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Tracheal intubation in patients immobilized by a rigid collar: a comparison of GlideScope and an intubating laryngeal mask airway*

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Background/aim: Intubation must be rapidly performed with the utmost care in cervical trauma patients. We present the first comparison of GlideScope and an intubating laryngeal mask airway (ILMA) regarding insertion and intubation times, intubation success rates, mucosal damage, need for optimization maneuvers, effects on hemodynamic changes, and postoperative minor complications in a simulated cervical injury with a Philadelphia cervical collar.

Materials and methods: Ethics committee approval and patient consent were obtained and 94 American Society of Anesthesiology physical status I or II patients were enrolled in this study. Following standard anesthesia monitoring and induction, the Philadelphia-type cervical collar was applied and patients were subsequently intubated with ILMA or GlideScope.

Results: The total intubation success rates were similar between the groups (96%). The insertion (14.9 ± 10 s vs. 21.9 ± 6.5 s, respectively; $P < 0.001$) and intubation (43.5 ± 13 s vs. 48.4 ± 11 s; $P = 0.02$) times for ILMA were longer than for GlideScope. The total intubation times for ILMA were longer than the intubation time for GlideScope (43.5 ± 13 s vs. 85.6 ± 13 s; $P < 0.001$). The mucosal damage was higher in the ILMA group ($P = 0.04$). The two airway devices increased the heart rate and mean arterial pressure after insertion compared with the postinduction values within groups.

Conclusion: GlideScope is superior to ILMA in terms of lower insertion and intubation times and lower levels of mucosal damage in cervical collar-immobilized patients.

Key words: GlideScope, intubating laryngeal mask airway, cervical collar

1. Introduction

The most important responsibility for an anesthetist in the event of suspected injury is to secure the airway with minimal movement of the cervical spine (1). An increase in the number of intubation attempts or number of failed intubations is the most important cause of morbidity and mortality in these patients (2).

Stabilization of the cervical spine by manual in-line stabilization (MAILS), rigid or semirigid collars, or banding the head with tape is recommended in trauma guidelines. However, applying a cervical collar reduces mouth opening and worsens facemask ventilation and Cormack–Lehane grading (3,4). Cervical collars may reduce cervical spine movement.

Direct laryngoscopy has decreased intubation success and increased cervical spine motion when compared to an intubating laryngeal mask airway (ILMA) fluoroscopically (5). If a cervical spine injury is suspected, nasal or oral awake fiberoptic intubation must be the first choice in elective procedures, but this technique needs skill and takes time; alternatively, blind intubation with ILMA and minimal optimization maneuvers is recommended (6). In addition, during intubation with videolaryngoscopes less force is required, and the glottic visualization in MAILS is improved (7,8). However, securing the airway in patients with potential cervical spine injuries remains a subject of debate.

The ILMA is a blind, difficult intubation tool that allows ventilation during intubation without moving the neck from the neutral position (9). In contrast, the GlideScope is an indirect video laryngoscope with a 60° curved blade that reduces the number of intubation attempts and decreases the intubation time in prehospital settings and in cervical collar-immobilized patients (10,11).

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With these findings, we present the first comparison of GlideScope and ILMA regarding insertion and intubation times, intubation success rates, mucosal damage, need for optimization maneuvers, effects on hemodynamic changes, and postoperative minor complications in simulated cervical injury with a Philadelphia-cervical collar.

