COMPARATIVE STUDY BETWEEN MMT CLASSIFICATION AND ULBT FOR PREDICTING DIFFICULTY DURING ENDOTRACHEAL INTUBATION

T. Jamuna[1], M. Srinivasa Rao[2], Naveen[3]

[1]Professor, Department of Anaesthesiology, S. V. Medical College, Tirupathi, Andhra Pradesh.
[2]Associate Professor, Department of Anaesthesiology, S. V. Medical College, Tirupathi, Andhra Pradesh.
[3]Postgraduate Student, Department of Anaesthesiology, S. V. Medical College, Tirupathi, Andhra Pradesh.

ABSTRACT

BACKGROUND

Airway management is of prime importance to the anaesthesiologist. Unexpected difficulty with endotracheal intubation is a significant contributor to anaesthetic morbidity and mortality in clinical practice. In order to avoid complications there has been a continuous search for better predictor of difficult airway, upper lip bite test (ULBT) is one such attempt.

MATERIALS AND METHODS

One hundred patients, aged between 18 to 55 years of age of both sexes scheduled for various elective surgeries under general anaesthesia after meeting inclusion and exclusion criteria were enrolled in this prospective study. Pre-operatively, patient's airway was evaluated by both MMT and ULBT. MMT class III and IV, ULBT class III were considered as predictors of difficult endotracheal intubation. On the day of surgery, after premedication and induction, laryngoscopy was performed in sniffing position. The glottic views were graded according to the Cormack and Lehane classification. Patients of Cormack-Lehane class III/IV were considered as difficult to intubate.

RESULTS

Incidence of difficult intubation in our study was found to be 7%. MMT was found to be more sensitive. But, positive and negative predictive value of both the tests were comparable.

CONCLUSION

MMT is a better predictor of difficult endotracheal intubation when compared to ULBT and both the tests are better predictors of easy intubations than of difficult intubation.

KEYWORDS

Difficult Intubation, Modified Mallampati Test, Upper Lip Bite Test.

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BACKGROUND

Unexpected difficulty with endotracheal intubation is a significant contributor to anaesthetic morbidity and mortality in clinical practice. These difficult intubations are probably the result of a lack of accurate predictive tests for difficult intubation and inadequate preoperative evaluation of the airway.

A perusal of the causes of difficult intubation leads to the conclusion that it is often due to deviation from the normal anatomy of the airway that makes it difficult to intubate. Hence, all the tests aimed at predicting difficult intubation have revolved around measuring dimensions of anatomical structures in the airway or maintenance of their normal relationships.

Airway management is of prime importance to the Anaesthesiologist. For securing airway, tracheal intubation using direct laryngoscopy remains the method of choice in most of the cases. No anaesthetic is safe unless diligent efforts are made to secure and maintain an intact airway.

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Corresponding Author:
M. Srinivasa Rao,
Associate Professor, Department of Anaesthesiology,
S. V. Medical College, SVRRG Hospital, Tirupathi, A. P.
E-mail: manduri60@gmail.com
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The reported incidence of difficult laryngoscopy and tracheal intubation occurs in 1.5% to 8% of patients in general anaesthesia.[1] Difficult laryngoscopy and intubation causes increased risk of complications to the patient ranging from sore throat to airway trauma. In some cases if Anaesthesiologist is not able to maintain a patent airway, it may lead to serious complications like hypoxic brain damage or death. Of all the anaesthetic deaths, 30% to 40% are attributed to the inability to manage a difficult airway.[2] Of the overall claims against anaesthetist in closed claims project, 17% involved difficult or impossible intubation.[3]

Although, prediction and forecasting are a tough business, in light of the complications considerable attention has been given to predict difficult intubation in patients.

There are many tests to predict difficult intubation viz. 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.[4,5] So, predicting a difficult intubation employing a myriad of measurements and observations has not demonstrated itself to be practicable or even reliable.

In 1984, Cormack and Lehane introduced grading system for the degree of glottic exposure upon direct laryngoscopy.[6] This grading system became the basis for documenting difficult laryngoscopy or tracheal intubation.

