A COMPARISON OF RATIO OF PATIENT'S HEIGHT TO THYROMENTAL DISTANCE WITH MODIFIED MALLAMPATI TEST AND UPPER LIP BITE TEST FOR PREDICTION OF DIFFICULT LARYNGOSCOPY

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ABSTRACT

Various airway evaluation tests are performed to predict difficult intubation. The ratio of Height to thyromental distance has been reported to have a good predictability. This study tested the performance of ratio of height to thyromental distance and compared it with commonly performed airway evaluation tests: the modified *Mallampati* test and upper lip bite test. This descriptive study was conducted in 120 patients presenting for surgery under general anesthesia with endotracheal intubation. Preoperative airway assessment was done using Modified *Mallampati* test, upper lip bite test and ratio of height to thyromental distance. The Cormack and Lehane grading was done during laryngoscopy to determine easy or difficult visualization of larynx. Sensitivity, specificity, positive predictive value, negative predictive value and accuracy of three tests were calculated. Difficult laryngoscopy was seen in 9 patients (7.5%). The sensitivity, specificity, positive predictive value, negative predictive value respectively for the tests were modified *Mallampati* test (22.2%, 89.2%, 14.3% and 93.4%), upper lip bite test (22.2%, 100%, 100% and 94.1%), ratio of height to thyromental distance (77.8%, 95.5%, 58.3% and 94.16%). In conclusion, we found that the ratio of patient's height to thyromental distance performed better than MMT and ULBT in predicting difficult visualization of larynx in our population.

KEYWORDS

Difficult laryngoscopy, modified mallampati test, thyromental distance, upper lip bite test

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INTRODUCTION

Airway related incidents are a major cause of anesthesia-related morbidity, mortality and litigations.[1] The vast majority (85.0%) of all mistakes regarding airway management result in permanent cerebral damage and up to 30.0% of all anesthetic deaths can be attributed to the management of difficult airway.[2] This fact makes the preoperative prediction of a difficult airway a vital skill in anesthesia practice. The fundamental initial and vital step in planning airway management is evaluation of airway. The ability to predict a difficult tracheal intubation permits anesthesiologists to take precautions to decrease the risk.[3]

Several preoperative bedside airway assessment tests are being performed for prediction of difficult airway. But which anatomical landmark and clinical factor is the best predictor of difficult airway has been a controversy.[4,5] The search for a predictive test that has ease of applicability and accuracy of prediction persists. Schmitt *et al*[6] introduced ratio of patient's height to thyromental distance (RHTMD) as a better predictor of difficult laryngoscopy than TMD. Due to anthropological differences, the accuracy of RHTMD in prediction of difficult laryngoscopy may be different in our population. With the objective of evaluating the ratio of patient's height to thyromental distance as a predictor of difficult laryngoscopy and comparing it with other predictors modified *Mallampati* test (MMT) and upper lip bite test (ULBT) that we commonly use, this study was conducted.

MATERIALS AND METHODS

This was a descriptive study conducted from December 2021 to August 2022 in the department of anesthesia, Nepal Medical College Teaching Hospital after approval from Institutional Review Committee (Ref: 056-078/079). We included the patients within the age group 18-65 years enrolled as ASA I and II scheduled for surgery under general anesthesia with endotracheal intubation and gave consent to participate in the study. Patients requiring rapid sequence induction, edentulous patients, patients with temporo-mandibular joint deformity, limited cervical joint movements, mouth opening less than 2 fingers breadth and patients with oro-pharyngeal and laryngeal pathology were not included. Assuming the prevalence of difficult laryngoscopy of 8.0% (1.5% to 13.0%),[7] at a confidence level of 95.0% and a desired error of 5.0%, a sample size of 113 was calculated.

