Airway Adjuncts

11

Pratishtha Yadav, Anju Gupta, and Nishkarsh Gupta

Key Messages

1. Airway adjuncts have evolved from simple Eschmann introducer to advanced Bonfils retromolar intubation scope.
2. Airway adjuncts such as tracheal tube introducers, airway exchange catheters, and stylets are important components of a difficult airway cart.
3. Appropriate use of adjuncts increases the efficacy and success of the primary airway techniques.
4. They are useful in both basic airway maneuvers and in basic and advanced airway techniques.
5. Different airway aids find place in difficult airway algorithms and anesthesiologist must be familiar with the use of at least a few of them.

1 Introduction

Airway management is an important skill required to be mastered by anesthesiologists, intensivists, and emergency physicians and learnt by all clinicians and paramedical staff. Placement of ETT correctly into the laryngeal inlet is the first step for ventilation and oxygenation. Use of direct laryngoscope is an age-old technique to pass the ETT into the laryngeal inlet. Incidence of difficult airway varies from 0.5% to 10% [1–5]. Worst case scenario in any airway management is "cannot intubate and cannot ventilate," which ranges from 0.001% to 0.007% [3]. Managing this life-threatening situation can be quite challenging and can lead to traumatic injuries and catastrophic events [6–8]. Several airway adjuncts like tracheal tube introducers, stylets, and tube exchangers are available to aid in such clinical scenarios. Intubation can be performed mainly by two methods while facing difficult intubation with direct laryngoscopy; first is intubating blindly or under vision using a bougie [9] and second, by passing tracheal tube introducer (TTI) blindly [10] and then railroading endotracheal tube (ETT). In view of their good success rate, these aids are highly recommended by guidelines throughout the world [11, 12].

P. Yadav
Department of Onco-Anaesthesiology and Palliative Medicine, DRBRAIRCH, AIIMS, New Delhi, India

A. Gupta
Department of Anaesthesia, Pain Medicine and Critical Care, All India Institute of Medical Sciences (AIIMS), New Delhi, India

N. Gupta (✉)
Department of Anesthesiology (BRA-IRCH), All India Institute of Medical Sciences (AIIMS), New Delhi, India

R. S. Ubaradka et al. (eds.), *The Airway Manual*, https://doi.org/10.1007/978-981-19-4747-6_11

2 Tracheal Tube Introducers

First TTI was introduced by Sir Robert Reynolds Macintosh in 1949. It was inspired from urethral dilatation catheter and named as "Gum Elastic Bougie" [13]. Based on Macintosh's description, later P.H. Venn designed first purpose-made introducer in 1970s [14]. Since then, various modifications have been done to make them more versatile. It was primarily introduced to aid in intubation, but now their role has been extended for ETT exchange as well to aid in extubation. TTI can be stiffness, single use or reusable, shape, type of distal end (angulated/Coudé or straight), soft versus hard tip, and full versus hollow core (Fig. 11.1).

Features

- Single use (original was sterilized and reusable).
- Polyester core and resin covering—conveys stiffness and flexibility [14].
- Length—600 mm (aids in railroading ETT over the introducer) and diameter—5 mm.
- Adult size fits size 6 or larger ETT and Pediatric size—allows ETT size 4 and up.
- Coudé tip—distal tip angel at 40° (aids in "hooking" under the epiglottis).
- Memory effect—retains shape when bent [15].

Tracheal Tube Introducers

1. Eschmann introducer.
2. Frova intubation introducer.
3. Muallem et tube stylet.
4. Muallem Endotracheal Tube Introducer.
5. Et introducer.
6. Schroeder direction stylet.
7. Introes pocket bougie.
8. Total control introducer.

Fig. 11.1 Eschmann introducer

2.1 Eschmann Introducer (EI) (Smiths Medical, UK)

P.H Venn proposed the basic design which was subsequently manufactured by a British company Eschmann under the name "Eschmann introducer" [14] (Fig. 11.1).

2.1.1 Technique of Use

EI can aid in intubation by directing the ETT towards the "anterior" or narrow larynx. If the epiglottis can be seen (i.e., Cormack Lehane 3) [16], Coudé tip can be hooked under the epiglottis and EI can be directed into the laryngeal inlet, subsequently ETT is railroaded over it.

One of the signs of correct placement is feeling of "clicks." If one turns the EI shallow with respect to the patient after it crosses the cords, "Clicking" sensation can be felt in 90% of the cases [17]. It indicates that the tip is in contact with the tracheal rings, hence correctly placed. These may be absent if EI is in esophagus, or tip is gliding against the posterior tracheal wall or tracheal muscles.

"Hold up" is another phenomenon that can give us a clue of correct placement in almost 100% of the cases [17]. On advancing further, EI may be perceived as deviating towards right and a resistance may be felt called as "hold up" sign. This is due to lodgment of EI in the distal airways at the mark of 30–35 cm. There is a potential risk of airway trauma, hence should be avoided.

