



Relevance of radiological and clinical measurements in predicting difficult intubation using light wand (Surch-lite™) in adult patients

Joungmin Kim¹, Kyong Shil Im²,
Jae Myeong Lee², Jaehun Ro², Kyung Yeon Yoo¹
and Jong Bun Kim²

Abstract

Objective: To determine the correlation between anatomical features of the upper airway (evaluated via computed tomography imaging) and the ease of light wand-assisted endotracheal intubation in patients undergoing ear, nose and throat surgery under general anaesthesia.

Methods: Mallampati class, laryngoscopic grade, thyromental distance, neck circumference, body mass index, mouth opening and upper lip bite class were assessed. Epiglottis length and angle, tongue size and narrowest pharyngeal distance were determined using computed tomography imaging. Intubation success rate, time to successful intubation (intubating time) and postoperative throat symptoms were documented.

Results: Of 152 patients, 148 (97.4%) were successfully intubated on the first attempt (mean intubating time 11.5 ± 6.7 s). Intubating time was positively correlated with laryngoscopic grade and body mass index in both male and female patients, and Mallampati class and neck circumference in male patients. Epiglottis length was positively correlated with intubating time.

Conclusions: Ease of intubation was influenced by epiglottis length. Radiological evaluation may be useful for preoperative assessment of patients undergoing endotracheal intubation with light wand.

Keywords

Epiglottis, Intubation, Light wand, Tongue

Date received: 15 February 2015; accepted: 10 June 2015

Introduction

Direct laryngoscopy is the standard method of tracheal intubation but it is either difficult or impossible to perform in 5.8% of

¹Department of Anaesthesiology and Pain Medicine, Chonnam National University Hospital, Gwangju, Republic of Korea

²Department of Anaesthesiology and Pain Medicine, Uijeongbu St. Mary's Hospital College of Medicine, The Catholic University of Korea, Seoul, Republic of Korea

Corresponding author:

Jong Bun Kim, Department of Anaesthesiology and Pain Medicine, Uijeongbu St Mary's Hospital College of Medicine, The Catholic University of Korea, 222 Banpo-daero, Seocho-gu, Seoul 137-701, Republic of Korea.
Email: jbkim@catholic.ac.kr



apparently normal individuals,¹ particularly in unprepared patients or those requiring emergency intubation.² There is currently no method of airway assessment that can reliably predict difficult laryngoscopic intubation, however.^{3,4}

Blind oral tracheal intubation using the transillumination technique with a light wand is simple, rapid and effective;^{5,6} it also results in fewer dental injuries than endotracheal intubation.³ This approach does not require visualization of the vocal cords and is particularly useful in patients with difficult airways, whether the difficulty was anticipated or not.⁷⁻¹⁰ In patients with high Mallampati class, a light wand was found to have a higher rate of intubation success and shorter intubating time than direct laryngoscopic intubation.⁸ The light wand is useful in cases of limited cervical motion, and may be an alternative to fiberoptic bronchoscopic intubation.^{9,10} Although light wand-guided intubation can be performed quickly and easily, the failure rate for a first intubation attempt is 28%;⁴ it should thus be avoided in patients with known abnormalities of the upper airway.¹¹

It is unclear whether airway parameters that predict difficult laryngoscopic intubation can also be applied to light wand intubation. In the case of light wand intubation, obesity (body mass index [BMI] ≥ 30 kg/m²) and Mallampati class III airway have been shown to predict prolonged intubating time in patients with no known airway abnormalities.¹² There was no apparent correlation between the laryngoscopic view and either orotracheal intubation¹³ or nasotracheal intubation success rate, however.¹⁴

Epiglottis length and tongue size (both measured radiologically) are used to predict difficulties in fiberoptic orotracheal intubation,¹⁵ and may also be relevant to light wand intubation.¹⁶ There are no studies that have investigated which airway anatomical features are associated with difficulties in

light wand intubation in adults, however. The aim of the present study was to determine the correlation between anatomical features of the upper airway (evaluated via computed tomography [CT] imaging) and the ease of light wand intubation in patients undergoing ear, nose and throat (ENT) surgery under general anaesthesia.

Patients and methods

Study population

The study recruited adult patients (aged ≥ 20 years) with American Society of Anesthesiologists physical status I or II (<https://www.asahq.org/resources/clinical-information/asa-physical-status-classification-system>), who were scheduled to undergo ENT surgery with endotracheal intubation at the Department of Anaesthesiology and Pain Medicine, Uijeongbu St Mary's Hospital College of Medicine, The Catholic University of Korea, Seoul, Republic of Korea, between October 2012 and February 2014. Exclusion criteria were: known upper airway abnormalities (tumours, polyps, infections); history of neck surgery; morbid obesity (BMI ≥ 35 kg/m²); significant cardiorespiratory disease.

