Indian Journal of Clinical Anaesthesia 2020;7(4):589–593

Content available at: https://www.ipinnovative.com/open-access-journals

Indian Journal of Clinical Anaesthesia

Journal homepage: www.ijca.in

Original Research Article

Anticipating difficult tracheal intubation by observing Modified Mallampati Grade, Thyromental Distance and Upper Lip Bite Test. A prospective observational study

Pavani Sudhamala[1], S Kalyani Surya Dhanalakshmi[1,*], Gopinath Ramachandran[1]

[1] *Dept. of Anaesthesiology, ESIC Medical College Hospital, Hyderabad, Telangana, India*

ARTICLE INFO

Article history:
Received 04-07-2020
Accepted 06-07-2020
Available online 25-11-2020

Keywords:
Airway predictors
Difficult airway
General anaesthesia
Incidence
Intubation

ABSTRACT

Context: Diagnostic accuracy of various difficult airway predictors in anticipating difficult intubation have been studied in literature.

Aims: To identify the best combination of bedside difficult airway tests in anticipating difficult intubation.

Settings and Design: In this study 200 patients between the ages18 -70 years, of American Society of Anaesthesiologists grade I II, posted for elective surgeries under general anaesthesia with intubation were enrolled.

Materials and Methods: Modified Mallampati Grade, Thyromental Distance, Upper Lip Bite Test were noted on airway examination. Intubation difficulty during general anaesthesia was assessed by observing Cormack Lehane Grade, number of intubation attempts, use of external laryngeal pressure, Gum elastic bougie.

Statistical Analysis used: Airway parameters of 200 patients were analysed in SPSS 20 software for sensitivity, specificity, positive predictive values, negative predictive values in individual tests and in various combinations with each other.

Results: Among 200 patients, incidence of difficult intubation was 7% (14 patients). Patients needing two or more attempts for intubation, gum elastic bougie, external laryngeal pressure were five, eight and 30 respectively. Modified Mallampati Grade had sensitivity 64.3%, specificity 79%. Upper lip bite test had sensitivity 71.4%, specificity 41.9%. Combination of Modified Mallampati Grade with Upper Lip Bite Test had sensitivity 64.3%, specificity 84.9%, positive predictive value 80.9% which were statistically significant.

Conclusions: Modified Mallampati Grade, Upper Lip Bite test individually and as combination have better diagnostic value, compared to other airway parameters, in predicting difficult intubation.

1. Introduction

Unanticipated difficult airway can lead to complications like hypoxic brain damage, emergency surgical airway, trauma to the airway, teeth.[1] Difficult tracheal intubation accounts for 28% of all anaesthesia related deaths, secondary to the inability to mask ventilate or intubate.[2] Single parameter tests like interincisor gap, thyromental distance, mallampati grade, group indices like Wilson scoring system, Benumofs 11 parameter analysis are available for prediction of difficult airway. None of them have a 100% sensitivity or specificity.To identify the best bedside predictors of difficult airway we studied Modified Mallampati grade, Thyromental distance, Upper Lip Bite test scores individually and in various combinations.

* *Corresponding author*.
E-mail address: sksdhanalakshmi@hotmail.com (S. K. S. Dhanalakshmi).

https://doi.org/10.18231/j.ijca.2020.107

2. Materials and Methods

After obtaining Institutional Ethical Committee approval (ESICMC/SNR/IEC-F084/01/2019), CTRI registration(CTRI/2019/05/019158), this study was conducted in the Operation theatres. The study was conducted over a period of eight months on 200 patients of either sex, coming for elective surgeries under general anaesthesia with endotracheal intubation, from all surgical specialties, after taking written informed consent from the patients.

The sample size of this study was based on a study conducted by Dhanger et al., where 200 patients were enrolled using power calculation with α=0.05 and β=0.20.[3]

All the patients were of age between 18 to 70 years, belonged to either ASA grade I or II. Patients undergoing emergency surgeries, those with restricted mouth opening, restricted cervical spine mobility, with tumours of oropharynx, pregnant women, oromaxillary and mandibular surgery patients were excluded from the study.

Patient examination, conduction of study, data assessment were all done by a single anaesthesiologist with five years of experience, to remove any observational bias. In the pre anaesthetic evaluation the Modified Mallampati grade (MMPG), Thyromental Distance (TMD), Upper Lip Bite Test (ULBT), Body mass index (BMI) were noted. Patient was seated and asked to open the mouth, with tongue protruded and head in neutral position. The examiner sat opposite to the patient at the same level to observe the Modified Mallampati Grade. Thyromental distance was recorded with the patient's head in full extension and by measuring the distance from the lower border of mentum to the thyroid notch with a ruler. The anaesthesiologist demonstrated, to the patient, how to perform the Upper Lip Bite test. The patient was asked to protrude his jaw to touch the upper lip with his lower incisors to the extent possible.

The grades of each test were assessed as follows.

Modified Mallampati Grades

Class I: Faucial pillars, uvula, and soft palate are visualized.

Class II: Base of the uvula and soft palate are visualized.

Class III: Soft palate only is visualized.

Class IV: Hard palate only is visualized.

Thyromental Distance/Patils Test

$\geq$ 6.5cm considered as normal value

6- 6.5cm and <6cm were considered difficult.[4]

Upper Lip Bite Test-described by Khan and collegues - assesses the range of freedom of mandibular movement and size of the teeth.[5]

Class 1-lower incisors can bite upper lip above the vermilion line

Class 2-lower incisors can bite upper lip below the vermilion line

Class 3-lower incisors cannot bite upper lip.

Anticipated Difficult Intubation was considered when

Modified Mallampati grade was 3 or 4,

Thyromental distance <6.5cm,

Upper Lip Bite test score 2 or 3.

Cormack and Lehane developed a grading scale in 1984 to describe laryngoscopic views.

The grades range from I to IV, as follows.

Grade I –visualisation of entire laryngeal aperture

Grade II-visualisation of only the posterior portion of the laryngeal aperture

Grade III-visualisation of only epiglottis

Grade IV-no visualisation of epiglottis or larynx.

On the day of surgery a review preanaesthestic check reaffirmed the findings of MMPG, TMD, ULBT. Once the patient was in the operation theatre, intravenous line was secured and standard ASA monitoring including pulse oximetry, 3 lead ECG, non invasive blood pressure and respiratory gas analyser with end tidal carbon dioxide were attached. Fentanyl 1-2 mcg/kg was given intravenously and preoxygenation done for three minutes, induction with propofol 2mg/kg, and intubating dose of vecuronium 0.1mg/kg was given followed by controlled ventilation for three minutes with air, oxygen (50:50) and sevoflurane (1 MAC). Direct laryngoscopy was done with patient's head in sniffing position using appropriate size Macintosh blade. Cormack Lehane grade was noted. Patient was then intubated with appropriate sized endotracheal tube. External laryngeal pressure and gum elastic bougie were used as needed and was noted. (Bougie used was Romsons15Fr). The number of attempts at intubation was recorded. Successful intubation was confirmed by chest movements, auscultation and capnography.

Primary end points for difficult intubation:

Cormack Lehane grading 3 or 4

$\geq$ 2 attempts at intubation

Secondary end Points for difficult intubation:

Use of External Laryngeal pressure (ELP)

Use of Gum Elastic Bougie (GEM).

The collected data from all the 200 patients was entered in SPSS 20 software to analyse the predictability of the airway parameters individually and in a variety of combinations. The purpose of the study was to find out whether patients with a Modified Mallampati grade of 3 or 4 and or a Thyromental distance of <6.5 and or an Upper Lip Bite test score of 2 or 3 and or a BMI of $\geq$30, or a combination of these parameters had a CLG of 3,4.

2.1. Statistical analysis

Sensitivity, specificity were calculated for all the individual predictors and their combinations using crosstabs on SPSS. Positive predictive value (PPV) and Negative predictive value (NPV) were calculated manually from True positive, false positive, true negative and false negative values.

3. Results

A total of 200 patients participated in the study, 64 (32%) were males and 136 (68%) were females. All of them were between 18-70 years, belonging to ASA I or II. The mean age of the study population was 35.36 ± 11.69 [Table 1]. The incidence of difficult intubation, which was defined as Cormack Lehane grade 3 or 4, according to our findings was 7% (14 patients out of 200).

Two point five percentage of the patients (five) needed ≥2 attempts at intubation, while 4% of the cases (eight) needed gum elastic bougie and 15% (30) needed external laryngeal pressure to pass the endotracheal tube down the vocal cords [Table 2].

Among the individual predictors of our study, MMPG predicted difficult intubation correctly in 75.38% (PPV) of the cases with a sensitivity of 64.3%. MMPG predicted that in 68.87% (NPV) of the cases there would not be any difficult intubation, with a specificity of 79.0%.

In our study ULBT had sensitivity of 71.4%, predicting difficult intubation correctly in 55.1% (PPV) of the cases. It had a negative predictive value of 59.4% with a specificity of 41.9% [Table 3]. According to our study TMD and BMI had NPV of 49.4% and 46.4% respectively.

Among the different difficult airway parameter combinations we studied, MMPG with ULBT had a sensitivity of 64.3% and specificity of 84.9%. This combination had a positive predictive value of 80.9% and a negative predictive value of 70.4%. Combination of MMPG with TMD had a negative predictive value of 50% while TMD with ULBT had a negative predictive value of 49.5%. Other combinations like MMPG with TMD and ULBT, BMI with MMPG, BMI with TMD, BMI with ULBT, BMI with MMPG TMD and ULBT had negative predictive values of 50%, 49%, 50%, 47.7% and, 50% respectively.

Table 1: Demographic data

Total number of patients	200
Number of male patients	64 (32%)
Number of female patients	136 (68%)
Mean age (years)	35.36±11.69
Mean weight (kgs)	60.31±12.13
Mean height (cms)	157.23±10.10

Table 2: Incidence of difficult intubation in our study.

Difficult intubation (CLG 3or 4)	**7% (14 patients)**
≥ 2 attempts	2.5% (5 patients)
External laryngeal pressure	15%(30 patients)
GEB	4%(8 patients)
GEB+ External laryngeal pressure	2%(4 Patients)

CLG-Cormack Lehane Grade, GEB-Gum Elastic Bougie

4. Discussion

Direct laryngoscopic intubation is difficult in 1.5-13% of patients who have seemingly normal airway.[2] An updated report by American Society of Anaesthesiologists task force on management of difficult airway defines difficult tracheal intubation as tracheal intubation requiring multiple attempts, in the presence or absence of tracheal pathology.[6] Unanticipated difficult intubation is an emergency situation which most anaesthesiologists have to experience at some point in their career. Such a problem is better tackled in a controlled environment, with necessary extra help as in manpower and equipment. Planning in an anticipated difficult intubation varies from awake fibreoptic intubation to elective tracheostomy depending on the patient circumstances and availability of equipment. It is the unanticipated difficult intubation which is a major hazard both for the patient and the attending anaesthesiologist in terms of mortality, morbidity and medicolegal implications. The Cannot Intubate Cannot ventilate (CICV) situation, the worst case scenario to be avoided, occurs in fewer than one in 5000 routine general anaesthetics and requires an emergency surgical airway in approximately one in 50000 during elective surgeries, but accounts for upto 25% of anaesthesia related deaths.[7] The incidence of failed intubation is approximately one in 1000-2000 in elective setting.[7]

Anticipation of difficult airway allows planning of appropriate measures to be taken to intubate the patient safely. Careful assessment of the patient's airway, primary and alternative plans for airway management, proper judgement at critical times, good team work and the use of a range of techniques and devices all together can help with the situation.

Our endeavour is to find a simple combination of manoeuvres that would improve the specificity and sensitivity of anticipating difficulty in intubation, so that the anaesthesiologist is prepared and armed for that scenario thereby reducing the complications.

There is no single definition of difficult intubation.[8] In most of the studies a Cormack Lehane grade of 3 or greater was accepted as the standard definition, as a difficult glottic view on direct laryngoscopy is the most common cause of difficult intubation.[8,9] Similar to these studies, we have also considered difficult intubation as Cormack Lehane grades 3 or 4.

The incidence of difficult intubation in our study was 7% (14 out of 200 patients). Different studies on difficult intubation show an incidence between 2.6 to 15.4%.[5,9–12] This difference is due to different parameters considered in each of these studies as well as the different populations studied. We studied 3 parameters, Modified Mallampati Grade, Thyromental distance and Upper Lip Bite Test, which were easy, simple to perform, repeatable and their grading was objective with clear end points. Among these

Table 3: Sensitivity, specificity, positive predictive value, negative predictive value of difficult intubation predictors

	Sensitivity	Specificity	PPV	NPV
a)MMPG(3 or 4)	64.3%	79.0%	75.38%	68.87%
b)ULBT(2 or 3)	71.4%	41.9%	55.1%	59.4%
(a+b) MMPG+ULBT	64.3%	84.9%	80.9%	70.4%

MMPG- Modified Mallampati Grade, ULBT-Upper Lip Bite Test, PPV-Positive predictive Value, NPV-Negative Predictive Value.

Modified Mallampati Grade and Upper Lip Bite tested individually and as a combination were found to be better predictors of difficult intubation in our study.

A meta analysis of 55 studies involving 177088 patients found that only 35% of the patients with a difficult intubation were identified as Mallampati 3 or 4.[13] This meta analysis suggests that MMPG is inadequate as a stand alone test of difficult intubation. In our study 64% of the patients with difficult intubation had a MMPG of 3 or 4. The sensitivity, specificity, positive predictive value and negative predictive value of MMPG in predicting CLG 3 or 4 were 64.3%, 79.0%, 75.38%, 68.87% respectively. Though the statistical values of MMPG as a predictor for difficult intubation seemed significant, in our study, its combination with ULBT yielded better results regarding the sensitivity, specificity, positive predictive value and negative predictive value.

A systematic review found that in 11 of the 27 studies conducted on ULBT as a bedside test for prediction of difficult intubation, the sensitivity of ULBT was more than 70%. All the 27 studies except one showed a high specificity of ULBT (>85%). These studies indicated a high negative predictive value of ULBT. Accuracy of ULBT was >85% in 24 out of 27 studies.[14] Moreover, our study was comparable to the study by Khan et al where ULBT was a good predictor of difficult intubation (specificity 91.69%, accuracy 91.05%).[5] They concluded that the specificity and accuracy of ULBT is significantly higher than other tests and is more accurate in airway assessment.

Several studies have found TMD to be a poor predictor of difficult intubation as a single test.[15,16] In a meta analysis conducted by Shiga et al., the diagnostic value of thyromental distance proved unsatisfactory. The different sensitivity values obtained among the studies considered in this meta analysis was due to the different cut off points taken for TMD (4.0cm to 7.0cm). The likelihood ratios improved when $\leq$ 6cm was applied as a cut off for difficult intubation.[9] Our study reiterated the finding of previous studies that TMD < 6.5 is a poor index for anticipating difficult intubation.

BMI >30 kg/m2 is the World Health Organisation threshold for obesity.[17] Obese patients are thought to have an increased risk for difficult airway due to the fat deposition in their airways. We calculated BMI in our data to study its association with difficult intubation, but BMI >30kg/m2 alone and with other parameters as a combination could not predict a CLG $\geq$ 3.

A cohort study of 91,332 patients planned for direct laryngoscopy suggested that BMI of 35 may be a better clinical cut off than a BMI of 30. It was found that a BMI of 35 or more was a risk factor for difficult tracheal intubation and during our study duration there was no patient with a BMI of > 35.[18]

In our study airway predictor combinations like MMPG+TMD, TMD+ULBT, MMPG+TMD+ULBT, BMI+MMPG, BMI+TMD, BMI+ULBT, MMPG+TMD+ULBT+BMI were not sensitive and had negative predictive values of 50%, 49.5%, 50%, 49%, 50%, 47.7%, 50% respectively, making these combinations not useful(clinically).

The combination of MMPG+ULBT had sensitivity of 64.3%, specificity of 84.9%, positive predictive value of 80.9% and negative predictive value of 70.4% This combination is more sensitive and better than the other combinations that we have studied. Moreover, this combination showed improved statistical association with difficult intubation compared to that of MMPG or ULBT alone.

Wajekar et al. found the combination of MMG with TMD to be more diagnostic and the combination of MMG+ULBT+TMD having the highest predictability for difficult intubation.[19] The three column model, developed by Keith Greenland, using MRI scans, grouped the airway into posterior column (flexion at cervical spine and extension at occipito –atlanto- axial complex), middle column (lumen of the airway) and the anterior column (triangular shaped pyramid that contains the submandibular space, glossal muscles and laryngeal skeleton).[20]

The MMG, ULBT and TMD all assess the anterior column and CLG assesses the middle column, while the movement of flexion and extension of the head assess the posterior column. The patient factors such as the anthropomorphic features as well as the extrinsic factors, like the height of pillow, the type of laryngoscope blade and experience of the anaesthesiologist all are features that have to be considered in the diagnosis of difficult intubation could also be a reason for the wide variation in results of different studies.

It is simplistic to use a single test to assess the airway, and in the present scenario a combination of tests seems to be the way forward until, a newer method, which comprehensively covers the three columns of intubation path in a non-invasive method, is devised.

Therefore we recommend combinations of airway predictor specially MMPG+ULBT in place of single parameters for prediction of a difficult intubation. Literature also recommends the use of combination of different tests to increase their diagnostic value in comparison to the value of each test alone. [1,12,19]

5. Limitations of the Study

A larger sample size would have added power to our study and there were no patients with BMI >35. Nonetheless, the results of our study bear good statistical significance stating that MMPG and ULBT individually and as a combination are very good at predicting difficult intubation.

6. Conclusion

Despite a plethora of research for predicting difficult intubation, no single test has emerged to be highly sensitive or specific; while a combination of difficult airway parameters have better predictability. We conclude Modified Mallampati Grade and Upper Lip Bite test as a combination are better to predict difficult intubation in patients undergoing elective surgeries.

7. Source of Funding

None.

8. Conflict of Interest

None.

References

1. Tamire T, Demelash H, Admasu W. Predictive Values of Preoperative Tests for Difficult Laryngoscopy and Intubation in Adult Patients at Tikur Anbessa Specialized Hospital. *Anesthesiol Res Pract*. 2019;2019:1–13. doi:10.1155/2019/1790413.
2. Benumof JL. Definition and Incidence of Difficult Airway. In: Benumof JL, editor. Airway Management: Principles and Practice. St Louis; Mosby: Mosby; 1996. p. 121–5.
3. Vinayagam S, Dhanger S, Gupta SL, Bidkar PU, Elakkumanan LB, Badhe AS. Diagnostic accuracy of bedside tests for predicting difficult intubation in Indian population: An observational study. *Anesth: Essays Res*. 2016;10(1):54–8. doi:10.4103/0259-1162.165503.
4. Sunanda G, Rajesh S, Dimpel J. Airway assessment: predictors of difficult airway. *Indian J Anaesth*. 2005;49(4):257–62.
5. Khan ZH, Mohammadi M, Rasouli MR, Farrokhnia F, Khan RH. "e diagnostic value of the upper lip bite test combined with sterno mental distance, thyromental distance, and interincisor distance for prediction of easy laryngoscopy and intubation: a prospective study. *Anesth Analg*. 2009;109(3):822–4.
6. Apfelbaum JL, Hagberg CA, Caplan RA. Practice guidelines for management of the difficult airway: an updated report by the american society of anesthesiologists task force on management of the difficult airway. *Anesthesiol*. 2013;118(2):251–70.
7. Cook TM, MacDougall-Davis SR. Complications and failure of airway management. *Br J Anaesth*. 2012;109(S1):68–85.
8. Vasudevan A, Badhe A. Predictors of difficult intubation - a simple approach. *Internet J Anesthesiol*. 2008;20(2).
9. Shiga T, Wajima Z, Inoue T, Sakamoto A. Predicting Difficult Intubation in Apparently Normal Patients. *Anesthesiol*. 2005;103(2):429–37. doi:10.1097/00000542-200508000-00027.
10. Aftab S, Raja D, Rashdi S, Khalid A. Preoperative assessment of risk factors for difficult intubation. *Pak J Surg*. 2008;24:60–4.
11. Prakash S, Kumar A, Bhandari S, Mullick P, Gogia AR, Singh R. Difficult laryngoscopy and intubation in the Indian population: An assessment of anatomical and clinical risk factors. *Indian J Anaesth*. 2013;57(6):569–75. doi:10.4103/0019-5049.123329.
12. Harwani B, Pannirselvam S, Shanmugham PS, Thirumaaran UG. Airway assessment factors as a predictive marker of difficult direct laryngoscopy: A prospective study. *Int J Med Anesthesiol*. 2019;2(2):84–8. doi:10.33545/26643766.2019.v2.i2b.34.
13. Lundstrøm LH, Vester-Andersen M, Møller AM, Charuluxananan S, L'Hermite J, Wetterslev J. Poor prognostic value of the modified Mallampati score: a meta-analysis involving 177 088 patients. *Br J Anaesth*. 2011;107(5):659–67. doi:10.1093/bja/aer292.
14. Faramarzi E, Soleimanpour H, Khan ZH, Mahmoodpoor A, Sanaie S. Upper lip bite test for prediction of difficult airway: A systematic review. *Pak J Med Sci*. 2018;34(4):1019–23. doi:10.12669/pjms.344.15364.
15. Iohom G, Ronayne M, Cunningham AJ. Prediction of difficult tracheal intubation. *Eur J Anaesthesiol*. 2003;20(1):31–6. doi:10.1097/00003643-200301000-00006.
16. Merah NA, Wong DT, Ffoulkes-Crabbe DJ, Kushimo OT, Bode CO. Cardiothoracic anesthesia, respiration and airway modified mallampati test, thyromental distance and inter-incisor gap are the best predictors of difficult laryngoscopy in West Africans. *Can J Anesth*. 2005;52(3):291–6. doi:10.1007/bf03016066.
17. Saasouh W, Laffey K, Turan A, Avitsian R, Zura A, You J, et al. Ruetzler Degree of obesity is not associated with more than one intubation attempt: a large centre experience. *Br J Anaesth*. 2018;120(5):1110–6.
18. Lundstrøm LH, Møller AM, Rosenstock C, Astrup G, Wetterslev J. High body mass index is a weak predictor for difficult and failed tracheal intubation: a cohort study of 91,332 consecutive patients scheduled for direct laryngoscopy registered in the Danish Anesthesia Database. *Anesthesiol*. 2009;110:266–74.
19. Wajekar AS, Chellam S, Toal PV. Prediction of ease of laryngoscopy and intubation-role of upper lip bite test, modified mallampati classification, and thyromental distance in various combination. *J Fam Med Prim Care*. 2015;4(1):101. doi:10.4103/2249-4863.152264.
20. Greenland KB. Airway Assessment Based on a three Column Model of Direct Laryngoscopy. *Anaesth Intensive Care*. 2010;38(1):14–9. doi:10.1177/0310057x1003800104.

Author biography

Pavani Sudhamala, Senior Resident

S Kalyani Surya Dhanalakshmi, Associate Professor

Gopinath Ramachandran, HOD

Cite this article: Sudhamala P, Dhanalakshmi SKS, Ramachandran G. Anticipating difficult tracheal intubation by observing Modified Mallampati Grade, Thyromental Distance and Upper Lip Bite Test. A prospective observational study. *Indian J Clin Anaesth* 2020;7(4):589-593.