DIFFICULT LARYNGOSCOPY;
THE PREDICTIVE VALUE OF RATIO OF HEIGHT TO THYROMENTAL DISTANCE VERSUS OTHER COMMON PREDICTIVE TESTS OF UPPER AIRWAY

ORIGINAL
PROF-1850

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ABSTRACT... Background: Preoperative evaluation of anatomical landmarks and clinical factors helps to identify potentially difficult laryngoscopies; however, its predictive reliability is unclear. As the ratio of height to thyromental distance (RHTMD) is a newer upper airway predictive test for difficult laryngoscopy, the predictive value and odds ratios of RHTMD versus mouth opening, thyromental distance(TMD), neck movement, and oropharyngeal view (modified Mallampati) were evaluated. **Methods:** Data of 407 consecutive patients scheduled for elective surgery with general anesthesia requiring endotracheal intubation were collected and all five factors were assessed before surgery. Four senior anesthesiology residents, not aware of the recorded preoperative airway assessment, performed the laryngoscopy and grading (as in Cormack and Lehane's classification). **Results:** Difficult laryngoscopy (Grade 3 or 4) occurred in 94 patients (23.1%). In the multivariate analysis, three criteria were found independent for difficult laryngoscopy (neck movement $\leqslant$ 80 degrees; Mallampati Class 3 or 4, and RHTMD $\geqslant$ 24). Neck movement (NM) $\leqslant$ 80 degrees had a higher sensitivity, specificity and PPV than the other factors. After neck movement, Mallampati class 3 and 4, IIG $\leqslant$ 3.5 cm and then RHTMD $\geqslant$ 24 were valuable with lowest NPV. The multivariate analysis Odds ratio (95% confidence interval) of the NM, Mallampati class, IIG and RHTMD were 18.16 (9.634 – 34.265), 12.498 (6.744 – 23.16), 11.183 (6.571 – 19.03) and 3.123 (1.933 – 5.047) respectively.TMD $\leqslant$ 6.5 cm was not recognized as independent variable for difficult laryngoscopy. Conclusions: RHTMD is a useful and valuable screening test for preoperative prediction of difficult laryngoscopy along with common predictive examinations.

Key words: Intubation Tracheal, Laryngoscopy

INTRODUCTION

The most remarkable cause of morbidity and mortality in anesthetized patients is airway management failure[1]. Difficult laryngoscopy which is defined by poor visualization of the glottis is synonymous with difficult intubation in most of the patients[2]. Difficult intubation is reported in 1.5 – 15.8% of patients[3–13]. Assessment of the airway in the preoperative period (mouth opening, TMD, neck movement and oropharyngeal view with modified Mallampati) has great importance in prediction of the risk of difficult airway management, but there is still debate about the prediction value of different anatomic landmarks and clinical factors[3,5,14–17]. Several studies describe prediction schemes using a single risk factor or a multifactorial index[3,10,12,18,19, 20].The thyromental distance (TMD) is a test for difficult laryngoscopy that changes with the patient's size[7].

However,whether TMD has enough sensitivity or specificity as a sole predictor of difficult laryngoscopy has been questioned by several studies[7,11,16,22,23].

In a few studies sensitivity, specificity and predictive value of RHTMD (ratio of height to TMD) was compared with other bedside tests for assessing a patient's airway for difficult laryngoscopy. Schmitt et al[21] concluded that RHTMD $\geqslant$ 25 can be used to predict difficult laryngoscopies in white men and women. Krobbuaban et

al[24] found RHTMD ⩾ 23.5 as a determining factor for predicting a poor laryngeal view in Thai patients. As there are anatomic variations between different races and ethnicities, a prospective, blind study has been conducted to determine RHTMD in Iranian patients and to compare predictive value of RHTMD versus four other methods of airway assessment for difficult laryngoscopy.

