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Predictive Value of Upper Lip Bite Test And Ratio of Height to Thyromental Distance Compared to Other Airway Assessment Tests for Difficult Laryngoscopy

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Abstract : *Unanticipated difficult tracheal intubation remains a primary concern of Anaesthesiologists. The aim of the present study was to compare Upper lip bite test (ULBT) with other four predictors (Modified Mallampati test MMT, Thyromental distance TMD ,Ratio of height to Thyromental distance RHTMD, Inter-incisor distance IID) for predicting difficulty in intubation. 500 American Society of Anaesthesiologists (ASA) physical status grade I and II (18-60 yrs of age group) adult patients scheduled to receive general anaesthesia with endotracheal intubation were included.Sensitivity, specificity, positive predictive value, negative predictive, accuracy and kappa coefficient was calculated for each predictive test. Difficult intubation was occurred in 26.7% of all patients studied. There was no significant difference in assessing easy and difficulty intubation pre-operatively and during the intubation. Out of 60 patients, 44 patients had easy intubation and 16 patients had difficult intubation When compared with Upper lip bite test , Modified Mallampati test was the best predictor in predicting difficulty in intubation. It had high sensitivity, better specificity, PPV and Accuracy. Kappa coefficient is 0.13 which had fair agreement with laryngoscopic view in predicting difficulty in intubation when compared to other predictive tests. We conclude that no single airway predictor is sufficient for predicting difficult intubation. A different combination of two or more airway predictors have to be analyzed to arrive at near ideal airway prediction model.*

Keywords : *Airway, Assessment, Upper lip bite test, Thyromental distance.*

I. Introduction

The primary responsibility of an anaesthesiologist is to maintain adequate gas exchange in the patient,for this to be acheived, the patient's airway must be managed so that it is almost continuously patent. Failure to maintain a patent airway for more than few minutes results in brain damage or death. A 1990 closed claims analysis showed that more than 85% of all respiratory events related to closed malpractice claims involved a brain damaged or dead patient[1]. Difficult intubations and problems with airway management during emergence remain among the leading causes of serious intraoperative problems, and it has been estimated that inability to manage successfully difficult airways (DAs) is responsible for as many as 30% of deaths totally attributable to anaesthesia [2,3,4]. The present study is designed to determine the ability to predict difficult / easy visualization of larynx in study population by comparing upper lip bite test with four different tests i.e., modified Mallampati test, sternomental distance, thyromental distance and inter incisor distance.

The objective of our study was to determine: Comparison of upper lip bite test with four other predictors for predicting difficulty in intubation.;To calculate sensitivity, specificity, positive predictive value, negative predictive value and kappa coefficient of different predictors in predicting difficulty in intubation;. The single predictor, which is more sensitive, specific and which has higher positive predictive value.

II. Material & Methods

This prospective study was conducted after obtaining approval from Institutional Research and Ethics Committee. Written informed consent was obtained from all the participants.500 American Society of Anaesthesiologists physical status (ASA) grade I and II (18-60 yrs of age group) adult patients scheduled to receive general anaesthesia with endotracheal intubation were included in our study [5].

Patients younger than 18 yrs of age group, Airway malformation, Edentulous patients, Pregnancy and lactating mothers, Patients who are unable to give written informed consent ,Patients who are not willing to participate in the study ,Patients with Craniofacial anomalies were excluded from this study.

In all the patients selected for the study a detailed history and general examination was performed. Preoperative airway examination was performed using multiple screening tests to predict difficult airway. The following screening tests were used in present study.

a) Recording of patient's → Height in cms ,Weight in kilogram
b) Pathologies associated with difficulty in laryngoscopy or intubation such as malformation of face, cervical spondylosis with limitation of neck movements, occipito – atlanto-axial disease, tumours of the airway, long term diabetes mellitus with stiff joint syndrome, post – burns contracture of face and neck and clinical symptoms of airway pathology such as dyspnoea related to compression of airway, dysphonia and dysphagia were noted.

c) Modified Mallampati Test : MMT is similar to that used by Samsoon and Young which is performed in a seated patient who opens his mouth as wide as he can and protrudes the tongue as far as possible, while the observer looks from the patient eye level and inspects the pharyngeal structures with a pen torch. It is important when performing this test that the patient does not phonate since this can alter what is seen. The view is then graded as :

