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ORIGINAL INVESTIGATION

Evaluation of thyromental height as a predictor of difficult laryngoscopy and difficult intubation: a cross-sectional observational study

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Abstract
Background and objectives: Several anthropometric measurements have been suggested to identify a potentially difficult airway. We studied thyromental height (TMH) as a predictor of difficult laryngoscopy and difficult intubation. We also compared TMH, ratio of height to thyromental distance (RHTMD), and thyromental distance (TMD) as predictors of difficult airway.
Methods: This cross-sectional observational study was conducted in 300 adult surgical patients requiring tracheal intubation. Preoperatively airway characteristics were assessed. Standard anesthesia was administered. Degree of difficulty with mask ventilation, laryngoscopic view, duration of laryngoscopy, and difficulty in tracheal intubation (intubation difficulty scale score) were noted. Multivariate logistics regression analysis was performed to identify independent predictors for difficult laryngoscopy.
Results: Laryngoscopy was difficult in 46 of 300 (15.3%) patients; all 46 patients had Cormack-Lehane grade 3 view. Duration of laryngoscopy was 27 ± 11 s in patients with difficult laryngoscopy and 12.7 ± 3.9 s in easy laryngoscopy; $p = 0.001$. Multivariate analysis identified that TMH, presence of short neck, and history of snoring were independently associated with difficult laryngoscopy. Incidence of difficult intubation was 17.0%. A shorter TMH was associated with higher IDS scores; $r = -0.16$, $p = 0.001$. TMH and duration of laryngoscopy were found to be negatively correlated; a shorter TMH was associated with a longer duration of laryngoscopy; $r = -0.13$, $p = 0.03$. The cut-off threshold value for TMH in our study is 4.4 cm with a sensitivity of 66% and a specificity of 54%.
Conclusion: Thyromental height predicts difficult laryngoscopy and difficult intubation.
TMD and RHTMD did not prove to be useful as predictors of difficult airway.

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Introduction

Unexpected difficult laryngoscopy (DL) or intubation, or failed tracheal intubation is an important etiological factor in anesthesia-related morbidity and mortality.[1] Several anthropometric measurements have been proposed to identify potentially difficult airways for reducing the risk related to difficult airway. Thyromental distance (TMD), though widely used in the preoperative airway evaluation, has a debatable role, as the sensitivity and specificity of TMD as a predictor for difficult laryngoscopy is low.[1] TMD varies with patient size. The ratio of height to TMD (RHTMD) has been found to have a better predictive value for difficult laryngoscopy than TMD alone, as the TMD cut-off value is adjusted for patient size.[2]

Etezadi et al.[3] studied the thyromental height (TMH), the height between the anterior borders of the mentum and thyroid cartilage with the patient in supine position and mouth closed, as a predictor of difficult laryngoscopy. They found TMH to be a more accurate predictor of difficult laryngoscopy compared to TMD, Mallampati oropharyngeal class, and sternomental distance (SMD). The authors, however, did not evaluate TMH as a predictor of difficult intubation in their study. We planned to study TMH as a predictor of difficult laryngoscopy and difficult intubation and to compare TMH, RHTMD, and TMD as predictors of difficult laryngoscopy (primary aim) and difficult intubation (secondary aim) in adult patients undergoing surgery under general anesthesia. We hypothesized that thyromental height is a better predictor of difficult laryngoscopy compared with RHTMD and TMD. We also determined the optimum threshold value of TMH for difficult laryngoscopy.

Methods

After obtaining clearance from hospital ethics committee and written informed consent from all patients, this prospective cross-sectional observational study was conducted in 300 American Society of Anesthesiologists (ASA) physical status grade I or II adult patients, aged 18 years and above, who were scheduled to undergo elective surgery under general anesthesia requiring tracheal intubation between January 2017 till November 2018. Patients with obvious abnormality of the airway requiring awake tracheal intubation, neck swelling or contractures, unstable cervical spine, interincisor distance < 2.5 cm, obese, pregnant patients, and those at increased risk of aspiration were excluded from the study. The study was registered with Clinical Trials Registry India, Number CTRI/2016/09/007313 [Registered on 27/09/2016].

