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A Comparative Study Of The Modified Mallampati Classification With The Ratio Of Patient's Height To Thyromental Distance And Upper Lip Bite Test In Predicting Difficult Laryngoscopy.

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Abstract: ***Background****: Various simple bedside preoperative anaesthetic airway assessment can be performed to predict difficult intubation. The present study was aimed to compare the predictive value of modified mallampati test (MMT) with upper lip bite test (ULBT) and ratio of patient's height to thyromental distance (RHTMD) for difficult laryngoscopy and airway.* ***Methods****: 65 patients aged 18-65 years of either sex, ASA grade I and II undergoing elective surgery under general anaesthesia were assessed and graded for ULBT, RHTMD and MMT according to standard methods and correlated with the Cormack and Lehane grading. Sensitivity, specificity, positive and negative predictive value, Receiver operating characteristic (ROC) Curve and the area under ROC curve (AUC) for each airway predictor in isolation were determined.* ***Results:*** *RHTMD has higher sensitivity, specificity, better positive predictive value, negative predictive value and accuracy compared to MMT and ULBT.* ***Conclusion****: RHTMD is superior to ULBT and MMT as a useful bedside screening test for preoperative prediction of difficult laryngoscopy.*

Key Words: *Airway assessment, prediction of difficult intubation, MMT, ULBT and RHTMD*

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I. Introduction

Airway management by tracheal intubation using direct laryngoscopic remains prime importance to the anaesthesiologist **[1]** Difficult laryngoscopy/intubation may cause various complications viz hypoxic brain damage or even death.[2] Several preoperative airway assessment tests have been proposed to identify patients with difficult intubation [3-7] thereby allowing the anaesthesiologists to take precaution to decrease the risk**.** [8]

Many bedside airway screening tests have been practiced for predicting difficult laryngoscopy or intubation. Tests like Patil's measurement of Thyromental distance, the Mallampati test and the Wilson scoring system which have been shown to have high false positive rates, which detract their usefulness. [9, 10] Ideally, any preoperative assessment of difficult tracheal intubation should have high sensitivity and specificity to result in minimal false positive or negative values. [10]. So, there is a need for a test, which is quick and easy to perform, highly sensitive and specific. The present study was an attempt to compare the predictive value of MMT classification with ULBT and RHTMD as methods of airway assessment for difficult laryngoscopy.

A new screening test, Upper lip bite test (ULBT) was found to have higher accuracy, specificity, positive predictive value than Thyromental Distance (TMD). [11] Although this technique shows much promise, limited data exist to support its wide spread adaptation as the method of choice for preoperative assessment.[7] Hence, we proposed this study to compare the ability of test to predict the visualization of larynx using modified mallampati classification, ratio of patient's height to thyromental distance and upper lip bite test.

II. Material And Methods

Following institutional ethical committee approval and obtaining written inform consent from all the patients, this study was performed on 65 patients with ASA I to III aged 18 to 65 of either sex posted for elective surgery under standard general anaesthesia in a tertiary Medical Institute at Imphal. Patients with a history of previous surgery, burns, trauma to the airways or to the cranial, cervical, and facial regions, patients with tumors or a mass in the above mentioned regions, patients with restricted motility of the neck and

mandible, inability to sit, edentulous were excluded from the study. Preoperatively, the subsequent three predictive test measurements were carried out on all patients to evaluate the airway by a single physician.

Modified mallampati test (MMT): Modified mallampati test records oropharyngeal structures visible upon maximal mouth opening.[12] While seated, each patient was asked to open mouth maximally and to protrude tongue without phonation. The view was classified as (Class 0) ability to see any part of the epiglottis upon mouth opening and tongue protrusion, (Class 1) soft palate, uvula, fauces, pillars visible, (Class 2) soft palate, uvula, fauces visible, (Class 3) soft palate, base of uvula visible, (Class 4) only hard palate visible.