Class 1 : soft palate , fauces , uvula and pillars seen - Easy
Class 2 : soft palate , fauces , uvula seen-Easy
Class 3 : soft palate and base of uvula seen - Difficult
Class 4 : soft palate not visible at all - Difficult

d) **Upper lip bite test :**

Class I : Lower incisors can bite the upper lip above the vermilion line - easy
Class II : Lower incisors can bite the upper lip below the vermilion line-easy
Class III : Lower incisors cannot bite the upper lip - difficult

RHTMD (Ratio of height to thyromental distance): Height of the patient is measured in centimeters from vertex to heel with the patient standing and is rounded to nearest 1cm.Then ratio of Height to Thyromental distance is calculated and graded.

RHTMD = Height (in cms) /TMD (in cms)
Grade 1 – less than 23.5 cms
Grade 2 – more than equal to 23.5 cms

f) Thyromental distance : The straight distance between the upper border of thyroid cartilage and bony point of mentum was measured .

Class I : ≥ 6 cm - Easy
Class II : <6 cm- Difficult

g) Inter incisor distance : IID was measured when the patient opened his / her mouth , and the distance between the incisors was obtained .

Class I : ≥3.5 cm- Easy
Class II : < 3.5cm- Difficult

h) HNM:Maximum range of head and neck movement(HNM) is noted and graded .The patient is first asked to extend the head and neck fully, while a pencil is placed vertically on the forehead and then while the pencil was held firmly in position the head and neck were flexed.

Grade 1- more than 80 degrees
Grade 2- less than equal to 80 degrees

- visualization was assessed using a modified Cormack and Lehane (CL) classification.
- Glottic visualization was assessed using Cormack and Lehane grading :

Grade I: complete glottis visible
Grade II: anterior glottis not seen
Grade III: epiglottis seen, but not glottis
Grade IV: epiglottis not seen

- No external pressure was applied while reporting the laryngeal view.
- After evaluation intubation was performed by observer and then subjected to anaesthetic management for the surgical procedure .

A note was made of whether intubation was difficult, if the view at laryngoscopy was grade III or IV even in patients who were predicted to have easy intubation using multiple screening tests. If difficulty was experienced in tracheal intubation, backward, upward and rightward pressure on thyroid cartilage-BURP was applied as appropriate for any improvement in visualization of glottis on direct laryngoscopy. Subsequently if

required laryngoscopy was repeated with MacIntosh extra large sized blade (size 4) and additional aids such as stylets were used if necessary to facilitate tracheal intubation. Number of attempts in intubating the trachea was noted. Failure to intubate the trachea was also noted.

Endotracheal intubation was considered truly difficult, if any of the following were positive.

1) Cormack and Lehane grade III and IV.
2) Three attempts at tracheal intubation or duration longer than ten minutes
3) If special manoeuvres were used to facilitate tracheal intubation which in our study were blind nasal intubation or fibreoptic intubation.
4) Failure to intubate.

Rest of the patients were considered to have truly easy endotracheal intubation

- After evaluation if needed external laryngeal pressure was permitted for endotracheal tube insertion.Difficult laryngoscopy in this study was set at Cormack and lehane grade III and grade
- IV.After evaluation and endotracheal intubation surgery is performed under standard anaesthesia.
- A proforma sheet containing the different airway assessment tests which we are taking into account is attached and the results will be calculated according to intubation difficulty scale and correlated accordingly.

- **Statistical Analysis**

All the observations were collected and tabulated on Microsoft Excel spread sheets and all the entries were double checked for data entry errors. Continuous variables are presented as mean ± standard deviation and categorical variables as counts and percentages. Chi-square test and Fischer's Exact test was performed to test the differences in frequency between groups of different methods in comparison to gold standard method. Sensitivity, Specificity, Positive predictive value and Negative predictive value for different methods were calculated. SPSS 22 version software, Open EPI software were used for statistical analysis.

III. Results

- The mean age of the study subjects was 52.54 ± 15.61 years. Among the study subjects 58.6% were males, 41.4% were females. Mean weight of the study group was 65.22 ± 11.47 Kgs and BMI was 25.72 ± 5.34 Kg/m2.

