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Tracheal intubation with videolaryngoscopes in patients with cervical spine immobilization: a randomized trial of the Airway Scope® and the GlideScope®

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Background. The GlideScope® (Verathon Inc., Bothell, WA, USA) and Airway Scope® (Hoya Corp., Tokyo, Japan) have both been used for difficult airway management, including in patients with cervical spine pathology. The Airway Scope®'s disposable blade has a tube channel to guide tracheal tube insertion through the glottis. Our hypothesis is that this tube guidance system improves the ease of tracheal intubation compared with the GlideScope®, which does not have a tube guiding system. We tested this hypothesis in a randomized comparison of the two videolaryngoscopes in patients whose cervical spines were immobilized.

Methods. Seventy consenting patients were randomized to have tracheal intubation with the GlideScope® ($n=35$) or the Airway Scope® ($n=35$). In all patients, we applied manual in-line stabilization of the cervical spine throughout airway management. All the airway procedures were carried out by two anaesthetists experienced in the use of both videolaryngoscopes.

Results. The tracheal intubation time was 34.2 (SD 25.1) s with the Airway Scope® compared with 71.9 (47.9) s with the GlideScope® ($P<0.001$). Tracheal intubation was successful with the Airway Scope® in 35 (100%) patients compared with 31 (88.6%) patients with the GlideScope® ($P=0.114$). Tracheal intubation was successful within 60 s in 33 (94.3%) patients with the Airway Scope® and 22 (62.9%) patients with the GlideScope® ($P=0.003$).

Conclusions. These results suggest that the Airway Scope®'s tube guide system enables more rapid tracheal intubation compared with the GlideScope® in patients with cervical spine immobilization.

In patients with cervical spine injury, neck movement during tracheal intubation may cause or worsen spinal cord injury.[1] Manual in-line stabilization (MILS) is commonly applied to minimize neck movement during tracheal intubation. Such immobilization can render direct laryngoscopy, fibreoptic tracheal intubation, and insertion of laryngeal mask airways more difficult.[2] [3] Difficulties in airway management increase the risk of hypoxia which can also lead to devastating neurological injury.[4]

Videolaryngoscopes enable visualization of the glottis without obtaining a straight line of view, unlike when a Macintosh laryngoscope is used.[5–7] Therefore, videolaryngoscopes may be useful in patients with cervical spine pathology in whom neck movement must be minimized during tracheal intubation. The GlideScope® (Verathon Inc., Bothell, WA, USA) and Pentax Airway Scope AWS-S100® (Hoya Corp., Tokyo, Japan) (Airway Scope®) are two videolaryngoscopes that have been successfully used in patients with cervical spine pathology.[8 9]

The GlideScope® has an anatomically shaped blade, a video camera mounted at the blade tip, and a separate liquid crystal display (LCD) screen. The GlideScope® does not have a tracheal tube channel and it is necessary to insert a tracheal tube separately, towards the glottis. A GlideScope®-specific rigid stylet with matching curvature to the blade is frequently used to facilitate tracheal

intubation.[10] Nevertheless, even when a full view of the glottis has been obtained and even when a stylet is used, it may frequently be difficult to direct a tube into the trachea.[8]

The Airway Scope® is a newer videolaryngoscope with a disposable blade called the PBlade. The PBlade completely encloses and protects the image tube and camera. The PBlade has a tube channel into which a tracheal tube is loaded and this channel guides the tracheal tube through the glottis. Recent studies have shown that in patients whose necks were stabilized by the manual in-line method, the success rate of tracheal intubation using the Airway Scope® is higher than with a Macintosh laryngoscope, less time is required with the Airway Scope®, and there is less upper cervical spine movement with the Airway Scope®.[11–13]

Although several studies have compared these two videolaryngoscopes with the Macintosh laryngoscope, there has to date been only one study which included both the GlideScope® and the Airway Scope® in comparisons with the Macintosh laryngoscope.[14] In that study, there was no significant difference in the success rate of tracheal intubation between the GlideScope® and the Airway Scope®.[14] In contrast, our hypothesis is that the tracheal tube guidance system of the Airway Scope® improves the ease of tracheal intubation compared with the GlideScope® which has no tube guidance system. We tested this hypothesis in a randomized trial of the Airway Scope® and the GlideScope®, in patients whose cervical spines were immobilized with MILS.

