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Stylet angulation for routine endotracheal intubation with McGrath videolaryngoscope

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Abstract

Background: The McGrath videolaryngoscope (VL) provides excellent laryngoscopic views, but directing an endotracheal tube can be difficult, and thus the routine use of a stylet is recommended. The goal of this study is to determine the appropriate angle (60° vs 90°) of the stylet when using the McGrath VL by comparing the time to intubation (TTI).

Methods: One hundred and forty patients aged 19 to 70 years (American Society of Anesthesiologists classification I or II) who required tracheal intubation for elective surgery were randomly allocated to 1 of 2 groups, at the 60° angle (n=70) or the 90° angle (n=70). Anesthesia was induced with propofol, fentanyl, and rocuronium. The primary outcome was TTI assessed by a blind observer. Glottic grade, use of optimal external laryngeal manipulation, failed intubation at first attempt, ease of intubation, and severity of oropharyngeal bleeding were also recorded.

Results: The mean TTI was significantly shorter in the 60° group than in the 90° group (29.3±6.4 vs 32.5±9.4 s, $P=0.022$). The glottic grade and degree of intubation difficulty were not significantly different between the 2 groups.

Conclusions: When intubating the patients with the McGrath videolaryngoscope, the 60° angled stylet allowed for faster orotracheal intubation than did the 90° angled stylet.

Abbreviations: ASA = American Society of Anesthesiologists, BIS = bispectral index, ETT = endotracheal tube, TTI = time to intubation, VL= videolaryngoscope.

Keywords: anesthetic technique, McGrath videolaryngoscope, stylet

1. Introduction

Videolaryngoscopes (VLs) were developed by integrating features of classic laryngoscopes and fiber-optic bronchoscopes. These VLs can facilitate tracheal intubation by providing an improved view of the larynx without aligning the oral-pharyngeal-laryngeal axes.[1–6] VLs decrease intubation difficulties, increase the overall success rates of intubation,[4,7,8] and can be used to educate novice practitioners.[9]

The McGrath VL (Aircraft Medical, Edinburgh, UK) is a portable VL that has an angulated single-use blade of adjustable length with a liquid crystal display monitor attached to the top of the handle. As with other VLs, the McGrath VL provides a better laryngeal view and also provides an advantage in airway management in patients for whom difficult or failed intubation is anticipated;[4,7,10–12] however, this good view does not always guarantee faster or successful intubation because these axes are not aligned,[10,12] and therefore, the tip of the endotracheal tube (ETT) must pass around an acute angle to enter the larynx. Manufacturers recommend using a stylet angled between 45° and 90° to overcome these problems.[12] For the GlideScope VL (Verathon Medical, Inc., Bothell, WA), using a 90° angulated stylet provided more successful endotracheal intubation and reduced intubating time compared with the 60° angulated stylet in 2 previous randomized controlled trials,[13,14] but to date, no studies have been conducted regarding the optimal stylet angulation for the McGrath VL. Therefore, we conducted a prospective, randomized comparison of intubation time for the McGrath VL between the 60° and 90° angulated stylets (Fig. 1).

2. Methods

This study was approved by the institutional review board (Ajou University Hospital, Suwon, Korea) and registered at ClinicalTrials.gov (NCT 03000088). We obtained written informed consent from all patients who participated in the study. We prospectively included 140 patients between the ages of 19 and 70 with an American Society of Anesthesiologists physical status I or II who were scheduled for elective surgery that required orotracheal intubation. The Mallampati score, weight, height, inter-incisor distance with maximal mouth opening, thyromental distance, movement of cervical spine (normal, reduced, fixed), and upper incisor status (normal, absent, prominent) were assessed preoperatively. Our exclusion criteria were a suspected difficult airway (Mallampati score 4), known cervical spine

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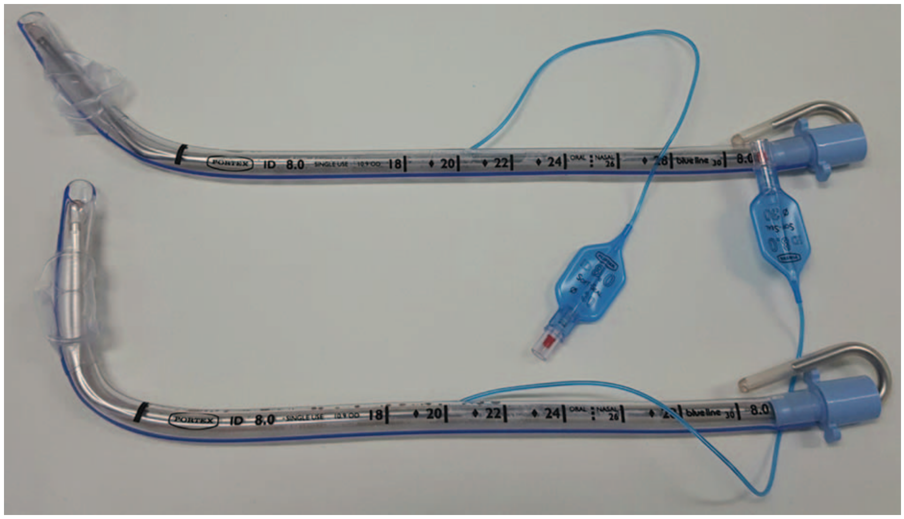

