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Comparison of dental force applied during endotracheal intubation with hyper-angulated and macintosh-type video laryngoscopy blades used by emergency medicine trainees: A randomized cross-over manikin study

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Abstract:

OBJECTIVES: This study aimed to compare the effects of Macintosh-type and hyperangulated video laryngoscopy (VL) blades on dental force during endotracheal intubation (ETI) using Glidescope and McGrath VL devices.

METHODS: In this randomized, crossover, manikin study conducted at a university emergency medicine (EM) program, 65 EM trainees included interns and residents performed 520 intubations using four different VL blades (GlideScope VL with Macintosh-type Mac T3 and hyperangular Lo Pro T3 blades and McGrath VL Macintosh-type MAC 4 and hyperangular McGrath X3 blades) in normal and difficult airway scenarios. The primary outcome of this study was the dental pressure (Newton) exerted during ETI. The secondary outcomes included c-spine motion (degree), intubation success (%), duration (seconds), successful glottic view (%), and intubator comfort (7-point Likert).

RESULTS: Significant differences were observed in dental force (H(3) = 11.7, *P* = 0.008), c-spine motion (H(3) = 8.34, *P* = 0.039), duration (H(3) = 16.56, *P* = 0.001), and comfort (H(3) = 174.96, *P* < 0.001) across blade types. Glidescope LoPro T3 provided a significant lower dental force (adjusted *P* = 0.01), less c-spine motion (adjusted *P* = 0.031), and shorter intubation duration (adj *P* < 0.01) than the McGrath Mac 4. First attempt success and intubator comfort were significantly better with all Glidescope blades (z score of 3.7 and 4.7) than with McGrath blades (z score of-4.1 and-4.4).

CONCLUSION: The Glidescope LoPro T3 blade demonstrated advantages in dental force, c-spine motion, and intubation duration compared with McGrath Mac 4. Overall, the Glidescope blades provided superior comfort and higher first attempt success rates.

Keywords:

Airway management, emergency department, intratracheal, intubation, laryngoscopy

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Box-ED section

What is already known on the study topic?

- Video laryngoscopy (VL) is increasingly used for endotracheal intubation, offering higher success rates, and potentially lower complication rates
- Different types of VL blades are available, but comparative data on their efficacy, particularly regarding dental force and cervical spine (c-spine) motion, are limited.

What is the conflict on the issue? Has it importance for readers?

- The impact of Macintosh and hyperangulated VL blades on dental force and c-spine motion during intubation is not well-established
- Understanding the differences can guide emergency physicians in choosing the appropriate blade to minimize the complications.

How is this study structured?

- This study is a randomized, crossover, manikin study conducted with emergency medicine trainees, comparing four different VL blades on dental force, c-spine motion, intubation success, duration, glottic view, and comfort.

What does this study tell us?

- The Glidescope LoPro T3 blade showed lower dental force, less c-spine motion, and shorter intubation duration compared to the McGrath Mac 4 blade
- Overall, Glidescope blades provided superior comfort and higher first attempt success rates than McGrath blades.

Introduction

Videolaryngoscopy (VL) has emerged as a valuable device for endotracheal intubation (ETI), offering higher success rates and potentially lower complication rates, particularly in challenging airway scenarios.[1] In recent years, different types of VL devices and blades have been developed to manage more challenging airway situations and prevent complications related to ETI.[1] Hyperangulated blades, designed for a broader angular field of vision, are hypothesized to reduce the risks associated with airway management.[1,2] The improved visualization and maneuverability provided by these blades could lower the likelihood of dental injuries, which are often caused by improper blade placement or excessive force during ETI.[3] Furthermore, in emergency settings where cervical spine (c-spine) injuries are a concern, these blades can facilitate intubation with minimal neck movement, thus reducing the risk of exacerbating spinal injuries.[4]

Glidescope (Verathon Inc., Seattle, WA, USA) and McGrath (Aircraft Medical, Edinburgh, UK) VL devices, which can accommodate both Macintosh and hyperangulated blades, are among the commonly used VL devices worldwide.[1] However, despite the variety of VL devices and blades available, there are limited comparative data on their efficacy, particularly regarding dental force and c-spine motion.[3,5,6] Therefore, we compared the effects of Macintosh-type and hyperangulated blades on dental force and c-spine motion during intubation using Glidescope and McGrath VL devices.

