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Performance of novice intubators in using direct laryngoscope with 3 stylets on a manikin model

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Abstract

Background: Tracheal intubation is an important clinical skill for medical students and junior residents (novice intubators). They are usually trained to use a direct laryngoscope (DL) with straight-to-cuff styletted tracheal tubes first. Only later are they exposed to the bougie as an airway adjunct and videolaryngoscope (VL) with either a standard blade or a hyperangulated blade. The purpose of this study was to investigate the performance of novice intubators in using DL with 3 common stylets.

Methods: We conducted a prospective study to compare the performance of DL with 3 common stylets, namely the straight-to-cuff stylet (S), hyperangulated VL stylet (G), and bougie (B), on a manikin model.

Results: Among 72 participants, no significant difference was observed between the success rates of S, G, and B at the first attempt (84.72%, 81.94%, and 86.11%, respectively [$P = .78$]) or within 2 minutes (91.67%, 93.06%, and 91.67%, respectively [$P = .94$]). For participants with successful intubation within 2 minutes, the average total intubation times for S, G, and B were 25.05, 24.39, and 37.45 seconds, respectively. Among the 3 stylets, B had the longest intubation time, which differed significantly from S and G ($P < .01$).

Conclusions: The performances of novice intubators with 3 different stylets were similar. The success rates for DL with either hyperangulated VL stylet or bougie were not inferior compared with the straight-to-cuff stylet on manikin airway training model. If we properly trained novice intubators to use corresponding maneuvers, they can learn to use the 3 stylets early in their airway learning course.

Abbreviations: B = bougie, DL = direct laryngoscope, G = hyperangulated VL stylet, S = straight-to-cuff stylet, VL = videolaryngoscope.

Keywords: airway management, direct laryngoscope, medical student, stylet, Tracheal intubation

1. Introduction

During the airway training process for tracheal intubation, medical students and junior residents (novice intubators) practice on a manikin model to ensure patient safety. As a standard tool first, a styletted tracheal tube is created through bending a malleable stylet into a straight-to-cuff shape for novice intubators to practice with a direct laryngoscope (DL). Moreover, this maneuver is universally used at emergency departments or general wards in Taiwan.

With technological advancements and the increasing use of videolaryngoscope (VL), hyperangulated stylet is one of the stylet used with VL (e.g. glidescope). Hyperangulated stylet is primary used in VL to match the hyperangulated blade. While many studies have compared bougie and VL in different situations of difficult airways,[1–3] less have focused on the basic situation and airway training course for students and junior residents.

Previous studies revealed that routine bougie use was associated with higher success intubation rate in difficult airway.[4] But bougie is seldom used for airway training and as the first attempt of intubation in Taiwan and other countries.[5] The purpose of this study was to investigate the performance of 3 common stylets and corresponding maneuvers for novice intubator with DL.

2. Methods

2.1. Participants

In this prospective study, 72 undergraduate medical students were enrolled from December 2018 to June 2019. None of the

S-IM and JR contributed equally to this study.

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The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request. Data are available upon request by emailing Jiann Ruey Ong.

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Key Points

- We conduct a prospective study to compare the performance of direct laryngoscope with 3 common stylets.
- The performances of novice intubators were studied.
- Hyperangulated stylet was used in direct laryngoscope with the corresponding maneuver.
- This is a manikin study with standard airway model.
- Attempts of intubation were not counted in this study.

participants had experience with intubation. Neither patient nor public involved in the study design.

2.2. Ethics

This study was approved by the Taipei Medical University—Joint Institutional Review Board, and written informed consent was obtained before the study.

2.3. Setting

2.3.1. Stylets. In this study, 3 stylets were used, namely the straight-to-cuff stylet (S, a malleable stylet bent into a straight-to-cuff shape at an angle of 35°, 14fr*38 cm),[6] the hyperangulated VL stylet (G, GlideRite® Rigid Stylet, curvature approaches 90°), and the bougie (B, Bougie-To-Go™ Introducer, 15fr*60 cm).