Methods

We obtained approval from the Domain Specific Review Board of the National University Health System and written informed consent from all patients for this trial. We recruited 70 patients aged 21–80, of American Society of Anesthesiologists physical status I–III, who were undergoing elective surgery for which tracheal intubation was required. We excluded patients who were at risk of pulmonary aspiration of gastric contents due to gastro-oesophageal pathology or who were severely obese with BMI >35 kg m^{-2}. After recruitment of patients, we used a block randomization table, with separate blocks of 10 for each investigator to assign patients to either Group GS, the GlideScope® group, or Group AWS, the Airway Scope® group.

In the operating theatre, we applied pulse oximetry, non-invasive arterial pressure, and electrocardiography monitoring in all patients before the start of anaesthesia. We used propofol 2–3 mg kg^{-1} for induction of anaesthesia, and sevoflurane at an end-tidal concentration 2.3–2.6% in an air–oxygen carrier gas mix for maintenance of anaesthesia. In all patients, we confirmed that face mask ventilation was possible before administering atracurium 0.5 mg kg^{-1} and fentanyl 1.5 μg kg^{-1}.

We positioned the patient's head on the operating table without any pillow or occipital support. An anaesthesia colleague knelt on the left side of the investigator and applied MILS by holding the sides of the patient's neck and the mastoid processes to prevent extension or flexion of the head and neck. Our colleagues maintained MILS throughout airway management until we had confirmed correct tracheal intubation and completed all measurements. All the airway procedures were carried out by two investigators (E.H.C.L. and R.W.L.G.). Both investigators had successfully used both of the videolaryngoscopes in at least 20 patients with each device before this study.

In both groups, after the application of MILS, we first carried out direct laryngoscopy with a Macintosh laryngoscope (Heine Optotechnik, Herrsching, Germany) and noted the best Cormack and Lehane grade of glottis view.[15] We then carried out face mask ventilation before using the videolaryngoscopes. We graded the videolaryngoscopy view with the Cormack and Lehane scale.

In Group GS, we used the GlideScope® for laryngoscopy and tracheal intubation. Before an intubation attempt, we inserted a GlideScope® Rigid Stylet (Verathon Inc.) into the tracheal tube. This stylet's 60° curvature matches the GlideScope® blade angulation, improving manoeuvrability, and facilitating intubation. We placed the GlideScope® LCD screen to the left of the patient's head. We inserted the GlideScope® blade in the midline, directing the tip towards the vallecula. After obtaining a view of the glottis, we inserted the tracheal tube into view on the screen and then into the trachea, viewing the process on the screen. We then removed the GlideScope® blade and stylet, connected the tube to the breathing circuit, and checked for correct intubation with end-tidal capnography. If there was difficulty in directing the tracheal tube into the trachea after two attempts, we attempted to direct a bougie into the trachea in the third attempt to guide the tracheal tube over the bougie into the trachea.

In Group AWS, we prepared the Airway Scope® by attaching and locking the PBlade into position. We then loaded a tracheal tube into the tube channel of the PBlade. We turned on the LCD screen and checked that the tip of the tracheal tube was just visible on the screen image. We inserted the Airway Scope® into the mouth in the midline, directing the tip of the PBlade to the inferior or glottic surface of the epiglottis. We optimized the alignment of the PBlade and tracheal tube with the glottis by centring the LCD's target symbol on the glottis. We slid the tracheal tube down the PBlade into the trachea under vision on the LCD screen, detached the tube from the PBlade, and removed the Airway Scope®. We connected the tracheal tube to the breathing circuit and checked for correct intubation with end-tidal capnography. If there was difficulty directing the PBlade tip posterior to the epiglottis, with the tip persistently entering the vallecula, we inserted a bougie through the tracheal tube into the trachea.

Table 1 Characteristics of patients in the trial. Data are expressed as mean (range), mean (SD), or numbers of patients (*n*) and percentages (%)

	GlideScope (*n*=35)	Airway Scope (*n*=35)
Age (yr)	47.7 (21−78)	49.4 (21−39)
Gender, male/female (*n*) (%)	23/12 (65.7/34.3)	20/15 (57.1/42.9)
Weight (kg)	66.3 (11.8)	64.3 (12.1)
Height (m)	1.63 (0.14)	1.63 (0.07)
Body mass index (kg m^{-2})	24.3 (4.3)	24.1 (3.8)
American Society of Anesthesiologists class I/II/III (*n*) (%)	18/11/6/0 (51.4/31.1/17.1)	18/11/6/0 (51.4/31.4/17.1)
Mallampati class 1/2/3/4 (*n*) (%)	14/9/12/0 (40.0/25.7/34.3/0.0)	17/8/8/2 (48.6/22.9/22.9/5.7)
Thyromental distance (cm)	6.2 (1.3)	6.5 (1.3)
Mouth opening (cm)	4.5 (0.7)	4.4 (0.6)
Neck circumference (cm)	38.1 (3.8)	37.6 (3.8)
Cormack and Lehane grade with Macintosh laryngoscope: 1/2/3/4 (*n*) (%)	7/8/14/6 (20.0/22.9/40.0/17.1)	6/10/10/9 (18.6/25.7/34.3/21.4)

We then detached the tracheal tube from the PBlade, guiding it into the trachea over the bougie, under vision.

