COMPARISON OF VARIOUS AIRWAY ASSESSMENT FACTORS WITH RATIO OF HEIGHT TO THYROMENTAL DISTANCE (RHTMD) IN PREDICTING DIFFICULT AIRWAY IN APPARENTLY NORMAL PATIENTS

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ABSTRACT

BACKGROUND

Non-invasive clinical tests or various anatomic landmark measurements either alone or in combination are performed preoperatively for predicting difficult airway. "Ratio of Height to Thyromental Distance (RHTMD)" is a recently claimed test with high predictability which is compared in this study with other airway assessment factors like Inter Incisor Gap (IIG), Modified Mallampati Test (MMT), Thyromental distance (TMD) and Upper Lip Bite Test (ULBT) for difficult airway prediction.

MATERIALS AND METHODS

A sample of 82 patients, both males and females of ASA grade I and II were assessed and graded for IIG, MMT, TMD, RHTMD and ULBT using standard techniques and correlated with Cormack and Lehane grading.

Settings and Design- Prospective, single blinded observational study.

Statistical Analysis- Using Chi square test and SPSS version 17.0.

RESULTS

RHTMD has the highest positive predictive value, odds ratio and likelihood ratio of 71.4%, 31.5 and 9.71 and ULBT has the highest sensitivity, negative predictive value and relative risk of 78.6%, 95.2 and 12.15 respectively.

CONCLUSION

Both ratio of height to thyromental distance and upper lip bite test are found to be equally effective in predicting difficult airway in apparently normal patients.

KEYWORDS

Predicting Difficult Airway, Ratio of Height to Thyromental Distance, Upper Lip Bite Test.

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BACKGROUND

In patients with apparently normal airways, anaesthesiologist should develop the ability to identify the risk of difficult tracheal intubation.(1) The key cause for intubation difficulty in most of the patients occurs due to difficulty in laryngeal visualisation.(2) Morbidity and death occurs maximum during failure in the management of difficult airway in anaesthetic practice.(1) Failure to mask ventilate or intubate the patients leads in 85% of cases to permanent cerebral damage and this explains a lot of importance for preoperative prediction of difficult airway. Also, failure in successful management of difficult airway has led to 30% of all anaesthetic deaths. Among patients who undergo surgeries in general, the incidence of difficult laryngoscopy and intubation is found to vary greatly.(3)

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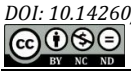

Laryngoscopy or change in blades or both requiring multiple attempts is found to be around 1-18% among Cormack and Lehane grade II and III patients.

In clinical practice, prediction of difficult laryngoscopy or intubation is done by several bedside screening tests - with the most popular being the Mallampati classification, Inter incisor gap, thyromental distance, upper lip bite test and head–neck mobility. Despite being simple, most of them require cooperation of the patients to properly perform and thus assess correctly.

These tests were found to have sensitivity and positive predictive value on lower side (33-71%) and false positivity on higher side.(4,5,6,7,8) Hence, there is no one test which is available with highest specificity, sensitivity, negative and positive predictive value as well as few false positive and negative results. Despite various studies being conducted on prediction of difficult airway, not many studies have been conducted as multivariate analysis of readily available variable like ratio of height to thyromental distance to be compared with other parameters for assessment of airway like upper lip bite test (ULBT), modified Mallampati test (MMT), inter incisor Gap (IIG) and thyromental distance (TMD).

Hence, in our study, we predict the ease or difficulty in intubation for ratio of height to thyromental distance and evaluate the specificity, sensitivity, negative and positive predictive value, relative risk, odds ratio and likelihood ratio for ratio of height to thyromental distance and compare it with other airway assessment parameters like ULBT, IIG, TMD and MMT in order to find out an easily available, clinically applicable preoperative airway assessment test with high accuracy that can be used on a daily basis.

MATERIALS & METHODS

After the approval of institutional ethics committee, 82 patients in the age group of 20-60 years of age, of either sex who undergo elective surgeries under general anaesthesia belonging to ASA grade I and II have been included in this study. Patients who refused to give consent, ASA class III and IV, patients less than 20 years and above 60 years of age, pregnant patients, patients who underwent recent surgeries or radiation therapy in head and neck region, patients who are edentulous, unable to sit and presenting with midline neck swellings are excluded from this study.

Detailed examination and routine investigations including laboratory tests (Complete blood count, haemoglobin, serum chemistry profile and urine analysis), ECG, Chest x-ray will be taken if indicated. Following preoperative evaluation, written informed consent was taken from each patient and preanaesthetic airway assessment done.

