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# ORIGINAL ARTICLE

## UPPER LIP BITE TEST: A NOVEL TEST OF PREDICTING DIFFICULTY IN INTUBATION

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**ABSTRACT: BACKGROUND:** Although there are many preoperative tests to predict difficult airway, they are far from being ideal i. e. easy to perform, highly sensitive and specific, having high positive predictive value with few false positive predictions. **AIMS:** to elucidate the role of upper lip bite test (ULBT) with other prevailing tests, hyomental/thyrosternal distance ((HMD/ TSD), and mandible length (ML) in predicting difficulty in endotracheal intubation. **MATERIAL AND METHOD:** 300 patients meeting inclusion criteria, aged 21-60 yrs. having ASA I and II status, posted for elective surgery under general anesthesia with endotracheal intubation were enrolled in this study. Preoperatively anesthesiologist not involved in intubation evaluated and assessed the ULBT class and obtained measurements of HMD, TSD, ML. Laryngoscopy was assesed by anesthesiologist blinded to the measurements and was graded according to Cormack and Lahane's Grading system. ULBT of class III, HMD<3.5cms, TSD<6.5cms and ML <9cms were considered as markers of a potentially difficult intubation. **STATISTICAL ANALYSIS:** Data was analysed using kappa agreement and sensitivity, specificity, positive predictive value, negative predictive value with their 95% confidence interval was calculated. **RESULTS:** The negative predictive value (NPV) and positive predictive value (PPV) of ULBT were 100% and 92. 2% respectively. These corresponding figures for HMD, ML, and TSD were 57.14, 0, 81.82 and 87, 71, 86.39, 89.27 respectively. Specificities for ULBT, HMD, ML, TSD were 45, 10, 0, 22.5% respectively. Sensitivity for ULBT, HMD, ML, TSD was 100, 98.85, 99.23, 97.69 respectively. ULBT showed greatest agreement with laryngoscopic grading (kappa=. 59 with p-value <0.0001). An agreement between HMD, ML, TSD and laryngoscopic grading which was comparatively weaker also existed (0.14, 0.31, -0.04, respectively.) **CONCLUSION:** The high specificity, NPV, PPV, and accuracy of ULBT as revealed in this study could be a good rationale for its application in the prediction of difficulty or easiness in intubation. The quantitative parameters, ML and HMD, had a slight and fair agreement with kappa coefficient. Hence, either of them can be useful in combination with a qualitative parameter, ULBT, so as to get acceptable and dependable result as it enhances its potential value in being diagnostic in airway assessment.

**KEYWORDS:** Difficult intubation, airway evaluation tests, endotracheal intubation.

**INTRODUCTION:** Till date, one of the common important factors in morbidity and mortality related to anaesthesia is difficulty of failure to intubate the patient.[1-4]

As per ASA closed claims analysis,[1] difficult tracheal intubation remains relatively constant amongst anesthesia related patient injuries and is the third most common cause among respiratory related events, leading to hypoxic brain damage or even death. The above said disastrous complications are due to failure to recognize a difficult airway before induction of anaesthesia. At times unanticipated difficult intubation can be challenging to the anesthesiologist.

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The incidence of unanticipated difficulty in tracheal intubation has been reported to be in the range of 0.5 to 18% in patients undergoing surgery.[5] Attempts have been made by numerous investigators to predict difficult intubation by using simple bedside physical examinations in the view of preoperative identification of patients whose trachea would be difficult to intubate, to decrease the rate of anaesthesia related adverse respiratory events.[6-10] Difficult intubation was graded according to the Cormack-Lehane classification.[11] Still there is paucity of full proof tests in predicting difficult intubation as no anatomical factor can correctly forecast it with 100% accuracy. We might expect predictive tests also to be unreliable.

The upper lip bite test (ULBT) introduced by Khan et al,[12] almost 20 years after Mallampatti classification, is perhaps the latest test in predicting difficulty in endotracheal intubation. Not much work has been published regarding the use of HMD (Hyomental Distance) or TSD (Thyrosternal Distance) as screening tests to detect difficulty in intubation.

In our study, we tried to elucidate the role of ULBT as a simple bedside airway predictive test and other prevailing tests, the hyomental distance (HMD), thyrosternal distance (TSD), and the mandible length (ML) in predicting difficulty in endotracheal intubation.

**MATERIAL AND METHODS:** After obtaining permission from the Institutional Ethics Committee, prospective, observational, single-blind study was carried out in 300 patients of either sex, undergoing elective surgery under general anaesthesia with endotracheal intubation Inclusion criteria being patients of ASA grade I/II, age: 21-60 years of either sex, elective surgery under General Anaesthesia Exclusion criteria were edentulous patient, unable to open the mouth, with pharyngolaryngeal pathology, H/O thyroid/neck surgery, limitations of Temporomandibular or Atlanto-axial joint. Congenital facial deformity.