The following airway characteristics were assessed preoperatively by one investigator to reduce inter-observer variability: Modified Mallampati class (MMC)[4,5] of oropharyngeal view obtained with the patient sitting (tongue protruding, without phonation); Thyromental distance (TMD) obtained by measuring the straight distance from the thyroid notch to the inner mentum with the head in extension; Thyromental height, the vertical distance between the anterior borders of the mentum and the thyroid cartilage (on the thyroid notch between the two thyroid laminae), while the patient lies supine with the head in neutral position and the mouth closed was measured using a digital depth gauge (Yuri precision instruments digital depth gauge)[3]; Ratio of height to thyromental distance was calculated by dividing the patient's height (cm) by the thyromental distance (cm)[2]; Sternomental distance (SMD) obtained by measuring the straight distance from the sternal notch to the inner mentum with the head in extension; Inter-incisor distance (IID) with the mouth fully open (inter-gingival distance in edentulous patients); Range of head and neck movement < or > 80° as described by Wilson et al.[6]; Mandible protrusion limitation class A: the lower incisors can be brought in front of the upper incisors, class B: the lower incisors can be advanced only to the level of upper incisors, class C: cannot reach the level of the upper incisors; Upper lip bite test class 1: lower incisors can bite above the vermilion border of the upper lip, class 2: lower incisors can bite the vermilion border of the upper lip, and class 3: unable to bite the upper lip; Dentition: loose, missing, protruding upper incisors, or edentulous; Other features such as history of snoring, short muscular neck, beard, or cervical spondylosis were noted. The age, gender, height, weight of each patient was noted. Body mass index (BMI), $kg.m^{-2}$ was calculated.

All patients fasted overnight. Oral alprazolam 0.25 mg was given as premedication the night before and on the morning of surgery. In the operating room, standard monitoring was established (electrocardiogram, noninvasive blood pressure, pulse oximetry and capnography). Intravenous access was secured. The height of the operating table was adjusted such that the plane of the patient's face was at the level of xiphisternum of the anesthesiologist performing direct laryngoscopy and intubation. A difficult airway cart was kept at hand.

Standard anesthesia protocol was followed in each patient. Anesthesia was induced with fentanyl 2 $\mu g.kg^{-1}$ and propofol 2–2.5 $mg.kg^{-1}$ until loss of verbal contact. Vecuronium 0.1 $mg.kg^{-1}$ was administered to facilitate intubation. The lungs were ventilated with O_2, N_2O (50:50) and isoflurane 0.6% for a period of 3 minutes.

The ability to ventilate by mask was graded according to the classification by Han et al.[7] with grade 0: ventilation by mask not attempted; grade1: ventilated by mask; grade 2: ventilated by mask with oral airway or other adjuvant; grade 3: difficult mask ventilation (inadequate, unstable or requiring two practitioners); grade 4: unable to ventilate.

Direct laryngoscopy was performed using Macintosh size 3 blade with the patients' head in sniffing position by an anesthesiologist with at least five years' experience, who was unaware of the airway measurements. Laryngoscopic view was graded by Cormack-Lehane grading[8] without external laryngeal manipulation (ELM). Grade 1: complete visualization of the vocal cords; grade 2: visualization of the inferior portion of the glottis; grade 3: visualization of only the epiglottis; and grade 4: non-visualized epiglottis. No external laryngeal manipulation was done for grading the laryngoscopic view. Difficult laryngoscopy was defined by Cormack-Lehane grade 3 and 4. External laryngeal manipulation was permitted, if necessary, after evaluation of laryngoscopy grade to facilitate intubation. The Cormack-Lehane grade obtained following application of ELM was also noted.

Tracheal intubation was performed using cuffed tracheal tube size 7 and 8 in female and male patients, respectively. Difficulty in intubation was assessed by the intubation difficulty scale (IDS) score.[9] The number of attempts and operators, alternate intubation techniques used, Cormack-Lehane grade, lifting force used, need for ELM, and vocal cord position were noted. Alternative intubation techniques used such as patient repositioning, change of blade or tracheal tube, use of stylet, laryngeal mask airway (LMA), intubating LMA, fiberoptic intubation, or intubation through LMA as described by Adnet et al.[9] were noted. The IDS score was calculated in each case. IDS score = 0 represents easy intubation, IDS score = 1–5 represents slight difficulty and IDS score > 5 represents moderate to major difficulty in intubation.[9]

