Comparison of Upper Lip Bite Test and Ratio of Height to Thyromental Distance in Predicting Difficult Tracheal Intubation in South Indian Population – A Descriptive Study

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ABSTRACT

BACKGROUND

Failure in managing the airway is the most important cause of death in patients undergoing general anaesthesia (GA). For effectively preventing airway catastrophe it is essential to have a meticulous airway assessment pre-operatively. Many methods are in use to predict difficult airway like Mallampati, Wilson's scoring, percentage of glottic opening (POGO) scoring, Cormack - Lehane classification, thyromental distance, mandibular hyoid distance, atlantooccipital joint extension etc. In this study, we compared between two popular methods of airway assessment, upper lip bite test (ULBT) and height to thyromental distance ratio (RHTMD) to predict the difficulty in tracheal intubation.

METHODS

This descriptive study was conducted at Government Medical college, Thrissur, over a period of one year , on 76 patients of American society of Anaesthesiologist (ASA) - PS I - III, requiring general anaesthesia. ULBT and RHTMD were used to assess the patient's airway. It was correlated with Cormack - Lehane classification during direct laryngoscopy. The data was analysed using Fisher exact test ($P < 0.05$) and Kappa statistics.

RESULTS

Out of the 76 patients, 41 (53.9%) were women 35 were men (46.1 %). ULBT predicted 89.6 % [25 + 43] belonging to class 1 and 2 as easy, while 10.5 % [8] of class 3 as difficult. RHTMD predicted 35 patients (46 %) as easy (grade 1) and 41 patients (54 %) as grade 2. Using ULBT, of the 8 patients predicted to have difficult intubation (Class 3), 2 were found practically difficult and 6 were easy. In remaining 68 patients, 23 patients had difficult view and 45 had easy view. According to Cormac and Lehane, among 41 patients who predicted difficult by RHTMD, 19 patients were practically difficult and 22 were easy. Of 35 patients, 6 patients were difficult and 29 were easy.

CONCLUSIONS

The RHTMD is more sensitive compared to ULBT in predicting difficult intubation. As assessed by Cormack - Lehane classification.

KEYWORDS

Difficult Intubation, Ratio of Height to Thyromental Distance, Upper Lip Bite Test

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BACKGROUND

Difficult airway is one in which there is a problem in establishing or maintaining gas exchange via mask, an artificial airway or both.[1,2] Expertise in airway management is essential in every medical speciality. Maintaining a patent airway is essential for adequate oxygenation and ventilation and failure to this results in brain damage or even death. Therefore, it is the primary responsibility of anaesthesiologist to preserve and protect airway during all stages of anaesthesia. Difficult airway is a situation in which conventionally trained anaesthesiologist experiences difficulty in mask ventilation, tracheal intubation or both.

Difficult ventilation is the inability of the trained anaesthesiologist to maintain oxygen saturation above 90 percent using 100 percent oxygen in an otherwise healthy individual. Difficult intubation is a situation in which proper insertion of tracheal tube with conventional laryngoscopy requires more than 3 attempts or more than 10 minutes.[3,4,5] Difficult laryngoscopy is a scenario in which it is not possible to visualize any portion of vocal cords with conventional laryngoscopy.[3,4,5]

Managing a difficult airway in anaesthesia is critical to the extent that, about 85 % of mistakes resulted in irreversible brain damage and contributed 30 % of anaesthetic deaths.[6,7,8] Incidence of difficult intubation varies from 1.5 to 13 %.[4,5] Thus meticulous airway assessment should be done pre-operatively and it can be considered as the first clinical step to the safe conduct of anaesthesia.

Many methods have been introduced to predict difficult airways, of which some require particular circumstances, and some require special equipment.[2] According to American society of Anaesthesiologist, the incidence of difficult and failed intubation in operating room is 1.2 - 3.8 % and 0.13 - 0.30 % respectively, while incidence of difficult intubation in intensive care unit (ICU) or emergency medicine department setting is as high as 20 %.[11] About 50 – 75 % of cardiac arrest during general anaesthesia are because of difficult intubation that causes inadequate oxygenation and/or ventilation, in which about 55 – 95 % of them causes death or brain death.[8-13]

Many pre-operative airway assessment tests such as inter-incisor gap (IIG), mouth opening, Mallampati grading (MPG), head and neck movements (HNM), horizontal length of mandible (HLM), sternomental distance (SMD) and thyromental distance (TMD) may be used to predict difficult intubations, but sensitivity and positive predictive value (PPV) of these tests are different.[14] Khan et al. in 2003 proposed and studied a new test the ULBT, which had better predictability and highest sensitivity, negative predictive value (NPV), relative risk (RR) and likelihood ratio (LR). They concluded, the test would improve its reliability and reduce interobserver variability.[15]

Schmitt et al. in 2002 introduced RHTMD and found that RHTMD has better predictive value than TMD, as it considers individual body proportions. which are not considered in TMD.[14]

Subsequent studies demonstrated role of ratio of height to thyromental distance in predicting difficult intubation and assumed RHTMD ≥ 23.5 cm as risk factor for difficult laryngoscopy. Mallampati test, the most commonly employed predictor of difficult intubation has high inter observer variability, and low reliability, necessitating the search of a more practical and reliable method of airway assessment.[11,12]

Objectives

We undertook this study to compare ULBT and RHTMD for predicting difficult intubation in south Asian population as such a comparison seems lacking in these settings.

