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SCIENTIFIC ARTICLE

Comparison of different stylets used for intubation with the C-MAC D-Blade® Videolaryngoscope: a randomized controlled study



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KEYWORDS

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videolaryngoscopy;
Intubation;
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Abstract

Objective: The angle of the C-MAC D-Blade® videolaryngoscope, which is used for difficult airway interventions, is not compatible with routinely used endotracheal tubes.

Methods: A prospective randomized crossover study was performed comparing five intubation methods for use with standardized airways, including using different stylets or no stylet: Group HS, hockey-stick stylet; Group DS, D-blade type stylet; Group CS, CoPilot® videolaryngoscope rigid stylet®; Group GEB, gum elastic bougie; and Group NS, no stylet. A manikin was used to simulate difficult intubation with a Storz C-MAC D-Blade® videolaryngoscope. The duration of each intubation stage was evaluated.

Results: Participants in this study (33 anesthesiology residents and 20 anesthesiology experts) completed a total of 265 intubations. The number of attempts made using no stylet was significantly greater than those made for the other groups ($p < 0.05$ for group NS- group GEB, group NS- group DS, group NS- group CS and group NS- group HS). The duration to pass the vocal cords significantly differed among all groups ($p < 0.001$). The total intubation duration was shortest when using D-blade stylet, CoPilot stylet and hockey stick stylet. Although no difference was observed between stylet groups, a significant difference was found between each of these three and no stylet and gum elastic bougie ($p < 0.05$ and $p < 0.001$, respectively).

Conclusion: Use of the correct stylet leads to a more efficient use of the Storz C-MAC D-Blade®. In our study, the use of the D-blade stylet, the CoPilot stylet and the hockey stick stylet provided quicker intubation, allowed easier passage of the vocal cords, and decreased the total intubation duration. To confirm the findings of our study, randomized controlled human studies are needed.

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PALAVRAS-CHAVE

Videolaringoscópio
C-MAC D-Blade®;
Intubação;
Estilete;
Manequim

Comparação de diferentes estiletes usados para intubação com o videolaringoscópio C-MAC D-Blade®: um estudo randômico e controlado

Resumo

Objetivo: O ângulo do videolaringoscópio C-D-MAC Blade®, usado para intervenções em via aérea difícil, não é compatível com os tubos endotraqueais rotineiramente usados.

Métodos: Um estudo prospectivo, randômico e cruzado foi conduzido para comparar cinco métodos de intubação em modelo de via aérea, com o uso de diferentes estiletes em cinco grupos: taco de Hockey; D-blade; CoPilot VL® rígido; Gum Elastic Bougie e controle (sem estilete). Um manequim foi utilizado para simular intubação difícil com o laringoscópio Storz C-MAC D-Blade®. Foi avaliada a duração de cada fase de intubação.

Resultados: Os participantes deste estudo (33 residentes de anestesiologia e 20 especialistas em anestesiologia) concluíram 265 intubações no total. O número de tentativas realizadas sem estilete foi significativamente maior que o dos outros grupos ($p < 0,05$ para SE-GEB, SE-DB, SE-CP e SE-HS). O tempo para passar pelas cordas vocais foi significativamente diferente entre todos os grupos ($p < 0,001$). O tempo total de intubação foi menor com o uso de D-blade, CoPilot VL® rígido e taco de Hockey. Embora não tenha havido diferença entre D-blade, CoPilot VL® rígido e taco de Hockey, uma diferença significativa foi observada entre cada um desses três e os grupos sem estilete e Gum Elastic Bougie ($p < 0,05$ e $p < 0,001$, respectivamente).

Conclusão: A escolha do estilete certo leva ao uso mais eficiente do videolaringoscópio Storz C-MAC D-Blade®. Em nosso estudo, o uso do D-blade, CoPilot VL® rígido e taco de Hockey proporcionou intubação mais rápida, facilitou a passagem pelas cordas vocais e diminuiu o tempo total de intubação. Para confirmar os resultados de nosso estudo, estudos controlados e randômicos com humanos são necessários.