Mallampati and Colleagues in 1985 emphasised the importance of the relative size of the tongue to the oral cavity

through examining hypopharynx. It was demonstrated that the extent to which tongue hides soft palate, faucial pillars and uvula strongly correlated with the ability to view glottis during direct laryngoscopy. They proposed Mallampati classification depending upon the structures that are visible in the oral cavity after asking the patient to open the mouth as wide as possible with head in neutral position.[7]

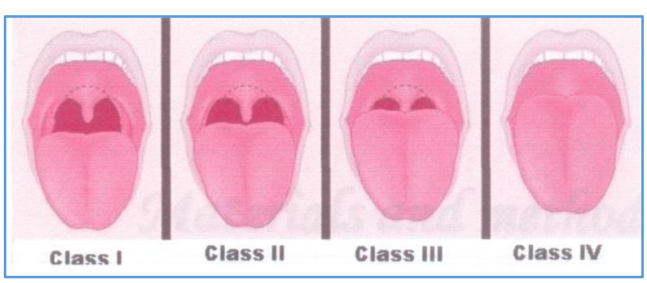
As the range and freedom of mandibular movement and architecture of teeth have pivotal roles in facilitating laryngoscopic intubation, a study was done by Zahid Khan and his colleagues where they compared a new bed side test and Upper lip bite test (ULBT) with MMT. Study concluded that a new, simple bed side test and Upper lip bite test (ULBT) have been found to have higher accuracy (88%), specificity (88.7%), positive predictive value (28.9%) than Modified Mallampati Test (MMT).[6] They also showed ULBT an acceptable option as a simple, single test to predict difficult intubation.[6]

In a day-to-day practice we use MMT to predict the difficult endotracheal intubation, whereas ULBT is not as popular as that. So ULBT needs to be evaluated as a useful test to predict difficult intubation in a day-to-day cases. Hence, we proposed this study to compare ULBT with MMT in predicting difficulty in endotracheal intubation in patients who are undergoing surgery under general anaesthesia.

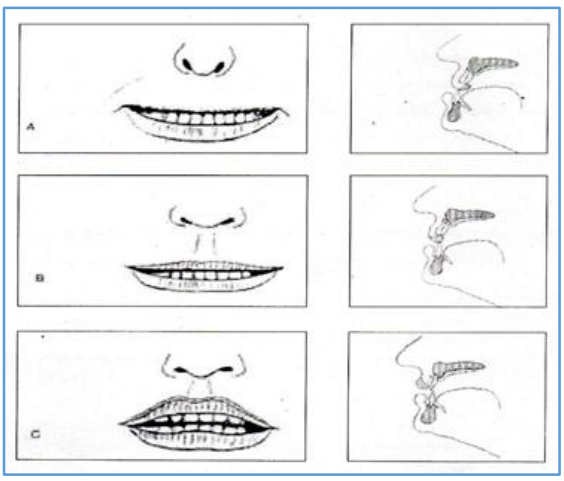
This new bed side test was externally evaluated by Eberhart LHJ et al[8] in 2005. They showed although it had better interobserver reliability compared to MMT, both the tests had poor predictive power indicating that both the tests were poor predictors of difficult intubation when they were used alone. Also found it (ULBT) cannot be applied to all the patients.

A recent meta-analysis was done on accuracy of the Mallampati tests by Lee et al and they found out Mallampati tests have limited accuracy for predicting difficult airway and thus not useful for screening.[9] As more researchers got interested in the new simple bed side test (ULBT), they compared this test with MMT. They found that it is more sensitive, specific and has high discriminative power than MMT.[10]

So, we decided to compare ULBT with MMT to predict difficult intubation.



Modified Mallampati Classification of Oropharynx



Schematic Frontal and Lateral View of the Upper Lip Bite Test

A. **Class I:** Lower incisors biting the upper lip, making the mucosa of the upper lip totally invisible.
B. **Class II:** The same biting manoeuvre revealing a partially visible mucosa.
C. **Class III:** The lower incisors fail to bite the upper lip.

Aim and Objective of the Study

To assess the value of modified Mallampati test (MMT) and Upper lip bite test (ULBT) to predict difficult endotracheal intubation in adult patients.

