AIDS FOR FACILITATION OF DIFFICULT TRACHEAL
INTUBATION REVIEW AND RECENT ADVANCES

MUSA MUALLEM*, ANIS BARAKA**

Abstract

Management of difficult tracheal intubation has been facilitated by different techniques which include the use of stylets, introducers, intubating laryngeal mask airway, as well as by the development of special laryngoscope blades and fiberoptic laryngoscopes. 

The most recent advances for facilitation of difficult tracheal intubation is the introduction of the video-assisted laryngoscopes.

The management of difficult tracheal intubation by video-assisted laryngoscopy can be further facilitated by using suspension laryngoscopy which frees the hands of the anesthesiologist to handle the insertion of the endotracheal tube with the aid of an endotracheal tube introducer, and a curved pipe stylet, under an umbrella of pharyngeal oxygen insufflation.

Background

With the introduction of muscle relaxants by Harold Griffith in the forties, failure to ventilate and/or intubate became a major concern and a nightmare to anesthesiologists because of the serious morbidity and mortality that may follow. The usual scenario of a difficult airway resulting in morbidity or even death is difficult mask ventilation, and repeated trials at laryngoscopy by one or more individuals, resulting in pharyngeal trauma and edema. Ventilation becomes more and more difficult, complicated with hypoxemia, brain damage, and cardiac arrest1,2.

Causes of difficult airway

The causes of difficult airway and difficult tracheal intubation can be due to the:

1. Anesthesiologist being inadequately trained,
2. Short of equipment, or
3. Due to the patient’s anatomic condition.

The following patient’s conditions have been found to contribute to difficult airway and difficult tracheal intubation.
1. History of difficult airway
2. Obesity
3. Pregnancy
4. Short neck
5. Receding Jaw
6. Short thyromental distance less than 4 cm³
7. Tumors, polyps, of larynx and pharynx
8. Trauma or burn to face and neck
9. Cervical Spine Injury
10. Carious front teeth, or expensive dental appliances
11. Short atlanto-occipital distance and angle
12. Restricted neck movement
13. Class III&IV Mallampati on pharyngeal examination
14. Grade III, IV Cormack airway during laryngoscopy

Evaluation and prediction of difficult airway

A difficult airway can usually be predicted during the preoperative anesthesia visit by history and physical examination of the patient considering the above mentioned contributing factors.

The mouth opening and the pharynx must be routinely examined and the view classified according to the Mallampati Airway Classification (Fig. 1).

Following induction of anesthesia and during laryngoscopy, the view of the pharynx and larynx can be evaluated and graded according to Cormack and Lehane Grades (Fig. 2). Grade I & II can be easily intubated by Macintosh blade while grade III & IV are considered difficult requiring special intubation equipment and technique.

The incidence of Cormack and Lehane airway grades in the general population as reported in the literatures is about;

1. Cormack I  65%
2. Cormack II  25%
3. Cormack III  8-10%
4. Cormack IV  0.5-1%

Early development of intubation aids

1. Stylets
2. Introducers
3. Special laryngoscope blades

1. Stylets

Malleable metal stylet has been introduced since a long time to preform and curve the endotracheal tube to face the glottis. However, it requires that the glottis be aligned to the line of vision of the operator.

2. Introducers

As early as 1949, Sir Robert Macintosh recommended the introduction of gum elastic catheter into the trachea as a guide for railroading the
endotracheal tube over it. Not until the 1980, with the introduction into the market of the multiple-use Eichmann Gum Elastic Bougie and later several other single-use introducers with a curved tip, that the use of introducers and the technique of railroading the endo-tracheal tube over it became popular as an aid for difficult intubation.

The disadvantage of the Eichmann Gum Elastic Bougie and many other similar introducers was that they all have a hard rigid tip that could injure the tracheal wall and produce pneumothorax or mediastinal emphysema.

This prompted the author of this review to develop a home-made prototype introducer with a soft curved rounded tip and semi rigid body that could be safely introduced into the trachea. Based on this prototype, the VBM Medizintechnik GmbH Company manufactured and put on the market in 2004 a new introducer, the Muallem endotracheal tube introducer (METTI) with the above mentioned characteristics (Fig. 3).