2.3.2. Manikin. Manikins (Life/form® "Airway Larry" Airway Management Trainer Torso) were used to simulate normal airways for evaluating the performance of the 3 stylets. All intubations were performed using a 7.0-mm cuffed endotracheal tube with a Macintosh laryngoscope.

2.3.3. Steps. In Step 1, all participants received 25 minutes of instruction from the investigator, including a 10-minute lecture and a 5-minute hands-on drill using each stylet. In Step 2, each participant attempted intubation using the 3 stylets. The order of stylets was randomly assigned by computer to decrease the learning effect. The participants did not know the order of stylets before intubation began. In Step 3, after the participant completed the intubation, we used the bag valve mask (Ambu bag) to check the tube position. If intubation failed (i.e. if no inflation was observed in the lungs), the participant extubated and tried intubation again until success for a maximum of 2 minutes. We recorded every participant's intubation by using a camera. The success rate and intubation time were calculated retrospectively based on video recordings (Fig. 1).

2.4. Outcomes

The primary outcomes were success rate at the first attempt of intubation and success rate of intubation within 2 minutes. Successful intubation was defined as the tube reaching 22 cm and bilateral lungs inflation by using the Ambu bag. Intubation failure was defined as the tube not inserted into the trachea or intubation time exceeding 2 minutes.[7]

The secondary outcome is "intubation time" for success intubation within 2 minutes. We measure 2 periods—blade to stylet: time required from insertion of the laryngoscope blade tip between the teeth to vocal cord exposure; and stylet to endo: time required from passage of the stylet between the teeth to passage of endotracheal tube reaching 22 cm.

2.5. Statistical analysis

For a significant level at 5% along with 80% power and effect size 0.3, a minimum of 37 participates were needed.[8]

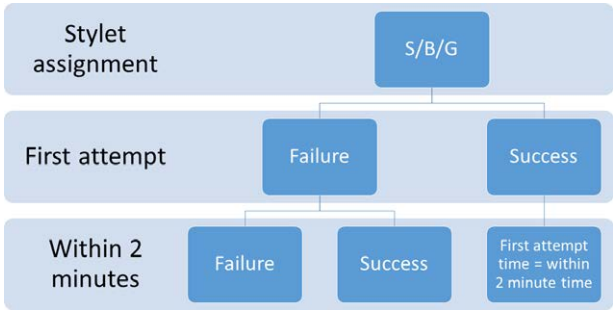

Figure 1. Study flow chart.

Univariate analysis of variance was performed to determine the differences between intubation times for the 3 stylets. Tukey multiple comparisons of mean was used for pairwise comparisons. All statistical analyses were performed using R software (version 3.4). Results with $P < .05$ indicated a significant difference.

3. Results

The success rates of the 3 stylets are shown in Table 1. Among the 72 participants, the success rate at the first attempt was greater for B (62, 86.11%) than for the other 2 stylets. Within 2 minutes, G had the highest success rate (93.06%). However, no significant difference was noted in the success rates of the 3 stylets either at the first attempt ($P = .78$) or within 2 minutes ($P = .94$).

For successful intubation, the average blade-to-stylet and stylet-to-endo times of the 3 stylets are shown in Figure 2. The average blade-to-stylet times were 12.26, 11.27, and 12.56 seconds for S, G, and B, respectively. For S, G, and B, the average stylet-to-endo times were 12.79, 13.12, and 24.89 seconds, respectively, and the total times were 25.05, 24.39, and 37.45 seconds, respectively. For participants who were successful within 2 minutes, no significant difference in the blade-to-stylet time was observed between the 3 stylets ($P = .89$). However, the stylet-to-endo times of the 3 stylets differed significantly ($P < .01$), and the average stylet-to-endo time of stylet B was longer than those of the other 2 stylets.

