

Use of the GlideScope does not lower the hemodynamic response to tracheal intubation more than the Macintosh laryngoscope: a systematic review and meta-analysis

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Abstract

Background: It is presently unclear whether the hemodynamic response to intubation is less marked with indirect laryngoscopy using the GlideScope (GlideScope) than with direct laryngoscopy using the Macintosh laryngoscope. Thus, the aim of this study was to determine whether using the GlideScope lowers the hemodynamic response to tracheal intubation more than using the Macintosh laryngoscope.

Methods: We performed a comprehensive literature search of electronic databases for clinical trials comparing hemodynamic response to tracheal intubation. The primary aim was to determine whether the heart rate (HR) and mean blood pressure (MBP) 60 s after tracheal intubation with the GlideScope were lower than after intubation with the Macintosh laryngoscope. We expressed pooled differences in HR and MBP between the devices as the weighted mean difference with 95% confidence interval and also performed trial sequential analysis (TSA). Second, we examined whether use of the GlideScope resulted in lower post-intubation hemodynamic responses at 120, 180, and 300 s compared with use of the Macintosh laryngoscope. For sensitivity analysis, we used a multivariate random effects model that accounted for within-study correlation of the longitudinal data.

Results: The literature search identified 13 articles. HR and MBP at 60 seconds post-intubation was not significantly lower with the GlideScope than with the Macintosh (HR vs MBP: weighted mean difference = 0.22 vs 2.56; 95% confidence interval -3.43 to 3.88 vs -0.82 to 5.93; $P = .90$ vs 0.14 ; $I^2 = 77\%$ vs 63% ; Cochran Q , 52.7 vs 27.2). Use of the GlideScope was not associated with a significantly lower HR or MBP at 120, 180, or 300 s post-intubation. TSA indicated that the total sample size was over the futility boundary for HR and MBP. Sensitivity analysis indicated no significant association between use of the GlideScope and a lower HR or MBP at any measurement point.

Conclusions: Compared with the Macintosh laryngoscope, the GlideScope did not lower the hemodynamic response after tracheal intubation. Sensitivity analysis results supported this finding, and the results of TSA suggest that the total sample size exceeded the TSA monitoring boundary for HR and MBP.

Abbreviations: CI = confidence interval, HR = heart rate, MBP = mean blood pressure, TSA = trial sequential analysis, WMD = weighted mean difference.

Keywords: GlideScope, hemodynamic response, Macintosh laryngoscope, meta-analysis, tracheal intubation

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The datasets generated during and/or analyzed during the current study are not publicly available, but are available from the corresponding author on reasonable request.

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1. Introduction

Oropharyngeal stimulation during tracheal intubation can cause hypertension and tachycardia,^[1,2] which are risk factors for myocardial infarction and stroke.^[3–5] This is a particular concern in elderly patients and in those with a history of myocardial infarction or stroke.^[6] The mechanism for the excessive cardiovascular response during tracheal intubation is thought to be sympathetic activation resulting from mechanical stimulation of the upper airway.^[7,8] Therefore, it is important to prevent hemodynamic fluctuation in terms of tracheal intubation.

The GlideScope (GlideScope, Verathon Inc., Bothell, WA) is a video laryngoscope with a high-resolution camera incorporated into the blade along with a light source that illuminates the pharynx and trachea. The 18-mm-wide laryngoscope blade is angled 60° at its midline. It is made from medical grade plastic for durability and to allow repeated sterilization. A small monitor displays the projected image.^[9]

One small study found that the hemodynamic response was less pronounced during tracheal intubation with the GlideScope than with the Macintosh laryngoscope^[10] and attempts to confirm this finding have yielded mixed results. For example, Ahmad et al. reported that suppression of the increase in heart rate after tracheal intubation with normal airway patients was better when the GlideScope was used instead of the Macintosh laryngoscope.^[10] However, other reports have shown no difference in hemodynamic responses during tracheal intubation with both laryngoscopes.^[11,12] Further, other studies reported to better suppression of the hemodynamic response during tracheal intubation when the Macintosh laryngoscope than the GlideScope was used.^[13,14] In a meta-analysis of GlideScope and Macintosh laryngoscope in 2012, they compared the success rate and intubation times of both laryngoscopes in tracheal intubation, but did not compare the hemodynamic response during tracheal intubation.^[11]

The aim of this systematic review and meta-analysis was to determine whether the hemodynamic response during single-lumen tracheal intubation with the GlideScope is lower than that with the Macintosh laryngoscope by measuring heart rate (HR) and mean blood pressure (MBP) in adult patients undergoing intubation with either device for general anesthesia.