In both groups, we limited tracheal intubation to three attempts within a maximum time of 180 s. We carried out face mask ventilation between attempts, to maintain oxygenation. If tracheal intubation with either videolaryngoscope failed, we stopped the application of MILS, and carried out tracheal intubation with a Macintosh laryngoscope. Our anaesthesia colleagues monitored the patients ensuring that no patient's oxygen saturation decreased below 95%.

We calculated the intubation difficulty scale score for every patient. This scale enables objective comparison of the difficulty and complexity of intubation, with a higher score indicating greater difficulty.[16] The scale is based on seven indices: the number of intubation attempts, the number of operators, the number of alternative intubation attempts used, the Cormack and Lehane grade, the need for lifting force, the need for external laryngeal pressure, and the position of the vocal cords at intubation. We noted complications such as oxygen desaturation, dental trauma, and lip trauma. We noted oropharyngeal mucosa trauma, if there was blood staining on the videolaryngoscope blade after removal, or if bleeding was seen with the videolaryngoscope.

Our primary outcome measure was the time for successful tracheal intubation, measured from the time the face mask was lifted off the face to the time of the first breath after tracheal intubation, with correct intubation and ventilation confirmed by end-tidal capnography. This timing did not include the time taken for direct laryngoscopy with the Macintosh laryngoscope. We also measured the time to achieve an optimal view of the glottis, and calculated the time from achieving an optimal view to achieving tracheal intubation. These times were measured with a stopwatch by another assistant. Our secondary outcome measures were the success rate of tracheal intubation, the success rate of tracheal intubation within 60 s, and the Cormack and Lehane grade of glottis visualization with the videolaryngoscopes.

On the basis of our experience in patients requiring MILS, we estimated that the time for tracheal intubation

with the GlideScope® was 60 s with a standard deviation of 30 s. We regarded a difference of 20 s as clinically worthwhile, and 35 patients in each group would provide at least 80% power to detect this difference with a *P*-value of <0.05.

We used SPSS 16.0 (SPSS Inc., Chicago, IL, USA) and STATA 7.0 (StataCorp LP, College Station, TX, USA) for all analysis. We used means and standard deviations to describe parametric data, medians and inter-quartile ranges to describe ordinal data, and patient numbers and percentages to describe categorical data. We used *t*-test to compare parametric data, Mann−Whitney *U*-test for ordinal data, and χ^2 test for categorical data. We regarded *P*-value of <0.05 as statistically significant.

Results

The patients in both groups had similar predictors of difficult airway management, including BMI, thyromental distance, mouth opening, neck circumference, and Mallampati classification (Table 1). The patients in both groups had similar Cormack and Lehane laryngoscopy grade with a Macintosh laryngoscope when MILS was applied: median grade of 3 with inter-quartile range 2−4 in Group AWS, and median grade of 3 with inter-quartile range 2−3 in Group GS (*P*=0.746).

There was no significant difference in the times required to achieve views of the glottis, with mean of 18.9 (SD 17.0) s in Group AWS and 20.1 (11.7) s in Group GS, with *P*=0.726. The total time for tracheal intubation was significantly shorter in Group AWS [34.2 (25.1) s] than in Group GS [71.9 (47.9) s] (*P*<0.001 and 95% confidence interval for difference: 19.3−56.0 s). Tracheal intubation was successful in 35 of 35 Group AWS patients, and in 31 of 35 Group GS patients (*P*=0.114). Tracheal intubation was successful within 60 s in 33 of 35 Group AWS patients and in 22 of 35 Group GS patients (*P*=0.003). The Cormack and Lehane grading of glottis views were better and the intubation difficulty scale scores were lower in Group AWS. These outcomes are detailed in Table 2. There was no oxygen desaturation, dental trauma, or lip