Preoperatively, anaesthesiologist not involved in intubation evaluated and assessed the ULBT class and obtained measurements of HMD, TSD and ML. Determination of ULBT class was done with patient in sitting position. The patient was asked to bite the upper lip with the lower incisors:

**Class I:** Lower incisors can bite upper lip above the vermilion line.
**Class II:** Lower incisors can bite upper lip below the vermilion line.
**Class III:** Lower incisors can't bite upper lip.

HMD measurement was done with the patient in supine position with head fully extended, with mouth closed. The straight distance from the lower border of mandibular mentum to superior border of the Hyoid Bone (cms) was measured. TSD measurement was also done with the patient in supine position with head fully extended and mouth closed. Distance between Prominentia Laryngea of thyroid cartilage & Incisura Jugularis of the sternal bone (cms) was measured. ML measurement was done with the patient in sitting position and head in neutral position, distance from angle of mandible to the tip of chin (cms) was measured.

The measurements were taken with the help of a measuring tape which was kept same throughout the study and by the same single person, who was not involved in the interpretation of C-L grading during laryngoscopy. Laryngoscopy was done by a senior anesthesiologist having minimum three years of experience in clinical anesthesia.

The ULBT of class III, HMD<3. 5cms, TSD<6. 5cms and ML<9cms were considered as markers of a potentially difficult intubation based on receiver operating characteristic (ROC) analysis referred from previous study.

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On the day of surgery, in the pre-operative room written and informed consent was checked and NBM status was confirmed. Intravenous line was secured. In the OT, three lead ECG, pulse oximetry (heart rate and $SpO_2$), noninvasive arterial pressure (NIBP) were connected to the patient. Patient was pre-medicated with inj. Ranitidine 50mg IV in drip and injection Ondansetron 4mg IV and intravenous fluid was started.

After premedication with Inj. Midazolam 0. 03mg/kg, Inj. Glyccopyrolate 0.004mg/kg, Inj. Fentanyl 1µg/kg, pre-oxygenation was done with 100% oxygen for three minutes. This was followed by induction with Inj. Propofol 2mg/kg and Inj. Succinylcholine 2mg/kg and laryngoscopy was done with identical Macintosh blade no. 3 or 4, with neck flexion and head extension in sniffing position, and the laryngoscopic view was determined using Cormack-Lehane grading system To minimize observer bias, anesthesiologists, not informed of the preoperative assessment of ULBT and other tests, assessed laryngeal view, without the application of external laryngeal pressure. if difficulty was encountered and the first attempt failed to provide a laryngoscopic view, the attempt was coupled with application of cricoid pressure by a third fixed assistant appropriately instructed in the technique and adjustment of head position as the situation demanded. C-L grades I & II were considered as "easy intubations" & grades III & IV as "difficult intubations". In patients with a C-L grade of III, intubation was done after applying cricoid pressure, while for patients with a C-L grade of IV; intubation was done with the help of a gum elastic bougie. Further management of cases was done according to the institutional protocol for general anesthesia.

**STATISTICAL ANALYSIS:** Data was analyzed using kappa agreement & calculation of sensitivity, specificity, positive predictive value, negative predictive value with their 95% confidence interval was done. Sample size estimation-The reported incidence of difficult intubation ranges from 0. 5 to 18%.

The sample size was estimated using formula:

$$n = \frac{Z_\alpha^{\,2} pq}{\delta^2},$$

Where $Z_\alpha$ is 1. 96 for 5% significance level, p is the targeted sensitivity or specificity, δ is the tolerable error and n is the (TP + FN) if p is sensitivity and (FP + TN) if p is specificity. Accordingly, the total sample size N is given by:

N = (TP + FN)/Incidence rate or

N = (FP + TN)/ (1- Incidence rate).

Thus, using the specificity of around 90%, incidence rate of 0. 5%, precision level of 0. 05 and 95% confidence limit, the estimated sample size is 279. (Approximately 280). The computation for estimating the sample size using above formulation was done using R-3. 0. 0 programming language. Although the sample estimate was 280, additional 20 cases reported during the study period were also included in the data set, thus rounding the sample to 300.

**RESULTS:** In our study 300 patients were recruited of which 140(46.67%) were males. The mean age was 40.62 ±11. 16 (mean ± SD) Difficult laryngoscopy (C-L grades III and IV) was seen in 32(10. 67%) & 8(2.67%) patients. None of the patients encountered difficult intubation.

