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A Study On Patient`s Height To Thyromental Distance, Sternomental Distance And The Upper Lip Bite Test As A Single Test And In Combination As Methods Of Airway Assessment For Difficult Laryngoscopy.

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ABSTRACT

Tracheal intubation is still the preferred approach for securing the airways. However, up to 13% of people with ostensibly normal airways may find it challenging.1 Maintaining an open airway during general anesthesia induction is a problem for anesthesiologists, providing an elevated risk of consequences ranging from sore throat to severe airway trauma and, in extreme cases, death. As a result of poorly managed difficult airways, severe cerebral damage and even death might occur. Preoperative prediction of difficult airway is critical since 85% of all airway management errors can result in permanent cerebral damage and 30% of all anesthesia deaths can be related to difficult airway management. To compare the sensitivity, specificity, predictive value and reliability of modified Mallampati test, ratio of patient`s height to thyromental distance, sternomental distance and the upper lip bite test as a single test and in combination as methods of airway assessment for difficult laryngoscopy. This Cross-sectional study was done in Department of Orthopaedics, Tirunelveli medical college Hospital in the year 2021-2022.A total of 350 patients belonging to ASA physical status I-III were studied**.** The patients admitted in our institutions for surgeries under general anaesthesia with endotracheal intubation were considered in this study**.** Ratio of height to thyromental distance predicted difficult intubation with 95.2% sensitivity and 66.7% specificity. According to our findings, the test has a PPV of 60.6% and an NPV of 96.3%. The total accuracy rate was 76.7% (Table 2). Mallampati classification exhibited a sensitivity of 61.9% and a specificity of 74.4% in predicting difficult intubation. The test has a 56.5% PPV, a 78.4% NPV, and an overall accuracy of 70, 56.5, 78.4, and 70%, respectively. : In assessing and preparing for anticipating a problematic endotracheal intubation airway, RHTMD as a single preoperative bedside test offers a high level of accuracy when compared to MPC and ULBT.

Keywords: Mallampati, Ratio of height to thyromental distance, Top lip bite test, Tracheal intubation

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INTRODUCTION

An anesthesiologist has fundamental responsibility to maintain an adequate gas exchange through a patent airway. Failure to maintain a patent airway and interruption of gas exchange during general anesthesia for even a few minutes can result in catastrophic outcome such as cerebral damage and even death [1]. Anaesthesia in a patient with a difficult airway can lead to direct airway trauma and morbidity from hypoxia and hypercarbia [2]. Tracheal intubation using direct laryngoscopy remains the method of choice in most cases for securing airway. There is no universally accepted definition of difficult intubation. The American Societyof Anesthesiologists (ASA)defined difficult endotracheal intubation, as when properplacement of endotracheal tube with conventional laryngoscopy requires more than 3attempts or more than 10mins. Similarly difficult airway is defined as a clinical situationin which a conventionally trained anesthesiologist experiences difficulty with maskventilation or difficulty tracheal intubation or both [3]. Difficult laryngoscopy which is defined as poor visualization of glottis is synonymous with difficult intubation in most of the patients [4]. Difficult laryngoscopy is described in 1.5 to 13% of patients [5]. Though an endotracheal intubation is a routine procedure for all anaesthesiologists, there may be occasions when even an experienced anaesthesiologist might have great difficulty in the intubation technique for successful control of airway. The ability to predict difficult tracheal intubation permits anaesthesiologist to take precautions to decrease the risk [6]. As difficult intubation occurs infrequently and is not easy to define, research has been directed towards predicting difficult laryngoscopy. It is argued that if difficult laryngoscopy has been predicted and intubation is essential, skilled personnel and special equipments should be available [7]. Pre-operative airway assessment is essential to predict the risk of difficult airway management, but which anatomical landmarks and clinical factors are the best predictors is a controversy [8]. Difficulty in achieving a patent airway depends mainly on anatomical factors which play a predominant role in deciding the degree of difficult airway. The identification of patients with difficult airway is vital in the preoperative evaluation and for the planning of anaesthesia, so that intubation and positive pressure ventilation can be achieved safely by alternate methods [9]. Many methods have been introduced in the past to overcome these problems and to identify the patients who will be difficult to intubate. However, it is questioned whether the true prediction is possible and which variable should be chosen for evaluation. [10]. The difficult airway is not a disease; neither it is just one particular anatomical characteristic of patient. It is a complex interaction of patient anatomy, clinical circumstances and physician skill. Many features that are believed to indicate difficulty of intubation have been described, but a strategy needs to be developed in order to anticipate problems. [11]. Initially, the airway assessment was carried out using a single factor, but soon it was realized that no single test is a good predictor of difficult airway and concluded that visualization of larynx during intubation is affected by many factors. Then the concept of multivariate factors came into existence. By using multivariate factors, one can overcome the deficiency which may occur with individual factor and anticipate difficult intubation with much better accuracy. Even with use of multivariate factors, prediction is not full proof. There have been instances when a patient predicted to have difficult intubation had an easy intubation and vice versa [12]. Our study was designed to compare the predictive value of the modified Mallampati test with the ratio of patient`s height to thyromental distance, upper lip bite test and sternomental distance for the prediction of difficult laryngoscopy. It also compared the ability of above tests as a single test and in combination, to predict difficult airway and to compare the results with Cormack-Lehane`s laryngoscopic view.