2. Methods

We followed the guidelines recommended by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement.^[12] The research protocol was registered in the UMIN Clinical Trials Registry (UMIN 000031572; principal investigator, H. Hoshijima) on March 5, 2018. Since our study is a meta-analysis, it does not require the approval of the ethics committee.

2.1. Inclusion and exclusion criteria

We selected articles that included adults who had undergone tracheal intubation (oral or nasal) under general anesthesia. An article comparing HR and MBP measurements recorded before and after tracheal intubation with the GlideScope or Macintosh laryngoscope was included. We included randomized controlled trials and excluded observational studies in this study. Studies that did not include information on changes in HR and MBP were excluded, as were those that involved

tracheal intubation using double-lumen tubes and those conducted in children. We also excluded studies of awake intubation.

Population: Patients undergoing general anesthesia with tracheal intubation by oral or nasal intubation.

Interventions: Trial tracheal intubation with GlideScope.

Comparisons: Trial tracheal intubation using Macintosh laryngoscope.

Outcomes: Changes in hemodynamic responses (HR and MBP) before and after tracheal intubation.

2.1.1. Literature search strategy. We performed a comprehensive literature search of 3 electronic databases (PubMed, EMBASE, and Cochrane Central Register of Controlled Trials) with no restrictions on language or type of publication. The cutoff date was June 2019. The search strategy is provided in Supplemental Content 1, <http://links.lww.com/MD/F223>.

2.2. Study selection and data extraction

Two author independently screened the title and abstract of each trial yielded by the search. Then, the 2 author evaluated the full-text version if appropriate to determine whether or not the inclusion criteria were met. Any disagreements were resolved by discussion. The authors were contacted directly in the event of missing data or inconsistent reporting. Where it is possible that the results of a report have been duplicated and published, only those reports that have analyzed the latest data have been added to our study. The primary aim of the meta-analysis was to ascertain whether the hemodynamic response, as indicated by HR and MBP at 60 s after tracheal intubation when indirect laryngoscope was performed, was lower when using the GlideScope than when direct laryngoscopy was performed using the Macintosh device. The secondary aim was to determine whether the hemodynamic response at 120, 180, and 300 s after tracheal intubation was lower when using the GlideScope than when using the Macintosh laryngoscope.

2.3. Study quality

2.3.1. Assessment of risk of bias and quality of evidence. We assessed the limitations of the present research by evaluating the risk of bias with reference to the Cochrane Handbook^[13] (see Supplemental Content 2, <http://links.lww.com/MD/F224>, which illustrates how to evaluate risk of bias assessment). We assessed the quality of evidence for the main outcomes using the Grading of Recommendations Assessment, Development and Evaluation approach^[14] (see Supplemental Content 3, <http://links.lww.com/MD/F225>, which illustrates how to evaluate GRADE assessment).

2.3.2. Data synthesis and analysis. All statistical analyses were performed using Review Manager version 5.2 (Nordic Cochrane Centre, The Cochrane Collaboration, Copenhagen, Denmark). We used DerSimonian and Laird random effects models for statistical processing. The pooled difference in hemodynamic changes between the GlideScope and Macintosh groups is expressed as a weighted mean difference (WMD) with 95% confidence interval (CI). Cochran *Q* test and the *I*² statistic were used to test the heterogeneity of effect size.^[15]

For the sensitivity analysis, we used a multivariate random-effects model that accounted for within-study correlation of the longitudinal data. This analysis was performed using the

metaphor package in R (R Project for Statistical Computing, Vienna, Austria).^[16]

We also performed trial sequential analysis (TSA) to prevent type I errors resulting from multiple testing of the effect in the meta-analysis.^[17] We began by calculating the required information (sample) size (RIS) and set the risk of type I and II errors at 5% and 10%, respectively. Minimum clinically important differences of 10 bpm for HR and 5 mm Hg for MBP were used in the TSA. We also calculated the alpha-spending (ie, trial sequential monitoring) boundaries of the meta-analysis and adjusted CIs. To check for type I and II errors and whether or not we needed to include further trials, we determined if the TSA monitoring boundaries had been crossed by plotting the cumulative Z-curve for the meta-analysis.^[18] TSA software version 0.9.5.5 beta (www.ctu.dk/tsa) was used for the analysis.

