Anaesthesia
Journal of the Association of Anaesthetists of Great Britain and Ireland

Anaesthesia, 2010, **65**, pages 674–678 doi:10.1111/j.1365-2044.2010.06335.x

ORIGINAL ARTICLE

Tracheal intubation following training with the GlideScope® compared to direct laryngoscopy

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Summary

Tracheal intubation using direct laryngoscopy has a high failure rate when performed by untrained medical personnel. This study compares tracheal intubation following direct laryngoscopy by inexperienced medical students when initially trained by using either the GlideScope®, a video assisted laryngoscope, or a rigid (Macintosh) laryngoscope. Forty-two medical students with no previous experience in tracheal intubation were randomly divided into two equal groups to receive training with the GlideScope or with direct laryngoscopy. Subsequently, each medical student performed three consecutive intubations on patients with normal airways that were observed by a anaesthetist who was blinded to the training method. The rates of successful intubation were significantly higher in the Glidescope group after the first (48%), second (62%), and third (81%) intubations compared with the Macintosh group (14%, 14% and 33%; p = 0.043, 0.004 and 0.004, respectively). The mean (SD) times for the first, second, and third successful tracheal intubations were significantly shorter in the Glidescope group (59.3 (4.4) s, 56.6 (7.1) s and 50.1 (4.0) s) than the Macintosh group (70.7 (7.5) s, 73.7 (7.3) s and 67.6 (2.0) s; p = 0.006, 0.003 and 0.0001, respectively). Training with a video-assisted device such as the GlideScope improves the success rate and time for tracheal intubation in patients with normal airways when this is performed by inexperienced individuals following a short training programme.

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Accepted: 1 March 2010

Recent studies have shown that novice intubators have low initial success when using a standard laryngoscope [1–4], with a mean success rate for the first 10 intubations of about 45%, and an average of 57 attempts needed to achieve a 90% success rate of intubation. These findings can be attributed to several factors. Previous teaching approaches using manikin models and drawings of anatomic landmarks lack the variability in the appearance of the laryngeal structures found in real patients [4, 5]. Also, the opportunity for practice on patients in the operating room is limited due to the large numbers of trainees [3, 4]. The low initial success rate in the operating room is detrimental to trainees' confidence and patients' care [3]. Multiple intubation attempts may cause bleeding and increased secretions, which may convert an easy intubation into a difficult one [6]. Recent studies have shown that the use of the GlideScope® (Verathon Medical Europe, Ijsselstein, the Netherlands), a video-assisted laryngoscope, can facilitate intubation, particularly when difficulty is secondary to insufficient exposure of the larynx [7–11]. We therefore compared the process of direct laryngoscopy and tracheal intubation in inexperienced medical students when initially trained to use either the GlideScope or a rigid laryngoscope for performing tracheal intubation.

Methods

The study was conducted at the American University of Beirut Medical Center after approval of the Institutional Review Board, and informed consent was obtained from patients and students.

Forty-two medical students at the American University of Beirut School of Medicine, with no previous experience of tracheal intubation, participated in the study. All received a series of lectures on airway evaluation and classification (Cormack-Lehane) as well as airway management. These lectures are an integral part of our core curriculum for medical student education that involves written instructions, video presentations and line drawings of anatomical landmarks. The students were then randomly assigned into two equal groups of 21: those in the Glidescope group were initially trained by a senior anaesthetist, not involved in the study, to perform tracheal intubation on a manikin using the GlideScope; those in the Macintosh group were initially trained by the same senior anaesthetist to perform tracheal intubation on a manikin using a standard rigid laryngoscope. Subsequently, these teaching sessions were extended for further explanations and demonstrations by the same senior anaesthetist on three patients. For students in the Glidescope group, the senior anaesthetist identified in sequence the uvula, epiglottis, pyriform fossa, and vocal cords, while for students in the Macintosh group, the epiglottis and the vocal cords were identified sequentially.

