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Original Article

Comparison of Upper Lip Bite Test, Ratio of Height to Thyromental Distance, and Maxillopharyngeal Angle to Predict Difficult Laryngoscopy

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Abstract

Introduction: The incidence of "difficult" intubation is approximately 1–4%, whereas the most dreadful incidence of "cannot ventilate by mask, cannot intubate" is around 0.0001–0.02%.

Materials and Methods: A total of 556 patients aged between 18 and 65 years of ASA I and II scheduled for elective general anesthesia with intubation were analyzed preoperatively for upper lip bite test (ULBT), ratio of height to thyromental distance (RHTMD), and maxillopharyngeal angle (MPA). Cormack-Lehane (CL) grading was noted in them by an experienced anesthesiologist who was unaware of the pre-operative findings.

Results: The incidence of difficult laryngoscopy was 12.8%. ULBT had a high positive predictive value (42.11%) and stood second in terms of sensitivity, specificity, negative predictive value (NPV), and accuracy (90.93%, 45.07%, 91.88%, and 81.07%), respectively. RHTMD had high sensitivity (71.83%) and NPV (93.49%). MPA had highest specificity and diagnostic accuracy (94.43% and 85.79%).

Conclusion: Each of the three parameters significantly correlated with CL grading. However, each test scored differently in terms of their sensitivity, specificity, accuracy, and predictive tests when compared to each other. Hence, it will be safer to use a combination of tests which assess different aspects of patient's airway.

Key words: Cormack-Lehane grading, Maxillopharyngeal angle, Ratio of height to thyromental distance, Upper lip bite test

INTRODUCTION

The incidence of "difficult" intubation is approximately 1–4%, whereas the most dreadful incidence of "cannot ventilate by mask, cannot intubate" is around 0.0001–0.02%.[1] No single anatomical factor determines the ease of direct laryngoscopy, and therefore, no single test to assess anatomical factor can be used to predict a difficult laryngoscopy.[2]

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Upper lip bite test (ULBT) is a representation of the temporomandibular joint movement.[3] Ratio of height to thyromental distance (RHTMD) will assess the submental space.[4] Maxillopharyngeal angle (MPA) will assess the occipito-atlantal joint movement. This angle <90° suggests difficult direct laryngoscopy.[5]

The sensitivity, specificity, positive predictive value, negative predictive value (NPV), and diagnostic accuracy were calculated for each variable.

MATERIALS AND METHODS

After obtaining approval from the Institutional Ethical Committee and taking consent from patient, 556 patients between 18 and 65 years of ASA I and II were assessed pre-operatively on the day before surgery by the same

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anesthesiologist in all patients to avoid interobserver error.

Three parameters were examined in each patient:

a. ULBT,
b. RHTMD, and
c. MPA.

The end point of the study was Cormack-Lehane (CL) grading score.

ULBT

ULBT was done by asking the patient to bite their upper lip with lower incisor.

1. Class I: Lower incisors can bite the upper lip above the vermilion line.
2. Class II: Lower incisors can bite the upper lip below the vermilion line.
3. Class III: Lower incisors cannot bite the upper lip.

Class III predicts difficult laryngoscopy [Figure 1].

RHTMD

Thyromental distance was measured from the bony point of the mentum to thyroid notch, while head was fully extended and mouth closed with the help of a flexible measuring tape. Height of the patient was measured in centimeters from vertex to heel with the patient standing and was rounded to the nearest 1 cm.

The RHTMD was calculated as follows:

RHTMD = Height (in cm)/TMD (in cm)

<23.5 predicts easy laryngoscopy.

≥23.5 predicts difficult laryngoscopy.

MPA

A lateral cervical radiograph was taken in erect posture of patient with the neutral position of head and jaw closed in the natural occlusive position. The radiograph was taken at the end of expiration. Anatomical landmarks were identified and connected for the purpose of angle measurements.

The maxillary angle (MA) and pharyngeal angle (PA) are the line parallel to the hard palate and the line passing through the anterior portion of the first cervical vertebra (atlas) and second cervical vertebra, respectively. The angle between the MA and PA was defined as the MPA [Figure 2].

MPA ≥90° predicts easy laryngoscopy.