After tracheal placement, the ETT can be railroaded over the EI into the trachea. If any resistance is felt, jaw lift-jaw thrust can be applied or ETT can be rotated by 90° counter clockwise to minimize catching of the glottic structures [18]. After intubation, position can be confirmed by conventional methods like end tidal carbon dioxide concentration ($EtCO_2$) and auscultation. If epiglottis is not seen (i.e., Cormach Lehane 4), use of EI is not recommended as chances of failure are high. It can also be used as airway exchange catheter and to place supraglottic airways (SGA) and double-lumen tubes [19].

Traffic light bougie variant [20]—color coded to determine depth of insertion, prevents airway trauma from advancing too far.

- Green color: safe depth (<21 cm).
- Yellow color: possible contact with the carina.
- Red color: high risk of impact with distal airways.

2.2 Frova Intubating Introducer (Cook Inc., Bloomington, IN)

Frova Intubating Introducer has been described as the "gold standard" for difficult intubation by some [21]. First-pass success rate with Frova introducer is like that of EI [22].

The proximal end can be connected via a Rapi-Fit connector to an anesthetic circuit or AMBU. An esophageal detector to can be attached to proximal end to confirm the position of the introducer. Distal end has side ports for conventional/jet ventilation.

Features

- Made of polyethylene (Firmer then EI).
- Single use, length—65 cm, blue coloured (adult).
- Allows ETT 5.5 mm ID and above.
- Coudé tip—35-degree.
- Rigid, removable internal cannula to provide extra stiffness.
- Has a hollow lumen for oxygen delivery.
- Memory effect: retains shape when bent [15].

Pediatric version is 33 cm long, yellow colored and allows ETT from 3 mm to 5 mm internal diameters.

Technique of use: same as EI.

2.3 Muallem Endotracheal Tube Stylet (METTS) (Muallem ET Tube Stylet, VBM Medizintechnik GmbH, Sulz a. N, Germany)

Muallem ET Tube Stylet is a variety of TTI where the conventional polyester core was been replaced by a metal one [23]. This slight modification imparts better memory effect.

Features

- Single use with metal core, flexible preformed soft tip.
- Adult and pediatric type—allows ETTs 3.5 mm and above.

2.4 Muallem Endotracheal Tube Introducer (METTI) [24] (Muallem ET Tube Introducer, VBM Medizintechnik GmbH, Sulz a. N, Germany)

Slightly longer, Length—80 cm (Fig. 11.2).

Use: aid in difficult intubation and Tube exchanger.

Fig. 11.2 Muallem Endotracheal Tube Stylet

2.5 Endotracheal Introducer (EI) (Sun Med, Largo, FL)

Features (Fig. 11.3)
- It is a single use.
- Size and shape similar to the EI Length: 10 cm longer (i.e., 70 cm long).
- Stiffer then the EI (like the Frova).
- 10-cm markings on the top to indicate the depth of insertion
- Adult size fits 6–11 mm ETT tube.
- Paediatric size fits 4–6 mm ETT tube.

Fig. 11.3 Endotracheal Introducer

2.6 Schroeder Directional Stylet (Parker Medical, Englewood, CO)

Schroeder direction stylet is also known as the Parker Flex-It Directional Stylet. It is a disposable device, suitable for aiding both oral and nasal intubations.

Features
- Disposable stylet.
- Shape can be modified during the intubation. On pressing the proximal end with the thumb, the distal end curves directing the stylet towards laryngeal inlet [25].
- Reported to be effective in difficult intubations (DIs) and blind intubations [26].

2.7 Introes Pocket Bougie

Introes pocket bougie (Fig. 11.4) is designed to fit into an airway kit, EMS trauma bag, tactical trauma kit or cargo pant pocket for ease of deployment for an airway rescue.

Features
- Self-lubricated bougie made up of Teflon with a preformed curve.
- Malleable with memory shape.
- Length—60 cm and width—4.7 mm.
- Distal end can be flexed for anterior airway.

Fig. 11.4 Introes Pocket Bougie

2.8 Total Control Introducer (TCI)

TCI (Fig. 11.5) is an of articulating type of TTI. It comprises of three parts—a flexible shaft, articulating tip, and a removable pistol grip handle. Articulating tip can be moved up and down with the help of pistol grip handle. This design of the device permits single operator intubations and easy overall device control. Color coded heads-up markings improve depth awareness. It is specifically designed for video assisted intubation.

Features

- Single use, sterile packaged.
- Length 70 cm, 15 Fr.
- Adult only.
- Fits ETT 6 mm ID and above.
- Compatible with any non-channelled video laryngoscope and blade.

Fig. 11.5 Total Control Introducer. (1) Articulating tip, (2) Intuitive depth control system, (3) Flexible shaft, (4) Removable pistol grip handle

TTI's were primarily introduced to aid in intubation but now their role has been extended to ETT exchange as well as extubation. EI also known as bougie is most used variety in hospitals by virtue of its versatile design. The shape of Schroeder direction stylet can be modified by simply pressing its proximal end, making it suitable for difficult and blind intubations. Last but not the least Introes Pocket bougie, as the name suggests is designed to fit the pocket making it a quintessential for every training resident to overcome any unforeseen DI situation.

