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REVIEW

The development of direct laryngoscopy

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SUMMARY

The use of direct laryngoscopy for endotracheal intubation is one of the key skills of anaesthesiologists and every physician involved in airway management. Direct laryngoscopy confers the known advantages of familiarity, direct glottic visualisation, cost effectiveness, equipment availability, and a steep learning curve. However, the prevalence of insufficient views of the glottis is persistent. Therefore, alternative intubation techniques should be available in such a crucial situation, including indirect laryngoscopic techniques such as videolaryngoscopy. Current videolaryngoscopes play an important role in the management of an unexpected difficult airway. Additionally, the use of a videolaryngoscope may be considered in a predicted difficult airway, if mask ventilation and oxygenation can be warranted. However, it is important to know that today videolaryngoscopes do not build a homogeneous class; moreover, they differ in design, technical configuration, monitor type and, most importantly, in blade type, so that the user has to become familiar with each device before they are used in an emergency situation. Therefore, the greatest benefit from videolaryngoscopy may be obtained, if it is used routinely in elective cases to become familiar with the device outside of a difficult intubation situation. In this case, videolaryngoscopy has the potential to save time and decrease-patient morbidity. This review addresses actual videolaryngoscopy techniques and their use in both clinical and pre-hospital airway management scenarios.

1. Introduction

Use of the videotechnique in addition to conventional laryngoscopy for both teaching routine laryngoscopy for endotracheal intubation and for managing a difficult airway has been known for more than 15 years. In the beginning, optical image guides and video cameras had been integrated into standard laryngoscopes, so that a magnified and detailed view could be displayed on an external monitor whilst conventional direct laryngoscopy was performed. Later on, this principle was advanced and resulted in laryngoscopes with differing shapes and integrated rigid or flexible fibreoptics, such as the WuScope,[1] Bullard,[2] and UpsherScope.[3] However, the past decade has witnessed some important developments in direct and indirect laryngoscopy, which were based on innovations in the field of video-assisted airway management. With the miniaturisation of optical cameras and liquid crystal displays (LCD), and the development of light sources with light-emitting-diodes (LED), optical quality, handling, and mobility of the devices were greatly improved. This resulted in a wide distribution of videolaryngoscopes, which became a standard procedure for patients with known or suspected difficult airway.

Nevertheless, it is important to know that today videolaryngoscopes do not build a homogeneous class; moreover, they differ in design, technical configuration, monitor type and, most importantly, in blade type, so that the user has to become familiar with each device before they are used in an emergency situation.[4,5] Therefore, it may take some more time before the best videolaryngoscopic system could be identified that may also become a standard for routine intubations.

2. Classification of videolaryngoscopes

The main difference in videolaryngoscopes arises from the type of blade that is incorporated into the system. Videolaryngoscopes that are based on a conventional blade shape, such as the Macintosh or Miller blade, allow direct visualisation of the glottic entrance by direct laryngoscopy in addition to the video view. As a side-effect, the user is familiar with the handling of these conventional blade types. Alternatively, videolaryngoscopes with highly-curved or angulated blades are available that allow an

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increased "look around the corner" to the glottic entrance. On the one hand, these videolaryngoscopes mostly allow the best visualisation of the glottis; on the other hand, generally, they provide obligatory indirect visualisation (no direct view of the glottic entrance possible; Fig. 1); further, due to the high blade angulation, the use of a malleable or rigid tube stylet is mandatory in nearly all cases. The user has to learn that intubation difficulties have moved from the impaired visualisation process to difficult tube advancement. Despite optimal glottic visualisation, the most difficult part now with indirect videolaryngoscopy is to enter the curved tube into the glottic entrance and to advance it into the trachea.[5]

Some obligatory indirect laryngoscopes come with a tube-guiding channel that is incorporated in the curved blade. Therefore, the use of a tube stylet to guide the tube to the glottic entrance is not mandatory; however, generally it also does not allow for a correction in the direction of the tube.

For hygienic purposes all videolaryngoscopic systems are available as a disposable variant. Compared to the reusable steel-made types which have lower blade profiles, the disposable versions are mainly made from plastic materials and have larger (thicker) blade profiles.

Finally, videolaryngoscopes are available with external and integrated monitors. External monitors have the advantage that they provide optimal visualisation of the intubation process for the whole team, which may anticipate actions such as extralaryngeal manipulations or suctioning. Additionally, recording options for images and videos are available. In contrast, the smaller integrated monitors offer the greatest mobility for videolaryngoscopy with minimal place requirement, which will only be improved once wireless technology has been implemented. Furthermore, these smaller systems are predominantly available at affordable prices. This emphasises their use in the emergency setting, e.g. in-hospital or pre-hospital emergency medicine. Since all devices are battery operated, great attention must be paid to the battery capacity to avoid a system blackout in the sensible phase of intubation.