To assess for publication bias, we tested for symmetry by a funnel plot^[19] using Begg test.^[20] Publication bias is confirmed when the *P*-value in Begg test is <.1. However, we did not evaluate publication bias when fewer than 9 studies were analyzed at 1 time.

3. Results

3.1. Characteristics of the studies in the meta-analysis

The database search initially identified 634 potentially relevant studies. Six hundred and 1 of these studies were excluded because they were not a randomized controlled trial, unrelated to the research question, or a review article. The remaining 33 articles were scrutinized in detail to determine whether or not they met the inclusion criteria. Twelve of these studies were excluded because they did not investigate hemodynamic response (n=5), compared laryngoscopes other than the GlideScope and Macintosh (n=6), or involved use of a double-lumen tube (n=2). Thirteen trials^[10,21-32] were confirmed to meet the inclusion criteria (Fig. 1) and are summarized in detail in Table 1 (see Table 1, which illustrates the characteristics of trials included in this meta analysis). In total,

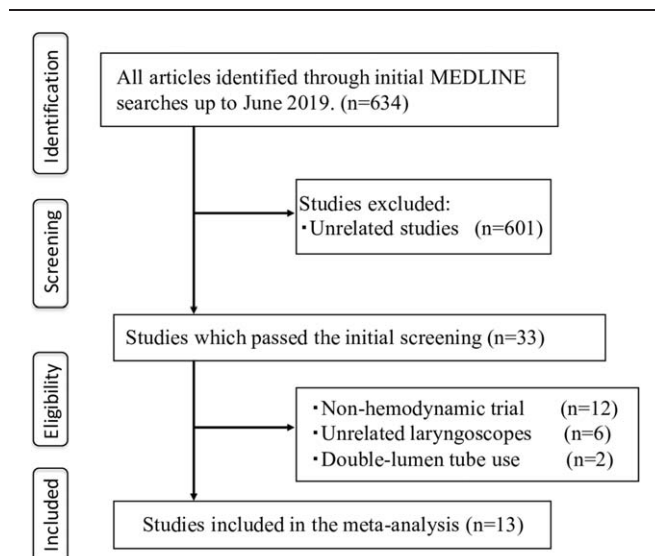


Figure 1. Meta-analysis flow chart. RCT = randomized controlled trial.

Table 1 Characteristics of the assessed studies.

First author	Publish year	GlideScope/ Mac	Preoperative airway assessment	Intubation path way	Surgery	Induction of anesthesia	Blood pressure measuring method
1 Xue Fu.S	2007	28/27	Normal	Oral intubation	Plastic surgery	Propofol 2 mg/kg, Vecuronium 0.1 mg/kg, Fentanyl 2 µg/kg	Non-invasive
2 Li X.Y	2007	20/20	Normal	Nasal intubation	Plastic surgery	Propofol 2 mg/kg, Vecuronium 0.1 mg/kg, Fentanyl 2 µg/kg	Non-invasive
3 Xue Fu.S	2008	38/38	Normal	Nasal intubation	Plastic surgery	Propofol 2 mg/kg, Vecuronium 0.1 mg/kg, Fentanyl 2 µg/kg	Non-invasive
4 Malik M.A	2008	30/30	M.L.S	Oral intubation	Elective surgery	Propofol 2-4 mg/kg, Atracurium 0.5 mg/kg, Fentanyl 1-1.5 µg/kg	Non-invasive
5 Malik M.A	2009	25/25	Predict difficult airway	Oral intubation	Elective surgery	Propofol 2-4 mg/kg, Atracurium 0.5 mg/kg, Fentanyl 1-1.5 µg/kg	Non-invasive
6 Siddiqui N	2009	20/20	Normal	Oral intubation	Elective surgery	Midazolam 0.03 mg/kg, Propofol 2 mg/kg, Rocuronium 0.6 mg/kg, Fentanyl 1.5 µg/kg	NR
7 Biehjani E	2009	40/40	Normal	Oral intubation	Coronary artery bypass graft	Midazolam 0.1 mg/kg, Cisatracurium 0.2 mg/kg, Fentanyl 5-7 µg/kg	Invasive
8 Ke J	2013	20/18	Normal	Oral intubation	Abnormal snoring	Propofol 1.5 mg/kg, Rocuronium 0.6 mg/kg, Fentanyl 2 µg/kg	Invasive
9 Pournajafian A.R	2014	46/49	Normal	Oral intubation	Elective surgery	Tiopental 5 mg/kg, Atracurium 0.6 mg/kg	Non-invasive
10 Dashti M	2014	30/29	Patients with untreated hypertension	Oral intubation	Elective surgery	Midazolam 0.05 mg/kg, Propofol 1.5 mg/kg, Cisatracurium 0.15 mg/kg, Remifentanyl 0.1 µg/ kg/min	N/R
11 Ahmad N	2015	25/25	Normal	Oral intubation	Ophthalmic surgery	Propofol, Rocuronium	N/R
12 Amini S	2015	35/35	Pregnant	Oral intubation	Cesarean section	Propofol 1.5 mg/kg, Succinylcholine 1.5 mg/kg	Non-invasive
13 Parasa M	2016	30/30	Normal	Oral intubation	Elective surgery	Midazolam 0.02 mg/kg, Fentanyl 1 µg/kg, Propofol, Vecuronium 0.1 mg/kg	Non-invasive

