COMPARISON AND EVALUATION OF VARIOUS BEDSIDE TESTS TO PREDICT DIFFICULT ENDOTRACHEAL INTUBATION

Krishna Pratap Mall[1], Sujit Rai[1], Rashmi Sharma[3], Richa Gangwar[2]

Assistant Professor, Departments of Anesthesia[1] and Gynaecology[2], MRA Medical College, Ambedkarnagar, UP, India
Professor, Department of Anesthesia[3], Santosh Medical College, Ghaziabad, UP, India

ABSTRACT

Introduction: As difficult laryngoscopy is a multifactorial problem, therefore any preoperative assessment of difficult tracheal intubation should have high sensitivity and specificity and result in minimal false positive and false negative values. This study was conducted in an attempt to devise a method of predicting difficult intubation and to assess the reliability of six simple bedside tests to predict difficult intubation.

Material and Methods: This double blind prospective study involved 100 adult patients posted for elective surgery under general anesthesia. The airways were assessed for modified Mallampati test, Thyromental Distance, Sternomental Distance, Inter incisor gap; Atlanto-Occipital joint extension and Upper Lip bite Test. The laryngoscopic view and difficulty of intubation were noted. The sensitivity, specificity, positive and negative predictive values were calculated.

Results: No method either individual or in combination with others had 100% sensitivity. The Modified Mallampati test had 76% sensitivity. Upper Lip bite Test had 98.66% specificity. The combination of Modified Mallampati test and Inter incisor gap had 52% sensitivity and 86.66% specificity.

Conclusion: The "composite intubation difficulty score" is an easy and reliable method of predicting difficult intubation.

Key words: Mallampati test, Thyromental Distance, Sternomental Distance, Inter incisor gap, Atlanto-Occipital joint extension and Upper Lip bite Test

Corresponding author: Krishna Pratap Mall E-mail: dr_mall_79@yahoo.co.in

INTRODUCTION

It has been estimated that inability to successfully manage very difficult airways is responsible for 30% of deaths totally attributable to anaesthesia[1]. Unexpected difficult intubations are probably the result of a lack of accurate predictive tests for difficult intubation and inadequate preoperative assessment of the patient's airway[2]. There is a substantial body of literature about the difficulties which may be encountered and how to handle them[3]. Research aimed at predicting difficult end tracheal intubation is concerned with defining the underlying anatomical problems and at producing a simple bed side test that will reliably predict patients with difficult intubation[4]. The Pioneer work in the related research was carried out by White and Kander[5], repeated by Bellhouse andDore[6]. Many airway assessment schemes varying in complexity and clinical convenience are used [4]. The simple test most widely advocated is that devised by Mallampatti and colleagues[7], but is not very reliable. The thyro-mental and sterna-mental distances are potentially useful tests because of the ease to measure. As a single test however they are unreliable but may work, if combined with other tests[4]. Clearly no one test is ideal. As difficult laryngoscopy is a multifactorial problem, therefore any preoperative assessment of difficult tracheal intubation should have high sensitivity and specificity and result in minimal false positive and false negative values. This study was undertaken to devise a comprehensive, accurate, simple and clinically applicable method of predicting difficult intubation, to assess the reliability of six simple bedside tests to predict difficult intubation and to determine if a

combination of these tests could enhance the sensitivity and specificity in predicting difficult intubation.

MATERIAL AND METHODS

This one year prospective double blind study was conducted among 100 patients of either sex in age group of 16-60 years presenting for pre-anaesthetic check-up in department of anesthesiology and critical care, Santosh Medical College and hospital, Ghaziabad after taking permission from the ethical committee. All patients scheduled for elective surgery under general anesthesia requiring intubation were selected. Edentulous patients, patients with loose or missing incisors, pregnant, emergency /trauma patients, patients unable to sit up, patients with temporo-mandibular joint ankylosis, intraoral mass/ tumor, rheumatoid arthritis and those with any anatomical cause of difficult intubation were excluded. All patients were explained the procedure and an informed consent was obtained. The airway of these patients was assessed using the following tests:

1.Modified Mallampatti Test
Grade Structures Visible Points
I Soft palate, uvula, fauces & (1) tonsillar pillar
II Soft palate, uvula and fauces (2)
III Soft palate (3)
IV Hard palate (4)
Grade III or IV was considered to be a predictor of difficult intubation.

