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Original Contribution

Can the new McGrath laryngoscope rival the GlideScope Ranger portable video laryngoscope? A randomized manikin study☆,☆☆

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ABSTRACT

Purpose: We hypothesized that novices would be able to use the McGrath MAC (Aircraft Medical Ltd, Edinburgh, UK) equally as well as the GlideScope Ranger (Verathon, Inc, Bothell, WA) for intubation in regular simulated airways.

Methods: We performed a prospective, randomized crossover study of 39 medical students using the McGrath MAC, GlideScope Ranger, and Macintosh in a manikin with 2 normal airways. The primary outcome was the intubation time. Secondary outcomes included the success rates and the overall glottic view of the 3 laryngoscopes.

Results: The mean intubation times for each attempt with the McGrath MAC were 30.8 ± 16.9 seconds or less and did not differ significantly from those obtained with the GlideScope Ranger or the Macintosh in both airway scenarios ($P = .18$; $P = .49$). The mean success rates at each attempt with the McGrath MAC were 82.0% ± 38.8% or more, equal to the Macintosh and the GlideScope Ranger in both scenarios ($P = .026$; $P = .72$) except during the first intubation attempt in a normal airway ($P = .008$). The median grades of the glottic view visible at each intubation attempt with the McGrath Mac were Cormack-Lehane grade 1 (scenario 1: interquartile range, 1-1; scenario 2: interquartile range, 1-2), which was significantly better than the Macintosh laryngoscope in both scenarios. However, the McGrath Mac did not produce a better glottic view than the GlideScope Ranger with either scenario.

Conclusions: The intubation performance of novices using the McGrath MAC was equal to their performance using the GlideScope Ranger in regular simulated airways.

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1. Introduction

Conventional tracheal intubation with a direct laryngoscope continues to be widely used despite the general availability of newly developed devices. Some physicians have also reported the continued use of direct laryngoscopy [1].

The video laryngoscope, which was first introduced in 2002, provides superior images of the larynx compared with a direct laryngoscope and is easy for novices to learn to use [1-4]. As a result, the video laryngoscope has been used both for typical tracheal intubations as well as an alternative in difficult airway situations [1,5-7]. The video laryngoscope performs particularly well when the mouth does not open well or when cervical extension is limited [1,5-7]. Some video laryngoscopes are portable and are affordable in the prehospital setting.

The GlideScope video laryngoscope (Verathon, Inc, Bothell, WA) was the first of these portable video laryngoscopes to be used clinically and is the most extensively studied [3,4]. Several studies have demonstrated that the GlideScope has advantages over the Macintosh direct laryngoscope for the tracheal intubation of patients with difficult airways and in simulated difficult airways [1,7]. The GlideScope Ranger (Verathon, Inc) is a member of the GlideScope series in which the feature of portability was emphasized, and it is suitable for the out-of-hospital environment [8].

The McGrath series 5 video laryngoscope (Aircraft Medical, Ltd, Edinburgh, UK) is a portable video laryngoscope similar to the GlideScope Ranger. The McGrath series 5 has advantages such as full portability, resistance to infection due to the use of disposable blades, and a relatively low price [9]. However, the McGrath series 5 video laryngoscope also has the disadvantages of a small, dark screen and poor picture quality. A few studies have reported that the McGrath series 5 has a lower rate of successful intubation and a longer intubation time than other video laryngoscopes [10].

The McGrath MAC (Aircraft Medical, Ltd) is a new model of the McGrath series. Some changes were made in the McGrath MAC compared with the McGrath series 5, such as widening of the LCD screen and the incorporation of a regular Macintosh-type blade [9].

We anticipated that these changes would make performing intubation with the McGrath MAC as fast and easy for novices as intubation using a GlideScope in regular simulated airways.