- **Table 1:** Distribution of different classes of ULBT, RHTMD, MMT, TMD, IIG, HNM and CML tests in study group

		Frequency (N=500)	**Percent**
ULBT	Class -I	466	93.2
	Class -II	26	5.2
	Class - III	8	1.6
RHTMD	Grade 1 (<23.5)	467	93.4
	Grade 2 (>23.5)	33	6.6
MMT	Grade I	396	79.2
	Grade II	62	12.4
	Grade III	42	8.4
TMD (cm)	Class I	479	95.8
	Class II	20	4.0
	Class III	1	0.2
IIG	Grade I (>4cms)	486	97.2
	Grade II (<4cms)	14	2.8
HNM	Grade I (>80 degree)	478	95.6
	Grade II (<80 degree)	22	4.4
CML	Grade I	268	53.6
	Grade II	199	39.8
	Grade III	27	5.4
	Grade IV	6	1.2

- showing the frequency distribution of different types of intubations based on Upper-lip bite test (ULBT). Out of 500 patients, 466 patients were in class-I, 26 patients were in class-II and 8 patients were in class-III. 98.4% of subjects had easy intubation whereas only 8 cases were predicted to be as difficult intubations.
- 93.4% of subjects had easy intubation whereas only 6.6% of cases were predicted to be as difficult intubations by ratio of height to thyromental distance (RHTMD).

- It was observed that during Preoperative assessment of intubation 87.8% had Easy intubation and 12.2% had difficult intubation.
- It was observed that during by Intubation difficulty score (IDS) 92.4% had Easy intubation and 7.6% had difficult intubation.

Table 2: IDS score comparison with demographic parameters

	Intubation Difficulty score grading				**P value**
	Easy		**Difficult**		
	Mean	**SD**	**Mean**	**SD**	
Age(years)	52.54	15.83	52.50	12.89	0.988
Sex (Male / Female)	271/191		22/16		0.927
Weight (kg)	65.21	11.37	65.45	12.85	0.901
Height (cm)	160.13	9.90	159.13	12.30	0.557
BMI	25.70	5.38	26.01	4.92	0.730

- Based on Laryngoscopic grading method to assess difficulty in intubation there was no significant difference in age, gender, weight, height and BMI in assessing difficulty in intubation.

Table 3: Upper Lip Bite test comparison with demographic parameters

	ULBT coded				P value
	Easy		Difficult		
	Mean	SD	Mean	SD	
Age (years)	52.53	15.57	52.75	19.34	0.969
Sex (Male/Female)	289/203		4/4		0.619
Weight (kg)	65.27	11.53	62.25	7.30	0.461
Height (cm)	160.23	10.02	149.13	9.28	0.002*
BMI	25.68	5.35	28.21	4.43	0.184

- Based on ULBT method to assess difficulty in intubation, a significant difference was observe with height of the subjects (160.23 ±10.02 v/s 149.13 ± 9.28; p=0.002*). I.e. subjects who had higher height intubation was easier. There was no significant difference in age, gender, weight and BMI in assessing difficulty in intubation based on ULBT method.
- Based on RHTMD method to assess difficulty in intubation there was no significant difference in age, gender, weight, height and BMI in assessing difficulty in intubation based on ULBT method.

Table 4: Comparison of Different tests in predicting difficult intubation and estimation of kappa coefficient (degree of agreement)

		Intubation Difficulty score grading				Kappa coefficient	P value
		Easy		Difficult			
		Count	%	Count	%		
ULBT	Easy	458	99.1%	34	89.5%	0.151 (0.086 to 0.216)	<0.001*
	Difficult	4	0.9%	4	10.5%		
RHTMD	Easy	441	95.5%	26	68.4%	0.287 (0.201 - 0.375)	<0.001*
	Difficult	21	4.5%	12	31.6%		
MMT	Easy	433	93.7%	25	65.8%	0.2665 (0.178 - 0.354)	<0.001*
	Difficult	29	6.3%	13	34.2%		
TMD	Easy	462	100.0%	37	97.4%	0.047 (0.02086 - 0.07428)	<0.001*
	Difficult	0	0.0%	1	2.6%		
IIG	Easy	450	97.4%	36	94.7%	0.037 (-0.0393 - 0.1144)	0.338
	Difficult	12	2.6%	2	5.3%		
HNM	Easy	447	96.8%	31	81.6%	0.188 (0.104 - 0.2722)	<0.001*
	Difficult	15	3.2%	7	18.4%		

- In the study it was observed that there was significant association (p<0.001*) in findings of IDS grading and other tests such as ULBT, RHTMD, MMT, TMD and HNM in assessing the Difficulty in Intubation. Kappa coefficient (Agreement between two tests) was highest for RHTMD with IDS score than ULBT and other tests.