2.Atlanto-Occipital Joint Extension
Grade Measurement Points
I > 35 degrees 1
II > 22 & ≤ 35 degrees 2
III > 13 & ≤ 22 degrees 3
IV ≤ 13 degrees 4
Grade III or IV was considered to be a predictor of difficult intubation.

3.Thyromental Distance
Measurement Points
> 7 cm: 1
> 6 – 7 cm: 2
> 5 – 6 cm: 3
> 4 – 5 cm: 4
≤ 4 cm: 5
Thyromental distance of ≤ 7 cm was considered to be a predictor of difficult intubation.

4. Inter-Incisor Gap
Measurement Points
> 5 cm: 1

> 4 – 5 cm: 2
> 3 – 4 cm: 3
> 2 – 3 cm: 4
≤ 2 cm: 5
Inter incisor gap of ≤ 4 cm was considered to be a predictor of difficult Intubation.

5.Sternomental Distance
Measurement Points
> 12.5 cm: 1
> 11.5 – 12.5 cm: 2
> 10.5 – 11.5 cm: 3
≤ 10.5 cm: 4
Sternomental distance of ≤ 12.5 cm was considered to be a predictor of difficult Intubation.

6.Upper Lip Bite Test
ASSESSMENT POINTS
Lower incisor can bite upper lip above vermilion line.   1
Lower incisor can bite below the vermilion line   2
Cannot bite upper lip   3
The points allotted in each test were then added and each patient was given a
Composite Intubation Difficulty Score (CIDS) graded as: points
Probably easy intubation   6-12
Probably difficult but possible intubation 13-18
Impossible intubation   >18
The best view was obtained both with and without applying external laryngeal pressure and noted using classification of Cormack and Lehane as follows:
Grade 1: Vocal cords visible
Grade 2: Only posterior commisure or arytenoids visible
Grade 3: Only epiglottis visible
Grade 4: No glottic structure visible
Intubation was termed difficult if either laryngoscopic view was grade 3 or 4 and if gum elastic bougie was required for tracheal intubation after failing twice with direct placement.

Statistical Analysis: The association between different variables and difficulty in intubation was evaluated using the chi-square test for qualitative data and the Student's t test for quantitative data. P<0.05 was regarded as significant. The sensitivity, specificity, Positive and negative predictive values were calculated for each test according to standard formulae.

RESULTS

Hundred patients (45 males and 55 females) were included. Majority of patients (74%) had a probably easy intubation based on CIDS.

Table-1 Distribution of patients based on Intubation difficulty score

Total no. of patients	Composite Intubation difficulty score
74	6-12
25	13-18
1	>18
100	Total

Table 2: Distribution of Data (Mean ± SD) based on laryngoscopic assessment

VARIABLE	LARYNGOSCOPIC ASSESSMENT		p VALUE
	Easy (n=75)	Difficult (n=25)	
Age	33.84 ± 13.83	37.52 ± 17.04	0.14
Weight	56.13 ± 9.35	61.20 ± 11.22	0.014*
Height	157.84 ± 6.70	155.76± 5.39	0.34
Sex-M/F	34/41	11/14	0.90

*Statistically significant

The mean weight of patients in the easy intubation group was 56.13 ± 9.35 kg whereas it was 61.20 ± 11.22 kg in those with difficult laryngoscopy, the difference being statistically significant (P<0.05). (Table 2)

Table 3: Comparison of mean values of various predictive tests in each Laryngoscopic grade

Cormack Lehane Grade	Total cases	TMD Mean (cm)	AOE Mean (degree)	SMD Mean (cm)	IIG Mean (cm)	CIDS Mean (points)
I	51	8.47	32.70	15.42	4.35	10.11
II	24	8.06	30.87	14.56	4.11	10.62
III	21	7.83	30.67	16.30	3.90	12.23
V	4	5.75	17.50	12.37	3.42	16.5