METHODS

This study was done at Government Medical College Thrissur, Kerala, India on 76 patients undergoing elective surgery under GA over a period of 1 year from 2nd May 2018 to 2nd May 2019. This was based on the formula

$$TP + FN = (Z\alpha)^2 \times sensitivity(1 - sensitivity)/d^2$$

Final Sample size

$$N = (TP + FN)/P, z\alpha = 1.96$$

TP- True positives

FN-False negatives

After obtaining approval from the institutional ethical committee and written informed consent from the patients, 76 adult ASA physical status I, II and III patients scheduled for elective surgery requiring general anaesthesia with tracheal intubation were included. The exclusion parameters were those with airway malformations, abnormal neck and TM joint function, edentulous, previous difficult intubation, previous surgery to fascial cervical or anterior neck region, patients with intraoral or laryngeal mass, patients requiring awake intubation and non-consenting patients. Pre-anaesthetic check-up and airway assessment were done by the investigator one day prior to the surgery. It includes previous airway difficulty, hoarseness, stridor, snoring, radiation exposure, infections affecting upper airway, trauma - cervical spine, maxillary and mandibular injury, diabetes, rheumatoid arthritis and ankylosing spondylitis affecting joint mobility. Hypothyroidism and acromegaly-large tongue, GERD (Gastro oesophageal reflux disease).

On the day of surgery, age, gender, height and weight were recorded. Upper lip bite test and ratio of height to thyromental distance was also calculated.

Upper lip bite test evaluated the possibility of a patient to cover the mucosa of the upper lip with the lower incisors.[10,15,16,17] Subsequently, three groups were identified.

- Class 1: Patient could bite the upper lip above the vermilion border.
- Class 2: Patient could bite the upper lip below the vermilion border.
- Class 3: Patient could not bite upper lip.

Thyromental distance (TMD) was measured from the bony point of the mentum to thyroid notch with full head extension and mouth closed, using measuring tape and graded as.

Class 1 - > 6.5 cm
Class 2 – 6 - 6.5 cm
Class 3 - < 6 cm

Height of patient was measured in centimetres from vertex to heel with patient standing by using measuring tape. Ratio of height in cms to thyromental distance in cms was calculated and graded as
Grade 1 = < 23.5
Grade 2 = > 23.5

ULBT class 3 and RHTMD grade 2 were considered as predictors of difficult intubation.[10]

The airway characteristics were assessed pre-operatively by primary investigator to avoid interobserver variability. The patients were then advised for routine pre-operative work up and proceeded as planned with the proposed surgery. In the operating room, standard monitoring was established such as electro cardiogram, capnography, non-invasive blood pressure (NIBP) and pulse oximetry.

A difficult airway cart was kept ready. 18 G cannula was inserted and intravenous fluid was administered. Analgesia was provided with fentanyl 2 mcg/kg. All patients were premedicated with glycopyrrolate 5 mcg/kg, midazolam 0.02 mg/kg intravenously. Preoxygenated with 100 % oxygen for 3 to 5 minutes. Anaesthesia was induced with thiopentone sodium 6 mg/kg and titrated doses of propofol. Haemodynamics was maintained during induction. Adequacy of bag and mask ventilation was checked. If bag and mask ventilation was adequate Succinylcholine 1.5 mg/kg was administered IV for muscle relaxation. Laryngoscopy was performed by the senior anaesthesiologist who was blinded to pre anaesthetic airway assessment. The view of the larynx without the external laryngeal manipulation was classified using Cormack and Lehane grading and recorded.
Class 1: Visualisation of entire laryngeal aperture.
Class 2: Visualisation of only posterior portion of laryngeal aperture.
Class 3: Visualisation of only epiglottis.
Class 4: No visualisation of epiglottis or larynx

After assessing Cormack and Lehane classification all patients were intubated with appropriate endotracheal tube and proceeded with surgery as planned.

Cormack and Lehane score 3 and 4 was considered as difficult intubation ULBT class 3 and RHTMD grade 2 are considered as predictors of difficult intubation.

Sensitivity, specificity, positive predictive value, negative predictive value and accuracy were calculated for ULBT and RHTMD and compared with Cormack -Lehane grading.