Ratio of height to thyromental distance: RHTMD: TMD was measured from the bony point of the mentum while the head was fully extended and the mouth closed.[13]Then the ratio of height to TMD was calculated. $\boldsymbol{RHTMD} = \frac{\boldsymbol{Height\ (incms)}}{\boldsymbol{TMD\ (incms)}}$

Upper lip bite test: The ULBT was rated as Class 1 if the lower incisors could bite the upper lip above the vermilion line, Class 2 if the lower incisors could bite the upper lip below the vermilion line and Class 3 if the lower incisors could not bite the upper lip. [11]

On the day of surgery intravenous line was secured prior to induction and patients were premedicated intravenously with ranitidine 1mg/kg, glycopyrrolate 10mcg/Kg, metoclopramide 150mcg/kg and butorphenol 15mcg/kg in the pre operative room , once the patient was shifted to the operating theatre, patients were monitored with an electrocardiogram, non-invasive blood pressure and pulse oximeter. After pre oxygenation with 100% oxygen for 3 minutes, patients were induced with IV propofol 2 mg/Kg and the endotracheal intubation was accomplished with suxamethonium 2 mg/Kg by an experienced anaesthesiologist who was not informed of the preoperative classes. The patients' head and neck were kept in optimal intubating position with an appropriate size head ring under the occiput during intubation (sniffing position), laryngoscopy was done using Macintosh blade #3 and glottic view was graded according to the Modified Cormack and Lehane grading without any external laryngeal manipulation. [14] Grade-1: Vocal cords visible, Grade-2: Only posterior commissure of arytenoids visible, Grade-3: Only epiglottis seen, none of glottis seen, Grade-4: None of the above. Difficult visualization was described as grade 3 and grade 4 classifications. Easy visualization was described as grade 1 and grade 2 classifications. Confirmation of intubation was done by bilateral auscultation of lung fields and capnography.

III. Statistical Analysis:

At the end of surgery patients were adequately reversed with inj. Glycopyrrolate 10 mcg / kg and inj. Neostigmine 50 mcg / kg and extubated after through oral suctioning. The data received during the preoperative airway assessment and the findings during laryngoscopy/ intubation (MMT, RHTMD, ULBT, and CL grade) for each patient were calculated for sensitivity, specificity, positive and negative likelihood ratio (LR+ & LR-), positive predictive value (PPV), and negative predictive value (NPV). Descriptive and inferential statistical analysis had been carried out in present study. Sensitivity, specificity, and (Receiver operating characteristic) ROC curve would be used to test the significance between proportions. A *P* value of < 0.05 would be considered significant. Results on continuous measurements was presented on Mean ± SD and results on categorical measurements was presented in Number (%). Significance was assessed at 5 % level of significance. Analysis of variance (ANOVA) had been used to find the significance of study parameters between three or more groups of patients, Chi-square/ Fisher Exact test had been used to find the significance of study parameters on categorical scale between two or more groups, Non-parametric setting for Qualitative data analysis, Sensitivity, Specificity, positive and negative predictive values (PPV & NPV), Accuracy were computed to find MMT, ULBT and RHTMD predict the difficult intubation of Cormack and Lehane grading (CL). Statistical analysis was carried out using software SPSS 18.0, and R environment ver.3.2.2 for the analysis of the data and Microsoft word and Excel had been used to generate graphs, tables etc**.**

Results: A total of 65 patients were included in our study and their demographic data are presented in **Table 1** below. All the patients were successfully intubated.

Table-1 Demographic data of the patient studied (n=65)

Variable	Value
Age (yrs) mean±SD	38.42±12.54
Sex:Male n(%) Sex: Female n(%)	15(23.1) 50(76.9)
Wt (kgs) mean±SD	59.41±13.35
Ht (cms) mean±SD	162.98±8.24
ASA: Class I n(%) ASA: Class II n(%)	30(46.2) 35(53.8)
TMD mean±SD	7.11±0.56
RHTMD mean±SD	23.03±1.85

Figure 1 Distribution of patients studied (n=65) according to Cormack-Lehane (CL) grading

