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Prediction of difficult intubation in apparently normal patients by combining modified mallampati test and thyromental distance: A prospective observational study

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Abstract
Introduction: Difficult intubation, often unexpected, remains a primary concern for the anesthesiologist. None of the bedside airway assessment tests have proven to be efficacious and highly predictive. This study was done to determine the sensitivity and specificity of Modified Mallampati test alone, Thyromental distance alone and in combination of both for predicting difficult intubation.
Material and Methods: A prospective observational study was conducted in Universal College of Medical Sciences Teaching Hospital (UCMSTH), which involved 80 American Society of Anesthesiologist Physical Status (ASA PS) I patients undergoing elective surgeries under general anesthesia with endotracheal intubation. All patients were included for preoperative assessment by Modified Mallampati test alone and Thyromental distance measurement. The correlation between these tests and Cormack and Lehane laryngoscopic grading was done to find out the result.
Results: Prediction of difficult intubation among 80 patients by Modified Mallampati test alone showed sensitivity of 72.7% and specificity of 98.6% whereas with Thyromental distance alone, showed sensitivity of 36.4% and specificity of 100%. When both predictors were combined, result showed sensitivity of 72.7% and specificity of 98.6% which was similar to that of Modified Mallampati test alone.
Conclusion: This study concluded that sensitivity to predict difficult intubation was higher with Modified Mallampati test alone or in combination with Thyromental distance test whereas specificity was highest with Thyromental distance test alone.

Keywords: difficult airway, modified mallampati test, thyromental distance

Introduction
Difficult airway is defined as a clinical situation in which a conventionally trained anesthesiologist experiences difficulty with mask ventilation or difficulty with tracheal intubation or both [1]. American Society of Anesthesiologists has defined difficult endotracheal intubation, as when proper placement of endotracheal tube with conventional laryngoscopy requires more than 3 attempts or more than 10 minutes by a normally trained anesthesiologist and this is the second most frequent proclaimed damaging event leading to anesthesia malpractice claims [2, 3]. The ASA closed claims database analysis of adverse respiratory events has found that vast majority of airway related events involve brain damage (85%) or death, and as many as 1/3rd of deaths is attributed solely to anesthesia due to inability to maintain patent airway [4].
If the cases of difficult airway could be predicted confidently in the preoperative period, the anesthesiologist could plan the safest and the most effective way of managing tracheal intubation by arranging special equipment like stylet, gum elastic bougie or plan for procedures like fibreoptic intubation, tracheostomy etc. Numerous investigators have attempted to predict difficult intubation by simple bed side physical examination. In 1985, Mallampati *et al*. introduced a currently well-known screening test that classify the visibility of oropharyngeal structures [5]. Thyromental distance, Sternomental distance and Wilson risk sum score are widely recognized tools for difficult intubation [6, 7]. Various methods or tests are available for the prediction of difficult airways like Inter-incisor gap, Body mass index, Neck circumference and length, Upper lip bite test, Tempero-Mandibular joint mobility test etc.
Many studies have been done to conclude that the use of Modified Mallampati test or Thyromental distance as a single examination is of limited value whereas some found combination of these tests to be more useful in predicting difficult airway and intubation [8, 9]. Thus, we compared Thyromental distance alone, Modified Mallampati test alone or both in combination to find out the better and useful method for predicting difficult airway and failed intubation considering Cormack and Lehane grading as gold standard [10].

Material and Methods
After obtaining ethical clearance from Institutional Review Committee and informed written consent from the patients, this prospective observational study was carried out for a duration of one year from 29thNovember 2015 to 30thNovember 2016. Eighty adult ASA PS I patients of either sex with age between 18 to 60 years admitted in UCMSTH for elective surgeries under general anesthesia with endotracheal intubation were enrolled in this study. Exclusion criteria were ASA PS >I, Pregnancy, Body Mass Index > 30kg/m^2, Mouth opening <3 cm, protruded upper incisors, Midline neck swelling, Difficult neck movement, Upper airway tumors, Cervical spine fracture/ deformities, any obvious head and neck pathology, Diabetes Mellitus, Past history of difficult intubation.
Sample size was calculated using sensitivity of combined

Modified Mallampati and Thyromental distance test in reference articles, assuming here sensitivity of 70%, allowable error 10% and at 95% confidence level.