After completion of the teaching phase during their first day of the anaesthesia rotation, each medical student in each group performed three intubations spread over a 1-week period using the Macintosh size-3 blade. An anesthetist blinded as to which group the medical student belonged was involved in the timing and scoring of each intubation performed by each medical student. The patient population consisted of randomly selected male and female patients of ASA grade 1-2. Exclusion criteria included any indication of a difficult airway (such as Mallampati class > 2, thyromental distance < 6 cm, gross obesity, inadequate mouth opening and abnormal anatomy), and any indication for rapid sequence induction (full stomach, gastro-oesophageal reflux). All patients were pre-oxygenated with 100% oxygen at 5 $l.min^{-1}$ oxygen flow for 3 min. Induction of anaesthesia was with lidoocaine 1.5 $mg.kg^{-1}$, propofol 2 $mg.kg^{-1}$, rocuronuim 0.6 $mg.kg^{-1}$, and fentanyl 2 $\mu g.kg^{-1}$. The lungs were manually ventilated with 100% oxygen for 90 s until full paralysis (train-of-four = 0) was achieved. Pre-oxygenation and ventilation were carried out by the anaesthetist. The same type of tracheal tube was used throughout (Mallinckrodt Medical, Athlone, Ireland), loaded on a stylet: 7.0 mm for female and 8.0 mm for male patients. All patients in the Macintosh group were in the sniffing position and all attempts were made with a size-3 blade. External laryngeal manipulation to facilitate the intubation was used by the supervising anaesthetist when requested by the student. Noninvasive blood pressure measurement, pulse oximetry and ECG monitoring was applied throughout the study.

The outcome of the intubation attempt and the time required in the event of a successful intubation (i.e. time from when the laryngoscope blade first passed the lips to when the end-expiratory CO_2 attained a value of at least 4.0 kPa) using the standard laryngoscope were determined by the supervising anaesthetist using a stopwatch. The attempt was considered a failure if there was no adequate end-expiratory CO2 tracing or once 150 s had elapsed. If attempts for tracheal intubation were terminated for a medical reason (e.g. $S_{pO_2} < 95\%$ or a significant haemodynamic alteration) these attempts were not considered in the analysis as they do not reflect the skills of intubator. In case of failure, the anaesthetist in charge of the case secured the patient's airway. Any cases of an unexpected difficult airway were excluded from the study.

This study was powered on the basis of historical results showing an approximate success rate for tracheal intubation for novice intubators of 45–50%. The sample size was calculated based on an alpha error of 0.05 and a beta error of 0.1, with a minimal difference of 20% in terms of the intubation success rate. The resulting minimal number of patients to be intubated was 63 per group. Since each medical student performed three intubations, 21 medical students were needed for each group. Data were analysed using ANOVA with the Scheffé test for post hoc analysis, and Fisher's exact test for testing proportions. A p value < 0.05 was considered statistically significant.

Results

The characteristics of patients whose tracheas were intubated by the medical students trained with the GlideScope and by those trained with the direct rigid laryngoscope (Macintosh) are presented in Table 1.

For tracheal intubations performed by the medical students in the GlideScope group, there were no statistically significant differences in the success rates between the first and second attempt (p = 0.536), between the first and third attempt (p = 0.052), and between the second and third attempt (p = 0.306) tracheal intubations. For tracheal intubations performed by the medical students in the Macintosh group, there were no statistically significant differences in the success rates between the first and second attempt (p = 1.0), the first and third attempt (p = 0.484), and the second and third attempt (p = 0.277) tracheal intubations. However, when comparing the success rates for each of the intubation attempts between the two groups, the success rates with the first, the second, and the third intubations in GlideScope group were significantly higher than those performed in Macintosh group (Table 2).

Table 1 Characteristics of patients whose tracheas were intubated after training using the GlideScope or Macintosh laryngoscope. Values are mean (SD).