ASA-PS=American Society of Anesthesiologists-Physical Status classification, Mac=Macintosh laryngoscope, NR=not Recorded.

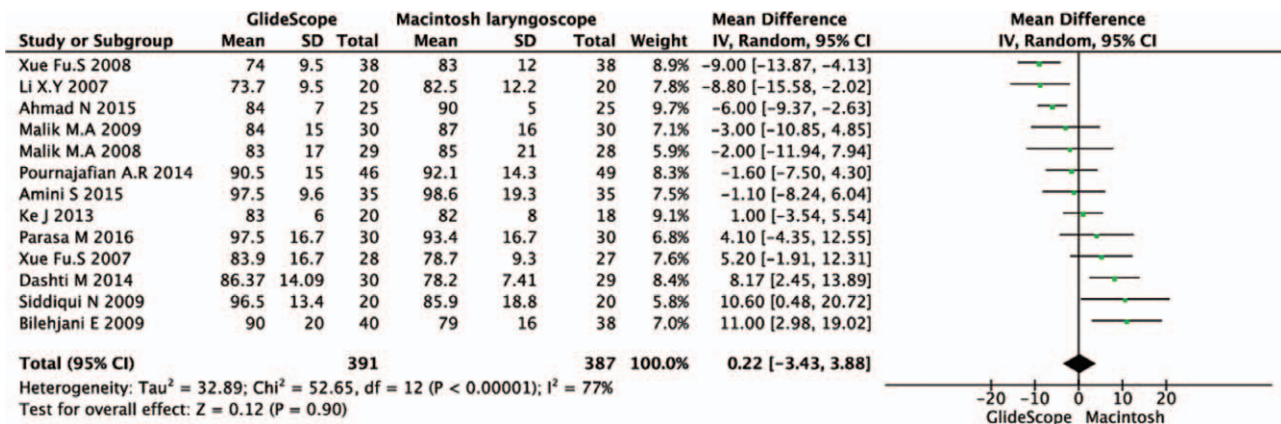


Figure 2. Forest plot of heart rate for tracheal intubation using the GlideScope compared with the Macintosh laryngoscope.

391 tracheal intubations were performed with the GlideScope and 387 with the Macintosh.

Table 1 depicts the studies characteristics we selected. Eight trials were for patients with American Society of Anesthesiologists-Physical Status classification 1-2.^[10,21,25-30] There were 4 trials including American Society of Anesthesiologists-Physical Status classification 3 patients.^[22-24,31] In our study, 11 out of 13 trials were tracheal intubated with oral intubation.^[10,21-26,29,31,32] Nasal intubation was only 2 trials.^[28,30] In the assessment of airways pre intubation, 10 trials were evaluated as normal airways.^[10,22,25-32] On the other hand, our studies included studies that predicted intubation difficulty such as studies in attempted manual in-line stabilization,^[23] studies that predicted difficulties in preoperative intubation,^[24] and studies in pregnant women.^[21] All operations were elective surgery, however, our study included surgery in which circulatory dynamics change easily such as coronary artery bypass graft surgery and cesarean section.

