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Original Article

Evaluation of five static or dynamic tracheal tube introducers during standard and difficult intubations with C-MAC® D-blade videolaryngoscopy in a manikin*

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Summary

Introduction Tracheal tube introducers facilitate tracheal intubation and include stylets and static/dynamic bougies. There is uncertainty over the most efficacious introducer with hyperangulated videolaryngoscopy.

Methods We evaluated five introducers. Thirty anaesthetists intubated a manikin 10 times with a reusable C-MAC® D-blade videolaryngoscope using five introducers in two airway setups. Airway setup was allocated randomly to standard or difficult tracheal intubation and the order of use of five introducers: two stylets (C-MAC Stylet; Universal Stylet Bougie™); two dynamic bougies (Total Control Introducer™; Steerable Tracheal Intubation Guide™); and a static bougie (Portex® Bougie). The primary outcome was first-attempt tracheal intubation success. Secondary outcomes were tracheal intubation within 120 seconds; time to tracheal intubation; and operator-rated ease of tracheal intubation, railroading and force required.

Results With the standard tracheal intubation setup, first-attempt tracheal intubation success rates (95%CI) were: C-MAC Stylet 100% (100–100%); Universal Stylet Bougie 93% (84–100%); Total Control Introducer 90% (79–100%); Steerable Tracheal Intubation Guide 80% (65–95%); and Portex bougie 57% (37–76%). With the difficult tracheal intubation setup, first-attempt tracheal intubation success rates (95%CI) were: C-MAC Stylet 93% (84–100%); Total Control Introducer 87% (74–99%); Universal Stylet Bougie 73% (56–90%); Steerable Tracheal Intubation Guide 60% (41–79%); and Portex bougie 33% (15–51%). The C-MAC Stylet was best and the static bougie worst across all outcomes, with differences greater when tracheal intubation was designed to be difficult. In pairwise comparisons of tracheal intubation first-attempt success in the difficult airway, the C-MAC Stylet, Universal Stylet Bougie and Total Control Introducer were statistically significantly better than the Portex Bougie; the C-MAC stylet was also statistically significantly better than the Steerable Tracheal Intubation Guide.

Discussion Among introducers for hyperangulated videolaryngoscopy, stylets were most efficacious and a static bougie least. Differences in performance increased when tracheal intubation was difficult.

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Introduction

Tracheal intubation with a hyperangulated videolaryngoscope is a mainstream technique of modern airway management. There is a large body of evidence showing the benefit of videolaryngoscopy over direct laryngoscopy. Videolaryngoscopy can improve the view of the larynx, particularly in patients with anticipated difficult airways [1], and one study found that the C-MAC® D-Blade provided a grade 1 Cormack and Lehane glottic view in 99.1% of patients [2].

Because there is no direct line of sight for the intubator to the larynx, successful use of hyperangulated videolaryngoscopy requires a tracheal tube introducer to facilitate tracheal intubation [3]. There are three broad categories of introducer. A static bougie is a narrow semi-rigid device that is passed through the vocal cords, over which the tracheal tube is then railroaded. A dynamic bougie differs from a static bougie in having a distal tip that can be deflected and redirected by the intubator. A stylet is a rigid or malleable device onto which the tracheal tube is preloaded that guides the tracheal tube towards the vocal cords, before being withdrawn as the tube is advanced [4]. Uncertainty remains over the most efficacious introducer to use during hyperangulated videolaryngoscopy.

A recent meta-analysis comparing static vs. dynamic bougies reported that dynamic bougies did not increase the overall first-attempt success rate or shorten tracheal intubation time in the hands of experienced users but did improve success and speed in patients with real or simulated difficult airways [5]. Notably, the analysis was severely limited by the inclusion of all types of laryngoscope, steerable optical stylets and a flexible optical bronchoscope as ´dynamic bougies´. When considering hyperangulated videolaryngoscopy specifically, there is contradictory evidence. A manikin study with the C-MAC D-blade reported little difference in time to tracheal intubation or subjective difficulty between four different static introducers but did not evaluate tracheal intubation of a significantly difficult airway [6]. Another clinical trial of 160 patients having tracheal intubation for elective surgery using a C-MAC D-blade reported a significant improvement in ease of tracheal intubation when using a Steerable Tracheal Intubation Guide™ compared with a standard bougie but likely did not study a substantial number of patients with difficult airways [7]. A recent randomised controlled trial of a static bougie vs. stylet concluded that a static bougie achieved higher rates of successful tracheal intubation at the first attempt [8]. Methodological drawbacks of that study include that the bougies were conformed to the laryngoscope blade, whereas the stylets were shaped in a different fashion; the results are statistically fragile; and few of the patients had difficult airways, as judged by view or need for repeat attempts [9–11].

