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Indirect laryngoscopic assessment for the diagnosis of difficult intubation in patients undergoing microlaryngeal surgery

Meltem Türkay · Tülin Şentürk · Birsen Yigit Arslan · Hacer Yeter · Mehmet Salih Sevdi · Salih Aydın · Ismail Gergin · Kerem Erkalp

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Summary
Background The aim of this study is to investigate the feasibility of using indirect laryngoscopy for the diagnosis of difficult intubations in patients who are undergoing microlaryngeal surgery.

Methods In the pre-anesthetic examination the thyromental distance, sternomental distance, interincisor distance, neck circumference, modified Mallampati scores, and Wilson risk scores were measured. An otolaryngologist conducted an indirect laryngoscopic assessment. Direct laryngoscopic profiles were classified according to their Cormack–Lehane scores.

Results Forty patients underwent microlaryngeal surgery. Their mean ages, neck circumferences, Cormack–Lehane scores of the patients who had intubation difficulties were statistically significantly higher than those who did not have intubation difficulties ($p<0.05$). The significant differences between the indirect laryngoscopic assessment distributions of patients who either had or did not have intubation difficulty were assessed ($p<0.05$).

Conclusions Indirect laryngoscopic assessment is a simple and valuable technique that can be used for the diagnosis of difficult intubation in patients who are undergoing microlaryngeal surgery.

M. Türkay (✉) · B. Y. Arslan · H. Yeter · M. S. Sevdi · I. Gergin · K. Erkalp
Department of Anesthesiology and Reanimation,
Bagcılar Training and Research Hospital,
34200 Bagcilar, Istanbul, Turkey
e-mail: meltem72_3@hotmail.com

T. Şentürk · S. Aydın
Department of Otorhinolaryngology,
Bagcılar Training and Research Hospital,
Istanbul, Turkey

Keywords Indirect laryngoscopy · Difficult airway · Microlaryngeal surgery

Indirekte laryngoskopische Untersuchung für die Diagnostik von schwierigen Intubationen bei Patienten, die sich einer Mikrolaryngoskopie unterziehen

Zusammenfassung
Grundlagen Ziel dieser Studie war es, zu untersuchen, inwiefern die Verwendung der indirekten Laryngoskopie für die Diagnostik von schwierigen Intubationen bei Patienten, die sich einer Mikrolaryngoskopie unterziehen, geeignet ist.

Methodik Im Laufe der voranästhetischen Untersuchung wurden die thyromentale Distanz, die sternomentale Distanz, der Schneidezahnabstand, der Genickumfang und die angepassten Mallampati-Scores sowie die Wilson-Risiko-Scores gemessen. Ein Otolaryngologe hat eine indirekte Laryngoskopie durchgeführt. Direkte laryngoskopische Profile wurden anhand ihres Cormack-Lehane-Scores eingestuft.

Ergebnisse Vierzig Patienten haben sich einer Mikrolaryngoskopie unterzogen. Das Durchschnittsalter, der durchschnittliche Genickumfang und die Cormack-Lehane-Scores der Patienten, die Intubationsschwierigkeiten hatten, waren statistisch betrachtet erheblich höher als die der Patienten, die keine solche Schwierigkeiten hatten ($p < 0{,}05$). Die signifikanten Unterschiede zwischen den Ergebnisverteilungen der indirekten laryngoskopischen Untersuchung für Patienten, die jeweils Intubationsschwierigkeiten hatten bzw. nicht hatten, wurden ausgewertet ($p < 0{,}05$).

Schlussfolgerungen Die indirekte laryngoskopische Untersuchung stellt ein einfaches und wertvolles Verfahren dar, das für die Diagnostik der Intubations-

schwierigkeiten bei Patienten, die sich einer Mikrolaryngoskopie unterziehen, verwendet werden kann.

Schlüsselwörter Indirekte Laryngoskopie · Schwierige Intubation · Mikrolaryngoskopie

Introduction

Difficult intubation is one of the major reasons for perioperative mortality and morbidity in relation to anesthesia [1]. Difficult intubations were defined as 'the clinical situation in which a conventionally trained anesthesiologist experiences difficulty with ventilation of the upper airway via a mask, difficulty with tracheal intubation, or both', in a paper published in 2013 [2]. Difficult intubations or difficult laryngoscopy incidence ranges from 1.5 to 13 % [3]. Problems associated with airway management in patients that have received general anesthesia and need intubation include brain damage and death. Hence, the detection of these patients is very important [1, 3]. However, the prediction of difficult or impossible intubations is not always possible [4]. Predicting which airways may prove to be difficult and the assessment of the state of the airways are very important skills for the anesthesiologist [5]. For this reason many protocols, including algorithms and various combinations, are currently under research [6].