3.2. Results of meta-analysis

3.2.1. Primary outcomes. Meta-analysis of the 13 trials showed that using the GlideScope did not result in a significantly lower

HR at 60 s post-intubation compared with using the Macintosh laryngoscope (WMD 0.22; 95% CI -3.43 to 3.88; P=.90; I²=77%, Cochran Q, 52.7; Fig. 2). TSA corrected the 95% CI to -3.76, 4.21 and revealed that the accrued information size (n = 228) was 89.0% of the estimated RIS (n=256).

MBP at 60 s post-intubation was recorded in 11 studies. Use of the GlideScope did not result in a significantly lower MBP at 60 s post-intubation when compared with the Macintosh laryngoscope (WMD 2.56; 95% CI -0.82 to 5.93; P=.14; I²=63%, Cochran Q, 27.2; Fig. 3). TSA adjusted the CI to -1.26, 6.38 and showed that the accrued information size (n=624) was 88.5% of the estimated RIS (n=705).

3.2.2. Secondary outcomes. Using the GlideScope did not result in a significantly lower HR or MBP at 120, 180, and 300 post-intubation when compared with using the Macintosh laryngoscope (see Table 2, which illustrates the HR or MBP hemodynamic response after tracheal intubation 120, 180, and 300 s).

3.2.3. Sensitivity analysis. Sensitivity analysis indicated that the GlideScope did not lead to a significantly lower HR or MBP at any measurement point after tracheal intubation (see Table 3,

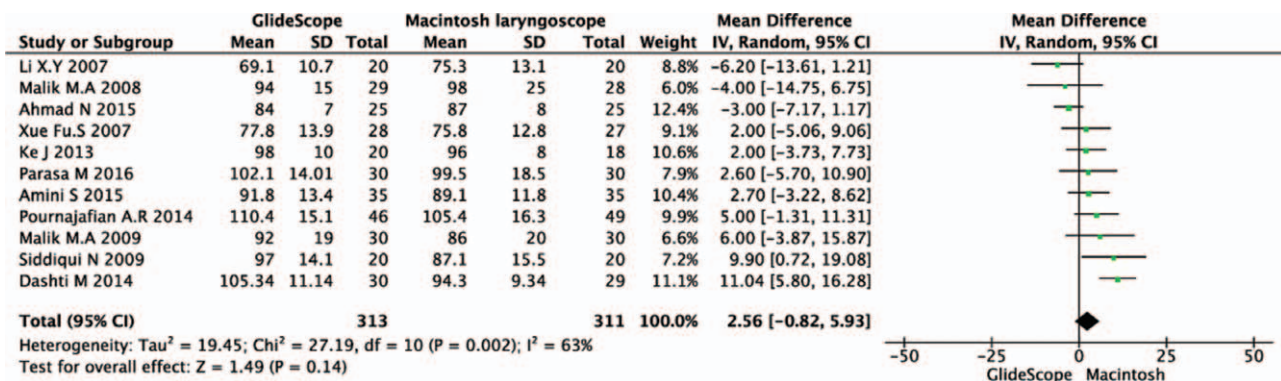


Figure 3. Forest plot of mean blood pressure for tracheal intubation using the GlideScope compared with the Macintosh laryngoscope.

Table 2

Results of the hemodynamic responses comparing heart rate or mean blood pressure in tracheal intubation using the Glidescope and the Macintosh laryngoscope.

	Number of trials	WMD (95% CI)	P value	Heterogeneity test	
				I^2 , %	Cochrane Q
HR					
Primary outcome					
60 s after intubation	13	0.22 (−3.43 to 3.88)	0.90	77	52.7
Secondary outcome					
120 s after intubation	8	−1.03 (−5.33 to 3.26)	0.64	71	24.6
180 s after intubation	10	−1.25 (−4.37 to 1.87)	0.43	61	23.4
300 s after intubation	11	−1.56 (−4.30 to 1.17)	0.26	60	25.1
MBP					
Primary outcome					
60 s after intubation	11	2.56 (−0.82 to 5.93)	0.14	63	27.2
Secondary outcome					
120 s after intubation	7	3.03 (−0.91 to 6.96)	0.13	63	16.2
180 second after intubation	10	0.79 (−1.23 to 2.81)	0.44	26	12.2
300 s after intubation	8	−0.13 (−1.68 to 1.41)	0.87	6	8.49

CI=confidence interval, HR=heart rate, MBP=mean blood pressure, WMD=weighted mean difference.

which illustrates the results of analysis using a multivariate random-effects model).