The ethics committee of Uijeongbu St Mary's Hospital College of Medicine, The Catholic University of Korea approved the study; and all patients provided written informed consent prior to enrolment.

Study parameters

The airway was evaluated at the preoperative visit, and the following parameters were recorded: modified Mallampati class with the patient's mouth wide open, head slightly extended and tongue maximally forward with phonation in the sitting position;¹⁷ mouth opening (distance between first incisors, with mouth fully opened); thyromental distance (distance between thyroid notch and lower border of the mandibular mentum, with head fully extended); neck

circumference at thyroid notch level; any neck motion limitation.

The upper lip bite test was performed and classified as: I (lower incisors can bite the upper lip above the vermilion line); II (lower incisors can bite the upper lip below the vermilion line); III (lower incisors cannot bite the upper lip).¹⁸ Patient age, sex, height, weight and BMI were recorded.

Patients were stratified into groups according to the following criteria: BMI ($<25\text{kg/m}^2$, $\geq 25\text{kg/m}^2$ to $<30\text{kg/m}^2$, $\geq 30\text{kg/m}^2$); neck circumference ($<40\text{cm}$, $\geq 40\text{cm}$); Mallampati class (I, II, III); laryngoscopic grade (1, 2, 3, 4); upper lip bite class (I, II, III). Overweight and obesity were classified according to the Centers for Disease Control and Prevention definition (<http://www.cdc.gov/obesity/adult/defining.html>).

All patients underwent routine preoperative CT scanning of the paranasal sinus or scout film of the temporal bone. CT scans were analysed by one investigator, blinded to possible intubation difficulties. Epiglottis length (tip of epiglottis to vallecula), tongue length (tip of tongue to vallecula), tongue height (from length line to highest portion of the tongue) and pharyngeal gap (narrowest pharyngeal dimension defined anteriorly by the posterior wall of the epiglottis and posteriorly by the posterior pharyngeal wall) were measured digitally on soft copies of scout views of temporal bone CT or sagittal views of paranasal sinus CT. Epiglottic angle was described as the angle between the perpendicular line subtended from the vallecula and the line subtended from the posterior wall of the epiglottis. Tongue size was calculated as its length \times height (Figure 1).

Anaesthesia and intubation

None of the patients received premedication. Routine monitoring included electrocardiogram, noninvasive blood pressure and pulse oximetry. Patients were placed in the

sniffing position with a 10-cm pillow under the head. Anaesthesia was induced with 2mg/kg propofol and $1.0\text{--}1.5\ \mu\text{g/kg}$ fentanyl, after preoxygenation with 100% oxygen for 3 min. After loss of eyelash reflex, 0.6mg/kg rocuronium was administered intravenously. The lungs were manually ventilated by face mask with 3–4% sevoflurane in 100% oxygen, with fresh gas flow of 6l/min .

After muscle relaxation, laryngoscopy grade was determined in all patients via direct laryngoscopy using a Macintosh no. 3 blade. Laryngeal view was graded without external laryngeal pressure according to the Cormack classification as: grade I (complete visualization of the vocal cords); grade II (visualization of the inferior portion of the glottis); grade III (visualization of the epiglottis only); grade IV (inability to visualize the epiglottis).¹⁹ Patients were ventilated by mask for 1 min after assessing laryngoscopic view in order to prevent hypoxaemia.

An experienced anaesthetist (J.K.) who was blinded to patients' radiological measurements performed all tracheal intubations using a well-lubricated endotracheal tube placed over a light wand (Surch-liteTM; Aaron Medical, St Petersburg, FL, USA). The light source was placed at the level of the endotracheal tube tip, and the distal end of the wand and covering tube were bent to 90° at 7cm from the tip.²⁰ A size 7 endotracheal tube was used for women and a size 8 tube for men, regardless of body weight. Operating room lights were dimmed during intubation to assist visualization of transillumination. The jaw was lifted forwards with the left hand of the intubating anaesthetist, and the light wand and tube were passed down the midline of the tongue using the right hand. The cuff of the endotracheal tube was then inflated with air and intubation was confirmed by both auscultation of breath sounds and detection of carbon dioxide by the capnograph. All patients were mechanically ventilated with 2–3%