Methods

Study design and setting

This is a randomized, crossover manikin study conducted at the simulation center of a university emergency medicine (EM) program. Institutional review board approval was obtained from the Kocaeli University Non-Interventional Clinical Research Ethical Committee, Kocaeli - Turkiye, on the date of 04.05.2023 with the number: KÜ GOKAEK 2023/08.32. Volunteers provided informed consent to participate in the study.

Participants

We invited all the trainees of the EM program, including residents and interns, to participate in the study. Those who volunteered were provided with 1 h of didactics and 1 h of practical VL training. The trainees who did not consent and did not complete the VL training were excluded from the study.

Randomization

After completing the training sessions, each participant was assigned a unique number to facilitate the randomization process. The group allocation for each participant was then determined using an online random number generator (www.randomizer.org), ensuring each was randomly assigned to one of eight groups. Each participant executed eight intubations using four different blades and two airway scenarios, all predetermined by a comprehensive randomization matrix [Figure 1]. A standardized 10-minute recalibration and rest period between intubations was implemented to maintain measurement consistency and minimize intubator fatigue. An investigator enrolled participants, monitored and recorded the variables during the procedures.

Protocol

An advanced cardiac life simulator (BT Inc– BT-ACTB, Korea) which has built-in sensors capable of measuring the pressure on maxillary incisors and c-spine angle (C1-C2) was used. Participants performed ETI in both normal and difficult airway scenarios using the GlideScope VL with Macintosh T3 and hyperangular Lo Pro T3 blades, and McGrath VL Macintosh MAC 4 and hyperangular X3 blades.