Duration of laryngoscopy (defined as the time from the instant the laryngoscope blade touches the patient until tracheal intubation and removal of the laryngoscope blade from the mouth) was noted. Laryngoscopy was considered prolonged if its duration exceeded 15 seconds. The stance of the anesthesiologist performing laryngoscopy and intubation (upright or leaning backwards, bending at the knee, or stooping) was noted. The study period ended after successful tracheal intubation had been confirmed by assessment of chest movement, auscultation for bilateral air entry and capnography. Anesthesia was maintained with O_2, N_2O (40:60) and isoflurane with intermittent doses of vecuronium and narcotic as per requirement. At the end of surgery, residual neuromuscular block was antagonized with neostigmine (0.05 mg.kg^{-1}) and glycopyrrolate (10 μg.kg^{-1}). The trachea was extubated when the patient followed commands with adequate respiration and return of protective reflexes.

Statistical methods

The incidence of difficult laryngoscopy is reported in the range of 1.5% to 20%.[3] Assuming the incidence of difficult laryngoscopy to be 10% in the population with 95% confidence interval (95% C.I.) and 5% margin error, a sample size of 150 would be sufficient for the study. We selected 300 consecutive patients who were planned for elective surgery under general anesthesia requiring tracheal intubation between January 2017 to November 2018.

Descriptive statistics in the form of mean and standard deviation for interval/continuous variables and frequency, and percentage for categorical variables were performed. All continuous variables were found with normal distribution, that is, mean, median, and mode were approximately the same. Student t-tests were performed to see mean differences between easy versus difficult laryngoscopy for all interval variables and *p*-values were selected using Levene's test for equal variance. Chi-square tests were performed to see association between categorical variables and easy versus difficult laryngoscopy. Multivariate logistic regression with enter method was performed to see risk factors associated with difficult laryngoscopy using all important and significant variables at univariate analysis. Adjusted odds ratios and 95% CI with *p*-values were presented in the table. C-statistics and ROC with Youden index was calculated to see discriminating accuracy for the difficult laryngoscopy. *P*-value 0.05 (two tailed) was used for the statistically significant level. SPSS 22.0 statistical package was used for the analysis.

Table 1 Overall patient demographic data and airway characteristics.

Patient characteristics (n= 300)	Values
Age (year)	40.9 ± 14.8
Gender (M/F)	182/118
Weight (kg)	60.3 ± 12.3
Height (cm)	162.4 ± 9.6
Body mass index (kg/m^2)	22.9 ± 4.2
Inter-incisor distance (cm)	4.4 ± 0.5
Mallampati class 0/1/2/3/4 (sitting)	1/142/112/36/9
Mallampati class 0/1/2/3/4 (supine)	5/108/115/52/20
Thyromental height (cm)	4.8 ± 0.9
Thyromental distance (cm)	6.7 ± 1.0
RHTMD	24.9 ± 3.5
Sternomental distance (cm)	16.0 ± 2.0
Mandibular length (cm)	9.2 ± 0.7
Mandibular protrusion test Class 1/2/3	284/8 / 0
Upper lip bite test class 1/2/3	277 / 15 / 0
Range of neck movement <80°	3 (1)
Short muscular neck	24 (8)
Neck circumference (cm)	35.7 ± 4.0
Receding mandible	1 (0.3)
Cervical spondylosis	4 (1.3)
History of snoring	72 (24)

RHTMD, ratio of height to thyromental distance.
Values are mean ± SD, numbers, or numbers (per cent).

Results

There were 314 potentially eligible patients. Of these, 308 patients were examined for eligibility as six patients refused to participate in the study. Eight patients did not meet the inclusion criteria, hence the number of confirmed eligible patients was 300. All of them were included in the study, completed follow-up, and analysed.

Mask ventilation was grade 0, 1, 2, 3, and 4 in 0 (0%), 203 (67.7%), 43 (14.3%), 54 (18%), and 0 (0%) patients, respectively. Laryngoscopy was difficult in 46 of 300 (15.3%) patients; all 46 patients presented with Cormack-Lehane grade 3 and no patient had grade 4 view at laryngoscopy. Duration of laryngoscopy was 27 ± 11 (mean ± SD) seconds in patients with difficult laryngoscopy and 12.7 ± 3.9 seconds in easy laryngoscopy; $p = 0.001$. There was no failed intubation.

