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COMPARISON OF THYROMENTAL HEIGHT TEST WITH RATIO OF HEIGHT TO THYROMENTAL DISTANCE AND MODIFIED MODIFIED MALLAMPATI TEST IN PREDICTING DIFFICULT LARYNGOSCOPY: A PROSPECTIVE OBSERVATIONAL STUDY.

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ABSTRACT A prospective observational single- blinded, comparative study was conducted to evaluate the accuracy of the TMHT in predicting difficult laryngoscopy, compared with the other established bedside airway parameters like Modified Mallampati Test (MMT), Thyro-Mental Distance (TMD) and Ratio of Height to Thyromental Distance (RHTMD). A total of 150 patients of American Society of Anesthesiologists (ASA) physical status I & II, aged between 18-60 years, BMI < 30 kg/m2 scheduled for elective surgery under general anesthesia (GA) with endotracheal intubation, were enrolled in the study. The airway assessment tests TMHT, TMD, RHTMD and MMT were performed in the preoperative holding area. A standard GA protocol was followed in all cases. In this study, we have considered CL Grade IIb III and IV as difficult laryngoscopy. 45 out of 150 cases were intubated with optimum external laryngeal manipulation/ backward upward rightward pressure/with the help of gum elastic bougie, within 15 seconds of intubation time. Video laryngoscope was used in 2 out of 25 cases of difficult laryngoscopy which had significantly low TMHT (36mm and 38mm), low TMD (5cm and 5.6cm) and belonged to MMT class IV. In our study, the TMHT demonstrated the highest sensitivity of 72%, specificity of 100%, positive predictive value (PPV) of 100%, and accuracy of 95% compared to TMD, RHTMD and MMT, thus indicating that TMHT is the best predictor of difficult laryngoscopy. RHTMD showed low sensitivity of 47% and high NPV of 95%. From the receiver operating characteristic curve (ROC), the area under the curve (AUC) for TMHT was calculated to be 0.99 which indicates that this has highest predictive value compared to other airway assessment tests.

KEYWORDS : Ratio of Height to Thyromental Distance, Difficult Airway

INTRODUCTION:

Successful endotracheal intubation (ETI) is an integral part of airway management. Failed intubation and acute hypoxia are amongst the major contributors of anesthesia related mortality and morbidity. The reported incidence of difficult laryngoscopy and intubation is 1.5%–13% [1,2,3,4,5] and cannot intubate and cannot ventilate is 0.0001%–0.02%. [2,6] It is reported that of all the anesthesia related deaths, 30%–40%, are attributed to inability to manage difficult airway[1] Hence, there is an absolute need of correctly anticipating and predicting a difficult airway, which includes difficult mask ventilation, difficult laryngoscopy and difficult ETI. Various airway parameters are used either singly or in combination to predict difficult laryngoscopy. However, none of them appears to be sensitive and specific enough to effectively predict difficult intubation. Recently, Thyromental height test (TMHT) has been proposed as a surrogate for frequently cited anthropometric measurements like mandibular protrusion, submandibular space dimensions and anteriorly placed larynx.[7]

Thyromental height (TMH) is defined as the height between the anterior border of the thyroid cartilage (on the thyroid notch just between the 2 thyroid laminae) and the anterior border of the mentum (on the mental protuberance of the mandible). It is measured with a depth gauge during routine preoperative anaesthetic visit in supine position and closed mouth.

TMHT is reported to have better predictability but not many published studies have compared it with other indices for predicting difficult laryngoscopy. We aimed to assess the role of TMH in predicting difficult laryngoscopy compared with modified Mallampati test (MMT), thyromental distance (TMD), and Ratio of Height to Thyromental Distance (RHTMD).

Aim & Objective:

The aim of this prospective observational study is to assess the role of TMHT in predicting difficult laryngoscopy, compared with the other established bedside airway parameters like MMT, TMD and RHTMD. The primary objective of this study was to determine accuracy of TMHT in predicting difficult laryngoscopy by using different validity indexes like sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy.

Secondary objective was to determine an airway predictor with highest diagnostic accuracy for predicting difficult laryngoscopy among the parameters like TMHT, TMD, RHTMD & MMT, correlating with Modified Cormack-Lehane grading.

Methodology:

This prospective, single blind, observational study of one-year duration (November 2020 to December 2021) was conducted in a tertiary care teaching hospital, after obtaining clearance from the institutional scientific research and ethics committee. 150 adult patients of either gender, between 18 to 60-years age, belonging to ASA I and II and scheduled for elective surgery under GA with ETI were enrolled in the study. After completion of a thorough preanaesthetic evaluation, informed written consent was obtained from all patients. Edentulous patients, those with craniofacial abnormality, neuromuscular disorders, cervical spine injury, midline neck swellings, unable to sit or strand, those requiring awake intubation, rapid sequence induction or posted for emergency procedures under GA, ASA 3 and 4, BMI > 30 kg/m2 and denying consents were excluded from the study.