Microlaryngeal surgery creates many difficulties both for the anesthesiologist and for the otolaryngologist [7]. In microlaryngeal surgery, there is a sensitive balance between monitoring the larynx anatomy properly and maintaining control of the airway [8]. It must be remembered that a difficult intubation and difficulties in ventilation may occur while assessing the airway in patients with an airway pathology [9]. Therefore, the anesthesiologist should develop a perioperative plan, even if it is difficult [10]. Endoscopic examination of the airway lesions is also a method used in the preoperative anesthetic assessment of airway maintenance planning. A visual inspection of the airway pathologies can change the approach of the anesthesiologist [10]. Indirect laryngoscopy, with a rigid endoscope, is a simple technique frequently used in otolaryngology for the assessment of the larynx and upper airway anatomy [5]. Jorge et al. [11] studied various methods to visualize the airway with the help of a laryngeal mirror or laryngeal illuminator in order to identify patients who may have intubation difficulties. In our study, we have primarily aimed to investigate the feasibility of indirect laryngoscopy for the diagnosis of difficult intubation in patients who had undergone microlaryngeal surgery.

Materials and methods

After the consent of the hospital's Board of Ethics and the written consent of the patients, we conducted a prospective and observational study with 40 patients who were to receive microlaryngeal surgery under general anesthesia. This study was completed within 6 months between 1 June 2013 and 1 December 2013. Patients with histories of difficult intubation, HIV, hepatitis, tuberculosis, and those that had undergone neck surgery were excluded from the study.

Table 1 Modified Mallampati score

Class 1: Soft palate, uvula, fauces, and pillars are easily visible
Class 2: Uvula and soft palate are visible
Class 3: Soft palate and uvular base are visible
Class 4: Uvula is closed totally by tongue base, and pharyngeal wall is not visible

Table 2 Cormack–Lehane score

Grade 1: The whole glottis is visible
Grade 2: The glottis is partially visible
Grade 3: Only epiglottis is visible
Grade 4: Epiglottis is not visible either

In the study protocol, an assistant anesthesiologist with more than 3 years of experience conducted a preanesthetic examination 1 day before the operation. We also recorded the patient's age, weight, sex, and physical condition according to the American Society of Anesthesiologists indicators (ASA score), diagnosis, and history of difficult intubations. The thyromental distance (normally over 6.5 cm), sternomental distance (normally over 12.5 cm), interincisor distance (normally over 3.5 cm), and neck circumference (over 43 cm showing difficult intubation) were measured. Modified Mallampati scores ([11]; Table 1) and Wilson risk scores (limitations of neck motion, mouth opening, jaw motion, mandibular protrusion, anterior teeth protrusion, body weight) were also evaluated [5].

Following the pre-anesthetic examination, an otolaryngologist conducted an indirect laryngoscopic assessment. Indirect laryngoscopy was performed with a 70 ° rigid endoscope. Patients on whom the procedure could not be performed by the third trial were excluded from the study. The indirect laryngoscopic examination findings were classified into four grades [11]:

Grade 1: Visible vocal cords
Grade 2: Visible posterior commissure and epiglottis
Grade 3: Only the epiglottis was visible
Grade 4: None of the glottic structures were visible

The patients were transferred to the operating room and their routine examinations (three-channeled ECG, noninvasive blood pressure, and peripheral oxygen saturation) were performed. Premedication with intravenous midazolam (2 mg) was administered to all patients. Anesthesia induction was provided by the administration of 1 μgr/kg fentanyl, 2 mg/kg propofol, and 0.5 mg/kg rocuronium. An anesthesiologist with more than 5 years of experience performed the direct laryngoscopy by means of a Macintosh laryngoscope of proper size.

Table 3 The patients' age, weight, modified Mallampati score, Cormack–Lehane score, thyromental distance, sternomental distance, interincisor distance, neck circumference, Wilson risk score, and mean durations of laryngoscopy and intubation

	n	Minimum	Maximum	Mean	SD
Age (year)	40	21	70	46.03	13.35
Weight (kg)	40	43	117	74.40	12.50
Modified Mallampati score	40	1	4	1.68	0.83
Cormack–Lehane score	40	1	3	1.58	0.84
Thyromental distance (cm)	40	6	12	8.74	1.24
Sternomental distance (cm)	40	13	19	15.09	1.43
Interincisor distance (cm)	40	3	6	4.15	0.74
Neck circumference (cm)	40	30	51	38.55	3.84
Wilson risk score	40	0	2	0.20	0.52
Laryngoscopy and intubation time (sec)	40	5	28	12.05	4.27

SD standard deviation

Table 4 The patients' sex, ASA score and indirect laryngoscopic assessment findings, diagnoses, and intubation difficulty

		n	%
Sex	Male	32	80.00
	Female	8	20.00
ASA	1	26	65.00
	2	12	30.00
	3	2	5.00
Indirect laryngoscopic assessment	Grade 1	32	80.00
	Grade 2	6	15.00
	Grade 3	2	5.00
Diagnosis	Supralaryngeal tumors	22	55
	Benign laryngeal lesions	18	45
Intubation difficulty		5	12.5

ASA American Society of Anesthesiologists

Direct laryngoscopic profiles were classified according to Cormack–Lehane scores ([5]; Table 2). All patients were intubated with a number 5 microlaryngeal tube.