MATERIALS AND METHODS

This is a prospective observational, single blinded study carried out This Cross-sectional study was done in Department of Orthopaedics, Tirunelveli medical college Hospital in the year 2021-2022.A total of 350 patients belonging to ASA physical status I-III were studied. The patients admitted in our institutions for surgeries under general anaesthesia with endotracheal intubation were considered in this study.

Inclusion criteria

- ASA physical status I-III
- Patients posted for elective surgeries who are scheduled to receive general anaesthesia (Orthopedic, ENT, Ophthalmologic, Abdominal, Urologic and Gynecological procedures)
- Age between 18-65yrs

Exclusion criteria

- Uncooperative and unwilling patients
- History of burns, trauma or surgeries to the airway
- Tumors or mass in the neck or the airway
- Patients with restricted mobility at the neck and mandible.
- Patients who are unable to sit or stand, edentulous or need awake intubation
- Pregnant female

After obtaining informed written consent from each patient, the airway examination was carried out by same anaesthesiologist in all studied patients to avoid inter-observer variability. Subsequently four predictive test measurements were carried out in all patients in the preoperative examination room. The predictive tests studied were modified Mallampati test, ratio of patient's height to thyromental distance, sternomental distance and the upper lip bite test.

Modified Mallampati Test

Samsoon and Young's modification of Mallampati's test was recorded. Here each patient while seated with head in neutral position was asked to open the mouth maximally and to protrude the tongue as far as possible without phonation and the oropharyngeal structures visible were observed.

Grade I: Good visualization of soft palate, fauces, uvula and tonsillar pillars.
Grade II: Pillars obscured by the base of the tongue but the soft palate, fauces and uvula visible.
Grade III: Soft palate and base of uvula visible.
Grade IV: Soft palate not visible. Grade I and II was considered as easy laryngoscopy while grade III and IV as difficult laryngoscopy.

Ratio of Height to Thyromental distance (RHTMD)

Here first thyromental distance was measured in cm with a measuring tape from the bony point of the mentum to the upper border of thyroid cartilage while head was fully extended and mouth closed and patient's height was measured from the vertex to heel in standing position in cm, then the ratio of patient's height to thyromental distance was calculated as follows
RHTMD = Height in cm / TMD in cm
RHTMD <23.5 considered as easy intubation and RHTMD >23.5 considered as difficult intubation.

Upper Lip Bite Test

This was done by assessing the ability of patient to cover the mucosa of the upper lip with lower incisors. Here while seated in neutral position at the eye level of investigator, patient was asked to bite his \ her upper lip with lower incisors as for as possible. The test was demonstrated by the examiner first, performed by the participants twice and graded as:

Grade I: If the lower incisors could bite the upper lip above the vermillion line
Grade II: If the lower incisors could bite the upper lip below the vermillion line
Grade III: If the lower incisors could not bite the upper lip

Grade I and II described as easy laryngoscopy while grade III described as difficult laryngoscopy.