Inter Incisor Gap

The patient is asked to sit comfortably. The patient is asked to open the mouth as wide as possible. The space between tip of the two incisors measured with the scale. The outcome is classified into two grades: Inter incisor gap of>4 cm - Grade I; ≤4 cm-Grade II.[9] Inter incisor gap of ≤4 cm (grade II) considered as difficult intubation.[10]

Modified Mallampati Test (MMT)

Patient is asked to perform maximal mouth opening with tongue protrusion without making any noise in the sitting posture.

Class I- Soft palate, fauces, uvula, anterior and posterior pillars seen.
Class II- Soft palate, uvula and fauces seen.
Class III- Base of uvula and soft palate seen.
Class IV- Only hard palate seen.[9]

Class III and IV considered as difficult intubation.[10]

Thyromental distance: In upright posture, patient is seated. With a closed mouth, head and neck extension is advised and the patient is asked to extend as much as possible. Measurement of distance that is straight from the outer surface of tip of mentum till thyroid notch is taken.
Grade I- > 6.5 cm
Grade II- 6-6.5 cm[9]
Grade III- <6.5 cm[9]

If distance is equal or less than 6.5 cm, laryngoscopy is predicted to be difficult. [10]

Upper Lip Bite Test

Concurrent assessment of mandibular movement range and teeth architecture is done by this study. With lower incisor, each patient is asked to bite the upper lip and categorised as:
Class I- Upper lip mucosa hidden by lower incisors.
Class II- Upper lip mucosa partially hidden by lower incisors.[9]
Class III- Upper lip mucosa unable to touch the lower incisor.[9]

Class III considered as difficult intubation.[10]

Ratio of Height to Thyromental Distance (RHTMD)

TMD was measured as straight distance between the thyroid notch and the lower border of mental prominence, when the head is fully extended and the mouth closed, using a rigid ruler. The distance was rounded to the nearest 0.5 cm. Height of patient was measured in centimetres with the patient standing straight by side of wall, with heel touching wall and will be rounded to nearest 1 cm. RHTMD calculated.

The Formula to Calculate RHTMD is Height (in cm)/TMD (in cm)

Grade I RHTMD- <23.5.
Grade II RHTMD- >23.5.[9]
Grade II considered as difficult intubation.[10]

In all patients, protocol which is standardised is used for induction of anaesthesia. After connecting standard monitors for baseline monitoring and after establishing intravenous cannulation, all patients are to be administered intravenous (IV) ondansetron 4 milligrams, glycopyrrolate (0.2 milligram /kilogram), Fentanyl (1-2 microgram/kilogram). Following preoxygenation, induction of anaesthesia is carried out with propofol (2 milligram/kilogram) IV and muscle relaxation by vecuronium (0.1 milligram/kilogram) IV to proceed with endotracheal intubation. Using facemask, ventilation of lungs is carried out with 100% oxygen. After achieving sniffing position of the patient's head, Macintosh #3 laryngoscope blade is used to perform laryngoscopy by an anaesthesiologist with at least two years of experience. By single blinding, the airway assessment tests done preoperatively are concealed from the anaesthesiologist performing laryngoscopy. Glottic visualisation assessed using a modified Cormack and Lehane (CL) classification.[11]

Grade	Description
1	Glottis fully viewed
2a	Glottis partially viewed
2b	Only posterior extremities of glottis/arytenoids cartilage is seen
3	epiglottis seen, glottis not seen
4	Both epiglottis and glottis not seen

For insertion of endotracheal tube, pressure externally on larynx is allowed if required after evaluation. In our study, laryngoscopy that is difficult is taken as Cormack and Lehane grade III and IV.

Statistical Analysis

The preoperative data of IIG, MMT, TMD and ULBT compared with RHTMD and the laryngoscopic findings are correlated to evaluate the specificity, sensitivity, negative and positive predictive value of each test according to standard formulas.

Odds Ratio (OR), Relative Risk (RR), likelihood ratio (LR) will be estimated and chi square test will be applied. SPSS version 17.0 is the statistical package applied to do the analysis. The study is significant statistically if the p value is <0.05.

RESULTS

The difficult laryngoscopy incidence was found to be 17% (14 out of 82 patients). Out of 14 patients, CL grade III seen in 12 patients and CL grade IV found in 2 patients. There are no failed endotracheal intubations in our study. Ratio of height to thyromental distance was found to have the highest positive predictive value, odds ratio and likelihood ratio and the highest sensitivity, negative predictive value and relative risk seen with upper lip bite test. With a p value of 0.0001(<0.05), both ULBT and RHTMD are found to be highly significant statistically.