The results of pairwise comparison of total time among the 3 stylets are shown in Figure 3. The total time of B was significantly longer than those of the other 2 stylets at first attempt and within 2 minutes. For S and G, no significant differences were observed for total time.

4. Discussion

Our study indicated that, for novice intubators, the success rate and intubation time using a DL with hyperangulated VL stylet

Table 1

Success rates of the 3 stylets.

Stylet (sample size)	Success number	Success rate (%)	Failure number	Failure rate (%)	*P* value
First attempt					.78
B (n = 72)	62	86.11	10	13.89	
G (n = 72)	59	81.94	13	19.06	
S (n = 72)	61	84.72	11	15.28	
Within 2 min					.94
B (n = 72)	66	91.67	6	8.33	
G (n = 72)	67	93.06	5	6.94	
S (n = 72)	66	91.67	6	8.33	

B = bougie, G = hyperangulated video laryngoscope stylet, *P* = proportional test for 3 proportions, S = straight-to-cuff stylet.

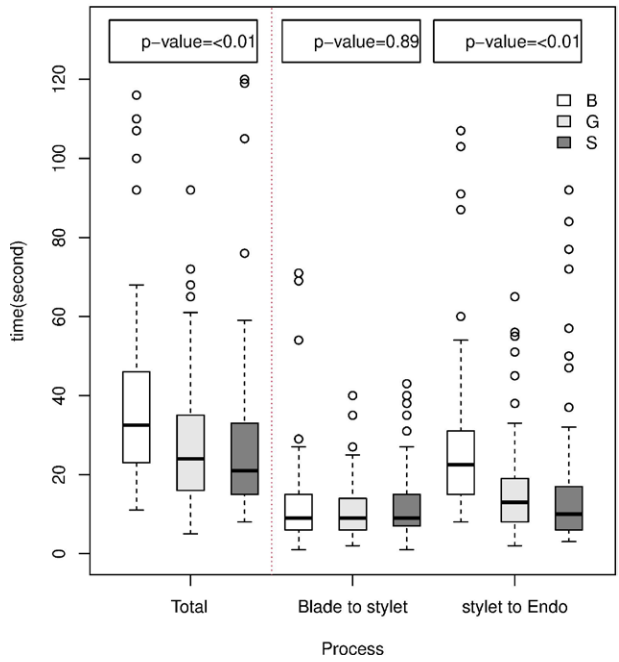

Figure 2. Times required for the 3 stylets.

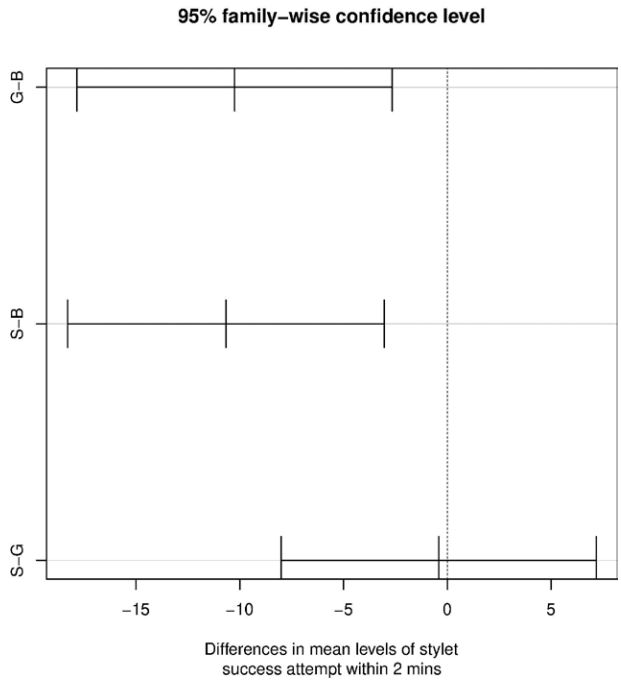

Figure 3. Pairwise comparison of total time between the 3 stylets.

were not inferior compared with straight-to-cuff stylet in a standard airway training model. Traditionally, hyperangulated stylet is primarily used in VL to match the hyperangulated blade. It is not used in DL in traditional airway learning course or clinical practice currently. Our study indicated that the novice intubators could adapt to this new maneuver with similar outcome. To our knowledge, this is the first study to compare the performance of S, G, and B with DL and the corresponding maneuver. With the increasing popularity of VL, we believe that novice intubators can use hyperangulated stylet to practice intubation with either DL or VL early.