3 Airway Exchange Catheter

These are the group of devices designed especially for exchanging ETT. These can be passed through ETT and LMAs before extubation to maintain airway. Proper steps must be followed while using AEC to prevent any adverse event. First step is to optimize the blood oxygenation followed by passage of AEC through existing ETT under direct vision, followed by airway removal. The new airway is then railroaded over the AEC, finally, the position of the airway must be confirmed by conventional technique.

Airway Exchange Catheters

1. Cook's airway exchange catheter.
2. Aintree Intubation Catheter.
3. Shreiden Tube Exchanger.

3.1 Cook Airway Exchange Catheter (Cook Critical Care, Bloomington, Indiana, USA)

Cook airway exchange catheter (Fig. 11.6) is a straight airway exchange catheter with oxygen lumen for tracheal tube exchange [27].

Features
- Single use, hollow catheter of size 8–19 Fr (internal diameter—1.6–3.4 mm).
- Length—45 cm (minimum) to 83 cm (maximum),
- Straight, blunt, soft and flexible tip.
- Proximal end—can be connected to oxygen source, adapter size 15 mm.
- Distal end—side ports to allow emergency oxygenation.
- Markings in centimeter for depth analysis.
- Compatible with ETT size—size 3 and above [28].

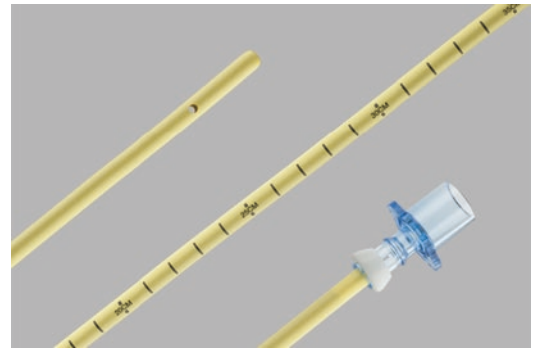

Fig. 11.6 Cook Airway Exchange Catheter

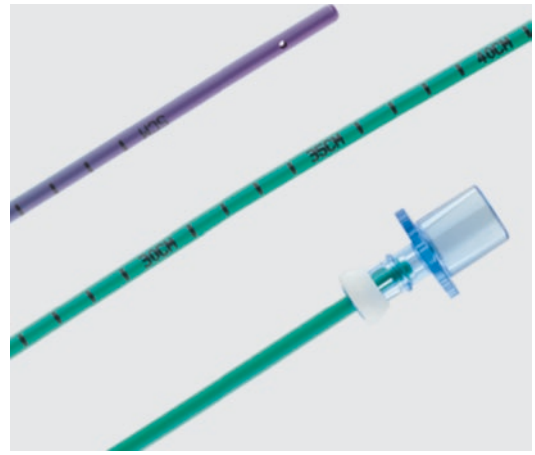

Fig. 11.7 Cook Airway Exchange Catheter: extra firm and soft tip

3.2 Cook Airway Exchange Catheter: Extra Firm with Soft Tip

It is a modification of the original design (Fig. 11.7). It is an extra firm catheter with a blunt, soft and flexible tip. Its firm design facilitates exchange of double-lumen shaft tubes and soft tip makes it atraumatic to internal structures.

Features
- Single use catheter of size 11 and 14 Fr.
- Length 100 cm.
- Compatible with ETT size 4 mm ID and above.
- Proximal end-can be connected to an oxygen source with adapter size 15 mm.
- Distal end-blunt fenestrated to allow air flow.
- Inner diameter—4.7 mm allows fiberoptic bronchoscope to pass.
- Can be used with ETT size 7 and above.

3.2.1 Aintree Intubation Catheter (Cook Critical Care, Bloomington, IN, USA)

Aintree intubating catheter (AIC) is a type of straight exchange catheter (Fig. 11.8) with lumen for fiberoptic bronchoscope [29].

Features
- Single use hollow flexible catheter of size 19 Fr.
- Proximal end-can be connected to an oxygen source with adapter size 15 mm.
- Distal end-blunt fenestrated to allow air flow.
- Inner diameter—4.7 mm allows fiberoptic bronchoscope to pass.
- Can be used with ETT size 7 and above.

Fig. 11.8 Aintree Intubation Catheter

AEC can be used as airway exchange catheter, bronchoscopy-guided tube exchange, unhurried fiberoptic intubation. It can also be used with supraglottic airway (SGA) as follows [30–32].

Unhurried fiberoptic intubation with SGA: In a case of a difficult airway, supraglottic airway is inserted to ventilate the patient. A fiberoptic bronchoscope loaded with AIC is inserted into the SGA and guided into the laryngeal inlet under the guidance of fiberscope. Once in position, FOB is removed along with the SGA leaving AIC in position. ETT size 7 or more can be railroaded over the AEC with the help of direct laryngoscopy. AEC is removed at the end of the procedure.

3.3 Sheridan Tracheal Tube Exchanger (Sheriden Catheter Corp., Oregon, NY)

Sheriden tracheal tube exchanger (Fig. 11.9) is a new tube exchanger developed to facilitate quick and efficient tube exchange. It serves similar function as Cook airway exchange catheter.