METHODS

The protocol was approved by the Ethics Committee of the Guilan University of medical sciences, and all patients signed written, informed consent to participate in the study. 407 consecutive adult patients with ASA physical status I – II that were scheduled for elective orthopedic, urologic, abdominal, and gynecologic surgery requiring general anesthesia with endotracheal intubation were selected. Patients younger than 18 year of age or having obvious airway malformations (like head and neck tumors, cleft lip and cleft palate, history of head and neck trauma), skeletal abnormalities affecting on the height (such as kyphoscoliosis, congenital dislocation of hip, …..), edentulous or requiring a rapid sequence induction or awake intubation were excluded from the study in order to avoiding the independent variables that might affect the predictability of difficult laryngoscopy. Preoperative airway assessment was performed for all patients by residents of anesthesiology in preoperative anesthesia clinics. Measurement of mouth opening, TMD, maximum range of head and neck movement, assessment of oropharyngeal view, height and ratio of height to thyromental distance (RHTMD) are the tests that were used to predict difficult laryngoscopy. Mouth opening was assessed by the inter incisor gap (IIG) measurement.

This assessment was performed by measuring the distance between the upper and lower incisors at the midline while the patient had opened his or her mouth as wide as possible[25]. IIG equal or less than 3.5 cm considered as predictive of difficult laryngoscopy. The maximum range of head and neck movement was assessed using the method described by Wilson et al[12]. While the patient was in sitting position and fully extended his or her neck, a pencil was placed vertically on the forehead. Then, holding the pencil firmly in position, the head and neck were flexed. The head and neck movement range was classified as less than 80 degrees or > 80 degrees. The movement range less than or equal to 80 degrees has predictive value of difficult laryngoscopy.

Mallampati score estimates the relationship between the size of the tongue and the oral cavity and may possibly indicate whether the tongue displacement using the laryngoscope blade would be easy or difficult. It evaluates the possibility of adequate opening of mouth for intubation as well. Mallampati test assesses both pharyngeal structure and head and neck mobility[13]. Assessing the oropharyngeal view was performed using a modified Mallampati classification[26]. The seated patient was asked to fully open his or her mouth and protrude the tongue without phonation[27].The view was classed as:

(I) Good visualization of the soft palate, fauces, uvula, and tonsillar pillars;
(II) Pillars obscured by the base of the tongue but the soft palate, fauces, and uvula visible;
(III) Soft palate and base of uvula visible; and
(IV) Soft palate not visible, only hard palate visible[26].

Mallampati class III and IV are considered as predictors of difficult laryngoscopy. The patient's height was measured in upright position and then RHTMD was calculated. Routine monitoring including electro-cardiography, pulse Oximetry, and a noninvasive blood pressure monitoring was established for every patient during the perioperative period. After preoxygenation for 2 minutes, all patients were anesthetized with fentanyl 3 µg/kg and propofol 2.5 mg/kg and then paralyzed by atracurium 0.5 mg/kg. Ventilation of the lungswith 100% oxygen was held by mask for 5 minutes until complete paralisation of the patient (no single twitch or train of fourresponse in monitoring by nerve stimulator). While the patient's head was in sniffing position laryngoscopy was performed with a number 3 Macintosh blade, by senior residents of anesthesia, who were blinded about the study. Glottic visualization was assessed using a modified Cormack and Lehane[28] classification without external laryngeal manipulation. This classification consisted of four grades:

Grade 1	Complete of the vocal cords.
Grade 2	The inferior portion of the glottis.
Grade 3	Only the epiglottis.
Grade 4	A nonvisualized epiglottis.

After evaluating of the glottis, external laryngeal pressure was permitted. In this study, Cormack and Lehane Grades 3 or 4 was considered as difficult laryngoscopy. After evaluating and scoring, endotracheal intubation was performed and anesthesia process was continued. The preoperative assessment data and the laryngoscopic findings were used to evaluate the predictive value of each test in difficult laryngoscopy. The sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of each test were calculated. In addition, receiver operating characteristic curves were used to identify the optimal predictive cut off point, for RHTMD measurement, interincisor gap, and TMD.

In this study, multivariate analysis and 95% confidence interval with SPSS 14 statistical package were used to compare the results. The diagnostic performance of each test was also assessed by summary receiver operating characteristic (ROC) curves according to the method described by Moses et al[13]. ROC curves were constructed.