Sternomental distance

Measured in cm using measuring tape as distance from upper border of manubrium to tip of mentum with neck fully extended and mouth closed.SMD<12.5 cm considered as easy intubation and SMD>12.5 cm considered as difficult intubation. Other data assessed were age, sex, height, body weight and body mass index (BMI). Height of the patient was measured in centimeter from vertex to heel with patient standing using a measuring tape and was rounded to nearest 0.5 cm. Using same weighing scale, body weight was measured in all patents and weight was rounded to the nearest 1 Kg. Body mass index was calculated as follows; BMI = weight in kg / (height in meter)2. On arrival in the operating room, routine monitors which include NIBP, ECG, Pulseoximetry and EtCO2 were attached. Standard anaesthestic

protocol was followed in all patients. Patients were preoxygenated with 100% oxygen for three minutes and were administered intravenous glycopyrrolate 0.2 mg and fentanyl 2 mcg / kg. Induction of anesthesia was done with injection Sodium thiopentone, 5 mg/kg IV bolus and injection succinyl choline 1.5 mg/kg IV given to facilitate intubation. Single anesthesiologist with three years of experience in anesthesia who was not informed of preoperative airway examination results performed the laryngoscopy using Mcintosh blade and evaluated difficulty of laryngoscopy at first attempt with the patient in sniffing position but without applying external laryngeal pressure. The view is classified as per Cormack and Lehane's scale. This scale is graded as:

Grade I: Full glottic opening visible.
Grade II: Only posterior commissure or arytenoids visible.
Grade III: Only epiglottis visible.
Grade IV: None of the above visible.

Grade III & IV of Cormack-Lehane's classification was described as difficult visualization /difficult laryngoscpy. Grade I &II of Cormack-Lehane's classification was described as easy visualization/easy laryngoscopy. After evaluation, endotracheal intubation was done and surgery was performed under standard anaesthesia. Using these clinical data (for the Mallampati score, the RHTMD, the ULBT, the SMD and the Cormack Lehane's classification) recorded for each patient, the sensitivity, the specificity, the positive predictive value, the negative predictive value, the accuracy and positive likelihood ratio of each test were calculated. Secondly combination of predictors was also formulated. The area under ROC (AUC) was used as the main end point of the study to determine whether or not the score was clinically valuable. A value of 0.5 area under the ROC indicates that the variable performs no better than chance and a value of 1.0 implies perfect discrimination. A larger area under the ROC curve denotes more reliability and good discrimination of the scoring system[5].The data were compared using chi square test and other calculation were performed using the SPSS version 21.0. P value of < 0.05 is taken as significant.

RESULTS

Table 1: Distribution and Comparison of patients of easy and difficult laryngoscopy with age groups

Age in yrs	Easy		Difficult		Total		Statistical inference
		%		%		%	
18 to 25	90	28.5	4	11.8	94	26.9	X^2=6.299 Df=4 .178>0.05 Not Significant
26 to 35	73	23.1	8	23.5	81	23.1	
36 to 45	69	21.8	9	26.5	78	22.3	
46 to 55	57	18.0	7	20.6	64	18.3	
56 to 65	27	8.5	6	17.6	33	9.4	
Total	316	100.0	34	100.0	350	100.0	

Mean age in study group was 36.83±12.53.The minimum age in study group was 18 years and maximum being 65 years.Large number of patients seen in group between 18-25 years.Mean age in difficult age group was 42.18±12.10 years.Mean age group in easy intubation was 36.25±12.45 years.When mean age in difficult and easy intubation were compared,The mean age of persons with difficult intubation was found to be significantly higher than those with easy intubation with statistically significant p value of 0.009.In our study 53% of patients belong to female group compared to 47% in male group.We found that out of 34 difficult intubations 15 were male group and 19 were in female group. Female participants were more compared to male but it is stastistically not significant.