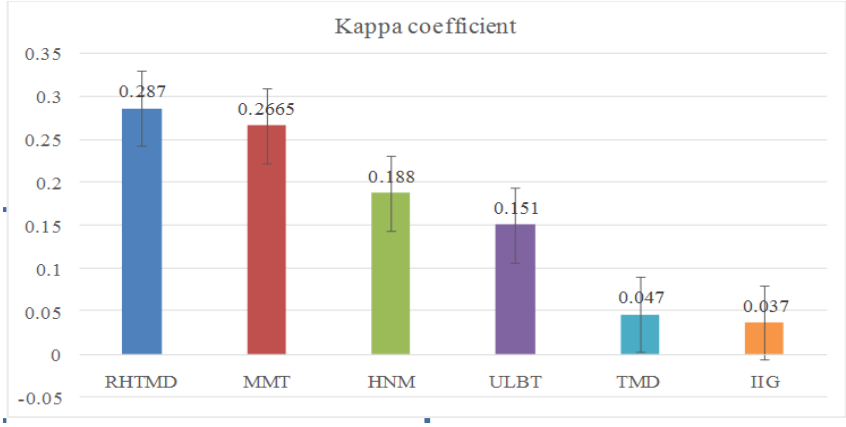

Figure 1: Bar diagram showing kappa coefficient (degree of agreement) for different tests

Table 5. Outcome distribution of various methods in predicting difficult intubation: Laryngoscopic view v/s ULBT, RHTMD, MMT, TMD, IIG and HNM

Test Method	Outcome			
	TP	FN	FP	TN
ULBT	4	34	4	458
RHTMD	12	26	21	441
MMT	13	25	29	433
TMD	01	37	0	462
IIG	2	36	121	450
HNM	7	31	15	447

- **True positive (TP):** A difficult endotracheal intubation that had been predicted to be difficult.TP was highest in MMT (hence highest sensitivity)
- **False positive (FP):** An easy intubation that had been predicted to be difficult. FP was highest in IIG (hence positive predictive value was lowest in IIG)
- **True negative (TN):** An easy intubation that had been predicted to be easy. TN was highest in TMD (hence highest specificity)
- **False negative (FN):** A difficult intubation that had been predicted to be easy. FN was highest in TMD (hence negative predictive value was lowest in TMD)

Table 6. Sensitivity, Specificity, PPV, NPV of ULBT, RHTMD, MMT, TMD, IIG and HNM in comparison with IDS score

Laryngoscopic view	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy
ULBT	10.53 (4.17, 24.13)	99.13 (97.8, 99.66)	50 (21.52, 78.48)	93.09 (90.5, 95.01)	92.4%
RHTMD	31.58 (19.08, 47.46)	95.45 (93.15, 97.01)	36.36 (22.19, 53.38)	94.43 (91.97, 96.17)	90.6%
MMT	34.21 (21.21, 50.11)	93.72 (91.13, 95.59)	30.95 (19.07, 46.03)	94.54 (92.07, 96.28)	89.2%
TMD	2.63 (0.466, 13.5)	100% (99.18, 100)	100% (20.65, 100)	92.59% (89.95, 94.57)	92.6%
IIG	5.263 (1.455, 17.29)	97.4 (95.52, 98.51)	14.29 (4.009, 39.94)	92.59 (89.92, 94.6)	90.4%
HNM	18.42 (9.222, 33.42)	96.75% (94.71, 98.02)	31.82 (16.36, 52.68)	93.51 (90.94, 95.39)	90.8%

- Above table showing sensitivity, specificity, positive predictive value, negative predictive value and accuracy of different predictive tests ULBT, RHTMD, MMT,TMD, IIG and HNM with laryngoscopic view in predicting difficulty in intubation. MMT had highest sensitivity (34.21), TMD had highest specificity (100%) and Positive predictive value (100%), MMT had highest Negative predictive value (94.54%) and TMD had highest diagnostic accuracy, followed by ULBT.