Pre-anesthetic evaluation was done one day prior to the schedule surgery date. ASA PS Grading and BMI was determined. Required investigations was advised and thorough airway assessment was done including Modified Mallampati test and Thyromental distance in all patients by the Principal investigator.

All patients were premedicated with Tab. Pantoprazole 40 mg and Tab Metoclopramide 10 mg night before surgery. Monitor was attached. Preoperative baseline hemodynamics like HR, NIBP, RR and SPO_2 were recorded. Intravenous access was opened with 18-gauge cannula on the dorsum of the hand. Difficult intubation cart was made ready. Preoxygenation was done for three minutes with 100% oxygen. Inj. Midazolam 1 mg, Fentanyl 2mcg/kg and Propofol 2 mg/kg IV was given. After checking Bag and Mask ventilation, Inj. Vecuronium 0.1mg/kg IV was given. After 3 minutes, patient head was kept in sniffing position and laryngoscopy was done with size 3 Macintosh blade by anesthesiologist having more than one year of experience. Maintenance of anesthesia was done with oxygen andIsoflurane1.5 %. For intubation, when required, external laryngeal manipulation was done but only after recording the grade of laryngoscopic view according to Cormack and Lehane Grading. During intubation, anesthetic nurse noted the number of attempts and any alternative technique used. At the end of surgery, reversal of neuromuscular blockade was done. On obeying command, trachea was extubated and patient was shifted to Post Anesthesia Care Unit.

Modified Mallampati test was performed by examiner sitting in front of the patient who should be sitting with head in neutral position and would open the mouth maximally and protrude the tongue maximally without phonating. Class 3 and 4 was taken as predictors of difficult intubation. (Figure 1).

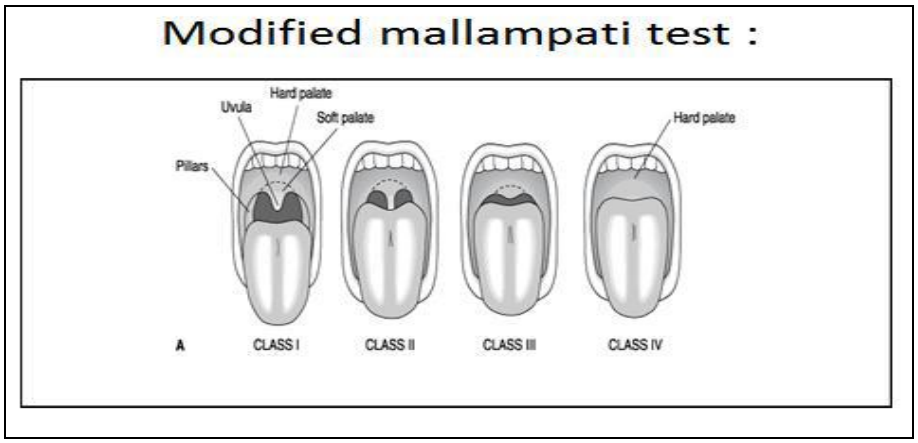

Fig 1: Modified Mallampati Class

Thyromental distance was measured using a measuring tape from mentum of mandible to the thyroid notch in the midline with fully extended neck. Measurement of less than 6 cm was considered to be the predictor of difficult intubation. (Figure 2).

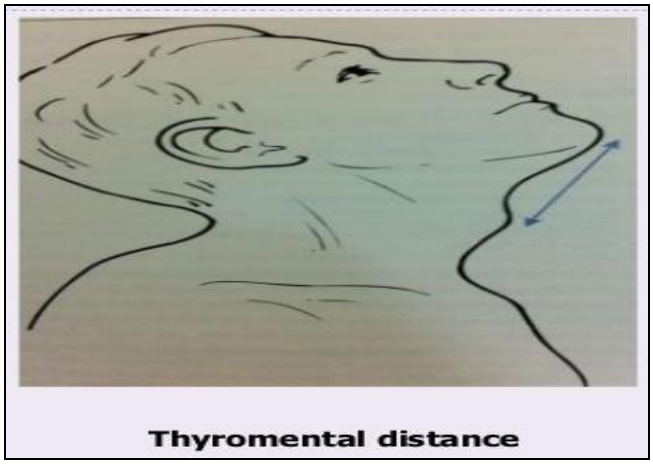

Fig 2: Thyromental Distance

Cormack and Lehane laryngoscopic view Grade 3 and 4 was taken as predictors of difficult intubation. (Figure 3).