Table 2 Times and success rates for tracheal intubation. Times are expressed as mean (SD) in s. Success rates are expressed as number (*n*), percentage (%), (95% confidence interval of percentage). *P*-values are for *t*-tests for times, Mann–Whitney tests for Cormack and Lehane data, number of attempts and intubation difficulty score, and χ^2 test for success rates and oropharyngeal mucosa bleeding rates

	GlideScope (*n*=35)	Airway Scope (*n*=35)	*P*-value
Cormack and Lehane grade with videolaryngoscope: 1/2/3/4 (*n*) (%)	14/21/0/0 (40.0/60.0/0.0/0.0)	34/1/0/0 (97.1/2.9/0.0/0.0)	<0.001
Median (inter-quartile range) (range)	2 (1–2) (1–2)	1 (1–1) (1–2)	
Time for complete tracheal intubation process (s)	71.9 (47.9)	34.2 (25.1)	<0.001
Time to obtain optimal glottis view (s)	20.1 (11.7)	18.9 (17.0)	0.726
Time from obtaining optimal view to achieving tracheal intubation (s)	51.8 (45.5)	15.3 (10.6)	<0.001
Success of intubation (*n*) (%)	31 (88.6) (73.3–96.8)	35 (100) (90.0–100)	0.114
Success of intubation within 60 s (*n*) (%)	22 (62.9) (44.9–78.5)	33 (94.3) (80.8–99.3)	0.003
One, two, three attempts and failure at intubation (*n*) (%)	29/2/4 (82.9/5.7/11.4%)	34/1/0 (97.1/2.9/0.0%)	0.043
Intubation Difficulty Score: median (inter-quartile range) (range)	1 (0–1) (0–3)	0 (0–0) (0–1)	<0.001
Oropharyngeal mucosa bleeding (*n*) (%)	5 (14.3) (4.8–30.5)	1 (2.9) (0.1–14.9)	0.099

trauma in either group. There was no significant difference in the incidence of oropharyngeal mucosa bleeding.

In one Group AWS patient, we were unable to direct the PBlade tip posterior to the epiglottis. We were able to insert a bougie through the mounted tracheal tube into the trachea, and to guide the tracheal tube through the glottis. In four Group GS patients, we were unable to direct the tracheal tube through the glottis into the trachea and we also failed with the bougie. In two of these patients, the laryngoscopy view was Grade 1 with the GlideScope®, and in the other two patients, the views were Grade 2. We stopped further attempts with the GlideScope®, stopped the application of MILS, and succeeded in tracheal intubation with the Macintosh laryngoscope in all four patients.

Discussion

We found that a shorter time was required for tracheal intubation with the Airway Scope® compared with the GlideScope® in patients whose cervical spines were immobilized with MILS. This shorter time, the higher success rate of tracheal intubation within 60 s, and the lower intubation difficulty scale score with the Airway Scope® suggest that tracheal intubation may be easier with the Airway Scope®.

A limitation of this trial is that the investigators were not blinded to the videolaryngoscope used and that Macintosh laryngoscopy was not carried out by independent anaesthetists. Secondly, difficult laryngoscopy could have been due to retrognathia, severe obesity, poor dentition, and short thick neck in some patients. Although both groups had similar airway features and Macintosh laryngoscopy grades, it was not possible to completely standardize these features in both groups. Thirdly, the investigators had moderate experience with both videolaryngoscopes. It was not possible to completely standardize their experience with both devices, and the GlideScope® had been in use for a longer time in our institution. Although our results may be relevant to those with similar or less experience with both videolaryngoscopes, very experienced expert users, particularly of the GlideScope®, may have different results.

The shorter time for tracheal intubation may be due to the tube guidance system of the Airway Scope®. The target symbol on the LCD display when centred on the glottis indicates optimal alignment of the PBlade, and the PBlade tube channel is designed to then direct the tube towards the glottis. Little manoeuvring of the tracheal tube is required. With the Airway Scope®, the tracheal tube is preloaded on the PBlade such that it is just visible on the LCD screen before laryngoscopy. Hence, it is easier and less time is required to manoeuvre the tube into view and into the trachea, compared with the GlideScope®. In this study, in well-oxygenated patients, the 30 s time difference between successful intubation was not associated with any difference in adverse effects between the videolaryngoscopes. However, the shorter time and higher success rate of tracheal intubation within 60 s with the Airway Scope® may be important during emergency airway management or cardiopulmonary resuscitation, to reduce interruption of ventilation and oxygenation.[17]