MATERIALS AND METHODS

In this descriptive study, after obtaining Institutional Scientific and Ethical Committee clearance and written informed consent, the study was conducted in 100 male/female patients aged between 18 yrs. and 55 yrs. of age at SVRRGH Hospital, Tirupati, AP. One hundred patients between 18 - 55 yrs. of age undergoing elective surgical procedures under general anaesthesia were enrolled in the study. The sensitivity, specificity, positive predictive and negative predictive values were analysed for the individual tests and in combination.

A thorough pre-anaesthetic evaluation was carried out in all the patients and the procedure was explained in detail to the patients. Exclusion Criteria applied in Edentulous patients, patients unable to open the mouth, patients with cervical spine fractures, deformities and patients with upper airway tumours. Preoperatively, all the patient's airway was evaluated using MMT and ULBT.

Classification of oropharyngeal view was done according to MMT, where the patients were made to be in sitting position with mouth fully open and tongue maximally protruded and patients were asked not to phonate.

Class I- Soft palate, fauces, uvula and pillars are seen.
Class II- Soft palate, fauces and portion of uvula are seen.
Class III- Soft palate and base of uvula.
Class IV- Hard palate only.

The ULBT was performed according to the following Criteria

- **Class 1-** Lower incisors can bite upper lip above the vermilion line.
- **Class II-** Lower incisors can bite upper lip below the vermillion line.
- **Class III-** Lower incisors cannot bite the upper lip.

Patients were anaesthetised using balanced anaesthesia technique i.e. pre-medicated with IV glycopyrrolate 0.005 mg/kg, IV midazolam 0.05 mg/kg and IV fentanyl 1 - 2 mcg/kg. After pre-oxygenation with 100% oxygen for 5 minutes, patients were induced with IV thiopentone 5 mg/kg and the endotracheal intubation was accomplished with suxamethonium 1.5 to 2 mg/kg by senior Anaesthesiologists having minimum five years of experience in clinical anaesthesia.

The patients' head and neck were kept in optimal intubating position with a pillow under the occiput during intubation (sniffing position). Laryngoscopy was done using appropriate sized Macintosh blade and glottic view was graded according to the-

Cormack and Lehane Grading

Grade I : Full view of the glottis.
Grade II : Only posterior commissure visible.
Grade III : Only tip of epiglottis visible.
Grade IV : No glottic structure visible.

Patients were intubated with appropriate sized endotracheal tube. Patient's vital signs were monitored throughout the procedure.

Sample Size Calculation

In a day-to-day practice we use MMT to evaluate the airway, so it is taken as gold standard against which ULBT will be compared.

Sample size was calculated using the formula

$$E = z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

η= is the sample size.

A 95% degree confidence corresponds to α = 0.05. The critical value is therefore $z_{\alpha/2}$ = 1.96. The margin of error E= 1 and the standard deviation σ = 5.0. Using the formula for sample size, we can calculate n:

$$n = \left[\frac{z_{\alpha/2}\sigma}{E}\right]^2$$ = $(\underline{1.96.\ 5.0})^2$ = $[9.8]^2$ =96.04, so we will need to sample at least 100 (rounded up) randomly selected patients.

The pre-operative airway assessment data and the findings during intubation were used to determine the sensitivity, specificity, positive and negative predictive values for each test.

Diagnostic test was used through MedCalc to calculate statistically significant difference in sensitivity and specificity between these tests respectively.

Statistical Terms

True Positive

A difficult intubation that had been predicted to be difficult.

False Positive

An easy intubation that had been predicted to be difficult.

True Negative

An easy intubation that had been predicted to be easy.

False Negative

A difficult intubation that had been predicted to be easy.

Sensitivity

The percentage of correctly predicted difficult intubations as a proportion of all intubations that were truly difficult, i.e. true positives/ (true positives + false negatives).

Specificity

The percentage of correctly predicted easy intubations as a proportion of all truly easy intubations, i.e. true negatives/ (true negatives + false positives).

Positive Predictive Value

The percentage of correctly predicted difficult intubations as a proportion of all predicted difficult intubations, i.e. true positives/ (true positives + false positives).