Fig. 3
METTI Introducer

3. Special laryngoscope blades

Several laryngoscope blades for improving the glottic view have been developed. The McCoy blade is worth mentioning. However, all these blades require the operator to see directly the epiglottis and glottis.

Still we had about 8% of the cases when we cannot see directly the glottis, and an instrument that allows us to see around the corner is required.

Development of the fiberscope

1. Rigid Fiberscopes (the Bullard),

These scopes will allow visualization of the glottis around a curve through an eyepiece that can be fitted with a camera and screen.

The Bullard scope is one example that gives a good view of the glottis. It is recommended in tight jaw opening where other thicker blades could not be introduced. Intubation with this scope may be difficult in spite of the good view. This scope had to be modified by the authors by adding a side channel and using an introducer as a guide to successful intubation (Fig. 4).

Fig. 4
Bullard scope as modified with the side channel and the METTI

2. Semi rigid fiberscope -The Bonfil

The Bonfils acts as a stylet with vision at its tip. It has been recommended as the first line of management of a difficult airway. It has similar drawbacks as the flexible fiberscope as will be mentioned below.

3. Flexible fiberscope

The flexible fiberscope for the past decade has been considered as the gold standard of difficult airway management. It serves like an introducer with vision at its tip. It can be curved to follow the mouth and pharyngeal and laryngeal curves into the trachea. When it is introduced into the trachea, the endotracheal tube is railroaded over it. However, the railroading is blind and the tube can be stuck along its way at the arytenoids or the vocal cords. Other drawbacks are, a narrow field of vision, and its tip can fog frequently or get covered by secretions or blood. Training in its use has a long learning curve, and it is quite expensive to purchase and maintain.
The Laryngeal Mask Airway (LMA)

These airways have been very popular and successful during the past ten years in opening the airway and providing adequate ventilation and oxygenation in normal and in difficult airways when face mask ventilation fails. In certain conditions, LMA has been used to replace endotracheal intubation successfully.

The LMA can be life-saving when faced by an unpredicted difficult airway that could not be adequately ventilated by a face mask nor could be intubated, by providing ventilation to the patient, and time to the anesthesiologist to plan for successful intubation technique, or awaken the patient and cancel the operation (Fig. 5).

Fig. 5
Laryngeal Mask Airway

Recent improvement in LMA design was the separation of the respiratory tract from the alimentary tract in the new generation of LMA. This allows emptying the stomach contents, safeguard against tracheal aspiration, and help confirmation of LMA proper placement.

The Supreme LMA has been recently found superior to others and has been recommended for use in the airway management during cardiopulmonary resuscitation.

Some of these airways (The intubating LMA) have been adapted and used to facilitate difficult tracheal intubation.

The Video-assisted Laryngoscopes

These scopes have been introduced during the past several years and are quickly gaining popularity worldwide. There are several brand names on the market and they definitely give a better view of the larynx, and all claim a high rate of successful intubation.

They provide a wide angle of vision of the larynx, they are curved to follow the anatomical curves of the pharynx, and they have a short learning curve and are easy to use even by a beginner.

In a recently published article the three most commonly used video-scopes are Pentax airway scope, the GlideScope, and the C-MAC of Storz. The three were compared clinically and were found to have comparable results, with a slight difference between them.

However, in spite of the improved vision of the glottis by the video scopes and their higher success rate of intubation, it remains difficult on occasions to negotiate the ET tube through the vocal cords into the trachea. The bevel of the ET tube may become stuck at the arytenoids or impact on the anterior wall of the larynx. In a retrospective review, primary intubation with the GlideScope was successful in 98% of 1,755 cases and rescued failed direct laryngoscopy in 94% of 239 cases. Altered neck anatomy with presence of a surgical scar, radiation changes, or mass, were the strongest predictor of GlideScope failure.

It has been suggested that a flexible stylet or a device (or a guide) that can allow the adjustment of the tube and hence might decrease intubation time and improve success rate. This device have been developed and used by the authors, and consist of an assembly of Muallem Endotracheal tube introducer, and Muallem pipe stylet as will be described later.

Management of the difficult airway

By Video-assisted Laryngoscopy

Management of a difficult airway should not come as a surprise. Each anesthesiologist should formulate a plan of action before-hand, rehearse it under normal conditions, and be prepared by training and equipments.