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2. Methods

2.1. Study design and recruitment

After obtaining permission from the institutional review board (Hanyang University Guri Hospital Institutional Review Board; approval date: September 2013, ref no. 2013-39) and written informed consent, we recruited 39 medical students who had no previous experience with intubation (27 males and 12 females; mean age, 25 years). The study was conducted at the simulation center of Hanyang University in Seoul, Republic of Korea. The period of recruitment and follow-up was from September 2013 to November 2013.

2.2. Equipment and experiment

We compared 2 portable video laryngoscopes (the GlideScope Ranger and the McGrath MAC) and used a German-type Macintosh as the reference laryngoscope. A blade size of 4 was used on all devices. All intubations using video laryngoscopes were performed according to the manufacturer's instructions. A specialized rigid stylet (the GlideRite) was used with the GlideScope, and a flexible plastic stylet bent with a hockey stick curvature was used with the McGrath MAC and the Macintosh laryngoscope. A size 7.5-mm endotracheal tube (Mallinckrodt Hi-Lo Oral/Nasal Tracheal Tube Cuffed Murphy Eye, Covidien, Ireland) was used with all of the laryngoscopes. Before starting the study, all of the participants were given 5 minutes of instruction, which included an explanation of the devices, oral instructions on how to use each laryngoscope, and a description of the Cormack-Lehane laryngoscopy grade. The participants then practiced laryngoscopy once with each of the laryngoscopes.

A randomized crossover trial design was used. After the instruction and practice session, all participants were randomly divided into 3 device groups. Each group was allowed to attempt to perform endotracheal intubation 5 more times using the Laerdal Airway Management Trainer (Laerdal Medical Korea, Ltd, Seoul, Korea) with the normal airway setting (scenario 1). After completing scenario 1, the participants performed another 5 attempts with an immobilized neck scenario, using a neck collar that was assumed to be common in the prehospital setting (scenario 2).

Thereafter, participants were randomly assigned following a simple randomization procedure (computerized random numbers) to 1 of 3 device groups. The allocation sequence was concealed from the participants in sealed envelopes. The researcher enrolling and assessing the participants was also blinded to the allocation sequence. All participants performed the same sequence at intervals of 5 weeks during the study (Fig. 1).

2.3. Data collection

The primary outcome was the time to intubation. The *time to intubation* was defined as the time from when the allocated laryngoscope was inserted into the manikin's mouth until the first ventilation was performed after a successful intubation. *Intubation failure* was defined as follows: intubation time longer than 40 seconds, the insertion of the endotracheal tube into the esophagus of the manikin, and removal of the endotracheal tube from the manikin's mouth before successful intubation. In previous similar studies, intubation failure was defined as 60 to 120 seconds [11-13]. However, performers intubating in an emergency would not have this amount of time. Therefore, we decided to regard a tracheal intubation time of less than 40 seconds as a successful intubation for our discussion of the average intubation time of the McGrath series 5 [11-13]. Other secondary outcomes included the rate of successful intubation and the Cormack-Lehane grade at laryngoscopy.

2.4. Statistical analysis

We based our minimum sample size estimate on the duration of the successful intubation attempts. Our sample size was calculated using informal pilot data generated by the research team. In the pilot study, the mean intubation times for the McGrath MAC and the GlidesScope Ranger were 31 and 24 seconds, respectively, with an SD of 8 seconds. Based on these figures and using $\alpha = .05$ and $\beta = .2$ for an experimental design examining 2 devices, we estimated that at least 28 novices would be required to detect a 7-second difference.