There was no significant gender wise difference regarding difficult laryngoscopic view (p>0.05). ULBT of class III was seen in 18(6%), HMD<3.5cm in 7(2.33%), TSD<6.5 cm in 6(2%), ML<9 cm was seen in 11(3.67) patients. Different classes of ULBT and measurements of other predictive values versus C-L grades are depicted in Table1. A significant agreement was found between ULBT, HMD and ML and laryngoscopic view (p<0.0001, 0.0071, 0.0001, 0.6097respectively), but there was no agreement between TSD and laryngoscopic view (Kappa co-eff. --0.04, p=0.6097).

ULBT and laryngoscopic view showed the greatest agreement (Kappa co-efficient=0.59). The sensitivity of ULBT was 100%. This was due to the minimum false negative results obtained by ULBT.

The specificity of ULBT was 45% which was highest amongst all the other parameters studied. This was attributable to the minimum false positive results obtained by ULBT. Also the PPV of ULBT was the highest amongst all the parameters studied, as there were few false positive results. The NPV of ULBT was also highest as there were no false negative results obtained with ULBT. Its highest sensitivity of 100% and highest PPV of 92.2% reflects that higher class of ULBT could correctly predict difficult intubation. TSD showed lowest parameters in comparison with other tests (table 2).

**DISCUSSION:** Unexpected difficult intubations are probably the result of a lack of accurate predictive tests for difficult intubation and inadequate preoperative examinations of the airway. Although there are many preoperative tests to predict difficult airway, they are far from being ideal i.e., one which is easy to perform, highly sensitive, highly specific and which possess high positive predictive value with few false positive predictions. Ideally, any preoperative assessment of difficult tracheal intubation should have high sensitivity and specificity to result in minimal false positive or negative values. A test to predict difficult intubation should have high sensitivity, so that it will identify most patients in whom intubation will truly be difficult.

It should also have a high PPV, so that only few patients with airways actually easy to intubate are subjected to the protocol for management of a difficult airway. Also, it should have a high NPV to correctly predict the ease of laryngoscopy and intubation. It should have a higher kappa value so as to have a comparatively stronger agreement between laryngoscopic grading and have pivotal roles in facilitating laryngoscopic intubation, we hypothesized that the 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. We used the Cormack-Lehane system as the gold standard for testing the validity of ULBT. The incidence of unanticipated difficult intubation in our study was 13.3% and there were no failures to intubate the trachea. The incidence of unanticipated difficult intubation varies between 0.5 to 18% in various studies.[5,12,13,14] Some authors blame different anthropomorphic features among populations as the cause of the discrepancies in the incidence of difficult intubation in different studies.

The incidence of unanticipated difficult intubation in our study was 13. 3% similar to other reports,[6,8] and there were no failures to intubate the trachea. A strong positive correlation between higher ULBT class and difficult laryngoscopic view was also observed as 18 patients with ULBT class III were found to have C-L grade III/IV. The PPV of ULBT was also statistically highest of all the other tests and was found in this particular class of ULBT. The probability of difficult laryngoscopic view was found to be low in patients with ULBT class I/II as reported in previous studies[12, 15] which is supported by its highest NPV, suggesting that ULBT class I and II could serve as valuable predictors of

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an easy laryngoscopic view. The accuracy that testifies lower false positive and negative values in predicting difficult laryngoscopic view was observed to be highest in ULBT. All tests had high accuracy ranging from 84% to 92.67%. ULBT had highest specificity and sensitivity suggesting that it can correctly predict both difficult and easy laryngoscopic view and its agreement was also highest amongst all, kappa coefficient being 0.59 (p-value <0.0001). There was stepwise increase in the incidence of C-L grade III and IV as the ULBT class shows a rise from I to II.

HMD and ML also showed significant agreement. Sensitivity of HMD was 98.85% reflecting its ability to correctly predict difficult laryngoscopies that were truly difficult, its specificity was only 10% it may not be a good predictor of easy laryngoscopy and intubation. PPV of HMD was 87. 71% suggesting that 87.71% of difficult laryngoscopies were correctly predicted to be difficult of the total difficult laryngoscopies. NPV of HMD was 57.14%, denoting that 57.14% intubations were correctly predicted easy of all predicted easy laryngoscopies by HMD. The accuracy of HMD in our study was high (87%) and was comparable to the original study of Khan ZH, Maleki A et al[16] (88.7%). This however suggests that it can correctly predict easy or difficult laryngoscopies as a proportion of all laryngoscopies The accuracy of ML was 89%, better than HMD (87%), TSD (84.67%), but less than that of ULBT (92.67%), suggesting that it can be used as a predictor for easy as well as difficult laryngoscopy. HMD<3.5 cm and ML<9 cm as markers of difficult intubation proved correlation with ULBT class III as well as with C-L grade III/IV, thus suggesting that higher values of both of them serve as predictors of easy intubation as the tongue can easily be compressed in these spaces during laryngoscopy. As the ML and HMD decreased from their predetermined values of 3.5 and 9 cm. respectively, there was stepwise increase in the incidence of C-L grade III and IV.