2. Materials and methods

Approval from the local research ethics committee (KOU KAEK 2013 / 33) was obtained. In addition, all patients' consent was obtained for study participation. Ninety-four ASA physical status I–II patients, aged from 18 to 60 years who were undergoing elective surgery requiring endotracheal intubation, were enrolled in this prospective study. This study is also registered at www.clinicaltrials (NCT: NCT02245880). Patients with laryngeal or pharyngeal pathology, known or expected difficult airway (interincisor distance < 2.5, Mallampati score of 3 or 4, thyromental distance [TMD] < 6 cm, sternomental distance [SMD] < 12 cm), and high cardiac or respiratory system insufficiency; patients with upper respiratory infection in the past 10 days; and patients undergoing emergency procedures were excluded from this study. Preoperative demographic or airway variables of patients were recorded, such as the age, sex, weight, height, body mass index (BMI), neck circumference, SMD, TMD, Mallampati scores, mandibular protrusions (A: the lower incisors can be protruded anterior to the upper incisors; B: the lower incisors can be brought edge to edge with the upper incisors; and C: the lower incisors cannot be brought edge to edge with the upper incisors), teeth morphology (full / lacking / absent), macrognathia, and micrognathia. After an intravenous (iv) cannula was inserted in the preoperative care unit, 0.03 mg kg^{-1} iv midazolam was administered for premedication. After arriving at the operating theater, patients were monitored using ECG, pulse oximetry (SpO_2), heart rate (HR), noninvasive blood pressure (NIBP), and mean arterial pressure (MAP). Patients were preoxygenated with 100% oxygen for 3–5 min using a facemask. Patients were randomized into two groups by the sealed envelope technique: the ILMA group (n = 47) (ILMA or Fastrach; Laryngeal Mask Co., Henley on Thames, UK) and the GlideScope group (n = 47) (Verathon Medical Inc., Bothell, WA, USA). Anesthesia was induced with 3 mg kg^{-1} propofol and 1 µg kg^{-1} fentanyl. Patients were ventilated with sevoflurane in a mixture of 66% nitrous oxide and oxygen. Mask ventilation difficulty was recorded as Longeron et al. described in their study (easy / airway / two-handed / O_2 flush / impossible) (12). Rocuronium (0.6 mg kg^{-1}, iv) was administered for muscle relaxation. The evoked response of the adductor pollicis muscle to ulnar nerve stimulation at the wrist (TOF-Guards acceleromyograph; TOF-Guard; Organon Teknika, Oss, the Netherlands) was used to ensure adequate neuromuscular blockade in all patients until the end of surgery. Then we removed the pillow under the patients' head and chose the appropriate size of Philadelphia cervical collar according to the manufacturer's recommendations (a small size was used if the neck circumference of the adult patient was between 25.4 and 33 cm, a medium size was used between 33 and 40.6 cm, and a large size collar was used between 40.6 and 48.3 cm) and put it in place. Mask ventilation difficulty was also recorded after the application of the collar (12). Suitable ILMA and GlideScope protocol were chosen according to the manufacturers' recommendations (13,14). In the ILMA group, the posterior surface of the ILMA was lubricated with a 2% lidocaine jelly. A size 3 ILMA was used for adults between 30 and 50 kg in weight and <160 cm tall, a size 4 ILMA was used for adults weighing between 50 and 70 kg and between 160 and 170 cm tall, and a size 5 ILMA was used for adults weighing >70 kg and >170 cm tall. The cuff was inflated with air (size 3, 20 mL; size 4, 30 mL; size 5, 40 mL). In the GlideScope group, a size 4 blade was used (>40 kg and morbidly obese).

Our primary outcome measures were the insertion and intubation times of these two devices. Our secondary outcome measures were number of intubation attempts (success rates), mucosal damage, need for optimization maneuvers, esophageal intubation, effects on hemodynamic parameters, and minor postoperative complications.

The insertion time of GlideScope was defined as the time elapsing from the handling of the device until optimal glottic visualization (optimization maneuvers included) was achieved. To determine the optimal GlideScope visualization, handling force and side-to-side maneuvers were used (Table 1). The GlideScope intubation time was defined as the time elapsing from the handling of the device until the confirmation of intubation by capnography through the endotracheal tube.