Table 7. Comparison of various tests:

Criteria	Order of various tests
Diagnostic Accuracy	TMD>ULBT>HNM>RHTMD>IIG>MMT
Sensitivity	MMT>RHTMD>HNM>ULBT>IIG>TMD
Specificity	TMD>ULBT>IIG>HNM>RHTMD>MMT

PPV	TMD>ULBT>RHTMD>HNM>MMT>IIG
NPV	MMT>RHTMD>HNM>ULBT>IIG &TMD
Kappa Coefficient	RHTMD>MMT>HNM>ULBT>TMD>IIG

- From the above table it can be observed that Diagnostic accuracy was highest for TMD, followed by ULBT and others. Hence TMD was better test. With respect to Kappa coefficient agreement between two tests. RHTMD had highest kappa coefficient than other tests.

Table 8: Association between Intubation Difficulty Score with Preoperative assessment of intubation

		Intubation Difficulty score grading				P value
		Easy		Difficult		
		Count	%	Count	%	
Preoperative assessment of Intubation	Easy	417	90.3%	22	57.9%	<0.001*
	Difficult	45	9.7%	16	42.1%	

- There was significant association between IDS grading and Preoperative assessment of
- Intubation. Among 439 subjects with easy intubation at pre-operative assessment, 417 subjects had easy intubation IDS score and among 61 subjects with preoperative difficult intubation 16 subjects had difficult IDS score.

Table 9: Showing kappa coefficient of different tests in predicting difficult intubation with ULBT

		ULBT				Kappa Coefficient	P value
		Easy		Difficult			
		Count	%	Count	%		
MMT	Easy	454	92.3%	4	50.0%	0.1368	<0.001*
	Difficult	38	7.7%	4	50.0%	(0.0741 - 0.1995)	
TMD	Easy	491	99.8%	8	100.0%	-0.003	0.898
	Difficult	1	0.2%	0	0.0%	(-0.058 - 0.051)	
IIG	Easy	478	97.2%	8	100.0%	-0.0207	0.628
	Difficult	14	2.8%	0	0.0%	(-0.105 - 0.0634)	
RHTMD	Easy	460	93.5%	7	87.5%	0.023	0.498
	Difficult	32	6.5%	1	12.5%	(-0.044 - 0.092)	
HNM	Easy	473	96.1%	5	62.5%	0.1808	<0.001*
	Difficult	19	3.9%	3	37.5%	(0.103 - 0.257)	

- There was significant association between ULBT and MMT, HNM tests. No significant was observed with TMD, IIG and RHTMD tests. Kappa coefficient was highest for HNM test, followed by MMT.

Table 10. Sensitivity, Specificity, PPV, NPV of RHTMD, MMT, TMD, IIG and HNM in comparison with ULBT

Parameter	**MMT**	TMD	IIG	RHTMD	HNM
Sensitivity	50%	0.0%	0.0%	12.5%	37.5%
Specificity	92.28%	99.8%	97.15%	93.5%	96.14%
Positive Predictive Value	9.524%	0.0%	0.0%	3.03%	13.64%
Negative Predictive Value	99.13%	98.4%	98.35%	98.5%	98.95%
Diagnostic Accuracy	91.6%	98.2%	95.6%	92.2%	95.2%

- Highest diagnostic accuracy with ULBT test was observed for TMD test and lowest was observed for MMT test.

Table 11: Showing kappa coefficient of different tests in predicting difficult intubation with RHTMD

		RHTMD				Kappa Coefficient	P value
		Easy		Difficult			
		Count	%	Count	%		
ULBT	Easy	460	98.5%	32	97.0%	0.023	0.498
	Difficult	7	1.5%	1	3.0%	(-0.044 - 0.09)	
MMT	Easy	440	94.2%	18	54.5%	0.3521	<0.001*
	Difficult	27	5.8%	15	45.5%	(0.2652 - 0.439)	
TMD	Easy	467	100.0%	32	97.0%	0.05516	<0.001*
	Difficult	0	0.0%	1	3.0%	(0.02645 - 0.08386)	
IIG	Easy	460	98.5%	26	78.8%	0.2691	<0.001*
	Difficult	7	1.5%	7	21.2%	(0.1896 - 0.3487)	
HNM	Easy	456	97.6%	22	66.7%	0.3666	<0.001*
	Difficult	11	2.4%	11	33.3%	(0.2809 - 0.4522)	

- There was significant association between RHTMD and MMT, TMD, IIG and HNM tests. No significant was observed with ULBT. Kappa coefficient was highest for HNM test, followed by MMT.

