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WHAT'S NEW IN LARYNGOSCOPES?

G. Lotz and C. Byhahn

INTRODUCTION

Andreas Vesalius first described endotracheal intubation and artificial respiration of animals in 1543. In 1878, the British surgeon William McEwen performed the first oral intubation [1] using a blind digital technique. Progress in direct laryngoscopy, however, was limited by inadequate light sources. In 1895, Alfred Kirstein invented the first laryngoscope with transmitted light [2, 3]. In 1913, Chevalier Jackson added a tungsten bulb as a light source [4]. In the same year, Henry Janeway developed the first battery-powered open-sided laryngoscope [5]. Robert Miller, in 1941, designed a blade with a curve on the bottom and a curved distal tip, known as the

Miller blade [6]. Robert Macintosh designed a blade with a continuous curve in 1943 [7], which was designed to reduce the chance of damage to the patient's upper teeth.

Endotracheal anesthesia slowly gained popularity over insufflation anesthesia. Nevertheless, in the 1920s, direct laryngoscopy had become an essential part of anesthetic practice.

Direct laryngoscopy requires a straight line of vision from the operator's eye to the glottic aperture, which cannot always be achieved even with optimal positioning of the patient's head. Numerous modifications of both Macintosh and Miller blades have been made over the last 70 years, ►

in order to provide more optimal intubation conditions for patients with a particular and more difficult airway anatomy.

Highlights in previous decades include the McCoy blade, a Macintosh blade with a levering tip. The lever allows the user to adjust the tip's angle during direct laryngoscopy, thereby lifting the epiglottis to improve laryngeal view [8].

The Dörge's Emergency Laryngoscope Blade (Karl Storz Endoscopy, Tuttlingen, Germany) is a universal blade for patients >10 kg, which combines features of both the Macintosh and Miller blades. It is inserted into the oropharynx to an appropriate depth that correlates with patient size [9].

Technological advances in the last decade have included the invention of high-power light-emitting diodes (LEDs). LEDs have become the standard light source for modern laryngoscopes. In combination with fibreoptic transmission of light, the light source may be located in either the laryngoscope handle or the blade. As costs for LEDs are low, single-use laryngoscopes or single-use blades are an affordable alternative, especially for equipment stored in rarely used emergency bags or carts. Modern rechargeable lithium-ion batteries allow for longer battery life.

Regardless of the fact that, during the last two decades, numerous supraglottic airway devices have been developed as an alternative to endotracheal intubation in patients with a difficult airway, endotracheal intubation is still considered the gold standard for ventilating a patient.

Indirect laryngoscopy, that does not require a direct view of the larynx and thus a straight line between the eye of the operator and the glottic area, was first described in 1829 [10]. Flexible fiberoptic intubation is

a technique allowing for indirect visualisation of the larynx but does not always guarantee easy insertion of the endotracheal tube. It did not prove to be a general solution for the unexpected difficult airway.

The most recent innovations in modern indirect laryngoscopy are video laryngoscopes, which have significantly improved both teaching and training in airway management. [11–13]. Compared with direct laryngoscopy, clinical studies suggest that the rate of difficult or failed intubating attempts are lower with most video-based devices. A recent meta-analysis, however, was unable to demonstrate a clear superiority of video-assisted intubating techniques in patients with an unexpected difficult airway [14].

Advances in video technology (charge-coupled device controllers) and display technology (high-resolution small liquid crystal displays (LCD)) combined with the previously described technological advances (LED, batteries) contributed to the development of small, light-weight and portable devices.

This article aims to give a comprehensive overview of the currently available rigid, portable laryngoscopes or laryngoscope-like devices for indirect laryngoscopy using video techniques.

Airtraq® optical laryngoscope (Prodol Medical S. A., Guecho, Spain)

The Airtraq® optical laryngoscope is the least expensive device reviewed in this article. It is a disposable optical laryngoscope with a guiding channel on the right side of the blade. The manufacturer recommends a Macintosh approach but a Miller approach is also possible. A standard endotracheal tube (ETT) up to 8.5 mm inner diameter (ID) can be used with the device. Features include an anti-fogging system to guarantee a clear

view. The Airtraq® has a connector for oxygen insufflation.

The standard Airtraq® is available in four different sizes, from infant (ETT size 2.5–3.5 mm) up to regular adult (ETT size 7.0–8.5 mm).

The Airtraq® DL is specifically designed to facilitate insertion of double lumen endobronchial tubes and Univent tubes for thoracic surgery. It can be used with double lumen tubes of sizes 35, 37, 39 and 41 French. The rigid stylet within the double lumen tube needs to be removed before inserting the tube into the guiding channel of the Airtraq® DL.

