Journal of Emergency Medicine, Vol. 2, No. 1: 33-42

"Difficult Airways" management
(principles, equipment, techniques)

Luca Vasilescu*

Abstract

Key points in upper airways management are knowledge of anatomy and physiology with a special concern for innervation, anticipation of technical problems based on assessment of airway, and finally, decision making based on clinical circumstances. Problems are encountered with "difficult airways" and this is the reason why focus is on defining and managing this issue. Airway instrumentation is a powerful noxious stimulus and therefore adequacy of using different techniques and devices is challenging for the practitioner that has to put in balance circumstances, indications and contraindications. Reviewing the available equipment and the technical clues for using it is one of the main purposes of this article in order to collect for the specialist useful information. Possible complications and adverse physiologic responses have to be kept in mind and prevented and by this minimize their incidence. (Revista de Medicină de Urgenţă, Vol. 2, Nr. 1, 33-42)

Key Words

airway management, supraglottic ventilatory devices, difficult intubation

Introduction

Responsibility of providing adequate ventilation for the patient is of paramount importance. Airway management is a primary goal for the critical care practitioner. A patient in need for an attitude directed towards a functional and secure airway represents an urgent to emergent situation. Indications for endotracheal intubation can be summarized in four categories: 1. acute airway obstruction; 2. loss of protective reflexes; 3. excessive pulmonary secretions; and 4. respiratory failure [1]. The fundamental principle *Primum non nocere* keeps value and governs any action conducted in this regard. Circumstances are always critical and represent a challenge for the specialist. Prompt and proper decision of the maneuver to be performed should consider the following parameters.

1. Adequacy of actual ventilation (gas exchange)
2. Hypoxia duration
3. Patency of airway and cough presence
4. Need for neuromuscular blockade (muscle tone, teeth clenching, severe obstructive pulmonary disease, etc.)
5. Cervical spine stability
6. Safety of technique and level of expertise (skill of operator)
7. Available equipment and circumstances

The initial choice may succeed or not. If it fails difficulty rises precipitously, time becomes critical, anxiety increases, and error potential compounds, making the risk of irreversible hypoxic injury progressive. In this situation, anticipation and experience are invaluable.

Forethinking has a key role in airway management and is closely linked to initial assessment and continuous monitoring.

In this regard, detailed knowledge of airway anatomy and physiology is mandatory.

Anatomy and physiology – Key Points

Nose and nasal cavity as the primary pathway for normal breathing have the important function of air humidification and warming. During quiet breathing, the resistance to air flow through nasal passage accounts for two thirds of total airway resistance and is twice that associated with oral breathing.

Pharynx: "U" – shaped fibro-muscular structure that extends from the base of the skull to the distal level of the cricoid cartilage, conventionally bounded in: **Nasopharynx** continuing the nasal cavity to the level of the soft palate, **Oropharynx** continuing the oral cavity from the level of the soft palate to the epiglottis and **Laryngopharynx (Hipopharynx)** from the epiglottis to the vocal cords.

Larynx: cartilaginous skeleton held together by ligaments and muscles, composed of 9 cartilages (epiglottic, thyroid, cricoid and (in pairs) arytenoid, corniculate and cuneiform), extended between the level of cervical vertebrae C3-C6.

Trachea Tubular structure, flattened posteriorly, that begins opposite to the sixth cervical vertebra at the level of the cricoid cartilage. It is supported along its 10-15 cm length by 16-20 horseshoe-shaped cartilages to the bifurcation at the carina at the level of the fifth thoracic vertebra**.**

Innervation: Sensory supply to the upper airway is derived from the cranial nerves. Nasal mucosa is inervated anteriorly by the **anterior ethmoidal nerve** originating in

* MD, Emergency Department, Bucharest Emergency Clinical Hospital, Calea Floreasca 8, Sector 1, Bucharest, e-mail: luca.v @dnt.ro

Abbreviations:
ABG – arterial blood gas
CPR – cardio-pulmonary resuscitation
COPA – cuffed oro-pharyngeal airway
ED – emergency department
ETC – esophageal- tracheal-Combitube
ETT – endotracheal tube
FOB – fiberoptic bronchoscope
LMA – laryngeal-mask-airway
TMJ – temporo-mandibular joint

Recieved December 6, 2004, accepted February 17, 2005.

the ophthalmic division (V_1) of the trigeminal nerve and posteriorly by the **sphenopalatine nerves** originating in the maxillary division (V_2). The **palatine nerves** provide sensory fibers from the trigeminal nerve (V) to the hard and soft palate. The **lingual nerve**, branch of the mandibular division (V_3) of the trigeminal nerve and the **glossopharyngeal nerve (IX)** provide general sensation to the anterior two thirds respectively posterior third of the tongue. The **glossopharyngeal nerve (IX)** also innervates the roof of the pharynx, the tonsils and the undersurface of the soft palate. The **vagus nerve (X)** provides sensation to the airway below the epiglottis, to the larynx, by the **internal laryngeal nerve** and the **recurrent laryngeal nerve**, above and below the vocal cords respectively [2, 3, 4].