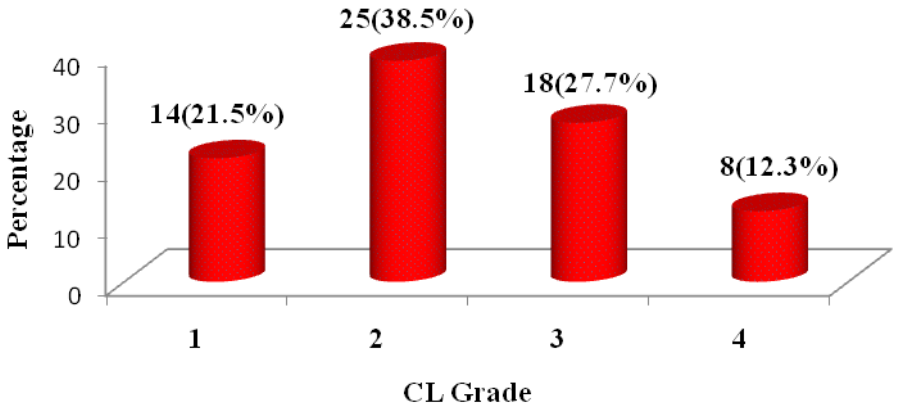

Table 2 Frequencies of airway assessment classification (n=65)

Class	MMT		ULBT		CL grade	
	n	%	n	%	n	%
1	9	13.8	16	24.6	14	21.5
2	25	38.5	28	43.1	25	38.5
3	26	40.0	21	32.3	**18**	**27.7**
4	5	7.7	-	-	**8**	**12.3**

Table 3 below shows the comparison of age, height, weight, TMD and RHTMD in relation to MMT (P=0.002) and ULBT (P= 0.023) respectively which were found significant only in the variable of height.

Variables	**MMT**				Total	P value
	1	2	3	4		
Age in years	34.44±16.22	39.44±12.48	40.04±12.18	32.00±4.00	38.42±12.54	0.429
Height (cm)	**156.33±8.77**	**161.12±6.40**	**165.69±7.97**	**170.20±7.53**	**162.98±8.24**	**0.002****
Weight (kg)	54.56±9.84	59.52±14.69	60.34±14.07	62.80±7.43	59.41±13.35	0.660
TMD	7.00±0.66	7.04±0.60	7.10±0.47	7.68±0.46	7.11±0.56	0.116
RHTMD	22.54±1.88	22.87±1.50	22.11±3.78	22.26±1.01	22.47±2.65	0.789
	ULBT				Total	P value
	Class 1	Class 2	Class 3			
Age in years	37.75±13.3	38.86±12.17	38.33±13.02		38.42±12.54	0.962
Height (cm)	158.44±8.07	165.43±8.33	163.19±7.07		162.98±8.24	0.023*
Weight (kg)	58.94±6.89	59.71±13.54	59.38±16.94		59.41±13.35	0.984
TMD	6.99±0.61	7.23±0.57	7.02±0.51		7.11±0.56	0.293
RHTMD	22.42±1.37	21.72±3.56	23.52±1.46		22.47±2.65	0.062

*Highly significant, ** strongly significant

Table 4a Predictive values (Chi-square test) for MMT, ULBTCL and RHTMD to predict difficult intubation (CL grade 3&4).

Test		CL grading		Total	P Value
		Easy Intubation (CL 1&2) n=(%)	Difficult Intubation (CL 2&3) n=(%)		
MMT	Easy	19(48.7%)	15(57.7%)	34(52.3%)	0.478 (not significant)
	Difficult	20(51.3%)	11(42.3%)	31(47.7%)	
ULBT	Easy	35(89.7%)	9(34.6%)	44(67.7%)	
	Difficult	4(10.3%)	17(65.4%)	21(32.3%)	**0.001****
RHTMD	Easy	39(100%)	6(23.1%)	45(69.2%)	
	Difficult	0(0%)	20(76.9%)	20(30.8%)	**0.001****

When compared MMT according to its difficulty in relation to CL grading it was found statistically not significant P=0.478, whereas the comparison of both ULBT and RHTMD in relation to CL grading for difficulty in intubation were found statistically significant with P<0.001 (Table 4).

Table 4b Predictive value (Fisher Exact Test) for MMT and ULBT to predict difficult intubation in relation to Cormack-Lehane (CL) grade (n=65).