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Introduction

Despite improvements in airway intervention devices, difficult airways remain among the most significant obstacles in anesthesia and emergency medicine. In the surgical environment, it has been reported that 5% and 1% of patients are eligible for grade 3 and grade 4 laryngoscopy, respectively. In 0.43% of patients, direct laryngoscopy with intubation is not possible.¹ Studies indicate that the incidence of difficult intubation varies from 0.4% to 4.7%; these numbers are higher for obstetric anesthesia (5.7%) and in obese patients (13.3%).²⁻⁴ The incidence of difficult intubation is greater in emergency situations. A multicenter study in the USA found that difficulties were encountered in 5% of 8937 intubations and reported that more than one method was used. The same study found that intubation could not be completed in 0.84% of patients, and surgical airway opening was performed.⁵ Consequently, the authors recommend the early use of devices designed for use with difficult airways to prevent complications.¹

For difficult airway interventions, videolaryngoscopy (VL) is a life-saving and effective method.^{6,7} The C-MAC D-Blade® VL is an increasingly popular laryngoscopy device that is specially designed for use in difficult intubations. To better observe the vocal cords, the C-MAC D-Blade® has a half-moon shape and is designed with a broader angle than direct laryngoscopy blades.⁸ Due to the elliptic and narrowing shape of the blade, compatibility with the anatomy of the oropharynx is possible. Laryngoscopic visualization is obtained using a camera located on the 3.5 cm tip of the

C-MAC D-Blade® VL.⁹ Whereas the angle of vision of the C-MAC® VL Macintosh blades nos. 3 and 4 are 72° and 60°, respectively, the C-MAC D-Blade® VL has a greater angle of vision of 80° due to the embedded optic lens.¹⁰ Thus, the user can obtain a wider view of the interior of the mouth.

The angling of the blade is not compatible with the angles of routinely used endotracheal tubes. Although the C-MAC D-Blade® VL provides better imaging, it can be difficult to direct the endotracheal tube within the mouth for successful intubation, and the duration of intubation may lengthen.⁷ To resolve this problem, it may be necessary to use a stylet of an appropriate shape within the intubation tube with the C-MAC D-Blade® VL.^{11,12} In difficult intubations that are not supported with an appropriate stylet, intubation can be unsuccessful; the number of intubation attempts can increase, and it might be necessary to reshape the tube and reattempt intubation. This situation increases the duration of intubation, can cause trauma to soft tissue, and negatively affects the hemodynamics of the patient. Although the current literature emphasizes the superiority of this device in normal and difficult intubations compared to other laryngoscopy devices, the use of this device with a stylet and important practical issues, such as stylet preparation, remain controversial.⁸

The hypotheses of our study are (1) that not using a stylet for cases involving C-MAC D-Blade® VL will reduce the success of intubation and (2) that the use of stylets will increase the success rate. To test these hypotheses, this study attempted to determine the ideal stylet for intubation

with a C-MAC D-Blade® VL (no stylet [NS] and four different stylets: hockey-stick stylet [HS], D-blade type stylet [DS], rigid stylet for VL [CS] and gum elastic bougie [GEB]); the effects of these stylets on intubation success, laryngoscopy images, the need for extra maneuvers, complications and the duration of intubation were assessed.

Material

Study population

The study began once permission was obtained from the Dokuz Eylül University Medical Faculty (DEUMF) Research Ethics Committee. Al-Qasbi et al.¹³ reported success in 90% of intubations using a hockey-stick-shaped stylet. The hypotheses studied here are (1) that not using any stylet will reduce the success of intubation and (2) that the use of a stylet will increase the success rate. To test these hypotheses in our planned study and obtain a 20% difference between the groups with an alpha error of 5% and 80% power, the number of insertions required for each group was determined to be at least 48. Assuming a 10% data loss, 53 insertions were planned for each group. Consequently, 53 physicians (experts or specialization students) from the DEUMF Anesthesiology Department who had experience using the Storz C-MAC D-Blade® were included in this study.