The ILMA insertion time was defined as the time elapsing from the handling of the device until optimal ventilation (optimization maneuvers included) was achieved. The ILMA intubation time was defined as the time elapsing from the handling of the device until the confirmation of the intubation by capnography while the ILMA was in place. The ILMA total intubation time was defined as the time elapsing from the handling of the device until the confirmation of the intubation by the capnography after removal of the ILMA and only the endotracheal tube was left in place.

For optimal ventilation, Chandy, up-and-down, side-to-side, and handling force maneuvers were used in the ILMA group (Table 1). Intubation was recorded as unsuccessful if there were more than three intubation

Table 1. Maneuvers that were used for optimization of ventilation and intubation.

Chandy maneuver	Pushing the mask slightly further in (tip of the mask towards the esophageal sphincter)
Up-and-Down maneuver	Backing the airway device out slowly up to 6 cm and reinserting
Side-to-Side maneuver	Turning the airway device slightly to the right and left side in place
Handling force maneuver	Holding the airway device strongly upwards

attempts. Then we removed the collar and intubated the patient with the same device. Bloodstaining on both the ILMA and GlideScope after removal was recorded as 'mucosal damage'. The number of intubation attempts, esophageal intubation, tooth and tongue damage, and lip damage were recorded. Skilled investigators performed all intubations (who had performed at least 50 successful attempts with both of the devices). The MAP and HR of patients were recorded preoperatively (baseline), after anesthesia induction, after the device insertion, and at 1-min intervals three times and 2-min intervals during the 15 min following intubation. Tramadol (1 mg kg^{-1}, iv) and ondansetron (0.5 mg kg^{-1}, iv) were administered at the end of the surgery for analgesia and to prevent vomiting. Neostigmine (0.04 mg kg^{-1}, iv) and atropine (0.02 mg kg^{-1}, iv) were used for antagonism of the neuromuscular blockage. Episodes of hypoxemia (SpO_2), postoperative sore throat, dysphagia, coughing, bronchospasm, and aspiration were also recorded just after the operation in a postoperative care unit and 2 h after the operation. An independent unblinded observer collected all data during the preoperative and postoperative period.

Statistical analysis was performed according to a study that found a GlideScope intubation time of 46.3 ± 59.1 s (15). Starting with that point to detect a 30-s difference between the groups, we calculated our sample size as 37 per group. However, we decided to enroll 47 patients for possible exclusions. We used the chi-square test to compare the categorical data. For continuous data, we used Student's t-test and the Mann–Whitney U test. For comparing the groups, we used the paired sample t-test and the Wilcoxon signed ranks test. Values are given as mean ± standard deviation (SD) or numbers. $P < 0.05$ was considered statistically significant.

3. Results

The demographic variables and airway characteristics of patients were similar (Table 2). All patients' neck movements were higher than 90°. No micrognathia or macroglossia was detected in any of the patients. Seven patients in ILMA group and 12 patients in the GlideScope group needed an oral airway during facemask ventilation. In the ILMA group, five patients needed an oral airway and two patients needed two-handed ventilation, and in the GlideScope group, 12 patients needed an oral airway and 2 patients needed two-handed ventilation during facemask ventilation through the cervical collar. Both groups had comparable facemask ventilation with or

Table 2. Demographic and airway variables of patients, given as mean ± SD or as numbers (n).

	GlideScope group (n = 47)	ILMA group (n = 47)	P
Age (years)	36.3 ± 1.6	35.3 ± 1.8	0.7
Sex (female / male)	28 / 19	31 / 16	0.5
Height (cm)	169.3 ± 1.6	167.6 ± 1.3	0.4
Weight (kg)	72.5 ± 16.5	67.5 ± 11.8	0.2
Body mass index (kg/m^2)	25.3 ± 0.7	24.1 ± 0.6	0.2
Thyromental distance (cm)	8.5 ± 1.4	8.1 ± 1.6	0.1
Sternomental distance (cm)	17 ± 1.8	16.7 ± 2.1	0.7
Interincisor distance (cm)	5 ± 0.6	4.9 ± 0.7	0.4
Neck circumference (cm)	37.3 ± 0.6	36.1 ± 0.5	0.1
Tooth morphology: full / lack / prosthesis	41 / 4 / 2	41 / 3 / 3	0.8
Mallampati: I / II	22 / 25	26 / 21	0.4
Mandibula protrusion: A / B	36 / 11	39 / 8	0.4
Upper teeth: long / normal	4 / 43	2 / 45	0.4

