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APPARATUS

The Glidescope® system: a clinical assessment of performance

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Summary

The Glidescope® is a new videolaryngoscope. It has a digital camera incorporated in the blade which displays a view of the vocal cords on a monitor. This allows the placement of a tracheal tube to be visualised. We describe its performance in 50 patients who required orotracheal intubation for elective surgery. Two investigators performed 25 intubations each. Intubation with the Glidescope® was successful in 47 of the 50 cases. The three failures occurred early in the series and were attributed to the initial learning curve. The success rate after the first eight patients in each series was 100%. The median (IQR [range]) time to intubation was 40 (30–55 [15–105]) s. The Glidescope® provided a grade I view of the glottis in 44 cases and a grade II view in six cases. The view of the larynx was improved in almost half (23) of the cases. The Glidescope® improved the view by one grade in 22 and by two grades in one patient. We conclude that the Glidescope® is an effective device for tracheal intubation and provides an improved view of the larynx. Further clinical studies are necessary to evaluate its role in airways that are difficult to manage.

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Mortality or significant morbidity resulting solely or principally from anaesthesia is a relatively infrequent event but difficulty with tracheal intubation continues to account for a significant proportion of this [1]. There has been extensive research into the development of new devices to aid difficult airway management and the last decade has seen a proliferation of such devices on the market. It is essential to assess formally the effectiveness and value of these new devices in clinical practice. The Glidescope® system (Saturn Biomedical Systems, Burnaby, British Columbia, Canada) is a camera laryngoscope which displays a clear monochrome (black and white) view of the pharyngeal and laryngeal structures on a dedicated monitor. The purpose of our study was to evaluate the efficacy of the Glidescope® as a device to aid tracheal intubation. The view of the larynx obtained, time to successful intubation, number of attempts at intubation and difficulties encountered during the intubation process were documented.

Description of the Glidescope® (Fig. 1)

The Glidescope® videolaryngoscope is made of medical grade plastic and is reusable. The device consists of a handle and a blade. The handle is similar to that of a standard laryngoscope. A digital video camera is embedded in the tip of the blade and there are two light emitting diodes on either side of the camera which provide continuous illumination. The camera has a wide angle lens and is equipped with an antifogging device. The image captured by the camera is displayed on a 7-inch LCD black and white monitor screen. The blade design differs from a standard laryngoscope blade in that it is not detachable, has a maximum width of 18 mm at any point and has a 60° curvature in the midline. It is available in a single size for adult patients. A smaller version, suitable for paediatric use, is being developed.

The Glidescope® is designed to be inserted along the midline of the tongue and advanced until the glottis is visible on the monitor. The tracheal tube is mounted

Figure 1 The Glidescope® system.

onto a flexible stylet and the distal tip is angulated upwards by about 60° to match the angulation of the blade. The preformed shape resembles that of an ice-hockey stick. The tracheal tube is then passed by the side of the blade into the trachea while viewing the entire process on the monitor.

Any resistance to advancement of the tube is managed by withdrawing the stylet approximately 4 cm and withdrawing the Glidescope® by 1–2 cm. This allows the glottis to drop down, making the angle of approach of the tracheal tube more favourable.

Methods

Following Local Research Ethics Committee approval, written informed consent was obtained from 50 adult patients. All patients recruited were ASA grade I–III and scheduled for elective surgery requiring general anaesthesia with orotracheal intubation to secure the airway. Patients under 18 years, pregnant women and patients at risk of regurgitation were excluded.

Two of the investigators (A.D. and C.V.) performed 25 tracheal intubations each. Both had > 5 years' experience in anaesthesia but neither had previous experience of intubation with the Glidescope®.