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Table 2: Distribution andcomparison of patients of easy and difficult laryngoscopy with weight

Weight in kg	Easy		Difficult		Total		Statistical inference
		%		%		%	
41 to 50	29	9.2	2	5.9	31	8.9	X^2=1.797 Df=4 .773>0.05 Not Significant
51 to 60	143	45.3	13	38.2	156	44.6	
61 to 70	91	28.8	12	35.3	103	29.4	
71 to 80	36	11.4	4	11.8	40	11.4	
81 to 90	17	5.4	3	8.8	20	5.7	
Total	**316**	**100.0**	**34**	**100.0**	**350**	**100.0**	

Mean body weight in study group was 61.91±9.65 kg. The minimum body weight in study group was 42 kg and maximum was 85 kg.Mean body weight in difficult group was 64.15±9.42 kg.

Mean body weight in easy group was 61.67±9.66 kg. Mean body weight in difficult and easy group showed p value of 0.156 which is statistically insignificant.

Table 3: Distribution andComparison of patients with easy and difficult laryngoscopy with height

Height in cm	Easy		Difficult		Total		Statistical inference
		%		%		%	
141 to 150	26	8.2	6	17.6	32	9.1	X^2=4.643 Df=3 .200>0.05 Not Significant
151 to 160	170	53.8	19	55.9	189	54.0	
161 to 170	111	35.1	9	26.5	120	34.3	
171 to 180	9	2.8	0	.0	9	2.6	
Total	**316**	**100.0**	**34**	**100.0**	**350**	**100.0**	

Mean height in study group was 158.55±5.74 cm. The minimum height in study group was 145 cm and maximum height being 176 cm. Mean height in difficult group was 157.09±5.74 cm.

Mean height in easy group was 158.70±5.72 cm. Mean height in difficult and easy group showed a p value of 0.120 which is statistically insignificant.

BMI

Table 4: Distribution and Comparison of patients with easy and difficult laryngoscopy with BMI

BMI	Easy		Difficult		Total		Statistical inference
		%		%		%	
Below 18.49	17	5.4	2	5.9	19	5.4	X^2=7.000 Df=3 .072>0.05 Not Significant
18.50 to 24.99	192	60.8	15	44.1	207	59.1	
25 to 29.99	87	27.5	11	32.4	98	28.0	
> 30	20	6.3	6	17.6	26	7.4	
Total	**316**	**100.0**	**34**	**100.0**	**350**	**100.0**	

Mean BMI in study group was 24.56±3.20. The minimum BMI in study group was 17.53 and maximum was 34.63.Mean BMI in difficult group was 25.99±3.53.Mean BMI in easy group was 24.41±3.14.When mean BMI in difficult and easy intubation were compared, The mean BMI of persons with difficult intubation was found to be significantly higher than those with easy intubation with statistically significant p value of 0.006.

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Table 5: Distribution of patients according to modified Mallampati class

Modified Mallampati class	No of patients	% of patients
I	203	58.0
II	49	14.0
III	92	26.3
IV	6	1.7

We found 252 patients in class I and II and 98 patients in class III and IV.

Table 6: Distribution of patients according to RHTMD

Particulars	Frequency	Percent
< 23.5	312	89.1
≥ 23.5	38	10.9
Total	350	100.0

312 patients had RHTMD < 23.5 and 38 patients had RHTMD ≥23.5

Table 7: Distribution of patients according to ULBT

ULBT	No of patients	% of patients
I	278	79.4
II	27	7.7
III	45	12.9
Total	350	100.0

In our study 305 patients are in class I and II and 45 patients were in class III

Table 8: Distribution of patients according to SMD

SMD	No of patients	% 0f patients
> 12.5	335	95.7
≤ 12.5	15	4.3
Total	350	100.0

Most of patients were with SMD >12.5 and only 15 patients with SMD ≤12.5

Table 9: distribution of patients according to Cormack-Lehane grading

Cormack –Lehane grading	No of patients	% of patients
I	240	68.6
II	76	21.7
III	34	9.7
IV	0	0
Total	350	100.0

316 patients found in Cormack-Lahane class I and II 34 patients in class III and IV.

