

# ALTERNATIVE APPROACHES TO ENDOTRACHEAL INTUBATION

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## Introduction

Conventional rigid laryngoscopy inevitably involves distortion of the upper airway anatomy in order to bring the glottis in line of sight for achieving successful endotracheal intubation. As it may not be always possible to distort the anatomy nor is there any guarantee that distortion of the oropharyngeal structures with the conventional laryngoscope will always succeed in bringing glottis into view, airway mismanagement remains an important cause of mortality and morbidity in anaesthetic practice.<sup>1</sup> In fact, conventional rigid direct laryngoscopy aids tracheal intubation in 98.1% of the cases.<sup>2</sup> Thus, even the most experienced operator may encounter difficulties with the rigid laryngoscope, and alternative techniques and equipment for Endotracheal intubation [ETI] must be readily available for the remaining 1.9% cases. Currently, there are several options available for the management of anticipated or unexpected difficult ETI. These options include, but are not limited to:

- a. Flexible fiberoptic intubation.
- b. Intubating laryngeal mask airway [Fastrach™] assisted intubation.
- c. Lightwand [Trachlight™] aided intubation.
- d. Indirect fiberoptic laryngoscope aided intubation [Bullard™, Upsher Scope™].
- e. Gum elastic bougie aided intubation.
- f. Retrograde intubation.

The first two techniques of achieving endotracheal intubation have been covered in other sections of this journal. Techniques 3-6 [stated above], are detailed below. Each intubation method includes a brief description of the equipment followed by the standard technique of its use.

## Lightwand [Trachlight™] aided intubation

One of the alternative techniques of ETI is the transillumination of the soft tissues of the neck using a lightwand. Although a semi blind technique, it is gaining popularity because the lightwand is lightweight, relatively inexpensive, can be used in pre hospital setting and can be

handled easily with minimum practice. The lightwand most commonly employed is the Trachlight™ [Laerdal Medical Corporation NY USA].

The Trachlight [TL] consists of 3 parts:

1. A reusable handle.
  2. A flexible wand.
  3. A stiff retractable stylet.
1. **Reusable handle** : The handle is made up of plastic with a lid at one end, which lodges 3 triple "A" alkaline batteries. A locking clamp is located on the front of the handle, which accepts and secures a standard ETT connector. The 2 battery indicators indicate the status of the batteries in use. A green light indicates that the batteries are charged whereas red indicator light means that batteries need replacement.
  2. **Flexible wand** : The wand consists of a flexible plastic shaft with a bright bulb affixed at the distal end. The TL now comes with 3 sized wands which are reusable up to ten times and will accommodate tracheal tubes from Internal diameter [ID] size 2.5-10 mm. The bulb provides illumination of the soft tissues of the neck during intubation using the TL. The light emitted by the TL is extremely bright with minimal heat production [a maximum surface temperature of approximately 60°C]. After 30 seconds of illumination, the light bulb blinks off & on to further minimize heat production and also indicates 30 seconds of apnea time. Affixed to the proximal end of the wand is a rigid plastic connector with a release arm allowing its connection to the grooves in the wand handle. This connector allows adjustment of the wand along the handle by depressing the release arm and gliding it along the handle to accommodate the endotracheal tube [ETT] of varying length.
  3. **Retractable stylet**: Enclosed within the wand is a stiff, but malleable, retractable stylet. The retractable stylet gives sufficient stiffness to the device, allowing the wand to be shaped in a "field-hockey stick" or "J-shaped" configuration. The shape enhances manoeuvrability during intubation and facilitates the placement of the ETT into the glottic opening.

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**Technique :** One needs to prepare the endotracheal tube – Trachlight [ETT-TL] assembly prior to use. In this, the stiff internal stylet of the wand is lubricated using water soluble KY jelly or silicone fluid ensuring its easy retraction during intubation. Water soluble lubricant is now applied over the wand to facilitate the removal of the wand following ETT placement. The length of the wand is now adjusted by sliding the wand along the handle, placing the light bulb at the end of the ETT without protruding beyond its tip. A bend is now placed in the ETT-TL unit to a 90° angle just proximal to the cuff of the tube in the shape of a “field-hockey stick” configuration for orotracheal intubation. Recently, Chen et al<sup>9</sup> have advocated personalized tailoring of the distal bend for orotracheal intubation taking into consideration the patient’s anatomy. In this, the patient is semi sitting [45°] and head is made neutral. Now measure the individual’s thyroid prominence to mandibular angle distance [TMD]. For patients having a TMD > 5.5 cm, bend between 6.5-8.5 cm length of the wand; < 5.5 cm TMD, use 6.5 cm bent length. For nasotracheal intubation with the metallic stylet in place, Favaro et al<sup>4</sup> have personalized the length and the angle of the short arm of the J-shaped ETT-TL leading to an overall success rate of 98.4% within an average duration of 28±15 seconds.