Overall patient demographic data and airway characteristics are presented in Table 1. The distribution of Cormack-Lehane grades, without and with external laryngeal manipulation, in patients with easy and difficult laryngoscopy are shown in Table 2. Incidence of difficult intubation was 17.0%. Moderate to major difficulty in tracheal intubation was evident in 40 of 46 (87%) patients in whom laryngoscopy was difficult, compared with 11 of 254 (4.3%) patients in whom laryngoscopy was easy (Table 3). Patients with difficult laryngoscopy had a significantly greater number of intubation attempts and number of operators, increased lifting force, need for external laryngeal manipulation, and increased use of alternative techniques; all $p = 0.001$ (Table 3). A statistically significant difference in patients with easy and difficult laryngoscopy was observed in the stance adopted by the anesthesiologists

Table 2 Distribution of Cormack-Lehane grades, without and with external laryngeal manipulation, in patients with easy and difficult laryngoscopy.

Cormack-Lehane grade	Laryngoscopy Easy (n = 254)	Laryngoscopy Difficult (n = 46)	*P*-value
Without external laryngeal manipulation			
1	172 (67.7)	0 (0)	0.000
2	82 (32.3)	0 (0)	
3	0 (0)	46 (100)	
4	0 (0)	0 (0)	
With external laryngeal manipulation (n = 101)			
1	33 (32.7)	0 (0)	0.001
2	67 (66.3)	0 (0)	
3	0 (0)	1 (0.01)	
4	0 (0)	0 (0)	

Values are numbers (per cent).

Table 3 Intubation difficulty scale (IDS) score and variables of IDS.

Variables	Laryngoscopy Easy (n = 254)	Laryngoscopy Difficult (n = 46)	*P*-value
IDS score	1.2 ± 2.0	8.9 ± 3.5	0.001
IDS break score			
0	156 (61.4)	0 (0)	0.001
1-5	87 (34.3)	6 (13)	
>5	11 (4.3)	40 (87)	
Variables of IDS			
Attempts >1	11 (4.3)	29 (63.0)	0.001
Operators >1	5 (2)	9 (19.6)	0.001
Cormack grade 3 and 4	0 (0)	46 (100)	-
Increased lifting force	24 (9.4)	41 (89.1)	0.001
ELM	55 (21.7)	46 (100)	0.001
Alternative techniques	15 (5.9)	32 (69.6)	0.001
Vocal cords adducted	0 (0)	0 (0)	-

ELM, External laryngeal manipulation.
Values are numbers (percent) or mean ± SD.

performing laryngoscopy and intubation; in patients with difficult laryngoscopy, the anesthesiologist leaned backwards, bent at the knee, or stooped to bring the face closer to the patient during laryngoscopy and intubation to obtain the best laryngeal view in 87% (40 of 46 patients) of cases compared with 11.4% (29 of 254 patients) in patients with easy laryngoscopy ($p = 0.001$).

Amongst the patient demographic variables, increasing age ($p = 0.002$) was associated with difficult laryngoscopy (Table 4). Univariate analysis demonstrated the following airway characteristics to be associated with difficult laryngoscopy: modified Mallampati class 3 and 4, TMH, TMD, RHTMD, SMD, IID, short neck, increased neck circumference, receding mandible, cervical spondylosis, and history of snoring (Table 5). Multivariate analysis identified TMH, short neck, and a history of snoring that were independently associated with difficult laryngoscopy (Table 6).

Area under the curve (AUC) of receiver operating characteristic (ROC) curve to predict difficult laryngoscopy from the multivariate regression model and that for TMH for predicting easy laryngoscopy are shown in Figs. 1 and 2, respectively. In our study, the cut-off threshold value for TMH is 4.4 cm with a sensitivity of 66%, specificity of 54% and AUC of ROC curve for TMH with 95% confidence interval (95% CI) is 0.63 (0.54–0.72). If the cut-off threshold value for TMH is taken as 5.0 cm, then the sensitivity decreased to 39%, specificity increased to 76%, AUC of ROC for TMH with 95% CI being the same; 0.63 (0.54 – 0.72). Youden index for RHTMD is 0.41 and the cutoff for prediction of difficult laryngoscopy is 26.7 with a sensitivity of 72% and specificity of 70%.

TMH influenced the duration of laryngoscopy and IDS score severity. Analysis of data showed that a shorter TMH is associated with a higher IDS score; $r = -0.16$, $p = 0.001$. TMH and duration of laryngoscopy were found to be negatively correlated; a shorter TMH was associated with a longer duration of laryngoscopy; $r = -0.13$, $p = 0.03$.

