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Comparison of Three Tracheal Intubation Techniques in Thyroid Tumor Patients with a Difficult Airway: A Randomized Controlled Trial

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Key Words

Tracheal intubation · Thyroid tumor · Direct laryngoscopy · Shikani optical stylet · GlideScope video laryngoscope

Abstract

Objective: To investigate the effectiveness of the Shikani optical stylet (SOS) and GlideScope video laryngoscope (GVL) for tracheal intubation of thyroid tumor patients with a difficult airway. ***Subjects and Methods:*** One hundred and twenty thyroid tumor patients with a difficult airway, who were undergoing elective surgery requiring general anesthesia, were enrolled in the study. They were randomly allocated to 3 groups (n = 40 each) who underwent direct laryngoscopy (DL), SOS or GVL. The outcomes recorded were time to intubation, first-attempt success rate, mean artery pressure (MAP), heart rate (HR) and incidence of complications. ***Results:*** The mean time to intubation in the SOS group (group S; 42.4 ± 24.1 s) and the GLV group (group G; 29.8 ± 22.3 s) was significantly less than that in the DL group (group D) (68.8 ± 26.6 s). The first-attempt success rate in group S (90.0%) and group G (97.5%) was significantly higher than that in group D (75.0%; all $p < 0.05$). The HR and MAP at 1 min after intubation were lowest in group S (76.4 ± 9.2 beats/min and 12.9 ± 1.1 kPa), followed by group G (79.9 ± 9.3 beats/min and 13.0 ± 0.9 kPa) and then group D (90.4 ± 8.1 beats/min and 16.6 ± 1.2 kPa). The difference was statistically significant (all $p < 0.05$). The incidence of lip or mucosal trauma was lowest in group S, followed by group G and then group D. ***Conclusion:*** The SOS and the GLV had advantages over the DL in the management of thyroid tumor patients with a difficult airway in terms of a shorter time to intubation, a higher first-attempt success rate and a reduced incidence of complications. Thus, a rational choice of one of these techniques may be better for the perioperative safety of thyroid tumor patients with a difficult airway.

Introduction

The thyroid tumor is one of the most common tumors encountered in daily clinical settings, and surgery is the primary therapy. However, due to displacement or narrowing of the trachea by the compression or invasion of the tumor, tracheal intubation is often difficult [1]. Thyroid tumor is one of the most common diseases encountered by surgeons, and the reported incidence of difficult tracheal intubation is between 5.3 and 12.7% in thyroid surgery [2–4]. As a thyroid tumor is anatomically close to the larynx, pharynx and trachea, limited mobility in the neck often occurs, along with tracheal displacement or narrowing, creating difficulties for tracheal intubation (fig. 1a).

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Table 1. Airway difficulty score

	Airway difficulty score		
	0	1	2
Weight, kg	<90	90–110	>110
Head and neck movement	>90°	90 ± 10°	<90°
Jaw movement (IG or SLux)	IG >5 cm or SLux >0	IG <5 cm or SLux = 0	IG <5 cm or SLux <0
Receding mandible	none (normal)	moderate	severe
Protruding upper teeth	absent	moderate	severe
A history of a difficult airway	no	suspected	yes
CT data	unaffected trachea	moderately affected trachea	severely affected trachea

Airway difficulty score >5 is defined as a difficult intubation. IG = Interincisor gap; SLux = subluxation.

Tracheal intubation is an essential safeguard procedure conducted under general anesthesia for the surgical procedure. Difficult intubation is associated with a greater incidence and severity of complications, and has been reported to be responsible for anesthetic deaths [5, 6]. Many efforts have therefore been made for better management of a difficult airway, which was defined as 'the clinical situation in which a conventionally trained anesthetist experiences difficulty with mask ventilation of the upper airway, tracheal intubation, or both' [7]. Although direct laryngoscopy (DL) is the most commonly used technique in current clinical intubation practice, the intubations are frequently difficult or even fail, and may lead to forced termination of the surgery, thereby threatening the safety of patients, especially in cases of emergency [8–10]. In recent years, new options have become available to anesthetists, such as the Shikani optical stylet (SOS) and the GlideScope video laryngoscope (GVL), both of which have been shown to have advantages over the DL for improving the successful intubation rate and lowering the incidence of complications (fig. 1b, c). They may thus enhance perioperative safety, but whether or not they are clinically useful remains controversial [11–16].

The primary objective of this study was to compare three laryngoscopes: the DL, SOS and GVL, taking into account factors such as time to intubation and first-attempt success rate. The secondary objective was to determine whether or not the SOS and GVL could attenuate the hemodynamic response, including the change of mean artery pressure (MAP) and heart rate (HR) before and after intubation, and to compare complications, e.g. the incidence of dental, lip or mucosal trauma, postoperative sore throat or hoarseness, to those that occur with the DL in the tracheal intubation of thyroid tumor patients with a difficult airway.