In this study, the times to obtaining views of the glottis were similar in both groups, suggesting that there was little difference in the ease of laryngoscopy. We obtained Grade 1 or 2 views with both videolaryngoscopes in all patients, but there was a higher proportion of Grade 2 views with the GlideScope®. This difference in grade of views may be due to the different positions of the Airway Scope® and GlideScope blade tips during use. However, further manipulation and lifting of the GlideScope® blade to convert Grade 2 to Grade 1 views may not improve the ease of tracheal intubation, and may be counter-productive by pulling the larynx more anterior. This may have occurred in the four patients in whom we failed to intubate the trachea with the GlideScope®. It is possible that releasing the lifting force on the GlideScope® and a poorer Grade 2 view may paradoxically have improved the ease of intubation in these patients.

A recent study comparing the Macintosh laryngoscope, Truview EVO$_2$®, GlideScope®, and Airway Scope® found that both the GlideScope® and the Airway Scope improved

the intubation difficulty scale scores compared with the Macintosh laryngoscope.[14] In contrast to our findings, there was no difference between the GlideScope® and the Airway Scope® in that study. It is possible that the investigators in that study were much more experienced and skilled with both videolaryngoscopes. Secondly, despite the application of MILS in that study, only five of 30 patients had Cormack and Lehane Grade 3 and none had Grade 4 views when the Macintosh laryngoscope was used. With the application of MILS in our 70 patients, 24 had Grade 3 views and 15 had Grade 4 views with the Macintosh laryngoscope. This suggests that our patient population may be different and that more of our patients would have been difficult to manage with conventional laryngoscopy with the application of MILS. This group also carried out a manikin study comparing the Macintosh laryngoscope, Truview EVO$_2$®, GlideScope®, and Airway Scope® in simulated normal and difficult airway scenarios.[18] They found that the Airway Scope® showed more advantages over the Macintosh laryngoscope than the GlideScope® did in the difficult airway scenario, but found no difference in the normal airway scenario. Our findings of faster and easier intubation with the Airway Scope® compared with the GlideScope® in the simulated difficult airway concur with these findings.

The GlideScope® may have the advantage that its use is more similar to conventional Macintosh laryngoscopy, as the GlideScope® tip is also directed towards the vallecula. The GlideScope® blade is available in different sizes and there is a newer version which uses disposable blades, although these also do not have a tube channel. The GlideScope® screen is much larger than that of the Airway Scope®. As the screen is mounted separately, the GlideScope® laryngoscope blade and handle is much lighter than the Airway Scope assembly. A disadvantage is that while the view of the glottis is usually good with the GlideScope®, tracheal intubation is frequently difficult in patients with limited neck movement and difficult intubation.[8 10] In this study, despite adequate views with the GlideScope®, we failed to manoeuvre the tracheal tube to the glottis in some patients. A flexible bronchoscope can be used with the GlideScope® to overcome the difficulty of tracheal intubation.[19] However, this method requires more assistance, preparation, and time. Difficulties during insertion of the tracheal tube into view on the GlideScope® screen can result in injuries to the soft palate, oropharynx, and tonsils.[20]

The Airway Scope® has some useful features: it is completely portable, water resistant, and powered by ordinary AA-sized batteries. Its PBlade has a separate channel through which a suction catheter can be inserted to clear secretions to improve laryngoscopy views. A disadvantage with the Airway Scope® is that it can be difficult to position the tip of the PBlade inferior to the epiglottis, with the PBlade tip repeatedly entering the vallecula. It is not possible to slide the tracheal tube through the glottis when this occurs. This problem can be overcome by insertion of a tube exchanger or bougie through the loaded tracheal tube into the trachea, then detaching the tracheal tube from the PBlade and inserting the tube over the tube exchanger into the trachea under vision.[21] A second limitation is that the length of the Airway Scope® may make its insertion difficult in patients with barrel chest or with big breasts, or in those with fixed flexed necks. There is currently only one PBlade size which is not suitable for small children, and it also cannot accommodate double-lumen tubes.

In conclusion, we found shorter tracheal intubation times and a higher success rate of intubation within 60 s with the Airway Scope® compared with the GlideScope®, in patients with simulated difficult intubation due to MILS. Our results suggest that the tube guidance system of the Airway Scope® improves the ease of tracheal intubation compared with the GlideScope® when cervical immobilization is applied.

