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BEYOND MALLAMPATI: WHICH BEDSIDE TEST BEST PREDICTS THE DIFFICULT AIRWAY?

Dr. Parvathy K P — MD, DNB Anaesthesiology, senior resident at Tata Memorial Centre-ACTREC, Mumbai, Maharashtra state, India

Dr. Vaijayanti Nitin Gadre* — MD Anaesthesiology Professor Anaesthesia, Trauma Care Centre, Government Medical College, Nagpur, Maharashtra state, India*Corresponding Author

ABSTRACT

Background: Unanticipated difficult airway continues to be a significant cause of anaesthesia-related morbidity and mortality. No single bedside test has proven to be consistently reliable across different populations. Evaluating simple and reproducible predictors of difficult airway remains clinically relevant, particularly in routine practice.**Objectives:** To compare the diagnostic accuracy of the Modified Mallampati Test (MMT), Upper Lip Bite Test (ULBT), and Ratio of Height to Thyromental Distance (RHTMD) in predicting difficult mask ventilation, Cormack–Lehane grading for laryngoscopic view, and difficult endotracheal intubation.**Methods:** This prospective observational study included 200 patients (18–60 years), ASA status I–II, and undergoing elective surgery under general anaesthesia. Preoperative airway assessment was performed using MMT, ULBT, and RHTMD (cut-off value 22). Intraoperative parameters recorded were difficulty in mask ventilation, Cormack–Lehane grading and ease of endotracheal intubation. Sensitivity, specificity, predictive values, and diagnostic accuracy were analysed.**Results:** Difficult mask ventilation was observed in 7.5% of patients, difficult laryngoscopic view in 14%, and difficult intubation in 14.5%. MMT showed good sensitivity (83–85%) with moderate specificity (44–60%). ULBT showed very high sensitivity (95–96%) and diagnostic accuracy (85–86%) for difficult laryngoscopy and intubation but low specificity. RHTMD showed a more balanced performance, with sensitivity of 78–83%, specificity of 60–68%, and high positive predictive values (94–96%). All tests, except ULBT for mask ventilation, showed statistically significant associations with difficult laryngoscopy and intubation.**Conclusion:** MMT, ULBT, and RHTMD are useful screening tools for predicting difficult airways. RHTMD provides a more objective and balanced prediction, while ULBT offers high sensitivity. Reliability of evaluation in anticipation of difficult airway can be increased by combining tests together

KEYWORDS : Difficult Airway, Predictors, Outcomes

INTRODUCTION

Endotracheal intubation is important to provide general anaesthesia, resuscitation and intensive care. When encountered with difficulty, intubation poses a threat to life. American Society of Anaesthesiologists define "difficult intubation as the clinical situation in which a conventionally trained anaesthesiologist experiences difficulty with facemask ventilation of the upper airway, difficulty with tracheal intubation, or both" (1); prevalence of unanticipated difficult airway was around 5.8 % (2). While preparing for unexpected difficulties in handling intubation with multistep planning and preparation, it is of utmost importance to be able to identify a difficult airway S. Rao Mallampati proposed a simple bedside test where the size of base of tongue is a determinant of difficulty in visualisation in direct laryngoscopy (3). Samsoon and Young modification of Mallampati score is used in this study. (4)

Upper lip bite test, introduced by Khan et al. suggests that the freedom of mandibular movements and architecture of teeth has pivotal role in facilitating intubation. (5)

Thyromental distance (TMD ≤6.5 cm predicted difficulty) is the distance between the thyroid prominence and the most anterior part mandibular mentum, with the head fully extended. Ratio of a person's height to thyromental distance is a recently proposed predictor of difficult intubation.

When assessed as a single predictor, none of the tests proved reliable predictive accuracy. Combining two or more methods significantly improve the positive predictive value to reduce unanticipated difficult airway.

This study compares MMT score, ULBT and RHTMD in predicting difficult airway; aim is to find an optimal combination and its predictive value.

METHODS-

This prospective observational study was conducted in a tertiary care centre on the patients who underwent general anaesthesia using endotracheal intubation. Primary objectives were to predict difficult airway in cases undergoing general anaesthesia using MMT score, ULBT and using ratio of height to thyromental distance. Comparisons of results of above with actual difficulty to intubate on table were secondary objectives.