An intravenous cannula was sited and standard monitoring instituted in the anaesthetic room. Following pre-oxygenation, anaesthesia was induced. The choice of anaesthetic agent, analgesic and neuromuscular blocking agent were in accordance with the preference of the anaesthetist present. In order to maintain oxygenation and anaesthesia, the patient's lungs were ventilated with sevoflurane or isoflurane in 100% oxygen using a standard facemask while neuromuscular blockade was established and between intubation attempts. Once full neuromuscular blockade, as judged by lack of response to peripheral nerve stimulation, was achieved, direct laryngoscopy with a standard Mackintosh laryngoscope was performed. The best view at laryngoscopy as graded by Cormack & Lehane was recorded [2]. The Mackintosh laryngoscope was then removed and the Glidescope® inserted as per the manufacturer's instructions and advanced until the vocal cords were seen on the monitor. The view of the cords as seen on the monitor was recorded and graded as before. The trachea was intubated using a cuffed orotracheal tube (7.0–8.0 mm internal diameter for females and 8.0 mm for male patients) mounted over a flexible stylet. The orotracheal tubes commonly used in our institution are the Portex (Portex Ltd, Hythe, Kent, UK) and the reinforced Mallinckrodt (Mallinckrodt, St. Louis, MO). The choice of the tube was left to the investigator performing the intubation. The orotracheal tube was preshaped by the investigators as per the manufacturer's instructions. The head was maintained in the standard 'sniffing' position during intubation. The position of the head was not altered and external laryngeal manipulation and cricoid pressure were not used in any of the patients.

The time to intubation was defined as the time from insertion of the blade into the patient's mouth to the appearance of an end-tidal carbon dioxide trace on the capnograph.

Attempt at intubation was abandoned if the patient's oxygen saturations dropped to below 94%, and ventilation was then re-established. The number of attempts required to intubate the trachea with the Glidescope® was recorded. If intubation was unsuccessful at the third attempt, tracheal intubation was performed with a conventional Mackintosh laryngoscope. The time to intubation using a conventional laryngoscope and the number of attempts required to intubate the trachea were also recorded. In the event of an unsuccessful tracheal intubation using a conventional laryngoscope, the investigator would follow local difficult intubation guidelines and document this in the data collection form. Any airway complications such as dental trauma, soft tissue trauma, bleeding and equipment malfunction were also recorded.

After every use, as recommended by the manufacturer, the Glidescope® was cleaned with a detergent solution to remove all particulate material, blood and debris from the device. The Glidescope® was then sterilised by placing it in a solution bath of activated glutaraldehyde for 12 min and then rinsed thoroughly with sterile water.

Results

The characteristics of the patients studied are given in Table 1. None of the patients in our study had any previous history of a difficult tracheal intubation. Two of the investigators (A.D. and C.V.) performed all of the laryngoscopies and inubations, dealing with 25 cases each. Intubation with the Glidescope® was successful in 47 of the 50 patients recruited in our study. The median (IQR

Table 1 Characteristics of patients recruited for assessment of intubation with the Glidescope® performed by the two investigators (A.D. and C.V.). Values are mean (SD) or number (%).

	Investigator AD (n = 25)	Investigator CV (n = 25)
Age; years	42 (14)	53 (13)
Weight; kg	77.7 (14.3)	73.8 (16.6)
Sex; M : F	0 : 25	19 : 6
ASA grade		
I	14 (56%)	5 (20%)
II	10 (40%)	18 (72%)
III	1 (4%)	2 (8%)

[range]) time to intubation for the 47 patients was 40 s (30–55 [15–105]). The median (IQR [range]) time to intubation for investigator A.D. was 54 s (35–69 [25–105]) and for investigator C.V. 36.5 s (25–43.5 [15–60]).

In 43 patients the trachea was intubated at the first attempt, two patients required two attempts and in another two patients the trachea was intubated at the third attempt with the Glidescope®.

The Cormack & Lehane view at conventional laryngoscopy was recorded as grade I in 22 patients and grade II in 26 patients. There was a grade III view on direct laryngoscopy in two patients. In 44 patients the view with the Glidescope® was a Cormack & Lehane grade I and six there was a grade II view on the Glidescope. The Glidescope® improved the view of the larynx in 23 patients. In 22 patients the view improved by one grade, i.e. from grade II to grade I in 21 patients and from grade III to grade II in one patient. In one patient the view with the Glidescope® was improved by two grades, from a grade III to a grade I. Hence the Glidescope® offered an improved view of the larynx as compared with a standard Mackintosh blade in 23 cases. In no case was the view obtained with the Glidescope® any worse than that obtained by conventional laryngoscopy. There were no major adverse events recorded for any of the 50 patients. Mild oropharyngeal trauma was noted in one patient who required three attempts at intubation and in one patient, intubation with the Glidescope® was abandoned at the second attempt due to rapid desaturation during attempts at intubation.