3. Technique of videolaryngoscopy (VLS)

Videolaryngoscopes provide a "look around the corner" to achieve optimal visualisation of the glottis without further manipulation of the patient (e.g. flexion or extension of the cervical spine), and without the need for alignment of the oro-pharyngo-laryngeal axis. However, the higher the curvature of the blade is, the more the chance to perform direct laryngoscopy is reduced; in this case tracheal intubation has to be done obligatory with indirect visualisation. Furthermore, to follow the high curvature of the blade with the endotracheal tube, a tube-guide/malleable stylet is necessary.[6,7] Additionally, injuries of pharyngeal structures with the use of videolaryngoscopes have been described, if advancement of the styletted endotracheal tube around the tongue is not directly observed, until it becomes visible on the monitor.[8,9] Compared with conventional direct laryngoscopy, videolaryngoscopy may result in a reduced pressure on the maxillary teeth.[4]

4. Use of videolaryngoscopy

4.1. Clinical use

Exemplarily, clinical investigations of the most studied videolaryngoscopes C-MAC (Karl Storz, Tuttlingen, Germany; Fig. 2), GlideScope (Verathon Medical, Bothell, WA, USA; Fig. 3), McGrath Series 5 videolaryngoscope (Aircraft Medical, Edinburgh, United Kingdom; Fig. 4), Truview (Truphatek International Limited, Netanya, Israel; Fig. 5), and Pentax-AWS-S100 (Pentax Medical; distributed by Ambu Inc.; Fig. 6) are mentioned.

Several authors were able to show superior visualisation of the glottis with the classical C-MAC compared to conventional direct laryngoscopy.[10–13] Aziz et al. compared the C-MAC with direct laryngoscopy (all using Macintosh blades sizes 3 or 4) in a single-centre study in 296 patients with a predicted difficult airway. They reported significantly improved glottis visualisation (Cormack–Lehane) and higher first-attempt intubation success with the use of videolaryngoscopy. As with all videolaryngoscopes, time to intubation was longer with C-MAC videolaryngoscopy than with direct laryngoscopy (successful attempts).[13] Even if the application of a stylet cannot be eliminated completely, most intubations using a C-MAC videolaryngoscope can be performed without stylet use.[6,7] In a preliminary study by Cavus et al. in patients, in whom conventional Macintosh laryngoscopy failed, the use of the curved C-MAC D-Blade provided better glottic visualisation and intubation success in all patients.[14]

The GlideScope is the prototype of modern obligate indirect videolaryngoscopes and many studies have been published regarding its use in the OR,[15–19] in normal and difficult intubation scenarios,[20–26] and in comparison to other videolaryngoscopes.[6,12,27–33] Use of the GlideScope resulted in improved glottic visualisation according to Cormack and Lehane in most patients,[34] and improvement of intubation success in difficult airways.[24,35] Recently, Aziz and colleagues analysed 2.004 GlideScope intubations and reported an overall intubation success rate of 97%. Conversely, 3% could not be intubated with the GlideScope; the authors concluded that maintenance of competency with alternate methods of intubation is mandatory.[26]

Compared to conventional laryngoscopy with a Macintosh blade, the glottic view may be improved by use of the Truview videolaryngoscope.[28,36,37] Also, it may result in a higher intubation success rate in difficult airway situations,[38] but in comparable intubation success rates in normal airways; however, airway morbidity related to laryngoscopy may be lower.[36] As known from

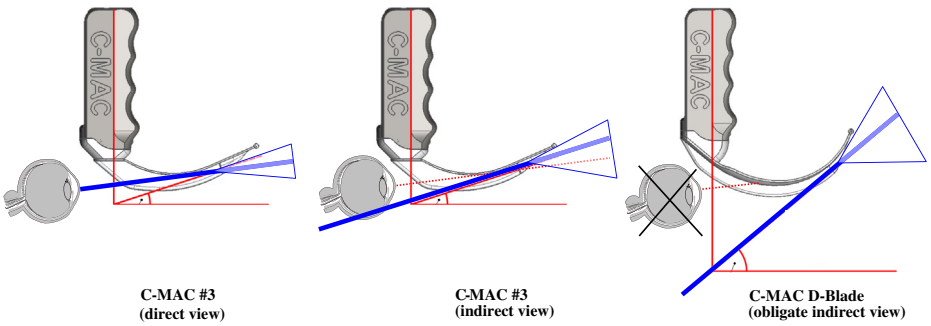

Fig. 1. Main differences in sight between Macintosh- and highly-curved blade videolaryngoscopes. Left: Macintosh blade with the option for direct laryngoscopy; Centre: Macintosh blade with the option for indirect (video-)laryngoscopy; Right: Highly-curved blade with the option for only indirect (video-)laryngoscopy.