintosh and Miller blades that are familiar to most airway providers thus can be easily used with familiar technique. When used as a DL, the intubator still gains the benefit of this device's very bright light source. The authors have found this permits better visualization compared to most battery operated, hand held standard laryngoscopes. This device is selected at our training institution for a majority of intubations. Novice laryngoscopists are encouraged to use the device as a direct laryngoscope while the instructor observes their view from the video screen as a teaching tool. Oropharyngeal secretions (or blood in the trauma patient) can coat the fiberoptic bundle at the tip of the blade leading to an obstructed view. In order to minimize this difficulty, it is helpful to deeply suction the airway prior to inserting the device. This "advanced suctioning" is not always common practice when using a standard laryngoscope because a small volume of secretions in the oropharynx can be suctioned after the blade is in proper position without harming the view. Application of a defogging solution to the fiberoptic bundle at the tip of the blade helps prevent loss of view on the video screen. The device can also be used primarily as a video device where the laryngoscopist watches the video screen during intubation rather than looking directly at the glottis through line of sight visualization. This is advantageous because the fiberoptic bundle is located at the tip of the blade and can allow visualization of a relatively "anterior airway" that might not otherwise be visualized by line of sight. This technique requires somewhat different hand-eye coordination and requires practice.

The Airtraq Optical Laryngoscope is a portable single use device that at the authors' institution is reserved for patients in which laryngoscopy is anticipated to be difficult. This device can be inserted with the patient's head in neutral position, in midline – differing from the insertion technique with a Macintosh laryngoscope blade (Figure 7) Because this device has a large prism lens at the tip of the blade, the authors have found it to be less effected by secretions and blood with respect to visualization. Preloading and lubricating the ETT are important prior to intubation. The blade of the Airtraq can be positioned either into the vallecula or under the epiglottis and still allow passage of the ETT. Once positioned, the device typically requires less force applied to the laryngoscope to obtain visualization of the glottis compared to direct laryngoscopy[5,6]. The laryngoscopist can visualize either through the device's built in eye piece or through an available teaching camera head that can be displayed onto a video screen. Positioning of this device is critical, with the initial goal of centering the vocal cords in the

field of view. Obtaining this view is important because the "guiding track" will aim the ETT through the center of the field of view. Without training and practice, many laryngoscopists will tend to ineffectively try to aim the ETT with their free hand. Because the ETT is held into the guiding track of the device, moving the proximal end of the ETT does not lead to a change of position of the tip of the ETT – this can be frustrating when not understood by the intubator. Once the vocal cords are centered in the field of view, the ETT can be advanced down the guiding track with the free hand and can be visualized as it passes through the vocal cords. The authors' and others have studied this device and believe that with proper training, it can be an effective tool particularly for those patients with cervical immobilization or in whom DL is predicted to be difficult[7]. Some authors also believe that the learning curve with this device may not be as steep compare to other devices[8,9].

When approaching the patient who appears to be potentially a difficult intubation or when suddenly confronted with that situation it is crucial for the EP to have equipment readily available and be prepared to alter his/her plan quickly if the first attempt fails. Better positioning of the patient, changing of blades, or help with manipulation of the thyroid cartilage may suffice to make a "backup" or second attempt successful, particularly if combined with usage of the bougie. But, if the "primary" or first attempt was unsuccessful the second attempt will often be difficult; if it fails the third attempt requires a major change in approach including use of airway adjuncts. The primary determinant of approach after a failed first attempt is the response to immediate rescue with BVM ventilation. If the patient's oxygenation can be maintained with bag-valve-mask ventilation, it is likely safe to attempt a "backup" plan and many adjuncts can be used but if the patient is hypoxic a "rescue device" or technique must be initiated.

The choice of rescue device is primarily amongst the supraglottic devices (ILMA, Combitube©, or King LT©) and cricothyrotomy and is dependent on patient characteristics and on the skill set and experience of the operator. Relative contraindications to supraglottic devices relate to trauma, infection, tumor, and burns involving the hypopharynx. In some patients with these findings a supraglottic device can be quickly placed and will actually ventilate better than the bag-valve-mask and can thus serve as a bridge to cricothyrotomy. When aspiration risk is high or there is an expectation of a need for high peak inspiratory pressures the ILMA may be less desirable than the Combitube© or King LT© devices but in most other circumstances the experienced operator will select the ILMA, a rescue device that facilitates endotracheal intubation once the patient is stabilized.

Figura 7. Videolaringoscope.

In the patient who can be oxygenated, the choice of "backup" method is broader including devices such as the bougie, ILMA, and video laryngoscopes if available. If the patient is able to spontaneously breath, fiberoptic nasotracheal intubation is excellent and in some circumstances the fiberscope can be used to facilitate either nasal or oral intubation.

Conclusion

The Emergency Physician must be prepared to achieve control of the airway in many types of patients with varying conditions and disease states. It is important to be familiar with basic airway measures and to possess the knowledge and equipment for alternate approaches with airway

adjuncts. Our recommendation is that each EP, if possible, be prepared to use a bougie; Combitube© or King© supraglottic device; a fiberoptic or ILMA device, and have the knowledge and equipment to perform a surgical airway. Incorporation of these devices into a specific and customized airway plan for the particular clinical scenario such as through the "PBR" approach can help achieve the goals of rapid control of the airway with minimal complications.

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Manejo de la vía aérea difícil

Smally AJ, Nowicki TA

El manejo de la vía aérea es la piedra angular en la Medicina de Urgencias y Emergencias (MUE). El *urgenciólogo* debe ser capaz de proteger la vía aérea, oxigenar y ventilar a cualquier paciente indistintamente de la edad o la superficie corporal, incluyendo aquéllos que poseen múltiples factores predictivos de una intubación potencialmente difícil. En muchas situaciones los *urgenciólogos* no tendrán disponibilidad de un plan "de apoyo" y no habrá posibilidad de diferir el procedimiento debido a que el paciente se encuentra al borde de la muerte. Afortunadamente, la formación y la experiencia de los *urgenciólogos* les hace capaces de conseguir, en la gran mayoría de los casos, un control de la vía aérea mediante sedación o con una secuencia rápida de intubación (SRI) con miorrelajantes y laringoscopia directa (LD). En el presente artículo, revisaremos la preparación, el abordaje y el uso del equipo que debería disminuir la posibilidad de un evento adverso o incluso un resultado catastrófico en la práctica clínica. [Emergencias 2011;23:479-485]

Palabras clave: Vía aérea difícil. Medicina de Urgencias y Emergencias.