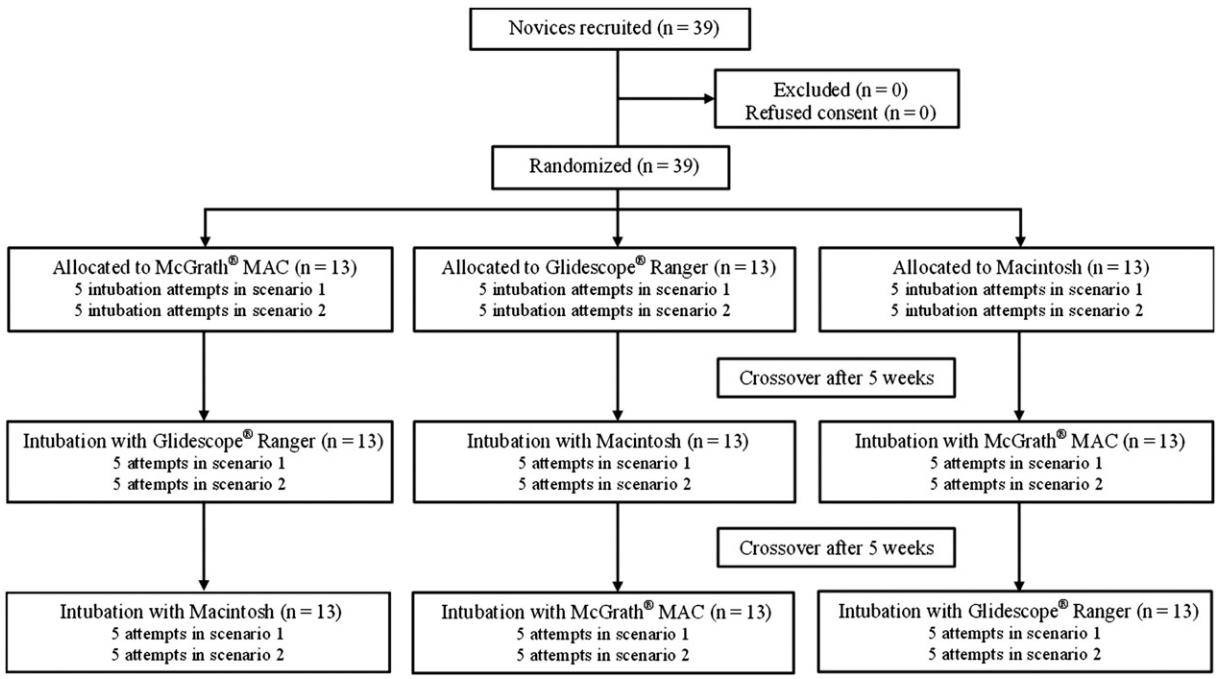

Fig. 1. Flow diagram of the experimental groups.

The results were analyzed using SPSS statistical software, version 20 (IBM Corp, New York, NY). The outcome from each participant was dependent on the time factor of intubation attempts. Therefore, the analysis of the time to intubation and the rate for successful intubation was performed using repeated-measures analysis of variance (ANOVA). The Kruskal-Wallis test was performed to compare the overall glottic view from all 3 devices. The Mann-Whitney *U* test was used as a posttest for all variables. The posttest was performed with a Bonferroni correction for the repeated-measures ANOVA when evaluating the intubation time and the success rate of each intubation attempt. For all statistical analyses, $P < .05$ was considered significant.

3. Results

Each novice performed 5 intubations with each of 3 laryngoscopes per scenario during the study period. As a result, 39 medical students performed 1170 total intubations in 2 types of scenarios.

3.1. Scenario 1: normal airway

The mean intubation times for the first intubation attempt were 30.8 seconds (SD, ±16.9 seconds) with the McGrath MAC, 26.6 seconds (SD, ±9.5 seconds) with the GlideScope Ranger, and 33.2 seconds (SD, ±18.0 seconds) with the Macintosh laryngoscope. In all laryngoscopes, the intubation times grew shorter with an increasing number of intubation attempts ($P < .001$) (Fig. 2). In the repeated-measures ANOVA, there were no significant differences in the mean intubation times for the 5 intubation attempts among the 3 laryngoscopes ($P = .18$).