Pre-operatively, the airway assessment was done in the preoperative holding area. The MMT and ULBT were performed and thyromental distance was measured. The primary investigator of the study performed the preoperative airway assessment tests on all the patients and was not involved in the intubation of the patients enrolled in study. The MMT was assessed with patients in sitting position, mouth wide open, and tongue maximally protruding without phonation.[8] The ULBT was assessed by asking the patient to bite his/her upper lip with lower incisors.[9] TMD was measured with a rigid ruler from lower border of thyroid notch to bony point of mentum with patients head extended and mouth closed.[10] The RHTMD was calculated by the formula: RHTMD = Height in cm/TMD in cm. MMT Class 3 and Class 4, ULBT Class 3, and RHTMD >23.5 were considered as predictors of difficult laryngoscopy.[11]

In the operation theatre standard monitors were attached and an intravenous access secured. Patient was kept in sniffing position with a 10 cm pillow under the head to maintain flexion at the cervical and extension at the atlanto occipital joint. A standard general anesthesia protocol was followed for all cases. All patients received premedication, inj midazolam 0.02 mg/kg and inj fentanyl 2 µg/kg intravenously. After preoxygenation with 100% O_2 in each patient, anesthesia was induced with propofol titrated to loss of eye lash reflex, inj. Rocuronium 0.9 mg/kg was given intravenously to facilitate tracheal intubation after ensuring mask ventilation. Only the anesthesiologists with a minimum of 2-years of experience in anesthesia performed laryngoscopy and intubation. The anesthesiologist was unaware of the patient's Mallampati, ULBT and TMD class. A Macintosh size 3 or 4 laryngoscope was used. And the glottic view was graded as per the Cormack and Lehane's grading[12] The Cormack and Lehane's Grades 3 and 4 was considered as difficult laryngoscopy. Tracheal intubation was done with an appropriately sized endotracheal tube. Correct endotracheal placement was confirmed by capnography. Rest of the anesthetic management was done as per hospital's protocol.

Statistical analysis of the data was done using SPSS-16. Demographic data were presented as mean±standard deviation. Using the MMT score, ULBT score, RHTMD value and the CL grade recorded for each patient, the sensitivity,

specificity, positive predictive value, negative predictive value, and accuracy of each test was calculated. Receiver operating characteristic (ROC) curve was plotted for the indices with sensitivity against 1-specificity. The area under the ROC (AUC) was calculated, which is a measure of the prognostic accuracy of the test. A larger area under the ROC denotes more reliability and good discrimination of the scoring system.[13,14]

RESULTS

A total of 120 patients were included in the study. The demographic characteristics are summarized in Table 1. Difficult laryngoscopy (CL grade 3) was seen in 9 patients (7.5%). None of the patients had a C L grade 4. There was no failed intubation in our study. Patient characteristics (age, gender, BMI) is given in Table 1.

Table 1: Patient characteristics

Variables	CL I/II	CL III/IV
Age (years)	40.53± 13.34	44.78±11.79
Gender (M:F)	53:58	4:5
BMI (kg/m^2)	25.59±4.37	29.1±5.14

The distribution of MMT, ULBT and RHTMD with respect to Cormack-Lehane's grading is given in Table 2. The MMT and the ULBT correctly identified only 2 of the 9 patients (22.2%) with difficult laryngoscopy whereas, the RHTMD correctly identified 7 of the 9 patients (77.8%) with difficult laryngoscopy.

The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of the three tests are presented in table 3. The highest sensitivity was observed with the RHTMD (77.8%). The MMT and ULBT had an equal sensitivity (22.2%). All the three tests showed good specificity with ULBT having the highest specificity (100.0%).

ROC was constructed and AUC for each index was calculated (Fig. 1). The AUC was highest for RHTMD (0.87) and lowest for MMT (0.56)

DISCUSSION

Difficult laryngoscopy is an inability to view the glottis opening using a conventional curved blade laryngoscope, corresponding to a Cormack and Lehane III or IV grade, in which only epiglottis or only pharynx and tongue, respectively, may be visualized, whereas difficult intubation is defined as usage of direct laryngoscopy taking more than 3 attempts or more than 10 minutes to complete tracheal intubation by the trained anesthetist.[15-17] The incidence of difficult intubation in various studies range from 1-18%, and that of failed intubation is between 0.05 to 0.35%.[10] The

Table 2: Distribution of predictive test with respect to Cormack-Lehane's grading

Test	Grade	n	CL I and II	CL III and IV
MMT	Easy (I and II)	106	99	7
	Difficult (III and IV)	14	12	2
ULBT	Easy (1 and 2)	118	111	7
	Difficult (3)	2	0	2
RHTMD	Easy (<23.5)	108	106	2
	Difficult (≥23.5)	12	5	7