The demographic data (age, gender, ASA class, height, weight, body mass index, etc.) was recorded along with the measurements obtained during detailed airway examination, namely MMT, TMD, TMHT and RHTMD. Airway assessment was done in the preoperative holding area by two experienced anaesthesiologists in order prevent observer bias.

TMH (distance between anterior border of thyroid cartilage and mentum = AB in Figure 1 a) was measured by a depth gauge in the neutral neck position keeping the patient in supine position with mouth closed. (Figure 1b) A height less than 50 mm was considered to be a predictor of difficult laryngoscopy, which was subsequently assessed clinically by experienced anesthetists by correlating with modified Cormack Lehane Grading, during direct laryngoscopy and intubation, but blinded to the preoperative airway assessment.

Figure 1 (a) **Figure 1 (b)**

TMD was measured using a rigid ruler, between the upper border of the thyroid cartilage and the bony point of mentum with patient's head

extended and mouth closed. TMD <6.5cm was considered predictive of difficult laryngoscopy. The RHTMD was calculated by the formula: RHTMD = Height in cm/TMD in cm and RHTMD > 23.5 was considered anticipatory of difficult laryngoscopy. MMT score was calculated depending on the visibility of the pharyngeal structures with the patient in a sitting posture, mouth widely open and tongue protruded without phonation. MMT Class 3 and Class 4, was considered as predictors of difficult laryngoscopy.

A standard GA protocol was followed in all cases. In the operating room, patients head was made to rest on a firm pillow of 10 cm height, standard ASA monitors were attached and GA was induced with 2µg/kg Inj. Fentanyl IV and 2-2.5mg/kg Inj. Propofol IV. After ensuring adequate mask ventilation, ETI was facilitated with 0.5mg/kg Inj. Atracurium IV and thereafter anaesthesia was maintained with titrated concentration of Sevoflurane with oxygen and air (50:50). Direct laryngoscopy was performed by an anaesthesiologist with a minimum of 5-year experience, using a Macintosh size 3 or 4 laryngoscope blade, with the patient in sniffing position, and the glottic view was graded using the modified Cormack–Lehane (CL) scale from I– IV without any external laryngeal maneuver. In order to minimize interobserver bias, the ETI and CL grading was done by a single experienced anaesthesiologist who not associated with the assessment of the preoperative airway indices.CL grades 1 and 2a was considered as "easy" laryngoscopy, CL Grades 2b and 3a as "restricted view" and CL grades 3b and 4 designated as difficult laryngoscopy. Tracheal intubation was considered easy, when performed within 15 seconds without any maneuver or additional intubation aids and noted as difficult if the procedure took longer than 15sec requiring any of the above additional means.

ROC curves were constructed and the area under the curve (AUC) was calculated for each index followed by comparison of the diagnostic accuracy of these tests with 95% confidence interval (CI). The validity indices of TMHT, TMD, RHTMD and MMT were compared and the best airway assessment predictor for difficult laryngoscopy was determined (Table 4). Greater area under the curve meant more reliability and discriminative power. The optimum cut-off values of TMHT, TMD and RHTMD was also determined from the ROC curve.
The necessary sample size was estimated to be 140 patients with a 95% confidence interval and alpha level of 0.05, with a precision of 5% to study the accuracy of Thyromental height as a preoperative airway assessment parameter to predict difficult laryngoscopy with incidence of 10%. We studied 150 population to compensate for dropouts. Statistical analysis was performed using Statistical Package for Social Sciences (SPSS) version 18.0 (SPSS Inc., Chicago, IL, USA). Kolmogorov-Smirnov analysis was used to check if data is following the normal distribution while Fischer exact test or Chi-square test was used to check the significance of difference between frequency distribution of data in different groups. Student's t test or Mann-Whitney U test was used to study significance of difference between two groups. Pearson's rank order correlation analysis and spearman's correlation analysis were used to assess correlation between two variables. To assess the difference between three groups ANOVA was used. P value < 0.05 was considered to be statistically significant.