Statistical Analysis

The statistical analysis was done by entering data into Microsoft Excel sheet and analysed using statistical package for social sciences (SPSS) software. The categorical variables were expressed as proportions and quantitative variables were expressed as mean and standard deviation. Then statistical significance of each test is compared using Kappa statistics and Fisher exact test. P value < 0.05 is considered as statistically significant.

RESULTS

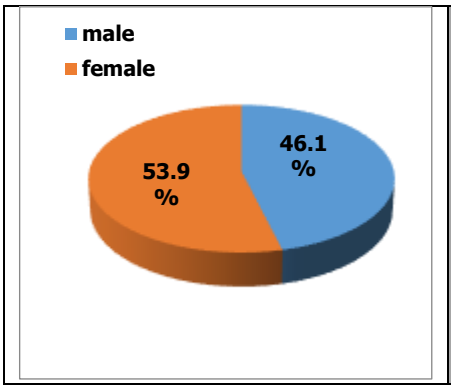

Figure 1. Sex Distribution of Patients

Among the total 76 patients, 41 (53.9 %) were females and 35 (46.1 %) were males (Figure 1).

The following terms were used for understanding the utility of clinical tests.

- True positive (TP): A difficult endotracheal intubation that had been predicted to be difficult.
- False positive (FP): An easy intubation that had been predicted to be difficult.
- True negative (TN): An easy intubation that had been predicted to be easy.
- False negative (FN): A difficult endotracheal intubation that had been predicted to be easy.

ULBT	No. of Patients	Percentage of Patients
Class 1	25	32.9
Class 2	43	56.7
Class 3	8	10.5
Total	**76**	**100.0**
RHTMD	**No: of Patients**	**Percentage of Patients**
Grade 1	35	46
Grade 2	41	54
Total	**76**	**100.0**

Table 1. Grading of Difficulty as per ULBT and RHTMD in the Study Population

Cormack and Lehane Grading	No. of Patients	% of Patients
Grade ≤ 2	51	67
Grade > 3	25	33
Total	76	100

Table 2. Grading of Difficulty as per Cormack and Lehane

ULBT	C and L		Total
	Difficult	Easy	
Difficult	2 (TP)	6 (FP)	8
Easy	23 (FN)	45 (TN)	68
Total	**25**	**51**	**76**
RHTMD	**C and L**		**Total**
	Difficult	**Easy**	
Difficult	19 (TP)	22 (FP)	41
Easy	6 (FN)	29 (TN)	35
Total	**25**	**51**	**76**

Table 3. Relation between Predictions of ULBT and RHTMD with Actual C & L Views

Table 1 depicts the difficulty grading in study population. ULBT predicted 89.6 % [25 + 43] belonging to class 1 and 2 as easy, while 10.5 % [8] of class 3 as difficult. It was noted that RHTMD predicted 35 patients (46 %) as easy (grade 1) and 41 patients (54 %) as grade 2, denoting difficulty in intubation. C & L grade 3 & 4 are considered as difficult intubation. Among 76 patients, 25 had grade 3 (difficult) and 0 patients were assessed as grade 4.

It was observed that using ULBT, among the 8 patients predicted to have difficult intubation (Class 3), 2 were found practically difficult and 6 were easy intubation by Cormac and Lehane. In the remaining 68 patients, 23 patients were found to have difficult view, while 45 had easy view according to Cormac and Lehane.

Out of 41 patients who were predicted to be difficult by RHTMD, 19 patients were found practically difficult and 22 were easy while assessing through Cormac and Lehane. In remaining 35 patients, 6 patients were found to have difficult view and 29 patients had easy view.

	RHTMD	ULBT
Sensitivity	78	8
Specificity	57	88
Positive predictive value	46	25
Negative predictive value	83	66
Accuracy	63	61
P value	.007	0.615
Kappa statistic	0.283	0.046

Table 4. Comparison between ULBT and RHTMD in Terms of Sensitivity, Specificity, Positive Predictive Value (PPV), Negative Predictive Value (NPV)

It was observed that RHTMD was highly sensitive in predicting difficult intubation but falls inferior to ULBT in specificity. RHTMD had a higher positive and negative predictive value with comparable accuracy with respect to ULBT

DISCUSSION

Failure to intubate a paralysed patient remains as the worst nightmares of any laryngoscopist. Hence various tools have been proposed to predict one.[16] Nevertheless, the incidence of unanticipated difficult intubation ranges between 1.3 – 13 %[10] .As per various studies, there are various anatomical and noninvasive clinical tests, which are used singly or in various combinations to predict difficult intubation.[10] The search for a simple, reliable and accurate pre-operative airway assessment test is ongoing. Our study included comparison between upper lip bite test and ratio of height to thyromental distance in predicting difficult intubation, as assessed by Cormac – Lehane classification.