Understanding whether one type of introducer performs more effectively may reduce the risk of difficult or failed tracheal intubation. This is particularly important with hyperangulated videolaryngoscopy, which is often used when tracheal intubation is predicted to be difficult or as a rescue technique. We conducted a manikin study to assess the efficacy and mechanical performance of introducers in standard and difficult tracheal intubation setups. It is hard to obtain large numbers of truly difficult tracheal intubations from a clinical population, and our use of a manikin enabled us to assess tracheal intubations in a consistently difficult airway [8, 12]. We hypothesised that performance characteristics of various introducers during hyperangulated videolaryngoscopy would differ, particularly in the difficult tracheal intubation setup.

Methods

This study did not require ethical approval but was registered with the Trust's Caldicott Guardian, and all anaesthetists participated voluntarily and gave written consent to participate and to be videorecorded.

We used an AirSim Difficult Airway Manikin (Trucorp, Craigavon, Northern Ireland) to simulate standard and difficult tracheal intubating conditions. We used the manikin in its default state for standard tracheal intubation. Three experienced anaesthetists used trial and error to establish a manikin setup which created difficult tracheal intubating conditions (online Supporting Information Table S1). Our criteria for ´difficult tracheal intubating conditions´ required all three anaesthetists to confirm that it was difficult to obtain a modified Cormack and Lehane view of the glottis better than grade 2b with a C-MAC D-blade [13], and find it difficult to intubate the trachea routinely at the first attempt.

We invited anaesthetists to perform orotracheal intubation of the manikin with five different introducers (Fig. 1), each under standard and difficult tracheal intubation setups (online Supporting Information Figure S1), yielding a total of 10 tracheal intubations per participant. The five introducers studied were: two stylets (C-MAC Stylet (Storz GmBh Tuttlingen, Germany) and the Universal Stylet Bougie™ (Intersurgical, Wokingham, UK)); two dynamic bougies (Total Control Introducer™ (Through the Cords, Salt Lake City, UT, USA) and the

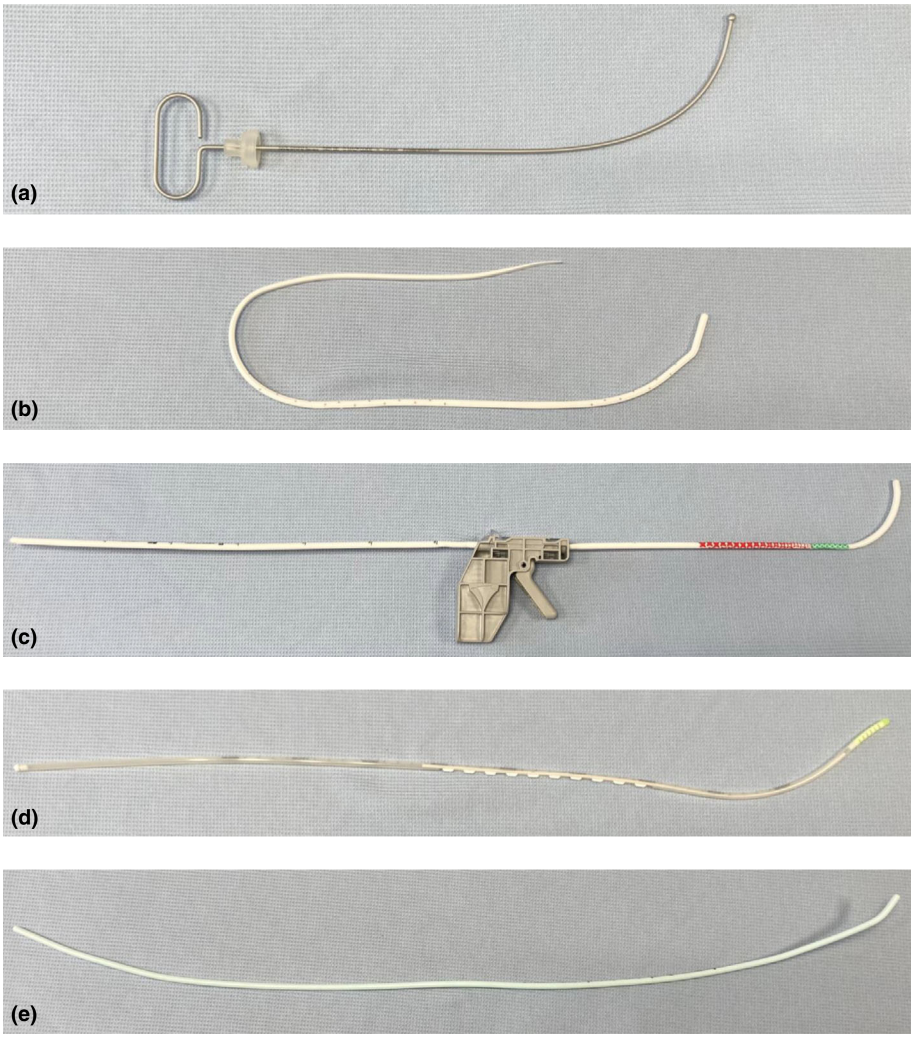

Figure 1 Introducers assessed in this study. (a) Storz C-MAC Stylet; (b) Universal Stylet Bougie; (c) Total Control Introducer; (d) Steerable Tracheal Intubation Guide; and (e) Portex Single-Use Bougie.