Features

- Flexible material.
- Frosted surface.
- Length—56 cm to 81 cm.
- Different sizes available.
- ETT 2.5 mm ID and above.
- Depth markings present.

Fig. 11.9 Sheridan Tracheal Tube Exchanger

The chief role of Airway exchange catheter is to maintain access to the airway even after extubation. Breakthrough in the design was introduction of Aintree intubation catheter. It is a straight exchange catheter with lumen for fiberoptic bronchoscope. This slight modification is ideal for permitting an unhurried fiberoptic intubation following SGA placement. Apart from being a primary intubation tool it is also useful for bronchoscopy-guided tube exchange.

4 Stylets

4.1 Simple Stylet

A simple stylet (Fig. 11.10) is an intubating aid made up of a metal rod coated with plastic. It is designed to be placed inside the ETT lumen, to provide extra stiffness and malleability. Shape of ETT with stylet can be modified as per clinician's choice, patient's position, and anatomy. Care must be taken to avoid protrusion of stylet beyond the ETT tip, avoiding airway trauma. The most preferred shape is straight till cuff then 35° or less angle near the tip like a hockey stick [33]. Once the tip of ETT crosses the vocal cords, stylet must be withdrawn to avoid any injury. Stylet is one of the simplest intubation aids used to assist intubation. Over the years number of up-gradations have been done like adding a light source, fiberoptic cable, etc. to increase its versatility.

Fig. 11.10 Simple Stylet

4.2 Optical Stylets

The use of lighted stylets can be dated back to 1956, when it was used to assist orotracheal intubation by Macintosh and Richards [34]. It was first described to be used under direct vision using a laryngoscope. The technique of transillumination to guide the tip of the ETT into the trachea was popularized much later by Yamamura and colleagues in 1959 [35]. Transillumination technique is since trachea is located superficially in front of the neck, anterior to the esophagus. A light source passing through the tracheal lumen will give a well circumscribed glow in front of neck, ensuring the correct position of ETT in the trachea. However, if the glow is diffused and not readily visible in ambient light, there is a possibility of esophageal intubation.

Optical Stylet

A. Trachlight.
B. Shikani Optical Stylet.
C. Clarus Video Stylet.
D. Levitan Fibreoptic Stylet.
E. Bonfils Retromolar Intubation Fibers.

Earlier varieties were short and rigid, with poor light intensity and no connector to secure ETT to the stylet. Number of modifications have been made over time to address these shortcomings which will be discussed in next section [36–39].

4.3 Trachlight (Laerdal Medical Corp., Wappingers Falls, NY)

Trachlight was introduces in 1995 with a superior design as compared to its predecessors. It is longer, more flexible with a better light source and suitable for both oral and nasal intubation. It comprises of a reusable handle, a flexible wand, and a retractable metal wire stylet. The handle comprises of power source which illuminates the light source. The flexible wand or stylet is a flexible plastic shaft with bulb at distal end. To avoid thermal injury from heated bulb as a safety measure, the bulb starts blinking once 30 s have elapsed. Length of the flexible wand can be adjusted with the help of plastic connector as per requirement. The most important component is retractable malleable wire stylet which guides the Trachlight into the glottis. Proper preparation and meticulous use of lighted stylet can ensure easy and successful intubation.

4.3.1 Technique

All the three components of stylet are attached together as a single unit prior to use. ETT is to be loaded over the unit and fixed with the help of a clamp on the handle. Lubricants like silicone fluid can be used to ensure easy retraction of ETT later. Once loaded, the length is adjusted to keep the light bulb near the ETT tip but not protruding beyond the tip. The ETT-Trachlight unit (ETT-TL) shape can be adjusted prior to use. Most used configuration is a hockey stick like bend, with a 90-degree angle just proximal to the cuff of the tube. Once inside the trachea, this 90-degree bend projects the light towards the skin over anterior part of the neck. In obese patients more acute bend (>90°) is suggested to provide better illumination in short thick neck. The tip of ETT must be lubricated to facilitate easy passage prior to use.

4.3.2 Patient Position

Neutral position or slight extension of head and neck is recommended during the procedure. The head of the table or bed must be adjusted as per clinician's height ensuring good visualization of anterior aspect of patient's neck. Sniffing position is not favorable as it opposes epiglottis to the posterior pharyngeal wall making the passage of stylet difficult.

Ambient lighting conditions are appropriate in most of the cases. Dimming of room light may be required in special conditions like obese patients or thick neck. If control of ambient light is not feasible, shading the neck with hand maybe be helpful.