RESULTS

407 patients who were candidates for elective surgery under general anesthesia entered the study.There was no failed tracheal intubation. The demographic data and the distribution of the Cormack and Lehane[28] grades for the interincisor gap, TMD, and RHTMD are presented in Table I. The receiver operating characteristic curves of the tests are showed in figure 1. The optimal cut off point for RHTMD, TMD, and interincisor gap (IIG) in predicting difficult laryngoscopy were 24 (sensitivity, 63.8%; specificity, 63.8%), 6.5 cm (sensitivity, 28.7%; specificity, 59.1%), and 3.5 cm (sensitivity, 62.7%; specificity, 86.9%), respectively.

An IIG $\leqslant$ 3.5, a TMD $\leqslant$ 6.5, neck movement $\leqslant$ 80 degrees and a Mallampati class 3 or 4 were selected predictive factors of difficult laryngoscopy. In this study a Cormack – Lehane grade of 3 or more was defined as the accepted standard for difficult laryngoscopy and difficult intubation, as in most studies[13]. Difficult laryngoscopy was reported in 94 patients (23.1%; table I).

Table-I. Demographic data of all patients and distribution of laryngoscopic view

Category	Value
Men n (%)	243 (59.7)
Women n (%)	164 (40.3)
Age (yr.) (Mean ± SD)	46.41 ± 15.25
Weight (kg) (mean ± SD)	69.91 ± 12.98
Height © (mean ± SD)	163.29 ± 11.43
TMD (cm) (mean ± SD)	7.06 ± 1.33
≤ 6.5 n (%)	155 (38.1)
> 6.5 n (%)	252 (61.9)
RHTMD (mean ± SD)	24.03 ± 5.35
Interincisor Gap (mean ± SD	4.28 ± 0.9
≤ 3.5 n (%)	100 (24.6)
> 3.5 n (%)	307 (75.4)
Neck movement	
≤ 80 degrees	65 (16)
> 80 degrees	342 (84)
Mallampati Class n (%)	1 195 (47.9) 2 151 (37.1) 3 58 (14.3) 4 43 (0.7)
Laryngoscopic View n (%)	I 197 (48.4) II 116 (28.5) III 86 (21.1) IV 8 (2)

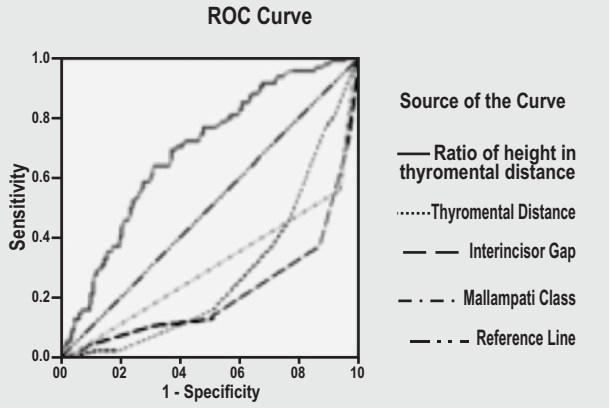
Neck movement (NM) $\leqslant$ 80 degrees had a higher sensitivity, specificity and PPV in comparison with the other factors.Following neck movement, Mallampati class 3 and 4, IIG $\leqslant$ 3.5 cm and finally RHTMD $\geqslant$ 24 were found valuable with lowest NPV. The multivariate analysis Odds ratio (95% confidence interval) of the NM, Mallampati class, IIG and RHTMD were 18.16(9.634 –

Table-II. Accuracy of risk factors in predicting difficult laryngoscopy

Sens Spec Risk Factors	PPV TP	NPV TN	Odds FP FN	%	%	%	%	Ratio 95% CI	p-value
IIG≤3.5 59	272	4135	62.7	86.9	59	88.5	11.183	6.571-19.03	<0.0001
TMD≤6.5	27185	12867	28.7	59.1	17.4	73.4	0.582	0.353-0.961	0.332
NM≤80°	48296	1746	73.8	94.5	73.8	86.5	18.16	9.634-34.265	<0.0001
MPC=3 or 4	42294	1952	44.6	93.9	68.8	84.9	12.498	6.744-23.16	<0.0001
RHTMD≥ 24	60200	11334	63.8	63.8	34.6	85.4	3.123	1.933-5.047	<0.0001