On initial laryngoscopy 21 patients out of the total 100 patients had a grade III view and 4 patients had a grade IV view

Table 4: Comparative analysis of Sensitivity, Specificity, Positive predictive value and Negative predictive value of six tests

TEST	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	ACCURACY
MMT	76%	69.33%	45.23%	89.65%	71%
AOE	36%	85.33%	45%	80%	73%
TMD	52%	72%	38.23%	81.81%	67%
IIG	60%	50.66%	28.84%	79.16%	53%
SMD	36%	77.33%	34.61%	78.37%	67%
CIDS	52%	82.66%	50%	83.78%	76%
ULBT	12%	98.66%	75%	77.08%	77%

Amongst the individual tests, the Modified Mallampati test had the greatest ability to predict difficult intubation i.e. sensitivity of 76% followed by IIG with 60% sensitivity. For correct identification of easy intubation, ULBT was found to have the best specificity (98.66%), followed by

OE and CIDS (85.33% and 82.66% respectively).(Table 4)

Table 5: Sensitivity and Specificity for various Combinations of Two tests

Combination of 2 tests:	Sensitivity	Specificity	PPV	NPV
MMT+TMD	40%	90.66%	60%	76.84%
MMT+SMD	20%	90.66%	50%	77.17%
MMT+AOE	36%	94.66%	31.25%	76.19%
MMT+IIG	52%	86.66%	33%	75.25%
MMT+ULBT	16%	98.66%	53.33%	80%
TMD+SMD	24%	89.33%	60%	76.84%
TMD+IIG	24%	80%	75%	77.08%
TMD+AOE	28%	92%	58.82%	81.92%
TMD+ULBT	12%	97.33%	41.66%	77.27%
SMD+IIG	20%	85.33%	69.23%	81.60%
SMD+AOE	16%	94.66%	56.65%	84.41%
SMD+ULBT	4%	97.33%	80%	77.89%
IIG+AOE	32%	90.66%	42.85%	77.90%
IIG+ULBT	12%	97.33%	28.57%	75.94%
AOE+ULBT	12%	98.66%	53.84%	79.30%

All the combinations had excellent specificity but had a low sensitivity. Amongst them, the combination of Modified Mallampati test and IIG had the best balance of sensitivity (52%) and specificity (86.66%). (Table 5)

DISCUSSION

Difficulty in endotracheal intubation constitutes an essential predisposing factor of morbidity and mortality, especially when not anticipated preoperatively [8]. Risk factors, identified at the preoperative visit, alert the anesthesiologist to use an alternative method of securing the airway [9]. A test to predict difficult intubation should have high sensitivity and a high Predictive Positive Value, so that only a few patients with easy airways are subjected to the protocol for management of a difficult airway[2]. Decreasing false negativity is also important as the consequences may be deleterious [10].

The *Modified Mallampati Test* is one of the commonest clinical method used to predict difficult intubation. The Mallampati classification[7] had reported a sensitivity of 100% and a specificity of 80%, but was found to be only 42.44% sensitive in two larger prospective series with specificity and PPV of 84% and 4.4% respectively [11, 12]. This was probably due to the absence of a definite demarcation between class 2 & class 3 and between class 3 & class 4 group and effect of phonation on the oropharyngeal classification leading to higher inter observer variability [13, 14] and decreased reliability [15]. Other limitations include failure to consider neck mobility and the size of mandibular space. [16]. In this study the sensitivity of MMT was 76% which

was higher than that reported by Bhatt et al [17] (59%), Savva et al [18] (64%), Dhara et al [19] (56%), but comparable with Khan et al [20] (82.4%). The specificity (69.33%) of MMT is similar to that (66.8%) reported by Khan et al [20] and (61%) Leopald et al [21]. Higher specificity is reported by Oates et al [12] (84%) and Frerk et al [22] (84%).The variation in reported specificity and sensitivity may be due to incorrect evaluation because of inter observer variability [21]. MMT showed a high False Positive rate (30.66%) in this study, as also reported in prior studies [7, 10, 11, 23].