	GlideScope (*n* = 63)	Macintosh (*n* = 63)
Age; years	52.6 (13.1)	53.2 (11.4)
Weight; kg	72.7 (10.1)	71.8 (9.8)
Height; cm	171.6 (9.3)	171.1 (9.5)
Sex; M / F	33 / 30	30 / 33
ASA classification; 1 / 2	25 / 38	27 / 36
Mallampati class; 1 / 2	39 / 24	41 / 22
Thyromental distance; cm	6.3 (0.2)	6.5 (0.3)

Table 2 Success rate of tracheal intubation by medical students after training using the GlideScope or Macintosh laryngoscope. Values are percentage (95% CI).

	GlideScope	Macintosh	p value
Success rate of 1st intubation	47.6 (28.3–67.6)	14.3 (5–34.7)	0.043
Success rate of 2nd intubation	69.9 (40.9–79.3)	14.3 (5–34.7)	0.004
Success rate of 3rd intubation	80.9 (60–92.3)	33.3 (17.2–54.6)	0.004

The average times for the first, second, and third tracheal successful intubations are presented in Table 3 and were significantly shorter in the GlideScope group than the Macintosh group. Moreover, the average time for successful tracheal intubation significantly decreased for the second and third intubations compared with the time for the first tracheal intubation, and for the third vs the second intubation for the GlideScope group (Table 3). However, there were no statistically significant changes in the average times for successful tracheal intubation between the first and the second ($p = 0.803$), between the first and the third ($p = 0.252$), and between the second and the third intubations ($p = 0.364$) in the Macintosh group.

Table 3 Time for tracheal intubation by medical students after training using the GlideScope or Macintosh laryngoscope. Values are mean (SD).

	GlideScope	Macintosh	p value
Time of 1st intubation; s	59.3 (4.4)	70.7 (7.5)	0.006
Time of 2nd intubation; s	56.6 (7.1)*	73.7 (7.3)	0.003
Time of 3rd intubation; s	50.1 (4.0)†‡	67.6 (2.0)	< 0.001

*p = 0.012 vs time of 1st intubation in GlideScope group.
†p < 0.0001 vs time of 1st intubation in GlideScope group.
‡p = 0.013 vs time of 2nd intubation in GlideScope group.

Discussion

Our study suggests that training novice medical students to perform laryngoscopy and tracheal intubation using the GlideScope led to a significantly higher successful intubation rate compared with using direct laryngoscopy as a training tool. For medical students who were trained with the GlideScope, there was a trend towards improvement in the intubation success rate after only their third intubation compared with their first intubation. Furthermore, the time to achieve a successful intubation was significantly decreased in those who were trained with the GlideScope compared with those who were trained with direct laryngoscopy.

Tracheal intubation training using standard laryngoscopy carries the disadvantage of a restricted view and monocularity. As such, the supervisor and the trainee cannot both simultaneously see the laryngeal structures and consequently the instructor cannot provide feedback to the trainee and vice versa [4]. In contrast, videolaryngoscopy enables the instructor and the trainee to see the anatomical structures of the airway simultaneously and to recognise and correct problems instantly [6, 12–15]. Video-imaging methods have been demonstrated to be effective in teaching complex psychomotor tasks such as fibre optic intubation and direct laryngoscopy [16, 17]. Levitan et al. [3] and Higgins et al. [18] have reported that using an 'airway cam' direct laryngoscopy video system of direct laryngoscopy significantly improves the initial success rates of novice intubators in the operating room setting.

As the inductions agents and their dosages were standardised and the patient groups did not differ, these factors should not have influenced our results. As indicated in Table 1, the anthropometric data of the patients assigned to medical students trained using the GlideScope were not different from the patients assigned to medical students trained using direct laryngoscopy. The students were exposed to the same intubation teaching and training programme by the same anaesthetists, the only difference being that one group of medical students received training with the GlideScope while another group received training with direct laryngoscopy.