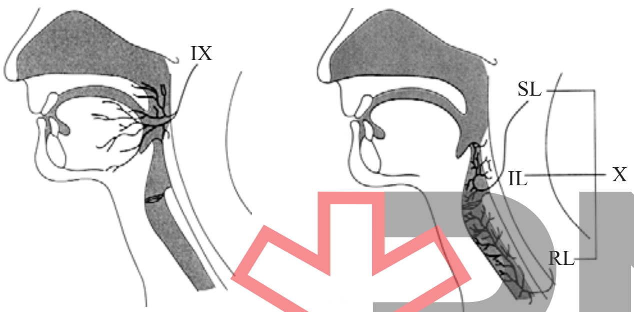


Fig. 1 Upper airway innervation. IX- glossopharyngeal nerve; X- vagus nerve; SL- superior laryngeal nerve; IL- internal laryngeal nerve; RL- recurrent laryngeal nerve

Airway assessment for difficult intubation

It is obvious that emergent intubation (i.e. apnea) leaves no time for evaluation and optimizing conditions**.** In urgent and elective situations**,** air exchange allows, more or less thorough assessment of patient's clinical situation, intravascular volume status, hemodynamic stability and airway evaluation in order to formulate a coherent airway management plan. Anticipation of the eventuality that mask ventilation or glottis visualization is difficult and even impossible will suggest if alternative techniques to direct laryngoscopy will be necessary and if a more experienced individual should be called for help. Systematic evaluation involves reviewing of the following anatomic modifications and factors [2, 5, 6]:

- general (obesity, kyphoscoliosis),
- head shape - abnormal (microcephaly, hydrocephalus),
- neck: possible cervical spine injury, short neck, neck mobility limitation (less than 35° flexion or extension) acquired by prior surgery, arthritis or immobilizing devices,
- face: micrognathia, retrognathia, surgical scars, facial trauma, and/or nasal, oral and pharyngeal bleeding, small nares, facial pilosity (bearded patients) that makes mask ventilation difficult or is hiding previous problems,
- mouth: limited opening by temporomandibular joint disease, scars, scleroderma, tetanus. Also long or prominent incisors may limit the normal, 2 or even 3 fingerbreadth, mouth opening. High arched palate is also associated with difficult glottis access.
- tongue and pharynx: tongue size relative to posterior pharynx evaluates the possibility of glottis visualization. Based on this the Mallampati classification describes the relative room within the pharynx linked with the ability of the examiner to visualize the soft palate, the fauces, tonsillar pillars and uvula when the patient has an open mouth and protruded tongue. The main shortcoming is that test is more appropriate for conscious and cooperative patients that can be asked to protrude the tongue without phonating,

MALLAMPATI CLASS	VISIBLE STRUCTURES
Class I	Soft palate, fauces, uvula, tonsillar pillars
Class II	Soft palate, fauces, uvula
Class III	Soft palate, base of uvula
Class IV	Hard palate only

- jaw: short thyromental distance (Patil's distance) - distance that estimates the length of the mandible and the available space anterior to the larynx. Less than 3 fingerbreadth (aproximately 6 cm) between the anterior prominence of the thyroid cartilage and the tip of the mandible indicates that the larynx may appear more anterior and consequently more difficult to visualize and to enter during laryngoscopy.

These predictors are derived from current anesthesiology practice and cannot be simply extrapolated in other conditions such as field or ED or even ICU where circumstances (space and light) are less favorable.

Direct Laryngoscopy

Is the most common method of endotracheal tube (ETT) placement due to its speed and high success rate but occasional, previously mentioned situations, make this difficult to achieve.

In patients with anatomic abnormalities, frequently more than 2 intubation attempts are needed. This situation accounts for approximately 5% of the general population and direct laryngoscopy is impossible in 0.2 to 1% or even more in the emergency setting [4,5]. Focus should be kept on technical clues, like positioning of the patient with abnormal body habitus (obesity, pregnancy, kyphoscoliosis) and external laryngeal manipulation by directing the cricoid and thyroid cartilages with backward, upward, rightward pressure ("burp"- maneuver), that may improve the laryngoscopic view.[5]

Difficult Airway Algorithm

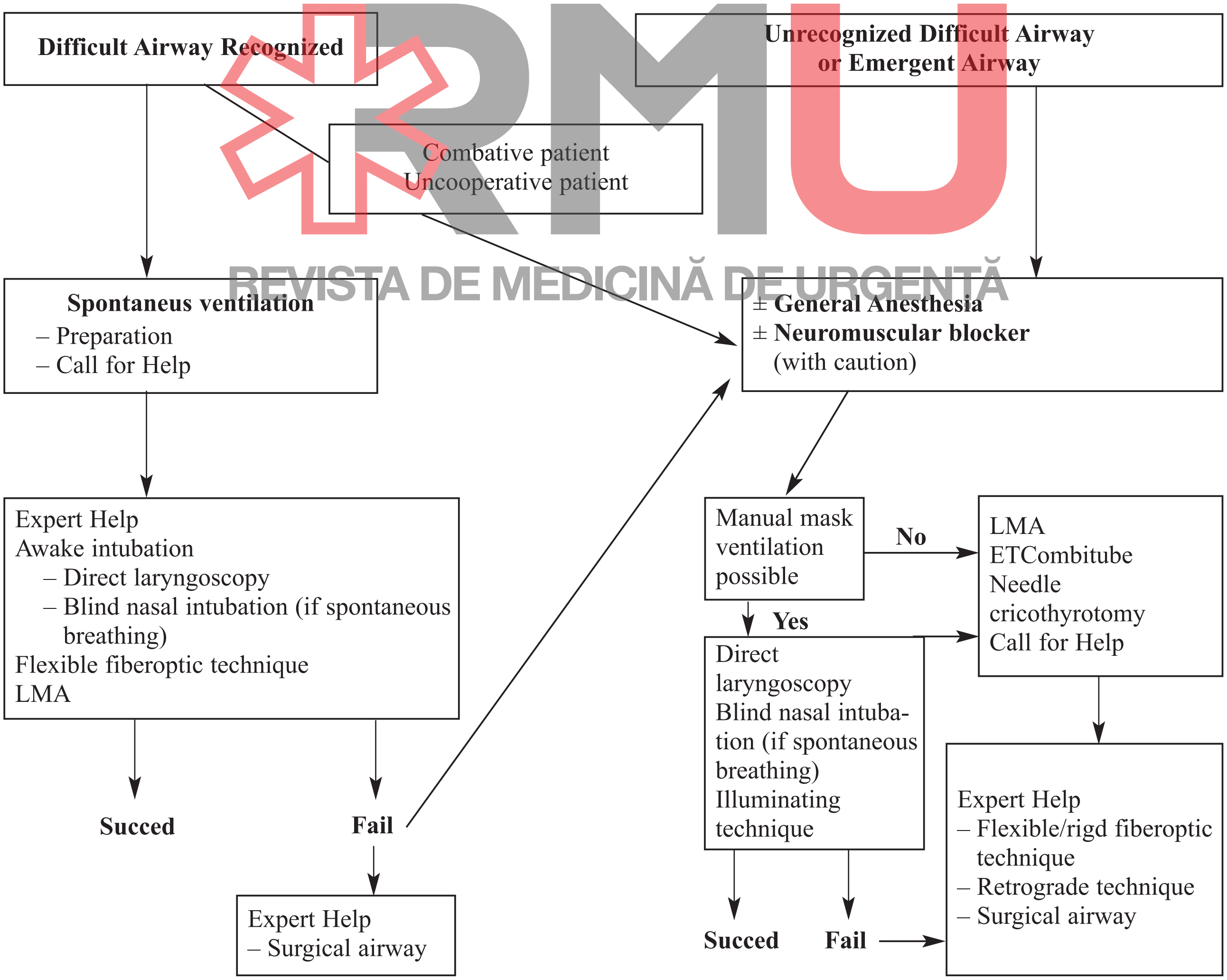
If systematical evaluation is pleading for a difficult airway and if the circumstances allow, options for securing the airway other than by direct laryngoscopy and obtaining another expert opinion should be considered. Avoiding or minimizing the risk of the critical situation "can't intubate, can't ventilate" is the mainstay of any decision to be taken. In this regard, the American Society of Anesthesiology developed an algorithm for managing potential or confirmed difficult airway. Even if focus is on operating room circumstances, the principles are suitable for any critical care situation.