Negative Predictive Value

The percentage of correctly predicted easy intubations as a proportion of all predicted easy intubations, i.e. true negatives/ (true negatives + false negatives).

Accuracy

The percentage of correctly predicted easy and difficult intubations as a proportion of all intubations, i.e., (true positives + true negatives)/ (true positives + true negatives + false positives + false negatives).

Statistical Analysis

Screening tests

Test	Positive	Negative	Total
Positive	True Positives (TP)	False Positives (FP)	TP + FP
Negative	False Negative (FN)	True Negatives (TN)	FN+TN
Total	**TP+FN**	**FP+TN**	**N= TP+FP+FN+TN**

$$\text{Sensitivity} = \frac{TP \times 100}{TP+FN}$$

$$\text{Specificity} = \frac{TN \times 100}{FP+TN}$$

$$PPV = \frac{TP \times 100}{TP+FP}$$

$$NPV = \frac{TN \times 100}{FN+TN}$$

$$\text{Accuracy} = TP+TN \times 100 / N$$

$$\text{McNemar test: } x^2 = \frac{(FP-FN)^2}{FP+FN}$$

The complete data sheets were analysed by MedCalc version 16.0 software. McNemar test was used to compare non-parametric variables between two groups. Considering that both ULBT and MMT were used to predict difficult airways and ultimately were contrasted with Cormack-Lehane classification and the two tests were not interdependent of each other. McNemar test was considered to be most appropriate.

P value < 0.05 was taken as level of significance.

RESULTS

Age (Years)	No. of Cases	Gender	No. of Cases
18-25	25	Male	60
26-35	40	Female	40
36-45	24	**Total**	**100**
46-55	11		
Total	**100**		
Mean	32.91		
SD	9.52		

Table 1. The Demographic Profile of the Patients is Depicted

BMI	No. of Cases
16-19.99	18
20-24.99	65
25-29.99	12
30-34.99	5

Hundred patients were enrolled in the study. Eighty-six had MMT class I and II and fourteen patients had class III. Of these two of the MMT class I and II and eight of the MMT class III had Cormack-Lehane grade III as shown in Table 2. None of the patients had MMT class IV.

As shown in Table 3 we found that ninety patients predicted to be easy for intubation by ULBT (i.e. patients who had ULBT class I and II), out of whom however we encountered difficult intubation in 8 patients. Two in ULBT class III also had difficult intubation. True positive, false positive, true negative and false negative results together with sensitivity, specificity, positive predictive value, negative predictive value and accuracy for MMT and ULBT are shown in Table 2, 3, 4.

Of the entire one hundred patients a total of ten patients had difficult intubation, all of whom had Cormack-Lehane class III on laryngoscopy. There were no cases of failed intubation in our study.

MMT Cormack-Lehane

	Difficult	Easy	Total
Difficult	8 (TP)	6 (FP)	14 (TP)
Easy	2 (FN)	84 (TN)	86 (TN)
Total	**10**	**90**	**100**

Table 2. Cormack-Lehane Grading vs. MMT

Difficult: Grade III and IV, Easy: Grade I and II.

ULBT Cormack-Lehane

	Difficult	Easy	Total
Difficult	2 (TP)	8 (FP)	10(TP)
Easy	8 (FN)	82(TN)	90(TN)
Total	**10**	**90**	**100**

Table 3. Cormack-Lehane Grading vs. ULBT

Difficult: Grade III, Easy: Grade I and II.

Sensitivity, specificity, PPV and NPV for both the tests were shown in Table 4 and 5.