TSD had Specificity and NPV zero and other parameters were lowest in comparison with the other tests. Its kappa coefficient was -0.040 (P-value 0.6097) Showing a less than chance agreement between TSD and laryngoscopic view. Hence, It will not be very useful for detecting difficult laryngoscopy or intubation but can be useful in predicting short tracheas, which will be useful for proper placement of endotracheal tube. As TSD fails to take into account viewing the oropharynx and thus fails to provide any significant data regarding airway difficulty. In multivariate analysis it is not a significant predictor of difficult intubation.[17]

Limitations of ULBT are that it is not appropriate for edentulous patients since it takes into consideration of buck teeth while performing the test. Due to ethnic variations in craniofacial configuration of populations and racial variations in morphology and morphometry of human mandible and maxillary bones.[18] ULBT may not be applicable for some populations[15,19,20] Patients do not completely understand the instructions. It requires patients' cooperation, ability to move the mouth and presence of teeth. In our study emergency patients were not considered wherein M J Redd et al[21] suggest an airway assessment score based on criteria of the LEMON method to stratify the risk of difficult intubation.

**CONCLUSION:** In conclusion ULBT is a highly sensitive, specific, with high positive and negative predictive value. It also has high accuracy for predicting both easy and difficult intubation. It showed highest agreement for laryngoscopic view, amongst all the other tests evaluated (HMD, TSD, ML). This could be a good rationale for its routine application in the prediction of difficulty or easiness of intubation. Though ULBT proved be effective as a simple, reliable predictive airway test however, should be used in combination with other airway assessment methods to predict difficult airway till further studies on a larger scale in all populations prove its validity beyond doubt.

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| | | **Laryngoscopic View** | **Kappa Co-efficient** | **P-value** |
|---|---|---|---|---|
| | | I/II III/IV | | |
| HMD | ≥ 3. 5 | 257 (85. 7) 36 (12) | 0. 14 | 0. 0071 |
| | < 3. 5 | 3 (1) 4 (1. 3) | | |
| TSD | ≥6. 5 | 254 (84. 7) 40 (13. 3) | -0. 04 | 0. 6097 |
| | <6. 5 | 6 (2) 0 | | |
| ML | ≥9. 0 | 258 (86) 31 (10. 3) | 0. 31 | <0. 0001 |
| | <9. 0 | 2 (0. 7) 9 (3) | | |
| ULBT | I/II | 260 (86. 7) 22 (7. 3) | 0. 59 | <0. 0001 |
| | III | 0 18 (6) | | |

Table 1: Agreement of HMD, TSD, ML and ULBT with Laryngoscopic view

| | **Sensitivity** | **Specificity** | **PPV** | **NPV** | **Accuracy** |
|---|---|---|---|---|---|
| HMD | 98. 85 | 10 | 87. 71 | 57. 14 | 87 |
| | (96. 38-99. 70) | (3. 25-24. 59) | (83. 26-91. 13) | (20. 23-88. 19) | (82. 66 – 90. 59) |
| TSD | 97. 69 | 0 | 86. 39 | 0 | 84. 67 |
| | (94. 80-99. 05) | (0-10. 91) | (81. 81-89. 99) | (0-48. 31) | (80. 08-88. 55) |
| ML | 99. 23 | 22. 5 | 89. 27 | 81. 81 | 89 |
| | (96. 94-99. 86) | (11. 40-38. 85) | (84. 98-92. 48) | (47. 75-96. 78) | (84. 90-92. 30) |
| ULBT | 100 | 45 | 92. 2 | 100 | 92. 67 |
| | (98. 18-100) | (29. 60-61. 34) | (88. 26-94. 93) | (78. 12-100) | (89. 10-95. 34) |

Table 2: Sensitivity, Specificity, PPV, NPV & Accuracy of HMD, TSD, ML & ULBT

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| | ULBT | HMD | TSD | ML |
|---|---|---|---|---|
| True positives | 260 | 257 | 254 | 258 |
| True negatives | 18 | 4 | 0 | 9 |
| False positives | 22 | 36 | 40 | 31 |
| False negatives | 0 | 3 | 6 | 2 |
| Sensitivity | 100 | 98. 85 | 97. 69 | 99. 23 |
| Specificity | 45 | 10 | 0 | 22. 5 |
| PPV | 92. 2 | 87. 71 | 86. 39 | 89. 27 |
| NPV | 100 | 57. 14 | 0 | 81. 82 |

Table 3: Comparison between the tests

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