With the anaesthetized patient lying supine and head in sniffing position, the jaw is grasped and lifted upward using the thumb and index finger of the intubator’s non-dominant hand. The preshaped ETT-TL unit is now inserted into the midline of the oropharynx using the dominant hand. The midline position of the ETT-TL is maintained while the device is advanced gently in a rocking motion along an imaginary midline sagittal arc. When resistance is felt, the ETT-TL is rotated backward and the tip redirected towards the thyroid prominence using the glow of the light as a guide. When the tip of the ETT-TL enters the glottic opening, a well-defined circumscribed glow is seen in the anterior neck slightly below the thyroid prominence. At this point, the stiff internal stylet is retracted approximately 10 cms. This makes the wand with premounted ETT pliable, allowing advancement into the trachea. The ETT-TL is then advanced until the glow starts to disappear at the sternal notch. Following release of the locking clamp, the TL is removed from the ETT.

Several modified tracheal intubation techniques have been developed using TL as an aid. Biehl and Bourke<sup>5</sup> combined direct laryngoscopy with TL to improve the laryngoscopic view and the transillumination assisted them in subsequently guiding the ETT into the trachea in patients of unanticipated difficult intubation. Agro et al<sup>6</sup> claimed a much higher success rate [100%] of tracheal intubation through a perfectly placed LMA using the TL. Lupien and

Taylor<sup>7</sup> described an oral fiberoptic intubation in a patient with cervical fusion using a lighted stylet that lay beside the fiberoptic scope in the ETT. Transillumination of the lighted stylet provided them visual clue that helped them to position the fiberscope and intubate the trachea in less than one minute.

Jensen et al<sup>8</sup> observed no difference between the lightwand technique and the direct vision rigid laryngoscopy induced changes in mean arterial pressure and heart rate during and after tracheal intubation. On the contrary, Nishikawa et al<sup>9</sup> noted a significant attenuation in hemodynamic changes after TLI in comparison with laryngoscopic technique in normotensive patients. However, in hypertensive patients they observed no difference between the two techniques.

First attempt at TLI should not be taken while cricoid pressure has been applied. This is known to reduce the first attempt success rate and is associated with a significantly prolonged intubation time.<sup>10</sup>

TL aided ETI is an easy technique, relatively easy to learn and requires less experience. It is relatively inexpensive [The handle costs approximately Rs. 18000 + Rs.1800 for the wand which is reusable for 10 times]. It is used as an aid in the placement of an ETT or in the positioning of an already placed ETT. TL is a useful adjunct in difficult airway. It does not require extensive neck manipulation and can be used in patients with potential cervical spine instability. It is useful in patients with poor or irregular dentition and in patients with limited mouth opening. It is less traumatic than blind nasal intubation and may be applied after failed intubation using rigid laryngoscopy. Presence of secretion or blood is of no consequence while using the instrument.

TL aided ETI is not without its share of limitations and disadvantages. It is not recommended for use in patients with laryngeal inflammatory disorders such as epiglottitis or tracheal stenosis. It should not be used in patients with foreign body in the airway. It is not recommended in patient with laryngeal or tracheal abnormalities such as polyps, tumors, or a retropharyngeal abscess. In morbidly obese patients, the ability to see the glow may be diminished. On the contrary, in thin or frail patients, some trans-illumination may occur even when the tube tip is in the esophagus.

**Some newer variants of intubating wands:** Seeing Optical Stylet System [SOS] is another lighted styled. However it is different from the trachlight in that it has a high resolution fiberoptic stainless steel endoscope to provide fiberoptic view during its use. Furthermore, the tip of this stylet is manoeuvrable as against a fixed shape of the

trachlight. It is available in adult [endotracheal tube >5.0 mm ID] and paediatric size [endotracheal tube 3.0 – 5.0 mm ID]. This is relatively simple equipment with the added advantage of a fiberoptic view. Its use can be more easily mastered than the fiberoptic bronchoscope.

The Flexible Airway Scope Tool [FAST] closely resembles the SOS stylet. However it differs from it in not being manoeuvrable. Its tip has a malleable portion whereby it can be made to bend as that done with the trachlight.