Considering the presence or absence of spontaneous ventilation, the management options are [2,5]:

1. Spontaneous ventilation present or ability to control ventilation assured
   - Awake intubation by direct laryngoscopy or blind naso-tracheal intubation
   - Laryngeal mask airway (LMA) (guided)
   - Indirect laryngoscopy
   - Flexible fiberoptic intubation
   - Retrograde/ guidewire techniques
   - Awake tracheostomy
2. No spontaneous ventilation, visualization of the glottis and mask ventilation impossible
   - LMA, Cuffed Orofaringeal Airway (COPA), Esophageal Tracheal Combitube (ETC)
   - LMA guided intubation
   - Needle cricothyrotomy, insuflation or jet ventilation
   - Percutaneous or surgical cricothyrotomy/ tracheostomy

Early decision shift towards these alternative methods avoids repeated failed intubation attempts leading to pharyngeal bleeding and periglottic edema with potentially catastrophic results.

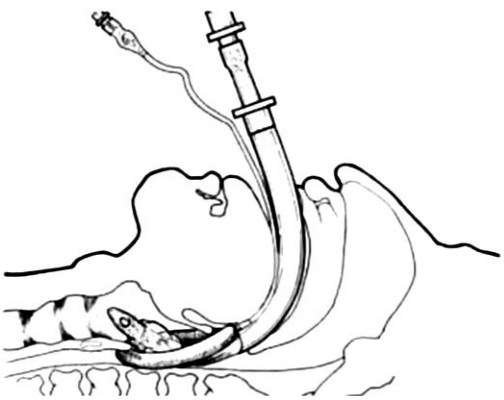
Fig. 2 Difficult airway algorythm (modified from [2, 5])



Airway adjuncts – Supraglottic ventilatory devices

Laryngeal mask (LMA) is used in place of a face mask or endotracheal tube to facilitate ventilation; to facilitate passage of an ETT or of the bronchoscope; to aid in ventilation during fiberoptic bronchoscopy (FOB). Standard reusable LMA is autoclavable and made of silicone rubber (latex-free). It consists in a wide bore tube with a proximal standard 15 mm connector and whose distal end has an elliptical cuff that can be inflated through a pilot tube. The cuff is designed with aperture bars to prevent the epiglottis from occluding the lumen of the device. The deflated cuff is inserted with the index of the dominant hand, blindly in the pharynx behind the tongue so that, once inflated, the cuff forms a low-pressure seal around the entrance into the larynx. This requires an anesthetic depth greater than that required for the insertion of an oral airway (Guedel). The requirement for adequate anesthesia makes the LMA generally unsuitable for use in the conscious emergency room patient. An ideally positioned cuff is bordered by the base of the tongue superiorly, the pyriform sinuses laterally, and the upper esophageal sphincter inferiorly. It is important to check if the cuff is correctly positioned by capnography as well as by pulmonary auscultation and visualization of the air movement through the tube [3, 4, 6].

Fig. 3 Laryngeal Mask Airway



Insertion of LMA has the following technical clues [4]:

- Choose the appropriate size (see table)
- Check for cuff leaks and aspect
- Lubricate only the back side of the cuff
- Provide adequate anesthesia (regional nerve block or general); Propofol with opioids recommended. (some professionals frequently use also succinylcoline)
- Index finger should guide the cuff along the hard palate and down in the hipopharynx until an increased resistance is felt and longitudinal black line should always be pointing cephalad
- Inflate the correct amount of air (see table 1)
- Obstruction after insertion is usually due to a downfolded epiglottis or transient laryngospasm
- Avoid pharyngeal suction, cuff deflation, or laryngeal mask removal until the patient is awake (coughing and opening mouth on command) [4]

Table 1. LMA cuff volume related to different-sized patients [4,6]

Mask size	Patient type	Weight (kg)	Cuff volume (ml)
1	Neonate	< 6.5	2 - 4
1,5	Infant	6.5-10	Up to 7
2	Child	10 - 20	up to 10
2.5	Child	20 – 30	up to 15
3	Small adult	> 30	up to 20
4	Normal adult		up to 30
5	Large adult		up to 30

While the standard insertion method involves total cuff deflation, some clinicians do insert the LMA with the cuff partially inflated.

