MAK HILL Publications Research Journal of Medical Sciences

Research Article
doi: 10.59218/makrjms.2023.953.958

# A Comparative Study of the Modified Mallampatti Test (MMT), Ratio of Patient's Neck Circumference to Thyromental Distance (NC/TM) and Upper Lip Bite Test (ULBT) in Predicting Difficult Laryngoscopy

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**ABSTRACT**

As science and technology advances, many tests such as modified mallampatti test (MMT), Ratio of Patient's neck circumference to thyromental distance (NC/TMD) and upper lip bite test (ULBT) were introduced to predict difficult intubations. The study is aiming at to find out the different predicting value of difficult laryngoscopy. To compare the predictive value of modified mallampatti test (MMT), ratio of patient's Neck circumference to thyromental distance (NC/TM) and upper lip bite test (ULBT) as methods of airway assessment for difficult laryngoscopy performed in patients undergoing surgeries under general anaesthesia in Tripura Medical College and Dr. BRAM Teaching Hospital. A comparative study has been conducted among 225 participants (75 each study group) in TMC and BRAM Hospital during 2022-23 aged between 18-65 years who are under general anaesthesia. All data were collected in a proforma and compared with Cormack-lehane scale. Data were entered and analyzed using SPSS 21.0 and expressed in descriptive statistics. Chi-square test for categorical variables and t test and ANOVA were applied for quantitative data. A p value of <0.05 were considered significant. Total 225 patients were participated in the study with the mean age was 40±13 years where male: Female is 1:1. Difficult intubation was seen more by MMT: 17.3% than UBLT: 20%. The ULBT shown good specific (93.74%) than other two test respectively (81.34%: MMT and 67.89%: NC/TMD). The significance AUC was also observed in ULBT and NC/TMD than MMT (p-value 0.02 and 0.001). The ULBT is better predictor for difficult intubation than MMT and NC/TMD directing further study with higher sample in multi-centric mode.

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**Key Words**
Difficult laryngoscopy, MMT, ULBT, NC/TMD, intubation

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**Received:** 2 August 2023
**Accepted:** 18 August 2023
**Published:** 19 August 2023

**Citation:** Dipanka Debnath, Aditi Bhattacharya and Ajoy Pal, 2023. A Comparative Study of the Modified Mallampatti Test (MMT), Ratio of Patient's Neck Circumference to Thyromental Distance (NC/TM) and Upper Lip Bite Test (ULBT) in Predicting Difficult Laryngoscopy. Res. J. Med. Sci., 17: 953-958, doi: 10.59218/makrjms.2023.953.958

## INTRODUCTION

The significance of preoperative prediction of a difficult airway is self-evident, as 85% of all airway management errors result in irreparable cerebral injury and up to 30% of anaesthetic deaths can be linked to difficult airway management. The thyromental distance (TMD) measurement is a straightforward bedside tool for challenging airway prediction. Despite the fact that several studies have recently questioned the method's validity due to low sensitivity, specificity and positive and negative predictive values, it has been widely used in every study to date[1]. In clinical practise, several bedside screening tests such as the upper lip bite test (ULBT), modified Mallampati classification (MMT), ratio of neck circumference to thyromental distance (NC/TM), inter incisor gap and head and neck movement are used to predict problematic laryngoscopy or intubation. The ULBT can be used as a single test to evaluate problematic airways prior to surgery. The test is classified based on the bite of the upper lip with the lower incisors. The author proposed that because upper lip bite test (ULBT) includes factors such as weight, head and neck movements, jaw movement, receding mandible and buck teeth, it should have a high predictive value for assessing difficult airway in patients with jaw subluxation combined with buck teeth[2]. Another preoperative method to assess the presence of difficult airway is modified mallampatti test (MMT)[3]. This examination assesses the size of the tongue in relation to the oropharynx as well as the ability to open the mouth. It is classified based on the inspection of pharyngeal structures with the mouth fully extended and the tongue maximally protruded. It is performed with the patient sitting, head in neutral posture, mouth wide open and tongue protruding to its maximum and the patient should not be actively pushed to phonate as this can result in soft palate contraction and elevation, resulting in a false picture. The thyromental distance can be difficult to measure in obese people who are immobilised, as well as those with goitres or other neck diseases[3]. The anatomy of the oropharyngeal structure, the size of the tongue, the amount of mouth opening, the position of the larynx, the circumference of the neck, the range and degree of neck movement and the alignment of the teeth are all elements that contribute to a difficult airway. The atalanto-occipital joint extension, thyromental distance and modified Mallampati test are used to evaluate these anatomical components clinically[4] Many tests are used to predict difficult intubation few of them are not very reliable[5,6]. The study's goal was to compare the predictive value of the modified mallampatti test (MMT), the patient's neck circumference to thyromental distance (NC/TM) and the upper lip bite test (ULBT) as methods of airway assessment for difficult laryngoscopy performed in patients undergoing general anaesthesia.