Several investigators have reported that the mean success rate for the first 10 intubations via direct laryngoscopy by medical personnel untrained in tracheal intubation is about 35–65% and that an average of 57 attempts are needed to achieve a 90% success rate of intubation [1–4, 19–22]. Our result of 63.5% after the first three intubations via direct laryngoscopy for medical students trained by the video-assisted laryngoscope is at the higher end of the reported range, while our result of 20.6% after the first three intubations via direct laryngoscopy for medical student trained by the rigid laryngoscope is well below the reported range. This could be attributed to the difference in the number of intubations averaged (i.e. the first 10 intubations vs the first three intubations). Although medical personnel can not be considered expert after three or 10 intubations, it is worth noting that in our study the medical students trained with the GlideScope achieved an average rate of successful intubation after only the first three attempts (63.5%) that is on the high end of the range of average rates of successful intubation after the first 10 intubations reported in the literature (35–65%). Furthermore, in our study the rate of success after the third intubation with the GlideScope was 80.9% which is comparable to the rate of success of 90% usually achieved after an average of 57 intubations [1, 5]. This represents a significant clinical and logistic advantage since 57 tracheal intubations can not be guaranteed in many institutions for the training of medical students and other healthcare personnel.

The GlideScope, a videolaryngoscope introduced in 2003, consists of a handle similar to that of a standard laryngoscope and a non-detachable blade that has a maximum width of 18 mm and a curvature of 60 degrees in the midline. A digital camera and two light-emitting diodes are embedded at the tip of the blade. The wide-angle lens, the central insertion of the blade and the camera's being remote from the laryngeal structures result in a wide field, giving an improved view of the glottis [23]. Also, the GlideScope offers the advantage of being equipped with a patent antifogging system which, together with a design that tends to keep the camera free of blood and secretions, makes it easier to obtain a view of airway structures [24]. These important characteristics of the GlideScope can make training in obtaining a view of the glottis faster and more accurate, which will ultimately result in improved outcome.

Our study design limited all intubation attempts to patients with expected easy intubation and thus the current findings can not be generalised to patients with difficult airways. Also, in our study each medical student was allowed only three intubations, a relatively small number and one that represents the steepest part of the intubation learning curve. Nevertheless, with only three intubations a favorable outcome was achieved with medical students who were trained with the GlideScope. Further studies needs to be carried out to determine whether or not the Macintosh group catch up with more practice (e.g. up to 10 intubations or more) or if the difference is maintained over time.

In conclusion, our study shows that medical students with no experience in tracheal intubation can achieve significantly higher successful intubation rates using rigid laryngoscopy in patients with normal airways if they were trained with a video-assisted technique (GlideScope) as compared to direct laryngoscopy. With a success rate of almost 81% after the third intubation, the GlideScope might be a very powerful tool for training medical personnel in succeeding with tracheal intubation using a rigid laryngoscope that otherwise requires high number of intubations.

Competing interests

No external funding and no competing interests declared.

References

1 Konrad C, Schüpfer G, Wietlisbach M, Gerber H. Learning manual skills in anesthesiology: is there a recommended number of cases for anesthetic procedures. *Anesthesia and Analgesia* 1998; **86**: 635–9.

2 Stewart RD, Paris PM, Pelton GH, Garretson D. Effect of varied training techniques on field endotracheal intubation success rates. *Annals of Emergency Medicine* 1984; **13**: 1032–6.

3 Levitan RM, Goldman TS, Bryan DA, Shofer F, Herlich A. Training with video imaging improves the initial intubation success rates of paramedic trainees in an operating room setting. *Annals of Emergency Medicine* 2001; **37**: 46–50.

4 Levitan RM, Cook-Sather SD, Ochroch EA. Demystifying direct laryngoscopy and intubation. *Hospital Physician* 2000; **36**: 47–59.