Steerable Tracheal Medical, Woolloongabba, QLD, Australia); and a static bougie (Portex® Single Use Bougie (Smiths Medical, Ashford, UK)). The Universal Stylet Bougie is designed to be used as either a stylet or a bougie, but in this study it was used exclusively as a stylet with the tracheal tube pre-loaded.

Participant inclusion criteria were anaesthetists with at least one year's experience since obtaining their initial assessment of competence, who had used a C-MAC D-Blade clinically at least 10 times (and were therefore likely to be competent with it) and who confirmed their competence to use a C-MAC D-Blade in clinical practice during a difficult tracheal intubation [12]. The C-MAC Stylet and Portex Bougie are in regular use in the host department, so all participants were deemed to be trained appropriately in their use. All participants received training in the use of the other three introducers using the manufacturers' training videos. Participants were given time to practise using the introducers on the manikin under the tuition of an anaesthetist experienced with the device before the evaluation started. Participants were permitted to pre-shape the Universal Stylet Bougie, dynamic bougies and Portex Bougie before use.

Participants were blinded to the setup of the manikin (standard or difficult tracheal intubation) for each attempt, but not to the introducer they were to use. Both tracheal intubation setup and order of introducers were randomised for each participant. Randomisation was performed by picking numbered balls from a bag. All tracheal intubations were performed with a reusable C-MAC D-blade videolaryngoscope (Storz GmBh) and a size 7.0 cuffed tracheal tube (Teleflex, Morrisville, NC, USA).

Participants were asked to attempt tracheal intubation in a normal timely manner and to confirm successful tracheal intubation by ventilating the lungs with a self-inflating bag. If tracheal intubation was not achieved within 120 s, it was deemed to have failed. One investigator acted as the assistant and was instructed to perform usual actions if requested by the participant. This included passing the introducer and/or tracheal tube, withdrawing the introducer and inflating the tracheal tube cuff. The C-MAC video screen and manikin lungs were videorecorded throughout.

Following pilot testing, we anticipated first-attempt success rates of 95% in the standard setup with the best-performing device and 65% in the difficult tracheal intubation setup with the worst-performing device. For α 0.05 and power of 80%, we calculated a requirement of 27 tracheal intubations per group. We included 30 tracheal intubations per group to account for dropouts or lost data.

The primary outcome was successful tracheal intubation on the first attempt. We defined an attempt as beginning when the laryngoscope entered the oropharynx and ending when any of the laryngoscope, introducer or tracheal tube was removed from the oropharynx. Secondary outcomes were: successful tracheal intubation within 120 s; time to tracheal intubation; subjective ease of tracheal intubation; subjective ease of railroading the tube if a bougie was used; and subjective force required for tracheal intubation.

First-attempt tracheal intubation success and successful tracheal intubation within 120 s were recorded by the first investigator and verified on videorecording by a second investigator who was blinded to the manikin setup. Time to successful tracheal intubation was defined as the time interval from obtaining an adequate view of the glottis to ventilating the lungs. We chose this interval to ensure we were evaluating the performance characteristics of the introducer and not the C-MAC or the manikin. Four participants' videos were selected randomly for repeat review by a third investigator. We specified that if any timestamp recordings varied by > 2 s between investigators, a senior investigator would adjudicate, and the full set of videos would be reviewed. Of the 112 time-points reviewed in this manner, 98 were identical and 24 differed by 1 s between investigators. Subjective ease of tracheal intubation and ease of railroading were recorded by the participant after each successful attempt on a 10-point Likert scale (1, most difficult; 10, most easy). Force required was recorded on a 10-point Likert scale (1, least force; 10, most force). Participants were asked to make comments about device performance at the end of the evaluation and these were recorded.

Statistical analysis was performed using R version 4.2.3 (online Supporting Information Appendix S1). We conducted pairwise comparisons of first-attempt tracheal intubation success rates using pairwise Fisher's exact test with Holm–Bonferroni correction method and ease of tracheal intubation between introducers using analysis of variance and Tukey's test. Time to tracheal intubation was visualised using a Kaplan–Meier plot and analysed using a Cox proportional hazards model. Missing values were excluded from analyses. We considered a p value < 0.05 as statistically significant.

Results

A total of 30 anaesthetists participated (Table 1). Rates of first-attempt successful tracheal intubation for standard and difficult tracheal intubation setups are shown in Fig. 2. Across both setups, the first-attempt tracheal intubation success rate was highest with the C-MAC stylet and lowest with the Portex bougie. Successful tracheal intubation was

Table 1 Characteristics of participants (n = 30). Values are number.