MPA <90° predicts difficult laryngoscopy.

Inside OT

After connecting all standard monitors and inducing the patient with propofol (2 mg/kg), atracurium (0.6 mg/kg) IV was given to facilitate endotracheal intubation. Laryngoscopy was performed with the patient's head in the sniffing position with a Macintosh #3 laryngoscope blade by an anesthesiologist (of at least 2 years' experience) who was blinded to the results of pre-operative airway assessment.

Glottic visualization was assessed using CL scale, without any external laryngeal manipulation.

CL scale

1. Grade 1: Vocal cords visible.
2. Grade 2: Only posterior commissure and arytenoids visible.
3. Grade 3: Only epiglottis visible.
4. Grade 4: None of the above visible.

Easy visualization was described as Classes 1 and 2 classifications.

Figure 1: ULBT demonstration

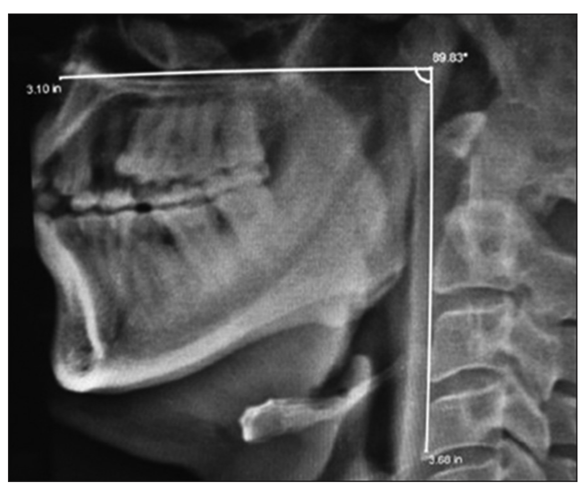

Figure 2: Radiographic measurement of MP angle

Difficult visualization was described as Grades 3 and 4 classifications.

After evaluation, if needed, external laryngeal pressure was permitted for endotracheal tube insertion. Surgery followed under standard anesthesia.

RESULTS

Sensitivity:
RHTMD > ULBT > MPA
71.83 45.07 26.76

Specificity:
MPA > ULBT > RHTMD
94.43 90.93 59.18

Positive predictive value:
ULBT > MPA > RHTMD
42.11 41.30 20.48

Negative predictive value:
RHTMD > ULBT > MPA
93.49 91.88 89.80

Accuracy:
MPA > ULBT > RHTMD
85.79 85.07 60.79

DISCUSSION

Anesthesiologists are recognized as airway management specialist in most aspect of modern practice and to some extent it's primary clinical skill that defines anaesthetists. Difficulty in managing the airway is the single most important cause of anesthesia-related morbidity and mortality.[6,7]

Successful management of a difficult airway begins with recognition of the potential problem. Many variables have been proposed for pre-operative identification of patients with difficult intubation. Unfortunately, no single test reliably predicts difficult airway. Lassic predictor criteria are mainly dependent on surface anatomy and tend to have poor sensitivity and low PPV.

The present study attempted to estimate diagnostic value of ULBT, RHTMD. and MPA in predicting CL III and CL IV of laryngoscopy.

In the present study, 556 cases studied. The age group was selected between 18 and 65 years and we observed age group between 18 and 27 years had significant easy laryngoscopy while between 48 and 57 years was significantly associated with difficult laryngoscopy. A study done by Prakash *et al.* pointed that difficult laryngoscopy increased with age due to osteoarthritic changes and poor dentition.[8] However, in the present study, age between 58 and 65 years did not show any significant relation to difficult laryngoscopy. There are studies done by Savva[9] and Patel *et al.*,[10] which do not show age-related changes to difficult laryngoscopy. The present study reflects two different results for age-related conclusions. This could be because the volume of cases in 48–57 years was 84 cases, and in 58–65 years, it was 28 cases which could have altered the proportion of patients with difficult laryngoscopy.