Parameter		95% CI
True Positives	8	
False Positives	6	
False Negatives	2	
True Negatives	84	
Sensitivity	80%	(44.39, 97.48)
Specificity	93.33%	(86.05, 97.51)
Positive Predictive Value	57.1%	(36.70, 75.41)
Negative Predictive Value	97.6%	(92.39, 99.32)
Diagnostic Accuracy	92%	(84.84, 96.48)

Table 4. MMT vs. Cormack-Lehane Grading

Parameter		95% CI
True Positives	2	
False Positives	8	
False Negatives	8	
True Negatives	82	
Sensitivity	20%	(2.52, 55.61)
Specificity	91.1%	(83.23, 96.08)
Positive Predictive Value	20%	(5.78, 50.47)
Negative Predictive Value	91.1%	(88.19, 93.36)
Diagnostic Accuracy	84%	(75.32, 90.57)

Table 5. ULBT Class vs. Cormack-Lehane Grading

Grades	MMT	ULBT	Cormack-Lehane Grading
I and II	86	90	**90**
III and IV	14	10	10

Table 6. Comparison of Difficult Intubation

Of one hundred patients 86 patients had MMT class I, II and 90 patients had ULBT class I and II in whom there were two cases of MMT I and II and 8 cases of ULBT I and II had difficult intubation. Eight out of the fourteen cases of MMT

class III and two out of ten cases in ULBT class III had difficult intubation. In our study, there were no cases of MMT class IV.

DISCUSSION

Airway management remains an important challenge in the contemporary practice of anaesthesia. Preoperative airway assessment facilitates appropriate preparation when difficulty with intubation or ventilation is anticipated prior to induction of anaesthesia. Benumof defined difficult endotracheal intubation as Cormack and Lehane grade III with several attempts made and defined intubation failure as Cormack and Lehane grade III or IV with failure.

Unanticipated difficult laryngoscopic tracheal intubation remains a primary concern of anaesthesiologists. The reported incidence of a difficult laryngoscopy or endotracheal intubation varies from 1.5% to 13% in patients undergoing surgery. Because of the potentially serious consequences of failed tracheal intubation, considerable attention has been focused on attempts to predict patients in whom laryngoscopy and intubation will be difficult.

Because the range and freedom of mandibular movement and the architecture of the teeth have pivotal roles in facilitating laryngoscopic intubation, we hypothesised that the upper lip bite test (ULBT) could serve as a good predictor for difficult laryngoscopic intubation. To test the validity of this hypothesis, we conducted a study in patients undergoing general anaesthesia.

Wilson et al described five risk factors that are important in predicting difficult intubation including weight (p= 0.05), head and neck movement (p= 0.001), jaw movement (p=0.001), receding mandible (p= 0.001), and buck teeth (p=0.001). Our technique, the ULBT, assesses a combination of jaw subluxation and the presence of buck teeth simultaneously, obviously enhancing its predictive value and reliability.

The demographic variables like mean age and weight were comparable between patients with easy and difficult laryngoscopy. However, mean height and BMI were statistically high in difficult laryngoscopy group. The Mallampati classification or Mallampati test (MMT) is a simple test to predict difficult tracheal intubation from anatomy of the oropharynx. The upper lip bite test (ULBT) has recently been introduced as a predictor test for difficult laryngoscopy (Cormack-Lehane classification grade 3 and 4), mask ventilation and intubation. All these parameters are relatively quick bedside tests and there is no need for special equipment and skills.

As per Khan and his colleagues,[11] Upper Lip Bite test (ULBT) was such an attempt. They proposed jaw subluxation and buck teeth as alternative to the most widely used Modified Mallampati Test. They found out that ULBT was easy to perform within seconds of demonstrating it to the patients and very convenient to perform as a bedside test. The classes are clearly demarcated and delineated making interobserver variability highly unlikely while using this test.

The current study therefore was undertaken to compare Upper Lip Bite Test (ULBT) with Modified Mallampati Test (MMT) for predicting difficulty during endotracheal intubation in 100 patients of both sexes, aged between 18 yrs. to 55 yrs. of age undergoing elective surgery under general anaesthesia.

In this study incidence of difficult intubation was found to be around 10%, which is comparable to the results obtained by Frerk and Savva. However, the reported incidence of difficult laryngoscopy intubation is 1.5% to 8%.[1] This wide variation in incidence is due to the criteria that are used to define the difficult intubation and different anthropometric features among populations.

There were no failures to intubate the trachea in any of the patients in the present study.

In this study, we found the sensitivity of MMT to be 80% which was almost near to the study conducted by Erzi et al (76%). The specificity of MMT in this study is 93.3%, which is more than of Khan et al (66.8%) and Eberhart et al (61%). A higher specificity similar to our study has also been reported by Cattano et al.