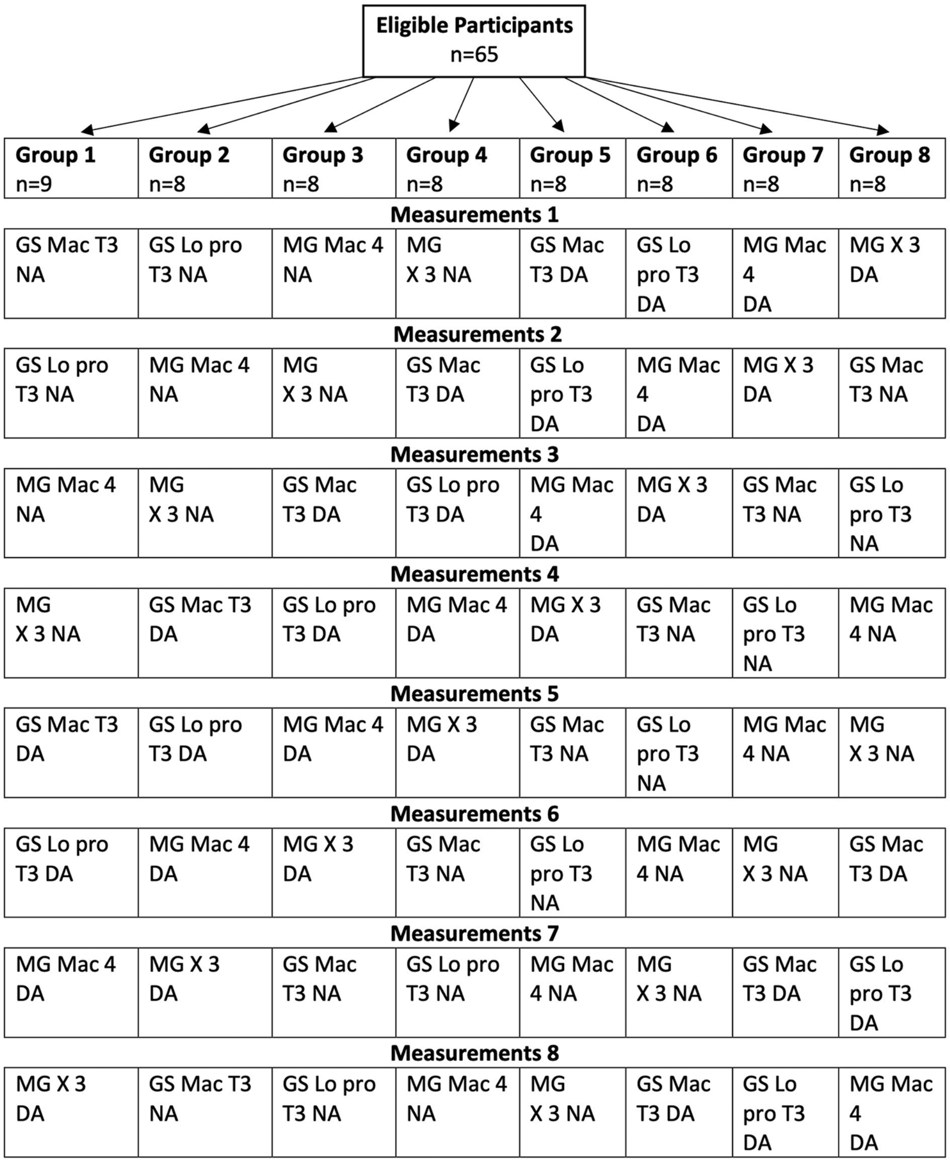

Figure 1: Study flowchart GS: Glidescope, MG: McGrath, NA: Normal airway, DA: Difficult airway

To create a difficult airway model, a Philadelphia-type neck collar was applied to the manikin. For all procedures, a flexible stylet was placed in the 7-mm endotracheal tube (ETT). Before each intervention, the manikin's head was positioned in a supine position, and the c-spine (C1-C2) angle of the manikin was set to 24 degrees to ensure a neutral position. During intubation, the pressure exerted on the maxillary incisors, degree of c-spine motion, intubation success, intubation duration, and glottic view, classified using the modified Cormack–Lehane scale, were recorded. After each application, the intubator's assessment of the comfort of the used VL blades was evaluated. Variables were compared across all the blade types used in both normal and difficult airway scenarios.

Measurements

Dental force

The highest value of the pressure on the maxillary incisors measured by the simulator was recorded in Newton (N = kg × m/s²).

C-spine motion

The difference between the neutral position (24°) and the highest or lowest value of the measurement of the c-spine angle measured by the simulator was recorded in delta angle degree.

Success at the first attempt

Successful intubation was defined as the passage of the ETT between the vocal cords. An intubation attempt was considered unsuccessful if the ETT was observed to be placed in the esophagus on the VL monitor or if the intubation attempt lasted longer than 60 s.

Duration

Duration was defined as the time between the blade tip passing between the front incisors and the ETT passing between the vocal cords, measured with a stopwatch.

Successful glottic view

The glottic view, as seen on the VL monitor during each intubation, was recorded by an EM specialist using the modified Cormack–Lehane classification. Grade 1, 2a, and 2b images were assumed to be successful glottic views.

Comfort

Comfort was assessed after each intubation using the 7-point Likert Scale (1-least comfortable, 7-most comfortable).

Outcome measures

Primary outcome

Dental force applied during ETI.

Secondary outcomes

C-spine motion, first-pass success, intubation duration, successful glottic view, and intubator comfort.

Data analysis

Kruskal–Wallis was used to compare the different types of blades for the continuous variables. A *post-hoc* test was used to determine the differences in significant results. Significance values have been adjusted by the Bonferroni correction for multiple tests and reported as the adjusted *P* value.