The Airtraq® NT is designed for nasotracheal intubation (available sizes: infant and adult) and lacks a guiding channel. It is inserted into the patient's mouth and allows to direct a nasally introduced ETT into the larynx under indirect vision.

In mannequin studies with the standard Airtraq®, both novice users and experienced anaesthetists had higher success rates for intubation than with Macintosh blades [15–18]. In another recent mannequin study, users preferred the Airtraq® over Glidescope® and McGrath® Series 5 [26].

TruView EVO2™ (Truphatek International Ltd., Netanya, Israel)

The TruView EVO2™ is a rigid indirect optical laryngoscope with LCD screen accessory. It utilizes 42-degree refraction from the line of sight to enlarge the view field. All green system battery handles can be used. The TruView EVO2™ is available in four different sizes from infant to adult.

The TruView EVO2™ is used like a Macintosh blade in a midline approach. The use of a OptiShape™ stylet is recommended.

An oxygen flow of 8–10 L·min⁻¹ can be applied for apnoeic oxygenation. This is also used to sweep away secretions and prevent fogging.

The TruView EVO2™ blade is reusable and can be sterilised. A Premier LCD monitor or an endoscopic camera head can be attached to the device.

In one study, the TruView EVO2™ showed advantages over the Macintosh blade, including better view of the larynx and a higher success rate for intubation [19]. In other studies, it allowed better view of the larynx. However, it did not facilitate but instead prolonged intubation without increase in success rates [18, 20, 21].

[Pentax Airwayscope AWS® \(Pentax, Tokyo, Japan\)](#)

The Pentax AWS® is a “classic” video laryngoscope with an LCD colour screen attached to the handle, a battery case and a video out port. A disposable Pentax PBlade® must be mounted on top of the light bundle and connected to the handle with a locking ring.

The blade has a guiding channel, in which the ETT (maximum size 8.0 mm ID) is preloaded, and a separate suction channel. A Miller blade approach is recommended.

Features of the Pentax AWS® include an anti-fog mechanism, battery indicator and auto-off feature. The PBlade® offers a suction port.

In a small mannequin study, the Pentax AWS® showed advantages over the TruView EVO2™ and the Glidescope® video laryngoscope in the management of the difficult airway [18].

In patients with cervical spine immobilisation, the Cormack-Lehane glottis view was significantly better with the Pentax AWS® compared with the Macintosh blade CTrach™. Intubation was successful in all patients [22]. Success rate was better than using the LMA CTrach™ [31].

[Storz C-MAC® \(Karl Storz GmbH & CoKG, Tuttlingen, Germany\)](#)

The C-MAC® video laryngoscope comes with regular reusable Macintosh blades. It offers a large 7” colour display. The approach is the same as with direct laryngoscopy. Ideal for teaching purposes, the device allows the trainee to perform a direct laryngoscopy under supervision by his tutor who can watch the procedure on the LCD.

Standard ETTs are used and there are no restrictions for tube sizes. The C-MAC® has no video out port but comes with a SD card. Screenshots and video sequences can be captured and transferred *via* USB. The blades can be re-sterilised and the display is waterproof.

In a mannequin study with a simulated difficult airway, the C-MAC® significantly improved the airway score by 1–2 grades and improved intubation success five-fold [23, 24].

[Glidescope® Video Laryngoscopes \(GVL®\) Cobalt and Ranger \(Verathon Medical Inc., Bothell, WA, USA\)](#)

The GVL® Cobalt comes with a reusable video baton with a high resolution image, shown on a 7” display. The GVL® Cobalt is available in two sizes. The small version is for patients, who weigh <10 kg and the large for patients >10 kg. Reusable and disposable blades come in four sizes. The blades have a slightly greater curvature than regular Macintosh blades. Cormack-Lehane grade view is improved using the GVL®. Because the camera is angled and provides a more anterior view of the larynx, it may prove difficult for the beginner to place the ETT. It is advisable to use the GlideRite® Rigid Stylet, a custom curved intubation stylet offered by the manufacturer.

Both GVL® models are battery powered and use an anti-fog

mechanism consisting of multiple heating elements. The GVL® Cobalt has a video output. It is not waterproof.

The GVL® Ranger is a smaller and more rugged video laryngoscope than the GVL® Cobalt. It is waterproof. Its transreflective display is smaller than the one of the GVL® Cobalt. It is intended for use in emergency medicine.

An optional accessory for both Glidescope® devices is the Glidescope® DVR, an attachable digital video recorder that comes with a SD memory card for recording.

The entire GVL® family does not allow direct laryngoscopy.