It may be used even by personnel with little experience, in order to obtain adequate tidal volumes and control ventilation.

Contraindications to LMA use are intact gag reflex, pharyngeal pathology or obstruction, full stomach, pregnancy, hiatal hernia, obesity and low pulmonary compliance requiring peak inspiratory pressures greater than 20 cmH_2O.

LMA should not be taken as a substitute for tracheal intubation and it is more likely a substitute for mask ventilation. Comparing the advantages and disadvantages of these devices is helpful in taking the appropriate decision (Table 2 and 3) (modified after [4]).

Table 2. *LMA compared with face mask*

Advantages	Disadvantages
Hands-free after insertion, easier to maintain	More invasive
Better seal in bearded patients	More risk of airway trauma
More space for facial and ENT surgery	Requires new skill
Protects against airway secretions	Deeper anesthesia required
Less facial nerve and eye trauma	Requires TMJ mobility
Less operating room pollution	Multiple contraindications

Table 3. *LMA compared with endotracheal intubation*

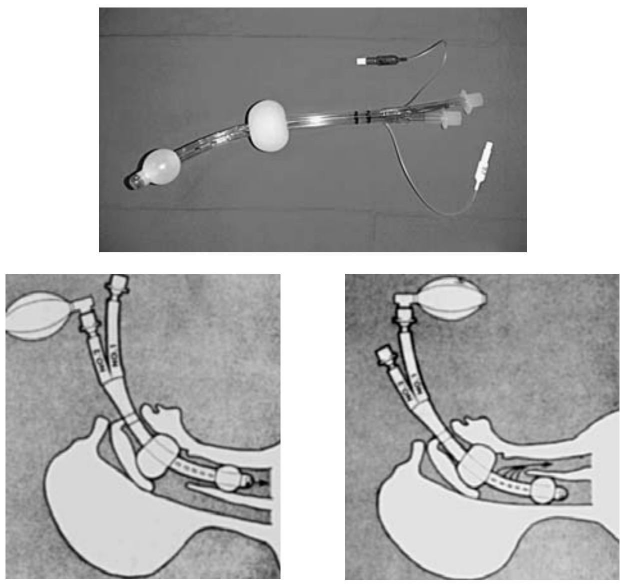
Advantages	Disadvantages
Less invasive	Prone or jackknife position cannot be used
Less anesthetic depth required	Less secure airway.
Useful in difficult intubations	Limits maximum PPV
Less tooth and laryngeal trauma	Can cause gastric distention
Less laryngospasm, bronchospasm, and other physiologic reflex response	Increased risk of G-I aspiration
Does not require muscle relaxation	Greater risk of gas leak and pollution
Does not require neck mobility	
Less risk of esophageal intubation	

Although it is not a substitute for endotracheal intubation, the LMA has proven particularly helpful as a temporizing measure in patients with difficult airways because of its ease of insertion and relatively high success rate (95% to 99%) [4]. It can be used also as a conduit for intubating stylet, ventilating jet stylet, flexible FOB, or small diameter (6.0 mm) ETT [4, 6].

Cuffed Oropharyngeal Airway (COPA) is a modified Guedel orofaryngeal airway with a standard 15 mm connector at its proximal end and an asimetrycal cuff that allows a seal of the hypopharynx. It is available in 4 sizes: 8,9,10 and 11 cm and it is blindly inserted with a success rate comparable to the LMA. A study of COPA versus LMA in a controlled situation in normal patients has shown that LMA had consistently higher leak pressures and returned greater tidal volumes than the COPA [4, 6].

Esophageal-tracheal Combitube is a two-lumen - two-cuff tube, each lumen ending on the proximal end with a standard 15 mm connector. It is designed to ventilate the lungs whether inserted in the esophagus or the trachea. The tracheal lumen, which is shorter, has an end-hole while the longer lumen (esophageal) is occluded but has small side-holes in the pharyngeal area, between the two cuffs. The distal small-volume cuff (15 cc) seals either the trachea or the esophagus while the proximal large volume cuff (100 cc) seals the hipopharynx [6]. It is blindly advanced until the black ring markers on the tube are positioned at the teeth. The pharyngeal cuff is inflated first in order to seal the hypopharynx and then the distal cuff is inflated. Ventilation is attempted through the esophageal lumen first, so the gas is forced through the small side holes, and lungs are checked by auscultation. If no breath sounds are heard, the tube has entered the trachea and ventilation is attempted through the tracheal lumen. Care must be taken to avoid excessively deep placement of the tube, which obstructs the glottic opening.

Fig 4. Esophageal tracheal Combitube



Combitube is available in two sizes: 41-Fr for male adults and 37-Fr for women and small adults. The tube enters the esophagus 95% of the time [6]. In this situation, the stomach can be aspirated through the tracheal lumen.

A redesigned Combitube with a larger pharyngeal orifice has been found effective in providing a conduit for tracheal suctioning, FOB and the use of a guide wire for tube exchange.[4].

Studies have shown a high rate of success in insertion of the ETC as a first line airway and also when it is used as a second choice after failed intubation. In addition, it has been successfully used in CPR. ABG of patients ventilated through ETC where nearly identical to patients with ETT [5].