The three patients who we were unable to intubate with the Glidescope® were successfully intubated with a Mackintosh laryngoscope.

Discussion

Using the Glidescope® system, 47 of the 50 patients recruited in our study were successfully intubated. Previous studies looking at intubation times with devices to aid tracheal intubation have suggested a learning experience of 20–25 cases [3] and at the start of the study, we had planned to recruit 100 patients with each investigator performing a minimum of 30 intubations. It was our decision to terminate the study at 50 patients as we found no significant changes in the time to intubation for the investigators with increasing number of patients. In three patients we were unable to intubate the trachea using the Glidescope® system, two by investigator A.D. and one by C.V. All of the failures occurred early in the series, the two with investigator A.D. being in the first seven patients and one with investigator CV in the first five patients. Two of these failures can be attributed to the initial learning curve and are believed to be related to inappropriate shaping of the tracheal tube. This problem was resolved by strict adherence to manufacturer's instructions regarding preshaping of the tracheal tube. The third failure was in a patient where intubation with the Glidescope® was abandoned after the second attempt as a result of rapid desaturation at every attempt. Intubation with conventional laryngoscope also proved to be difficult and the patient's trachea was intubated at the second attempt with the Mackintosh laryngoscope. Hence, if the results of the first eight patients in each group were included in the learning curve, the success rate for the subsequent patients was 100% for both the investigators.

Intubation was completed at the first attempt in 43 patients. The median time to intubation was 40 s, which is comparable to the times achieved with other devices designed to aid tracheal intubation [4–6]. Four patients required more than one attempt to intubate the trachea with the Glidescope®; all of these patients were clinically obese with a body metabolic index (BMI) ranging from 28–32 $kg.m^{-2}$. Two of these four patients were a Cormack & Lehane grade III view on conventional laryngoscopy and the Glidescope® improved the view of the larynx in both of these patients and facilitated intubation. The Glidescope® offered an improved view of the larynx as compared to a standard Mackintosh blade in 23 cases. We can hypothesise that in the absence of the Glidescope®, a significant proportion of these patients would have presented with varying degrees of difficulty with intubation.

Difficulty with airway management continues to be a significant cause of morbidity and mortality in anaesthesia. Difficult direct laryngoscopy occurs in 1.5–8.5% of general anaesthetics, and difficult intubation has a similar incidence [7]. Most of the problems encountered during difficult tracheal intubations are due to an inability to view the larynx adequately.

Fibreoptic laryngoscopy (FOL), performed in awake or anaesthetised patients is the gold standard to aid tracheal intubation in the difficult airway. However, FOL has

certain limitations; the learning curve is steep and considerable training is required to be proficient in its use. In addition, fibreoptic scopes are expensive, their maintenance is time-consuming and they may suffer from fogging and obstruction of the lens. Fibreoptic laryngoscopy may not always be appropriate or easy to use in an acute situation.

The ideal device in a difficult airway scenario, especially an unanticipated difficult airway, is one that is designed to be used as a standard laryngoscope but provides improved views of the larynx. In the past few years many devices have tried to bridge this gulf between simple direct laryngoscopy and FOL [4, 5]. Many of the early devices were modifications of the Mackintosh blade aimed at providing an improved view of the larynx [8, 9]. We feel that the Glidescope® is a device that may be able to bridge that gap. It has many advantages. It is similar in design to a conventional laryngoscope, hence personnel accustomed to using a laryngoscope should find it easy to adapt to the Glidescope®. The blade has a 60° angulation, and the location of the camera, midway along the bottom of the blade, provides a wider field of view than the fibreoptic laryngoscope. Also, the clinician does not require a direct line of sight to the glottis when intubating with the Glidescope® and as a result intubation is much less stimulating to the patient. The Glidescope® also uses video technology which provides several distinct advantages. It is less expensive and more durable than fibreoptics, the displayed anatomy is magnified and recognition of anatomical structures and anomalies is easier. The Glidescope® incorporates an antifog mechanism that prevents clouding of the image on the video display. This allows for an unobstructed view of the larynx and visualization of the entire process of tracheal tube placement.