## MATERIALS AND METHODS

A cross sectional comparative study has been conducted among aged between 18-65 years of both sexes in the Department of Anaesthesiology, Tripura Medical College and Dr. BRAM Teaching Hospital during 2022-2023 among undergone general anaesthesia for elective surgeries other than tumor surgeries with a sample size of 225 (75 each group of modified mallampatti test (MMT), ratio of patient's Neck circumference to thyromental distance (NC/TM) and upper lip bite test (ULBT) respectively)[15]. All cases were selected conveniently. A case record form was used to gather the data. Patients who were unwilling, burn cases, Trauma, inability seat and very irritable were excluded.

**Data collection procedure:** Patients were randomly allocated in to three groups of 75 each. Three predictive tests were done in preoperative examination room of those patients to be operated under general anaesthesia. They are modified mallampatti classification (MMT), ratio of Neck Circumference to thyromental distance (NC/TM in cms) and upper lip bite test (ULBT). Modified mallampatti test records oropharyngeal structures visible upon maximal mouth opening. Each patient seated was asked to open mouth maximally and to protrude tongue without phonation. The view is classified as:

- **Class 0:** Ability to see any part of the epiglottis upon mouth opening and tongue protrusion
- **Class 1:** Soft palate, uvula, fauces, pillars visible
- **Class 2:** Soft palate, uvula, fauces visible
- **Class 3:** Soft palate, base of uvula visible
- **Class 4:** Only hard palate visible

Ratio of Neck Circumference to thyromental distance was measured from bony point of the mentum to thyroid notch while head is fully extended and mouth closed. Then ratio of Neck Circumference to thyromental distance was calculated: Neck Circumference/TMD (in cms). Upper lip bite test was done by assessing the ability of patient to cover the mucosa of upper lip with lower incisors. This test is rated as:

- **Class 1:** If the lower incisors could bite the upper lip above the vermillion line
- **Class 2:** If the lower incisors could bite the upper lip below the vermillion line
- **Class 3:** If the lower incisors could not bite the upper lip

In operation theatre, monitors attached were NIBP, ECG, pulse oximeter. Then patient is preoxygenated with 100% oxygen for 3 min. Induction of anaesthesia were with propofol 2 mg $kg^{-1}$ body weight given intravenously. Laryngoscopy and intubation were done using Macintosh blade No. 3 by an experienced anesthesiologist using 2 mg $kg^{-1}$ of succinylcholine and the view were classified as per Cormack-lehane scale without any external laryngeal manipulation. This scale has been graded as:

- **Grade 1:** Vocal cords visible
- **Grade 2:** Only posterior commissure of arytenoids visible
- **Grade 3:** Only epiglottis seen, none of glottis seen
- **Grade 4:** None of the above. Difficult visualization is described as grade 3 and grade 4 classification

Easy visualization is described as grade 1 and grade 2 classification. Confirmation of intubation is done by bilateral auscultation of lung fields and capnography.

Data were entered and analyzed using SPSS 21.0 version IBM for windows. Descriptive statistics like mean standard deviation and percentage were used. Sensitivity, specificity and ROC curve were used to test the significance between proportions. Chi-square test for categorical variables and t test and ANOVA were applied for quantitative data. A $p<0.05$ were considered significant.