The duration of both the laryngoscopy and intubation, as well as the presence of intubation difficulties, was recorded. If more than three procedures were needed for intubation, the procedure was recorded as an intubation difficulty.

Statistical evaluation

Statistical analyses in this study were conducted with the Number Cruncher Statistical System (NCSS) 2007 Statistical Software (Utah, USA) program package.

For the evaluation of the data, descriptive statistical methods (mean and standard deviations), a one-way analysis of variance in intergroup comparisons, an independent *t* test in dual-group comparisons, a chi-square test, and a Fisher's exact test for qualitative data comparisons were used. The results were evaluated according to a significance value of $p<0.05$.

Results

The patient's age, weight, modified Mallampati score, Cormack–Lehane score, thyromental distance, sternomental distance, interincisor distance, neck circumference, Wilson risk score, and mean durations of the laryngoscopy and intubation are shown in Table 3.

Microlaryngeal surgery was planned for 22 of the 40 patients due to supralaryngeal tumors and for 18 other patients due to benign laryngeal lesions (polyp, nodule, etc.). The patient's sex, ASA score, indirect laryngoscopic assessments, diagnosis, and intubation difficulty are shown in Table 4.

The mean age of the patients who had intubation difficulties was significantly higher than that of patients who did not have intubation difficulties. Means for weight, sex, ASA distribution, modified Mallampati score, thyromental distance, sternomental distance, interincisor distance, Wilson risk score, and durations of laryngoscopy and intubation of patients who either had or did not have intubation difficulty were not significantly different from each other (Table 5).

Statistically significant differences between the indirect laryngoscopic assessment distributions of patients who either had or did not have intubation difficulty were observed. The number of patients with a Grade 3 score for those who had intubation difficulty was high. The mean Cormack–Lehane scores of the patients who had intubation difficulty were significantly higher than those of patients who did not have intubation difficulty. The mean neck circumferences of patients who had intubation difficulty were also significantly higher than those of patients who did not have intubation difficulty (Table 5).

There was no significant difference between indirect laryngoscopic assessment (Grades 1, 2, and 3) and the other assessment tests (the means of the modified Mallampati score, the thyromental distance, the sternomental

Table 5 The comparison of the age, weight, sex, indirect laryngoscopic assessment, modified Mallampati score, Cormack–Lehane score, thyromental distance, sternomental distance, interincisor distance, neck circumference, and Wilson risk score of patients having and not having intubation difficulty

		Intubation difficulty (–)		Intubation difficulty (+)		*p*
Age (year)		43.89 ± 12.83		61 ± 4.18		0.006*
Weight (kg)		73.80 ± 12.68		78.60 ± 11.52		0.429
Sex	Male	27	77.14 %	5	100.00 %	0.232
	Female	8	22.86 %	0	0.00 %	
Indirect laryngoscopic assessment	Grade 1	30	85.71 %	2	40.00 %	0.0001*
	Grade 2	5	14.29 %	1	20.00 %	
	Grade 3	0	0.00 %	2	40.00 %	
Modified Mallampati score		1.6 ± 0.81		2.2 ± 0.84		0.132
Cormack–Lehane score		1.43 ± 0.74		2.6 ± 0.89		0.003*
Thyromental distance (cm)		8.76 ± 1.27		8.6 ± 1.08		0.794
Sternomental distance (cm)		15.19 ± 1.45		14.4 ± 1.14		0.255
Interincisor distance (cm)		4.14 ± 0.77		4.2 ± 0.57		0.875
Neck circumference (cm)		38.01 ± 3.27		42.3 ± 5.76		0.018*
Wilson risk score		0.2 ± 0.53		0.2 ± 0.45		0.998

Mean ± standard deviation
*$p < 0.05$

Table 6 The comparison of indirect laryngoscopic assessment (Grades 1, 2, and 3) and the other assessment tests (the means of the modified Mallampati score, Cormack–Lehane score, the thyromental distance, the sternomental distance, the Wilson risk score, the interincisor distance, and neck circumference)