**Indirect fiberoptic laryngoscope aided eti : 1. Bullard™, 2. Upsher Scope.™**

**The Bullard laryngoscope (BL)**

(Circon ACMI, Stamford, CT), is a rigid, fiberoptic intubating laryngoscope for indirect oral laryngoscopy, transmitting the view from the tip of the L-shaped blade to a proximal view finder. It has been reported to be a valuable aid for the management of the predicted as well as the unanticipated difficult tracheal intubation. When using the BL, the oral, pharyngeal, and tracheal axes do not have to be aligned to view the larynx and it may result in less extension of the head and cervical spine during laryngoscopy and endotracheal intubation. It has been suggested, therefore, that the BL may be the instrument of choice in the emergency trauma situation for patients with suspected injury to the cervical spine.

**Equipment** : BL is a curved rigid fiberoptic intubation device. It consists of a conventional laryngoscope battery handle with light source and a unique anatomically shaped blade. The laryngoscope has fiberoptic bundles for both airway illumination and transmission of the view from the distal tip to the proximally located eyepiece. There is provision for the attachment of conventional video endoscope camera.<sup>11</sup> BL comes in 3 sizes:<sup>12</sup>

- A. Pediatric [newborn to two years]: It consists of a blade which is 1.3 cm wide, 0.64 cm thick, and has an internal radius of curvature of 0.74 inch.
- B. Pediatric long [newborn to ten years].
- C. Adult: The adult has the following dimensions- width 2.5 cm, blade thickness of 0.64 cm, and an internal radius of curvature of 1.32 inch.

A further feature of the BL includes a 3.7 mm working channel. This is incorporated into the laryngoscope which permits suctioning and administration of oxygen and / or local anesthetics. The proximal end of the working channel is provided with a Luer-lock connector for the attachment of a three-way stopcock so that all the above mentioned 3 functions can be done with a flick of the knob. A tip extender is also provided by the manufacturer. The

purpose of the tip extender is to facilitate lifting of the epiglottis when the patient's anatomy necessitates a longer blade.

In the most recent version of this laryngoscope [Bullard Elite Laryngoscope], the metal stylet for mounting the ETT has been made detachable. Like the earlier models, it has an anatomically curved blade and a fiberoptic port for visualization. It incorporates a working channel for oxygen insufflation / suction of secretions, instillation of saline or local anesthetics. It is currently available in adult and pediatric sizes. The pediatric size can be used from newborn onwards.

**Technique** : Select an appropriate size BL. Attach the "blade extender" to the device if it is to be used in large adults. The blade extender provides sufficient length to pick up the epiglottis. Load the chosen ETT over the stylet. Lubricate the blade and the handle. The scope is now held in the left hand. The blade-stylet assembly with premounted ETT is inserted into the mouth in the horizontal plane, over the top of the tongue, and then swung caudad in the sagittal plane into the posterior pharynx. The device follows the natural curve of the oropharynx. As the scope-ETT assembly is advanced, epiglottis is visualized. It is then picked up and lifted anteriorly. It is important to remember that like with the conventional rigid laryngoscope, never use the teeth as the fulcrum, and instead lift the handle. On visualizing the glottic opening, advance the ETT off the stylet into the trachea. If tip extender has been used, following two cautions needs to be taken to prevent its detachment while still in the oropharynx: 1. Read the instruction manual and verify proper tip attachment and 2. Exercise caution when using a tip-extender in patient's with abnormal airway anatomy by verifying that the tip is still attached when the BL is removed.<sup>13</sup>

**The upsher scope**

[Upsher Laryngoscope Corporation, Foster City, CA] is a steel C-shaped laryngoscope with an integrated fiberoptic system for use as an adjunct to the alternative intubation techniques in routine and difficult airway patients. This equipment takes shorter time to prepare and does not need an external light source.<sup>14</sup>

**Equipment** : The Upsher Scope [US] consists of a C-shaped metal blade of fixed curve. It has a light channel and viewing fiberoptic bundle running along the entire length of the curved blade. The US is equipped with a focusing ring on the eyepiece. The tube channel of the US is loaded with a 6.5-8.5 mm ID ETT.

**Technique** : After adequate anesthesia [local or general], the patient's head and neck is positioned neutral.

The US is now inserted following the oropharyngeal curve and is made to slide down the back of the tongue until the epiglottis is visualized. At this stage the tongue of the patient is pulled out of the mouth or is asked to be protruded. The epiglottis is now loaded onto the US tip with a scooping motion. This movement is akin to that done while using the straight blade laryngoscope. The US is now elevated in an anterior direction. This elevates the epiglottis and exposes the glottic aperture. After having visualized the vocal cords, the pre-loaded ETT is advanced through the glottic opening under vision. Care is to be taken not to lose the sight of the advancing ETT as it passes between the vocal cords. The ETT is now disengaged from the channel, and the US is carefully withdrawn.