The wide variations in reported specificity and sensitivity in various studies may be because of incorrect evaluation of the test and interobserver variability seen in MMT as was also found by Eberhart et al.

The positive predictive value of MMT in our study was 57.1%, which was quite high when compared to other studies. This can be explained by the fact that all the patients' airway was evaluated by a single resident unlike in other studies wherein two or more than two Anaesthesiologists were being involved in assessing the airway, which might have contributed to the interobserver variability in their study leading to high false positivity.

The experience of the Anaesthesiologist performing the intubation also might have caused variation in results. In our study Anaesthesiologist with minimum 5 years of experience in clinical anaesthesia was involved, thereby further reducing the false positivity and hence high positive predictive value. The negative predictive value of MMT was 97.6%, which is comparable to the study done by Eberhart et al.

The sensitivity of ULBT in our study was 20%, which was well below what Khan et al had got in their study (76.5%), but it was nearer to the value obtained by Eberhart et al (28%). This means that several patients who present with difficult intubation will not be identified by ULBT (larger number of patients with false negative test). Lower sensitivity of the ULBT can be explained due to low incidence of ULBT class III in our study.

The specificity of ULBT in our study was 91%, well above the original trial by Khan et al. This is because of the lesser number of false negative results obtained in our study with ULBT.

The PPV of ULBT in our study was 20%, which was not comparable to study done by Eberhart et al. The NPV was 91%, which was comparable to original study by Khan et al.

On comparing both the tests, we found that MMT was more sensitive (80%) than ULBT (20%), but both tests had high specificity and NPV.

Difference in the sensitivity between the two tests was found to be statistically significant.

Although, ULBT had higher specificity, which was statistically significant ($p < 0.05$), it had a very poor sensitivity making it an unreliable test to screen the patients for difficult intubations.

Both the tests have a negative predictive value of 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.

Ali et al[12] compared ULBT with MMT in predicting difficult intubation. ULBT showed significantly higher accuracy (91.9%), PPV (71.6% and 95% CI: 59.1–81.7) and NPV (97.3% and 95% CI: 94.2–98.8) compared to the MMT. Comparison of specificity (93%), however, did not reveal any significant difference between the two tests. The sensitivity was 87.5% (95% CI: 74.9–94.3).

Eberhart et al made the same comparison, but reported different results. Discriminating power for both tests was low and for the ULBT (0.60 [95% CI: 0.57–0.63]) it was lower than Mallampati score (0.66 [0.63–0.69]).

In a similar study done on 50 patients older than 18 yrs., undergoing elective surgical procedures, they found out that ULBT is superior in every aspect as compared to MMT: sensitivity (55% vs. 11%). specificity (97% vs. 75%), positive predictive value (83% vs. 9%) and accuracy (90% vs. 64%) supporting the study of Khan et al.

Incidentally, during the study we found that repeated demonstrations were required for patients to perform ULBT and a few failed to understand the procedure in spite of our efforts. We went on to exclude some of these patients from our study, which numbered to only three. Another interesting observation was the reflex movement of the upper lip in the reverse direction over the upper teeth. This movement may alter the point of meeting of vermilion line with the lower incisors. It might be different in different age groups and also in males and females. In the same individual, this may also vary according to the effort applied.

However, the distinct advantage of ULBT as we found out included less or no chance for interobserver variability because of clear demarcation of the different classes and the appreciation of buck teeth during assessment, which is one of the important factor predicting difficult intubation.

A study in future with larger sample size and also using these tests in conjunction with other tests of airway assessment viz. thyromental distance, hyomental distance, inter-incisor distance to predict difficult airway may prove to be better to predict difficult intubation.

Currently available screening tests for difficult intubation have only poor-to-moderate discriminative power when used alone. Thus, combining two of the most valuable risk factors may increase the diagnostic value without increasing the burden of test significantly.

CONCLUSION

From our study, we conclude that MMT is a better test at predicting difficult endotracheal intubation when compared to ULBT.

Both the tests are better predictors of easy intubations rather than difficult intubations (high negative predictive value).

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