Grade	
Core trainee	7
Senior trainee or equivalent	9
Consultant	11
Staff Grade, Associate Specialist and Specialty Doctors	3
Previous tracheal intubations with C-MAC D-Blade	
10–20	11
20–50	13
50–100	5
> 100	1

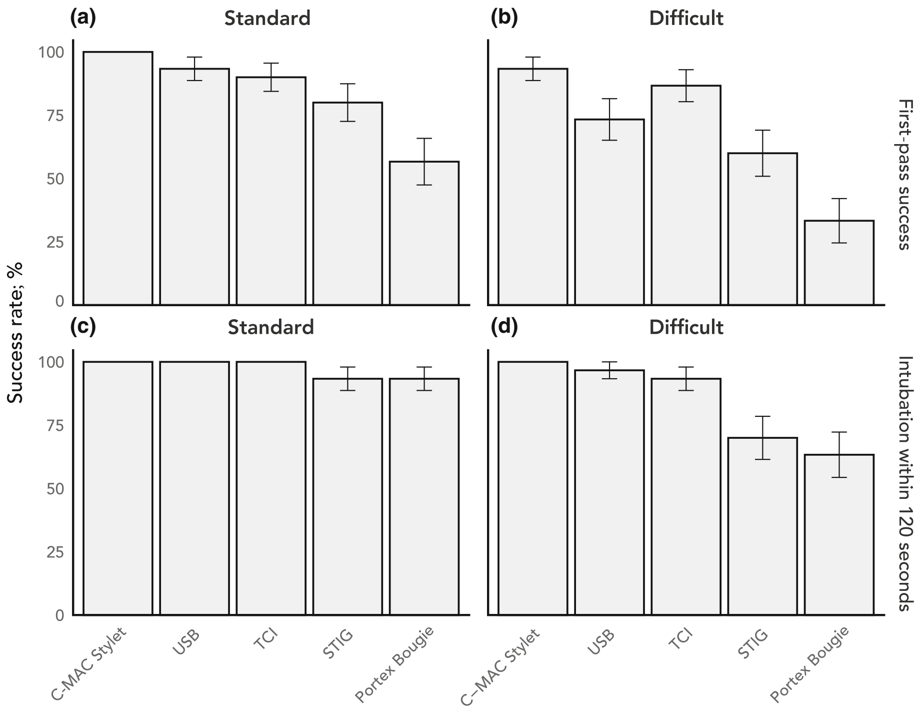

Figure 2 First-attempt success for each introducer in the (a) standard and (b) difficult tracheal intubation manikin setup. Tracheal intubation within 120 s for each introducer in the (c) standard and (d) difficult tracheal intubation manikin setup. Error bars are 95%CI. USB, Universal Stylet Bougie; TCI, Runnels Total Control Introducer; STIG, Steerable Tracheal Intubation Guide.

achieved in > 90% of attempts with the standard setup but was lower with the difficult tracheal intubation setup (Table 2).

Time to successful tracheal intubation is shown in Fig. 3. The Cox proportional hazards model hazard ratios (95%CI) for time to successful tracheal intubation in reference to the C-MAC Stylet with the difficult tracheal intubation setup were: Universal Stylet Bougie 0.67 (0.40–1.14), $p = 0.139$; Total Control Introducer 0.27 (0.16–0.46), $p < 0.001$; Steerable Tracheal Intubation Guide 0.23 (0.13–0.40), $p < 0.001$; and Portex Bougie 0.23 (0.13–0.42), $p < 0.001$. Values for the standard manikin setup are presented in online Supporting Information Table S2. Results relating to operator assessment of ease of tracheal intubation, ease of railroading and force required for tracheal intubation are shown in Fig. 4. Pairwise comparisons of first-attempt success and ease of tracheal intubation between introducers are shown in online Supporting Information Tables S3 and S4, respectively. For first-attempt tracheal intubation success in the difficult tracheal intubation setup, the C-MAC Stylet, Universal Stylet Bougie and Total Control Introducer showed better performance than the Portex Bougie; the C-MAC Stylet also showed better performance than the Steerable Tracheal Intubation Guide. Complete outcome data are available in online Supporting Information Appendix S2.

Discussion

In this study, first-attempt tracheal intubation success varied widely between introducers used for hyperangulated videolaryngoscopy with the C-MAC D-blade. Across all our assessed outcome measures (except for force required) the C-MAC Stylet performed best. The Universal Stylet Bougie generally performed next best, followed by the dynamic bougies. The (static) Portex Bougie performed worst of all. Time to tracheal intubation was shorter using stylets than other devices. Differences between device performance were increased when tracheal intubation was difficult.