Another method for difficult airway prediction is measurement of the **Thyromental Distance.** Although many studies have questioned the value of this method because of its low sensitivity, specificity, and positive and negative predictive values [24-30], it remains widely used [30]. Patil et al [31] reported a TMD less than 6 cm was associated with difficult intubation. Mathew et al [32] observed a sensitivity, specificity and PPV of 100% using a TMD of <6 cm and Mandibular length of <9 cm. A TMD of ≤ 7 cm to predict difficult intubation was used in this study. In spite of the higher cut off value this study had a low sensitivity, specificity, PPV and accuracy (52%, 72%, 38.23% and 67% respectively). The test had a false positivity of 28%. Alireza et al [33] also reported similar sensitivity (55%), specificity (88%), PPV (22%), and NPV (97%), though they used a lower cut off of 4 cm.

Sterno mental distance has also been used as a predictor of difficult intubation. Savva et al [18] reported that the measurement of SMD was the best of the preoperative tests used. We considered the cut off between difficult and easy intubation as ≤ 12.5 cm. The sensitivity and specificity improved at higher levels of cut off, both being optimum at SMD of ≤ 17 cm. Our study also shows that SMD may not be an accurate sole predictor of difficult intubation though it can be incorporated into a series of quick and simple preoperative tests. This is because, SMD fails to take into account relative tongue and pharyngeal size, location of larynx, over riding maxilla, enlarged incisors, decreased TM joint mobility and a narrow high arched palate [19].

Atlanto occipital joint extension: Thirty five degrees of extension is usually possible at the normal AO joint [34]. This range of head and neck movements has been assessed differently in other studies. Few studies having taken neck movement from full extension > 90° and movement < 80° is associated with difficult intubation [2, 3, 10, 24]. Other studies have considered neck extension from neutral to full extension of head, the range being 35 degrees [6, 10, 16]. In our study, head extension was recorded from a neutral position and an AOE ≤ 22° was considered to be a predictor of difficult intubation. We had a higher sensitivity and PPV as compared to earlier studies [2,10]. This could be attributed to the difference in criteria used to define reduced neck extension.

Inter Incisor Gap as an indicator of limited mouth opening is used to predict difficult intubation. In our study, an IIG of ≤ 4 cm was used as the cut off point, having 60% sensitivity and 50.66% specificity. The accuracy at this cut off was 53%.The percentage of false negative cases was also low than other tests except MMT. At the cut off ≤ 5 cm the specificity would be remarkably lower (9.33%). Koay et al [35] found that 13.5% of difficult intubation cases were due to limited mouth opening which was defined as IIG ≤ 5 cm. Savva et al [18] reported no correlation between IIG and laryngoscopic view.

The **Upper Lip Bite Test** assessed a combination of jaw subluxation and the presence of buck teeth simultaneously, obviously enhancing its predictive value and reliability [20]. In this study the sensitivity, specificity, positive and negative predictive values and accuracy of the ULBT were 12%, 98.66%, 75%, 77.08% and 77% respectively and are comparable with the results of Chodheri et al [36]. From the observations by Khan et al[20] and Hester et al[37], ULBT was found superior to the MMT for difficult airway prediction. Linde et al [38] concluded that no single anatomical factor determines the ease of direct laryngoscopy but rather a combination of them. In our study, a CIDS was formulated by assigning points to each discriminate value of the six tests being evaluated individually. This cut off had a sensitivity of 52%, FP of 16%, specificity of 84% and NPV of 84%. A cut off score of 10 was observed to have a higher sensitivity (80%) and a lower specificity (62.66%). This is comparable to the studies of Wilson et al [3] (75% sensitivity and 88% specificity) and El Ganzouri et al [24] (65% sensitivity and 94% specificity) that have used different predictive clinical multivariate indices.