Sample size was calculated using Open-Epi version 3, an open-source calculator using formula Sample size n = [DEFF*Np(1-p)]/ [(d2/Z21- /2*(N-1)+p*(1-p)] where N= Population size (300, approximate elective general surgery cases within inclusion criteria), p = prevalence of difficult intubation (taken as1.5 %, from data from previous studies), d = Presion (DEFF adjusts the sample size to account for the loss of statistical efficiency due to the clustering of observations, ensuring that the sample size is adequate for the more complex design), DEFF = Design effect (1), Z1− /2 = 1.96; taking confidence level as 97% sample size is taken as 200.The patients willing to participate in study and giving written valid and informed consent, aged between 18 – 60 years, ASA 1&2 undergoing elective surgery under GA with endotracheal intubation were included. Those not willing to participate and not giving consent, undergoing emergency surgeries or with anatomical distortions of airway, pregnant patients, patients with BMI > 28 were excluded. Permission from the Institutional Ethics Committee was obtained; all the data collected were kept strictly confidential and used for the purpose of this study. The pre-anesthetic check-up was done on the consenting subjects one day prior to surgery. After recording basic details including name, age, height, weight, history of presenting complaints, comorbidities, medications etc., each individual was subjected to three tests viz., MMT score, ULBT, RHTMD by an anaesthesiologist trained to conduct the tests scientifically.

For MMT score, the patient was in sitting posture, with head in

neutral position mouth opened and tongue protruded maximally without phonation. Grading was done as

Class 1: Faucial pillars, soft palate and uvula could be visualized.

Class 2: Faucial pillars and soft palate could be visualized, but uvula masked by the base of the tongue

Class 3: Only soft palate visualized (4)

Class 4: Impossible to visualize soft palate (Fig.1, 2)

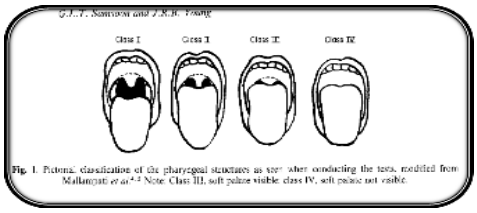

Fig. 1. Pictorial classification of the pharyngeal structures as seen when conducting the tests, modified from Mallampati et al.[4,5] Note: Class III, soft palate visible; class IV, soft palate not visible.

Fig.2: Mallampati class II in a study subject

Similarly in ULBT the patient was asked to bite his upper lip with lower incisors and based on the ability to bite, divided into three classes.

Class I: If the lower incisors could bite the upper lip above the vermilion line

Class II: If the lower incisors could bite the upper lip below the vermilion line

Class III: If the lower incisors could not bite the upper lip (5) (Fig.3)

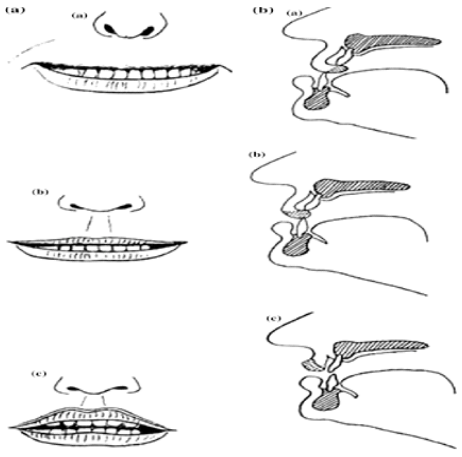

Fig. 3: Upper lip bite test schematic

Then RHTMD was calculated. Blood investigations were noted, chest x-ray and ECG were examined. On table, ensuring six hours of fasting, appropriate consents for anaesthesia, standard monitoring viz. ECG, pulse oxi-meter and non- invasive blood pressure were employed. EtCO2 kept ready. After pre-oxygenation with 100% oxygen, pre medication with intravenous glycopyrrolate 5microg/kg, midazolam 0.2mg/kg, fentanyl 2microgm/kg, ondansetron 4 mg; intravenous induction was done with propofol 1.5-2mg /kg till centralization of pupils. A tight fitting mask was used for ventilation. The ease of mask ventilation was classified using

Grade 1: Ventilation by mask

Grade 2: Ventilation by mask with oral airway or other adjuvant

Grade 3: Difficult mask ventilation (requiring 2 practitioners, inadequate, unstable)

Grade 4: Unable to mask ventilate

After confirming mask ventilation, intravenous suxamethonium 1.5 mg/kg was given for laryngoscopy done after 60 seconds with patient's head in sniffing position using the standard appropriately sized Macintosh blade. A trained anaesthesiologist did the laryngoscopy and glottic view was classified. (Fig.4)