Table 12: Sensitivity, Specificity, PPV, NPV of ULBT, MMT, TMD, IIG and HNM in comparison with RHTMD

Parameter	ULBT	**MMT**	**TMD**	**IIG**	**HNM**
Sensitivity	3.03%	45.45%	3.03%	21.21%	33.33%
Specificity	98.5%	94.22%	100%	98.5%	97.64%
Positive Predictive Value	12.5%	35.71%	100%	50%	50%
Negative Predictive Value	93.5%	96.07%	93.59%	94.65%	95.4%
Diagnostic Accuracy	92.2%	91%	93.6%	93.4%	93.4%

- Highest diagnostic accuracy with RHTMD test was observed for TMD test and lowest was observed for MMT test.
- In the study 36 subjects required 1 additional attempt for intubation, 4 subjects's required 2 attempts and 2 subjects required 3 additional attempts for intubation.
- 42 subjects required I additional operators and 2 subjects required 2 additional operators.
- 53 subjects required 1 and 4 subjects required 2 additional intubation techniques
- 56 subjects required 1 and 2 subjects required 3 Lifting force applied during intubation
- 77 subjects required one additional External laryngeal pressure applied during intubation
- In 30 subjects Position of vocal records during intubation was grade 1.

Table 13: Association between Different tests and No of additional intubation attempts taken

		No of additional intubation attempts								P value
		0		1		2		3		
		Count	%	Count	%	Count	%	Count	%	
ULBT	Easy	454	99.1%	34	94.4%	2	50.0%	2	100.0%	<0.001*
	Difficult	4	0.9%	2	5.6%	2	50.0%	0	0.0%	
RHTMD	Easy	437	95.4%	24	66.7%	4	100.0%	2	100.0%	<0.001*
	Difficult	21	4.6%	12	33.3%	0	0.0%	0	0.0%	
MMT	Easy	430	93.9%	24	66.7%	2	50.0%	2	100.0%	<0.001*
	Difficult	28	6.1%	12	33.3%	2	50.0%	0	0.0%	
TMD	Easy	458	100.0%	35	97.2%	4	100.0%	2	100.0%	0.005*
	Difficult	0	0.0%	1	2.8%	0	0.0%	0	0.0%	
IIG	Easy	446	97.4%	34	94.4%	4	100.0%	2	100.0%	0.745
	Difficult	12	2.6%	2	5.6%	0	0.0%	0	0.0%	
HNM	Easy	443	96.7%	29	80.6%	4	100.0%	2	100.0%	<0.001*
	Difficult	15	3.3%	7	19.4%	0	0.0%	0	0.0%	

- There was significant association between No of additional intubation attempts required and tests conducted.

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IV. Discussion

Prediction of difficult intubation can reduce anaesthesia associated morbidity and mortality[1]. In order to be clinically useful , a test predicting difficult intubation must be easily applicable at the bedside and must give reliable results. No test has 100% sensitivity and there will always be some patients with unpredicted difficult intubation .are desirable. A test to predict difficult intubation should have high sensitivity so that it will identify most patients in whom intubation will truly be difficult. It should also have a high positive predictive value so that only a few patients who can be actually intubated easily and subjected to the protocol for management of a difficult intubation. Though there are many preoperative tests to predict difficult airway, they are no ideal test i.e, one which is easy to perform, highly sensitive , highly specific and which posses high predictive value with few false positive prediction.

In the present study, the sensitivity of Upper lip bite test (ULBT) is only 10.53% that means in about 90% could not identify possibility of difficult intubation. This is in contrast to the results obtained by Khan et al[6], Azmat ali et al[7], Ali et al[8] and Eberhart et al[9]where in they found a sensitivity of 76.5%, 91.5%, 87.5%, and 26.2% respectively. our study is in concordance with the study done by Karci et al[10]' wherein they found sensitivity of 13%. The lower sensitivity of ULBT in our study can be explained due to low incidence of ULBT Class III in our study (4 out of 500 patients) .We found that repeated demonstration were required for the patients to perform ULBT and a few still failed to understand the procedure inspite of our efforts. Also in some ,there was a reflex movement of upper lip in the reverse direction over the upper teeth which may alter the point of meeting of vermilion line with lower incisors. In the same individual measured, the ULBT may vary according to the effort applied by the patient.