Table 10: Comparison of Mallampati class with Cormack-Lehane grading

Modified Mallampati class	Easy		Difficult		Total		Statistical inference
		%		%		%	
I	203	64.2	0	.0	203	58.0	X^2=87.051 Df=3 .000<0.05 Significant
II	44	13.9	5	14.7	49	14.0	
III	68	21.5	24	70.6	92	26.3	
IV	1	.3	5	14.7	6	1.7	
Total	**316**	**100.0**	**34**	**100.0**	**350**	**100.0**	

24 out of 34 difficult laryngoscopy patients were found in Mallampati class III

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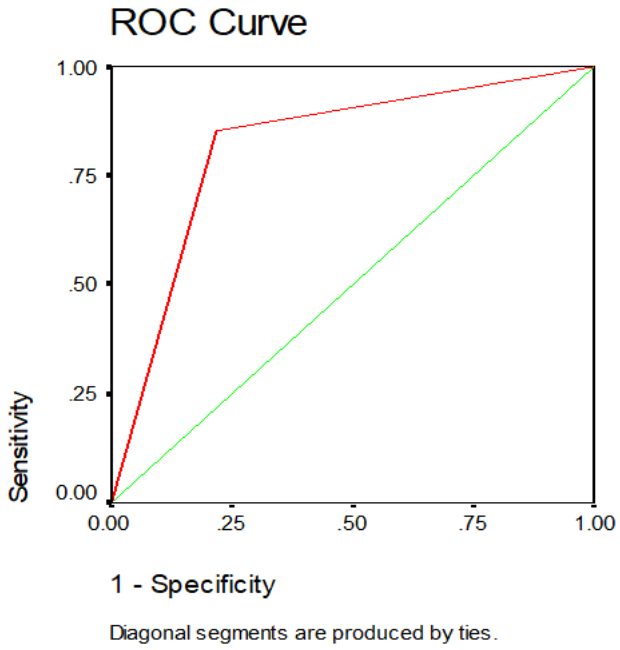
Table 11

Mallampati class	Easy		Difficult		Total		Statistical inference
		%		%		%	
Easy(class I and II)	247	78.2	5	14.7	252	72.0	X^2=61.318 Df=1 .000<0.05 Significant
Difficult(class III and IV)	69	21.8	29	85.3	98	28.0	
Total	**316**	**100.0**	**34**	**100.0**	**350**	**100.0**	

Modified Mallampati test identified 29 out of 34 patients of difficult laryngoscopy.

Chart 1: %Comparison of MMT with Cormack-Lehane grading



Our study showed direct relationship between MMT and Cormack-lahane grading with p value <0.05

Sensitivity	85.29%
Specificity	78.16%
Positive predictive value	29.59%
Negative predictive value	98.02%
Positive likelihood ratio	3.91
Accuracy	78.85%
AUC(ROC)	0.817

Table 12: Comparison of ULBT with Cormack-Lehane grading

ULBT	Easy		Difficult		Total		Statistical inference
		%		%		%	
I	263	83.2	15	44.1	278	79.4	X^2=54.084 Df=2 .000<0.05 Significant
II	26	8.2	1	2.9	27	7.7	
III	27	8.5	18	52.9	45	12.9	
Total	**316**	**100.0**	**34**	**100.0**	**350**	**100.0**	

Out of 34 patients with difficult intubation 18 belong to grade III and 16 belongs to grade I and II

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ULBT	Easy		Difficult		Total		Statistical inference
		%		%		%	
Easy(grade I and II)	289	91.5	16	47.1	305	87.1	X^2=54.004 Df=1 .000<0.05 Significant
Difficult(grade III)	27	8.5	18	52.9	45	12.9	
Total	**316**	**100.0**	**34**	**100.0**	**350**	**100.0**	

Table 13: Comparison of RHTMD with Cormack-Lehane grading

RHTMD	Easy		Difficult		Total		Statistical inference
		%		%		%	
< 23.5 (Easy)	302	95.6	10	29.4	312	89.1	X^2=138.822 Df=1 .000<0.05 Significant
≥ 23.5 (Difficult)	14	4.4	24	70.6	38	10.9	
Total	**316**	**100.0**	**34**	**100.0**	**350**	**100.0**	

RHTMD identified 24 out of 34 difficult laryngoscopies.