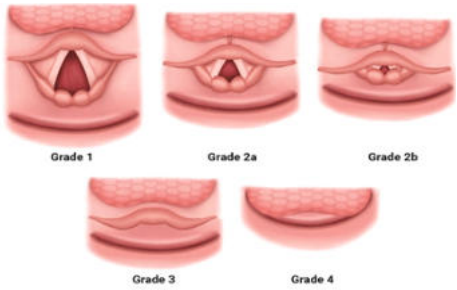

Fig. 4: Schematic representation of Cormack Lehane grading

- Grade 1 (full view of glottis)
- Grade 2a (partial view of glottis)
- Grade 2b (arytenoid or posterior part of vocal cords just only visible
- Grade 3(only epiglottis visible)
- Grade 4(neither glottis nor epiglottis visible)[6]

Five point Likert score was used to assess the ease of insertion of the tube

- Easy insertion (Grade 0)
- Mild difficulty (grade 1)
- Moderate difficulty (grade 2)
- Severe difficulty (grade 3)
- Impossible insertion (grade 4)[7]

Tube was secured after intubation; anaesthesia was maintained with oxygen, nitrous oxide 50:50 and inhalational agent sevoflurane. 1-2% to provide 1-1.5 MAC Neuromuscular blockade was provided with intravenous vecuronium 0.1mg/kg loading followed by 0.03-0.05mg/kg increments. After completion of surgery with patient still adequately anaesthetized, the oropharynx was gently suctioned and inhalational agent turned off. Inspiratory oxygen increased to 100%. Neuromuscular blockade was reversed using Neostigmine 50mcg/kg and glycopyrrolate 8mcg/kg. On return of spontaneous ventilation, patient was extubated. After regaining consciousness, patient was shifted to recovery room for observation. Recorded observations were evaluated using appropriate statistical tests and data analysed by applying the required tests according whether the data is qualitative or quantitative.

RESULTS AND OBSERVATIONS-

Data was analysed using SPSS software v23. Level of significance kept at 5%. The two groups were compared using

chi square tests data was analysed for sensitivity, specificity, positive and negative predictive value, and the odds ratio was calculated. In entire study, the P value < 0.005 is considered to be statistically significant.

Age distribution among study population -Mean age was 43.1 years with a significant standard deviation of 31.8, suggesting a wide age range among participants. This indicates a diverse age group, potentially reflecting varied health profiles and conditions.

Gender distribution among study population was nearly balanced, with 52% male and 48% female participants, demonstrating an equitable representation of both genders in the study.

Height distribution among study population showed mean height of 163.3 cm with a standard deviation of 9.1 cm, indicating a relatively uniform height distribution within the study group.

Weight distribution among study population was 61.3 kg, with a standard deviation of 10.1 kg, showing moderate variation in body weight among participants.

BMI distribution among study population was 22.9 kg/m^2 with a standard deviation of 2.9, placing the average participant within the normal weight range, though individual BMI varied within the study.

Table 1 Mallampati score distribution, Upper Lip Bite Test and Range and Ratio of Height to TMD distribution among study population

Mallampati score	Frequency	Percentage	Upper lip bite test	Frequency	Percentage	Range of RHTMD	Frequency
I	78	39	I	130	65	<22	176
II	83	41.5	II	55	27.5	22 – 23.5	9
III	37	18.5	III	15	7.5	>23.5	13
IV	2	1	-	-	-	Ratio Height /TMD Mean and SD	
Total	200	100	Total	200	100	Mean 18	SD 3.2

The Mallampati score, an indicator of airway visibility, showed that most participants fell within Class I (39%) and Class II (41.5%), with fewer in Classes III (18.5%) and IV (1%), According to various previous studies, Class III and IV are considered a predictor of difficult airway. That consists of 19.5% according to the data. (Table 1)

The majority of participants were classified as Class I (65%) in the Upper Lip Bite Test, which assesses mandibular mobility, indicating good jaw movement among most participants, with fewer in Classes II (27.5%) and III (7.5%). Class III is considered predictor of difficult intubation. (Table 1)

The average ratio of height to thyromental distance was 18, with a standard deviation of 3.2, providing insight into the proportionality between height and airway anatomy across the study population. (Table 1) According to various studies RHTMD cut off value for different study population varies greatly. The original article by Schmitt et.al [8] gives a cut-off value of 25, In Thailand it was 23.5, while study conducted on India by Kaniyil et al [9], found, the cut off value for difficult intubation was 22. For the purpose of this study 22 was taken as the cut-off value as the study by Kaniyil et.al reflects population similar to the study.