Fig. 3 presents the mean intubation success rates of the 3 laryngoscopes according to the number of intubation attempts. Novices achieved an 82% (SD, ±38.8%) to 97.4% (SD, ±16%) intubation success rate with the McGrath MAC and rates of 87.1% (SD, ±33.8%) to 100% (SD, ±0%) and 58.9% (SD, ±49.8%) to 94.8% (SD, ±22.3%) with the GlideScope Ranger and the Macintosh laryngoscope, respectively. The success rate of the McGrath MAC differed from the Macintosh and GlideScope Ranger over 5 intubation attempts ($P = .026$), but the difference was only significant during the first intubation attempt in scenario 1 ($P = .008$).

The median grades of the glottic view visible with the McGrath MAC and GlideScope were Cormack-Lehane 1 for all attempts in the normal airway scenario, which is significantly better than the Macintosh laryngoscope (2; interquartile range [IQR], 1-2) regardless of the number of times the user attempted intubation ($P = .001$) (Fig. 4).

3.2. Scenario 2: immobilized neck

The mean intubation times for the first intubation attempt were 25.0 seconds (SD, ±10.4 seconds) with the McGrath MAC, 23.8 seconds (SD, ±9.6 seconds) with the GlideScope Ranger, and 26.1 seconds (SD, ±9.6 seconds) with the Macintosh laryngoscope, which were shorter than those observed in the normal airway setting. For all laryngoscopes, the intubation times grew shorter with an increasing number of intubation attempts ($P < .001$) (Fig. 2). In the repeated-measures ANOVA0, there were no significant differences in the mean intubation times over 5 intubation attempts among the 3 laryngoscopes ($P = .49$).

The mean intubation success rates for the McGrath MAC at each attempt were 87.1% (SD, ±33.8%) to 100% (SD, ±0%), which was equal to those seen with the GlideScope Ranger (89.7% [SD, ±30.7%] to 97.4% [SD, ±16%]) and the Macintosh laryngoscope (87.1% [SD, ±33.8%] to 94.8% [SD, ±22.3%]) ($P = .72$) (Fig. 3).

Fig. 4 presents the median glottic view grades that were visible with each laryngoscope. The McGrath MAC produced better glottic views (median Cormack-Lehane 1; IQR, 1-2) than the Macintosh laryngoscope (median Cormack-Lehane 3; IQR, 2-3) ($P < .001$); however, the McGrath MAC was inferior to the GlideScope Ranger (median Cormack-Lehane 1 [1-1]; $P = .001$).