Devices which can most accurately match the curvature of a hyperangulated blade showed the greatest success. As further evidence for this, with the three devices which are most able to match the curvature of the blade, there was minimal difference in median time to tracheal intubation between the standard and difficult setups. Stylets, which require fewer steps to complete tracheal intubation than bougies, led to marginally faster tracheal intubations than any of the bougies. Whether the differences in time to

Table 2 Performance characteristics of tracheal tube introducers. Values are number (proportion [95%CI]) or median (IQR [range]).

	Storz C-MAC Stylet n = 60	Universal Stylet Bougie n = 60	Total Control Introducer n = 60	Steerable Tracheal Intubation Guide n = 60	Portex Single-Use Bougie n = 60
First-attempt tracheal intubation success	58 (97% [92–100%])	50 (83% [74–93%])	53 (88% [80–97%])	42 (70% [58–82%])	27 (45% [32–58%])
Standard	30 (100% [100–100%])	28 (93% [95–100%])	27 (90% [79–100%])	24 (80% [65–95%])	17 (57% [38–76%])
Difficult	28 (93% [84–100%])	22 (73% [56–90%])	26 (87% [74–99%])	18 (60% [41–79%])	10 (33% [15–51%])
Tracheal intubation success within 120 s	60 (100% [100–100%])	59 (98% [95–100%])	58 (97% [92–100%])	49 (82% [72–92%])	47 (78% [68–89%])
Standard	30 (100% [100–100%])	30 (100% [100–100%])	30 (100% [100–100%])	28 (93% [84–100%])	28 (93% [84–100%])
Difficult	30 (100% [100–100%])	29 (97% [90–100%])	28 (93% [84–100%])	21 (70% [53–87%])	19 (63% [46–81%])
Time to tracheal intubation; s	22 (19–25 [13–64])	21 (18–25 [13–89])	36 (31–46 [21–130])	35 (29–52 [17–140])	34 (25–53 [14–174])
Standard	22 (18–25 [14–30])	21 (18–23 [13–45])	37 (31–46 [23–114])	33 (29–44 [17–73])	30 (21–47 [18–90])
Difficult	22 (20–26 [13–64])	22 (19–34 [16–89])	36 (31–51 [21–130])	45 (34–64 [25–140])	43 (28–62 [14–174])
Ease of tracheal intubation*	8 (7–9 [3–10])	8 (7–9 [1–10])	7 (6–8 [1–10])	6 (3–7 [1–10])	5.5 (2–8 [1–10])
Standard	8 (8–9 [5–10])	8.5 (8–9 [3–10])	8 (6–9 [4–10])	6.5 (5–8 [1–10])	8 (3.5–9 [1–10])
Difficult	8 (6–9 [3–10])	7 (3–8 [1–10])	7 (5–8 [1–9])	4 (1–7 [1–10])	3 (1–7 [1–10])
Ease of railroading*	–	–	8 (5–9 [1–10])	6 (3–8 [1–10])	8 (6–9 [2–10])
Standard	–	–	9 (6–10 [3–10])	7 (5–9 [1–10])	9 (8–10 [2–10])
Difficult	–	–	8 (5–9 [1–10])	4 (3–7 [1–10])	6.5 (5–8 [3–10])
Force used*	6 (3–7 [1–10])	5 (3–7 [1–10])	5 (3–7 [1–10])	6.5 (4–8 [1–10])	6 (3–8 [1–10])
Standard	5 (2–7 [1–9])	4.5 (3–6 [1–9])	4 (3–7 [1–9])	5 (4–7 [1–9])	4 (3–6 [1–9])
Difficult	6 (5–8 [2–10])	7 (4–8 [2–10])	6 (4–8 [1–10])	7 (5–8 [1–10])	7 (4–9 [2–10])

*Verbal rating scale, 1–10.

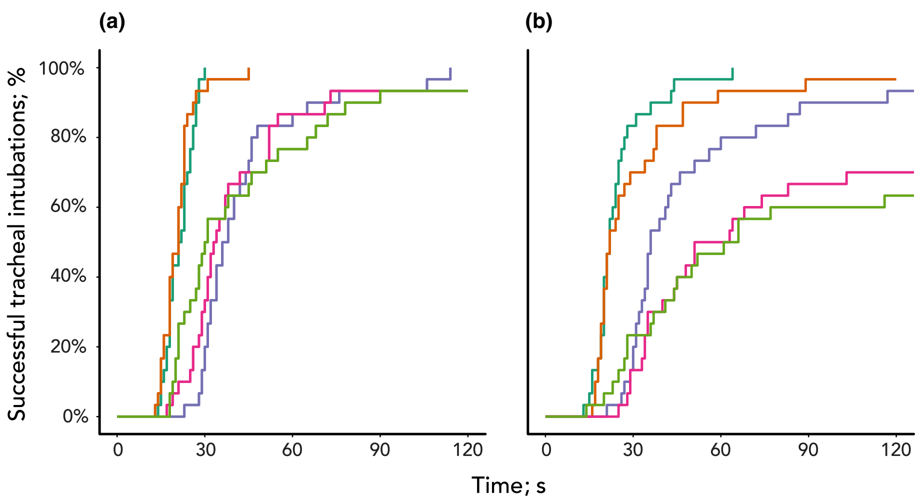

Figure 3 Kaplan–Meier plots showing time to successful tracheal intubation in the (a) standard and (b) difficult tracheal intubation manikin setup for each introducer. Teal, Storz C-MAC Stylet; orange, Universal Stylet Bougie; blue, Total Control Introducer; magenta, Steerable Tracheal Intubation Guide; green, Portex Single Use Bougie.