However, no gender or body mass index -related difference in difficult laryngoscopy was observed in our study [Table 1]. The American Society of Anesthesiologists physical status classification was not found to be independent risk factors of difficult laryngoscopy according to the study by Lundstrøm *et al.*[11]

In the present study, the ASA II patients had a greater degree of difficult laryngoscopy than ASA I. 'This difference could be due to associated controlled comorbidities patient can have for which they are categorized in ASA II status.[12]

The incidence of difficult laryngoscopy in our study was found to be 12.8% which coincides with the incidence reported by other studies.[8,13-16] Any difference in incidence of difficult laryngoscopy in the present study might have been due to factors such as different anthropometric features, unavailability of uniform grading in description of laryngeal views, application of cricoid pressure, position of head, and the degree of muscle relaxation.

A perfect predictor is characterized by high sensitivity, specificity, and diagnostic accuracy, to identify almost every patient at risk with minimal false-positive predictions. In clinical practice, we are mostly concerned for the unanticipated difficult airway (false-negative predictions). However, false-positive predictions, although distressing and inconvenient, have no life-threatening sequelae. The most significant clinical problem is the false-negative predictions when intubations predicted to be easy, proved to be difficult later. Sensitivity and NPV are statistical measures of a test performance incorporating the false-negative predictions in their calculation formula. Among the tests studied, the above-mentioned characteristics apply best to RHTMD as a single predictor of difficult laryngoscopy.

ULBT in the present study showed to have a sensitivity of 45.07% which is between the sensitivities of 76.5% found by Khan *et al.*[3] and 28.9% by Zadeh *et al.*[17] Jain *et al.* compared ULBT and RHTMD and found a specificity of 91.53%,[2] as compared to 88.7% found in the present study. The accuracy of this study was similar to the study by Eberhart *et al.* and he did not recommend ULBT as the sole predictor for difficult laryngoscopy.[18]

ULBT is a simple bedside test to perform; however, it is highly operator dependent and we may experience change in class in the same individuals if patient does not understand the maneuver. A clear explanation and demonstration to the patient may limit the error. In the present study, 13.7% of patients belonged to Class III ULBT, and this could have affected the sensitivity of ULBT in our study [Figure 3].

The present study highlights that ULBT with the highest PPV and second highest sensitivity, specificity, NPV, and diagnostic accuracy has total power in predicting CL grading when compared to the other tests in spite of low sensitivity [Table 2].

The present study with a RHTMD "cut off" value of 23.5 got the highest sensitivity of 71.83% [Table 2]. Although this is comparable to the studies by Jain *et al.* (76.4% with the same cutoff), ULBT ranked first in their study.[2] RHTMD also stood first in terms of NPV of 93.49%. The results are in accordance with Safavi *et al.* 98.4% who found higher NPV than ULBT.[13] Krobbuaban *et al.*[4] and Krishna *et al.*[19] assumed RHTMD ≥23.5 cm as risk factor showed high sensitivity, specificity, and NPV and observed variable results. RHTMD is based on precise measurement of patient's TMD and height, and thereby, interobserver variations are highly unlikely as shown by Srinivasa *et al.*,[20] and consistency is maintained.

It is crucial that RHTMD is interpreted in terms of its cutoff value. Ratios as high as 29.5 have been used in westerners. However, anthropological assays in India derive a range of 17.1–23.5. This is a vital issue influencing its accuracy.[13,16,19,21]

Thus, in this study, RHTMD had the highest NPV and sensitivity which means that it misses the least number of difficult laryngoscopies which reduces life-threatening events. However, it stands last compared to other two tests in terms of specificity, PPV, and accuracy. This may unnecessarily subject the patients to receive follow-up diagnostic procedures which can be invasive or expensive and they may be subjected to difficult airway algorithm. Thus, it would be prudent to combine with other tests to strengthen its diagnostic value.