## RESULTS

Total 225 patients were participated in the study who were equally distributed to the test groups. The mean age was 40±13 years ranges from 22-61 years. All demographic details of the participants were shown in Table 1.

Table 1 shows that there is no difference in gender distribution among the study groups i.e., all participants are almost equally enrolled in the study group ($p = 0.11$).

Number of difficult cases predicted according to ULBT, MMT and NC/TMD are shown Table 2. As per Mallampati test:

- **Class I:** Soft palate, fauces, uvua and pillars are seen
- **Class II:** Soft palate, fauces and uvula seen
- **Class III:** Soft palate and base of uvula seen
- **Class IV:** Soft palate no visible

Class I and II are considered as predictors of easy intubation. Class II and IV are considered as predictors of difficult intubation (17.3%). Class I (44.0) and Class II (38.7%) among the difficult intubations (Table 2). The incidence of difficult intubation in ULBT is 20%.

On direct laryngoscopy glottis view was classified according to Cormack and Lehane, grade I and grade II were considered as easy intubations and grade III and grade IV were difficult intubations. In the present study, grade I (42.3%) and grade II (38.2%) were the most observed values. Here, Grade I: full view of glottis, Grade II: Glottis partly exposed, only posterior commissure is seen, Grade III: Only epiglottis is seen and Grade IV: Epiglottis not seen. The actual difficult intubation is 19.5% (Table 3).

Predictive values of 3 tests in predicting difficult laryngoscopy (sensitivity, specificity, positive predictive value, negative predictive value and Area Under Curve) are presented in Table 4. The Mallampati test has shown higher sensitivity (89.51%) than ULBT (87.81%) and NC/TMD (78.21%). However, UBLT shown good specific (93.74%) than other two test respectively (81.34 and 67.89%). When it is compared with Cormack and Lehane method (direct visualization of

Table 1: Demographic profile of the study participants (N = 225)

| | Study groups | | | |
|---|---|---|---|---|
| Variables | Mallampati test N(%)/Mean±SD | NC/TMD* N(%)/Mean±SD | Upper lip bite test N(%)/Mean±SD | p-value |
| Age (Mean, SD) | 43±14 | 37±11 | 39±8 | 0.06 |
| **Sex** | | | | |
| Male | 47% | 52% | 49% | 0.11 |
| Female | 53% | 48% | 51% | |
| Weight (kg) | 60±3.3 | 58±6.5 | 56±8.0 | 0.08 |

*Ratio of neck circumference to thyromental distance and SD: Standard deviation

Table 2: Distribution of laryngoscopy view test results by different methods

| Laryngoscope view | Frequency (%)/Mean±SD |
|---|---|
| Mallampati test (MMT) | |
| Class I | 33 (44.0) |
| Class II | 29 (38.7) |
| Class III | 10 (13.3) |
| Class IV | 3 (4.0) |
| Ratio of neck circumference to thyromental distance (NC/TMD) | 5.3±0.67 |
| **Upper lip bite test (ULBT)** | |
| Grade 1 | 35 (46.6) |
| Grade 2 | 25 (33.4) |
| Grade 3 | 15 (20.0) |

Table 3: Actual difficult cases by Cormack and Lehane[16]

| Grade I | Grade II | Grade III | Grade IV |
|---|---|---|---|
| 95 (42.3) | 86 (38.2) | 37 (16.4) | 7 (3.1) |

Table 4: Predictive values of three methods in predicting difficult

| Test | Sensitivity (%) | Specificity (%) | PPV (%) | NPV (%) | Area under curve (AUC) | p-value |
|---|---|---|---|---|---|---|
| Mallampati test (MMT) | 89.51 | 81.34 | 94.04 | 11.18 | 0.651 | 0.450 |
| NC/TMD | 78.21 | 67.89 | 91.29 | 17.80 | 0.716 | 0.002 |
| Upper lip bite test (ULBT) | 87.81 | 93.74 | 95.10 | 17.23 | 0.760 | 0.010 |

NC/TMD: Ratio of neck circumference to thyromental distance, PPV: Positive predictive value, NPV: Negative predictive value

larynx), the area under curve (AUC) of UBLT shows better accuracy (76%) than Mallampati test (65%) and NC/TMD (71.6%). Both ULBT and NC/TMD has shown better predictors (p = 0.01 and 0.002) than Mallampati test (p = 0.45).