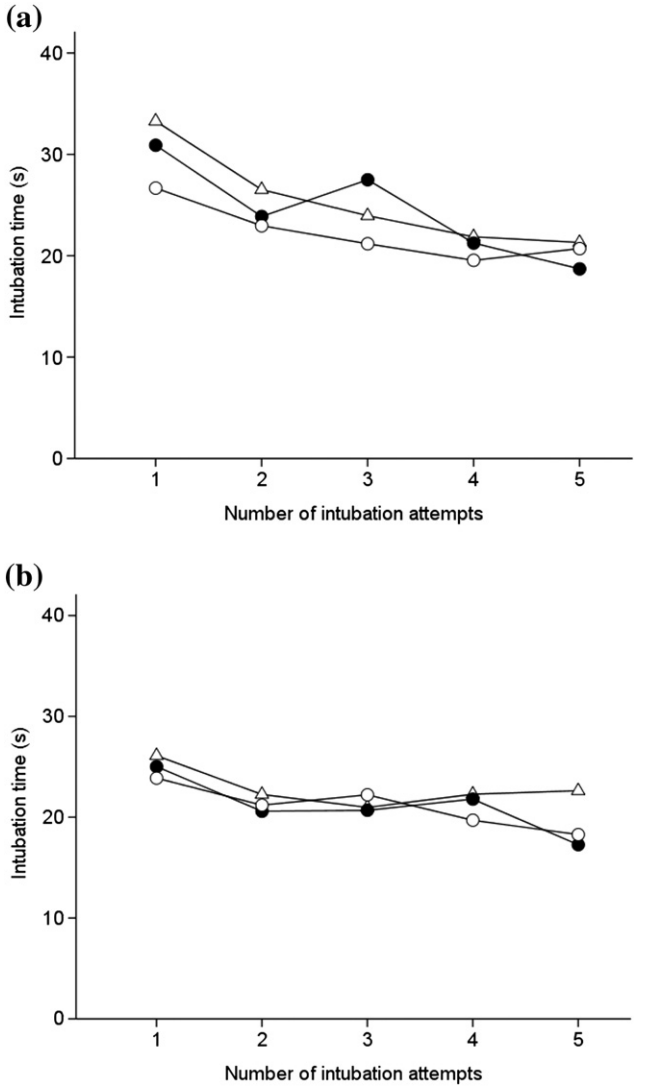

Fig. 2. Mean intubation times with the McGrath MAC (●), the GlideScope Ranger (○), and the Macintosh (△) in scenarios 1 and 2 (graphs a and b, respectively). There were no significant differences among the laryngoscopes in either scenario.

4. Discussion

Of the several video laryngoscopes that are available, both the McGrath MAC and the GlideScope Ranger are compact, portable, and affordable to use in emergency situations that occur both inside and outside the hospital. However, there is a distinct difference in the blade shapes of the 2 instruments. The performance of the GlideScope Ranger has been evaluated in a few previous studies [13]. However, as far as we know, this is the first randomized trial using the newly developed McGrath MAC.

Three major changes were made in the McGrath MAC from the McGrath series 5: an enhanced view, a moderate-curve Macintosh blade, and a fog-free disposable blade [9]. The first 2 changes were reflected in this study, but the antifogging effect was not assessed because this study was not performed on patients. Furthermore, the McGrath MAC was not directly compared with the McGrath series 5 in this study.

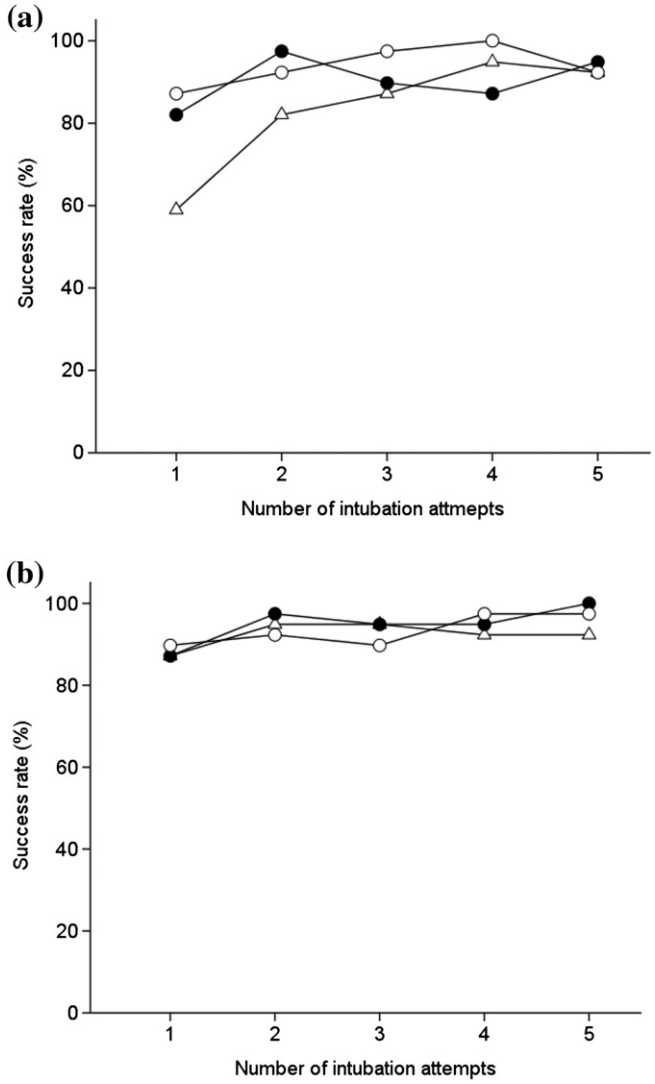

Fig. 3. The mean successful intubation rates of the McGrath MAC (●), the GlideScope Ranger (○), and the Macintosh (△) in scenarios 1 and 2 (graphs a and b, respectively). There were no significant differences among the laryngoscopes in either scenario.