Many factors can influence the success rate of intubation, such as the choice of laryngoscope (DL or VL),[9] the endotracheal tube,[10] the angle and shape of the stylet,[6,11] the maneuver,[12,13] the experience of the intubator, and the difficulty of the airway. However, many studies focus on the difficult airway evaluation by experienced attending physicians.[14] Our study investigated novice intubators' ability to perform intubation by using DL with 3 stylets. On the basis of our results, for airway training, novice intubators may begin airway training with DL and use either a hyperangulated stylet or a bougie early. Then, novice intubators can enhance their technique and experience of intubation with VL in future.

Levitan et al[6] suggested that the ideal angle of the stylet is 35° when using DL for intubation. For straight-to-cuff styletted tracheal tubes, bend angles beyond 35° increase the risk of difficult tube passage into the trachea. However, our study did not observe a significant difference in the success rates of intubation at first attempt and within 2 minutes among the 3 stylets with different angles. We believe that using the correct maneuver with a hyperangulated stylet may be the key factor for successful intubation. We adapted the maneuver from that of a previous study.[13] First, we held the tube close to the connector (far from the endo tip) when using a hyperangulated stylet. Second, once the stylet tip reached the vocal cord, we stopped insertion and started passing the tube and pulling out the stylet simultaneously. This maneuver reduced the impingement of the stylet tip and tube on the anterior trachea ring. We believe that this maneuver is the key factor in producing different results.

To truly compare the difference of the intubation time, we divide the intubation time to 2 parts as previously mentioned. The first part, "blade to stylet" time, measured the time of epiglottoscopy and valleculoscopy until vocal cord exposure. We consider that this time is independent from the stylet. It is most influenced by the technique and experience of using the blade. The second part, as called "stylet to endo," assesses the time to pass the endotracheal tube. It is influenced by stylet shaping or the maneuver. In our study, stylet B had the longest time at this part. We did not teach students to preload the bougie, like Kiwi technique.[15] It takes 1 more step to load the endotracheal tube through the bougie. It may explain that stylet B had longer intubation time. Because it takes 1 more step to load the endotracheal tube through the bougie. As for the total time, blade to stylet has the same results as the second part (stylet to endo). For stylets G and S, there is no statistical significant difference of intubation time. Like the result of success rate, we consider that the angle is not related with the intubation time for normal airway scenario. We use 2 minutes as the cut off value of failure intubation because previous study indicated that the patient would have desaturation after 2 minutes if not well pre-oxygenated.[7]

The most important limitation of this study is that all intubation procedures were performed on the standard manikin model. Our results might not be applicable to either real patients, difficult airway or re-intubation, such as movable teeth, movable tongue, limited neck extension, and edema or soft tissue collapse.[16] Second, our study focused on medical students without intubation experience. Experienced intubators may have different results. Nevertheless, we aimed to train novice intubators with different stylets on a manikin. Airway characteristics are constant rather than varied when using the manikin setting. More studies are needed in future for difficult airways or real patients.

5. Conclusions

In conclusion, the performance of novice intubators with 3 different stylets was similar. The success rate for DL with either hyperangulated VL stylet or bougie was not inferior compared with the straight-to-cuff stylet on manikin airway training model. If we properly trained novice intubators to use

corresponding maneuvers, they can learn to use the 3 stylets early in their airway learning course.

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Approval of the final version of manuscript: all authors.
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