	Grade 1	Grade 2	Grade 3	*p*
Modified Mallampati score	1.69 ± 0.82	1.33 ± 0.82	1.68 ± 0.83	0.598
Cormack–Lehane score (cm)	1.5 ± 0.8	1.5 ± 0.84	1.58 ± 0.84	0.999
Thyromental distance (cm)	8.73 ± 1.35	8.92 ± 0.49	8.74 ± 1.24	0.944
Sternomental distance (cm)	15.11 ± 1.52	15.5 ± 0.55	15.09 ± 1.43	0.808
Interincisor distance (cm)	4.2 ± 0.77	4 ± 0.71	4.15 ± 0.74	0.818
Neck circumference (cm)	38.69 ± 3.9	36.67 ± 2.89	38.55 ± 3.84	0.461
Wilson risk score	0.22 ± 0.55	0.17 ± 0.41	0.2 ± 0.52	0.973
Laryngoscopy and intubation time (sec)	11.78 ± 4.42	14.33 ± 3.39	12.05 ± 4.27	0.375

Mean ± standard deviation

distance, the Wilson risk score, the interincisor distance, and neck circumference) (Table 6).

Discussion

It is ideal to see the upper airway before endotracheal intubation [11]. Yamamoto et al. [4] reported that preoperative indirect laryngoscopy is a perfect method for predicting the difficulty of an intubation. Another study that had assumed indirect laryngoscopy and is superior to traditional methods reported that indirect laryngoscopy can be used as a supplemental examination to assess changes in upper airway anatomy in more than 25 % of patients with potentially difficult airways [5]. However, Yamamoto et al. [4] added that, although this method can provide reliable information about anatomical limitations in the larynx and pharynx, it cannot always be used for determining modified Mallampati scores and Wilson risk scores. Zhang et al. [12] examined two cases involving microlaryngeal surgery due to a laryngeal cyst and stated that an endoscopic examination alone is not sufficient for a difficult airway assessment and can cause a high number of false positives. According to the indirect laryngoscopy classification in our study, a Grade 4 classification was not observed in any of the patients. However, statistically significant differences between indirect laryngoscopic examination findings of patients who either had or did not have intubation difficulty were observed. The presence of a Grade 3 classification in patients with intubation difficulties was found to be high in the indirect laryngoscopic examination. The anesthesiologist should be careful about difficult intubation in patients who have been evaluated as Grade 3 in indirect laryngoscopic assessment. Generally, if more than three procedures, or more than 10 min, are needed to properly

place an endotracheal tube, if direct laryngoscopy cannot be performed, if extra apparatuses are required, or if the glottis cannot be seen when pressure is applied from the outside, the procedure is determined to have had intubation difficulty [13]. The incidence of difficult intubation was reported between 0.05 and 2 % in nonobstetric surgical patients [4]. The probability of experiencing intubation difficulties is high in supralaryngeal tumors due to tumoral lesions [9]. We observed intubation difficulties in five cases in our study. In two of our cases involving difficult intubation we had planned to conduct biopsies for supralaryngeal masses. In one of these cases, although the larynx was visible, proper orientation of the tube could not be made due to tumors in front of the glottis. However, with the help of assistant maneuvers, the tubes were placed. In one case, the intubation was made with a small numbered tube. Budde et al. [5] reported that in patients with Cormack–Lehane scores of 3 or 4, the possibility of difficult intubation is high. In one of our cases that was determined to have a difficult intubation, the Cormack–Lehane score was 3. The intubation in this patient was made by using an in-tube stylet. In two other cases, the proper placement of the tube was enabled by using a difficult intubation stylet.

Due to osteoarthritic changes that may develop in the process of aging, advanced age is considered a predictor for difficult intubation and laryngoscopy [3, 14]. In our study, the mean age of the patients who had intubation difficulties was higher than the mean age of the patients who did not have intubation difficulties; thus, our study supports previous findings.

Classic clinical predictors of difficult laryngeal visualization (modified Mallampati score, mouth opening, cervical mobility, neck thickness, thyromental distance, etc.) are frequently used before intubation [11]. Modified Mallampati scores and Wilson risk scores are the most popular tests traditionally used for determining difficult intubation; however, their positive predictive values are low [5]. Lundstrom et al. [1] reported that a modified Mallampati score alone is not sufficient for predicting a difficult intubation or a difficult laryngoscopy, but it can be part of a multivariate analysis [1]. In our study, no significant difference was observed between patient groups who either had or did not have intubation difficulties in terms of modified Mallampati scores and Wilson risk scores. However, the mean neck circumferences of patients with intubation difficulties were statistically significantly higher than the means of patients who did not have intubation difficulties. Furthermore, in obese patients, the thickness of the neck circumference (over 43 cm) can cause a difficult intubation [15–17]. However, none of the patients with difficult intubations were obese.

We think that the small number of patients is a limitation of our study.

Conclusion

We propose that, together with traditional scanning tests, indirect laryngoscopic examination findings can be used in preoperative airway assessments to detect potentially difficult intubations in patients who are to receive microlaryngeal surgery.

Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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