Randomization

The study followed a prospective randomized crossover design. For randomization, five closed envelopes were prepared, each containing the name of a method. All envelopes were left in a basket beside the VL device, and the physician performing the intervention chose an envelope at random and used the method listed in the envelope.

Methods performed and preparation

The study compared the following 5 intubation methods for standardized airway visualization: using no stylet and 4 different stylets. For all intubations, a Storz C-MAC D-Blade® (Karl Storz GmbH & CoKG, Tuttlingen, Germany) external imaging unit was used in the laryngoscopy.

For all applications, an no. 7.5 standard-cuff intubation tube was used. In a randomized fashion, all participants completed the applications using no stylet and four different stylets for intubation. The stylet methods used in our study were as follows: (1) endotracheal intubation without stylet (no stylet, NS); (2) endotracheal intubation with a hockey-stick-shaped stylet (the tip of the stylet was bent to form a 90° angle; hockey-stick stylet, HS); (3) endotracheal intubation using the D-Blade angle (the tip of the tube was bent to form a shape similar to the angle of the D-Blade; D-blade type stylet, DS); (4) endotracheal intubation using a Co-Pilot® VL rigid stylet (Rigid Stylet for Co-Pilot VL, CS; Magaw Medical Fort Worth, TX, USA); and (5) intubation using a gum elastic bougie, which was passed over the vocal cords; the tube was then slid over it (gum elastic bougie; GEB) (Fig. 1).

Standardized difficult airway simulation

Difficult intubation conditions were simulated using a manikin (AirSim® Advance Combo; Trucorp Ltd.; Belfast, Northern Ireland) for standardized trauma patient simulations with removable teeth and a difficult intubation airway. An appropriate trauma collar (Ambu® Perfit, Copenhagen, Denmark) was used to prevent movement of the neck and chin of the manikin (2). Additionally, to prevent head-neck movement of the manikin, the manikin was fixed to the surgical table with plaster across the forehead and neck.

Method

For the study, the manikin was placed on an operating table. Following a predetermined order, the randomized participants performed each method sequentially. An assistant was present to aid the participant during each endotracheal intubation attempt. Before each application, the participant was asked to ventilate the manikin using a Balloon Valve Mask (BVM). The intubation began when the participant felt ready. For each procedure, the participant inflated the cuff of the tube, removed the stylet from the tube, and provided ventilation from the tube to the BVM. The assistant provided laryngeal external intervention if requested by the participant. When the simulated lungs appeared to be ventilated, the procedure ended, and intubation was accepted as successful. In cases requiring longer than 60s to pass the vocal cords, the attempt was ended, and the next attempt began. The manikin was newly ventilated with the BVM, and all steps were performed again. If 3 attempts were unsuccessful, the intubation was assessed as unsuccessful.

The study team determined the intubation success and the duration of intubation stages. The durations assessed were as follows: (1) duration to visualizing the vocal cords: the duration from the moment the participant picked up the laryngoscope to when they observed the vocal cords; (2) duration to pass the vocal cords: the duration from the moment the vocal cords were observed to when the intubation tube passed the vocal cord interval; (3) duration to cuff inflation: the duration from the moment the tube passed the vocal cord interval to when the intubation was performed and the cuff was inflated; (4) duration to first ventilation: the duration from the inflation of the cuff to the first successful ventilation; and (5) total intubation duration: the duration from the moment the participant picked up the laryngoscope to when the first successful ventilation was performed. The vocal cord images on the external imaging unit were assessed and recorded by the study team according to the Cormak Lehane classification.¹⁴

A chronometer (iPhone 5) was used to record the intubation durations.