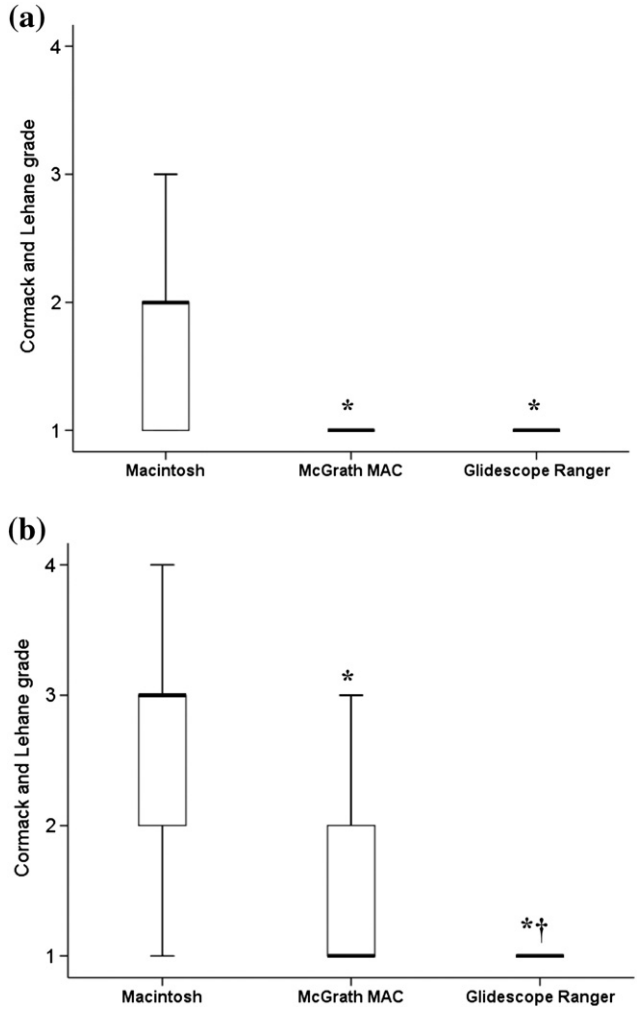

Fig. 4. The overall glottic view of each laryngoscope in scenarios 1 and 2 (graphs a and b, respectively). The central line represents the median, the box is the IQR, and the error bars are the range. $^{*}P < .05$ compared with the Macintosh. $^{\dagger}P < .05$ compared with the McGrath MAC.

In this study, we evaluated the performances of the McGrath MAC in comparison with the GlideScope Ranger and the Macintosh laryngoscope in normal airways and an immobilized neck scenario, which was expected to provide an advantage for the 2 video laryngoscopes. Of the 2 video laryngoscopes, some previous studies have demonstrated that the McGrath series 5 was not better than the GlideScope with respect to the intubation time and the success rate of intubation [14-16]. One study showed that the success rates for the McGrath series 5 and the GlideScope were similar to the success rates for the Macintosh laryngoscope, but the time to first ventilation for the McGrath series 5 was longer during the first intubation attempt [13]. The other study, which used experienced anesthesiologists, reported that the GlideScope reduced the total intubation time compared with the McGrath series 5 in normal airways [14]. However, the McGrath MAC exhibited equal intubation times and intubation success rates in this study. Moreover, cervical immobilization had no significant effects on these 2 outcomes. Therefore, despite the small video screen, the McGrath MAC appears to be as effective as other portable video laryngoscopes, even for patients who are believed to have cervical spine trauma.