There are not many studies which have focused on MPA. A study done by Gupta and Gupta emphasized the importance of this angle by correlating it with modified Mallampati test, thyromental distance, and atlanto-occipital extension. They found that MPA <90° reflects difficult

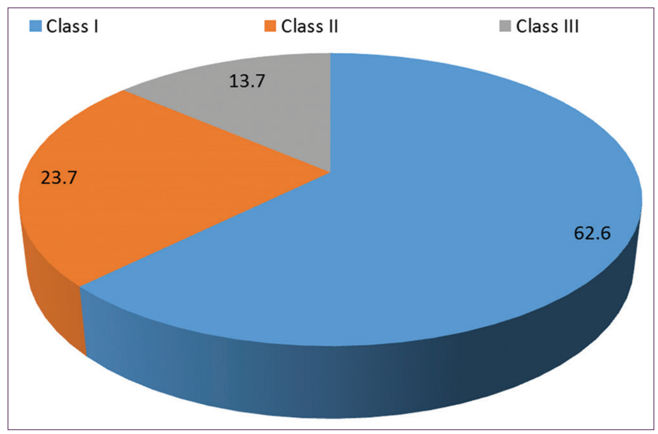

Figure 3: Distribution of cases according to upper lip bite test class

Table 1: Distribution of cases studied according age, sex, BMI, ASA class, and difficult airway

Parameters	Difficult *n* (%)	Easy *n* (%)	Total *n* (%)	*P*
Age group (years)				
18.0–27.0	47 (37.6)	78 (62.4)	125 (100.0)	0.001***
28.0–37.0	90 (48.9)	94 (51.1)	184 (100.0)	0.590 NS
38.0–47.0	69 (51.1)	66 (48.9)	135 (100.0)	0.879 NS
48.0–57.0	59 (70.2)	25 (29.8)	84 (100.0)	0.001***
58.0–65.0	16 (57.1)	12 (42.9)	28 (100.0)	0.473 NS
Sex				
Male	149 (52.7)	134 (47.3)	283 (100.0)	0.311 NS
Female	132 (48.4)	141 (51.6)	273 (100.0)	
BMI (kg/m^2)				
Normal (18.50–24.99)	163 (51.6)	153 (48.4)	316 (100.0)	0.573NS
Overweight (25.00–29.99)	118 (49.2)	122 (50.8)	240 (100.0)	
ASA class				
Class I	159 (45.2)	193 (54.8)	352 (100.0)	0.001***
Class II	122 (59.8)	82 (40.2)	204 (100.0)	

Values are *n* (% of cases). *P* value by Chi-square test, *P*=0.001***, NS: Statistically non-significant. BMI: Body mass index

Table 2: Diagnostic efficiency of ULBT, RHTMD and MP angle against CL grading

Statistical measure	ULBT (%)	RHTMD (%)	MPA (%)
Sensitivity	45.07	71.83	26.76
Specificity	90.93	59.18	94.43
PPV	42.11	20.48	41.30
NPV	91.88	93.49	89.80
Diagnostic accuracy	85.07	60.79	85.79

PPV: Positive predictive value, NPV: Negative predictive value, MPA: Maxillopharyngeal angle, ULPT: Upper lip bite test, RHTMD: Ratio of height to thyromental distance

laryngoscopy in approximately 80% of patients and is a very simple, non-invasive test. She also found that Grade III and IV CL which correlated with MPA <90° also correlated with A-O angle <30° and TM distance <6.5 cm.[5]

In this study, MPA ranked first in specificity and diagnostic accuracy, and this shows its value in recognizing easy laryngoscopy [Table 2]. Its values were similar to ULBT in all parameters except a low sensitivity. MPA has to be combined with other tests to increase the recognition of difficult airway which is essential as it has a low sensitivity.[22]

The present study analyzed individual parameters and each one was correlated to CL; however, results may have differed if analyzed in combination. In addition, a study would be more conclusive if we would have considered odds ratio, Kappa coefficient, and likelihood ratio to measure its clinical significance.

To summarize [Table 2], ULBT had a high specificity, PPV, and diagnostic accuracy while it stood second in sensitivity and NPV. RHTMD was more sensitive with a high NPV by which it can identify difficult laryngoscopy more effectively. MPA with high specificity and diagnostic accuracy is comparable to ULBT and can be used as an objective test in addition to bedside tests to predict difficult laryngoscopy as it is least susceptible to measurement errors. However, each test has its own drawbacks as it scores differently in terms of their sensitivity, specificity, accuracy, and predictive tests when compared to each other. Hence, it will be safer to use a combination of tests which assess different aspects of patient's airway.

CONCLUSION

The ULBT is an acceptable alternative test to predict difficult tracheal intubation and can be used in combination with other bedside tests in pre-operative airway evaluation.

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