If the participant requested extra manipulation to ease the intubation, the study team recorded "additional laryngeal manipulation" (BURP [cricoid pressure with backward, upward, rightward pressure] or OELM [optimal external laryngeal manipulation]). The upper teeth of the manikin were removable. If the upper teeth of the manikin were

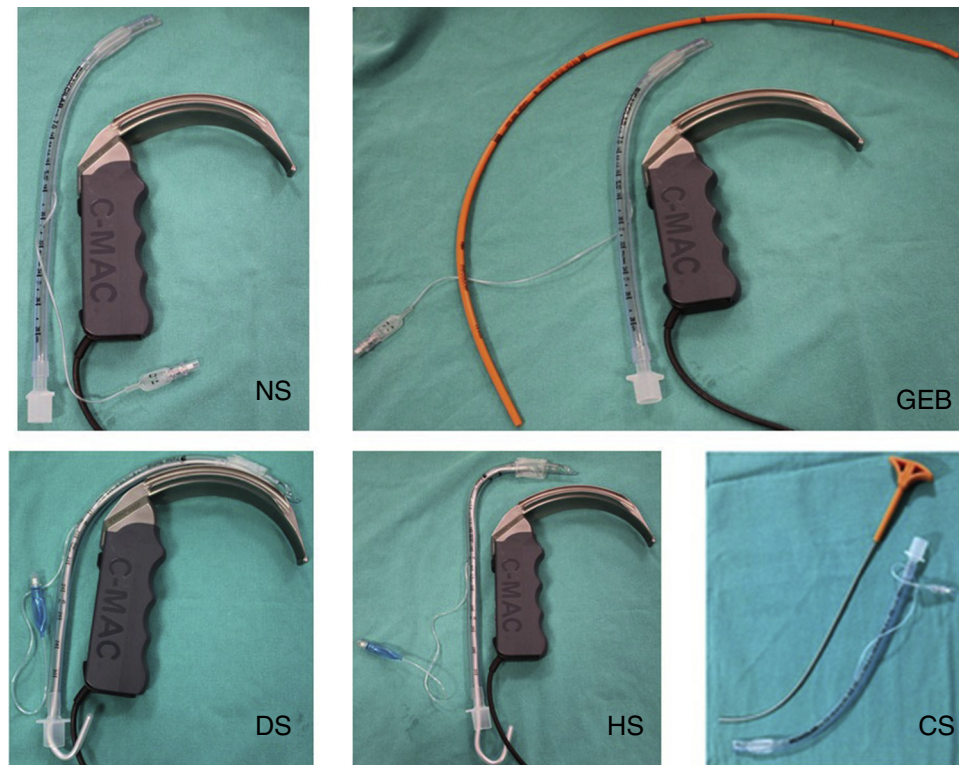


Figure 1 Stylets according to group. NS, no stylet; HS, hockey-stick stylet; DS, D-blade type stylet; GEB, gum elastic bougie; CS, CoPilot VL rigid stylet®.

damaged during the application, this was recorded as a complication of the procedure.

Correlation of dependent and independent variables for statistical analysis

Statistical analysis was performed using SPSS 15.0 for Windows. For the descriptive statistics, categorical variables are presented as numbers and percentages, and numerical variables are presented as the means and standard deviations. Numerical variables between two independent groups were compared using Student's *t*-test for normally distributed data and the Mann-Whitney *U* test for data without normal distribution. Differences between categorical variables in independent groups were tested using the Chi-square analysis. To compare the means of more than two groups, a one-way ANOVA test was used. If differences were

found in the variance homogeneity, the Bonferroni test was used. The results were considered statistically significant if $p < 0.05$.

Results

The participants included 33 anesthesiology residents and 20 anesthesiology experts (Table 1).

A total of 265 intubations were completed by the participants. Nineteen intubations were completed on the 2nd attempt, and four were successfully completed on the 3rd attempt. All intubations were completed within three attempts. A duration of 60s for the tube to pass the vocal cords was permitted in the study. A third attempt was required only for intubations without the use of a stylet. When compared separately with the other groups, no difference was found between NS and GEB ($p > 0.05$); however,

Table 1 Participant demographic data.

	<i>n</i>	%	Mean	Min-max
Resident	33	62.3	-	-
Expert	20	37.7	-	-
Age (years)		-	34.7 ± 8.8	25-56
Sex				
Female	28	52.8	-	-
Male	25	47.2	-	-
Years of experience (years)		-	6.3 ± 6.9	1.4-26

Table 2 Intubation attempts.