Parameter	Definition	Formula
Sensitivity	No. of difficult intubations correctly predicted / No. of difficult intubations	TP/(TP+FP)
Specificity	No. of easy intubations correctly predicted / No. of easy intubations	TN/(TN+FP)
Positive predictive value	No. of difficult intubations correctly Predicted / No. of intubations predicted to be difficult	TP/(TP+FP)
Negative Predictive value	No. of easy intubations correctly predicted / No. of intubations predicted to be easy	TN/(TN+FN)
Relative risk	Probability of difficult intubation in anticipated difficult airway (Pa) / Probability of difficult intubation in unanticipated difficult airway (Pb)	(TP/TP+FP)/ (FN/FN+TN)
Odds ratio	Compare the probability of difficult intubation in anticipated and unanticipated difficult intubation	Pa(1-Pa)/ Pb (1-Pb)
Likelihood Ratio +	Sensitivity/(1–Specificity)	
Likelihood Ratio -	(1–Sensitivity)/Specificity	

Table 1. Standard Formula for Different tests for Data Analysis

TP –True Positive; TN – True Negative; FP – False Positive; FN – False Negative.

Factors	Grade	Total No. of Cases	CL I	CL II	CL III	CL IV
IIG	1	77	56	10	9	2
	2	5	1	1	3	0
MMT	1	27	22	3	2	0
	2	19	15	2	1	1
	3	28	17	5	6	0
	4	8	3	1	3	1
TMD	1	72	55	9	8	0
	2	8	2	2	3	1
	3	2	0	0	1	1
RHTMD	1	67	54	9	3	1
	2	15	3	2	9	1
ULBT	1	42	35	6	1	0
	2	21	15	4	1	1
	3	19	7	1	10	1

Table 2. Distribution of Various Predictive Tests based on Cormack and Lehane Laryngoscopy Grading

IIG – Inter incisor Gap; MMT – Modified Mallampati test; TMD – Thyromental distance; ULBT – Upper Lip bite test; RHTMD – Ratio of height to thyromental distance.

Parameter	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	OR	RR	LR	p value
IIG	21.4	97.1	60	85.7	9.000	4.200	7.285	P=0.008 (<0.05)
MMT	71.4	61.8	27.8	91.3	4.038	3.194	1.86	P=0.023 (<0.05)
TMD	42.9	94.1	60	88.9	12.000	5.400	7.28	P=0.0001 (<0.05)
RHTMD	71.4	92.6	66.7	94.0	31.5	11.16	9.71	P=0.0001 (<0.01)
ULBT	78.6	88.24	57.89	95.24	27.5	12.15	6.68	P=0.0001 (<0.05)

Table 3. Comparison of Various Predictive Tests

Criteria	Order of Various Airway Assessment Tests
Sensitivity	ULBT > RHTMD =MMT > TMD > IIG
Specificity	IIG > TMD > RHTMD > ULBT>MMT
Positive predictive value	RHTMD > TMD = IIG > ULBT >MMT
Negative Predictive value	ULBT > RHTMD > MMT > TMD >IIG
Relative risk	RHTMD > TMD > IIG > ULBT >MMT
Odds ratio	ULBT> RHTMD > TMD > IIG > MMT
Likelihood ratio	RHTMD > TMD = IIG > ULBT >MMT

Table 4: Comparison of Various Predictive Tests:

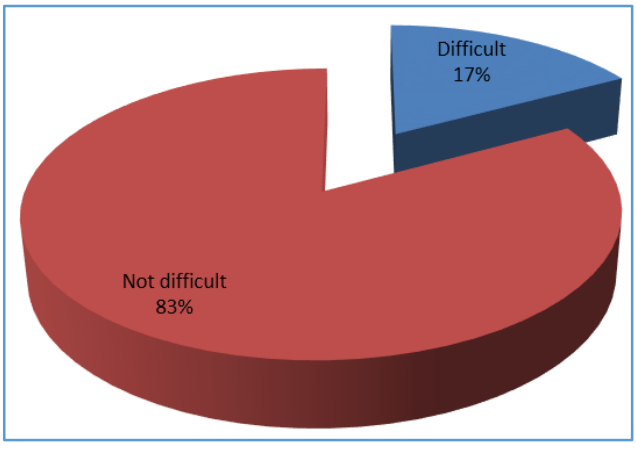

Figure 1. Pie Diagram representing the Percentage of Incidence of Difficult Airway in the Study Population