Compared with LMA, Combitube provides a better seal and better protection of the airway against aspiration but it can be used only for adults (age > 15 years, height > 150 cm) because the pharyngeal cuff can occlude smaller size airway. Another disadvantage is that transition from ETC to a regular intubation is more difficult than with LMA [4]. ***Contraindications*** are intact laryngeal or pharyngeal reflexes or known esophageal pathology (caustic burns). Complications as subcutaneous emphysema and pneumomediastinum have been mentioned with ETC use [5].

Conscious ("Awake") Intubation

After appropriate sedation, topical anesthesia, and/or nerve blocks such intubations can be performed with minimal discomfort in the conscious patient.

Indications include a history or anticipation of a difficult intubation, severe risk for aspiration or hemodynamic instability.

Drugs for sedation

Narcotic analgesics are the key to facilitating conscious intubation because they afford mild sedation, analgesia, and reduction in airway reactivity that may result in cough, bronchospasm and hemodynamic impairment.

The overall characteristics of Fentanyl have made it the most useful drug in such procedures. The dose requirements vary greatly (25-500µg), the drug should be administered in small increments, the effect is easily reversed with Naloxone if respiratory depression results [2].

In order to afford more sedation than moderate dose narcotics provide, a second drug is usually given such as Droperidol, a butyrophenone, without adding too narcotic-induced respiratory depression. Another choice is a benzodiazepine (Midazolam) which provides also anterograde amnesia, but care should be taken regarding respiratory depression. The disadvantage using benzodiazepine is decreased level of consciousness that results in loss of verbal contact with the patient [2].

Topical anesthesia / Anticholinergics

Before difficult intubation, an anticholinergic is advised in order to blunt response to airway instrumentation, being also useful to improve visualisation by decreasing secretions that also are diluting and washing-off topical anesthetics.

Anesthesia of the nares and nasopharynx should be added to vasoconstriction by using a lidocaine 4% -phenylefrine 0.25% combination. Further application of lidocaine gelly on the ETT will complete blunting of the sensory input from the nasal mucosa [2].

The tongue and oropharynx can be anesthetized with 10% lidocaine spray as well as supraglottic and glottic structures.

Trachea and subglottic structures can be anesthetized by a **translaryngeal (transtracheal) block**. This consists in injecting quikly with a needle 23-gauge or a 14-16-gauge IV catheter of 2-4 ml of lidocaine 2 or 4% through the cricothyroid membrane in the trachea at the end-expiration. Following cough, trachea and supraglottic structures are anesthetized as well. The catheter can be left in place and used for transtracheal jet ventilation or placement of a wire for retrograde intubation [4].

Nerve blocks

Glossopharyngeal block (fig. 5) cuts the sensory input from the areas of the tongue and oropharynx by blocking the lingual nerve and pharyngeal branches of the glossopharyngeal nerve.

Fig. 5 Glossopharyngeal block [4]

This is easily achieved by injecting bilaterally at the base of the palatoglossal arch 2-3ml of lidocaine 1% with 22-gauge spinal needle [4]. Aspiration is mandatory in order to avoid intravascular delivery of the anesthetic. This block is acceptable with a full stomach and does not affect airway integrity.

However, controlled studies have shown that lidocaine gargling followed by spray application of 10% lidocaine is equally effective.

Superior laryngeal nerve block will anesthetize the airway below the epiglottis. This is done by locating the hyoid bone and injecting, 1 cm below each greater cornu, 3 ml of lidocaine 2% and by this blocking the internal branch of the superior laryngeal nerve at the penetration point of the thyrohyoid membrane [4]. This block is contraindicated by coagulopathy, local pathology or full stomach.

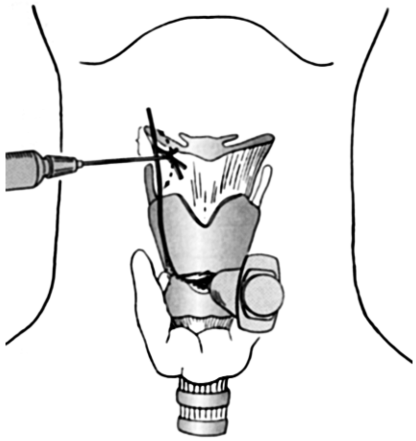


Fig 6. Superior laryngeal nerve block and transtracheal block [4]

Subglottic airway is blocked by **transtracheal block** as previously described.

These blocks allow the awake patient to better tolerate intubation by obtunding protective reflexes (cough, swallow) but the risk of aspiration is increased as well as transient obstruction due to the the loss of regulation of airway caliber.

Blind nasotracheal intubation

Nasal intubation may be chosen because direct laryngoscopy is imposible. It may be quicker and more comfortable than oral intubation in the patient with a short thick neck, suspected cervical injury or restricted neck motion, clenched teeth, oral injuries or gagging and resisting the use of the laryngoscope. Nasal intubation is equally possible in anesthetized and awake patients and in the sitting position for patients with congestive heart failure or kyphoscoliosis that cannot tolerate lying flat [5].

The patient is encouraged to breathe spontaneously in order to facilitate blind intubation. The tube is lubricated with lidocaine jelly and advanced through the nares, at a plane perpendicular to the face, during inspiration, until maximum breath sounds are heard (usually 14-16 cm in adults). Breath-holding and coughing signal close proximity to the larynx. The tube is then inserted into the glottis during inspiration.