Variable	NS	HS	DS	CS	GEB	n (%)
<i>Number of attempts</i>						
1	40 (75.5%)	52 (98.1%)	51 (96.2%)	52 (98.1%)	47 (88.7%)	242 (92.5%)
2	9 (17.0%)	1 (1.9)	2 (3.8%)	1 (1.9)	6 (11.3%)	19 (7.2%)
3	4 (7.5%)	–	–	–	–	4 (1.5%)

NS, no stylet; HS, hockey-stick stylet; DS, D-blade type stylet; GEB, gum elastic bougie; CS, CoPilot VL rigid stylet®.

significantly more attempts were required for NS than for the other groups ($p < 0.05$ for NS-GEB, NS-DS, NS-CS, and NS-HS). No significant difference was observed between the other groups in terms of the number of attempts ($p > 0.05$ for each comparison) (Table 2).

During all applications, C/L1–2 images were obtained. No statistically significant difference was found between the participants' years of experience and intubation success, extra manipulation use and complications ($p > 0.05$).

Intubation duration did not significantly differ in terms of vocal cord visualization between the groups. Duration to pass the vocal cords significantly differed between all groups ($p < 0.001$) (Table 3).

Duration to pass the vocal cords was clearly shorter for DS, HS and CS, and no difference were found between GEB and NS in this respect ($p < 0.05$). A significant difference existed between GEB and NS and all other groups ($p < 0.001$ for all comparisons). No significant difference was found between DS, HS and NS ($p > 0.05$ for all comparisons). Although the duration of cuff inflation appeared to be shorter in the NS group, the difference was not statistically significant ($p > 0.05$). The shortest total intubation durations

were obtained using DS, CS and HS, in that order. Although DS, CS and HS did not appear to differ, a significant difference was found between each of the three and NS and GEB ($p < 0.05$ and $p < 0.001$, respectively) (Fig. 2).

Intubation without a stylet caused dental damage complications a maximum of 15 times (28.3%), followed by GEB with 6 incidents (11.3%). When compared separately with the other groups, dental damage in the NS group was significantly greater than that in the other groups ($p < 0.05$ for NS-GEB, NS-DS, NS-CS, and NS-HS). No significant difference was observed among the other groups in terms of dental damage ($p > 0.05$ for all comparisons) (Table 4).

Discussion

This study compared intubations with and without stylets using a Storz C-MAC D-Blade® on a manikin that simulated a difficult airway; the intubations were performed by anesthesiology experts and residents, and the results showed that intubations with no stylet and with GEB required longer to complete, required more attempts and resulted in increased

Table 3 Intubation durations.

Variable	NS	HS	DS	CS	GEB	p-Value
<i>Duration to visualize the vocal cords (s)</i>						
Mean	8.0 ± 3.2	8.2 ± 3.4	8.6 ± 3.6	9.2 ± 5.2	9.8 ± 5.4	>0.05
95% confidence interval	7.2–8.9	7.3–9.2	7.6–9.6	7.7–10.7	8.3–11.3	
Min–max	3.5–20	2.3–17.7	2.5–18.4	2.7–36.8	2.4–32.1	
<i>Duration to pass the vocal cords (s)</i>						
Mean	33.8 ± 15.5	14.3 ± 12.2	8.7 ± 6.2	10.3 ± 8.8	28.8 ± 15.2	<0.001
95% confidence interval	29.5–38.1	10.0–17.7	6.0–10.4	7.8–12.9	24.6–33.0	
Min–max	7.6–58.5	2.7–46.3	2.2–33.2	2.2–46.2	4.9–58	
<i>Duration of cuff inflation (s)</i>						
Mean	8.0 ± 7.1	9.6 ± 4.3	8.5 ± 2.4	9.4 ± 5.2	9.9 ± 7.0	0.407
95% confidence interval	6.1–10.1	8.4–10.8	7.9–9.2	7.8–10.9	7.9–11.9	
Min–max	2.7–55.6	1.6–20.5	3.0–13.4	3.4–39.2	2.4–34.2	
<i>Duration to first ventilation (s)</i>						
Mean	5.0 ± 1.9	5.3 ± 3.3	5.1 ± 1.8	5.8 ± 1.9	5.3 ± 3.2	0.451
95% confidence interval	4.5–5.6	4.4–6.2	4.6–5.6	5.2–6.3	4.4–6.2	
Min–max	1.8–12.8	1.5–18.3	1.2–11.8	2.3–9.9	1.4–16.5	
<i>Total duration (s)</i>						
Mean	55.0 ± 19.3	37.4 ± 13.3	30.8 ± 7.9	34.9 ± 12.4	53.9 ± 18.3	0.009
95% confidence interval	49.7–60.3	33.8–41.1	28.7–33.2	31.3–38.4	48.8–58.9	
Min–max	24.4–133	14.7–73.4	18.2–54.9	18.2–73.5	17.3–97.7	–