Discussion

We found an incidence of 15.3% and 17% for difficult laryngoscopy and difficult tracheal intubation (IDS score > 5), respectively. We identified three risk factors associated with

Table 4 Demographic data of patients with easy and difficult laryngoscopy.

Parameters	Laryngoscopy Easy (n = 254)	Laryngoscopy Difficult (n = 46)	*P*-value
Age (year)	39.8 ± 14.7	47.1 ± 14.4	0.002
Sex ratio (M/F)	153 /101	29/ 17	0.75
Weight (kg)	59.8 ± 12.2	63.2 ± 12.6	0.08
Height (cm)	162.3 ± 9.8	162.9 ± 8.2	0.70
Body mass index (kg/m^2)	22.7 ± 4.0	23.9 ± 4.8	0.07

Values are mean ± SD or numbers.

Table 5 Airway characteristics of patients with easy and difficult laryngoscopy.

Parameter	Laryngoscopy Easy (n = 254)	Laryngoscopy Difficult (n = 46)	*P*-value
Mallampati class sitting 0/1/2/3/4	1/132/95/23/3	0/10/17/13/6	0.001
Mallampatti class supine0/1/2/3/4	0/245/4/0/0	0/39/4/0/0	0.02
Thyromental height (cm)	4.9 ± 0.9	4.4 ± 0.9	0.005
Thyromental distance (cm)	6.8 ± 1.0	6.1 ± 0.9	0.001
RHTMD	24.4 ± 3.2	27.3 ± 3.8	0.001
Sternomental distance (cm)	16.2 ± 1.9	15.0 ± 2.3	0.002
Interincisor distance (cm)	4.5 ± 0.5	4.2 ± 0.7	0.03
Mandibular length (cm)	9.2 ± 0.7	9.2 ± 0.7	0.46
Neck movement < 80°	1 (0.4)	2 (4.3)	0.06
Neck circumference (cm)	35.5 ± 3.9	36.8 ± 4.3	0.04
Upper lip bite test class 1/2/3	239/10/0	38/5/0	0.05
Short neck	13 (5.1)	11 (23.9)	0.001
Beard	2 (0.8)	1 (2.2)	0.39
Facial malformation	0 (0)	1 (2.2)	0.15
Receding mandible	0 (0)	1 (2.2)	0.02
Cervical spondylosis	1(0.4)	3 (6.5)	0.01
History of snoring	46 (18.1)	26 (56.5)	0.001

RHTMD, ratio of height to thyromental distance.
Values are mean ± SD or numbers (per cent).

Table 6 Predictors of difficult laryngoscopy through multivariate logistic regression.

Variable	Adjusted OR	95% C.I.	*P*-value
Age	1.03	1.0 – 1.06	0.05
Gender Male	0.77	0.18 – 3.39	0.73
Body mass index	0.97	0.84 – 1.11	0.66
Thyromental height	0.53	0.31 – 0.89	0.02
TMD	1.36	0.24 – 7.67	0.73
RHTMD	1.35	0.91 – 2.0	0.14
SMD	1.06	0.75 – 1.50	0.74
Incisors	0.51	0.25 – 1.03	0.06
Neck Circumference	0.95	0.80 – 1.11	0.50
ULBT class 3	2.39	0.29 – 19.5	0.42
MPT class C	8.22	0.58 – 115.9	0.12
Cervical Spondylosis	1.01	0.86 – 166.0	0.10
Short Neck	6.90	1.63 -33.3	0.008
Snoring	3.78	1.50 -9.60	0.005
Constant	0.23	-	0.80

TMD, thyromental distance; RHTMD, ratio of height to thyromental distance; SMD, sternomental distance; ULBT, upper lip bite test; MPT, mandibular protrusion test.
Hosmer and Lemeshow test (chi-square 7.26, df = 8, $p = 0.58$) suggesting observed and expected proportions were same across all data in the model.