The Chi-square test was used to compare the categorical variables. For the *post hoc* comparisons, z-scores were used to identify the specific blade type that contributed most to the observed Chi-square value. A value >2 or <2 was assumed as a significant deviation from the expected count at the. 05 level.

The sample size was determined using the effect size calculated from preliminary data gathered after study initiation. To achieve 80% study power, a determined effect size (f) of 0.16 and an alpha error probability of 0.05, 432 intubations were required for the primary outcome.

Results

A total of 65 EM trainees performed 520 intubations using 4 different VL blades in normal and difficult airway scenarios [Figure 1]. The characteristics of the volunteers are shown in Table 1.

Table 1: Characteristics of participants

Age median (IQR)	25 (24–27)
Sex (female), *n* (%)	33 (50.8)
Training level, *n* (%)	
Intern	42 (64.6)
EM-1	6 (9.2)
EM-2	4 (6.2)
EM-3	10 (15.4)
EM-4	3 (4.6)
Number of intubation experience median (IQR)	1 (0–20)
Number of VL experience	0 (0–2)

IQR: Interquartile range, EM: Emergency medicine, EM-X: EM residency year, VL: Video laryngoscopy

The performance of blades was significantly different in dental force (H(3) = 11.7, *P* = 0.008), c-spine motion (H(3) = 8.34, *P* = 0.039), duration (H(3) =16.56, *P* = 0.001), and comfort (H(3) =174.96, *P* < 0.001) [Table 2]. *Post hoc* pairwise comparisons showed that Glidescope LoPro T3 provided a significant lower dental force (adjusted *P* = 0.01), less c-spine motion (adjusted *P* = 0.031), and shorter intubation duration (adj *P* < 0.01) than the McGrath Mac 4. The other pairwise comparisons were not significant for dental force, c-spine motion, and intubation duration. In addition, comfort was significantly better in all Glidescope blades than McGrath blades (adjusted *P* < 0.001). There were no differences between Glidescope Mac T3 and Glidescope LoPro 3 (adjusted *P* = 0.1), and McGrath Mac 4 and McGrath X3 (adj *P* = 1.0) [Supplementary Table 1].

A significant association was observed between blade types and first attempt success rate, (χ^2 [3, *n* = 520] = 53.976, *P* < 0.0001) [Table 2]. *Post hoc* pairwise comparisons revealed significant differences between blade types. Specifically, Glidescope Mac T4 and LoPro 3 have comparable (z score of 3.7 and 4.7, respectively) and notably high success rates, both of which significantly exceed the success rates of McGrath Mac 4 and McGrath X (z score of −4.1 and −4.4, respectively). Conversely, McGrath Mac 4 and X demonstrated similar success rates but lagged behind Glidescope Mac T3 and LoPro 3 [Supplementary Table 1].

The results also revealed a significant association between blade type and the outcome of glottic view, (χ^2 [3, *n* = 520] = 51.173, *P* < 0.001) [Table 2]. In the *post hoc* comparisons, Glidescope Mac T3 and LoPro 3 had similar proportions of successful views (z score of 2.2 and 4.1, respectively), which did not differ significantly from each other. On the other hand, McGrath Mac 4 had a significantly different proportion (z score of-6.8), with a notably lower successful view rate [Supplementary Table 1].

In the subgroup analyses, blade types were not significantly different for dental force and c-spine motion in both normal (*P* = 0.08 and *P* = 0.06, respectively) and difficult airway models ($P = 0.14$ and $P = 0.06$, respectively). However, intubation duration, first attempt success, successful glottic view, and comfort were significantly different between the blades in both normal and difficult airway models [Table 3].