NS, no stylet; HS, hockey-stick stylet; DS, D-blade type stylet; GEB, gum elastic bougie; CS, CoPilot VL rigid stylet.

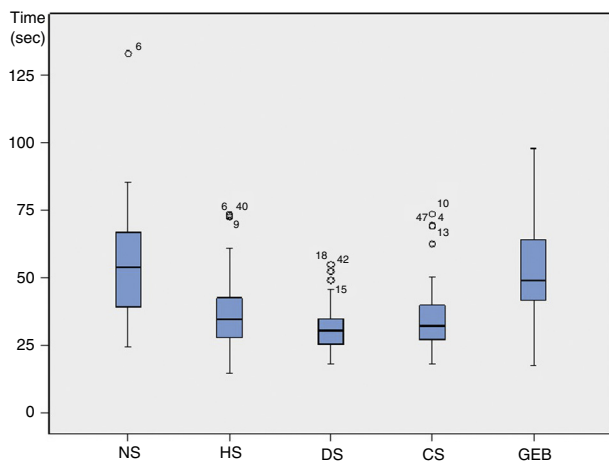


Figure 2 Total intubation time according to group. NS, no stylet; HS, hockey-stick stylet; DS, D-blade type stylet; GEB, gum elastic bougie; CS, CoPilot VL rigid stylet®.

complication rates. The use of an appropriate stylet eased passage past the vocal cords and reduced the duration of intubation; intubation was more rapidly accomplished using the DS, CS and HS, in that order.

Endotracheal intubation is among the most frequently used life-saving interventions. Although technological advances have resulted in the development of novel devices, the classic Miller and Macintosh laryngoscopes remained unequalled until the development of VL. Beginning in the 2000s, developments in VL technology, increases in the availability of these devices, and the positive results shown by scientific studies have resulted in these devices becoming considered the acme of airway management today. After the development of conventional VLs, more angled blades that are suitable for use with difficult intubations were developed. Whereas the conventional C-MAC laryngoscope provides an 18° view angle, the D-Blade provides a 40° view angle. This difference in angle improves the operator’s view during laryngoscopy; however, inserting the tube into the trachea is more difficult.^{8,15,16}

To correctly advance the tube through the trachea with a Storz C-MAC D-Blade® VL, the use of a stylet is necessary. Changing the initial angle of the stylet or using different types of stylets greatly facilitates intubation. In this study, intubation durations were investigated. Durations involving the visualization of the vocal cords, cuff inflation and first ventilation were similar; however, total intubation duration differed significantly between not using a stylet and the GEB compared to the other intubation methods (Table 2). This

result is apparently due to the passage of the tube through the trachea. The use of an appropriate stylet with the Storz C-MAC D-Blade® eases the passage of the tube through the trachea and reduces the duration of intubation, as well as increases the possibility of successful intubation on the first attempt. Additionally, it was possible to complete the intubation without additional manipulation. This result is similar to those found in previous studies.^{11,17}

HS are used with VL or with the classic Macintosh laryngoscope for difficult airway interventions. A study comparing the use of different stylets with the Storz C-MAC® found that the best performance was obtained using this stylet type.¹¹ The HS is prepared by angling the distal end of the intubation tube at a 9–100° angle.^{11,17} However, using this type of stylet can make stylet insertion and removal from the intubation tube more difficult. It has been reported that distal tube angles of greater than 35° can render passage through the trachea more difficult.¹⁸ In our study, although intubation with the HS provided better results than use of no stylet or GEB, the results obtained were similar to those obtained using a rigid stylet with a smaller distal angle and those obtained using a DS.