The specificity of ULBT in our study was 99.13%, which correlates with the studies done by Khan et al[6](88.7%), Eberhart et al[9] (92.5%), Hester et al [11](97%). The specificity of Modified Mallampati test (MMT) was 93.72% in our study. This is in contrary to the results obtained by Khan et al[6], Eberhart et al[9]and Hester et al[11] wherein they reported specificity of MMT as 66.8%, 61.0%, and 75% respectively. This discrepancy may be explained by the fact that in our study both the preoperative evaluation of airway predictors and intubation was done by different person. So the chances of inter observer bias as reported by many authors may be an issue here. .

In the present study sensitivity, specificity for thyromental distance (TMD) was 2.63% and 100% respectively. In a study Salimi et al[12] reported a sensitivity of 55% and specificity of 88% , Khan et al[13] reported sensitivity of 73% and specificity of 82.2%. This wide variation in reported sensitivity in various studies may be because of incorrect evaluation of the measurement from inner or outer mentum and anthropometric peculiarities. In our study all the patients' airway were evaluated by a single anaesthesiologist unlike in other studies where two or more than two anaesthesiologists were involved in assessing the airway which might have contributed to interobserver variability leading to variable positivity.

The negative predictive value of ULBT, MMT,RHTMD, TMD and inter incisor Gap(IIG) are almost similar in our study (93.09%, 94.54%, 94.43%,92.59 and 92.59%) respectively. Naithani et al[14]observed NPV for above said airway parameters as 98.3%,96.7%,90.5%,91.7% and 94.7 respectively. In contrast Khan et al[13] reported NPVs for ULBT, SMD, TMD and IID as 98.8%, 98.8%, 98.3% and 97.8% respectively.

In the present study, we found that the sensitivity and PPV of Inter incisor distance (IID) was zero, that is it is unable to identify difficult intubation. This result is in concordance with results of Allahyary et al [15]who obtained same results. In the present study, kappa coefficient for ULBT, MMT,RHTMD TMD and IID were 0.02, 0.35, 0.05, 0.03 respectively and there was no statistically significant difference($p>0.05$) in predicting difficulty in intubation with respect to Cormack and Lehane laryngoscopic grading [16]III/IV. This is in contrast to results obtained by Eberhart et al [9]who observed better interobserver reliability for ULBT when compared to MMT(0.79 v/s 0.59; $p<0.01$). This difference in the results obtained may be explained due to different ethnicity of study population, low sample size and that in our study only one investigator recorded both the preoperative predictors and intraoperative laryngoscopic view.

To the best of our knowledge,no study till date had compared ULBT with other predictors of difficult directly. They only compared indirectly all the airway predictors based upon the Laryngoscopic view. We attempted to check the efficacy of ULBT in predicting difficulty in intubation v/s other airway predictors directly. We found no agreement between the groups. Of all these tests TMD has a fair agreement of 0.375 with ULBT in predicting difficult intubation. We also found that all the tests (MMT, SMD, TMD, IID) are almost equally efficacious in predicting easy intubation as evidenced by higher specificity and higher NPV.

In the ideal scenario, a test to predict difficult intubation should have higher sensitivity so that it will identify most patients in whom intubation will truly be difficult[17]. It should also have a high PPV so that only few patients with airways actually easy to intubate are subjected to protocol for management of difficult airway [18]. Finally it should have high NPV to correctly predict ease of laryngoscopy and intubation. However as seen in our study and in numerous other published studies till date there is no ideal predictor for preoperative evaluation of difficult airway. Therefore we suggest just like other authors, combination of various assessment methods in predicting the ease of intubation for improving the sensitivity rates.

V. Limitations

All participants were scheduled for elective surgery and there were no participants with a American Society of Anaesthesiologists (ASA) physical status of grade more than III, Emergency and obstetric cases were not included. Age between 16-60 years were only included in this study. No specialized population group like Paediatric, Obstetric patients which might have lead to more positive results. Combination of two or three more predictors might have been a better alternative than comparing single predictor.

VI. Conclusions

We conclude that no single airway predictor is sufficient for predicting difficult intubation. A different combination of two or more airway predictors have to be analyzed to arrive at near ideal airway prediction model. Till then the search for an ideal preoperative airway prediction parameter remains utopian.

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