Figure 1. 60° angled and 90° angled styletted endotracheal tubes.

injury, required rapid sequence induction, and required an emergency operation. The eligible 140 patients were randomly allocated to the 60° (n=70) or 90° (n=70) groups, and our randomization (1:1) was based on a computer-generated random number table.

Patients received no premedication before surgery. In the operating room, all patients received standard monitoring including pulse oximetry, electrocardiography, noninvasive blood pressure monitoring, and the bispectral index (BIS) with a BIS Quattro sensor (Covidien LLC, Mansfield, MA). Three minutes after preoxygenation, anesthesia was induced with fentanyl 0.5 to 1.5 μg/kg, propofol 1.5 to 2.0 mg/kg, and rocuronium 0.6 mg/kg; after induction, the patients' lungs were ventilated with 100% oxygen. Orotracheal intubation was performed about 2 minutes after rocuronium injection with adequate neuromuscular blockade; the intubations were performed by 1 of 2 anesthesiologists who had more than 10 years of clinical experience and who had each performed at least 20 successful intubations using the McGrath VL. The vocal cords and ETT insertions were visualized using the McGrath VL's video

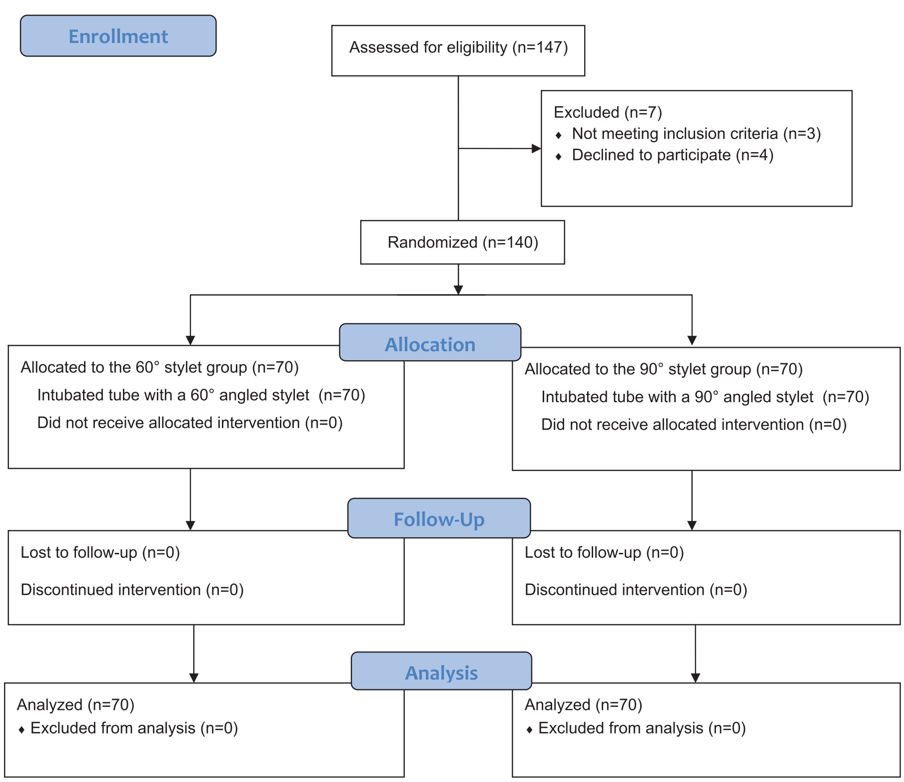

Figure 2. Patient allocation flow diagram.

Table 1

Patient characteristics.