Table 2 Mask ventilation grade, CL grade and Ease of insertion distribution among study population-

Mask ventilation Grade	Frequency	Percentage	CL grade	Frequency	Percentage	Ease of insertion	Frequency	Percentage
I	115	57.5	I	65	32.5	0	85	42.5
II	70	35	IIa	57	28.5	1	40	20
III	15	7.5	IIb	52	26	2	46	23
IV	0	0	III	24	12	3	28	14
Total	200	100	IV	2	1	4	1	0.5
			Total	200	100	Total	200	100

The majority of participants (57.5%) had a Grade I mask ventilation score, indicating easy ventilation, while the remainder had Grades II (35%) and III (7.5%), showing varying degrees of difficulty in mask ventilation. There was no case in which mask ventilation was impossible (Grade IV). We did not encounter any cannot intubate cannot oxygenate situation in the current study. (Table 2) Cormack-Lehane (CL) grading, which assesses the view obtained during laryngoscopy, showed that most participants had favorable grades (I and IIa IIb), with only a small percentage (13%) having more challenging grades (III and IV). (Table 2) The ease of insertion during the procedure varied, with 42.5% of participants experiencing no difficulty (Grade 0), while others encountered mild to moderate challenges (Grades 1-3), and a very small number (0.5%) faced significant difficulty (Grade 4). Application of external laryngeal manipulation has been considered grade 2 or higher depending on the difficulty after the manipulation. (Table 2)

Table 3 Association between Mallampati score with mask ventilation grade, CL grade and Ease of ET tube insertion grade

Mallampati score	Easy mask ventilation among various grades	Difficult mask ventilation among various grades	CL grade 1 ,2 Frequency	C L grade 3,4 Frequency	Easy insertion-Grades 0,1	Difficult insertion-Grades 2,3,4
I	77	1	72	6	74	4
II	78	5	74	9	71	12
III	28	9	26	11	26	11
IV	2	0	0	2	0	2
Total	185	15	172	28	171	29

Difficult mask ventilation though occurred among all grades of Mallampati, Grade III has the highest frequency. Applying chi square test, p=0.0001, as p value <0.005, which shows statistical significance. (Table3)

Table 4 Assessing three aspects of difficult airway- mask ventilation, visualization and insertion using Mallampati

	Ease of mask ventilation for each grade of Mallampati		Predictive accuracy of Mallampati score with CL score for ease of visualization of vocal cord		Estimating predictive accuracy of Mallampati in ease of insertion of the tube		
Parameter	Estimate	Lower - Upper 95% Confidence intervals	Estimate	Lower - Upper 95% Confidence intervals	Estimate	Lower - Upper 95% Confidence intervals	Method
Sensitivity	83.78 %	(77.79, 88.41)	84.88%	(78.77, 89.471)	84.8%	(78.65, 89.411)	Wilson Score
Specificity	60%	(35.75, 80.181)	46.43%	(29.53, 64.191)	44.83 %	(28.41, 62.451)	Wilson Score
Positive Predictive Value	96.27 %	(92.11, 98.281)	90.68%	(85.2, 94.271)	90.06 %	(84.47, 93.791)	Wilson Score

Negative Predictive Value	23.08 %	(12.65, 38.34[1])	33.33%	(20.63, 49.02[1])	33.33 %	(20.63, 49.02[1])	Wilson Score
Diagnostic Accuracy	82%	(76.09, 86.71[1])	79.5%	(73.37, 84.51[1])	79%	(72.84, 84.07[1])	Wilson Score

Here we assess three aspects of difficult airway- mask ventilation, visualization and insertion. In the above comparison, ease of mask ventilation for each of Mallampati grades are assessed. (Table 4) It shows a good sensitivity of 83.7 for predicting difficult mask ventilation, fairly good specificity of 60% with an overall diagnostic accuracy of 82%. Applying chi square test, p=0.00003, as p value <0.05, which shows statistical significance.

Cormack-Lehane score, the gold standard test for ease of visualization of vocal cord is used to compare the predictive accuracy of Mallampati score in this table. The sensitivity of Mallampati score is 84.88% in this aspect. Specificity is relatively lower, with a value of 46.43. Applying chi square test, p=0.00002, as p value <0.05, which shows statistical significance. Estimating predictive accuracy of Mallampati in ease of insertion of the tube, it gives a value of 84.8% sensitivity and 44.3% specificity. The diagnostic accuracy of Mallampati comes around 79% in predicting ease of insertion. (Table 4)

Table 5 Comparing Upper lip bite test with mask ventilation grade, CL grade and Ease of ETT insertion

Upper lip bite test	Easy mask ventilation	Difficult mask ventilation	Total	Easy CL grade 1,2	Difficult –CL grade 3,4	Total	Easy ETT insertion	Difficult ETT insertion	Total
I	122	8	130	118	12	130	120	10	130
II	49	6	55	46	9	55	44	11	55
III	14	1	15	8	7	15	7	8	15
Total	185	15	200	172	28	200	171	29	200