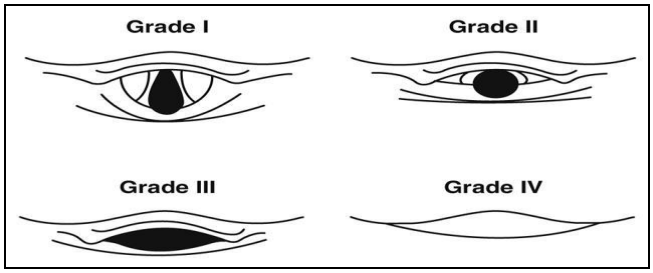

Fig 3: Cormack and Lehane Grading

Data were entered in Microsoft Excel and SPSS version 20.0 was used. Comparison of the predictors of difficult intubation was expressed in terms of sensitivity, specificity, positive predictive value and negative predictive value. Independent sample t test was also applied and statistical data analysis was considered significant at p value <0.05.

Results

All patients were included in study. Majority of the patients were between 35 to 44 years with 57.5% females. Mean BMI values of patients belonging to difficult and not difficult intubation group according to Cormack and Lehane grading was differed by 0.43 kg/m2 which was not statistically significant (p = 0.596).

Edotracheal tube stylet and external laryngeal manipulation was used after recording laryngoscopic grade in two patients to assist intubation. Change of blade to size 4 was done in one patient. Change of performer was not require in any patient.

Difficult intubation determined by Modified Mallampati test alone showed that 57.5% belonged to Class II, 7.5% belonged to Class III and only 3.8% belonged to Class IV. The frequency of difficult intubation that belonged to both Class III and IV was found to be 11.3% whereas the frequency of difficult intubation by measuring Thyromental distance showed that only 5 % of these patients had Thyromental distance of less than 6 cm. When combining both Modified Mallampati test Class III and IV with Thyromental distance of less than 6 cm, the frequency of difficult intubation was 11.25%. Around 12.5% of patients belonged to Cormack and Lehane Grade 3 & only 1.25% belonged to Grade 4, resulting the prediction of difficult intubation as 13.75%. (Table 1).

Table 1: Comparison of difficulty prediction by Modified Mallampati Class, Thyromental distance and both in combination with Cormack and Lehane Grading

Parameters	Cormack and Lehane Grading	
	Difficult (Grade III/IV)	Not difficult (Grade I/II)
Modified Mallampati Class		
Difficult (Class III/IV)	08 (True positive)	01 (False positive)
Not difficult (Class I/II)	03 (False negative)	68 (True negative)
Thyromental Distance		
Difficult (<6 cm)	04 (True positive)	00 (False positive)
Not difficult (>6 cm)	07 (False negative)	69 (True negative)
Combined Modified Mallampati Test and Thyromental Distance		
Difficult (Class III/IV or < 6 cm)	08 (True positive)	01 (False negative)
Not difficult (Class I/II) or > 6 cm)	03 (False negative)	68 (True negative)

We have compared the parameters of all three tests with the gold standard of Cormack and Lehane grading to predict difficulty in intubation. The results showed that sensitivity to predict difficult intubation was higher in combined test (72.7%) and was also similar to Modified Mallampati test alone (72.7%) when than Thyromental distance alone (36.4%) when compared with Specificity was 100% in Thyromental test alone whereas only 98.6% both in Modified Mallampati test alone and in combined test. (Table 2).