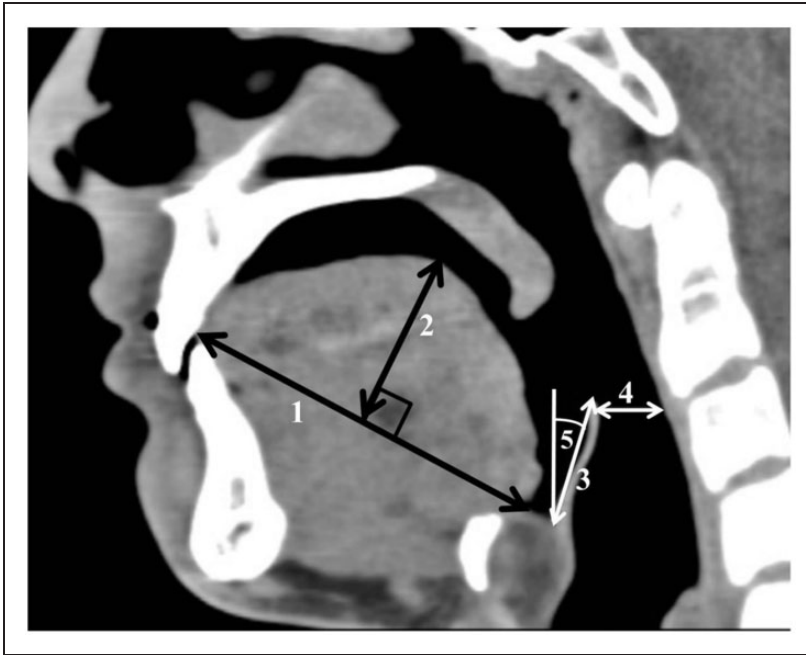


Figure 1. Sagittal computed tomography image of the paranasal sinus indicating the measurements used in the study. 1, tongue length; 2, tongue height; 3, epiglottis length; 4, pharyngeal gap; 5, epiglottic angle (angle between a perpendicular line subtended from the vallecula and the line subtended from the posterior wall of the epiglottis)

sevoflurane in air/oxygen and received continuous remifentanyl infusion.

The time to intubation (intubating time) and numbers of attempts and failures were recorded. Intubating time was defined as the interval from the device touching the patient's lip to complete unthreading of the light wand. A maximum of two attempts, each lasting ≤ 30 s, was allowed; the 30-s time limit was adopted because intubation using light wand is successful within 30s in 95% of patients.^{7,8,12} Patients were ventilated with 100% oxygen by mask between intubation attempts. If tracheal intubation was unsuccessful after two attempts, intubation was achieved using conventional laryngoscopy.

Postoperative assessment

The presence and severity of sore throat, hoarseness and dysphagia were assessed at

18–24h postoperatively. Symptom grading was: sore throat (0, none; 1, less severe than with a cold; 2, like a cold; 3, more severe than with a cold); hoarseness (0, none; 1, noticed by patient; 2, obvious to observer; 3, aphonia); dysphagia (0, none; 1, painful with certain foods; 2, painful with all food and drink; 3, unable to swallow own secretions).²¹ All complications were recorded.

Statistical analyses

The sample size calculation was based on the difference in intubating time (26.4 ± 12.1 s) in a pilot study of 12 patients (unpublished data). We assumed that the difference in intubating time was clinically significant if > 5.5 s. Power analysis indicated that a sample size of 76 patients in each group should be adequate to detect a difference between the two groups, with a two-sided

Table 1. Demographic and anatomical data of patients undergoing ear, nose and throat surgery under general anaesthesia included in a study to determine the correlation between anatomical features of the upper airway and the ease of light wand-assisted endotracheal intubation.

Characteristic	All patients <i>n</i> = 152	Male patients <i>n</i> = 107	Female patients <i>n</i> = 45
Age, years	42.3 ± 12.5	39.7 ± 12.8*	45.0 ± 11.8
Height, cm	168.8 ± 8.1	173.0 ± 5.6**	159.6 ± 5.2
Weight, kg	68.4 ± 12.2	72.5 ± 11.2**	58.7 ± 8.4
Body mass index, kg/m ²	23.9 ± 3.3	24.2 ± 3.3*	22.9 ± 3.3
Neck circumference, cm	37.5 ± 3.7	39.1 ± 2.8**	33.7 ± 2.3
Thyromental distance, cm	8.5 ± 1.0	8.8 ± 0.9**	7.8 ± 1.0
Mouth opening, cm	5.1 ± 0.6	5.3 ± 0.6**	4.7 ± 0.5
Tongue height, mm	36.3 ± 4.3	37.8 ± 3.8**	32.8 ± 3.6
Tongue length, mm	67.6 ± 5.6	69.1 ± 5.4**	64.0 ± 4.5
Tongue size, mm ²	2463.6 ± 404.8	2614.7 ± 344.6**	2104.5 ± 298.4
Epiglottis length, mm	19.5 ± 2.7	20.7 ± 2.1**	16.7 ± 1.9
Epiglottic angle, degrees	31.2 ± 8.8	32.1 ± 8.5*	29.0 ± 9.3
Pharyngeal gap, mm	6.0 ± 2.3	6.2 ± 2.4	5.5 ± 2.1

Data presented as mean ± SD.