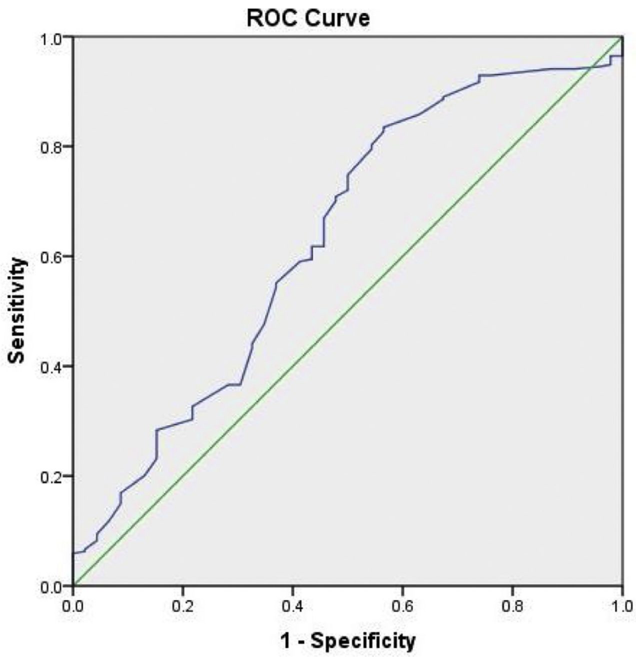

Figure 1 Receiver operating characteristic (ROC) curve to predict difficult laryngoscopy from the multivariate regression model. The area under the curve (AUC) of the receiver operating characteristic (ROC) curve from the multivariate regression model to predict difficult laryngoscopy was 0.85; 95% confidence interval 0.79–0.92.

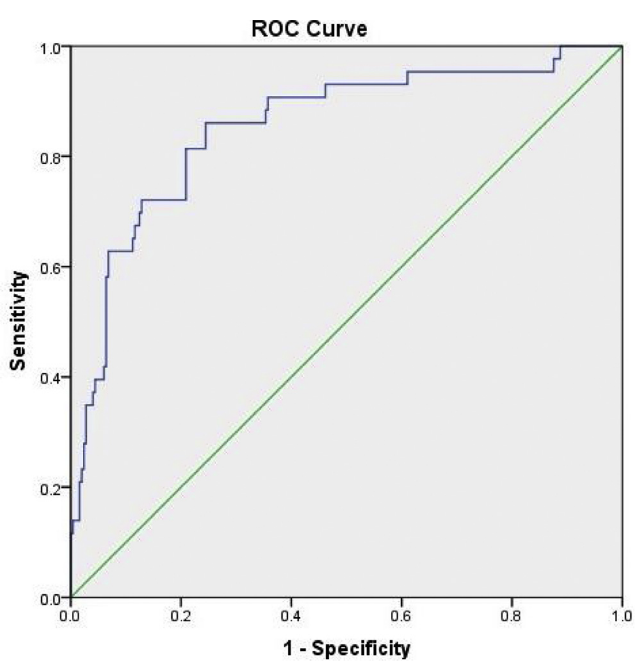

Figure 2 Receiver Operating Characteristic (ROC) curve for thyromental height to predict easy laryngoscopy. The area under the curve (AUC) of the receiver operating characteristic (ROC) curve is 0.63 with 95% confidence interval 0.54–0.72.

difficult laryngoscopy: thyromental height, presence of a short neck, and history of snoring. TMH influenced the duration of laryngoscopy and IDS score severity. The cut-off threshold value for TMH in our study is 4.4 cm with a sensitivity of 66% and a specificity of 54%.

TMD is a frequently used airway assessment test. However, its role as a predictive test for identifying patients with a difficult airway is limited. The mean TMD in our study was 6.7 ± 1.0 cm. Other studies in the Indian population have reported mean TMD values as 7.48 cm, 9.03 cm, 5.95 cm, and 6.5 cm.[10–13] This wide difference in the reported TMD is possibly due to incorrect method of measurement of TMD. The TMD should be measured as a straight distance between the thyroid notch (not thyroid prominence) to the inner bony mentum (not outer aspect of mentum) as TMD is an indicator of ''mandibular space''. In our study, TMD was identified as one of the parameters associated with difficult laryngoscopy in univariate analysis, but not in multivariate analysis. A wide range of TMD cut-off values ranging from 5.5 to 7.0 cm have been used in the literature to predict difficult laryngoscopy.[2] A meta-analysis concluded that the diagnostic value of TMD was unsatisfactory due to a wide range in sensitivity, possibly due to different cut off points (4–7 cm).[14]