To our knowledge, there have been no studies about subsequent intubation attempts with the GlideScope Ranger. However, several previous studies have been performed using a GlideScope that was nearly identical to the GlideScope Ranger, with the exception of suboptimal portability [8,17-19]. One meta-analysis demonstrated that the rates of successful intubations, the time to intubation, and the glottic view of the GlideScope were superior to the Macintosh laryngoscope among nonexpert operators [5]. Jeon et al [14] reported that the GlideScope reduced the total intubation time compared with the McGrath in normal airways. We do not suggest that the results for the GlideScope would be the same as for the GlideScope Ranger in an emergency. The GlideScope tends to be maintained in a fixed position during emergency intubations. In contrast, the position of the screen of the GlideScope Ranger is more unstable than the GlideScope, possibly due to the absence of a screen-fixing device and the short connecting cable between the handle and the screen. Indeed, we encountered the unexpected situation of the LCD screen of the GlideScope Ranger falling from the bed in our pilot study.

In terms of glottic views, the McGrath MAC was superior to the Macintosh laryngoscope in both airway scenarios. The frequency of poor views (Cormack-Lehane 3 and 4) using the McGrath MAC (3/585) was similar to the GlideScope Ranger (1/585) in the neck immobilization scenarios. As a result, endotracheal intubation with the McGrath MAC could be regarded as “easy,” like the GlideScope Ranger, for all attempts.

In our study, despite the better glottic view, the McGrath MAC did not exhibit superiority to the Macintosh laryngoscope in terms of the intubation success rate or the intubation time. We thought that

difficulties in dealing with the handle of the laryngoscope or the stylet were likely to have increased the intubation time after exposing the glottis. A previous study demonstrated that the time to view the vocal cords with the McGrath is shorter than with the Macintosh and that the time to intubate, except for the time to view the vocal cords, is longer than in the Macintosh [20]. Moreover, we studied novice intubators who were not skilled in eye-hand coordination and had difficulty intubating with the indirect view of the GlideScope [21]. In this study, we found that it continued to be difficult for novices to intubate with the McGrath MAC when using a conventional stylet.

Because the blade shape of the McGrath MAC is similar to that of the Macintosh, direct laryngoscopy using the McGrath MAC was also possible in cases when indirect laryngoscopy through the LCD screen was difficult. However, direct laryngoscopy with the McGrath MAC was not used in our study, and we only used indirect laryngoscopy for intubation.

Our study had several limitations; the major limitation of this study was that it was performed in clinically simulated airway situations with a manikin. In addition, of the many possible airway situations, we tested only normal simulated airways, including cervical immobilization with a neck collar [20]. Difficult airway situations, such as pharyngeal obstruction and tongue edema, were not investigated [22]. Recent studies have demonstrated that the outcomes of laryngoscopy using high-fidelity manikins are similar to those observed in patients [7]. However, data from manikin studies cannot be directly extrapolated into clinical practice [23]. Therefore, the results of this study would not be guaranteed to be the same in patients. In addition, 5 prior intubation attempts in scenario 1 most likely shortened the intubation times and increased the rate of successful intubations in scenario 2.

The secondary outcomes in previous studies, such as dental clicks, were not considered in this study [11,16,22]. Because the manikins used in this study were very sensitive, dental clicks were caused easily, even when the emergency physician performed the intubations with a video laryngoscope. More dental clicks were caused when the novices performed the intubation on the manikin. We believed that the dental clicks could not be counted objectively in this study. Therefore, only objective measures were used to evaluate the effectiveness of the laryngoscopes, and no other subjective measures, such as the ease of intubation or the favorite laryngoscope, were evaluated [11,16,22].

5. Conclusions

In this simulated manikin study, the intubation times and the rates of successful intubation with the McGrath MAC were equal to those of the GlideScope Ranger in a group of novice users. The novices achieved a better glottic view with the McGrath MAC than the Macintosh laryngoscope.

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