The main limitation of the Glidescope® as compared to standard laryngoscopes is the resistance to the advancement of the tracheal tube. This accounts for the major proportion of the time taken to complete intubation and is the most important aspect of the learning curve with the Glidescope®. Two of our failures with the Glidescope® occurred in the early stages of our study and are believed to be related to incorrect preshaping of the tracheal tube. We would emphasise that the most important aspect of success with the Glidescope® is adherence to the manufacturer's guidelines regarding the preshaping of the tracheal tube over the stylet so that the distal tip is angulated upwards by about 60° to match the angulation of the blade. Resistance to advancement of the tube was managed in all our cases by withdrawing the stylet by approximately 4 cm and withdrawing the Glidescope® by 1–2 cm, as recommended by the manufacturer. We feel that a device such as a flexible tip stylet, which would allow for adjustment of the tip of the tube, might result in a significant decrease in intubation times and enhance the success rates.

None of the patients in our study had a history of a previous difficult intubation. Agro *et al.* [10] compared the Glidescope® with a standard Mackintosh laryngoscope in 15 patients presenting for general anaesthesia wearing cervical collars to simulate difficult laryngoscopy and intubation. Their average time to intubation was 38 s. They found that the Glidescope® improved the Cormack & Lehane grading in 14 of 15 patients. A more recent case report [11] has described the successful use of the Glidescope® in a patient with a difficult-to-manage airway. Asai & Shingu [12] described the successful use of a similar device, the X-lite Video laryngoscope (Rusch, Germany), in an unanticipated difficult airway. Further studies need to be done to evaluate the performance of the Glidescope® in patients with known difficult airways.

The clinical potential of the Glidescope® has yet to be determined. It may have a role in awake fibreoptic intubations as it is a device that is not very stimulating to the patient and does not require manipulation of the head and neck to visualise the airway anatomy. It reliably improves the view of the larynx as compared to conventional laryngoscopy, which may facilitate the passage of a tracheal tube, bougie or a stylet under vision in difficult intubation scenarios. The Glidescope® can be used for nasal intubation, a significant advantage over devices such as the Bullard laryngoscope and the Bonfils intubating laryngoscope. Theoretically, there is no reason to preclude its use during a rapid sequence induction. The Glidescope® would also be useful in the intensive care unit for visualization of anatomy, tracheal tube exchanges and placement of difficult nasogastric tubes.

In recent years, the widespread use of the Laryngeal Mask Airway™ and other supraglottic devices has markedly reduced the number of conventional tracheal intubations. This has greatly reduced the opportunities for teaching tracheal intubation to the novice. The Glidescope® system can aid teaching and training as the camera system incorporated in the tip allows visualisation of airway anatomy and demonstration of the intubation process at the same time, as opposed to 'over the shoulder' teaching. It could be a valuable teaching tool for trainees in anaesthesia, critical care and accident and emergency and paramedics.

Kaplan *et al.* have described the use of a Video Mackintosh Intubating laryngoscope system (VMS) in 235 patients [13]. The VMS system employed a standard Mackintosh blade and handle with a camera incorporated in the handle. The image was displayed on a monitor as with the Glidescope®. The improved co-ordination afforded by an image on a video monitor seen by both

the assistant providing the laryngeal manipulation and the anaesthetist handling the laryngoscope was considered a significant advantage over conventional laryngoscopy.

In another study, Asai *et al.* [14] have described the use of the videolaryngoscope for training in the correct technique of airway manoeuvres such as the cricoid pressure or the 'backward, upward and rightward manoeuvre' (BURP). Videolaryngoscopes may soon become the method of choice for training of airway management.

We feel that the Glidescope® is an effective device for orotracheal intubation. It provides an improved view of the larynx and allows for successful tracheal intubation. We are aware that this is a preliminary study and further studies are needed to determine its effectiveness in difficult airway situations when conventional methods have failed. Its role in the management of the difficult airway and its potential in the teaching and training of airway management remain to be established.

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