Although the indirect fiberoptic laryngoscope is more sturdy and cheaper than the flexible fiberscope, it is also handicapped in presence of blood and secretion in the oral cavity. It has a fairly long learning curve but once mastered, it is a useful adjunct to airway management.

#### **Gum elastic bougie aided intubation [GEBI]:**

GEBI is a standard technique of achieving ETI in difficult airway scenario. Gum Elastic Bougie [GEB] may be used blindly or aided by indirect laryngoscopy with a laryngeal mirror / laryngeal mask airway. Recently, Weisenberg et al<sup>15</sup> have reported a 96.6% success rate of GEBI when it was assisted by the laryngeal mirror. This was in contrast to a success rate of 73.3% when GEBI was done unaided.

**Equipment :** Currently, two types of GEB are available. One is straight while the other is angled distally.<sup>16</sup> The straight GEB is basically a tube changer while the angled GEB is recommended for ETI in difficult airway situations. The angled GEB [SIMS Portex Ltd. Hythe, UK] has a length of 60 cm and a diameter 15 French. It has an angulation at its distal end approximately 5 cm from its tip. It is this angulation that permits the tip to be steered around obstacles when the GEB's shaft is rotated. It also assists the GEB to be manoeuvred blindly underneath the posterior surface of the epiglottis in patients with Cormack Lehane's grade 3 direct laryngoscopy view. The manufacturer recommends that the GEB be used a maximum of five times after which the tip tends to lose its angulation.

The straight GEB also has a diameter of 15 French but is longer [70 cm]. This is not recommended during difficult airway manoeuvres. It should be reserved to function as a tube exchanger.

**Technique :** GEB is used in a number of ways to assist difficult intubation. They are as follows:

- A. While performing left handed direct laryngoscopy in patients with grade III or IV Cormack and Lehane's view, the laryngoscopist passes the 15 French 60 cm-long GEB blindly under the epiglottis with his right hand. The GEB is considered to be correctly introduced intratracheally if the anaesthesiologist/laryngoscopist feels a click sensation as the tip of the GEB slides over the tracheal cartilage and/or feels a resistance at 20-40 cm as the tip of the GEB hits the carina or a small bronchus. After eliciting one or both of these vital signs, the ETT is slid over the bougie into the trachea and its correct position is confirmed with capnography and auscultation of the chest.
- B. If one is using indirect laryngoscopy with a laryngeal mirror, an appropriate size laryngeal mirror is introduced with the left hand while an assistant gives a good jaw thrust. The operator now focuses his head light on the mirror and tries to visualize the laryngeal structures. With his right hand the operator passes the GEB into the trachea via the glottis. Subsequently, the ETT is rail-roaded into the trachea over the GEB and confirmed for its correct position by auscultation and capnography.
- C. Bougie aided intubation via the LMA: In this method, after the LMA has been noted to be in correct position, a GEB is passed into the trachea and the operator feels for the clicks or resistance. The LMA is now deflated and removed and the ETT is railroaded over the stylet or the bougie into trachea. One can improve the success rate of this method by keeping the bougie in the midline and angling the distal tip of the bougie anteriorly, if not present. Once the laryngeal vestibule is entered, the bougie is rotated through 180°. This facilitates the advancement of the bougie down the patient's trachea.

#### **Retrograde intubation [RI]**

In a situation of difficult ETI, a RI technique is an accepted mode of establishing an airway.<sup>17</sup> RI is a two stage procedure. The first stage includes retrograde passage of a catheter or a long guide wire from the larynx to the mouth or nose. The second stage consists of railroading an ETT over the guide wire or the catheter. Several new innovations have been devised to enhance the success rate of this technique, but the basic technique remains the same.

**Equipments :** The essential equipment for this technique consists of an IV cannula/catheter over needle, a long catheter or a guide wire. Although readymade disposable sets are available, one can easily assemble the same components at a fraction of the cost.

One can use a 16-18 gauge IV catheter over needle [Vasocon, Jelco, Venflon or even Medicut] for making the cricothyroid puncture. A 18 gauge epidural catheter [Concorde Portex, B Braun or even Romson] or a J-tipped vascular guide-wire, 70 cm in length and 0.6-0.8 in diameter [B Braun Melsungen] can be easily arranged for retrograde passage via the cannula and out of the nose or mouth of the patient. An artery forceps may be used to hold the guide wire/catheter at the level of the cricothyroid membrane so as to prevent it from slipping in.