ULBT is a combination of jaw subluxation and buck teeth. It is easy to perform within seconds at bedside by simple observation of patient. It doesn't require equipments and hence easy to perform. The classes of ULBT are clearly demarcated and delineated making the interobserver variability unlikely. But one of its major limitations is inability to assess patients who are edentulous and it could not assess neck mobility. Although these limitations appear subtle, they are really limiting factors in clinical practice because there exists a major chunk of patients who are edentulous, elderly and those with movement limitations arising from very rampant chronic diseases like diabetes, rheumatoid arthritis. In these patients, RHTMD is definitely a better option to practice. RHTMD ratio allowed consideration to body proportion in assessment of difficult airway.[10] Identical thyromental distance in a women with height of 160 cm and men with height of 180 cm may be associated with different jaw proportion.[18] However it also has few limitations to be considered as a sole method to predict difficult intubation. Factors contributing to difficult intubation such as mouth and dentition are not assessed by RHTMD. But, at the same time assess the ability of neck extension compared to ULBT. RHTMD needs a measuring tape at bedside for accurate measurement, unlike ULBT. A combination of these are probably the best predictors to draw a definite conclusion on the ease of intubation.

The incidence of difficult intubation in this study was 33 %, i.e. 25 out of 76 patients. Of these only 2 are correctly predicted to be difficult intubation by ULBT and 19 are predicted as difficult, correctly by RHTMD. The incidence of difficult intubation in a study conducted by Badheka et al. in 2016 was 30 %, which is comparable to our study.

We observed the sensitivity of RHTMD was 78 %, which is comparable to previous studies undertaken by Krobbuaban et al. (77 %), Shah et al. (71.64 %) and Schmitt et al. (81 %). Specificity in our study was 57 % with the sample size of 76, comparable to a study conducted in South Indian population by Balakrishnan K P et al. (53 %).[19] It was observed that specificity was lower than Badheka et al. (80.39 %),[10] Shah et al. (92.01 %) and Schmitt et al. (90 %).[17] Therefore, false negative prediction which has got deleterious and life-threatening effect is minimal with RHTMD. Decreasing false negativity is crucial than falsely predicting difficult intubation in unaffected patients.[20]

The positive predictive value, negative predictive value, and accuracy of RHTMD is 46 %, 83 % and 63 % respectively in our study implying that RHTMD is a better predictor of easy intubation than difficult intubation. RHTMD is statistically significant as Fisher exact test P value is < 0.05. RHTMD showed agreement with Cormack - Lehane classification by KAPPA statistics. We found that the sensitivity of ULBT was 8 %, similar to study by Khan et al. (7 %),[15] but this was much lower compared to study conducted by Badheka et al. (96.64 %),[10] and Shah et al. (74.63 %).[21] This striking lower sensitivity of ULBT may miss identification of patients with difficult laryngoscopy.

The specificity of ULBT in our study was 88 %, when compared to studies of Badheka et al. (82.35 %),[10] Khan et al. (98.5 %) and Shah et al. (91.53 %). Higher specificity indicates that negative ULBT is more predictive of an easy intubation than negative RHTMD.

This wide variation in sensitivity and specificity of our study was due to the larger spectra of patient included in class 1 and 2 of ULBT (68 out of 76 patients) and class 3 was only 8 out of 76 (11 %). A possible explanation to this is the elective surgical population included in the study, while patients with difficult airway and emergency nature were excluded and ULBT may not be applicable to all subgroups of general population. Difference in patient understanding of technique and comparative smaller sample size may be contributary. The positive predictive value, negative predictive value and accuracy of ULBT in our study was 25 %, 66 % and 61 % respectively. But the test is statistically insignificant as Fisher exact test P value was > 0.05 in our study.

Thus, from our study, we found out that ULBT as a single test cannot be used for identifying difficult intubation, since it has got very low sensitivity and accuracy. Even though

specificity is higher than RHTMD, we cannot take it into consideration as P value is > 0.05. RHTMD is a better predictor of difficult intubation while comparing with ULBT.

Our study considered elective cases only and may not be a cross section of general population. Future studies aiming at these lacunae, considering emergent surgeries, involving elderly, obstetric and different ethnic groups with a larger sample size are warranted.

CONCLUSIONS

Although the search for an absolute predictor of difficult intubation is still in the road of progress with new and new scales and ratios get added up from every corner of scientific research, an absolutely reproduceable and acceptable, handy method is still a mirage. This is the lacunae, to be filled by RHTMD due to its acceptability and reproducibility. From our observations, we would like to recommend that the ratio of height to thyromental distance is definitively a sensitive and better bedside airway assessment test in comparison with upper lip bite test while predicting difficult intubation. Every attempt to popularize and practice RHTMD should be encouraged and further studies in this regard has to be undertaken for a definitive opinion.

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