TMD is related to body size and proportion. Schmitt et al. introduced the RHTMD to allow for individual body proportions which are not taken into account in the use of TMD.[2] They reported that RHTMD had a better predictive value compared with TMD and suggested a cut-off value of ≥ 25 for this ratio to predict difficult laryngoscopy in Caucasians.[2] Cut-off values for RHTMD recommended for predicting difficult laryngoscopy are 25 in Caucasians,[2] 24 in Iranian patients[15] and 23.5 in Thai patients.[16] The cut-off value derived in the Indian population is 22.1 with a sensitivity of 81.3% and specificity of 84.9 %.[17] In the present study, although there was a statistically significant difference between patients with an easy laryngoscopy and those with difficult laryngoscopy in TMD (6.8 ± 1.0 cm versus 6.1 ± 0.9 cm, respectively) and RHTMD (24.4 ± 3.2 versus 27.3 ± 3.8, respectively), both failed to be of use in the prediction of difficult laryngoscopy and intubation in multivariate analysis.

The thyromental height could be a surrogate for the degree of mandibular protrusion, the submandibular space, and anterior position of the larynx.[3] TMH was proposed by Etezadi et al.[3] and found to be a more accurate predictor of difficult laryngoscopy than the modified Mallampati test, TMD and SMD. They found that the optimal sensitivity and specificity values for TMH ranged between 47.46 to 51.02 mm. They chose a cut-off value of 50 mm to facilitate clinical application. Using the 50-mm cut-off point for TMH, Selvi et al.[18] reported a high sensitivity (91.89%) and high NPV (98.63%) with low specificity (52.2%) and low PPV values (14.7%).

Rao et al.[14] reported that the ROC curve for TMH, modified Mallampati class and inter-incisor gap had AUC value > 0.7, with that of TMH being the highest (0.92). Another study in the Indian population found a sensitivity of 81.25% and specificity of 92.33%, using a TMH cut-off value of 52.17 mm.[19] Contrary to the above results, we could not verify the high efficiency of TMH as a predictive test. The cut-off value of TMH was 4.4 cm with a sensitivity of 66%, specificity of 54% and AUC of ROC curve for TMH was 0.63. If the cut-off threshold value is increased to 5.0 cm, the sensitivity decreased to 39% and specificity increased to 76%. We found TMH, presence of a short neck and a history of snoring to be independently associated with difficult laryngoscopy.

Intubation Difficulty Scale (IDS) is one of the frequently used methods to determine difficult intubation in which a total score over 5 indicates a difficult intubation.[9] TMH influenced the duration of laryngoscopy and IDS score severity. We found that a shorter TMH was associated with longer duration of laryngoscopy and higher IDS scores. Our results are consistent with those of Palczynski et al.,[20] who reported that patients with difficult intubation had a significant lower thyromental height (46 mm vs. 54 mm) and a higher Cormack-Lehane class. An increase in TMH by 1 mm decreased the risk of difficult intubation by 7%.[20] A recent study reported that TMH was the best predictive test for difficult laryngoscopy compared with TMD, RHTMD and Mallampati test.[21] The TMH cut-off value for predicting difficult laryngoscopy was 5.1 cm.[21] Similarly, in our study, TMH was 4.9 ± 0.9 cm in patients with easy laryngoscopy (Cormack-Lehane grade 1 and 2) and was 4.4 ± 0.9 cm in those with difficult laryngoscopy (Cormack-Lehane grade 3 and 4).

TMH is a simple and easily applicable objective measure of difficult laryngoscopy and intubation. Unlike TMD and SMD, that need to be measured in head extension position, TMH is measured in the neutral head position. Therefore, TMH is independent of cervical spine mobility, dentition, and patient's cooperation.[14] A depth gauge is required for accurate measurement of TMH.

Our study has some limitations. We did not include pregnant and obese patients in our study. Hence, our results may not be applicable to this patient population and to those belonging to other racial/ethnic groups, for example, Caucasians.

Conclusion

Thyromental height is a simple bedside test to predict difficult laryngoscopy and difficult intubation. Thyromental height, presence of a short neck, and a history of snoring were independently associated with difficult laryngoscopy in adult patients. On multivariate analysis, thyromental distance and ratio of height to thyromental distance did not prove to be useful as predictors of difficult airway.

Conflicts of interest

The authors declare no conflicts of interest.

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