**P* < 0.05 versus female patients;

***P* < 0.01 versus female patients; independent samples *t*-test.

significance level of $\alpha = 0.05$ and a power of 0.8.

Data were presented as mean ± SD or *n* (%) of patients. Demographic data were analysed using an independent samples *t*-test, and radiological measurements in relation to intubating time were compared using univariate linear regression analysis. The correlation between Mallampati class and laryngoscopic grade was analysed by Spearman's rank correlation coefficient. Intubating times within groups were analysed using Kruskal–Wallis one-way analysis of variance on ranks, and intubating times for each variable were analysed using Pearson's and Spearman's rank correlation coefficients. The incidence and severity of sore throat were analysed using the Mann–Whitney U test and Fisher's exact test. All statistical analyses were performed using SPSS® version 13.0 (SPSS Inc., Chicago, IL, USA) for Windows®. *P*-values < 0.05 were considered statistically significant.

Results

The study enrolled 153 patients, one of whom was excluded following cancellation of surgery. The final analysis therefore included 152 (107 male/45 female; mean age 42.3 ± 12.5 years; age range 20–65 years). Demographic and anatomical data for the patients are shown in Table 1.

The 30-s time limit for intubating was exceeded in two patients, and oesophageal intubation occurred in two patients; all four of these patients were successfully intubated on the second attempt. Three of the four patients were overweight/obese (i.e., BMI ≥ 25 kg/m²). First-attempt and overall tracheal intubation success rates were 148/152 (97.4%) and 152/152 (100%), respectively. Mean time to successful intubation on the first attempt and overall intubating time were 11.5 ± 6.7s and 12.4 ± 8.7s, respectively.

There was a statistically significant relationship between laryngoscopic grade and Mallampati class (*P* < 0.0001; Table 2).

Table 2. Relationship between Mallampati class¹⁷ and laryngoscopic grade¹⁹ in patients undergoing ear, nose and throat surgery under general anaesthesia ($n = 152$).

Mallampati class	Laryngoscopic grade				Total
	1	2	3	4	
I	61 (40.1)	28 (18.4)	5 (3.2)	0 (0)	94 (61.8)
II	16 (10.5)	29 (19.0)	0 (0)	1 (0.6)	55 (36.1)
III	0 (0)	0 (0)	3 (2.0)	0 (0)	3 (1.9)
Total	77 (50.6)	57 (37.5)	17 (11.1)	1 (0.6)	152 (100)

Data presented as n (%) of patients.

There was significant correlation between Mallampati class and laryngoscopic grade ($P < 0.0001$); Spearman's rank correlation coefficient.

Data regarding intubating time in the patient groups stratified according to BMI, neck circumference, Mallampati class and laryngoscopic grade are shown in Table 3. Intubating time was significantly longer with increasing laryngoscopic grade, Mallampati class, BMI and neck circumference ($P < 0.05$ for each comparison; Table 3).

Data regarding the association between intubating time and radiologically assessed anatomical features of the upper airway are depicted in Table 4. There was a significant positive correlation between epiglottis length and intubating time ($\beta = 0.488 \pm 0.198$, $P = 0.015$). No other parameter was associated with intubating time.

Table 5 shows the correlations between intubating time and anatomical parameters. There were significant positive correlations between intubating time and epiglottis length, laryngoscopic grade, Mallampati class, BMI and neck circumference in the total study population, and in male patients ($P < 0.05$ for all correlations). In female patients, there was a significant positive correlation between laryngoscopic grade and BMI, and a significant negative correlation between thyromental distance and intubating time ($P < 0.05$ for all correlations). There were no correlations between intubating time and epiglottic angle, tongue size, pharyngeal gap, mouth opening or upper lip bite class in the study

population as a whole, or when stratified according to sex.

There were no correlations between intubating time and the incidence and severity of sore throat, hoarseness or dysphagia (Table 6).