Rigid stylets can alternatively be used to ease intubation through the trachea when performing VL. Their use presents no advantages over malleable stylets with distal angles.¹⁹ In our study, the Co-Pilot VL® rigid stylet was used. In a literature review, we did not find any previous study using this stylet. Although intubation was more rapid using this stylet, no differences in intubation duration, success and the need for additional manipulation were found when compared to the HS. Although both stylets present advantages, the stylet prepared with the blade angle (DS) exhibited equal success to the other tested stylet types. Although it appears that the possibility of dental damage using this stylet type is higher, we believe that intubation with DS and D-Blade VL is easily applied. Importantly, this stylet type passed the trachea most quickly. This is probably because the angle of the tube is not at the distal end; thus, it advances more easily along the blade.

The portability, cheapness, availability, high success rates and ease of use render the GEB an important life-saving airway device for use in difficult situations.²⁰ This method is recommended for difficult airway interventions by DAS. The results of many studies undertaken worldwide have shown that the GEB is the most successful, effective and commonly used device for use with a normal laryngoscope.²¹ In our study, a GEB was inserted first; then, a tube was slid over the GEB to provide intubation. Although this represents the classic use, this procedure can cause increased intubation duration in practice. Various methods of using a GEB are

Table 4 Complications.

Variable	NS	HS	DS	CS	GEB	p-Value
Dental damage	15 (28.3%)	1 (1.9%)	4 (7.5%)	2 (3.8%)	6 (11.3%)	<0.001
Use of external laryngeal manipulation, n (%)						
BURP or OELM	53 (100%)	7 (13.2%)	6 (11.3%)	7 (13.2%)	31 (58.5%)	<0.001

NS, no stylet; HS, hockey-stick stylet; DS, D-blade type stylet; GEB, gum elastic bougie; CS, CoPilot VL rigid stylet; BURP, cricoid pressure with backward, upward, rightward pressure; OELM, optimal external laryngeal manipulation.

available, such as first inserting the GEB in the tube or inserting the GEB such that the tube protrudes from the Murphy hole; these methods are thought to affect the duration and success of intubation. In their study, Batuwitage et al. did not show the effects of different uses of GEB on intubation duration. In that study, similar to our own, the use of GEB did not reduce the duration of intubation.¹⁷ In our study of intubation duration, we found the GEB did not ease passage through the trachea, and the increase in the total intubation duration when using a GEB was not linked to the method of GEB use but was due rather to delays in insertion into the trachea. Using a GEB with the Storz C-MAC D-Blade® VL did not ease passage through the trachea.

Limitations

Our study used a manikin; although conditions were standardized, the interventions performed might have differed from real-world applications. In our study, only dental damage was assessed as a complication. In clinical applications, other complications, such as mucosal hemorrhage, larynx damage and subcutaneous emphysema, can occur. The applications examined in this study might produce different results in live patients.

Conclusion

Although observation of the vocal cords during intubation with the Storz C-MAC D-Blade® VL, which is designed for use with difficult airways, can be successful, it is necessary to use an appropriate stylet for use with the blade structure during intubation. In our study, intubations with no stylet and with a GEB required more time to complete, required more attempts, and resulted in increased complication rates. The D-Blade stylet, the rigid stylet, and the hockey-stick stylet (in that order) afforded more rapid intubation, easier passage past the vocal cords, and reduced the duration of intubation. Because this study used a manikin, the results obtained might be similar to those obtained in humans in real-life situations; however, randomized controlled human studies are warranted to confirm our results.

Conflicts of interest

The authors declare no conflicts of interest.

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