tracheal intubation are clinically relevant is likely to depend on the setting. Force required for tracheal intubation was broadly similar for all devices. This supports the internal validity of our study as the force required during laryngoscopy is largely a result of the manikin setup and not the introducer.

Our results contradict those of a recently published randomised clinical trial which showed significantly higher

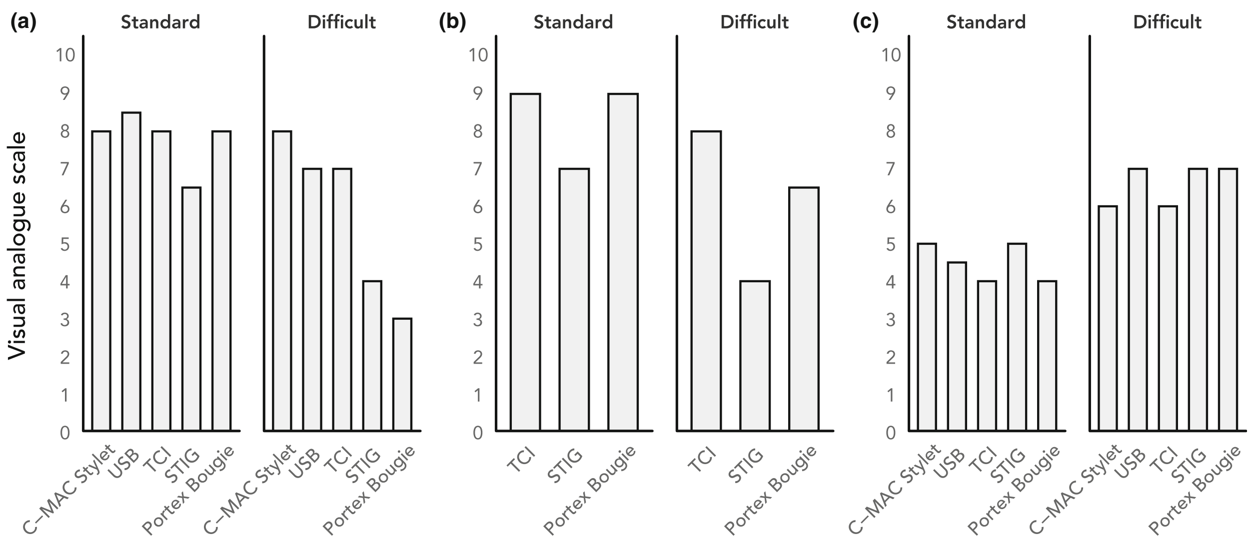

Figure 4 (a) Ease of tracheal intubation; (b) ease of railroading; and (c) force required for intubating a manikin in standard and difficult tracheal intubation manikin setup for each introducer. USB, Universal Stylet Bougie; TCI, Total Control Introducer; STIG, Steerable Tracheal Intubation Guide.

first attempt tracheal intubation success using a static bougie compared with stylet during hyperangulated videolaryngoscopy with a Glidescope in patients with anticipated difficult airway management [8]. The stylet used in that study was a straight, malleable stylet bent into a `hockey-stick´ shape before use, and this may be one reason for its inferior performance [9, 10]. Furthermore, despite risk factors for difficult airway, this cohort did not include many difficult tracheal intubations: 96% of patients had a Cormack and Lehane grade 1 or 2 view at videolaryngoscopy and 93% of attempts were successful first time. Performance of introducers likely differs between straightforward and difficult hyperangulated videolaryngoscopy. While our manikin-based study was able to overcome the above design limitations, it remains manikin-based and therefore is more suited to hypothesis generation than testing. Our results highlight the need for clinical studies of high methodological quality.

The C-MAC Stylet is a rigid metal device which is designed to match the curvature of the C-MAC D-Blade. If a view of the glottis is obtained with a C-MAC D-Blade, correct advancement of a C-MAC Stylet should cause the tracheal tube to be delivered to a point just proximal to the vocal cords [14]. This theory is borne out by the success of the C-MAC Stylet across all our outcome measures.

The Universal Stylet Bougie is a malleable plastic device which can be used as either a bougie or a stylet and was used as a stylet in this study with the tracheal tube pre-loaded [15]. It is designed to be re-shaped as required before tracheal intubation, and unlike the Portex Bougie, due to metal sections within, will retain its new shape. We hypothesise that this explains its superior performance to the bougie; if shaped accurately it can match the curvature of the D-blade and deliver a tracheal tube to the correct location.