4.3.3 Orotracheal Intubation

For intubation standard steps like preoxygenation, adequate muscle relaxation and proper positioning is recommended. Muscle relaxation has demonstrated higher success rates, fewer attempts, and decreased intubation time [40]. Clinician stands at the head end of the patient with clear visibility of front of neck. With the nondominant hand, jaw or mandible is pulled forward to prevent back falling of the tongue. Same hand is kept close to the angle of the mouth to ensure clear passage of stylet into the oral cavity. Dominant hand is used to hold the lighted stylet, and guide ETT-TL unit through middle of the mouth. Keeping the unit in midline, device is advanced in an imaginary arch in sagittal plane. The ETT-TL unit is gently progressed towards larynx under visual guidance till transillumination is visible in front of neck. A jaw lift or tongue retraction can elevate epiglottis and enhance passage of ETT-TL under the epiglottis. A well-defined glow in front of neck indicates that the ETT-TL has crossed the vocal cords. The inner wire stylet is then withdrawn by 10 cm to make the wand more pliable, reducing the chances of injury. Externally the glow can be seen migrating down the neck, later disappearing at the sternal notch. Now the clamp can be released, optical stylet is withdrawn keeping ETT in situ. The cuff is inflated, position of the ETT is confirmed using auscultation and capnography.

Glow in front of neck may not be visible clearly in obese patients. Neck extension with support under the shoulders may be helpful. Retraction of breast or chest wall tissue away from neck along with dimming of ambient light may help enhance transillumination.

4.3.4 Nasotracheal Intubation

Light guided nasotracheal intubation is useful in blind nasal intubation in emergency situations with limited mouth opening and cervical instability. The preparation requires use of vasoconstrictor nasal spray to minimize the bleeding. The whole unit ETT-TL can be kept in warm water prior to use to soften it making it less traumatic. Water based lubricant can be applied to nostril prior to procedure to allow easy passage. While using nasal Ring Adair Elwyn (RAE) ETT for nasal intubation, the wire stylet is pulled out by about 15 cm to straighten up the RAE tube.

The patient is positioned in neutral or slight extended position of head and neck, jaw thrust is applied to retract epiglottis. The Trachlight is turned on when the unit reaches the oropharynx. The manipulation of tip can be difficult due to absence of internal wire stylet. There is a tendency of ETT to move posteriorly which can be counteracted by flexing the neck. If flexion is contraindicated, cuff can be inflated, redirecting the tip anteriorly towards the glottis [41]. Once beyond the glottis, tracheal rings can be identified, Trachlight is withdrawn keeping ETT in situ. Final position can be confirmed by auscultation and capnography.

4.3.5 Role in Difficult Airway

Optical stylets have shown good success rates in anticipated and unanticipated difficult intubations [42], including patients with Mallampati 3/4 [43], restricted mouth opening [44], severe burn contractures [45], Pierre

Robin syndrome [46] or craniofacial abnormalities in pediatric patients [47], cervical spine abnormalities [48], and pediatric tongue flap surgery [49].

Although optical stylets have shown good success rate, but its success primarily depends upon the principle of transillumination. Use of optical stylet is limited in abnormalities of upper airway like tumors, polyp, trauma, excess neck fat, etc. or any abnormality that may obscure transillumination.

Complications reported include trauma to airway mucosa, pushing back of epiglottis into laryngeal inlet along with ETT [50], laryngeal damage, subluxation of cricothyroid cartilage [51].

4.3.6 Fiberoptic and Video Intubating Stylet

Fiberoptic stylets are the stylets which utilizes fiberoptic bundle or video to visualize glottis through proximal eyepiece. These can be used with or without direct laryngoscopy as an aid to intubation under direct vision. These are portable and easy to use. These can be classified as rigid or semirigid based on their design. They comprise of a curved steel plate containing fiberoptic bundle or video apparatus which helps navigate through the oral cavity. Rigid stylets include the Bonfils Retromolar Intubation Fiberscope and Video Rigid Flexible laryngoscope. Examples of semirigid stylets are Shikani optical stylet (SOS) and Levitan/First-pass scope (FPS).

Fiberoptic and Video intubation stylets have shown significant potential as adjunctive devices in difficult airways as well as a rescue device.

4.4 Shikani Optical Stylet (Clarus Medical, Minneapolis, MN)

Shikani optical stylet (SOS) is a type of semirigid optical stylet first described in 1999 [52]. This device uses fiberoptic bundle for light and image transmission.

SOS has a limited depth of vision of around 1 cm. Moreover, due to angulated shape there is difficulty in passing stylet much beyond the vocal cords.

Features

- Inexpensive, reusable.
- Round malleable stylet with angle of 70–80°.
- Adult: Internal diameter 5.5 mm, supports ETT 5.5–9.0 mm ID.
- Paediatric version: Internal diameter 3–5 mm, supports ETT 3.5–5 mm ID.
- Parts:
  - Shaft has a fibreoptic cable connected to camera and video monitor.
  - Malleable distal end—adjustable distal angle as per patient's anatomy.
  - Adjustable stop at proximal portion of stylet to hold ETT in position.
  - Oxygen port for oxygen insufflation and delaying desaturation [53].
- High resolution and fixed focus eye piece with halogen light.
- Limited depth of vision—can focus up to 1 cm only.
- May be used with or without direct laryngoscopy.

It is reported to facilitate intubation with Intubating Laryngeal Mask Airway also.