	All (n=140)	60° (n=70)	90° (n=70)	*P*
Men	111 (79)	54 (77)	57 (81)	0.532
Age, y	41±14	41±14	41±14	0.824
Weight, kg	70±12	71±12	70±13	0.679
Height, cm	169±9	170±8	169±9	0.457
ASA physical status, 1/2	117/23	59/11	58/12	0.820
TMD, cm	9.2±1.3	9.2±1.3	9.2±1.4	0.975
Mouth opening, cm	5.3±1.0	5.4±1.1	5.2±0.9	0.318
ROM of cervical spine, normal/reduced/fixed	139 /1/0	69/1/0	70/0/0	1.000
Upper incisors, normal/absent/prominent	138/1/1	68/1/1	70/0/0	0.496
Mallampatiscore, 1/2/3	82/42/16	41/22/7	41/20/9	0.841

Values are presented as mean±SD or number of patients (%).
ASA=American Society of Anesthesiologists, TMD=thyromental distance, ROM=range of motion.

Table 2

Intubation profiles.

	60° (n=70)	90° (n=70)	*P*
Time to intubation, s	29.3±6.4	32.5±9.4	0.022
Glottic grade, 1/2a/2b/3/4	59/10/1/0/0	56/11/3/0/0	0.658
OELM, −/+	69/1	64/6	0.116
First attempt failure, −/+	70/0	67/3	0.245
Ease of intubation, easy/moderate/difficult	65/5/0	58/12/0	0.070
Bleeding, none/trace/moderate/severe	67/3/0/0	65/5/0/0	0.718

Values are presented as mean±SD or number of patients.
OELM=optimal external laryngeal manipulation.

screen, and the ETTs were 8.0 mm for men and 7.0 mm for women. We angulated the stylets (Mallinckrodt intubating stylet, Covidien, Ireland) by bending them 6.5 cm above the ETT tip. The primary outcome variable was the time to intubation (TTI), which we defined as the time from inserting the blade between the patient's incisors to seeing the first end-tidal carbon dioxide tracing on the capnograph. A blind observer who was unaware of the patient group and intubation procedure continuously watched a monitor positioned behind each patient and measured the TTI, and optimal external laryngeal manipulation (OELM) was performed by another investigator to facilitate intubation if the operator requested it. When the intubation attempt took more than 60 seconds or oxygen saturation (SpO_2) decreased below 95%, we considered the intubation failed. For the second trial, we applied mask ventilation again; we allowed a maximum of 2 intubation attempts and intended to use a different method for third intubation attempts. The operator recorded the Cormack–-Lehane glottic view classifications[15] and the ease of intubation (easy, moderate, difficult). Oropharyngeal bleeding was checked if blood was tinged on the VL blade or if the patient had mucosal bleeding right after intubation and was graded as none, trace, moderate, or severe. Mean arterial pressure, heart rate, SpO_2, and BIS were checked before anesthesia induction, 1 minute after induction, before attempt of intubation, and 1 minute after intubation.

3. Statistical analysis

To estimate the sample size, we assumed a between-group difference of 10 seconds in TTI to be clinically significant; we estimated the TTI mean and SD from previous studies as between 24.7 and 37 seconds and 20.4 seconds, respectively.[12,16] We calculated the sample size to be 67 per each group, but we increased the size to 140 patients to compensate for potential dropouts and missing data. We performed all statistical analyses using IBM SPSS version 21.0 for Windows; we used the chi-square or Fisher's exact tests to analyze the categorical data and the independent *t*-test to analyze the continuous data between the groups. We showed the data as mean±SD or number of patients, and we considered results statistically significant when $P<0.05$.

4. Results

A total of 140 patients completed this study (Fig. 2), and the baseline clinical characteristics and airway assessment findings were similar between the 2 groups (Table 1).

Table 3

Hemodynamic changes during anesthesia induction.

	Group	T0	T1	T2	T3
MAP, mm Hg	60°	99.0±12.3	83.6±13.9	78.1±12.3	114.0±23.2
	90°	97.5±14.1	82.6±15.3	78.0±13.3	114.6±22.6
HR, beats/min	60°	72.1±13.8	70.9±13.0	67.9±13.2	89.8±15.9
	90°	72.1±12.8	69.5±11.8	66.9±11.1	89.6±14.5
SpO_2, %	60°	98.1±1.5	99.8±0.4	99.6±0.6	99.5±0.7
	90°	98.2±1.3	99.6±0.7	99.5±0.7	99.5±0.7
BIS	60°	98.5±0.7	46.7±11.6	44.5±9.8	47.3±12.2
	90°	98.3±0.6	45.4±14.3	43.9±10.6	47.8±10.3

Values represent as mean±SD.
BIS=bispectral index, HR=heart rate, MAP=mean arterial pressure, SpO_2=oxygen saturation, T0=baseline, T1=1 min after induction, T2=prior to intubation, T3=1 min after intubation.