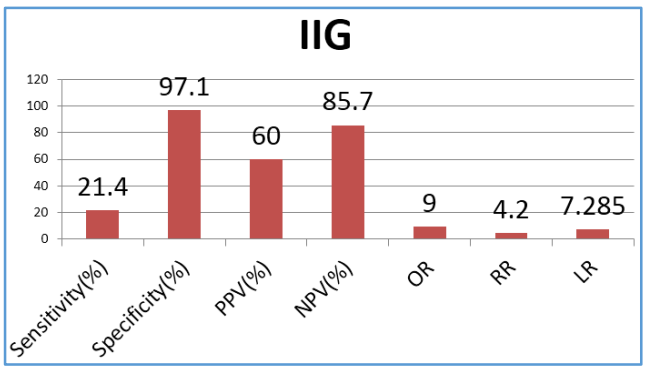

Figure 2a

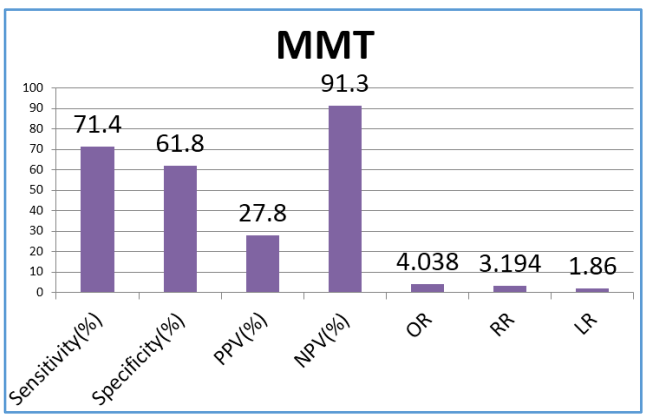

Figure 2b

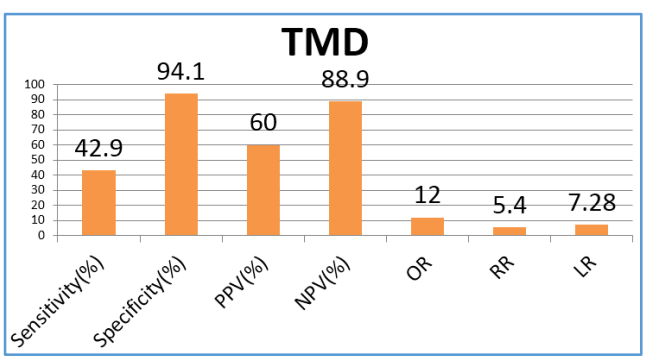

Figure 2c

ULBT & RHTMD

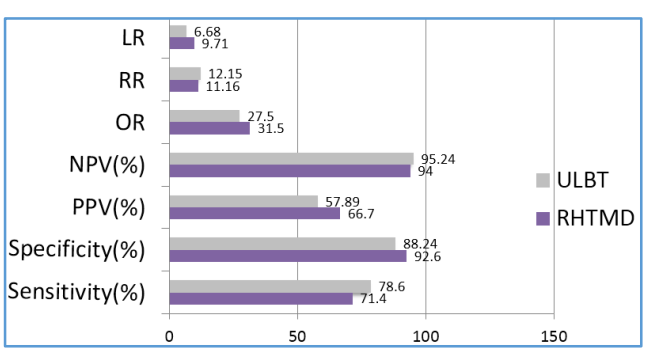

Figure 2a, b, c & d. Distribution of Statistical Variables of Various Airway Assessment Factors included in this Study

DISCUSSION

A lot of unexpected bad outcomes happen due to an unanticipation of difficulty in securing an airway. By selective use of techniques for tracheal intubation that are specialised, securing an airway with difficulty is possible provided it is recognised before induction. The reported incidence of difficult airway varies from 1.3 to 18% in general population. In this study, the observed incidence of difficult airway was found to be 17%. Patients with difficulty in laryngeal visualisation were intubated with external laryngeal pressure. The higher range of incidence can be attributed to variations in the anthropometric measurements among the chosen study population. Nonavailability of data regarding uniformity in the description of laryngoscopic views, the extent of muscle relaxation in the patient, position of the head and the level of external laryngeal pressure also determines the extent of difficulty in laryngoscopy and intubation.