Successful intubation depends;

a. on the skill and training of the operator,
b. on the equipment and intubation aids available

c. on the patient’s airway and type of the anatomical difficulty present.

Faced with difficult tracheal intubation, we should avoid repeated trials, and aim for maintaining adequate ventilation and oxygenation, keeping the patient alive until a proper plan of action is developed.

During the past fifteen years different guidelines and algorithms have been developed and recommended by the ASA and other societies for the difficult airway management. These guidelines have been very useful and have reduced the incidence of complications since their introduction23,24.

Following the introduction of the video-assisted laryngoscopes many of the steps of the guidelines could be omitted, and if the proper equipment is available, we can go directly to the most recently recommended technique.

In spite of the advance in videoscope, we still find some airways difficult to intubate. Providing a good view of the glottis with the video-scope does not always correlate with successful tracheal intubation.

Muallem and Baraka have added to the video-scope the use of an assembly of an introducer (METTI-VBM) and a curved pipe stylet Muallem pipe stylet (MPS-VBM) to facilitate tracheal intubation using the GlideScope. After visualization of the glottis, the ET tube introducer (METTI) is inserted into the trachea by the help of the pipe stylet (MPS), and the ET tube is railroaded over the introducer into the trachea (Fig. 7). The tip of the introducer can be rotated for 360 degree circle by rotating the body of the introducer inside the pipe stylet.

The GlideScope have been used in combination with the flexible fiberscope instead of the assembly described above, where the fiberscope was used as a flexible introducer (an expensive alternative) over which the endotracheal tube was railroaded successfully into the trachea.

Intubation of the difficult airway should always be done under an umbrella of pharyngeal oxygen insufflation. These patients desaturate quickly after induction of anesthesia and the production of apnea. Baraka and al. have shown in obese patients that pharyngeal oxygen insufflation can maintain apneic oxygenation and prolong apneic time, and safe intubation time27. Intubation becomes unhurried atraumatic and safe procedure.

Pharyngeal oxygen insufflation following mask preoxygenation can be simply produced by nasopharyngeal oxygen catheter or by the curved disposable dental evacuator hooked to the angle of the mouth and used as an oral oxygen insufflator (Fig. 8).

The assembly of (METTI) introducer and (MPS) pipe stylet (or J tube) makes one device where each component can be maneuvered independently. The
at the level of the arytenoids, turning the bevel of the tube posteriorly will allow the tube to pass to larynx.

The tube may also get stuck at the anterior commissure, turning the bevel of the tube anteriorly will allow the tube to pass to the trachea.

The presence of an introducer in the trachea will allow rotation of the tube bevel under vision to overcome the obstacles met on the way during railroading\(^{28}\) (Fig. 9).

**Fig. 9**
铁路 ET管过导引器

Using the above mentioned technique i.e.; a videoscope (GlideScope), an introducer (METTI), and Muallem Pipe Stylet (MPS), it was found that a third hand by an assistant was required to manipulate all these intubation aids.

Muallem and Baraka have added a hook on the handle of the GlideScope (Fig. 10) for its suspension on a bipod to free the two hands of the anesthesiologist who performs the intubation\(^{29}\) (Fig. 11).

**Fig. 10**
荧光镜手柄钩和支持底座

**Conclusion**

Aids to facilitate intubation of the difficult airway have been reviewed. The most recent advances in the management of difficult intubation is the introduction of the video-assisted laryngoscopes.

The technique described of suspension video-assisted laryngoscopy combined with an assembly of introducer and pipe stylet (the J tube) is recommended by the authors\(^{30}\) for the management of difficult intubation and consists of the following steps;

- The awake patient is preoxygenated by a face mask
- Induction of anesthesia by a sleeping agent and muscle relaxant
- Pharyngeal oxygen insufflation by an oral oxygen insufflator
- Viewing of the larynx by a video-assisted laryngoscope
- Suspension of the videoscope on a bipod to free operator hands
- Insertion of an introducer METTI into the trachea by the aid of Muallem Pipe Stylet (VBM)
- Railroading the endotracheal tube over the introducer into the trachea under full vision, and rotating the tube to overcome obstacles as required.
References