Applying chi square test, p=0.0003, as p value <0.05, which shows statistical significance when ULBT and CL grade were compared
Applying chi square test, p=0.52, as p value >0.05, which shows no statistical significance when ULBT and mask ventilation were compared

Table 6 Assessing three aspects of difficult airway- mask ventilation, visualization and insertion using ULBT

	Comparing ULBT with Ease of mask ventilation		Predictive accuracy of UBLT score with CL score for ease of visualization of vocal cord		Estimating predictive accuracy of ULBT in ease of insertion of the tube		
Parameter	Estimate	Lower - Upper 95% Confidence intervals	Estimate	Lower - Upper 95% Confidence intervals	Estimate	Lower - Upper 95% Confidence intervals	Method
Sensitivity	92.43 %	(87.7, 95.44[1])	95.35 %	(91.09, 97.62[1])	95.91%	(91.79, 98[1])	Wilson Score
Specificity	6.667 %	(1.187, 29.82[1])	25%	(12.68, 43.36[1])	27.59%	(14.7, 45.72[1])	Wilson Score
Positive Predictive Value	92.43 %	(87.7, 95.44[1])	88.65 %	(83.27, 92.45[1])	88.65%	(83.27, 92.45[1])	Wilson Score
Negative Predictive Value	6.667 %	(1.187, 29.82[1])	46.67 %	(24.81, 69.88[1])	53.33%	(30.12, 75.19[1])	Wilson Score
Diagnostic Accuracy	86%	(80.51, 90.13[1])	85.5%	(79.95, 89.71[1])	86%	(80.51, 90.13[1])	Wilson Score

Similarly, when upper lip bite test is compared with ease of mask ventilation score, it gives a good sensitivity of 92.4, but lack in specificity. It gives a diagnostic accuracy of 86%. Lack of specificity may result in wrongly predicted difficult intubations. (Table 6)

ULBT showed better specificity in predicting difficult visualization than difficult mask ventilation. Yet the specificity is just 25%. With a sensitivity of 95.35% the diagnostic accuracy comes to 85.5% Applying chi square test, p=0.00004, as p value <0.05, which shows statistical significance. (Table 6)

ULBT When compared for ease of insertion, shows sensitivity of 95.91% with a much lower specificity of 27.59% .The diagnostic accuracy come up to 86% (Table 6)

Table 7 Comparing Ratio of height to thyromental distance with mask ventilation grade, CL grade and Ease of ETT insertion

Ratio of height to thyromental distance	Easy	Difficult	Total	Easy CL grade 1,2	Difficult –CL grade 3,4	Total	Easy ETT insertion	Difficult ETT insertion	Total
<22	170	6	176	162	14	176	163	13	176
>22	16	8	24	10	14	24	8	16	24
Total	185	15	200	172	28	200	171	29	200

To assess ease of mask ventilation by using RHTMD -Applying chi square test, p=0.00004, as p value <0.05, which shows statistical significance. (Table 7)

To assess CL grade by using RHTMD - Applying chi square test, p<0.0001, as p value <0.05, which shows statistical significance (Table 7)

To assess ease of insertion of ETT using RHTMD- Applying chi-square test, p<0.0001, as p value <0.05, which shows statistical significance (Table 7)

Table 8 Assessing three aspects of difficult airway- mask ventilation, visualization and insertion using RHTMD-

	Comparing RHTMD with Ease of mask ventilation		Predictive accuracy of RHTMD score with CL score for ease of visualization of vocal cord		Estimating predictive accuracy of RHTMD in ease of insertion of the tube		
Parameter	Estimate	Lower - Upper 95% Confidence intervals	Estimate	Lower - Upper 95% Confidence intervals	Estimate	Lower - Upper 95% Confidence intervals	Method

Sensitivity	78.38%	(71.9, 83.7[1])	82.56%	(76.19, 87.5[1])	82.00%	(76.19, 87.5[1])	Wilson Score
Specificity	60%	(35.75, 80.18[1])	67.86%	(49.34, 82.07[1])	66.84%	(49.34, 82.07[1])	Wilson Score
Positive Predictive Value	96.03%	(91.6, 98.17[1])	94.04%	(89.06, 96.83[1])	94.00%	(89.06, 96.83[1])	Wilson Score
Negative Predictive Value	18.37%	(9.976, 31.36[1])	38.78%	(26.43, 52.75[1])	38.78%	(26.43, 52.75[1])	Wilson Score
Diagnostic Accuracy	77%	(70.69, 82.29[1])	80.5%	(74.46, 85.39[1])	80.0%	(74.46, 85.39[1])	Wilson Score