All patients in the 60° group were successfully intubated within 60 seconds on the first attempt, but there were 3 intubation failures in the 90° group (4.3%). The TTI was significantly shorter in the 60° group than in the 90° group (29.3 ± 6.4 s vs 32.5 ± 9.4 s, $P = 0.022$), although the Cormack–Lehane glottis view grade did not differ between the 2 groups. In terms of intubation difficulty, there was more moderate intubation in the 90° group (12/70, 17.1%) than in the 60° group (5/70, 7.1%), but it did not reach statistical significance ($P = 0.07$) (Table 2).

Hemodynamic changes and BIS values during anesthesia induction are listed in Table 3; there were no significant differences in hemodynamic changes over time between the groups.

5. Discussion

To our knowledge, this is the first randomized controlled clinical trial to compare the efficacy of 60° vs 90° angled malleable stylets with standard ETT loading using a McGrath VL. The results of this study showed that a 60° styletted tube with the McGrath VL provided significantly shorter intubation time, a tendency toward lower failure rates, and improved ease of intubation than did a 90° styletted tube.

Previous studies have reported that a McGrath VL with a 60° styletted tube is an effective aid to airway management considering the high intubation success rates and the ability to rapidly secure the airway.[4,12] In this study, mean TTI in the 60° group was significantly shorter than that in the 90° group, and there is a likely explanation: Ergonomically, it was easier to use the 60° than the 90° angle to deliver the tube to the glottic opening through the oral cavity. Additionally, the distal tip of the 90° styletted tube had a tendency to veer toward the anterior commissure, and it was difficult to advance the tube into the trachea at the vocal cord. In the open airway model during GlideScope VL intubation, it was easier to advance the tube and TTI was shorter using the 60° styletted tube rather than the 90° tube.[17] In addition, despite the application of lubricant, removing the stylet and advancing the tube into the trachea were more difficult in the 90° group than in the 60° group.

Tracheal intubation has 3 steps: laryngeal sighting, delivering the tube to the glottic opening, and advancing the tube into the trachea. Laryngeal sighting is greatly improved with VLs,[1–3] but this good view does not guarantee easy intubation,[2,18,19] especially in extra-curved and channeled blades; delivering the tube to the glottis opening slows down easy intubation. Meanwhile, advancement is a major obstacle with all indirect VLs because of their indirect views of the glottis.[12] Because the pharyngeal-laryngeal-tracheal axes are not aligned, we need to be able to bend the stylet more acutely than the conventional 35° "hockey stick" angle to aid in entering the glottis that presents anteriorly. Using a better stylet for the ETT may play an important role. Therefore, in searching for the most optimal ETT configurations for orotracheal intubation with different VLs, previous research has shown that 90° angled malleable stylets provided better results than did 60° angled stylets that resembled the blade shape of the GlideScope VL.[14] The C-MAC video laryngoscope (Karl Stortz Endoscopy, Tuttlingen, Germany) is another VL that uses a standard Macintosh blade; compared with most other VLs, which require stylets for the majority of patients, the C-MAC requires stylets for only approximately 10% of patients.[20] McElwain et al[21] found that there was no advantage in the easy laryngoscopy scenario and that the hockey stick configuration performed best in the difficult scenario. The reason for the different results between the GlideScope VL and C-MAC studies is the different blade angles between the 2 VLs. The angle of the distal portion of the GlideScope VL blade is 60°, which requires the tube to be passed over a very steep angle from the oropharynx into the trachea, and the 90° acute angulated stylet can aid in this. The curvature of the McGrath VL blade is closer to that of the Macintosh laryngoscope than the GlideScope VL, and therefore, a 60° angulated stylet was more useful in this study.

Our mean TTI with an experienced anesthesiologist was 30.9 s in patients with normal expected airways, and this was comparable with previous studies that used the McGrath VL. Shippey et al[7] and Walker et al[22] reported median TTIs of 24.7 seconds and 47 seconds by experienced and inexperienced anesthesiologists, respectively, and Kleine-Brueggeney et al[23] and Taylor et al[4] reported a median TTI of 53 seconds and a mean TTI of 35.8 seconds in patients with simulated difficult airways, respectively; meanwhile, Foulds et al[24] found a median TTI of 45 seconds in patients with manual cervical spine immobilization.

There are some limitations in this study. First, we were not able to blind the intubating anesthesiologist to the device being used, so that Hawthorne effects might have affected the clinical performance during intubation.[25] Second, regarding camber configuration, the ETT was loaded only in a forward fashion (in which the concave side of the tube matches the concave side of stylet), not in reverse. However, the camber configuration of the styletted tube does not affect the TTI during GlideScope VL intubation.[14] Third, for this study, we excluded patients with expected difficult airways; additional real-time or simulated studies of patients with difficult airways might be needed.

In conclusion, bending an ETT with a distal 60° angulated malleable stylet decreased the average TTI with the McGrath VL by 3.2 seconds compared with the 90° angled stylet.

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