In the normal airway, *post hoc* pairwise comparisons showed a shorter intubation duration for Glidescope LoPro compared with McGrath Mac 4 (adj $P = 0.02$). Other comparisons were not significant. Comfort was significantly better in all Glidescope blades compared with McGrath blades (adjusted $P < 0.001$). The first attempt success was significantly better in Glidescope Mac T3 and Glidescope LoPro 3 (z score of 2.4 and 3.2, respectively) than in McGrath Mac 4 and McGrath X3 blades (z score of −2.6 and −3, respectively). In addition, successful glottic view was better in Glidescope LoPro (z score of 3.2) compared with Glidescope Mac T3, McGrath Mac 4, and McGrath X3 blades (z score of 1.8, −5.1 and 0.1, respectively) [Supplementary Table 2].

In difficult airways, Glidescope LoPro 3 also showed a significantly shorter intubation duration compared with McGrath Mac 4 (adj $P = 0.03$). Comfort was significantly better in all Glidescope blades compared with McGrath blades (adjusted $P < 0.001$). First attempt success was significantly better in Glidescope Mac T3 and Glidescope LoPro 3 (z score of 2.8 and 3.6, respectively) than in McGrath Mac 4 and McGrath X3 blades (z score of-3.2 and-3.2, respectively). However, successful glottic view was only significantly better in Glidescope LoPro (z score of 2.6) compared with Glidescope Mac T3, McGrath Mac 4, and McGrath X3 blades (z score of 1.3, −4.6 and 0.7, respectively) [Supplementary Table 2].

Discussion

In this study, we compared the impact of four different VL blades (GlideScope Mac T3, GlideScope Lo-pro T3, McGrath Mac 4, McGrath X3) on the dental force exerted on maxillary incisors, c-spine motion, intubation duration, glottic view, and intubator comfort during ETI. Our results revealed that the Glidescope LoPro T3 blade exerted significantly lower dental force, demonstrated less cervical spine motion, and facilitated shorter intubation duration than the McGrath Mac 4 blade. Notably, all Glidescope blades showed significantly better comfort than the McGrath blades. In addition, both the GlideScope Mac T3 and Lo-pro T3 exhibited similar and significantly higher first attempt success rates.

Table 2: Comparison of video laryngoscopy blades in all scenarios

All intubations (*n*=520)	Median (IQR) (*n*=130)				*P*
	GlideScope Mac T3	GlideScope Lo pro T3	McGrath Mac 4	McGrath X3	
Dental force (newton)	33.5 (26–45)	30 (24–40)	38 (28–48)	32 (24–42)	0.008
C-spine motion (°)	5 (4–8)	5 (4–8)	6 (5–8)	6 (4–8)	0.039
Success at first attempt, *n* (%)	120 (92)	124 (95)	90 (69)	89 (68.5)	<0.001
Duration (s)	13.4 (9.2–17.6)	12 (9–15.4)	14.9 (10.5–20.6)	13 (9–17)	0.001
Successful glottic view (mCL 1, 2a, or 2b), *n* (%)	108 (83)	116 (89)	70 (54)	101 (78)	<0.001
Comfort 7-likert	6 (5–6)	6 (6–6)	4 (3–5)	4 (3–5)	<0.001

IQR: Interquartile range, C-spine: Cervical spine, mCL: Modified Cormack–Lehane

Table 3: Subgroup analysis of video laryngoscopy blades in normal and difficult airways