**Technique :** The skin in front of the neck is infiltrated with 1% lignocaine 1-2 ml, if awake RI is being performed. Next, the larynx is stabilized between the thumb and the index finger of one hand while the cricothyroid membrane is punctured with the catheter over needle assembly held at 45° pointing cephalad. Some anaesthesiologists prefer to puncture through the cricotracheal membrane as this site has a reduced vascularity, carries minimal risk of damage to vocal cords by the needle and a better depth of insertion of the tracheal tube inside the larynx thus decreasing the risk of accidental extubation at catheter removal. This is the subcricoid technique of RI.<sup>18</sup> After confirmation of tracheal placement of IV catheter by the aspiration of free air, catheter over needle assembly is pushed further at an obtuse angle closer to the axis of the larynx. The needle stylet is now withdrawn. A J-tipped guide wire or epidural catheter is inserted through the IV catheter and advanced cephalad into the oro/nasopharynx. The guide-wire or the epidural catheter is readily retrieved from the mouth using a Magill forceps if patient fails to deliver it spontaneously. Often the guide wire or the catheter emerges from one of the nostrils. The other end of the catheter or the wire in front of the neck, at the level of the cricothyroid membrane, is held by the artery forceps so that it may not slip inside. The catheter or the wire is now inserted into an appropriate size ETT and it is pulled to make it taut. The tip of the ETT is well lubricated so as to facilitate its entry into the glottic opening. In case of awake intubation, the patient is now asked to protrude his tongue. If the patient has been anaesthetized, an assistant gently pulls the tongue forwards. This maneuver elevates the epiglottis and provides a clear passage of the ETT into the glottis. As the ETT enters the larynx, resistance is felt at the level of the cricothyroid membrane. At this stage the catheter is relaxed so as to relieve the tension at its distal end. This permits the gentle advancement of the ETT into the trachea. Following confirmation of the intra-tracheal placement of the ETT by auscultation over chest and capnography, the catheter or the wire is removed through the mouth.

The choice of using a guide wire or an epidural catheter rests with the operator, but one should know the pros and cons of each. An epidural catheter is inexpensive and is readily available in the operation theaters. The catheter is flexible and relatively soft. It can easily bend during intubation and permits easy advancement of the ETT deep into the trachea past the puncture site at the cricothyroid membrane. Furthermore, the catheter fits easily between the connector of the ETT and the breathing circuit. This permits mechanical ventilation, oxygenation, and capnography prior to the removal of the ETT. This is often difficult to achieve if a wire has been used although its relative rigidity makes the railroading of the ETT easier. Epidural catheters have been reported to “kink” and are more difficult to retrieve from the oropharynx than the guide-wire. Lastly, if an epidural catheter has been used, it can be tied to the end of the ETT via the Murphy’s eye. This can help to pull the ETT past the glottis without railroading it – a procedure [railroading] entailing some difficulty at the entrance to of the ETT into the glottis.

A number of hybrid techniques of RI have been reported to increase the speed and success rate of correct intubation. One is a lightwand guided RI.<sup>19</sup> In this technique, while pulling the epidural catheter taut, the ETT with the lightwand in place [without the rigid stylet], is advanced into the glottis. A bright glow is seen in front of the neck as the ETT-lightwand assembly enters the glottis. This is specially suited in patients with cervical spine instability. Others have suggested that the epidural catheter or the wire should be inserted through the “Murphy’s” eye of the ETT. RI using a guide wire together with a flexible fiberscope has also been shown to be very effective as the tip of the ETT can be guided into the glottis under direct vision.

Complications of RI include peritracheal hematoma and tracheal laceration, infection [including soft-tissue neck infection], subcutaneous emphysema, pneumothorax, pneumomediastinum, mediastinitis and trigeminal nerve trauma. Injury to the larynx and vocal apparatus, including recurrent laryngeal nerve damage has been reported, though very rarely.

Advantage of the RI is that it is ideal for patients with cervical spine fractures where C-spine motion is to be avoided. It is a safe alternative strategy if intubation is anticipated to be difficult or impossible. It is effective in cases of failed intubation where bag-mask ventilation is adequate and time is available.

Disadvantage of retrograde intubation is that the technique cannot be used in patients with infected neck

skin. It is not recommended in patients with infectious or neoplastic laryngeal lesions like any other indirect intubation techniques.

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