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References

1 Hastings RH, Kelley SD. Neurologic deterioration associated with airway management in a cervical spine-injured patient. *Anesthesiology* 1993; **78**: 580–3

2 Heath KJ. The effect of laryngoscopy of different cervical spine immobilisation techniques. *Anaesthesia* 1994; **49**: 843–5

3 Asai T, Neil J, Stacey M. Ease of placement of the laryngeal mask during manual in-line neck stabilization. *Br J Anaesth* 1998; **80**: 617–20

4 Peterson GN, Domino KB, Caplan RA, Posner KL, Lee LA, Cheney FW. Management of the difficult airway: a closed claims analysis. *Anesthesiology* 2005; **103**: 33–9

5 Cooper RM, Pacey JA, Bishop MJ, McCluskey SA. Early clinical experience with a new videolaryngoscope (GlideScope) in 728 patients. *Can J Anaesth* 2005; **52**: 191–8

6 Robitaille A, Williams SR, Tremblay MH, Guilbert F, Theiault M, Drolet P. Cervical spine motion during tracheal intubation with manual in-line stabilization: direct laryngoscopy versus GlideScope videolaryngoscopy. *Anesth Analg* 2008; **106**: 935–41

7 Maruyama K, Yamada T, Kawakami R, Kamata T, Yokochi M, Hara K. Upper cervical spine movement during intubation: fluoroscopic comparison of the AirWay Scope, McCoy laryngoscope, and Macintosh laryngoscope. *Br J Anaesth* 2008; **100**: 120–4

8 Lai HY, Chen IH, Chen A, Hwang FY, Lee Y. The use of the GlideScope for tracheal intubation in patients with ankylosing spondylitis. *Br J Anaesth* 2006; **97**: 419–22

9 Liu EH, Poon KH, Ng BS, Goh EY, Goy RW. The Airway Scope, a new video laryngoscope: its use in three patients with cervical spine problems. *Br J Anaesth* 2008; **100**: 142–3

10 Turkstra TP, Harle CC, Armstrong KP, *et al*. The GlideScope-specific rigid stylet and standard malleable stylet are equally effective for GlideScope use. *Can J Anaesth* 2007; **54**: 891–6

11 Enomoto Y, Asai T, Arai T, Kamashima K, Okuda Y. Pentax-AWS, a new videolaryngoscope, is more effective than the Macintosh laryngoscope for tracheal intubation in patients with restricted neck movements: a randomized comparative study. *Br J Anaesth* 2008; **100**: 544–8

12 Komatsu R, Kamata K, Hoshi I, Sessler DI, Ozaki M. Airway scope and gum elastic bougie with Macintosh laryngoscope for tracheal intubation in patients with simulated restricted neck mobility. *Br J Anaesth* 2008; **101**: 863–9

13 Maruyama K, Yamada T, Kawakami R, Hara K. Randomized cross-over comparison of cervical-spine motion with the AirWay Scope or Macintosh laryngoscope with in-line stabilization: a video-fluoroscopic study. *Br J Anaesth* 2008; **101**: 563–7

14 Malik MA, Maharaj CH, Harte BH, Laffey JG. Comparison of Macintosh, Truview EVO$_2$, Glidescope, and Airwayscope laryngoscope use in patients with cervical spine immobilization. *Br J Anaesth* 2008; **101**: 723–30

15 Cormack RS, Lehane J. Difficult tracheal intubation in obstetrics. *Anaesthesia* 1984; **39**: 1105–11

16 Adnet F, Borron SW, Racine SX, *et al*. The intubation difficulty scale (IDS): proposal and evaluation of a new score characterizing the complexity of endotracheal intubation. *Anesthesiology* 1997; **87**: 1290–7

17 Cheney FW. The American Society of Anesthesiologists Closed Claims Project: what have we learned, how has it affected practice, and how will it affect practice in the future? *Anesthesiology* 1999; **91**: 552–6

18 Malik MA, O'Donoghue C, Carney J, Maharaj CH, Harte BH, Laffey JG. Comparison of the Glidescope, the Pentax AWS, and the Truview EVO$_2$ with the Macintosh laryngoscope in experienced anaesthetists: a manikin study. *Br J Anaesth* 2009; **102**: 128–34

19 Moore MS, Wong AB. GlideScope intubation assisted by fiberoptic scope. *Anesthesiology* 2007; **106**: 885

20 Cooper RM. Complications associated with the use of the GlideScope videolaryngoscope. *Can J Anaesth* 2007; **54**: 54–7

21 Tan BH, Narasimhan U, Liu EH. Use of a bougie to overcome malposition of the Airway Scope during difficult tracheal intubation. *Can J Anaesth* 2008; **55**: 253–4