Table 2: Correlation of Modified Mallampati Class, Thyromental distance and combined tests with Cormack and Lehane Grade

Diagnostic Parameters	Modified Mallampati Class	Thyromental Distance	Combined Modified Mallampati test and Thyromental distance
Sensitivity	72.7%	36.4%	72.7%
Specificity	98.6%	100%	98.6%
Positive Predictive Value	88.9%	100%	88.9%
Negative Predictive Value	95.8%	90.8%	95.8%

Discussion

Failed intubation is a primary concern to all the anesthesiologists, so studies to find appropriate predictor for difficult intubation has been widely carried out around the world. We also conducted such study and our study showed similar findings like that of a meta-analysis done from thirty-five studies (50,760 patients), using various screening tests. It found, combination of the Mallampati classification and Thyromental distance test as the most useful bedside test for prediction of difficult intubation (positive likelihood ratio, 9.9; 95% confidence interval, 3.1-31.9) [11].

Difficult airway prediction done in 244 patients, found highest (90.8%) sensitivity for Thyromental distance and highest specificity for both combined test and Modified Mallampati test alone which was different from our study results [12]. Like our study, lower sensitivity and highest specificity for Thyromental distance test was found in many other studies but with variable Positive and Negative Predictive Value [13, 16]. Also, wide difference in sensitivity (43%, 59%, 82.4%) and specificity (66.8%, 93%) for Modified Mallampati test was observed in various studies [16, 18].

Intubation Difficulty Scale was also used for the study to predict difficulties [19]. Few suggested that the ratio to height to Thyromental distance could be better bed side screening test to predict difficult laryngoscopy [20, 21]. One study that included Thyromental Height test in supine position had highest sensitivity (84.62%) and specificity (98.97%) with positive predictive value of 88% and negative predictive value of 98.63% when compared with Modified Mallampati test, suggesting that this could be the only anatomical measure to predict difficult laryngoscopy [22]. The wide variation in reported specificity and sensitivity in various studies may be because of the observer bias as inter-observer variability may occurs during airway assessment bedside tests. Singhal *et al* proposed that the Modified Mallampati test shows higher grades if the patient is assessed in the supine instead of sitting position [23]. Intubation usually is performed in the supine position and hence validity of Modified Mallampati test measured in the sitting position may not be helpful in accurately predicting a difficult intubation.

12.5 times risk for difficult laryngoscopy was observed with Mallampati Class III and IV with magnitude of difficult laryngoscopy and intubation being 13.6% and 5% respectively [24]. Using similar bedside tests, incidence of difficult laryngoscopy was found in between 2 to 27% whereas that for difficult intubation was in between 1.4 to 17% {11, 16, 21, 25, 26]. Our study showed prediction of difficult intubation to be 13.75%. The laryngoscopic view grading

might depends on the experience and performance of particular anesthesiologist. Diagnostic accuracy of screening tests varies in different studies. Lack of standard cut off values for preoperative airway parameters and considering different cut off values in various studies may impose difficulties in comparing the results.

Preparation and availability of equipment, use of various size of blades, expertise in laryngoscopy and intubation, degree of muscle relaxation, and anatomical variations in different population may have impact on magnitude of difficult laryngoscopy and intubation. Ideally, any preoperative assessment tool for difficult laryngoscopy should have a high sensitivity and specificity and produce few false positives and negatives. The consequence of a false-negative result may be deleterious and even life threatening. Therefore, decreasing false negative prediction is far more important than falsely predicting difficult laryngoscopy in unaffected patients. Nevertheless, a test should be sufficiently sensitive to detect possible difficulties with laryngoscopy.

Limitations in our study were use of small sample size, anesthesiologist performing laryngoscopy and intubations were different and only two bedside tests were included that may contribute to higher incidence of difficult laryngoscopy and intubation.

Conclusion

Unanticipated difficult airway could lead to failed intubation leading to hypoxia, brain injury and death. There are many tests to determine the best single method or combination of methods for predicting difficult intubation and this study is such an attempt. This study concluded that the prediction of difficult intubation in Nepalese population was 13.75%. Modified Mallampati test with higher sensitivity and Thyromental distance measurement with highest specificity and positive predictor value was observed. However, none of these tests can be used as a single best predictor of difficult intubations, rather we should consider as many possible tests to determine the prediction of difficult intubation in larger population.

Conflict of Interest- None

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