Several technical maneuvers can help [2,4,6] :

- Extension of the neck will guide the tube more anteriorly
- Rotation of the head will guide the tube laterally
- Laryngeal pressure may guide the tip of the tube into the glottis
- A C-shaped stylet can be put inside the tube
- Magill forceps inserted through the mouth can also direct the tube associated or not with direct laryngoscopy. Care should be taken not to damage the cuff.
- Voluntary tongue protrusion will inhibit the swallowing and guide the tube anteriorly
- Partial cuff inflation (15 ml) in the hipopharynx will also direct the tip anteriorly

Contraindications to nasal intubation make this choice less frequent. Apnea is a major contraindication because trying to place the tube without respiration as a guide is futile. Other contraindications are relative but significant: coagulopathy, facial and basilar skull trauma, intranasal disorder or tumor, expanding neck hemathomas, patient combativeness (if not controlled with sedation), as well as adverse effects: bacteriemia, sinusitis and pharyngeal laceration.

Flexible Fiberoptic Intubation

Fiberoptic bronchoscope (FOB) **(Fig.7)** is used for intubation when neck movement is to be avoided or when a difficult to manage airway is known or predicted. Indications are unstable cervical spine, expanding neck masses, upper airway infection, facial and airway burns, and anatomic deformities. It can also guide blind nasal intubation.

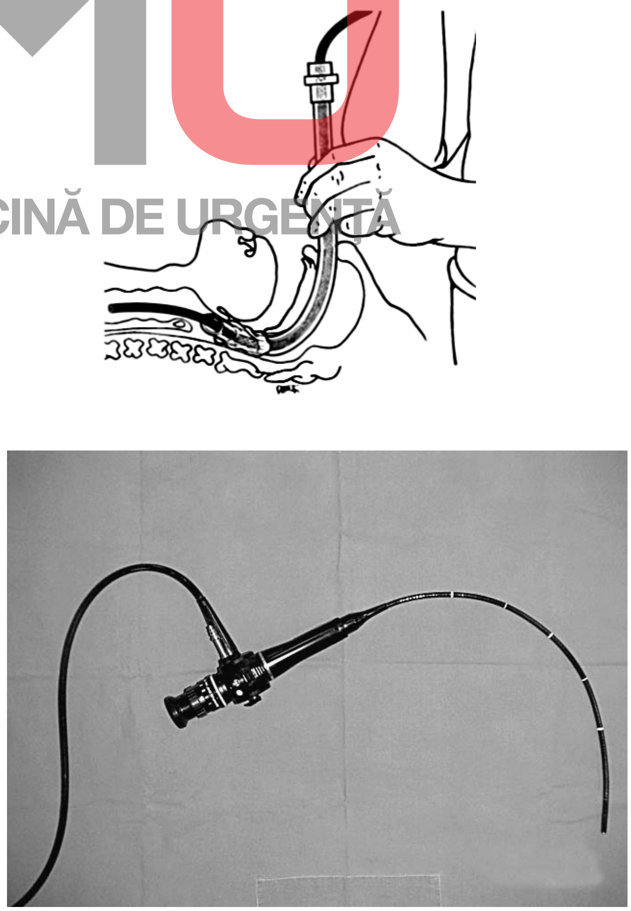


Fig. 7 Flexible Fiberoptic Bronchoscope [3]

It is considered a very reliable approach to difficult airway management and has more universal application than any other technique. It can be inserted nasally or orally for both upper and lower airway problems in patients of any age and in any position. Secretions or blood can impair visualization and therefore a vasoconstrictor is needed. Contraindications are relative and represented by severe midface trauma and coagulopathy, active airway bleeding or vomiting. Apnea may represent a contraindication for the inexperienced operator. Shortcomings are also represented by the cost and fragility and the fact that it requires more training than any other equipment.[4,6]

Light Wand / Lighted Stylet (Fig. 8)

Intubation can be performed using a malleable stylet with an atraumatic lighted tip connected to to a light source. This light wand allows transillumination of the anterior neck tissues when inserted in the trachea. In the trachea, the light is bright, but in the esophagus, the light is less intense and more diffuse. Several studies have shown the lighted stylet to have a very high success rate (454/ 459 in an aggregate study) [3] in patients with known or anticipated difficult airway.

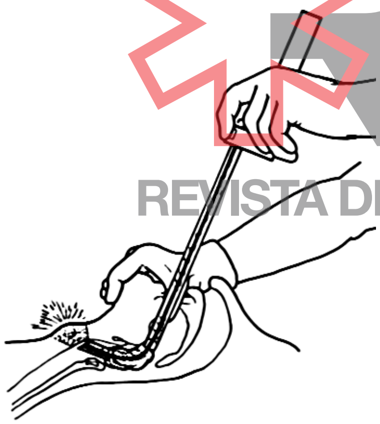


Fig. 8. Trachlight [3]

The failed intubations were in morbidly obese patients in whom transillumination was difficult. This technique may be particularly useful in patients with restricted neck movements or mouth opening, in facial trauma and also when the FOB is not available (ambulances, ED) or bronchoscopy is difficult to perform. ***Contraindications*** are polyps, retropharyngeal abscess, tumor, laryngeal fracture or other airway pathology like in any other blind technique [6].

Indirect Rigid Fiberoptic Laryngoscopes (Fig. 9)

Are designed for the same patients as those considered for FOB (limited mouth opening or neck movement). Because of their anatomically shaped blade, the alignment of oropharyngeal and laryngeal axes is not necessary and no manipulation of the neck is needed. It can be used in awake as well as in unresponsive patients Compared with FOB they are hard and control soft tissue better, more portable, allow better management of secretions and are not so costly. Also less training in their use is required.