In several studies the GVL® improved laryngeal view during intubation. It did not consistently improve success rates for intubation [25–29].

[LMA CTrach™ \(LMA Deutschland GmbH, Bonn, Germany\)](#)

The CTrach™ is not derived from a laryngoscope but from the intubating laryngeal mask airway, a supraglottic device that allows blind placement of an ETT. The CTrach™ is a laryngeal mask airway with a built-in fiberoptic with 3.5” colour LCD screen that provides visualisation of the glottic aperture. It is used like the LMA Fastrach™. After placement of the mask, the patient can first be ventilated through this supraglottic device. Then the CTrach™ Viewer is attached to a magnetic latch connector. A special ETT is now being placed under indirect vision of the camera eye into the trachea. Once the patient’s trachea is intubated, the viewer is removed and the mask is removed, leaving only the ETT in place.

A major advantage of the CTrach™ over the other devices discussed in this article is the possibility to ►

continuously ventilate the patient during the procedure.

Using the CTrach™ for intubating morbidly obese patients provided better oxygenation than direct laryngoscopy [30]. In a small study, with patients with cervical spine immobilisation, Macintosh blade and Pentax AWS® had advantages over the LMA CTrach™ [31].

McGrath® Series 5 (Aircraft Medical Ltd., Edinburgh, UK)

The McGrath® Series 5 video laryngoscope consists of a steel-bodied camera stick with an LED light source and a tiltable LCD, mounted at its proximal end. The stick is inserted into a disposable optical blade. It can be adjusted into three different positions resulting in different lengths of the blade. This allows better customisation of the device for different anatomical conditions. The device uses a single standard or rechargeable AA battery inserted into the handle, which powers the device for up to 2 h.

The approach is a modified midline approach similar to normal

Macintosh blades. The use of a malleable stylet is recommended. Bending the ETT in a hockey stick shape facilitates its advancement through the vocal cords. As it has no anti-fog system, the use of a special anti-fog solution is advisable.

In a case series the McGrath® Series 5 was shown to be effective and safe [32].

In a recent mannequin study with simulated difficult airways, the McGrath® Series 5 provided better view of larynx and facilitated intubation compared with Glidescope® or direct laryngoscopy [26].

CONCLUSION

After 70 years of direct laryngoscopy, it seems that with the latest technological advances indirect, video-based laryngoscopy is becoming a serious alternative. It can be used for teaching and training as well as for managing normal and difficult airways. These modern devices are

lightweight, portable, safe and easy to use.

Users should familiarise themselves with the particular device they intend to use for the unexpected difficult airway. This can be achieved best by using the device in the daily routine.

This article describes eight video-based devices currently available. They all have common features and distinct differences. In studies, all of the devices showed to be equal or superior to direct laryngoscopy. However, most studies are heterogenous with small numbers, making interpretation of the data difficult to impossible. Despite of the fact that a few studies have become available, which compare the performance of one of the devices against another [18, 19, 22, 23, 24, 26], data are sparse and sufficient evidence to give a general recommendation for one video laryngoscope over another is lacking at this time.

Before picking one device as the standard within one's department, all pros and cons should be carefully considered. ■

SUPPLIER DETAILS

Airtraq® optical laryngoscope

For national distributors go to
<http://www.airtraq.com>

TrueView EVO2™

Truphatek International Limited
9, Haomanut Street, POB 8051
Netanya, Israel, 425040
Tel: +972 - 9 - 8851155
Fax: +972 - 9 - 8851212
<http://www.truphatek.com>
email: helpdsk@truphatek.com

Pentax Airwayscope AWS®

Ambu GmbH
In der Hub 5
61231 Bad Nauheim
Telefon: +49 60 32/92 50-0
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<http://www.ambu.de/>
e-mail: info@ambu.de

Storz C-MAC®

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Glidescope® Video Laryngoscopes (GVL®) Cobalt and Ranger

Verathon Medical (Europe)
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LMA CTrach™