Discussion

Radiological assessment of airway anatomical characteristics determined that epiglottis length was correlated with intubating time in the present study. Both laryngoscopic grade and BMI were correlated with intubating time in male and female patients, and there were significant correlations between intubating time and Mallampati class and neck circumference in male patients. Epiglottic angle, tongue size, pharyngeal gap, mouth opening and upper lip bite class were not associated with intubating time in male or female patients.

Anaesthetic induction affects muscle tone, resulting in a degree of upper airway obstruction ranging from narrowing to complete obstruction, which may hinder manoeuvrability of a light wand.²² Use of a jaw lift (as in the present study) elevates the epiglottis and enhances the passage of the intubation tube/light wand.¹⁶ It is possible that a long epiglottis may prevent the free advancement of the tube into the trachea, even with the use of a jaw lift. A study of 76

Table 3. Time taken to successful first-attempt light wand-assisted endotracheal intubation^a in patients undergoing ear, nose and throat surgery under general anaesthesia ($n = 152$).

Group	N	Intubating time, s
Body mass index, kg/m ²		
<25	107	9.5 ± 4.9 (3.3–28.2)
≥25 to < 30	33	16.1 ± 7.8 ^b (5.2–29.7)
≥30	8	19.1 ± 8.1 ^b (8.2–27.3)
Neck circumference, cm		
<40	109	9.6 ± 5.3 (3.3–28.3)
≥40	39	16.8 ± 7.2 ^c (4.4–29.7)
Mallampati class ¹⁷		
I	92	10.1 ± 5.5 (3.3–29.7)
II	53	11.4 ± 7.8 ^d (3.4–29.4)
III	3	11.4 ± 5.4 (6.3–17.1)
Laryngoscopic grade ¹⁹		
I	76	8.7 ± 4.8 (3.3–28.2)
2	56	13.7 ± 7.0 ^e (4.3–29.7)
3	16	17.2 ± 7.1 ^e (6.3–28.3)
4	0	–
Upper lip bite class ¹⁸		
I	124	11.7 ± 7.0 (3.3–27.7)
II	23	11.0 ± 4.5 (4.2–20.8)
III	1	5.6

Data presented as mean ± SD (range).

^aThe interval from device touching the patient's lip to complete unthreading of the light wand.

^b $P < 0.05$ versus body mass index <25 kg/m²;

^c $P < 0.05$ versus neck circumference < 40 cm;

^d $P < 0.05$ versus Mallampati class I;

^e $P < 0.05$ versus laryngoscopic grade I; Kruskal–Wallis one-way analysis of variance.

patients undergoing light wand intubation with jaw lift found that the epiglottis was deviated in five patients (6.6%) and enfolded in one (1.3%), even when intubation was successful.¹⁶

Although a long epiglottis significantly prolonged the time required for successful intubation in the present study, all of our

Table 4. Univariate linear regression analysis of the association between anatomical features of the upper airway (evaluated via computed tomography imaging) and the time taken to successful first-attempt light wand-assisted endotracheal intubation^a in patients undergoing ear, nose and throat surgery under general anaesthesia ($n = 152$).

Parameter	$\beta \pm SE$	Statistical significance
Tongue height	0.028 ± 0.128	NS
Tongue length	0.159 ± 0.100	NS
Tongue size	0.001 ± 0.001	NS
Epiglottis length	0.488 ± 0.198	$P = 0.015$
Epiglottic angle	−0.020 ± 0.062	NS
Pharyngeal gap	0.201 ± 0.236	NS

NS, not statistically significant ($P \geq 0.05$); linear regression analysis.

^aThe interval from device touching the patient's lip to complete unthreading of the light wand.

patients were successfully intubated, in accordance with the findings of others.^{7,8,13} Moreover, there was no correlation between intubating time and any other radiologically assessed airway parameter (epiglottic angle, tongue size and pharyngeal gap) in the present study. We performed CT imaging with the patients awake and in the supine position, without jaw lifting. It is therefore possible that the position of the epiglottis and tongue in relation to the pharynx, as revealed by these scans, would differ from that occurring under general anaesthesia. However, even in cases where the epiglottis falls on the posterior pharyngeal wall, the tip of the light wand can be placed at the glottic opening when guided from the lateral posterior side through the piriform fossa.⁵ Our findings are in accordance with others who showed that, in contrast to laryngoscopy, the ease of light wand-assisted intubation did not appear to be influenced by anatomical variations in the upper airway.³ In a study of 265 patients who experienced difficult intubation, all patients were successfully intubated using a light wand.⁷

Table 5. Correlation between anatomical parameters and time taken to successful first-attempt light wand-assisted endotracheal intubation^a in patients undergoing ear, nose and throat surgery under general anaesthesia.