The Total Control Introducer is a dynamic bougie with a trigger mechanism which enables the distal tip to be redirected during tracheal intubation [16]. The articulation point allows this device to match the shape of the D-Blade more accurately than the Steerable Tracheal Intubation Guide. The Total Control Introducer has several steps and, in the standard airway, tracheal intubation with this device was slower than with other introducers. The default position of the tip is at its maximal anterior position, and if the trigger mechanism is released quickly the tip will revert from straight to maximally anterior with some force. Some participants expressed concern that this might risk causing trauma to the trachea in clinical practice. The device designer has reported other evaluations indicate low force is exerted in clinical practice (Sean Runnels, personal communication).

The Steerable Tracheal Intubation Guide is a dynamic bougie with a slider tab mechanism which enables reversible anterior–posterior displacement of the distal tip during tracheal intubation [17]. The point of articulation is approximately 3 cm from the tip, which gives this device a smaller range of redirection than the Total Control Introducer. Ease of railroading the tracheal tube was rated harder with this device than with either of the other bougies. After passing through the cords, the device's narrow diameter allowed it to sit very posteriorly between the arytenoids; passing a tracheal tube caused the device to bow more posteriorly, frequently causing tube hang-up on the arytenoids. This may be an artefact of the simulation manikin, and we do not know whether the same issue occurs in clinical practice.

Like many static bougies currently available, the Portex Bougie is made of a malleable plastic polymer with a coudé tip at its distal end. The Portex Bougie can be deformed to alter its shape but rapidly returns to its original straight shape. This lack of plasticity appeared to contribute to its poor performance in this study, and it often directed the tracheal tube posterior to the glottic opening.

Strengths of our study include that we evaluated a full range of tracheal tube introducers. We also simulated difficult tracheal intubating conditions successfully, using a manikin specifically designed for that. The manikin's use has not been reported in a study previously and we found it effective in creating a difficult tracheal intubation setup consistently. This is important because performance of the introducers could plausibly differ depending on whether tracheal intubation is `standard´ or `difficult´, as we have shown in this study. By using a manikin that can create a difficult airway, we have been able to test the latter scenario more reliably than could be done clinically. In our study, in the difficult airway setup, 46 (31%) of 150 tracheal intubation attempts required multiple attempts or failed, whereas in a recent clinical study evaluating tracheal tube introducers in patients with predictors of difficult airway, only 7% did not have their tracheas intubated at the first attempt [8].

The main limitation of our study is that it was undertaken in a manikin, and this means the findings may not be transferable to clinical practice. Many features of a manikin do not reflect airway management in clinical practice, but we believe our careful design and choice of outcomes enabled a robust evaluation of introducer performance and separation of this from manikin and laryngoscope performance. We opted for a manikin design due to the relative infrequency of difficult airways encountered in clinical practice. Furthermore, a simulation design is a more cost-effective way of assessing efficacy than a clinical trial. It is likely that participants benefited from a degree of improvement through repeated tracheal intubation attempts of the same manikin, which might bias towards improved results with the devices they used later. We managed this by presenting the devices and airway setups in a random sequence for each participant. A difficult airway was simulated with a fixed amount of anterior laryngeal displacement; this allowed the setup to be replicated between participants, but it does not reflect the broad range of anatomical and physiological features which can lead to challenging tracheal intubating conditions in clinical practice. We performed this study at a single site, so there may be bias towards the equipment and techniques which are used commonly in our department. However, it is notable that of the five introducers evaluated here, the only two available for routine clinical use in our department are the C-MAC Stylet and the Portex Bougie, which performed, respectively, best and worst in the primary outcome and in the majority of secondary outcomes. We only used one specific model of hyperangulated videolaryngoscope, the reusable C-MAC D-blade, so results may not be applicable directly to other models. Finally, a manikin study only enables evaluation of efficacy and does not enable evaluation of device safety, and this, including risk of trauma with the devices studied, merits further evaluation [18].

In conclusion, this study raises questions about the use of static bougies as the first-line tracheal tube introducer for hyperangulated videolaryngoscopy in difficult airways. A rigid stylet is likely to perform best. Dynamic (steerable) bougies appear to perform well and merit further formal study in clinical practice.

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References

1. Hansel J, Rogers AM, Lewis SR, Cook TM, Smith AF. Videolaryngoscopy versus direct laryngoscopy for adults undergoing tracheal intubation. *Cochrane Database Syst Rev* 2022; **4**: CD011136. https://doi.org/10.1002/14651858.CD011136.pub3.