5 Mulcaster JT, Mills J, Hung OR, et al. Laryngoscopic intubation. *Anesthesiology* 2003; **98**: 23–7.

6 Weiss M, Schwarz U, Dillier CM, Gerber AC. Teaching and supervising tracheal intubation in paediatric patients using videolaryngoscopy. *Paediatric Anaesthesia* 2001; **11**: 343–8.

7 Cortellazzi P, Minati L, Falcone C, Pantaleoni C, Caldiroli D. Predictive value of the El-Ganzouri multivariate risk index for difficult tracheal intubation: a comparison of GlideScope videolaryngoscope and conventional Macintosh laryngoscope. *British Journal of Anaesthesia* 2007; **99**: 906–11.

8 Sun DA, Warriner CB, Parsons DG, Klein R, Umedaly HS, Moult M. The GlideScope video laryngoscope: randomized clinical trial in 200 patients. *British Journal of Anaesthesia* 2005; **94**: 381–4.

9 Rai MR, Dering A, Verghese C. The GlideScope system: a clinical assessment of performance. *Anaesthesia* 2005; **60**: 60–4.

10 Cooper RM. Use of a new videolaryngoscope (GlideScope) in the management of a difficult airway. *Canadian Journal of Anesthesia* 2003; **50**: 611–3.

11 Xue FS, Zhang GH, Liu J, et al. The clinical assessment of GlideScope in orotracheal intubation under general anesthesia. *Minerva Anestesiologica* 2007; **73**: 451–7.

12 Levitan RM. A new tool for teaching and supervising direct laryngoscopy. *Academic Emergency Medicine* 1996; **3**: 79–81.

13 Flamik DE. Airway Cam direct laryngoscopy video system. *Annals of Emergency Medicine* 1993; **34**: 418–9.
14 Bryan JH. Airway Cam video series: orotracheal intubation. *Academic Emergency Medicine* 1997; **4**: 130.
15 Doyle J. Video review – orotracheal intubation. *Canadian Journal of Anesthesia* 1998; **45**: 288.
16 Smith JE, Jackson APF, Hurdley J, Clifton PJM. Learning curves for fiberoptic nasotracheal intubation when using the endoscopic video camera. *Anaesthesia* 1997; **52**: 101–6.
17 Smith JE, Fenner SG, King MJ. Teaching fiberoptic nasotracheal intubation with and without closed circuit television. *British Journal of Anaesthesia* 1993; **71**: 206–11.
18 Higgins MS, Deshphande JK, Badr A. A new video system improves teaching of direct laryngoscopy. *Anesthesiology* 1996; **84**: 1010–1.
19 Bradley JS, Billows GL, Olinger ML, Boha SP, Cordell WH, Nelson DR. Prehospital oral endotracheal intubations by rural basic emergency medical technicians. *Annals of Emergency Medicine* 1998; **32**: 26–32.
20 Sayre MR, Sakles JC, Mistler AF, Evans JL, Kramer AT, Pancioli AM. Field trial of endotracheal intubations by basic EMTs. *Annals of Emergency Medicine* 1998; **31**: 228–33.
21 Hohlrieder M, Brimacombe J, von GoedeckeA, Keller C. Guided insertion of the ProSeal laryngeal mask airway is superior to conventional tracgeal intubation by first-month anesthesia residents after brief manikin-only training. *Anesthesia and Analgesia* 2006; **103**: 458–62.
22 Avidan MS, Harvey A, Chitkara N, Ponte J. The intubating laryngeal mask airway compared with direct laryngoscopy. *British Journal of Anaesthesia* 1999; **83**: 615–7.
23 Cho JE, Kil HK. A maneuver to facilitate endotracheal intubation using the GlideScope. *Canadian Journal of Anesthesia* 2008; **55**: 56–7.
24 Moore MS, Wong AB. GlideScope intubation assisted by fiberoptic Scope. *Anesthesiology* 2007; **106**: 885.