MMT	CL 1	CL 2	CL 3	CL 4	Total	P value
1	**6(42.9%)**	0(0%)	2(11.1%)	1(12.5%)	9(13.8%)	
2	4(28.6%)	9(36%)	**9(50%)**	3(37.5%)	25(38.5%)	
3	3(21.4%)	**13(52%)**	6(33.3%)	4(50%)	26(40%)	P=0.052+

4	1(7.1%)	**3(12%)**	1(5.6%)	0(0%)	5(7.7%)	
Total	14(100%)	25(100%)	18(100%)	8(100%)	65(100%)	
ULBT	1	2	3	4	Total	P value
1	**12(85.7%)**	3(12%)	1(5.6%)	0(0%)	16(24.6%)	P<0.001**
2	2(14.3%)	**18(72%)**	5(27.8%)	3(37.5%)	28(43.1%)	
3	0(0%)	4(16%)	**12(66.7%)**	5(62.5%)	21(32.3%)	
Total	14(100%)	25(100%)	18(100%)	8(100%)	65(100%)	

+ Suggestive significance (P value: 0.05<P<0.10)

Table 5 Correlation of MMT, ULBT and RHTMD in percentage to predict difficult intubation in relation to Cormack-Lehane (CL) grading

Test	Observation					Correlation					P value
	TP	FP	FN	TN	Total	Se	Sp	PPV	NPV	Accuracy	
MMT	11	20	15	19	65	42.31	48.7	35.5	55.9	46.2	0.477
ULBT	17	4	9	32	65	**65.4**	**89.7**	**80.9**	**79.6**	**80.0**	**<0.001****
RHTMD	20	0	6	39	65	**76.9**	**100.0**	**100.0**	**86.7**	**90.8**	**<0.001****

TP=True positive; FP=False positive; FN=False negative; TN=true negative; Se= sensitivity; SP=specificity; PPV=positive predictive value; NPV=Negative predictive value.

Table 6 ROC Curve analysis

Variables	**ROC results to predict Difficult Intubation (CL Grade)**				**Cut-off**	**AUROC**	**Specificity**	**P value**
	Sensitivity	**Specificity**	**+LR**	**-LR**				
RHTMD	88.46	100.00	1.57	0.12	>22.80	0.903	0.056	**<0.001****
MMT	57.69	51.28	1.18	0.83	≤2.0	0.540	0.067	0.551
ULBT	65.38	89.74	6.38	0.39	>2.0	0.825	0.045	**<0.001****

+LR=positive likelyhood ratio; -LR=negative likelyhood ratio

IV. Disscussion

The maintenance of a patent airway is of prime concern while caring for a patient, especially under general anesthesia.[15] Its failure due to difficult intubation is one of the most common causes of anaesthesia related morbidity and mortality. [16,-18] A thorough preoperative physical and clinical examination including airway assessment are crucial for assessments and prediction of possible airway difficulties and its effective management to avoid any life threatening complications.

Table 2 shows the frequencies of classifications on the three airway assessments. There were 26(40%) patients with an MMT grade of III and 5(7.7%) patients with grade IV; 21(32.3%) demonstrated with ULBT of grade III. A grade III or IV on the CL scale was exhibited by 26(40%); all were successfully intubated.

In the present study, according to CL grading, the incidence of difficult intubation was found to be 40% **(Figure 1 & Table 2)** which is in contrast when compare to the results obtained by Evan Hester *et al* [19] i.e. 18%. However the reported incidence of difficult laryngoscopy was 1.3%, 1.5%, 1.8%, 3.5%, 4%, 4.5%, 4.9%, 7%, 8%, and 13% depending on the criteria used to characterized it.[20-22] Those with difficult grading in MMT, ULBT had a higher mean height as compared to those with easy grading of MMT and ULBT respectively. i. e height is associated with difficult intubation as per MMT,ULBT. Similarly weight, TMD and RHTMD were not significantly associated with MMT grading and ULBT grading (p =0.002, p= 0.023 respectively) **Table 3.**

When compared MMT according to its difficulty in relation to CL grading it was found statistically not significant (P=0.478), whereas ULBT and RHTMD when compared in relation to CL grading for difficulty in intubation both were found statistically significant P<0.001 **(Table 4a).** Our finding is in consistent with the study of Khan *et al* [11] and also supported by the finding of Hester *et al* [19] which reported that ULBT was superior in every aspect studied, including sensitivity (55% vs. 11%), specificity (97% vs. 75%), positive predictive value (83% vs. 9%), and accuracy (90% vs. 64%).