Subgroups	Median (IQR) (*n*=65)				*P*
	GlideScope Mac T3	GlideScope Lo pro T3	McGrath Mac 4	McGrath X3 blade	
Normal airway (*n*=260)					
Dental force (newton)	32 (26–40)	28 (24–37)	35 (25–44)	30 (22–40)	0.08
C-spine motion (°)	8 (5–10)	7 (5–8)	8 (6–10)	8 (5–10)	0.06
Success at first attempt, *n* (%)	59 (91)	61 (94)	45 (69)	44 (68)	<0.001
Duration (s)	12.5 (9.2–18)	11.2 (8.6–15.3)	14.9 (10.8–21.7)	12.5 (8.8–18)	0.03
Successful glottic view (mCL 1, 2a, or 2b), *n* (%)	56 (86)	60 (92)	36 (55)	51 (78.5)	<0.001
Comfort 7-likert	6 (5–6)	6 (5–6)	4 (3–5)	4 (3–5)	<0.001
Difficult airway (*n*=260)					
Dental force (newton)	35 (28–50)	32 (24–42)	40 (29–52)	34 (28–42)	0.14
C-spine motion (°)	4 (3–6)	4 (3–6)	5 (4–6)	5 (3–6)	0.06
Success at first attempt, *n* (%)	61 (94)	63 (97)	45 (69)	45 (69)	<0.001
Duration (s)	13.8 (9.2–17.2)	12.4 (9.6–15.4)	14.9 (10.3–19.8)	14 (9.4–16.3)	0.042
Successful glottic view (mCL 1, 2a, or 2b) *n*, (%)	52 (80)	56 (86)	34 (52)	50 (77)	<0.001
Comfort 7-likert	6 (5–6)	6 (6–6)	4 (3–5)	4 (3–5)	<0.001

IQR: Interquartile range, C-spine: Cervical spine, mCL: Modified Cormack–Lehane

Studies on the force applied to the maxillary incisors and potential dental trauma are limited in the literature. Defosse *et al*. compared the dental forces exerted by the Macintosh blade of C-MAC, hyperangulated blades of GlideScope, and KingVision in a normal and difficult airway model in a manikin.[5] In the normal airway model, the hyperangulated blade of GlideScope (15.7 Newtons) was found to exert lower dental pressure than the Macintosh blade of C-MAC (18.2 Newtons). Under difficult airway conditions, GlideScope with a hyperangulated blade (17.4 Newtons) and KingVision (19.2 Newtons) exerted lower dental pressure than C-MAC with a Macintosh blade (30.2 Newtons).[5] Another study by Hanoglu *et al*. compared the peak force applied to the maxillary incisors during tracheal intubation using six different laryngoscopes/blades (Glidescope MAC T3, McGrath MAC 3 and X blade, C-MAC 3, and D-blade) in normal and difficult airway scenarios in a manikin model.[6] They reported that the mean peak forces exerted by McGrath MAC and X blades were lower than those exerted by other blades in both airway scenarios. CMAC-d and Glidescope T3 had similar measurements, and the Macintosh and CMAC #3 blades exerted the highest forces on the maxillary incisors in both airway scenarios.[6] Another manikin study by Schieren *et al*. compared the forces applied to the maxillary incisors in both normal and difficult airways using the DL Macintosh blade, C-MAC Macintosh blade, and hyperangulated blades of Glidescope and Kingvision. In both scenarios, hyperangulated blades caused lower median peak forces than Macintosh Blades.[3] In this study, we found that the Glidescope Lo-pro T3 exerts less dental force than the McGrath Mac 4, along with a lack of significant differences among other blades. Our results and the conflicting previous literature led to a pivotal question regarding their clinical significance. In adults with a healthy dental structure, the biting force of maxillary teeth varies between 94 and 150 newtons.[7] Therefore, compared with normal biting forces, the previously reported pressures and measured values in this study were significantly low. Therefore, if the dental structures are healthy, the risk of injury during VL should be very low.

C-spine stability during ETI is a critical concern if cervical immobilization is required, such as in neck trauma.[4] Several studies have compared the impact of different laryngoscope blades on c-spine motion during intubation. Most of these studies confirmed that VLs can provide less c-spine motion during intubation.[1] Romito *et al*. conducted a study comparing direct laryngoscopy and VLs with hyperangulated blades in two cadaver models.[8] The study used a Macintosh direct laryngoscope, Glidescope Lo-pro T3, C-Mac d-Blade, and McGrath X3. The hypothesis was that the Glidescope Lo-pro T3 would facilitate intubation with the least c-spine movement. However, the results showed no significant difference in c-spine movement among VLs.[8] Our study also found no difference in cervical movement between the hyperangulated blades, Glidescope Lo-Pro and McGrath X3. Despite being conducted on a mannequin, our findings were similar to those of Romito *et al*., indicating a consistent pattern across different models.