RHTMD when compared for its accuracy in predicting mask ventilation, of larynx, gives a sensitivity of 78.38% and specificity of 60%. It has a reasonable diagnostic accuracy of 77% (Table 8)

RHTMD when compared for its accuracy in predicting difficult visualization of larynx, gives a sensitivity of 82.56% and specificity of 67.86%. It has a good diagnostic accuracy of 80.5% (Table 8)

RHTMD when compared for its accuracy in predicting difficult insertion of ET tube, gives a sensitivity of 82.00% and specificity of 66.84%. It has a good diagnostic accuracy of 80%.The results are comparable to its ability to predict difficult visualization. (Table 8)

DISCUSSION

Airway management is one skill which is of utmost importance in Anaesthesiology, critical care and emergency medicine. An unpredicted difficult airway poses a serious threat to the patient's life. Around 1.5-13% of patients are described to have difficult laryngoscopy. [10]Around 9.7% of Indian population experience difficult laryngoscopy. The incidence of difficult intubation among Indian population is around 4.5% [11] Identification of difficult airway is of utmost importance to reduce the morbidity and mortality related to a delayed or failed intubation. [12]

In this prospective observational study we tried to assess the diagnostic accuracy of MMT score, ULBT and RHTMD. The focus was on determining predictive values of these tests for difficult mask ventilation, difficult in visualising the larynx and insertion of the endotracheal tube thus evaluating its utility in a low resource setup.

A total of two hundred adult patients between 18-60 years, ASA1, 2 scheduled for general anaesthesia were included. The study population had a mean age of 43.1 years (SD 31.8), with an almost equal gender distribution (104 males and 96 females), ensuring comparability of findings across sexes.

Each participant underwent preoperative assessment using the MMT score, ULBT, and RHTMD. The results were then correlated with difficulty in mask ventilation, Cormack-Lehane grading during laryngoscopy and ease of insertion of endotracheal tube.

Difficult mask ventilation was noted in 7.5% of patients. Difficult visualisation of larynx (CL grade 3 or 4) occurred 14%. Difficult intubation was seen in 14.5%.

Among the 200 patients, 19.5% had Mallampati Class III or IV (Class III – 18.5%, Class IV – 1%). This was comparable to previous studies reporting 16% and 3.5%, respectively. In assessing MMT score's ability to predict a difficult mask ventilation, the p value was found to be 0.0001, with sensitivity of 83.78%, specificity of 60%, positive predictive value of 96.27% Negative predictive value of 23.08 with an overall diagnostic accuracy of 82%.This indicates that a higher Mallampati class strongly predicts difficult mask ventilation, though an easy Mallampati grade does not rule out difficulty.

When comparing MMT score with CL grading it was found that there is a significant correlation between higher MMT grade and difficult laryngoscopy. MMT score showed a sensitivity of 84.88%, specificity of 46.43%, positive predictive value of 90.6% and negative predictive value of 33.3%. MMT score showed good predictive value when using it to predict ease of introducing the tube through the larynx. P value: 0.00002, Sensitivity: 84.8%, Specificity: 44%, PPV: 90, NPV: 33.33%, and predictive accuracy: 79%. In conclusion, in this study, the MMT score shows a good predictive value in all three steps - Mask ventilation, visualising and tube insertion.

Previous literature presents variable results for MMT; Ray [13] reported sensitivity 42.86%, specificity 82.56%, PPV 28.57%, NPV 89.87%. Khatiwada[14] found sensitivity 83%, accuracy 96%, consistent with this study.

The current study's higher sensitivity (≈85%) and lower specificity (≈45–60%) imply that MMT is a good screening tool for difficult airways but less reliable in ruling out difficulty when the score is low. Inter-observer variation and patient phonation during assessment are possible sources of variability.

Upper lip bite test evaluates mandibular protrusion by asking patients to bite the upper lip with lower incisors. It indirectly assesses temporomandibular joint and mandibular mobility. While not correlating significantly with difficult mask ventilation in the current study; it shows significance in predicting difficulty in visualising larynx and insertion of tube. When comparing scores of ULBT with CL grades, it showed P value: 0.0003 (significant), Sensitivity: 95.35%, Specificity: 25%, PPV: 88.65%, NPV: 46.67% and accuracy: 85.5%. When compared with ease of intubation, P value: 0.00004 (significant), Sensitivity: 95.91%, Specificity: 27.59%, PPV: 88.56%, NPV: 33.33% and Accuracy: 86%.Thus, ULBT demonstrated very high sensitivity and PPV, suggesting strong capability to detect difficult laryngoscopy and intubation, though its specificity and NPV were low, leading to over-classification of difficulty.