The results of our study also shows that ULBT was second best test, with higher sensitivity, specificity, PPV, NPV. About 85.7% of patients had grade I in both ULBT and CL grade, 72% had grade II in both ULBT & CL, 66.7% had grade III in both. However 62.5% belonged to grade IV in CL and grade III in ULBT. The difference was found to be statistically significant with p <0.001. The results are comparable with the study of Khan *et al*,[11] which also support our finding. The variations in statistical data could be due to population differences **(Table 4b).**

In the present study, we found lower sensitivity and lower specificity of Mallampati score when compared to the studies of Iohom *et al* [23] and Oates *et al* [18] . It was found that 42.9% of patients had grade I in both CL grading and MMT classification, 36% as grade II in both grading, 33.3% as grade III and none of the patients had grade IV in both the grading systems. This difference was found to be statistically significant (p <0.05) which confirms the low specificity and sensitivity of the test **(Table 4b)**.

Tse *et al* [22] evaluated one or more anatomic features of the head for prediction of difficult intubation and found sensitivity and specificity of TMD were 33% and 80% respectively. The results of our study are comparable to the values obtained in the above mentioned study. In our study, it was found that 100% of those with easy intubation (CL) also had easy grading in RHTMD and 76.9% of those with difficult intubation (CL) showed difficult grading in RHTMD. The results were statistically significant ($p < 0.001$). The sensitivity, specificity, PPV , NPV and accuracy of RHTMD were found to be 76.9%,100%,100%,86.7% and 90.8% respectively (**Table 5).**

Krobbuaban *et al* [24], conducted a study and found the sensitivity and specificity of RHTMD as 83% and 65% respectively. Schmitt *et al* [25] presented a study that determined a sensitivity and specificity of RHTMD as 81% and 90% respectively. In our study, we had higher sensitivity and specificity compared to above mentioned studies. As per our study, RHTMD has higher sensitivity, specificity, better positive predictive value, negative predictive value and accuracy compared to MMT and ULBT.

We used the analysis of ROC curves to assess and compare the overall performance of the predictive tests. In our study the Area under Curve (AUC) of RHTMD was 0.903, it is significantly higher than MMT (0.0540) and ULBT (0.825), indicating a more accurate prediction of RHTMD with *p* value of 0.001**(Table 6).**

The results clearly demonstrated that the RHTMD has a higher predictive value compared to ULBT and MMT. This result is not unexpected since the RHTMD takes individual proportions into account. The ease of calculation using routinely measured vital parameters (weight and height) and less time consuming bedside measurements (TMD) makes it a handy tool for prediction of difficult airway.

V. Limitations Of Our Study:

Though Mallampati scoring system based on oropharyngeal structures has been in use for more than two decades, over the years many of its limitations have been pointed out by various trials. The absence of a definite demarcation between class II and III and between class III and IV, the effect of phonation and patient's cooperation leads to high inter-observer variability and decreased reliability. In our evaluation, MMT had a low sensitivity, specificity and PPV, with an acceptable NPV.

RHTMD has some limitations. It depends on accurate measurement of patient's TMD and height that lessens simplicity of this method. Also, the cutoff point of RHTMD for prediction of difficult laryngoscopy is race dependent. The RHTMD cutoff point equal 21.06 may not be applicable in the other population.

The ULBT score of predicting difficult laryngoscopy has also some limitations. It is not appropriate for edentulous patients. In addition, the anthropological literature emphasized that there is ethnic variation in craniofacial configuration of populations. Moreover, review of dental literature shows that there are significant racial variation in morphology and morphometry of human mandible and maxillary bones. So, the ULBT may not applicable for some populations. The predictive power of ULBT for prediction of difficult laryngoscopy must be calculated in each population independently.

Safe outcome of anaesthesia continues to be an important goal for every anesthesiologist. Unfortunately, there is still no test or group of tests that can predict 100% of difficult laryngoscopies. Our study was concerned only with elective surgical patients, and emergency patients were not considered. Even though the internal validity in the present study seems adequate, it may not be applicable to all subgroups of the general population (e.g., patients for emergency cesarean sections or toothless patients).

VI. Conclusion

It may be concluded from the present study that RHTMD is superior to ULBT and MMT as a useful bedside screening test for preoperative prediction of difficult laryngoscopy. Compared with RHTMD, ULBT and MMT are poor predictor of difficult laryngoscopy when used as a single bedside screening test. More studies with larger sample size in different populations are suggested for documentations of our results.

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