3.3. Quality of evidence

As shown in Figure 4, the risk of bias in the trials included in the meta-analysis was considered moderate because it was not possible to blind the physicians to the various types of laryngoscopes used in the trials. Moreover, because the heterogeneity was high, the quality of evidence was downgraded to low. Therefore, we judged the quality of evidence to be low for the effect of the GlideScope on both HR and MBP when compared with that of the Macintosh laryngoscope

3.4. Publication bias and Risk of bias

Begg test did not detect significant publication bias for either HR or MBP in the funnel plots for the trials included in the meta-analysis. The result of risks of bias are summarized in Figure 5. Risks of bias was listed as 1 of the potential types of bias because

of inability to blind the investigators to the type of laryngoscope used.

4. Discussion

The findings of this study suggest that the hemodynamic response is not significantly lower with the GlideScope than with the Macintosh laryngoscope at 60 s post-intubation. Moreover, HR and MBP values were not significantly lower at 120, 180, and 300 s post-intubation with the GlideScope compared with the Macintosh device. The results of the sensitivity analysis support these findings, and the TSA has determined that both HR and MBP have enough samples to show results.

The hemodynamic response to tracheal intubation is elicited primarily by mechanical stimulation of the upper airway induced by laryngoscopy and intubation procedures.^[7,8] When the trachea is intubated with the Macintosh laryngoscope, an upward lifting force is applied to the tongue and epiglottis to align the oral, pharyngeal, and tracheal axes and secure a line of sight. The maximal force applied to the base of the tongue by the Macintosh laryngoscope is 30 to 50 N.^[33–36] In contrast, the digital camera located in the tip of the blade of the GlideScope displays the glottis on an external display monitor, allowing visualization of the glottis and intubation of the trachea without aligning the 3 axes. Therefore, we assumed that use of the GlideScope would result in a significantly lower hemodynamic response. However, no significant decrease in the hemodynamic response after tracheal intubation was found with the GlideScope compared with the Macintosh laryngoscope.

One possible explanation why using the GlideScope does not lead to lower hemodynamic responses is as follows. The design of the GlideScope blade appears to be derived from that of the Macintosh-type blade, such that the blade requires the characteristic amount of upward manipulation of the Macintosh laryngoscope to allow the tracheal tube to pass through the glottis. Although the GlideScope allows intubation with an upward force that is 27 N less than that required with the Macintosh laryngoscope,^[37] the upward movement might still exert pressure on the oropharyngeal tissue that is painful, leading

Table 3

Sensitive analysis of the hemodynamic responses of heart rate and mean blood pressure in tracheal intubation using the GlideScope and the Macintosh laryngoscope.

HR	WMD (95% CI)	P value
60 s after intubation	0.05 (−3.69 to 3.79)	.98
120 s after intubation	−0.49 (−4.22 to 3.24)	.79
180 s after intubation	−1.01 (−4.11 to 2.09)	.52
300 s after intubation	−1.39 (−3.85 to 1.06)	.27
MBP		
60 s after intubation	2.81 (−0.46 to 6.07)	.09
120 s after intubation	2.16 (−1.32 to 5.64)	.22
180 s after intubation	0.76 (−1.55 to 3.09)	.52
300 second after intubation	−0.09 (−1.74 to 1.55)	0.91

CI=confidence interval, HR=heart rate, MBP=mean blood pressure, WMD=weighted mean difference.

Summary of findings:

Glidescope compared to Macintosh for Hemodynamic response

Patient or population: Hemodynamic response
Setting: Glidescope
Intervention: Glidescope
Comparison: Macintosh

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	N of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with Macintosh	Risk with Glidescope				
Heart rate	The mean heart rate ranged from 79-98.6 bpm	The mean heart rate in the intervention group was 0.22 bpm higher (3.43 lower to 3.88 higher)	-	778 (13 RCTs)	⊕⊕○○ LOW ^{a,b}	
Mean blood pressure	The mean mean blood pressure ranged from 75.3-105.4 mmHg	The mean mean blood pressure in the intervention group was 2.56 mmHg higher (0.82 lower to 5.93 higher)	-	624 (11 RCTs)	⊕⊕○○ LOW ^{a,b}	

***The risk in the intervention group** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval; **MD:** Mean difference

GRADE Working Group grades of evidence
High certainty: We are very confident that the true effect lies close to that of the estimate of the effect
Moderate certainty: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
Low certainty: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect
Very low certainty: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

Explanations

- a. There was no study with moderate risk of bias in the overall domain, because of all type of laryngoscope could not be blinded to the provider.
- b. There was high or moderate heterogeneity in the over all effect.