IIG = interincisor gap; TMD = thyromental distance; NM = neck movement; MPC = Mallampati class; RHTMD = ratio of height to thyromental distance; TP = true positive; TN = true negative; FP = false positive; FN = false negative; Sens = sensitivity; Spec = specificity; PPV = positive predictive value; NPV = negative predictive value; CI = confidence interval

Fig-1. Receiver operating characteristic (ROC) curve for the ratio of height to thyromental distance, thyromental distance , interincisor gap and Mallampati Class in predicting difficult tracheal intubation in all patients



34.265), 12.498 (6.744 – 23.16), 11.183 (6.571 – 19.03) and 3.123 (1.933 – 5.047) respectively. TMD ⩽ 6.5 cm was not recognized as independent variable for difficult laryngoscopy.

DISCUSSION

In our study, the incidence of difficult laryngoscopy (23.1%) was more than other studies[3,4,5,13,24]. Therefore our results might offer a low NPV and a high PPV. RHTMD allows a higher PPV (34.6%) in comparison with previous reports (9% – 24%)[3,4,5,24].

Ideally, any preoperative assessment scheme for difficult laryngoscopy should have a high sensitivity and specificity and produce few false positives and negatives. False – negative results may be accompanied by deleterious and even life – threateningconsequences; therefore, decreasing false – negative prediction is far more important than falsely predicting difficult laryngoscopy in patients.The most important finding in our study is that RHTMD ⩾ 24 has the least false negative (FN) value as reported by Krobbuaban et al[24]. Using a multivariate analysis, it was found that NM⩽ 80 degrees, Mallampati class 3 or 4, RHTMD ⩾ 24 and IIG⩽ 3.5 cm were the major predicting factors of difficult laryngoscopy. Neck movement had the highest Odds ratio for prediction of a difficult laryngoscopy. Results of our study agrees with reports from Randell[22] and G. Iohom[23] and Krobbuaban[24] and Chou and Wu[29] who suggested that although TMD has been investigated, it had little proved value ofin predicting difficult intubation. Unlike our findings, Savva[11] did not found any correlation between IIG and laryngoscopic view. Schmitt et al[21] found that RHTMD ⩾ 25 can be used to predict difficult laryngoscopy in white men and women. They suggested that may be it shouldn't be applied in other races. Krobbuaban et al[24] found that RHTMD ⩾ 23.5 was a determining factor inpredicting of poor laryngeal view among Thai patients. In our study, a RHTMD ⩾24 was a determining factor in predicting difficult laryngoscopy in Iranian patients. These differences were small, and further investigation in other ethnicities and races are necessary for determining the significance of ethnicity.

In conclusion, several studies have evaluated single or multiple clinical risk factors in order to find a useful method for prediction of difficult intubation. Our findings suggest that RHTMD might be a useful bedside screening test for preoperative prediction of difficult laryngoscopy.

Appendix 1: Statistical Terms[30]

True positive a difficult laryngoscopy that had been predicted to be difficult

False positive an easy laryngoscopy that had been predicted to be difficult

True negative an easy laryngoscopy that had been predicted to be easy

False negative a difficult laryngoscopy that had been predicted to be easy

Sensitivity the percentage of correctly predicted difficult laryngoscopies as a proportion of all laryngoscopies that were truly difficult, i.e., true positive/ (true positives + false negatives)

Specificity the percentage of correctly predicted easy laryngoscopies as a proportion of all laryngoscopies that were truly easy, i.e., true negatives / (true negatives + false positives)

PPV Positive predictive value the percentage of correctly predicted difficult laryngoscopies as a proportion of all predicted difficult laryngoscopies, i.e. e., true positives / (true positives + false positives)

NPV Negative predictive value the percentage of correctly predicted easy laryngoscopies as a proportion of all predicted easy laryngoscopies, i.e., true negatives / (true negatives + false negatives)

Accuracy the percentage of correctly predicted easy or difficult laryngoscopies as a proportion of all laryngoscopies, i.e., (true positives + true negatives)/ (true positives + true negatives + false positives + false negatives)

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Trust men and they will be true to you; treat them greatly, and they will show themselves great.

Ralph Waldo Emerson (1803 - 1882)