In the original article by Khan [5] sensitivity, specificity, and accuracy 76.5%, 88.7% and 88% respectively. When comparing current study to the original study, the major difference is in the specificity of ULBT. Similar to the original article Shah et al. [15] showed sensitivity 74.63%, specificity 91.53%, and accuracy 87.8%. Wajekar [16] (Sensitivity 98.6%, specificity 8.7%) on the other hand closely resembling current findings. Faramarzi [17] who systematically reviewed 18141 studies showed that ULBT has high specificity and relatively good sensitivity. Eberhart[18] (Sensitivity 28.2%, specificity 92.5%) the study was originally conducted to test the findings of Khan [5].

Hence, ULBT's diagnostic profile varies widely among studies. The high sensitivity we obtained shows that the test can successfully be used to screen for difficult airways, though it has a tendency to overestimate.

RHTMD integrates an individual's height with thyromental distance, normalizing for body proportions and eliminating absolute measurement bias. It provides a more objective assessment of airway anatomy. In current study in comparison

to RHTMD grades with difficulty of mask ventilation, the p value was < 0.05 showing statistical significance. It showed a sensitivity of 78.38%, specificity of 60% PPV of 96.03% and NPV of 18.37%. While comparing RHTMD with CL grading, P value was 0.0001, sensitivity 82.58%, specificity 67.86%, PPV was 94.04% and NPV 35.78%. When comparing the results obtained with RHTMD and ease of intubation, P value was 0.0001 which showed statistical significance, with sensitivity 82.58%, specificity 67.86%, PPV 94.04% and NPV 35.78%. In the original article by Schmidt [8] with a cut off value 25, sensitivity was 81% and specificity was 90%. Kaniyil [9] with RHTMD cut off value of 22 showed sensitivity of 62.5%,specificity 100%,and accuracy of 94.3%.This study, conducted in the Indian population, is comparable to the findings of the current study. A study by Krobuban [19] et al in the Thai population too showed similar sensitivity and specificity to the current study, but with a higher cut-off value of 23.5.

RHTMD has certain advantages over commonly used thyromental distance. It takes an individual's proportions into consideration. There are variations in length of neck, size of tongue and soft tissues around neck. RHTMD provides a more objective comparison tool.

In conclusion, in the study ULBT showed highest sensitivity and overall diagnostic accuracy. However being highly sensitive and less specific ULBT may over predict difficult airway. RHTMD provided a more balanced diagnostic profile, with a good sensitivity and specificity with higher positive predictive value, making it a more reliable indicator of truly difficult intubations. MMT, a widely used and well regarded tool remains a useful tool in the armamentarium of anaesthesiologists, though it has certain limitations of subjectivity compared to the other tools. From a clinical perspective, relying on a single test may result in unexpected airway emergencies. Thus combining tests together can significantly enhance the predictive accuracy.