Figure 4. The Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach.

to increases in HR and MBP. This stimulation of the oropharyngeal tissue may explain why the hemodynamic response was not lowered when using the GlideScope compared with when using the Macintosh laryngoscope.

Another potential reason why the hemodynamic responses are not lower with the GlideScope concerns differences in the tracheal intubation procedure itself. The GlideScope is an indirect laryngoscope that does not guide insertion of the tracheal tube, and the physician needs to manipulate the scope with 1 hand to visualize the glottis while intubating the trachea with the other hand. This procedure requires complex hand-eye coordination within the limited oral space, which could increase mechanical stimulation during manipulation.^[38] Moreover, a rigid stylet is typically used to facilitate tracheal tube with the GlideScope. Although the rigid stylet is removed after the tip of the tube passes through the glottis, it could temporarily increase the intensity of mechanical contact between the tube tip and the tracheal tissue, consequently increasing the intensity of the cardiovascular response after intubation.

Time spent in tracheal intubation may also influence hemodynamic responses. In fact, some studies suggest that shortening of tracheal intubation time suppresses fluctuations in circulatory dynamics.^[39] A meta-analysis performed by Griesdale et al in 2012

reported similar intubation times for the GlideScope and the Macintosh (WMD 3.8 s; 95% CI, -1.7–9.3; $P = .17$).^[11] Thus, the reason for the GlideScope not lowering the hemodynamic responses may also be influenced by intubation time.

5. Limitations

This study has some potential limitations. First, all the studies included in this meta-analysis were considered to have at least a moderate risk of bias because the investigators could not be blinded to the type of laryngoscope used in any of the studies. Second, there was significant statistical heterogeneity. Third, the patients in the studies included in the meta-analysis received different types of airway management. Nine studies included patients with a normal airway. However, some of the studies included patients in whom manual in-line neck stabilization was performed, patients who were pregnant, and patients with a predicted difficult airway. Fourth, variations in study design resulted in clinical and methodological heterogeneity. For example, there was considerable variation in patient populations, the skill levels of the laryngoscopists, and intubation routes (oral and nasal) and anesthesia methods used. However, heterogeneity is an inherent limitation in all meta-analyses.

	Random sequence generation	Allocation concealment	Blind of participants and personnel	Incomplete outcome data	Selective reporting	Other potential threats to validity
Xue Fu. S 2007	+	+	-	+	?	-
Li X.Y 2007	+	?	-	+	?	-
Xue Fu. S 2008	+	+	-	+	?	-
Malik M. A 2008	+	+	-	+	?	+
Malik M. A 2009	+	-	-	-	?	+
Siddiqui N 2009	+	+	-	+	?	-
Bilehjani E 2009	+	?	-	+	?	-
Ke J 2013	+	?	-	+	?	-
Pournajafian A.R 2014	+	+	-	+	?	-
Dashti M 2014	+	?	-	+	?	-
Ahmad N 2015	+	?	-	+	?	-
Amini S 2015	+	?	-	-	?	-
Parasa M 2016	+	+	-	-	?	+

Figure 5. Green circles, red circles, and yellow circles indicate “low risk of bias,” “high risk of bias,” and “unclear risk of bias,” respectively.

6. Conclusions

This systematic review and meta-analysis found that the hemodynamic response after tracheal intubation is when using the GlideScope is not lower than when using the Macintosh laryngoscope (Grading of Recommendations Assessment, Development and Evaluation score: low). The results of the sensitivity analysis supported this finding and the results of TSA suggest that the total sample size exceeded the monitoring boundary for HR and MBP.

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Supervision: Koichi Maruyama, Aiji Sato(Boku).
Writing – original draft: Hiroshi Hoshijima, Toshiya Shiga.
Writing – review & editing: Hiroshi Hoshijima, Koichi Maruyama.

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