Subjects and Methods

Ethical approval was obtained from the Hospital Ethics Committee and written informed consent from all the subjects. From June 2012 to October 2012, we enrolled 120 thyroid tumor patients (with goiter grades ≥2) undergoing elective surgery requiring general anesthesia. Patients were randomly allocated to 3 groups (with 40 patients in each) by the random number table method: group D underwent laryngoscopy with the DL, group S with the SOS and group G with the GVL. Inclusion criteria were: males and females between 35 and 60 years of age, a body weight of between 42 and 76 kg, BMI <30, an American Society of Anesthesiology physical status I–II and a comprehensive airway difficulty score >5 upon assessment (table 1) [17]. Exclusion criteria were: acute inflammation of the throat, a history of gastroesophageal reflux disease, hematological disease or drug allergy or abnormalities in the heart, lungs, liver or kidneys. Patients requiring rapid-sequence induction or emergency surgery and those considered for awake intubation were also excluded. A research assistant not involved in the study obtained presealed, numbered, opaque envelopes containing the randomized group allotments according to a computer-generated randomization table. All intubations were performed by one anesthetist (H.Y.), who is familiar with all three techniques and has extensive experience in using the devices in the difficult-airway scenario.

Patients ate no solid food for 12 h and did not drink liquids for 4 h before the operation. They were premedicated with atropine (0.05 $mg \cdot kg^{-1}$) intramuscularly 30 min before anesthesia. Routine monitoring was done before the induction of anesthesia, including heart rate (HR), saturation of pulse oxygenation, electrocardiography and blood pressure readings. The depth of sedation was monitored with a BIS monitor (Covidien, Dublin, Ireland), and radial arterial pressure was monitored by inserting a catheter into the radial artery. For the induction of anesthesia, all patients received propofol at 3.5–4.0 μg/ml via target-controlled infusion and the BIS value was reduced to <60. Sufentanil (0.3–0.5 $\mu g \cdot kg^{-1}$) and rocuronium (0.6 $mg \cdot kg^{-1}$) were administered intravenously. Patients were in a supine position with the head tilted back and the mouth fully open. One minute after the administration of rocuronium, tracheal intubation was performed with the DL, SOS or GVL. For the patients in group D, the DL was introduced along the palatopharyngeal arch, and

Table 2. Patient characteristics

	Age, years	Weight, kg	Height, cm	BMI	Sex (M/F)	ADS
Group D (n = 40)	60±15	68±9	168±9	22±5	22/18	5.9±1.1
Group S (n = 40)	61±14	71±12	170±7	23±4	20/20	6.1±0.9
Group G (n = 40)	60±16	72±10	172±8	23±5	22/18	6.0±1.0

ADS = Airway difficulty score.

Fig. 1. a A thyroid tumor with tracheal compression. **b** SOS. **c** GVL.

once the epiglottis was fully exposed, the intubation was performed with the aid of anterior cervical pressing. For the patients in group S, the SOS was preloaded with an endotracheal tube (ETT), the operator then lifted the patient's mandible and inserted the SOS (preloaded with an ETT) and advanced it medially and caudally until a 'light spot' (indicating the ETT tip) was visualized beneath the thyroid cartilage. The glottis and vocal cords were visualized via the eyepiece, and the SOS was advanced until the tracheal rings were visible. For the patients in group G, the GVL was slid to the left of the oral pharynx, allowing more room for the ETT to be inserted to its right side. The GVL was introduced and gently advanced until the blade tip was past the posterior portion of the tongue. With the aid of the video screen provided by the inserted scope, the best glottic view was obtained, and the ETT was inserted under direct vision until its distal tip was close to that of the laryngoscope blade. Finally, the ETT was advanced through the glottis and the intubation was completed. Failure to intubate was defined as the inability to place the ETT into the trachea after three attempts. If this situation occurred, intubation under the guidance of fibrobronchoscope was performed. For severe tachycardia (HR >100 beats/min for >60 s) associated with intubation, 30 mg esmolol was administered intravenously.

The MAP and HR immediately after the successful induction of anesthesia (T1), before the intubation (T2) and at 1 and 3 min after intubation (T3 and T4) were recorded before the surgical procedure. The time to intubation (i.e. the time from insertion of the laryngoscope to the appearance of an end-tidal carbon dioxide trace on the capnograph), the first-attempt success rate and the number of failures were also recorded. After the intubation, any cases of the following were recorded immediately: dental, lip or mucosal trauma (including any bleeding noted on the lips or oropharyngeal mucosa) and blood stains on the tracheal tube upon extubation. All patients were asked about a sore throat and hoarseness before their discharge from the postanesthesia care unit, and those who complained about these symptoms were followed up for 3 days postoperatively.

Statistical Analysis

SPSS 16.0 software was used for statistical analysis. Numerical variables are given as mean ± standard deviation (SD). For quantitative variables, statistical differences were analyzed using ANOVA, and categorical data were analyzed using the χ^2 test. A p value <0.05 was considered statistically significant.