We found direct relationship between RHTMD and Cormack-Lahane grading with p value<0.05

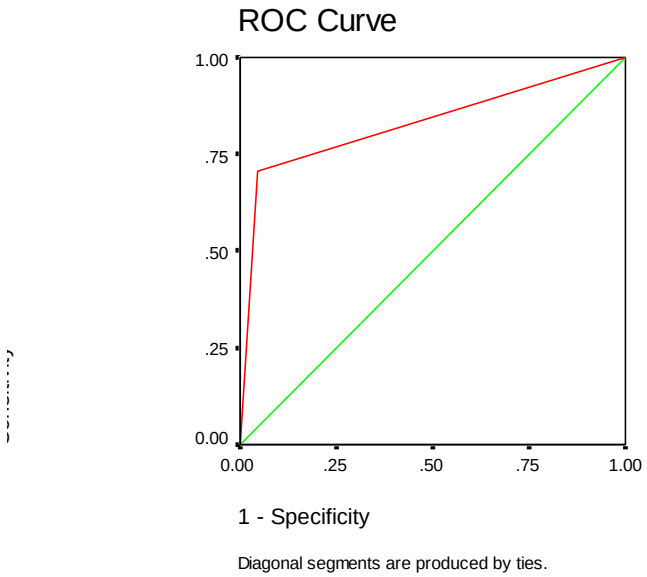

Chart 2: %Comparison of RHTMD with Cormack-Lehane grading

Table 14: Comparision of SMD with Cormack-Lehane grading

SMD	Easy		Difficult		Total		Statistical inference
		%		%		%	
> 12.5 (Easy)	310	98.1	25	73.5	335	95.7	X^2=45.183 Df=1 .000<0.05 Significant
≤ 12.5 (Difficult)	6	1.9	9	26.5	15	4.3	
Total	**316**	**100.0**	**34**	**100.0**	**350**	**100.0**	

SMD predicted 9 out of 34 difficult laryngoscopy.

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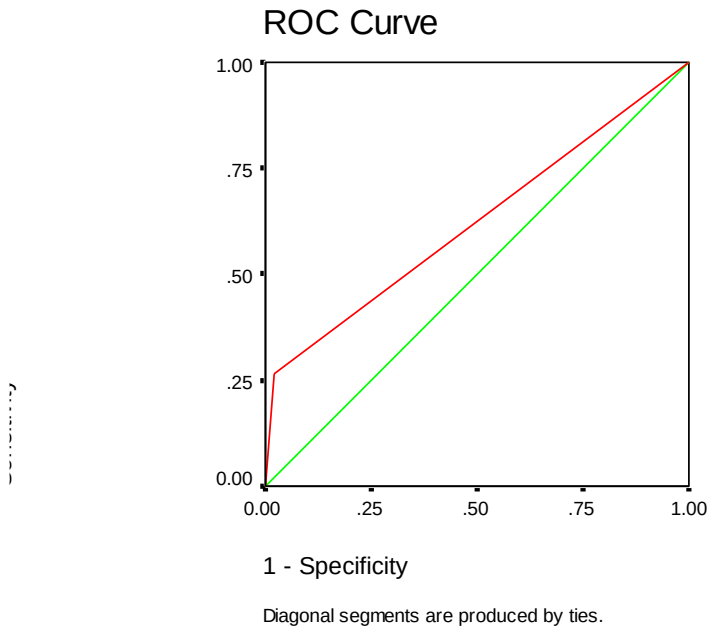
Chart 3: %Comparison of SMD with Cormack-Lehane grading



In our study we found direct relationship between SMD and Cormack-Lahane grading with p value<0.05