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McGrath® Series 5

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Device	McGRATH® Series 5	LMA CTrach™	Glidescope® Ranger	Glidescope® Cobalt	C-MAC®	Airwayscope AWS®	TruView EVO2™	Airtraq®
Manufacturer	Aircraft Medical Ltd., Edinburgh, UK	LMA Deutschland GmbH, Bonn, Germany	Verathon Medical Inc., Bothell, WA, USA	Verathon Medical Inc., Bothell, WA, USA	Karl Storz GmbH & Co KG, Tuttlingen, Germany	Pentax, Tokyo, Japan	Truphatek International Ltd., Netanya, Israel	Prodol Meditec S.A., Guecho, Spain
Website	www.aircraftmedical.com	www.lmaco.com	www.verathon.eu	www.verathon.eu	www.karlstorz.com	www.ambu.de	www.truphatek.com	www.airtraq.com
Light source	High intensity LEDs	100 lux, 10,000 Pixel	LED	LED	High power LED	White LEDs	Xenon bulb or LED	LED
Display size	1.7" Colour LCD	3.5" Colour LCD	3.5" Colour LCD	7" Colour LCD	7" Colour LCD high resolution 800 x 480px	2.4" Colour LCD	Optional 5.5" colour LCD	29'26 mm
Video output	No	No	No external device (Glidescope® DVR – digital video recorder) available	Yes	No, but storing management with SD-Card: Video -clips and pictures (mpeg4 / jpg)	NTSC Composite, Video	Endoscopic camera head attachable Optional: colour LCD	No Optional clip-on video camera: Optional wireless monitor (for Germany)
Waterproof	IP65	No	Yes	No	Monitor IP54 Laryngoscope IPX08 and waterproofed for disinfection and sterilisation	IPX7	Yes	No
Dimensions (H'W'D) mm	200'50'150	80'150'30	168'173'49	167'207'83	230'155'54	48'305'72	Adult: 172 long'15.6 wide Small adult: 158'12.5 Paediatric: 132'8 Infant: 115'7	197'107'60

Continued

							
Airtraq®	TruView EVO2™	Airwayscope AWS®	C-MAC®	Glidescope® Cobalt	Glidescope® Ranger	LMA CTrach™	McGRATH® Series 5
115	Adult: 129 Small adult: 114.2 Paediatric: 80.2 Infant: 79	375	1500	1400	680	200	275
3 AAA Alkaline batteries	Compatible with all green system battery powered handles. LCD screen with rechargeable battery pack	2 AA 1.5V Alkaline Batteries	Li-ion Batteries rechargeable; main supply; intelligent power management system	Lithium polymer battery	Lithium polymer battery	6V DC, 900mAh	1 x standard AA rechargeable AA 1.2V battery / x standard lithium AA1.5V battery
40 min	Depends on handle	60 min	120 min	90 min continuous (minimum)	90 min continuous (minimum)	30 min	Up to 180 min
Different sizes available from neonate to large adults.	Truview EVO2™ blades available in 4 sizes	disposable PBlade®	Original Macintosh Blades #2, 3, 4 (english original style and European closed design)	Reusable OR Single-Use versions available w/ system	Reusable OR Single-Use versions available w/ system	No	Sterile single-use, one size fits all blade 110'12'15 mm
8.5 single lumen 41 Fr double lumen	No restrictions	8.0	No restrictions	No restrictions	No restrictions	8.0	No restrictions
Direct laryngoscopy possible?	No	No	Yes	No	No	No	No