CONCLUSION

The composite intubation difficulty score used in this study is an easy and reliable method of predicting difficult intubation as it involves assessment of most of the common variables and has an optimal balance of sensitivity and specificity with a high PPV and low FP.

REFERENCES

1. Benumof JL. Management of the difficult adult airway. Anaesthesiology 1991; 75: 1087-1110.
2. Tse JC, Rimm EB, Hussain A. Predicting difficult endotracheal intubation in surgical patients scheduled for general anesthesia; a prospective blind study. Anesth Analg 1995; 81(2); 254-8.
3. Wilson ME, Spiegelhalter D, Robertson JA, Lesser P. Predicting difficult intubation. Br J Anaesth 1988; 61(2): 211-6.
4. Wilson ME. Predicting difficult intubation. Br J Anaesth 1993; 71(3): 333-4.
5. White A, Kander PL. Anatomical factors in difficult direct laryngoscopy. Br J Anaesth 1975; 47: 468-73.
6. Bellhouse CP, Dore C. Criteria for estimating likelihood of difficulty of endotracheal intubation with the Macintosh laryngoscope. Anaesth Intensive Care 1988; 16(3): 329-37.
7. Mallampati SR, Gatt SP, Gugino LD, Desai SP, Waraksa B, Freiberger D, Liu PL. A Clinical sign to predict difficult tracheal intubation: a prospective study. Can Anaesth Soc J 1985; 32(4): 429-34.
8. Suyama H, Tsuno S, Takeyoshi S. [The clinical usefulness of predicting difficult endotracheal intubation]. Masui 1999; 48(1): 37-41.
9. Rocke DA, Murray WB, Row CC. Relative risk analysis of factors associated with difficult intubation in obstetric anaesthesia. Anesthesiology 1992; 77; 67-73.
10. Nath G, Sekar M. Predicting difficult intubation- a comprehensive scoring system. Anaesth Intensive Care 1997; 25(5):482-6.
11. Voyagis GS, Kyriakis KP, Roussaki-Danou K, Bastounis EA. Evaluating the difficult airway. An epidemiological study. Minerva Anesthesiol 1995; 61(12): 483-9.
12. Oates JD, Macleod AD, Oates PD, Pearsall FJ, Howie JC, Murray GD. Comparison of two methods for predicting difficult intubation. Br J Anaesth 1991; 66(3):305-9.
13. Horon WA, Fahy L, Charters P: Disposition of cervical vertebrae atlanto axial joint, hyoid and mandible during X ray laryngoscopy. British Journal of Anaesthesia 1989: 63:435-38.
14. Leopald HJ, Eberhart. Christian Arndt : the reliability and validity of the upper lip bit test compared with the Mallampati Classification to predict difficult laryngoscopy: An external prospective Evaluation. Anaesth Analg 2005: 101: 284-9.
15. Krobbuaban B, Diregpoke S, Kurnkeaw S. An assessment of the ratio of height to Thyromental distance as a predictive test for prediction of difficult tracheal intubation in Thai patients. J Med Assoc Thai 2006; 89:638-42.
16. Faecon EL, Kim MH, Marx GF. Changing Mallampati score during labor. Can J Anaesth 1994; 41: 50.
17. Bhatt R R, S K Mishra, A Badhe: Comparison of Upper lip bite Test and Modified Mallampati Classification in Predicting Difficult Intubation. The Internet Journal of Anaesthesiology 20079 (13): 345-51
18. Savva D. Prediction of difficult tracheal intubation. Br J Anaesth 1994; 73: 149-153.
19. Butler PJ, Dhara SS. Prediction of difficult laryngoscopy: an assessment of the Thyromental distance and Mallampati predictive tests. Anaesth intensive care 1992; 20(2): 139-42.
20. Khan ZH, Kashfi A, Ebrahimkhani E. A comparison of the upper lip bite test (a simple new technique) with Modified Mallampati classification in predicting difficulty in endotracheal intubation: a prospective blinded study. Anesth Analg 2003; 96: 595-9.
21. