

A Study to Predict Difficult Intubation Using Simple Non-invasive test: A Prospective Observational Study

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ABSTRACT

Background: Airway Management is prime importance to the anaesthesiologist of all the anaesthetic deaths 30 % to 40 % are attributed to the inability to manage a difficult airway. The various simple bedside predictors of difficult airway like Mallampati test, Upper lip bite test, Thyromental, Hyomental, Thyrosternal & Sternomental distances, mandibular length, Neck circumferences etc. are easy to perform with No extra cost or inconvenience to patients. **Aim:** To assess the predictability of Upper lip bite test, Hyomental distance, Thyromental distance, Thyrosternal distance & Mandibular length. **Objective:** 1) To find out the best predictor of difficult intubation amongst the Upper Lip Bite Test, Hyomental Distance, Thyromental Distance, Thyrosternal Distance & Mandibular Length on the basis of the test. **Methods:** This is a prospective observational study of 110 patients are randomly selected & age caring between 20 to 59 yrs both male and female are presented in anaesthesia of routine per anaesthetic check-up. After from mouth opening & mallampati test which are routinely done airway assessment included ULBT, HMD, TMD, TSD & ML will be done. **Results:** After analysing study state that the age ($P = 0.031$) were significant, & sex ($P = 0.213$) ASA ($P = 0.091$) were not significant with difficult intubation on the basis of Cormack lehane grading. All these factors were applicant on next set of 110 patients to found sensitivity & specificity to be ULBT (SE = 50.00%, SP = 100.00%), HMD (SE = 10.00%, SP = 97.00%), TSD (SE = 0.00%, SP = 97.00%), ML (SE = 20.00%, SP = 97.00%) & TMD (SE = 70.00%, SP = 85.00%) respectively. **Conclusions:** Thyromental distance is the most important sensitive factors predicting difficult intubation on the basis of cormack lehane grading in indian patients.

Keywords: Airway Management, ULBT, HMD, TSD, TMD, ML & Cormack Lehane grading.

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INTRODUCTION

Failure to achieve endotracheal intubation causes considerable morbidity and mortality in anaesthetised patients. Of all the anaesthetic deaths 30% to 40 % are attributed to the inability to manage a difficult airway.¹ Securing an airway is the most important part of general anaesthesia. Difficult intubation is nightmares for every anaesthesiologist. Being prepared for a difficult intubation is a nightmare for every anaesthesiologist. To be prepared for Difficult intubation, it is vital to predict the difficult airway correctly before induction of anaesthesia. For securing airway, tracheal intubation using direct laryngoscopy remains the method of choice in most of the cases. The reported incidence of difficult intubation ranges from 0.5 to 18 %.²

Some airway may be difficult to maintain under mask anaesthesia, but are easily intubated, other airways are difficult to intubate but may be maintained with mask anaesthesia for the duration of operation & some are difficult to manage in both the aspects.³

The purpose of this study was to conduct the ability to predict difficult visualisation of Larynx using ULBT, HMD, TMD, TSD & ML. We wish to determine whether each of these parameters had a direct correlation with difficult laryngoscopic view. I.e Cormack lehane grading & difficult intubation & the diagnostic value i.e. which test predict the difficult visualisation better than others with the help of statistical test.

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Aim: To assess the predictability of Upper lip bite test, Hyomental distance, Thyromental distance, Thyrosternal distance & Mandibular length.

Objective: 1) To find out the best predictor of difficult intubation amongst the Upper Lip Bite Test, Hyomental Distance, Thyromental Distance, Thyrosternal Distance & Mandibular Length on the basis of the test.

METHODS

This prospective observation study was conducted in 110 patients are randomly selected and age varying between 20 to 59 yrs and both male & female are presented in anaesthesia of routine pre anaesthetic check-up. The study prepare written informed consent was taken from patient and was approved by the Institutional Ethical committee.

Study Area: Department of Anaesthesia, Vedantaa Institute of Medical Sciences, Palghar.

Duration: Study duration was Aug 2017 to July 2018.

Sample Size: Sample size was calculated by applying Z test⁴

$$n = Z^2 * (PQ / M.E.^2)$$

Where Z = 1.96, P = 9.65 %, Q = 90.35 %, M.E. = 0.056
Therefore, sample size come to 107, for simplification 110 patients were included in this study.

Data Collection: Data was collected as ULBT, HMD, TMD, TSD & ML & Cormack lehane grading. Cormack lehane grading of class I & class II were taken as actual easy & class III & class IV were taken as actual difficult.

Inclusion Criteria were:

- 1) Age varying between 20 to 59 yrs.
- 2) Male & Female
- 3) ASA physical status I & II
- 4) elective surgery under General Anaesthesia with endotracheal intubation.

Exclusion Criteria were:

- 1) Edentous patients
- 2) Uncooperative patients, altered level of consciousness, unable to follow commands
- 3) Unable to open the mouth, trauma or medical condition, facial or neck disease
- 4) Pregnancy
- 5) Temporomandibular joint & Atlanta Axial joint dislocation cervical vertebra pathology.

Outcomes Measures:

- Predicted Easy: 1) Upper Lip Bite Test I & II.
2) Thyrosternal Distance \geq 6.5.
3) Thyromental Distance $>$ 6 cm.
4) Hyomental Distance \geq 3.5 cm.
5) Mandibula Length \geq 9cm.

- Predicted Difficult: 1) Upper Lip Bite Test III & IV.
2) Thyrosternal Distance $<$ 6.5.
3) Thyromental Distance $<$ 6 cm.
4) Hyomental Distance $<$ 3.5 cm.
5) Mandibula Length $<$ 9cm.

Actual Easy: 1) Cormack Lehane grade I & II.

Actual Difficult: 1) Cormack Lehane grade III & IV.

Description of the airway assessment tests is as follows:

Upper Lip Bite Test (ULBT): It is a scale indicating range of motion of bite of lower teeth on upper lip. ULBT was assessed with the participant in sitting position at eye level and graded as follows.

Class 1: Lower incisors can bite the upper lip above the vermilion border.

Class 2: Lower incisors cannot bite the upper lip (potentially difficult intubation).

Hyomental distance (HMD) Test: HMD was measured in supine position with head in full extension and mouth closed. The straight distance from the lower border of the mandibular mentum to the superior border of the hyoid bone was measured in centimeters.

HMD is graded as:

\geq 3.5 cm- expected easy intubation

$<$ 3.5 cm-potentially difficult intubation

Thyrosternal distance (TSD) Test: TSD was measured in supine position with head in full extension and mouth closed. The straight distance between the prominent laryngeal of the thyroid cartilage and incisura jugularis of the sternal bone was measured in centimetres.

TSD is graded as:

\geq 6.5 cm- expected easy intubation

$<$ 6.5 cm- potentially difficult intubation

Mandibular length (ML): ML was measured from the angle of the mandible to the tip of the chin with the patient in a sitting position. ML is graded as:

\geq 9 cm- expected easy intubation

$<$ 9 cm- potentially difficult intubation

Thyromental distance (Patil's test) : It is defined as the distance from the mentum to the thyroid notch while the patient's neck is fully extended. This measurement helps in determining how readily the laryngeal axis will fall in line with the pharyngeal axis when the atlanto-occipital joint is extended. It estimates the potential space into which the tongue can be displaced on laryngoscopy. TMD is graded as:

\geq 6 cm- expected easy intubation

$<$ 6 cm- potentially difficult intubation

CORMACK and LEHANE grading⁵ system is the gold standard parameter in diagnosing level of difficulty in INTUBATION. Laryngoscopy view was graded according to Cormack and Lehane scale as follows:

Grade 1: Full view of glottis seen.

Grade 2: Anterior commissure not visible, Glottis seen partially. Grade 3: Only epiglottis is seen.

Grade 4: Epiglottis is not seen.

Grade 3 and 4 are considered as potentially difficult intubations.

RESULTS

Our study included 110 patients, 48 Males & 62 Females, 66 patients came under ASA status I and 44 under ASA II. Mean age was 38.7 years. Difficult intubation was seen in 10 (9.10%) patients. Cormack Lehane (CL) Grades I and II were included in Easy Cormack Lehane grading, whereas Grades III and IV were included in Difficult Cormack Lehane. All of our patients with difficult intubation had CL grading III and none had CL grade IV. There was no failure to intubate the trachea in any of the patients in our study.

We studied the validity of Upper Lip Bite Test, Hyomental Distance, Thyrosternal Distance, Thyromental Distance and Mandibular Length on the basis of sensitivity, specificity, positive predictive value and negative predictive value. In our study we found Sensitivity of Upper Lip Bite Test (ULBT) to

be 50 %, a specificity of 100 %, positive predictive value of 100% and negative predictive value of 95.24% (Table-1). This means ULBT is less sensitive but highly specific and has very good positive predictive value with good negative predictive value. Hyomental distance (HMD) showed a Sensitivity (10%), Specificity (97%), Positive Predictive Value (25%) and Negative Predictive Value (91.51%) respectively (Table-2). Thyrosternal distance showed a Sensitivity and Positive Predictive Value came of 0% while the Specificity and Negative Predictive value of the test to be 97% and 90.65%, respectively (Table-3). Mandibular length showed Sensitivity, Specificity, Positive Predictive Value and Negative Predictive Value and found of 20%, 98%, 50% and 92.45%, respectively (Table-4). Thyromental Distance showed a sensitivity (70%), specificity (85%), Positive Predictive Value (31.80%) and Negative Predictive Value (96.59%) respectively (Table 5).

Table 1: Modified Cormak Lahane Grading.

ULBT	Modified Cormak Lahane Grading			Total
	No	Difficult	Easy	
Predicted Difficult	No	5	0	5
	%	100.00%	0.00%	100.00%
Predicted Easy	No	5	100	105
	%	4.80%	95.20%	100.00%
Total	No	10	100	110
	%	9.10%	90.90%	100.00%

Diagnostic tests	Estimate	Lower 95% CI	Upper 95% CI
Sensitivity	50.00%	18.71%	81.29%
Specificity	100.00%	96.38%	100.00%
Predictive value of positive test	100.00%		
Predictive value of negative test	95.24%	91.50%	97.38%

Table 2: Modified Cormak Lahane Grading

HMD	Modified Cormak Lahane Grading			Total
	No	Difficult	Easy	
Predicted Difficult	No	1	3	4
	%	25.00%	75.00%	100.00%
Predicted Easy	No	9	97	106
	%	8.50%	91.50%	100.00%
Total	No	10	100	110
	%	9.10%	90.90%	100.00%

Diagnostic tests	Estimate	Lower 95% CI	Upper 95% CI
Sensitivity	10.00%	0.25%	44.50%
Specificity	97.00%	91.84%	99.38%
Predictive value of positive test	25.00%	3.67%	74.45%
Predictive value of negative test	91.51%	89.73%	93.00%

Table 3: Modified Cormak Lahane Grading

TSD	Modified Cormak Lahane Grading			Total
	No	Difficult	Easy	
Predicted Difficult	No	0	3	3
	%	0.00%	100.00%	100.00%
Predicted Easy	No	10	97	107
	%	9.30%	90.70%	100.00%
Total	No	10	100	110
	%	9.10%	90.90%	100.00%

Diagnostic tests	Estimate	Lower 95% CI	Upper 95% CI
Sensitivity	0.00%	0.00%	30.85%
Specificity	97.00%	91.48%	99.38%
Predictive value of positive test	0.00%		
Predictive value of negative test	90.65%	90.36%	90.94%

Table 4: Modified Cormak Lahane Grading

ML	Modified Cormak Lahane Grading			Total
	No	Difficult	Easy	
Predicted Difficult	No	2	2	4
	%	50.00%	50.00%	100.00%
Predicted Easy	No	8	98	106
	%	7.50%	92.50%	100.00%
Total	No	10	100	110
	%	9.10%	90.90%	100.00%

Diagnostic tests	Estimate	Lower 95% CI	Upper 95% CI
Sensitivity	20.00%	2.52%	55.61%
Specificity	98.00%	92.96%	99.97%
Predictive value of positive test	50.00%	13.60%	86.40%
Predictive value of negative test	92.45%	89.97%	94.36%

Table 5: Modified Cormak Lahane Grading

TMD	Modified Cormack Lahane Grading			Total
	No	Difficult	Easy	
Predicted Difficult	No	7	15	22
	%	31.80%	68.20%	100.00%
Predicted Easy	No	3	85	88
	%	3.40%	96.60%	100.00%
Total	No	10	100	110
	%	9.10%	90.90%	100.00%

Diagnostic tests	Estimate	Lower 95% CI	Upper 95% CI
Sensitivity	70.00%	34.75%	93.33%
Specificity	85.00%	76.47%	91.35%
Predictive value of positive test	31.80%	20.09%	46.41%
Predictive value of negative test	96.59%	91.63%	98.65%

DISCUSSION

Securing an airway is the most important part of general anaesthesia. Difficult Intubation is a nightmare for every anaesthesiologist. Being prepared for a difficult intubation reduces the adverse events due to difficulty or failure to intubate. To be prepared for Difficult Intubation, it is vital to predict the difficult airway correctly before induction of anaesthesia. There has been extensive research on the predictors for difficulty in intubation, right from radiological imaging to external anatomical factors, but almost all of them are far from being ideal i.e. one which is easy to perform, highly sensitive, highly specific and which possess high positive predictive value with few false negative predictions. A test to predict difficult intubation should have high sensitivity, so that it will identify most patients in whom intubation will truly be difficult. It should also have a high Positive Predictive Value, so that only few patients with airways actually easy to intubate are subjected to the protocol for the management of a difficult airway. Similarly, a test should have a high specificity and Negative Predictive Value to correctly predict the ease of laryngoscopy and intubation.

This study was designed to evaluate the efficacy of Upper Lip Bite Test, Hyomental distance, Thyrosternal distance, Thyromental distance and Mandibular length in terms of Sensitivity, Specificity, Positive Predictive Value and Negative Predictive Value in forecasting a difficult intubation, and to draw a possible relation between the Tests/Parameters and Cormack–Lehane grades which was used as the gold standard in our study.

We divide the cases into two groups, group one is Actual easy with Cormack Lehane in Class I & Class II. Another group is Actual difficult with Cormack Lehane in Class III & Class IV.

Upper Lip Bite Test proposed by Khan et. al. in 2003⁶ is a simple new assessment method in predicting difficulty in intubation. It tests the range and freedom of mandibular movement and the architecture of the teeth.

In our study we found Sensitivity of Upper Lip Bite Test (ULBT) to be 50%, specificity of 100%, positive predictive value of 100% and negative predictive value of 95.24%. This means ULBT is less sensitive but highly specific and has very good positive predictive value with good negative predictive value which was comparable to the findings of Khan et. al.² They found High specificity and positive predictive value for Upper Lip Bite Test. Khan et. al.² had proposed Upper Lip Bite Test as better predictor than other three parameters i.e. Hyomental distance, Thyrosternal distance and Mandibular length.

Our study also included Hyomental distance (HMD) which gives a clue of the potential space where the tongue would be displaced during laryngoscopy. We found its sensitivity to be very low as 10% which was in accordance with study of Khan et. al.² in 2011, who found the sensitivity of HMD to be 8.8%. One more study by Huh J et. al.⁷ in 2009 assessed Modified Mallampati Test, HMD, HMD ratio and Thyromental distance and found the sensitivity of HMD to be 23% which was again not a very good predictor in terms of screening test which requires a good sensitivity. Specificity, Positive Predictive Value and Negative Predictive Value in our study for HMD were 97.00%, 25% and 91.51%, respectively. Khan et. al.² found the Specificity, Positive Predictive Value and Negative Predictive Value of HMD to be 98.9%, 50% and 89.5%, respectively which were almost similar to what we

found in our study. Huh J et. al.⁷ found the Specificity, Positive Predictive Value and Negative Predictive Value of HMD to be 95%, 40% and 90%, respectively, which were also similar to what we found in our study.

Cattano et. al.⁸ studied Hyomental distance and found its sensitivity to be 16%, a specificity of 91%, Positive Predictive Value of 4% and Negative Predictive Value of 98%. All other results were comparable to our study except the very low positive predictive value they found which might be due to not calculating the Hyomental distance in full extension of neck and taking the cut off point for predicting difficult intubation by Hyomental distance as 4.5cm against our study and also the other studies conducted by Khan et. al.² and Huh J et. al.⁷

We also studied Thyrosternal distance (TSD). In our study, Thyrosternal distance did not predict even a single difficult intubation correctly and hence its Sensitivity and Positive Predictive Value came out to be 0%. We found the specificity and Negative Predictive value of the test to be 97.00% and 90.65%, respectively. Khan et. al.² in 2011 who also found similar low sensitivity and Positive Predictive Value for TSD as a predictor of difficult intubation. There are not many studies done on Thyrosternal distance as a predictor of Difficult intubation. So, it appears that TSD has a poor sensitivity and Positive Predictive value and needs more evaluation in a larger sample study to evaluate its diagnostic value.

The parameter which we studied was Mandibular length. We studied it in terms of Sensitivity, Specificity, Positive Predictive Value and Negative Predictive Value and found it to be 20%, 98.00%, 50% and 92.45%, respectively. So, it has a low sensitivity but comparatively higher positive predictive value, good specificity and Negative Predictive Value.

In our study we found Sensitivity of Thyromental Distance (TMD) to be 70%, a specificity of 85%, positive predictive value of 31.80% and negative predictive value of 96.59%.

This means TMD is less sensitive and very good specific and less positive predictive value with high negative predictive value. Respectively, Deepak TS, Vikas KN.⁹ also found overall sensitivity of diagnostic predictors was relatively less. The highest sensitivity of 44.44% was observed in predicting difficult laryngoscopy with modified mallampati followed by TMD (11.11%) & HMD (11.11%). In contrast, the specificity in our study was relatively high. The highest specificity of 99.44% was observed in predicting difficult laryngoscopy with modified mallampati with followed by TMD (96.67%) & HMD (95.56%).

In our study, we found the sensitivity of TMD to be higher compared to ULBT, HMD, TSD and ML. Sensitivities of TMD, ULBT, HMD, TSD and ML were 70%, 50%, 10%, 0% and 20%, respectively. The Specificity of TMD, ULBT, HMD, TSD & ML were 85%, 100%, 97% 97% & 98%, respectively. Thus, we found a very a specificity of all the tests but even in them ULBT had the highest specificity of 100%, which means the predictions on the basis of ULBT were every time correct. The high specificity of ULBT means it is a good test to predict easy intubations. So, comparing the above parameters, ULBT comes out to be a better predictor of Difficult Intubation over HMD, TSD and ML. Also, we found out that ULBT is easy to perform and very convenient to use as a bedside test.

CONCLUSION

Though, TMD appears to be better amongst the four tests, none of them is a foolproof test. None of them can be used

as a reliable screening test as no one had a sensitivity even more than 70%. So, a negative test doesn't rule out a difficult intubation and we need to be prepared with the Difficult Intubation cart all the time.

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