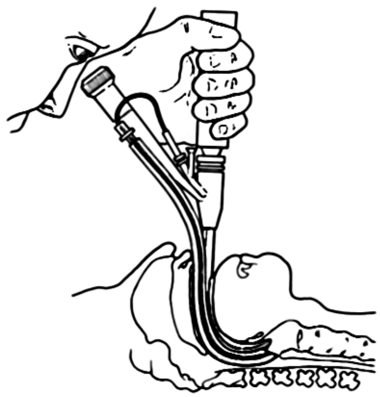


Fig. 9: Bullard Laryngoscope [3]

Bullard laryngoscope has proven itself useful in difficult airway and there is a significant learning curve with this device. Bullard Elite Laryngoscope, the recent version of the Bullard laryngoscope, is the only indirect laryngoscope that incorporates attachable metal stylets. It has also a channel for oxygen insufflation, suction, and instillation of local anesthetics [3, 6].

UpsherScope is the simplest in design, has a C-shaped delivery slot on the right side of the instrument. Only an adult size is available.

WuScope is similar to the previous ones, with a handle, an anatomically designed blade, a fiberoptic view port with a fiberoptic rhino laryngoscope and a port for oxygen insufflation. The system accounts for better visualization capacity but the cost is higher.

The major difficulty in using these devices is the inability to visualize the larynx because of blood, emesis or secretions or inability to place the tip of the blade under the epiglottis [6].

Retrograde Intubation

It is a technique especially useful in patients with cervical spine injuries, abnormal anatomy, or who have suffered airway trauma. It consists in passage of a wire or plastic stylet through the cricothyroid membrane that is coughed out in the larynx and further in the oropharynx. It can be done in the anesthetized or the conscious patient. If the patient is conscious, the maneuver should be preceded by transtracheal topicalization. The tracheal tube is then inserted over the wire, which is held in with mild tension. The tip of the tube may catch the anterior commissure and therefore not pass. Technical tricks may be used such as turning the tube, loosening the wire or threading the tube onto the wire via the Murphy eye [3, 4].

Because the technique is performed blindly, it is important to be cautious in order to avoid worsening of preexisting conditions. If the practitioner is not experienced in this technique, it should not be considered in a "difficult airway" intubation.

Recently a needle holder has been developed that reduces undesired events when the wire is introduced in the trachea.[6].

Cricothyrotomy

Needle cricothyrotomy Inability to provide oxygen to the trachea via other means makes urgent performance of cricothyrotomy or tracheostomy necessary. In the emergency setting, cricothyrotomy is a safer and timelier option than tracheostomy. It should be performed with catheters at least 4 cm long and up to 14 cm in adults. Standard catheters are subject for kinking and this is the reason that leads to a special 6-Fr emergency transtracheal airway catheters production (Cook Critical Care). They are introduced using the Seldinger technique through the cricothyroid membrane. An upgrade to such catheter is the presence of a durable, elastic, high-volume, low-pressure cuff that seals the airway [6].

Surgical cricothyrotomy is performed by making an incision through cricothyroid membrane using a scalpel after which an ETT is inserted. This is the most rapid technique and should be used when equipment for less invasive techniques is unavailable and situation is critical.

Tracheostomy

Consists in establishing transcutaneous access to the trachea below the level of the cricoyd cartilage. It may be necessary when acute airway impairment occurs in children whose cricothyroid space is considered too small for cannulation, as well as in persons with laryngeal pathology with effect on the local anatomy.

Percutaneous dilatational tracheostomy is the most commonly performed tracheostomy technique. It is considered the last option because its invasiveness and trauma to the tracheal wall. The technique is also not recommended for emergency tube placement in patients with an enlarged thyroid gland.

Translaryngeal tracheostomy can be performed at the bedside. It is a newer tracheostomy technique considered safe, and cost-effective. If compared with percutaneous dilational technique it is less invasive and has fewer complications. The method (Fantoni technique) consists of making the stoma outward by inserting a tracheal tube into the mouth and pulling it retrograde outside the neck, through the larynx using a guidewire introduced in the trachea. The tracheal rings are simply spreaded apart. It is also considered beneficial in patients who are coagulopathic[6].

Surgical tracheostomy is the most invasive and should be performed in a sterile environment in an elective manner. It is a non-emergent airway performed for patients with stable airways when intubation is impossible via oral or nasal route, patients in whom prolonged intubation is anticipated (> 2 weeks) and patients who have been intubated translayngeally for more than 3 days[5,6].

There are not absolute contraindications to tracheostomy because this is a lifesaving procedure. However the benefits should be weighted when there is a a coagulopathy, an infection of the neck or inability to extend the neck [4].

Transtracheal Jet Ventilation

The use of high gas flow rates (15-40 liters/min) through the transcricoid or transtracheal catheter will permit ventilation. This can be achieved with a special device similar to an automobile tire inflator or directly from a wall or cylinder high-pressure oxygen delivery system through a 3-way stopcock attached to some tubing. Short bursts of oxygen will allow oxygenation and limit the risk of barotrauma but in the same time care should be taken for the gas to escape by maintaining airway open by chin-lift maneuver or Guedel airway. Complications are not infrequent: pneumothorax, pneumomediastinum, subcutaneous emphysema [5, 6].

Physiologic responses to airway instrumentation and Complications

Laryngoscopy and intubation are powerful noxious stimuli by violating the patient's protective airway reflexes and the responses may have deleterious respiratory, neurological and cardiovascular effects. This stressful condition predictably leads to violent cough, hypertension and tachycardia. A deeper level of anesthesia is needed to blunt this response compared to the response to surgical incision. In this regard, laryngoscopy and intubation should be considered a very invasive procedure. Hemodynamic changes and dysrhythmias (particularly ventricular bigeminy) can be attenuated by administering iv lidocaine (1,5mg/kg), fentayl (0,5-5μg/kg), remifentanil (1μg/kg), alfentanil (10-20 μg/kg) before laryngoscopy. There is a high-risk population with coronary artery disease, asthma, high intracerebral pressure [2, 4, 5].