The other secondary outcomes of our study included intubation duration, comfort, rate of first pass success, and successful glottic view. The intubator comfort and first pass success rates were significantly better in all Glidescope blades than in the McGrath blades. This difference can be related to the design of the VLs in which McGrath VL's monitor screen, camera, and blade components are integrated into a single piece, which could make manipulation by the intubator difficult during ETI. In addition, the fact that the Glidescope VL provides an image on a wider and larger screen might have seemed more comfortable to the intubators. This finding was supported by a study by Wan *et al*. that compared the McGrath Series 5 VL with the Airtraq VL for double-lumen tube intubation and found that the secondary outcomes included glottic view, success rate, and subjective ease of intubation.[9] The study demonstrated that the McGrath blades may have design limitations, as the integrated monitor screen, camera, and blade components could make manipulation difficult during ETI.[9] In addition, the study by Mosier *et al*. supports our results by indicating that the GlideScope VL showed an improved grade of view and first-attempt success rate in ETI performed by nonexperts.[10] This suggests that the design of the Glidescope VL may indeed contribute to better intubator comfort and first-pass success rates.

In our study, the glottic view with the Glidescope Lo-pro, Mac T3 had similar rates of successful glottic view that significantly better than the McGrath MAC-4 blade. In addition, the intubation duration was shorter in the Glidescope Lo-pro than in the McGrath MAC-4 blade. The reason for this could be that in our study, we used the McGrath MAC-4 blade, which is wider and longer than the other blades. The literature presents conflicting evidence regarding the performance of different VLs and DLs in terms of the glottic view.[1] Maassen *et al*. compared direct laryngoscopy with three different VLs (GlideScope, V-MAC, and McGrath) and reported that VLs provided better glottic images and successful intubation without the need for a stylet.[11] However, another study by Gu *et al*. reported that persistent attempts to achieve a full glottic view with the GlideScope resulted in slower and more difficult intubations than accepting a restricted glottic view.[12] In addition, a systematic review and meta-analysis study by Hoshijima *et al*. demonstrated that the Pentax AWS VL offered a better glottic view than a DL with Macintosh blade, but this was not associated with a shorter time to intubation.[13] Therefore, further research is needed to elucidate the comparative efficacy of different laryngoscope blades and VLs in clinical practice.

Limitations

Our study has several limitations. First, the study was conducted using a manikin at a single center, which restricts the generalizability of our findings to real patient scenarios or to other medical centers. Second, the most significant findings of this study were associated with the use of the McGrath MAC 4 blade, which is larger than the other blades used in the study. The use of the McGrath MAC 3 blade may have yielded better results. Third, there was considerable heterogeneity in the characteristics of the study participants. Interns outnumbered residents, leading to a wide range of intubation experiences among participants. This variation could have impacted the success rate and duration of intubation. Fourth, although each participant performed randomized ETI and took 10-min breaks between scenarios, there may have been a bias toward the VLs that they were more accustomed to using. To mitigate this, participants received an hour of practice training with both VLs before the study. Nevertheless, the potential for learning bias influencing our results cannot be ruled out.

Conclusion

Our study demonstrated that the Glidescope LoPro T3 blade exhibited lower dental force, reduced c-spine movement, and shorter intubation duration than the McGrath Macintosh blade Mac 4. In addition, we observed superior first pass success rates and greater comfort with all Glidescope blades in contrast to McGrath blades. Although not statistically significant, our findings suggest that the use of hyperangulated blades tends to exert less dental force across both airway models. These preliminary results highlight the need for further clinical studies to substantiate the reliability and applicability of our findings.