4.4.1 Procedure

ETT is loaded on the stylet, with the distal end positioned just proximal to the ETT tip with the help of tube stop. To avoid fogging the tip of the stylet can be warmed with warm saline or warm blanket or one can use antifog solution at the tip. Dominant hand is used to hold the stylet loaded with ETT. The whole unit is directed through middle of the oral cavity, with the nondominant hand stabilizing the jaw with forward thrust making room for the stylet. The entire stylet is advanced under direct vision along the curvature of the tongue under direct vision. With gentle manipulations stylet can be guided behind the epiglottis into the glottic opening. It is important to ensure that the primary motion of the scope is rotation to avoid advancing the scope into the hypopharynx. The same procedure can be done along with direct laryngoscopy, where the epi-

glottis is identified with the help of laryngoscope and then the stylet is guided behind it into the glottis. Once inside, the ETT is left in place and the stylet is slowly withdrawn with rotating movement. Finally, position is confirmed by auscultation and capnography.

SOS can be used in routine as well as difficult intubation. One of the limitations is fogging or obscuring of the vision with blood or secretion.

4.5 Clarus Video System (Clarus Medical, Minneapolis, MN)

Features (Fig. 11.11)
- Durable, affordable, portable.
- Stylet length—31.7 cm, diameter—5.01 mm.
- ETT tube size range—5.5–9.0 mm.
- Atraumatic tip with wide-angle view.
- Additional red LED.
- Stylet can be soaked in chemicals for safe and efficient sterilization.
- Rechargeable battery.

Clarus video system is a modification of SOS with a camera and a 4-in. liquid crystal display screen. Stylet is made more malleable than SOS and has a red LED near the stylet tip, which helps in transillumination if the view gets obscured by secretions or blood. Lastly the power source is a rechargeable battery system instead of disposable batteries as in SOS.

Fig. 11.11 Clarus Video System

4.6 Levitan Fiberoptic Stylet (Clarus Medical, Minneapolis, MN)

FPS is a semirigid fiberoptic stylet like SOS with small alterations. Unlike other optical stylets it is designed only for direct laryngoscopy.

Features
- Malleable stylet with atraumatic tip.
- Length—short (30 cm).
- Gentler curve near the tip (45°) which is suitable for most airways.
- Size—one size, suitable for ETT 5.5–9 mm ID.
- No tube stopper. The length is short enough to allow ETT to be fitted directly without a need of tube stop.
- The handle has a battery pack with a high-resolution eyepiece at the top.
- Stylet can be soaked in chemicals for sterilization.

4.7 Bonfils Retromolar Intubation Fiberscope (Karl Storz GmbH, Tuttlingen, Germany)

Bonfils retromolar intubation fiberscope was first described by Bonfils in 1983 for intubating children with Pierre Robin Syndrome by retromolar approach [54].

Features
- Rigid, straight fibreoptic device.
- Light weight, durable and portable.
- Length—40 cm and outer diameter (OD)—5 mm.
- 40-degree angle at the tip
- Angle of view 110-degree.
- Proximal end—handle with eyepiece.
- Working channel within shaft—1.2 mm wide, used to deliver drug for "spray as we go" technique.
- Adult (5 mm OD) and paediatric (2 mm and 3.5 mm OD) version.

4.7.1 Preparation and Intubation Technique

Preparation involves lubricating and loading of the ETT over the scope body. ETT is fixed with the help of ETT holder in such a way that the proximal end of scope is near but does not extend beyond the tip of ETT. Oxygen insufflation and the suctioning can be done via working channel from within the loaded ETT. Oxygen insufflation prevents the fogging and helps disperse the secretions away from lens tip. Prior to use, focus must be checked, and camera must be oriented correctly. Patient is positioned in neutral position and height adjusted as per comfort of the clinician.

Non dominant hand is used to retract the mandible and pull tongue and epiglottis away from the posterior pharyngeal wall, whereas the scope is held in the dominant hand. In the retromolar approach, the scope is inserted from the right sided angle of the mouth. The scope is swept along the molars over the tongue gradually advancing towards the epiglottis. Passing below the epiglottis, glottis is identified, and scope is carefully guided through the glottic aperture. ETT is railroaded into the trachea, scope is withdrawn, and final position is checked with auscultation and capnography. An alternate approach is advancing the scope from the midline.

Versatile design of Bonfils allows successful intubation in normal airways, difficult airways as well as for awake intubation [55]. It requires minimal mouth opening, lesser teeth leverage and associated with less airway trauma and hemodynamic instability.

5 Conclusion

Airway adjuvants vary from simple to sophisticated pieces of equipment which enhances the efficacy of airway techniques, thus contributing to the safety of airway management. They find applications in managing both anticipated and unanticipated difficult airway management. When appropriately used this equipment can significantly reduce risk of major airway complications. Their role encompasses all phases of AM, from intubation to extubation. Ability to combine them with other intubation aids enables anesthesiologist to manage complex and difficult airway situations.