## DISCUSSIONS

Predicting a difficult airway in order to avoid unexpected difficult tracheal intubation and subsequent events, as well as developing a plan to transform a difficult intubation into a simple one, is a major concern for anaesthesiologists. The incidence of difficult laryngoscopy in this study was 17-19%, which was higher than in prior investigations[17-18]. Failed tracheal intubation can have catastrophic implications such as hypoxemia and cardiopulmonary collapse, as well as morbidity and mortality[18-21]. It is critical to anticipate difficulties in laryngoscopy and intubation so that we can be prepared with sophisticated devices or novel alternative techniques to secure the airway. Many factors have a role in problematic intubation, which is why there are so many prognostic tests available, either alone or in combination[22]. Predictive tests should ideally be quick, simple, dependable and accurate. It should recognise practically all difficult cases and properly anticipate all easy cases. It should have a high PPV with minimal negative predictions so that challenging cases are not missed and potentially fatal outcomes are averted. Because no single screening test is 100% specific or 100% sensitive, we face unexpectedly challenging intubation even with so many prognostic assays. As a result, combining such tests may provide us with a high prediction value for problematic intubation[22].

Since its debut in 1985 by Mallampati *et al*.[3] the Mallampati test has become a globally utilised scoring system. Later, in 1987, it was updated and renamed the updated mallampati test (MMT) after a retrospective investigation and analysis by Sansoon and Young *et al*.[23]. It primarily affects mouth opening and tongue base size in relation to the oropharynx. MMT's accuracy has been called into question several times and its value is debatable[8,24,25]. Lee *et al*.[25] discovered low to good MMT accuracy in a large systemic analysis of 34,513 patients in 42 studies. When the test was first developed, there were 22 data collectors. Because MMT score changes with phonation and usage of auxiliary muscles in the neck, the impact of inter-observer variance was large, which could explain why MMT was not found to be reliable in a number of investigations[26,27]. The ULBT evaluates jaw movement, bucked teeth and the ability to protrude the lower jaw. The goal of this study was to evaluate MMT, NC/TMD and ULBT to laryngoscopic visualisation in terms of accuracy, PPV, NPV, specificity and sensitivity using gold standard CL grading[16]. The results showed that ULBT had greater accuracy (76%), sensitivity (87.81%), PPV (95.1%) and NPV (17.23%) than MMT and NC/TMD. While the specificity of both tests was comparable. Our results are comparable to other studies[6,7,11-14,23]. According to some research, ULBT is more accurate than MMT but their PPV, NPV and sensitivity are equivalent[28]. Our study's sensitivity is higher than that of many earlier investigations[1,2,9,28,29]. This could be due to a lack of inter-observer variation as well as ethnic differences. According to the anthropological literature, craniofacial and dental alignment differs between races[30-32]. There are certain limits to the ULBT score for predicting difficult laryngoscopy. It is not suitable for edentulous patients. Furthermore, the anthropological literature emphasises ethnic heterogeneity in population craniofacial morphology. Moreover, review of dental literature shows that there is significant racial variation in morphology and morphometry of human mandible and maxillary bones. So, the ULBT may not applicable for some populations[28,33-35]. The predictive power of ULBT for prediction of difficult laryngoscopy must be calculated in each population independently.

Because the tests were assessed by the principal investigator among a sufficient sample, the danger of inter-observer variance was significantly decreased, which is the main strength of our study. Our study has a limitation in that we cannot conduct tests on people who are uncooperative or mentally impaired. The outcomes of edentulous patients are also unreliable. Furthermore, ethnic variation was not taken into account and sample bias is probable.

## CONCLUSION

The upper lip bite test has been found to be a good predictor of difficult intubation and can be used as bedside screening tool. The accuracy of the UBLT has been much higher than MMT and NC/TMD, however in some studies findings are contradicting, hence the present study is directing further multicentric controlled studies controlling confounding factors.

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