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Author contributions CReDiT statement

ARK: Conceptualization, methodology, investigation, Writing - Original Draft, Review and Editing, İUÖ: Conceptualization (lead), methodology (lead), formal analysis, investigation, Writing - Original Draft, Review and Editing, Supervision, Project administration, ÖFŞ: Conceptualization, methodology, investigation, data curation, NÖD: Conceptualization, methodology, formal analysis, Review and Editing, EY: Conceptualization, methodology, formal analysis, Review and Editing, SY: Conceptualization, methodology, formal analysis, Review and Editing, MP: Conceptualization, methodology, formal analysis, Review and Editing.

Conflicts of interest

None Declared.

Ethical approval

Institutional review board approval was obtained for this study (Kocaeli University Non-Interventional Clinical Research Ethics Committee, Kocaeli – Turkiye, KÜ GOKAEK 2023/08.32, May 4, 2023).

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Supplementary Table 1: *Post hoc* pairwise comparison of the blades in all scenarios

All intubations	GS LoPro T3 versus MG Mac 4	GS LoPro T3 versus GS Mac T3	GS LoPro T3 versus MG X3	MG Mac 4 versus GS Mac T3	MG Mac 4 versus MG X3	GS Mac T3 versus MG X3
Dental force (*P*)	0.01	0.22	1.00	1.00	0.10	1.00
C-spine motion (°) (*P*)	0.031	1.00	1.00	0.26	0.69	1.00
Success at first attempt *Z*-score	4.7 versus −4.1	4.7 versus 3.7	4.7 versus −4.4	−4.1 versus 3.7	−4.1 versus −4.4	3.7 versus −4.4
Duration (*P*)	<0.01	0.70	1.00	0.09	0.052	1.00
Successful glottic view (mCL 1, 2a, or 2b) *Z*-score	4.1 versus −6.8	4.1 versus 2.2	4.1 versus 0.5	−6.8 versus 2.2	−6.8 versus 0.5	2.2 versus 0.5
Comfort 7-likert (*P*)	<0.001	0.14	<0.001	<0.001	1.00	<0.001

GS: Glidescope, MG: McGrath, C-spine: Cervical spine, mCL: Modified Cormack–Lehane

Supplementary Table 2: *Post hoc* pairwise comparison of the blades in the subgroups

	GS LoPro T3 versus MG Mac 4	GS LoPro T3 versus GS Mac T3	GS LoPro T3 versus MG X3	MG Mac 4 versus GS Mac T3	MG Mac 4 versus MG X3	GS Mac T3 versus MG X3
Normal airway						
Success at first attempt *Z*-score	3.2 versus−2.6	3.2 versus 2.4	3.2 versus −3	−2.6 versus 2.4	−2.6 versus −3	2.4 versus −3
Duration (*P*)	0.02	1.00	1.00	0.744	0.322	1.00
Successful glottic view (mCL 1, 2a, or 2b) *Z*-score	3.2 versus−5.1	3.2 versus 1.8	3.2 versus 0.1	−5.1 versus 1.8	−5.1 versus 0.1	1.8 versus 0.1
Comfort 7-likert (*P*)	<0.001	0.977	<0.001	<0.001	1.00	<0.001
Difficult airway						
Success at first attempt *Z*-score	3.6 versus −3.2	3.6 versus 2.8	3.6 versus −3.2	−3.2 versus 2.8	−3.2 versus −3.2	2.8 versus −3.2
Duration (*P*)	0.032	1.00	1.00	0.35	0.43	1.00
Successful glottic view (mCL 1, 2a, or 2b) *Z*-score	2.6 versus −4.6	2.6 versus 1.3	2.6 versus 0.7	−4.6 versus 1.3	−4.6 versus 0.7	1.3 versus 0.7
Comfort 7-likert (*P*)	<0.001	0.42	<0.001	<0.001	1.00	<0.001

GS: Glidescope, MG: McGrath, mCL: Modified Cormack–Lehane