References

1. Shah PN, Sundaram V. Incidence and predictors of difficult mask ventilation and intubation. J Anaesthesiol Clin Pharmacol. 2012;28:451–5.
2. Kheterpal S, Han R, Tremper KK, et al. Incidence and predictors of difficult and impossible mask ventilation. Anesthesiology. 2006;105:885–91.
3. Crosby E. The unanticipated difficult airway–evolving strategies for successful salvage. Can J Anaesth. 2005;52:562–7.
4. Arne J, Descoins P, Fusciardi J, et al. Preoperative assessment for difficult intubation in general and ENT surgery: predictive value of a clinical multivariate risk index. Br J Anaesth. 1998;80:140–6.
5. Rose DK, Cohen MM. The incidence of airway problems depends on the definition used. Can J Anaesth. 1996;43:30–4.
6. Hove LD, Steinmetz J, Christoffersen JK, Moller A, Nielsen J, Schmidt H. Analysis of deaths related to anesthesia in the period 1996–2004 from closed claims registered by the Danish Patient Insurance Association. Anesthesiology. 2007;106(4):675–80.
7. Peterson GN, Domino KB, Caplan RA, Posner KL, Lee LA, Cheney FW. Management of the difficult airway: a closed claims analysis. Anesthesiology. 2005;103(1):33–9.
8. Cook TM, Woodall N, Frerk C. Fourth National Audit P. Major complications of airway management in the UK: results of the Fourth National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society Part 1: anaesthesia. Br J Anaesth. 2011;106(5):617–31.
9. Stasiuk RB. Improving styletted oral tracheal intubation: rational use of the OTSU. Can J Anaesth. 2001;48(9):911–8.
10. Kidd JF, Dyson A, Latto IP. Successful difficult intubation. Use of the gum elastic bougie. Anaesthesia. 1988;43(6):437–8.
11. Difficult Airway Society. Unanticipated difficult tracheal intubation during routine induction of anaesthesia in an adult patient. 2015.
12. Apfelbaum JL, Hagberg CA, Caplan RA, Blitt CD, Connis RT, Nickinovich DG, Hagberg CA, Caplan RA, Benumof JL, Berry FA, Blitt CD, Bode RH, Cheney FW, Connis RT, Guidry OF, Nickinovich DG, Ovassapian A, American Society of Anesthesiologists Task Force on Management of the Difficult Airway. Practice guidelines for management of the difficult airway: an updated report by the American Society of Anesthesiologists Task Force on Management of the Difficult Airway. Anesthesiology. 2013;118(2):251–70.