Table 3: Sensitivity, specificity, predictive values and accuracy of the three tests

Test	Sensitivity	Specificity	PPV	NPV	Accuracy
MMT	22.2	89.2	14.3	93.4	84.16
ULBT	22.2	100	100	94.1	94.16
RHTMD	77.8	95.5	58.3	98.1	94.16

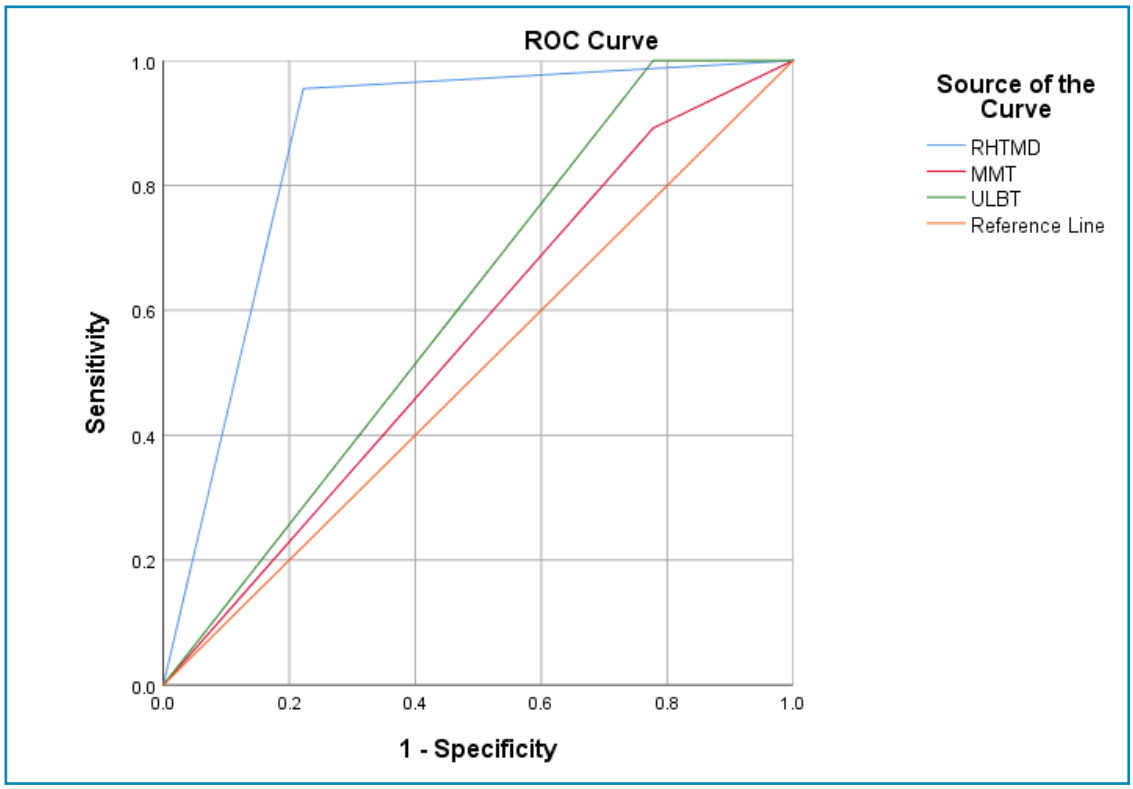

Fig. 1: Receiver operating characteristic curves for the airway predictors

wide variations in the incidence of difficult visualization of larynx have been attributed to factors such as different anthropomorphic features, cricoid pressure application, head position, degree of muscle relaxation, type or size of laryngoscope blade used.[18] In our study, the overall prevalence of difficult laryngoscopy was 7.5%, and there was no failed intubation.