REFERENCES

- MacEwen W. Introduction of tracheal tubes by the mouth instead of performing tracheotomy or laryngotomy. *Br Med J* 1880; 2: 122–124.
- Hirsch NP, Smith GB, Hirsch PO: Alfred Kirstein: pioneer of direct laryngoscopy. *Anaesthesia* 1986; 41: 42–45.
- Koltai PJ, Nixon RE. The story of the laryngoscope. *Ear Nose Throat J* 1989; 68: 494–502.
- Zeitels SM. Chevalier Jackson's contributions to direct laryngoscopy. *J Voice* 1998; 12: 1–6.
- Janeway HH. Intra-tracheal anesthesia from the standpoint of the nose, throat and oral surgeon with a description of a new instrument for catheterizing the trachea. *Laryngoscope* 1913; 23: 1082–1090.
- Miller RA. A new laryngoscope. *Anesthesiology* 1941; 2: 317–320.
- Macintosh RR. New laryngoscope. *Lancet*, 1943; 1:205.
- McCoy EP. The levering laryngoscope. *Anaesthesia*, 1993; 48: 516–519.
- Gerlach K, Wenzel V, von Knobelsdorff G, et al. A new universal laryngoscope blade: a preliminary comparison with Macintosh laryngoscope blades. *Resuscitation* 2003; 57: 63–67.
- Bailey B. Laryngoscopy and laryngoscopes – who's first?: the forefathers/four fathers of laryngology. *Laryngoscope* 1996; 06: 939–943.
- Kaplan MB, Hagberg CA, Ward DS, et al. Comparison of direct and video-assisted views of the larynx during routine intubation. *J Clin Anesth* 2006; 18: 357–362.
- Kaplan MB, Ward DS, Berci G. A new video laryngoscope – an aid to intubation and teaching. *J Clin Anesth* 2002; 14: 620–626.
- Smith JE, Fenner SG, King MJ. Teaching fibreoptic nasotracheal intubation with and without closed circuit television. *Br J Anaesth* 1993; 71: 206–211.
- Mihai R, Blair E, Kay H, et al. A quantitative review and meta-analysis of performance of nonstandard laryngoscopes and rigid fibreoptic intubation aids. *Anaesthesia* 2008; 63: 745–760.
- Maharaj CH, Higgins BD, Harte BH, et al. Evaluation of intubation using the Airtraq or Macintosh laryngoscope by anaesthetists in easy and simulated difficult laryngoscopy – a manikin study. *Anaesthesia*. 2006 May; 61: 469–477.
- Maharaj CH, Costello JF, Higgins BD, et al. Learning and performance of tracheal intubation by novice personnel: a comparison of the Airtraq and Macintosh laryngoscope. *Anaesthesia*. 2006 Jul; 61: 671–677.
- Maharaj CH, Ni Chonghaile M, Higgins BD, et al. Tracheal intubation by inexperienced medical residents using the Airtraq and Macintosh laryngoscopes – a manikin study. *Am J Emerg Med* 2006; 24: 769–774.
- Maharaj CH, McDonnell JG, Harte BH, et al. A comparison of direct and indirect laryngoscopes and the ILMA in novice users: a manikin study. *Anaesthesia* 2007; 62: 1161–1166.
- Malik MA, O'Donoghue C, Carney J, et al. Comparison of the Glidescope®, the Pentax AWS®, and the Truview EVO2® with the Macintosh laryngoscope in experienced anaesthetists: a manikin study. *Br J Anaesth* 2009; 102: 128–134.
- Miceli L, Cecconi M, Tripi G, et al. Evaluation of new laryngoscope blade for tracheal intubation, Truview EVO2: a manikin study. *Eur J Anaesthesiol* 2008; 25: 446–449.
- Li JB, Xiong YC, Wang XL, et al. An evaluation of the TruView EVO2 laryngoscope. *Anaesthesia*. 2007; 62: 940–943.
- Malik MA, Maharaj CH, Harte BH, et al. Comparison of Macintosh, Truview EVO2, Glidescope, and Airwayscope laryngoscope use in patients with cervical spine immobilization. *Br J Anaesth* 2008; 101: 723–730.
- Boedeker BH, Berg BW, Bernhagen MA, et al. Endotracheal intubation comparing a prototype Storz CMAC and a glidescope videolaryngoscope in a medical transport helicopter – a pilot study. *Stud Health Technol Inform* 2009; 142: 37–39.
- Boedeker BH, Berg BW, Bernhagen M, et al. Endotracheal intubation in a medical transport helicopter – comparing direct laryngoscopy with the prototype Storz CMAC videolaryngoscope in a simulated difficult intubating position. *Stud Health Technol Inform* 2009; 142: 40–42.
- Cooper RM, Pacey JA, Bishop MJ, et al. Early clinical experience with a new videolaryngoscope (GlideScope) in 728 patients. *Can J Anaesth* 2005; 52: 191–198.
- Savoldelli GL, Schiffer E, Abegg C, et al. Comparison of the Glidescope, the McGrath, the Airtraq and the Macintosh laryngoscopes in simulated difficult airways. *Anaesthesia* 2008; 63: 1358–1364.
- Benjamin FJ, Boon D, French RA. An evaluation of the GlideScope, a new video laryngoscope for difficult airways: a manikin study. *Eur J Anaesthesiol* 2006; 23: 517–521.
- Kim HJ, Chung SP, Park IC, et al. Comparison of the GlideScope video laryngoscope and Macintosh laryngoscope in simulated tracheal intubation scenarios. *Emerg Med J* 2008; 25: 279–282.
- Sun DA, Warriner CB, Parsons DG, et al. The GlideScope Video Laryngoscope: randomized clinical trial in 200 patients. *Br J Anaesth* 2005; 94: 381–384.
- Dhonneur G, Ndoko SK, Yavchitz A, et al. Tracheal intubation of morbidly obese patients: LMA CTrach versus direct laryngoscopy. *Br J Anaesth* 2006; 97: 742–745.
- Malik MA, Subramaniam R, Churasia S, et al. Tracheal intubation in patients with cervical spine immobilization: a comparison of the Airwayscope, LMA CTrach, and the Macintosh laryngoscopes. *Br J Anaesth* 2009; 102: 654–661.
- Shippey B, Ray D, McKeown D. Case series: the McGrath videolaryngoscope—an initial clinical evaluation. *Can J Anaesth* 2007; 54: 307–313.