13. Macintosh RR. An aid to oral intubation. BMJ. 1949;1:28.
14. Henderson JJ. Development of the 'gum-elastic bougie'. Anaesthesia. 2003;58(1):103–4.
15. Nolan JP, Wilson ME. An evaluation of the gum elastic bougie. Intubation times and incidence of sore throat. Anaesthesia. 1992;47(10):878–81.
16. Cormack RS, Lehane J. Difficult tracheal intubation in obstetrics. Anaesthesia. 1984;39:1105–11.
17. Kidd JF, Dyson A, Latto IP. Successful difficult intubation: use of the gum elastic bougie. Anaesthesia. 1988;43:437–8.
18. Hagberg CA. Special devices and techniques. Anesthesiol Clin North America. 2002;20:907–32.
19. Arisaka H, Sakuraba S, Furuya M, et al. Application of gum elastic bougie to nasal intubation. Anesth Prog. 2010;57:112–3.
20. Paul A, Gibson AA, Robinson OD, Koch J. The traffic light bougie: a study of a novel safety modification. Anaesthesia. 2014;69(3):214–8.
21. Evans H, Hodzovic I, Latto IP. Tracheal tube introducers: choose and use with care. Anaesthesia. 2010;65(8):859.
22. Hodzovic I, Latto IP, Wilkes AR, et al. Evaluation of Frova, singleuse intubation introducer, in a manikin: comparison with Eschmann multiple-use introducer and Portex single-use introducer. Anaesthesia. 2004;59:811–6.
23. Muallem M. Endotracheal tube introducer: an aid for the difficult airway. Middle East J Anaesthesiol. 2000;15(6):687–92.
24. Muallem MK, Azar MS, Gerges FJ, Nasr VG, Baraka A. Muallem endo-tracheal tube introducer: (METTI)–an aid for the difficult airway. Middle East J Anaesthesiol. 2005;18(2):385–9.
25. Levitan R, Ochroch EA. Airway management and direct laryngoscopy: a review and update. Crit Care Clin. 2000;6:v:373–88.
26. Weiss M. Management of difficult tracheal intubation with a video-optically modified Schroeder intubation stylet. Anesth Analg. 1997;85:1181–2.
27. McLean S, Lanam CR, Benedict W, Kirkpatrick N, Kheterpal S, Ramachandran SK. Airway exchange failure and complications with the use of the Cook Airway Exchange Catheter: a single center cohort study of 1177 patients. Anesth Analg. 2013;117(6):1325–7.
28. Choi EK, Kim JE, Soh SR, Kim CK, Park WK. Usefulness of a Cook airway exchange catheter in laryngeal mask airway-guided fiberoptic intubation in a neonate with Pierre Robin syndrome—a case report. Korean J Anesthesiol. 2013;64(2):168–71.
29. Atherton DP, O'Sullivan E, Lowe D, Charters P. A ventilation exchange bougie for fibreoptic intubations with the laryngeal mask airway. Anaesthesia. 1996;51(12):1123–6.
30. Heard AM, Lacquiere DA, Riley RH. Manikin study of fibreoptic-guided intubation through the classic laryngeal mask airway with the Aintree intubating catheter vs the intubating laryngeal mask airway in the simulated difficult airway. Anaesthesia. 2010;65(8):841–7.
31. Malcharek MJ, Rockmann K, Zumpe R, Sorge O, Winter V, Sablotzki A, Schneider G. Comparison of Aintree and Fastrach techniques for low-skill fibreoptic intubation in patients at risk of secondary cervical injury: a randomised controlled trial. Eur J Anaesthesiol. 2014;31(3):153–8.
32. Cook TM, Seller C, Gupta K, Thornton M, O'Sullivan E. Nonconventional uses of the Aintree Intubating Catheter in management of the difficult airway. Anaesthesia. 2007;62(2):169–74.
33. Levitan RM, Pisaturo JT, Kinkle WC, et al. Stylet bend angles and tracheal tube passage using a straight-to-cuff shape. Acad Emerg Med. 2006;13:1255–8.
34. Macintosh R, Richards H. Illuminated introducer for endotracheal tubes. Anaesthesia. 1957;12:223–5.
35. Yamamura H, Yamamato T, Kamiyama M. Device for blind nasal intubation. Anesthesiology. 1959;20:221.
36. Vollmer TP, Stewart RD, Paris PM, et al. Use of a lighted stylet for guided orotracheal intubation in the prehospital setting. Ann Emerg Med. 1985;14:324–8.
37. Ellis DG, Stewart RD, Kaplan RM, et al. Success rates of blind orotracheal intubation using a transillumination technique with a lighted stylet. Ann Emerg Med. 1986;15:138–42.
38. Ainsworth QP, Howells TH. Transilluminated tracheal intubation. Br J Anaesth. 1989;62:494–7.
39. Weis FR, Hatton MN. Intubation by use of the light wand: experience in 253 patient. J Oral Maxillofac Surg. 1989;47:577–80.
40. Masso E, Sabate S, Hinojosa M, Vila P, Canet J, Langeron O. Lightwand tracheal intubation with and without muscle relaxation. Anesthesiology. 2006;104:249–54.
41. Hung OR. Nasal intubation with the Trachlight. Can J Anaesth. 1999;46:907–8.
42. Hung OR, Pytka S, Morris I, et al. Lightwand intubation: II. Clinical trail of a new lightwand to intubate patients with difficult airways. Can J Anaesth. 1995;42:826–30.
43. Rhee KY, Lee JR, Kim J, et al. A comparison of lighted stylet (Surch-Lite) and direct laryngoscopic intubation in patients with high Mallampati scores. Anesth Analg. 2009;108:1215–9.
44. Favaro R, Tordiglione P, Di Lascio F, et al. Effective nasotracheal intubation using a modified transillumination technique. Can J Anaesth. 2002;49:91–5.
45. Bhardwaj A, Kidwai SN, Verma V, et al. Continuous anesthetic insufflation and topical anesthesia of the airway using Trachlight in chronic facial burns. Anesth Analg. 2006;102:334.
46. Iseki K, Watanabe K, Iwama H. Use of the Trachlight for intubation in the Pierre-Robin syndrome. Anaesthesia. 1997;52:801–2.
47. Xue FS, Yang QY, Lio X, et al. Lightwand guided intubation in paediatric patients with a known dif-

ficult airway: a report of four cases. Anaesthesia. 2008;63:520–5.
48. Gille A, Komar K, Schmidt E, Alexander T. Transillumination technique in difficult intubations in heart surgery. Anasthesiol Intensivmed Notfallmed Schmerzther. 2002;37:604–8.
49. Garg R. Trachlight for airway management in tongue flap division surgery. Paediatr Anaesth. 2009;19:279–80.
50. Aoyama K, Takenaka I, Nagaoka E, et al. Potential damage to the larynx associated with light-guided intubation: a case and series of fiberoptic examinations. Anesthesiology. 2001;94:165–7.
51. Debo RF, Colonna D, Dewerd G, Gonzalez C. Cricoarytenoid subluxation: complication of blind intubation with a lighted stylet. Ear Nose Throat J. 1989;68:517–20.
52. Shikani AH. New "seeing" stylet-scope and method for the management of the difficult airway. Otolaryngol Head Neck Surg. 1999;120:113–6.
53. Agrò F, Cataldo R, Carassiti M, Costa F. The seeing stylet: a new device for tracheal intubation. Resuscitation. 2000;44:177–80.
54. Bonfils P. Difficult intubation in Pierre-Robin children, a new method: the retromolar route [in German]. Anaesthesist. 1983;32:363–7.
55. Mihai R, Blair E, Kay H, Cook TM. A quantitative review and meta-analysis of performance of non-standard laryngoscopes and rigid fibreoptic intubation aids. Anaesthesia. 2008;63:745–60.