MMT is one of the oldest and most performed airway evaluation tests. In the present study, the sensitivity, specificity, PPV and NPV of MMT was 22.2%, 89.2%, 14.3% and 93.4% respectively. We found that MMT failed to identify majority of patients with difficult visualization of larynx as it has a low sensitivity and poor positive predictive value. However, its prediction of easy visualization of larynx was good. Since safety in airway management requires correct prediction of difficult airway than prediction of easy airway, MMT alone cannot be considered reliable in our population. The value of MMT in predicting difficult intubation has been controversial. In a meta-analysis including 34,513 patients from 42 studies, the accuracy of MMT ranged from poor to good.[19] This variation in accuracy with MMT may be due to a lack of standardization of technique or interobserver variability. Phonation, maximal extrusion of tongue and opening of mouth have been reported to be critical factors that affect predictability of *Mallampati* grading.[20,21] Similarly, neck extension while performing the MMT also affects its specificity and predictive value.[22] This high interobserver variability makes MMT a less reliable tool.[23]

The ULBT was originally described by Khan *et al*[9] as a simple test that assesses a combination of jaw subluxation and the presence of buck teeth. Khan *et al*[23] reported a sensitivity, specificity, PPV and NPV of ULBT as 76.5%, 88.7%, 28.9% and 98.4% respectively. We found a sensitivity, specificity, PPV and NPV of 22.2%, 100.0%, 100.0% and 94.1% respectively. Its sensitivity was much lower in our study. Similarly, low sensitivity was reported in a few other studies.[24-26] Unlike MMT, the risk of interobserver bias is less in ULBT due to definite demarcation of grades. There are anthropological literatures that have described that craniofacial and dental alignment varies from race to race and there are significant racial differences in mandibular and maxillary morphological measurements.[27-29] Due to excessive soft lip tissues and an anterior temporomandibular joint, there is scarcity of grade III ULBT in Asians.[30] One of the factors contributing to low sensitivity of ULBT in our study may be the lesser number of patients with

ULBT grade III in our population. Thus, ULBT may be a useful predictor in some population, but in our study, it failed to identify majority of the patients with difficult visualization of larynx.

The RHTMD was introduced by Schmitt *et al*,[6] as a better predictor of difficult laryngoscopy than TMD. It was also found to be a better predictor of difficult laryngoscopy than MMT and ULBT.[31] Different cut off value for RHTMD has been used to predict difficult visualization of larynx in different studies. We used a cut off value of 23.5 in this study as this value was reported to be predictive of difficult laryngoscopy in our part of the world.[31,32] In our study, RHTMD had the highest sensitivity (77.8%) and NPV (98.1%). It showed a high specificity (95%) and accuracy (94.16%) and a good PPV (58.3%). TMD varies with patient's size, but when the ratio of height to thyromental distance is calculated, the value obtained will be adjusted for patient's size and will better predict ease of laryngoscopy. Like ULBT, interobserver bias is less likely with RHTMD, as it is based on precise measurement of patient's TMD and height. However, a new cut off value for RHTMD could not be quoted based on the present study, as the number of patients in our study is small.

Preferably, any preoperative evaluation test for difficult laryngoscopy should be highly sensitive, specific, and should have a high PPV with few negative predictions. We used the analysis of ROC curves to assess and compare the overall performance of the three predictive tests. In our study, the AUC is in the order of RHTMD> ULBT> MMT (0.87> 0.61> 0.56). RHTMD has the least number of false negative value (22.2% with RHTMD vs 77.8% with ULBT and MMT). The false positive value of RHTMD though high (41.7%) is less than that of MMT (85.7%). Thus, when we compare the three tests, RHTMD has a better predictive value than MMT and ULBT. But as difficult airway is multifactorial in origin, using combination of tests will yield better results than any single test alone.

Considering the low prevalence of difficult visualization of larynx found in our population, a limitation of our study is a small sample size. A multicentered study with a larger sample size needs to be done to further confirm our findings and to determine appropriate RHTMD cut off levels for our population. Difficult laryngoscopy was the measured outcome in our study. Alternatives like intubation difficulty or an arbitrary number as in "intubation difficulty scale" as used in some of the studies might have been better.[32] Another limitation of our study is possibility of observer bias in grading laryngeal view as per Cormack and Lehane's grading. We tried to limit it by including the anesthesiologists who had more than 2 years of experience, still their skill and experience may vary, making interobserver bias inevitable.

Our study results suggest that the ratio of patient's height to thyromental distance is better than MMT and ULBT in predicting difficult visualization of larynx in our population. As some other aspects which may contribute to difficult intubation such as mouth opening and dentition are not assessed by RHTMD, it is safe to use multiple tests in combination for prediction of difficult laryngoscopy.

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