REFERENCES

1. Updated By The Committee On Standards And Practice Parameters, Apfelbaum JL, Hagberg CA, Caplan RA, Blitt CD, Connis RT, Et Al. Practice Guidelines For Management Of The Difficult Airway. Anaesthesiology. 2013 Feb 1; 118(2):251–70.PMID: 23364566DOI: 10.1097/ALN.0b013e31827773b2
2. Shiga T, Wajima Z, Inoue T, Inoue T, Sakamoto A. Predicting Difficult Intubation In Apparently Normal Patients: a meta-analysis of bedside screening test performance Anesthesiology. 2005 Aug 1; 103(2):429–37. PMID: 16052126 DOI: 10.1097/00000542-200508000-00027
3. Mallampati SR, Gatt SP, Gugino LD, Desai SP, Waraksa B, Freiberger D, P L Liu. A Clinical Sign to Predict Difficult Tracheal Intubation: A Prospective Study. Can Anaesthesia Society J. 1985 Jul; 32(4):429–34. PMID: 4027773 DOI: 10.1007/BF03011357
4. Samsoon GL, Young JR. Difficult Tracheal Intubation: A Retrospective Study. Anaesthesia. 1987 May; 42(5):487–90. PMID: 3592174 DOI: 10.1111/j.1365-2044.1987.tb04039.x
5. Khan ZH, Kashfi A, Ebrahimkhani E. A Comparison of the Upper Lip Bite Test (A Simple New Technique) with modified Mallampati Classification in Predicting Difficulty in Endotracheal Intubation: A Prospective Blinded Study: Anaesthesia Analgesia. 2003 Feb; 96(2):595–9. PMID: 12538218 DOI: 10.1097/00000539-200302000-00053
6. Cormack RS, Lehane J. Difficult Tracheal Intubation in Obstetrics. Anaesthesia1984 Nov; 39(11):1105–11. PMID: 6507827
7. Shravanalakshmi D, Bidkar P, Narmadalakshmi K, Lata S, Mishra S, Adinarayanan S. Comparison of Intubation Success and Glottic Visualization Using King Vision And C-Mac Videolaryngoscopes in Patients with Cervical Spine Injuries with Cervical Immobilization: A Randomized Clinical Trial. Surgical Neurology International 2017;8(1):19.doi: 10.4103/2152-7806.199560.PMCID: PMC5309444
8. Schmitt HJ, Kirmse M, Radespiel-Troger M. Ratio of Patient's Height To Thyromental Distance Improves Prediction of Difficult Laryngoscopy. Anaesth Intensive Care. 2002 Dec; 30(6):763–5. PMID: 12500514DOI: 10.1177/0310057X0203000607
9. Kaniyil S, Anandan K, Thomas S. Ratio of Height To Thyromental Distance As A Predictor Of Difficult Laryngoscopy: A Prospective Observational Study. Journal of Anaesthesiology and Clinical Pharmacology. 2018; 34(4):485–9. PMCID: PMC6360890 PMID: 30774228
10. Randell T. Prediction of Difficult Intubation. Acta Anaesthesiol Scand. 1996 Sep; 40(8p2):1016–23. PMID: 8908216DOI: 10.1111/j.1399-6576.1996.tb05620.x
11. Prakash S, Kumar A, Bhandari S, Mullick P, Singh R, Gogia A. Difficult Laryngoscopy And Intubation In The Indian Population: An Assessment Of Anatomical And Clinical Risk Factors. Indian J Anaesth. 2013; 57(6):569. PMID: 24403616 PMCID: PMC3883391 DOI: 10.4103/0019-5049.123329
12. Cooper RM. Preparation For and Management of "Failed" Laryngoscopy and/or Intubation. Anesthesiology. 2019 May 1; 130(5):833–49. https://www.researchgate.net/publication/330985046_Preparation_for_and_Management_of_Failed_Laryngoscopy_andor_Intubation
13. Ray S, Sanyal R, Chakraverty P, Kanti Bhattacharya M. Comparision Of Airway Assessment By Mallampati Classification And Cormack And Lehane Grading In Indian Population. Indian J Clin Anaesth. 2019 Mar 28; 6(1):140–2.
14. Khatiwada S, Acharya R, Bhattarai B, Pokharel K. Prediction Of Difficult Airway Among Patients Requiring Endotracheal Intubation In A Tertiary Care Hospital In Eastern Nepal. J Nepal Med Assoc 2017 Jul-Sep; 56(207):314-8. PMID: 29255312
15. Shah P, Dubey K, Yadav J. Predictive Value Of Upper Lip Bite Test And Ratio Of Height To Thyromental Distance Compared To Other Multivariate Airway Assessment Tests For Difficult Laryngoscopy In Apparently Normal Patients. J Anaesthesiol Clin Pharmacol. 2013; 29(2):191. PMID: 23878440 PMCID: PMC3713666 DOI: 10.4103/0970-9185.111700
16. Wajekar A, Chellam S, Toal P. Prediction Of Ease Of Laryngoscopy And Intubation-Role Of Upper Lip Bite Test, Modified Mallampati Classification, And Thyromental Distance In Various Combination. J Fam Med Prim Care. 2015;4(1):101. PMID: 25810998 PMCID: PMC4366978 DOI: 10.4103/2249-4863.152264
17. Faramarzi E, Soleimanpour H, Hussain Khan Z, Mahmoodpoor A, Sanaie S. Upper Lip Bite Test For Prediction Of Difficult Airway: A Systematic Review. Pak J Med Sci [Internet]. 2018 Jul 13 [Cited 2022 Oct 6]; 34(4). Available From: Http://Pjms.Com.Pk/Index.Php/Pjms/Article/View/15364
18. Eberhart Lhj, Arndt C, Cierpka T, Schwanekamp J, Wulf H, Putzke C. The Reliability And Validity Of The Upper Lip Bite Test Compared With The Mallampati Classification To Predict Difficult Laryngoscopy: An External Prospective Evaluation: Anesth Analg. 2005 Jul; 101(1):284–9. PMID: 15976247DOI: 10.1213/01.ANE.0000154535.33429.36
19. Krobbuaban B, Diregpoke S, Kumkeaw S. An Assessment Of The Ratio Of Height To Thyromental Distance Compared To Thyromental Distance As A Predictive Test For Prediction Of Difficult Tracheal Intubation In Thai Patients. J Med Assoc Thail Chotmaihet Thangphaet. 2006 May; 89(5):638–42.