2. Al-Qasmi A, Al-Alawi W, Malik AM, Manzoor Khan R, Kaul N. Comparison of tracheal intubation using the Storz's C-Mac D-blade™ video-laryngoscope aided by Truflex™ articulating stylet and the Portex™ intubating stylet. *Anesth Pain Med* 2015; **5**: e32299. https://doi.org/10.5812/aapm.32299.
3. Reynolds EC, Crowther N, Corbett L, Cominos T, Thomas V, Cook TM, Kelly FE. Improving laryngoscopy technique and success with the C-MAC® D blade: development and dissemination of the `Bath C-MAC D blade guide´. *Br J Anaesth* 2020; **125**: e162–4. https://doi.org/10.1016/j.bja.2019.12.024.
4. Ömür D, Bayram B, Özbilgin Ş, Hancı V, Kuvaki B. Comparison of different stylets used for intubation with the C-MAC D-Blade® Videolaryngoscope: a randomized controlled study. *Braz J Anesthesiol* 2017; **67**: 450–6. https://doi.org/10.1016/j.bjane.2016.06.001.
5. Sastre JA, Gómez-Ríos MA, López T, Gutiérrez-Couto U, Casans-Francés R. Dynamic versus standard bougies for tracheal intubation with direct or indirect laryngoscopy in simulated or real scenarios: a systematic review and meta-analysis. *Expert Rev Med Devices* 2024; **21**: 427–38. https://doi.org/10.1080/17434440.2024.2344667.
6. Batuwitage B, McDonald A, Nishikawa K, Lythgoe D, Mercer S, Charters P. Comparison between bougies and stylets for simulated tracheal intubation with the C-MAC D-blade videolaryngoscope. *Eur J Anaesthesiol* 2015; **32**: 400–5. https://doi.org/10.1097/EJA.0000000000000070.
7. Oxenham O, Pairaudeau C, Moody T, Mendonca C. Standard and flexible tip bougie for tracheal intubation using a non-channelled hyperangulated videolaryngoscope: a randomised comparison. *Anaesthesia* 2022; **77**: 1368–75. https://doi.org/10.1111/anae.15854.
8. Eum D, Ji YJ, Kim HJ. Comparison of the success rate of tracheal intubation between stylet and bougie with a hyperangulated videolaryngoscope: a randomised controlled trial. *Anaesthesia* 2024; **79**: 603–10. https://doi.org/10.1111/anae.16202.
9. Cafferkey J, Ward PA. Intubation aids in hyperangulated videolaryngoscopy: essential components more than just adjuncts. *Anaesthesia* 2024; **79**: 659–60. https://doi.org/10.1111/anae.16244.
10. Cook TM. Stylets, bougies and hyperangulated videolaryngoscopy. *Anaesthesia* 2024; **79**: 999–1000. https://doi.org/10.1111/anae.16355.
11. Perry LA, Chrimes NC. Stylet vs. bougie for hyperangulated videolaryngoscopy: fragility, generalisability and the Cooper manoeuvre. *Anaesthesia* 2024; **79**: 1134–5. https://doi.org/10.1111/anae.16373.
12. Penders R, Kelly FE, Cook TM. Universal C-MAC® videolaryngoscope use in adult patients: a single-centre experience. *Anaesth Rep* 2024; **12**: e12314. https://doi.org/10.1002/anr3.12314.
13. Cook TM. A new practical classification of laryngeal view. *Anaesthesia* 2000; **55**: 274–9. https://doi.org/10.1046/j.1365-2044.2000.01270.x.
14. Corbett L, Kelly FE, Cook TM. Development and maintenance of direct laryngoscopy skills using a videolaryngoscope with a Macintosh-shaped blade. *Anaesthesia* 2024; **79**: 1255–6. https://doi.org/10.1111/anae.16372.
15. Intersurgical. Universal Stylet Bougie. https://www.intersurgical.com/products/airway-management/universal-stylet-bougie (accessed 31/10/2024).
16. Shah A, Durnford K, Knecht L, Jacobson C, Runnels ST. A consecutive case series of rescue intubations with the articulating total control introducer for precision tracheal access. *A&A Practice* 2021; **15**: e01418. https://doi.org/10.1213/XAA.0000000000001418.
17. Lateral Medical. Steerable Tracheal Intubation Guide. https://lateralmedical.com/anaesthetics-critical-care/airway-management/flexible-tip-bougie/ (accessed 31/10/2024).
18. Boulton AJ, Smith E, Yasin A, Moreton J, Mendonca C. Tracheal tube introducer-associated airway trauma: a systematic review. *Anaesthesia* 2024; **79**: 1091–101. https://doi.org/10.1111/anae.16379.

Supporting Information

Additional supporting information may be found online via the journal website.

Table S1. Manikin setup.

Table S2. Time to successful tracheal intubation according to device and manikin difficulty setup.

Table S3. First-attempt tracheal intubation success between introducers.

Table S4. Ease of tracheal intubation between introducers.

Figure S1. Trial setup.

Appendix S1. Code used for statistical analysis.

Appendix S2. Full outcome data.