Results

Patient demographic data in the 3 groups were statistically similar with regard to gender, age, weight, BMI and airway classification (all $p > 0.05$; table 2).

The mean (SD) time to intubation in group S and group G was 42.4 ± 24.1 s and 29.8 ± 22.3 s, respectively, i.e. significantly less than in group D (68.8 ± 26.6 s; all $p < 0.05$). The time to intubation in group G was less than in group S ($p < 0.05$). The intubation success rate was 100% in all 3 groups. The first-attempt success rate in

Table 3. Intubation data

	Time to intubate, s	First-attempt success rate, %
Group D (n = 40)	68.8±26.6	75.0
Group S (n = 40)	42.4±24.1*	90.0*
Group G (n = 40)	29.8±22.3*, #	97.5*

* $p < 0.05$, compared with group D. # $p < 0.05$, compared with group S.

Table 4. Cardiovascular responses

	T1	T2	T3	T4
Group D (n = 40)				
HR, beats/min	75.4±9.2	71.3±8.9	90.4±8.1*	73.5±9.1
MAP, kPa	12.3±0.8	11.8±0.9	16.6±1.2*	13.0±0.9
Group S (n = 40)				
HR, beats/min	74.2±8.8	71.1±8.4	76.4±9.2#	74.0±8.9
MAP, kPa	12.1±0.9	11.5±0.8	12.9±1.1#	12.0±0.8
Group G (n = 40)				
HR, beats/min	74.7±9.1	71.9±8.9	79.9±9.3*, #	73.9±9.2
MAP, kPa	12.2±0.8	11.6±0.9	13.0±0.9#	12.1±0.9

T1 = Immediately after successful induction of anesthesia; T2 = before intubation; T3 = at 1 min after intubation; T4 = at 3 min after intubation. * $p < 0.05$, compared with T1. # $p < 0.05$, compared with group D.

Table 5. Intubation-related complications

	Dental trauma	Lip or mucosal trauma	Sore throat	Hoarseness
Group D (n = 40)	5	50	50	5
Group S (n = 40)	0	0*	10*	0
Group G (n = 40)	0	10*, #	10*	0

All values are expressed as percentages. * $p < 0.05$, compared with group D. # $p < 0.05$, compared with group S.

group S and group G was 90.0% (36/40) and 97.5% (39/40), respectively, which was significantly higher than in group D [75.0% (30/40); all $p < 0.05$; table 3].

There was no difference in MAP and HR between groups immediately after the successful induction of anesthesia and at 3 min after intubation. However, both these values were significantly elevated at 1 min after intubation in group D (as well as the HR in group G) compared to immediately after the successful induction of anesthesia. The MAP and HR were lower in group S and group G than in group D at 1 min after intubation (all $p < 0.05$; table 4).

A lower incidence of lip or mucosal trauma and a sore throat after the surgery were noted in group S and group G, but not in group D (table 5), and this was lower in group S than in group G (all $p < 0.05$).

Discussion

We showed that both the SOS and GLV were better than the DL for intubation with regard to time to intubation and first-attempt success rate in thyroid tumor patients with a difficult airway. The cardiovascular responses and mucosal injuries when using the SOS or GLV were attenuated in comparison to when using the DL.

These advantages may be due to the visual aids afforded by the SOS and GLV. The SOS combines the features of a fiberoptic bronchoscope and a light wand. The wand is composed of a J-shaped malleable body, a lens and a light source at the tip and an optical eyepiece at the proximal end, and it can be used alone or combined with a camera or monitor [18, 19]. The GVL is equipped with a magnified screen and an antifog device, so it provides an improved, real-time view of the larynx and glottis [20, 21].

Our finding that both the SOS and GVL are better than DL is consistent with previous studies [11–16]. Equally important, in this study, intubation took longer with the DL than with the GVL, and we observed a higher incidence of complications with the DL compared to previous reports carried out in patients with a normal airway [11, 14]; it is possible that this was partially due to the adverse impact of the thyroid tumor. The observation that the time to intubation in group G was less than in group S could be due to the fact that, in a patient with a huge thyroid tumor, the light spot of the SOS gets blocked out by the tumor tissue, i.e. in this particular situation, the GLV was better than the SOS. On the other hand, the incidence of mucosal injury was lower in group S than in group G, consistent with a previous report [22]. A probable reason for this could be that, in patients with smaller mouths, the larger size of the GLV increases the difficulty of the intubation, with the laryngoscope in the mouth reducing the space for the ETT; in such cases, the SOS may indeed be preferable.

This study had several limitations. It was a single-center study. All the intubations were performed by the same anesthetist, so a bias may have occurred because it was not possible to blind this anesthetist to the device being used.

Conclusion

For the intubation of thyroid tumor patients with a difficult airway, both the SOS and GLV techniques displayed advantages with regard to time to intubation, first-attempt success rates, cardiovascular responses and mucosal injuries. Compared to the SOS, the GVL takes less time to intubate. The SOS has potentially lower risks of mucosal injury than the GLV.

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