OBSERVATION AND RESULTS:

This prospective, observational, single blinded comparative study involved 150 patients, aged between 18-60 years, requiring general anesthesia with elective ETI. All the enrolled 150 patients completed the study. The demography data (age, weight, height, BMI, gender) was comparable and not clinically significant. Fifty nine percent patients were ASA 1 and remaining 41 % were ASA 2 (non-significant). (Table 1)

Table 1

Variables	Mean		SD	Range
Age (years)	47.15		13.6	18-74
Weight (kg)	65.65		9.94	44-96
Height (cm)	161.89		8.8	142-185
BMI (kg/m^2)	25.17		2.99	18.1-29.8
Gender	Male(%) 54%	Female(%) 46%		

Of the 150-study population, 127 cases had MMT I&II of which 116 cases had easy laryngoscopy while laryngoscopy was difficult in 11 cases.23 cases had MMT III & IV of which 11 cases out of 23 cases had easy laryngoscopy (CL I & II a) and 14 cases underwent difficult laryngoscopy. The correlation of easy and difficult laryngoscopy related to each of the airway assessment tests namely TMHT, TMD, RHTMD and MMT were found to have statistically significant p value (<0.001). (Table 2)

Table 2

Comparison between CL grades and four preoperative airway assessment tests (TMHT, RHTMD, TMD, and MMT)

		Laryngoscopy		P-Value
		Easy	Difficult	
TMHT	*Easy>5cm*	125	7	<0.001
	Difficult<5cm	0	18	
TMD	*Easy >6.5cm*	125	9	<0.001
	Difficult<6.5cm	0	16	
RHTMD	*Easy<23.5*	103	5	<0.001
	Difficult >23.5	22	20	
MMT	*Easy(I and II)*	116	11	<0.001
	Difficult(III & IV)	9	14	

Table 3 Manoeuvres/ Equipment used as an aid for endotracheal intubation

BURP (backward upward rightward pressure	2 patients
OELM (optimum external laryngeal maneuver)	25 patients
BOUGIE	7 patients
OELM + BOUGIE	11 patients
VIDEO LARYNGOSCOPE	2 patients

In total of 45 cases out of 150cases manoeuvres like OELM, BURP with or without Bougie as intubation aid was used. Video laryngoscope was used in 2 out of 25 cases of difficult laryngoscopy which had significantly low TMHT (36mm and 38mm), low TMD (5cm and 5.6cm) and belonged to MMT class IV (Table 3). There was no failed intubation in our study.

Table 4

Validity indexes for TMHT, RHTMD, TMD, and MMT to predict the occurrence of difficult laryngoscopy

Test	TP	TN	FP	FN	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
TMH	18	125	0	7	72%	100%	100%	91%
TMD	16	125	0	9	64%	100%	100%	93%
RHTMD	20	103	22	5	47%	20%	48%	95%
MMT	14	116	11	9	56%	91%	55%	92%

TEST	Accuracy	AUC	P	95% C.I
TMH	95%	0.99	<0.001	0.98-1.006
TMD	94%	0.92	<0.001	0.85-1.00
RHTMD	82%	0.14	<0.001	0.039-0.24
MMT	86%	0.22	<0.001	0.10-0.33

TMH (Thyromental height) test was found to have the highest sensitivity (72%), PPV (100%), least NPV (91%) and better accuracy (95%) compared to other airway assessment tests TMD, RHTMD, MMT. However, specificity of TMHT was found to be similar to TMD.

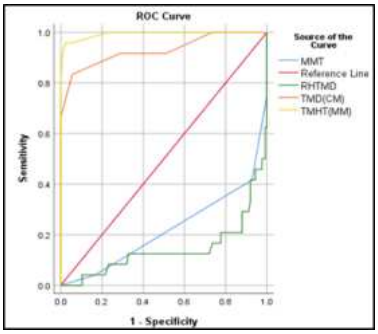

Figure 1 Receiver operating characteristic (ROC) curve for TMHT, TMD, RHTMD and MMT

ROC curves were created and the area under the curve (AUC) was calculated for each of the above studied indices. AUC was found to represent the largest area for TMHT, thus indicating it as the best predictor compared to other assessment tests like TMD, RHTMD and

MMT. All tests have p value<0.001 which is statistically significant. ROC curve for TMH and TMD lies above the diagonal reference line indicating them as good predictors as compared to RHTMD and MMT which lies below this line (Figure 1). The optimum cut-off value derived from ROC curve was found to be 50mm for TMH (AUC 0.99 with 95% CI 0.98-1.006), 6.5cm for TMD (AUC 0.92 with 95% CI 0.85-1.00) and 23.5 cm for RHTMD (AUC 0.14 with 95% CI 0.039-0.24).