A test for assessment of preoperative airway should be able to correctly predict a difficult direct laryngoscopy in maximum number of patients with a high sensitivity and also should be able to correctly predict easy direct laryngoscopy in many patients with high specificity. Preoperative airway assessment tests should be such that only a few patients with laryngoscopy which is easy should be subjected to the protocols for difficult intubation, with a high positive predictive value and also it should be able to avoid harmful and even critical consequences with few negative predictions indicating the negative predictive value.

Both ULBT and RHTMD that are easy to perform are found to be effective means for difficult airway prediction by preoperative assessment as per our study. For assessing difficulty in laryngoscopy, one of the best predictors is ratio of height to thyromental distance with highest PPV, Odds ratio and likelihood ratio and with relatively higher sensitivity, specificity and relative risk. These results are comparable to Shah et al and Chara et al.[12]

In this study, RHTMD values for positive predictive value, odds ratio and likelihood ratio are 66.7%, 31.5 and 9.71 respectively and it is almost comparable to the results given by Shah et al. Hence, the odds ratio and likelihood ratio values of RHTMD in our study are much higher than the other airway assessment parameters making it a more useful predictive tool for assessing difficult airway in clinical practice. In our study, we have taken RHTMD as an optimal cut-off of ≥23.5 cm as suggested by Krobbuban et al[13] and Krishna et al[14] and the differences in cut-off values can be attributed to interobserver variations since RHTMD involves the precise measurement of height and thyromental distance in varying study population.

Upper lip bite test also proves to be one of the best preoperative airway assessment tool with the highest negative predictive value, sensitivity and relative risk of 78.6%, 95.2% and 12.15 respectively in this study which is nearly similar to the results observed by Eberhart et al.[15] The results obtained are comparable to results as described by Khan et al[16] where upper lip bite test is compared with MMT and found that ULBT has got better accuracy, specificity and positive predictive value than the modified Mallampati test and declared that ULBT has a better prediction of difficult airway than MMT.

Thyromental distance as introduced by Patil et al[17] has been utilised as a routine screening test in airway assessment. Wide range of cut-off values have been taken up ranging from 5.5 to 7 cm for different studies. In our study, we have taken

cut-off value of TMD as ≤ 6.5 cm as suggested by Shah et al, and we have found that TMD has a relatively higher specificity, negative predictive value and odds ratio of 94.1%, 88.9% and 12.000 respectively with a poor sensitivity and positive predictive value. We have also observed in our study that RHTMD with a sensitivity, PPV and overall accuracy of 74.1%, 66.7% and 89% is found a better predictor of difficult airway than TMD with the values of the same variables as 42.9%, 60% and 85.3 respectively and this inference is found to be almost comparable to the observations by Krishna et al.[14]

Introduced in 1983 by Mallampati SR et al [18] and modified by Sampsoon and Young,[19] Modified Mallampati Test (MMT) assessment is based on oropharyngeal structures and it is used as a successful tool for airway assessment for more than 20 years. The tongue size with relation to oropharyngeal structures can be assessed along with extent of mouth opening and head and neck mobility in this test. High inter-observer variations and a reduction in the reliability can be attributed to patient's non-cooperation, phonation effect and absence of clear differentiation between class II and class III as well as class III and class IV.[9]

It was found in our study that inter incisor gap is the least sensitive of all with a sensitivity of 21.4% which is similar to results obtained by Shah et al[9] and it is also observed that with poor odds ratio, relative risk and likelihood ratio along with poor sensitivity, we can declare that ULBT and RHTMD both are superior to IIG in predicting the difficult airway. To conclude, we can say that with Odds ratio, relative risk and likelihood ratio values of >1, it has been observed that though almost all the tests included in this study were found to be statistically significant and both ULBT and RHTMD with a p value of < 0.0001 have been found to have higher statistical significance compared to the other airway parameters assessed.

Our study also had quite a few limitations. Though many parameters were used for airway assessment in our study, all parameters taken into account were assessed independently and a combination of these parameters have not been taken into account which could have given more reliability for difficult airway prediction. There are other parameters like movements of head and neck, sternomental and hyomental distance, length of mandible that is horizontal and neck circumference, etc. which are used as common parameters among various tests done for difficult airway prediction which are not included in this study. This study could have been done on a higher sample size for a better credibility and reliability of the results obtained.

CONCLUSION

We conclude that ratio of height to thyromental distance is found to be a better predictor of difficulty in laryngoscopy and intubation compared to the other airway assessment parameters and upper lip bite test is comparable to ratio of height to thyromental distance and equally effective in predicting the difficult airway. We also observe that a combination of airway assessment parameters can be taken for a better prediction of difficult airway than independent airway assessment tests.

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