Parameter	All patients n = 152		Male patients n = 107		Female patients n = 44	
	r	P	r	P	r	P
Epiglottis length	0.200	0.015	0.207	0.035	-0.175	NS
Epiglottic angle	-0.027	NS	0.000	NS	-0.212	NS
Tongue size	0.076	NS	0.021	NS	-0.178	NS
Pharyngeal gap	0.070	NS	0.046	NS	0.084	NS
Laryngoscopic grade ¹⁹	0.458	<0.001	0.380	<0.001	0.355	0.004
Mallampati class ¹⁷	0.250	0.002	0.272	0.001	0.082	NS
Body mass index	0.537	<0.001	0.520	<0.001	0.547	<0.001
Neck circumference	0.502	<0.001	0.610	<0.001	0.252	NS
Thyromental distance	-0.030	NS	-0.050	NS	-0.312	0.039
Mouth opening	-0.006	NS	-0.096	NS	-0.049	NS
Upper lip bite class ¹⁸	-0.066	NS	-0.030	NS	0.042	NS

NS, not statistically significant ($P \geq 0.05$).

Spearman's rank correlation coefficient for laryngoscopic grade and Mallampati class, Pearson's correlation coefficient for all other measurements.

^aThe interval from device touching the patient's lip to complete unthreading of the light wand.

The Cormack and Lehane classification of laryngoscopic view is frequently used to predict a difficult laryngoscopy.¹⁹ Intubating time was longer in patients with high laryngoscopic grade in the present study, regardless of sex. Other studies have found no correlation between high laryngoscopic grade and orotracheal intubation¹³ or nasotracheal intubation success rates.¹⁴ These studies placed the patient's head and neck in a neutral or relatively extended position, in contrast to the present study where the head was placed in the sniff position with jaw lift. In a sniff position, the epiglottis is almost in contact with the posterior pharyngeal wall, making it difficult for the light wand to pass underneath the epiglottis.¹¹ The discrepancy between these studies and our study may, in part, be accounted for by the different head position during the intubation.

Mallampati class was significantly correlated with intubating time in the present

study. This finding is in accordance with others, who reported that Mallampati class is a good indicator of ease of light wand intubation in patients without known airway abnormality.¹² In contrast, a further study reported no correlation between Mallampati class and ease of light wand intubation in patients without known or potential problems relating to intubation.³ Mallampati class is a valuable estimate of tongue size relative to the capacity of the oropharynx,²³ and was modified to reliably predict difficult laryngoscopy with the patient sitting, head in extension, tongue out and with phonation.¹⁷ Differences in the methods used to assess Mallampati class may explain the discrepancies between different study findings. Alternatively, these differences may be due to variation in the definition of intubating time. The present study defined the beginning of intubation as the moment when the device touched the patient's lip, whereas Hung et al³ used the

Table 6. Throat discomfort parameters following light wand-assisted endotracheal intubation in patients undergoing ear, nose and throat surgery under general anaesthesia, stratified according to intubating time^a

Parameter	Intubating time, s	
	< 15 n = 115	≥ 15 n = 33
Sore throat grade ^b		
0	49 (42.6)	13 (39.4)
1	44 (36.5)	12 (36.3)
2	20 (17.3)	5 (15.1)
3	2 (1.7)	3 (9.1)
Hoarseness grade ^c		
0	73 (63.4)	19 (57.5)
1	30 (26.1)	12 (36.3)
2	12 (10.4)	2 (6.1)
3	0 (0.0)	0 (0.0)
Dysphagia grade ^d		
0	102 (88.7)	27 (81.8)
1	11 (9.5)	4 (12.1)
2	2 (1.7)	2 (6.1)
3	0 (0.0)	0 (0.0)

Data presented as n (%) of patients.

No statistically significant between-group differences ($P \geq 0.05$); Mann–Whitney U test.

^aThe interval from device touching the patient's lip to complete unthreading of the light wand.

^bSore throat: 0, none; 1, less severe than with a cold; 2, like a cold; 3, more severe than with a cold.

^cHoarseness: 0, none; 1, noticed by patient; 2, obvious to observer; 3, aphonia.

^dDysphagia: 0, none; 1, painful with certain foods; 2, painful with all food and drink; 3, unable to swallow own secretions.

point when the device was inserted into the hypopharynx – this may have meant that the time-consuming part of intubation in patients with a large tongue was excluded, resulting in a similar intubation time in patients with or without hindrance from the tongue.