Hemodynamic changes: **Pressor response** – hypertension and tachicardia occur as a result of sympathetic stimulation and begin within 5 seconds, plateaus approximately 1 minute and returns to baseline at 5 minutes. **Increased intracranial pressure** and **increased intraocular pressure** do not have a fully cleared physiopathology but seem like having the same afferent pathway and sympathetic mechanism. **Vagal response**, more common in children, may result in bradicardia or sinus arrest. **Hypotension** is common after tracheal intubation due to reduced venous return consequent to PPV and the decreased cardiac output can precipitate arrhythmias or cardiac arrest. Sedative agents can also act on peripheral vasculature or myocardium with a hypotensive effect and the rare development of postintubation pneumotorax can also contribute to hypotension [2, 4, 5].

Airway trauma. Laryngoscopy and intubation can lead to a range of complications from tooth damage, lip, tongue or mucosal laceration, dislocated mandible, retropharyngeal injury and sore throat, to tracheal stenosis. Most of these are due to instrumentation and pressure on delicate and sensitive airway structures. The cuff pressure needed to seal airway is usually 20 mmHg and reduces the tracheal mucosal blood flow by 75%. When the pressure exceeds the capillary-arteriolar blood pressure (30 mmHg), tissue ischemia can lead to a sequence of inflammation, ulceration, granulation and stenosis[4]. Repeated laryngoscopy attempts during difficult intubations are most frequently leading to pharyngeal bleeding and periglottic edema with the inability to ventilate, thus turning a bad situation into a life-threatening one. Delayed injuries due to direct wounds and tissue edema are postintubation croup, vocal cords paralysis associated with hoarseness and increased risk of aspiration[5].

A special concern for the practitioner facing a difficult airway situation is laryngospasm. **Laryngospasm** is a forceful, involuntary spasm of the laryngeal musculature caused by sensory stimulation of the superior laryngeal nerve. It represents an abnormal sensitive reflex to inhaled agents, secretions or foreign bodies. It is usually prevented by maneuvering patient either deeply asleep or fully awake, but it can still occur. Treatment consists in administering positive pressure ventilation by bag valve and mask with 100% oxygen or administering iv lidocaine. If it persists and hypoxia develops succinylcoline (0,25-1mg/kg) should be given in order to paralyze the laryngeal muscles [2]. Consequent relaxation of pharyngeal muscles may lead to upper airway obstruction and continued inability to ventilate.

Another method of relieving laryngospasm consists in anterior displacement of the mandible and in the same time applying digital pressure in what is called "laryngospasm notch" (see Fig. 10). This is behind the ear lobule in a point bounded anteriorly by the ascending ramus of the mandible, posteriorly by the mastoid and cephalad by the base of the skull [4].

Pressure is applied firmly inward and toward the base of the skull on each side with the index or the middle fingers while at the same time lifting the mandible.

The large negative intrathoracic pressures generated by the struggle in laryngospasm can lead to pulmonary edema even in young adults [4].

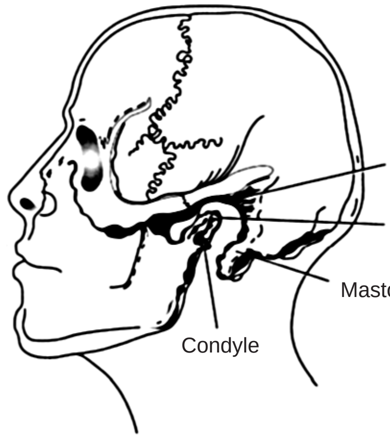


Fig. 10 "Laryngospasm notch" [4]

Bronchospasm as reflex response to intubation is most frequent in asthmatic patients. It can also be a clue to endobronchial intubation.

Tube malpositioning and malfunction. Esophageal intubation, over insertion of the ETT in the right main bronchus or cuff positioning in the larynx as well as valve or cuff damage or tube obstruction are not unusual events with deleterious effects if not catastrophic. Checking and excluding each of these eventualities is mandatory [2, 5].

Conclusions

Oral and nasal intubations can be performed in awake and anesthetized patients by rigid laryngoscopy, fiber optic visualization or "blind" technique guided or not in at least 12 possible methods of passing an ETT tube through the larynx. Alternative techniques of preserving an airway using LMA, Combitube, cricothyrotomy or tracheostomy can be added. Circumstances (location, pathologic, available tools and skills) are of paramount importance for the adequate decision to be taken in order to overcome a "difficult airway". Therefore, clearheaded assessment of the actual situation, anticipation of further events and skillfulness are the key of successful difficult airway management.

References

1. Kaur S, Heard OS. Airway management and endotracheal intubation. In: Irwin RS, Cerra FB, and Rippe JM, editors, Intensive Care Medicine. Boston: Lippincott Williams and Wilkins, 1999: 1-15.

2. Stone DJ and Gal TJ : Airways management. In : Miller RD editor. Anesthesia. Fifth edition. Philadelphia: Churchill Livingstone; 2000. p.1414-1451.

3. Clinton JE and McGill JW : Basic Airway Management and Decision Making. In. Roberts J, Hedges J, editors. Clinical Procedures in Emergency Medicine. Philadephia: W.B. Saunders; 1998. pp. 1-44.

4. Larson PC. Airway Management. In: Morgan, Jr. GE, Mikhail MS,.Murray MJ, editors. Clinical Anesthesiology. Third edition. McGraw-Hill; 2002. pp. 59-86.

5. Freid E. Airway Management: New and Innovative Techniques. Society of Critical Care Medicine-6 Critical Care Refresher Course. San Diego. Cal. 2002. pp. 59-68.

6. Hagberg CA. Current Concepts in the Management of the Difficult Airway. ASA.refreshment course 2001 vol 29 chapter 13.