DISCUSSION:

The incidence of difficult laryngoscopy and intubation reported by numerous studies varies from 1.3% to 13% in patients undergoing general anesthesia. [8,9,10,11] This wide variation in incidence of difficult laryngoscopy and intubation can be attributed to lack of uniformity in the practice of laryngoscopy and intubation as in head and neck positioning, application of Sellick maneuver, external laryngeal manipulation, multiple attempts, type of blade used, and varying skill of anesthesiologists[12]

In this study, the incidence of difficult laryngoscopy (CL IIb, III and IV) occurred in 25/ 150 cases (16.6%) which is high comparable to previous studies like 9.7 % incidence in a study by Prakash S et al [13] & 10% Panjiar, et al. [14.] Inclusion of CL Grade IIb (represented restricted glottic view) under difficult laryngoscopy is the reason of deriving slightly higher incidence of the latter compared to the former similar studies.

Predictors such as weight, head and neck movement, jaw movement, receding mandible, buck teeth, modified Mallampati classification, TMD, sternomental distance (SMD), mouth opening, and Wilson risk score are not foolproof to predict a difficult intubation.[15] Hence, there arises need for a bedside airway assessment test, that is quick and easy to perform; highly sensitive and specific and easily interpretable.

An ideal airway predictor should have a high sensitivity, specificity, and PPV. TMHT is a recent airway predictor proposed by Etezadi et al. for the assessment of difficult airway[16]. Etezadi et al in their study, found the sensitivity of TMHT as 82.6% (CI 74%–88%), is approximately equal to Naguib et al.'s multivariate clinical model[18]. Panjiar, et al[14] has also found TMHT as the most accurate predictor compared with other airway predictors like MMT, TMD and SMD. Moreover, TMHT is not dependent on active head extension, patient's cooperation, adequate cervical spine mobility, and can be done in patients with contraindication for full head extension.

In our study, the cut off value for TMHT was 50mm in assessing difficult laryngoscopy which is similar to the study of Etezadi et al[16] and found that 18 cases out of 150 cases had TMHT <50 mm associated with difficult laryngoscopy in all of them. We found the sensitivity of TMHT to be 72% , specificity 100%, PPV 100%, NPV 100% and accuracy was calculated to be 95% which is almost similar to the study conducted by Panjiar, et al.[14]. The area under the ROC curve, which is a measure of accuracy and discriminative power was found to be higher for TMHT in our study. We however found the sensitivity and accuracy of RHTMD was lower in our study, due to anthropometric differences among population. The ROC curve for TMHT and TMD lies above the diagonal line indicating them as good predictors compared to RHTMD which lies below diagonal line indicating its negative correlation to ease of intubation. In our study, the next best predictor was found to be TMD with 64% sensitivity, 100% specificity, 100% PPV, 93% NPV and 94% accuracy. As compared to the study conducted by Panjiar, et al[14], the sensitivity, specificity, PPV and accuracy of TMD was higher in our study and moreover the sensitivity and accuracy of TMD was higher than RHTMD and MMT. RHTMD addresses the body proportions of the patient and hence should be a better index than TMD. However, unlike other studies RHTMD in our study, showed lower sensitivity, specificity and accuracy in comparison to TMD.

Samsoon and Young's[6] modification of the Mallampati test is a routinely used simple, bedside, clinical airway assessment test and has been commonly practiced as an airway predictor since many years, but it has a higher interobserver variability and a large number of false positives. In our study MMT was found to have 56% sensitivity, 91 % specificity, 55% PPV, 92% NPV and an accuracy of 86% which is comparable to study conducted by Jain, et al.[7]. Panjiar, et al [14] in their study showed sensitivity of MMT to be 32.73% which is much lower compared to our study, however the specificity 94.55%, PPV 28.95%, NPV 91.41% and accuracy 88.36% which are similar to our study results. MMT as a single test, has low sensitivity and accuracy but when combined with other airway assessment tests like TMHT, MMT can be used as a better predictor.

When we compared the four tests, the single best test was found to be TMHT since it showed high specificity, PPV, NPV and accuracy and with moderate sensitivity, and independent patient cooperation. Predictive value of any single clinical test is limited.[17] TMHT was found to be a better predictor of difficult laryngoscopy, as compared to all available bedside airway predictors. By performing all the four tests parallelly,we can increase the sensitivity to 100% so that all cases of difficult laryngoscopy can be correctly predicted.

Study Limitation:

Anthropometric variations in different populations makes it challenging to get an optimum cut off value for many indices predicting difficult intubation uniformly in all groups of population, hence our result may not be applicable to other racial groups. Further research will be required in this field. A thorough preoperative airway assessment and meticulously following the difficult airway algorithms are indispensable tools for preventing airway related catastrophes and critical events in our day to day practice.

CONCLUSION:

Our study concluded that TMHT is a far better predictor of difficult laryngoscopy, as compared to other bedside airway predictors like TMD, RHTMD and MMT. Since difficult airway is multifactorial in origin, using combination of tests would be more reasonable and will definitely yield better results than a single test alone.

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