Being overweight or obese (i.e., $BMI \geq 25 \text{ kg/m}^2$) significantly increased intubating time in the present study. In accordance with our findings, others have noted failure of light wand-assisted intubation in overweight or obese patients.^{3,7,24} Intubation using the

Surch-lite™ requires visualization of a central bright transillumination glow through the anterior neck rather than visualization of the laryngeal structure. Magnetic resonance imaging of fat deposits around the upper airway in obese patients revealed that these fat deposits were anterior to the laryngopharyngeal air-space and in submental regions.²⁵ It is expected, therefore, that intubating time would be prolonged with increasing BMI, because the increased fat deposits in the neck mask the light, and thereby increase the time taken to visualize the transillumination.²⁶ Patients with severe obesity ($BMI \geq 35 \text{ kg/m}^2$) were therefore excluded from the present study.

Neck circumference is significantly correlated with visceral abdominal and neck fat.²⁷ Light wand-guided intubation has been shown to be difficult in obese patients and in those with short, thick necks.²⁸ These problems may be overcome by using simple steps, such as extending the neck by placing a support under the shoulder, using a brighter light source, and switching off or dimming the operating room lights when necessary.^{6,7,11} Transillumination of the light wand at the neck can also be enhanced by adjustment of the bent length or angle of the light wand against the wall of the trachea.²⁰

Sore throat and hoarseness are common complaints after laryngoscopy and endotracheal intubation.²¹ Since light wand-guided intubation is performed without visualization of the laryngeal structures, it would be expected to result in airway complications more frequently than laryngoscopic intubation. Sore throat has been shown to occur less frequently after light wand-guided intubation than laryngoscopic intubation (17.1% versus 25.3%), however,³ thus suggesting that the former is less traumatic than the latter. The incidence of throat discomfort was higher in the present study than in other studies;³ this is because we included mild degrees of discomfort, most of which would not have been regarded as true symptoms in routine practice. The incidence

of more severe symptoms (grade 2/3) in our study was comparable with the findings of others.²⁹ We found no relationship between intubating time and the incidence and severity of throat discomfort symptoms.

The current study has several limitations. First, the epiglottis is concave and round but was measured as a straight line, meaning its true length may not have been represented. Secondly, a reduction in light intensity may affect the success rate of light wand intubation, but we did not adjust the intensity of the light bulb. Thirdly, we excluded patients with known upper airway abnormalities because these are absolute contraindications to the blind light wand technique.⁶ As a result, our findings may not be applicable to patients with known abnormalities. Finally, all intubations were performed by a single anaesthetist, and our data may therefore be biased towards the expertise of that operator. Patients were unintentionally sampled so that the likelihood of a difficult airway was dispersed throughout the study period, however. In addition, the anaesthetist was very experienced in light wand intubation.

In conclusion, the ease of intubation using a light wand (Surch-liteTM) is influenced by epiglottis length. In addition, high laryngoscopic grade and high BMI in male and female patients, and high Mallampati class and neck circumference in male patients, may complicate light wand-guided tracheal intubation. Radiological evaluation may be useful for preoperative assessment of patients undergoing endotracheal intubation with light wand.

Declaration of conflicting interest

The authors declare that there are no conflicts of interest.

Funding

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

References

1. Shiga T, Wajima Z, Inoue T, et al. Predicting difficult intubation in apparently normal patients: a meta-analysis of bedside screening test performance. *Anesthesiology* 2005; 103: 429–437.
2. Schwartz DE, Matthay MA and Cohen NH. Death and other complications of emergency airway management in critically ill adults. A prospective investigation of 297 tracheal intubations. *Anesthesiology* 1995; 82: 367–376.
3. Hung OR, Pytka S, Morris I, et al. Clinical trial of a new lightwand device (Trachlight) to intubate the trachea. *Anesthesiology* 1995; 83: 509–514.
4. Ellis DG, Jakymec A, Kaplan RM, et al. Guided orotracheal intubation in the operating room using a lighted stylet: a comparison with direct laryngoscopic technique. *Anesthesiology* 1986; 64: 823–826.
5. Inoue Y. Lightwand intubation can improve airway management. *Can J Anaesth* 2004; 51: 1052–1053.
6. Davis L, Cook-Sather SD and Schreiner MS. Lighted stylet tracheal intubation: a review. *Anesth Analg* 2000; 90: 745–756.
7. Hung OR, Pytka S, Morris I, et al. Lightwand intubation: II—Clinical trial of a new lightwand for tracheal intubation in patients with difficult airways. *Can J Anaesth* 1995; 42: 826–830.
8. Rhee KY, Lee JR, Kim J, et al. A comparison of lighted stylet (Surch-Lite) and direct laryngoscopic intubation in patients with high Mallampati scores. *Anesth Analg* 2009; 108: 1215–1219.
9. Turkstra TP, Craen RA, Pelz DM, et al. Cervical spine motion: a fluoroscopic comparison during intubation with lighted stylet, GlideScope, and Macintosh laryngoscope. *Anesth Analg* 2005; 101: 910–915.
10. Rehman MA and Schreiner MS. Oral and nasotracheal light wand guided intubation after failed fiberoptic bronchoscopy. *Paediatr Anaesth* 1997; 7: 349–351.
11. Agrò F, Hung OR, Cataldo R, et al. Lightwand intubation using the Trachlight: a brief review of current knowledge. *Can J Anaesth* 2001; 48: 592–599.