Table 15: Comparison of MMT and ULBT with Cormack-Lehane grading

MMT and ULBT	Easy		Difficult		Total		Statistical inference
		%		%		%	
Easy	220	69.6	1	2.9	221	63.1	X^2=58.645 Df=1 .000<0.05 Significant
Difficult	96	30.48	33	97.18	129	36.08	
Total	**316**	**100**	**34**	**100**	**350**	**100**	

Table 16: Comparison of MMT and RHTMD with Cormack-Lehane grading

MMT and RHTMD	Easy		Difficult		Total		Statistical inference
		%		%		%	
Easy	234	74.1			234	66.9	X^2=75.966 Df=1 .000<0.05 Significant
Difficult	82	25.9	34	100	116	33.1	
Total	**316**	**100**	**34**	**100**	**350**	**100**	

When MMT and RHTMD are combined it identified all 34 difficult intubations

Table 17: Comparison of MMT and SMD with Cormack-Lehane grading

MMT and SMD	Easy		Difficult		Total		Statistical inference
		%		%		%	
Easy	241	76.3	4	11.8	245	70	X^2=60.815 Df=1 .000<0.05 Significant
Difficult	75	23.7	30	88.2	105	30	
Total	**316**	**100**	**34**	**100**	**350**	**100**	

DISCUSSION

Preoperative airway assessment should be highly sensitive to predict maximum number of patients with difficult laryngoscopy correctly, and highly specific to predict easy laryngoscopy correctly. Test should also have a high positive predictive value (so that only few patients with easy laryngoscopy are subjected to the protocols for difficult laryngoscopy), with few negative predictions (to avoid deleterious and even life-threatening consequences) [13]. Likelihood ratio for a positive test result may be useful measure to judge the efficacy of a predictive tool in daily practice. We conducted this study to evaluate sensitivity, specificity, positive predictive value, negative predictive value, positive likelihood ratio, accuracy and AUC of ROC for modified Mallampati test, RHTMD, SMD and the upper lip bite test in isolation and in combination, with an attempt to determine a more comprehensive and accurate as well as simple and clinically applicable to day-to-day basis parameter for predicting difficult laryngoscopy [14]. The reported incidence of difficult laryngoscopy varies from 1.3 – 13% in general population depending on the criteria used to describeit. The incidence of difficult laryngoscopy in our study is 9.71%without external laryngeal pressure which is comparable to that observed by earlier studies [15]. Variations in the incidence of difficult laryngoscopy have been attributed to different factors such as different anthropomorphic features among populations, lack of uniformity in describing or grading laryngeal views, cricoid pressure application, position of head, degree of muscle relaxation and type or size of laryngoscope blade [16]. Many previous studies reported an association between difficult laryngoscopy, and increasing age and weight. Osteoarthritic changes and poor dentition may be responsible for the age-related increase in difficult laryngoscopy. Obesity has been reported to be a risk factor for difficult laryngoscopy [17]. The mean height and weight in our study did not find any association between height and weight with difficult laryngoscopy. In our study there is an increased occurrence of difficult laryngoscopy in female sex compared to male group, but it is statistically not significant [18]. 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. [19]. The absence of 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 [20]. The RHTMD has some limitations; it depends on accurate measurement of patient's thyromental distance and height that lessens the simplicity of this method and is race dependent. The predictive values for RHTMD were found to be lower in the Indian population as compared to Caucasians. [21]. All the tests have a negative predictive value more than 90%, thus stressing the fact that all these tests can be good predictors of easy intubation, rather as positive predictors of difficult intubation which has a very low incidence [22]. The main end point of present study is the AUC of ROC is significantly higher for RHTMD than the upper lip bite test, MMT and SMD indicating that RHTMD has a better predictive value than the other three tests. We also found that MMT may be used as single pre-operative bed side screening test for the prediction of difficult laryngoscopy with high sensitivity, but in combination with RHTMD, their predictive value is increased [23-25].

CONCLUSION

We found RHTMD has a better predictive value as a single preoperative bed side screening test for prediction of difficult laryngoscopy than MMT, SMD, ULBT.Modified Mallampati class may be used as single preoperative bedside screening test for prediction of difficult laryngoscopy, but the combination of MMT and RHTMD has a better predictive than when applied individually.

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