without a cervical collar (Table 3). Two patients could not be intubated in each group. Thus, the total intubation success rates were similar between the groups (96%). Optimization maneuvers were used in 15% of the patients in the ILMA and 22% of the patients in the GlideScope group. They were not differ from each other regarding the need for maneuvers. Two patients in each group could not be intubated after three intubation attempts and were recorded as failures (Table 3).

The insertion (14.9 ± 10 s vs. 21.9 ± 6.5 s; $P < 0.001$) and intubation (43.5 ± 13 s vs. 48.4 ± 11 s; $P = 0.02$) times of ILMA were longer than those of GlideScope. Total intubation times for ILMA were longer than the intubation times for GlideScope (43.5 ± 13 s vs. 85.6 ± 13 s; $P < 0.001$). Mucosal damage was higher in the ILMA group ($P = 0.04$) (Table 3).

The HR and MAP were increased after insertion in both of the groups compared with the postinduction values (Tables 4 and 5). Esophageal intubation was observed in three patients in the ILMA group and two patients in the GlideScope group. There were no differences in hypoxemia; lip, tongue, and tooth damage; sore throat; dysphagia; bronchospasm; or aspiration between the groups.

4. Discussion

Although fiberoptic intubation is the gold standard in patients with cervical spine injury, it needs skill and is time-consuming. Even though direct laryngoscopy is the fastest method, it was shown to increase the cervical spine movement more than videolaryngoscopes and the ILMA fluoroscopically (5,15,16). In addition, ILMA was recommended as a second choice in these situations in previously published literature and the Advanced Trauma Life Support guidelines (3,6). Trauma patients frequently have to be intubated at the scene urgently without being fully evaluated. Only some of them can be intubated in the operating theater. There are currently many videolaryngoscopes available in different shapes; GlideScope was shown to increase the first intubation success rate in cervical collar-immobilized patients (11). However, we are not aware of any comparative studies between ILMA and GlideScope in collar-immobilized patients.

We reported higher first attempt intubation success rates than previously published literature for ILMA (87%). Bilgin and Bozkurt (17) reported ILMA first attempt and total intubation success rates in MAILS as 54% and 87%, respectively. These results were lower than ours. This result may be due to the choice of the optimization maneuvers. Bilgin and Bozkurt confirmed optimal ventilation, as we did in our study, but if the ventilation was not adequate they performed only the Chandy maneuver or changed the size of the ILMA. However, we knew (according to our previous trials and other reports) that if the ventilation was not adequate or intubation was impossible, it was strongly due to a down-folded epiglottis and one can only overcome that problem by using the up-and-down maneuver (18,19). According to our results the first intubation success rate for GlideScope was 93%, similar to previous reports in MAILS in real patients (20).

In contrast with previous reports, we found the total intubation success rates of both devices as 96%. Other researchers used the same optimization techniques (up-down maneuver first, then Chandy maneuver and changing the tube) and the same (Philadelphia) collar as we did in our study (21–23). Contrary to our findings, Wetsch et al. found lower total intubation success rates (87%) with GlideScope in a collar-immobilized manikin. Twenty-three anesthetists performed these intubations; they had different skills, and manikins could not replace people (15).

Prasarn et al. (24) compared four airway devices (Airtraq, Macintosh, Lightwand, and ILMA) in a ligamentous instability model (manikin) and demonstrated that the lowest intubation success rates were with ILMA.