12. Wong SY, Coskunfirat ND, Hee HI, et al. Factors influencing time of intubation with a lightwand device in patients without known airway abnormality. *J Clin Anesth* 2004; 16: 326–331.
13. Ainsworth QP and Howells TH. Transilluminated tracheal intubation. *Br J Anaesth* 1989; 62: 494–497.
14. Manabe Y, Seto M, Iwamoto S, et al. The success rate of nasotracheal intubation using lightwand does not depend on the laryngoscopic view. *J Anesth* 2011; 25: 350–355.
15. Randell T, Hakala P, Kyttä J, et al. The relevance of clinical and radiological measurements in predicting difficulties in fiberoptic orotracheal intubation in adults. *Anaesthesia* 1998; 53: 1144–1147.
16. Goneppanavar U, Nair A and Kini G. Jaw lift causes less laryngeal interference during lightwand-guided intubation than combined jaw and tongue traction applied by single operator. *Indian J Anaesth* 2011; 55: 154–159.
17. Lewis M, Keramati S, Benumof JL, et al. What is the best way to determine oropharyngeal classification and mandibular space length to predict difficult laryngoscopy? *Anesthesiology* 1994; 81: 69–75.
18. Khan ZH, Kashfi A and Ebrahimkhani E. A comparison of the upper lip bite test (a simple new technique) with modified Mallampati classification in predicting difficulty in endotracheal intubation: a prospective blinded study. *Anesth Analg* 2003; 96: 595–599.
19. Cormack RS and Lehane J. Difficult tracheal intubation in obstetrics. *Anaesthesia* 1984; 39: 1105–1111.
20. Chen J, Luo W, Wang E, et al. Optimal bent length of lightwand for intubation in adults: a randomized, prospective, comparative study. *J Int Med Res* 2012; 40: 1519–1531.
21. Stout DM, Bishop MJ, Dwersteg JF, et al. Correlation of endotracheal tube size with sore throat and hoarseness following general anesthesia. *Anesthesiology* 1987; 67: 419–421.
22. Shorten GD, Opie NJ, Graziotti P, et al. Assessment of upper airway anatomy in awake, sedated and anaesthetised patients using magnetic resonance imaging. *Anaesth Intensive Care* 1994; 22: 165–169.
23. Mallampati SR, Gatt SP, Gugino LD, et al. A clinical sign to predict difficult tracheal intubation; a prospective study. *Can Anaesth Soc J* 1985; 32: 429–434.
24. Nishiyama T, Matsukawa T and Hanaoka K. Optimal length and angle of a new lightwand device (Trachlight). *J Clin Anesth* 1999; 11: 332–335.
25. Horner RL, Mohiaddin RH, Lowell DG, et al. Sites and sizes of fat deposits around the pharynx in obese patients with obstructive sleep apnoea and weight matched controls. *Eur Respir J* 1989; 2: 613–622.
26. Ezri T, Gewürtz G, Sessler DI, et al. Prediction of difficult laryngoscopy in obese patients by ultrasound quantification of anterior neck soft tissue. *Anaesthesia* 2003; 58: 1111–1114.
27. Li HX, Zhang F, Zhao D, et al. Neck circumference as a measure of neck fat and abdominal visceral fat in Chinese adults. *BMC Public Health* 2014; 14: 311.
28. Umesh G, Mathew G and Ramkumar V. Trachlight - more practical solutions to commonly encountered problems. *Can J Anaesth* 2007; 54: 398–399.
29. Friedman PG, Rosenberg MK and Lebenbom-Mansour M. A comparison of light wand and suspension laryngoscopic intubation techniques in outpatients. *Anesth Analg* 1997; 85: 578–582.