Table 3. Airway management variables of patients, given as the number (n) or percentage.
*: Statistically significant.

	GlideScope group (n = 47)	ILMA group (n = 47)	P
Facemask ventilation: easy / airway / two hands	35 / 12 / 0	40 / 7 / 0	0.2
Ventilation through collar: easy / airway / two hands	33 / 12 / 2	40 / 5 / 2	0.2
Intubation attempts: I / II/ III	43 / 2 / 2 (92% / 4% / 4%)	41 / 4 / 2 (87% / 9% / 4%)	0.4
Mucosal damage: yes / no	5 / 42	13 / 34*	0.04*

Table 4. Mean arterial pressure changes in the patients, with values given as mean ± SD.

	GlideScope group (n = 45)	ILMA group (n = 45)
Mean arterial pressure, preinduction (mmHg)	101.8 ± 14	100 ± 14.7
Mean arterial pressure, postinduction	89.3 ± 15.2	89.1 ± 15.7
Mean arterial pressure, postinsertion	98.4 ± 22.7…	97.8 ± 19.5…
Mean arterial pressure 1 min after intubation	91.7 ± 16.5	86.2 ± 14.8
Mean arterial pressure 2 min after intubation	80.4 ± 11.2	78.7 ± 10.8

…P < 0.001; postinduction mean arterial pressure values compared with the postinsertion mean arterial pressure values.

Table 5. Heart rate values of patients, with values given as mean ± SD.

	GlideScope group (n = 45)	ILMA group (n = 45)
Heart rate, preinduction (beats/min)	87.6 ± 17.7	84.1 ± 15.1
Heart rate, postinduction	86 ± 14.3	82.4 ± 13.3
Heart rate, postinsertion	95 ± 16…	87.6 ± 12.6*
Heart rate, 1 min after intubation	91.3 ± 13	87.8 ± 14.2
Heart rate, 2 min after intubation	88.1 ± 13.4	85.8 ± 13.5

*P < 0.05 and … P < 0.001; postinduction heart rate values compared with postinsertion heart rate values.

Our study demonstrated that the insertion and intubation times were longer and mucosal damage was higher in the ILMA group than in the GlideScope group. A study reported longer insertion and intubation times than our findings with ILMA under MAILS and collar immobilization (17,21). However, previously immobilized patients were intubated for similar durations as we did in our study by GlideScope (11,15).

Fun et al. (25) compared GlideScope and ILMA in women with normal airways. Their study showed that the number of intubation attempts and rate of mucosal damage were higher and the intubation times were longer in the ILMA group than in the GlideScope group in women with normal airways. They mentioned that, despite its limitations, ILMA is a valuable tool in difficult airways because it provides ventilation during intubation.

Optimization maneuvers of ILMA were used in 60% of patients during MAILS (17). We needed maneuvers in 15% of patients in the ILMA group. Our study and other studies demonstrated that GlideScope needed 21% maneuver application in difficult airways (11,26).

As previously described, both GlideScope and ILMA increased the HR and MAP after insertion compared with the postinduction values in our study (27–30).

The main limitation of our study was the absence of the standard comparator arm (direct laryngoscopy). Some other limitations of our study included that these results could not be attributed to real cervical trauma patients and hemodynamic changes could not be attributed to unstable cardiovascular patients. Our surgery types were as follows: septorhinoplasty, tympanoplasty, laparoscopy, and abdominal hysterectomy. These were not trauma patients that needed cervical stabilization. Optimization maneuvers were used in both groups in our study, and these maneuvers have potential risk for damage in real cervical trauma patients. Future investigation are required in real cervical-injured patients.

In conclusion, the insertion time, intubation time, and mucosal damage rates were higher in the ILMA group than in the GlideScope group, but the total intubation success rates, effects on hemodynamic parameters, and postoperative complications were similar between the groups. GlideScope is superior to ILMA in cervical collar-immobilized patients.

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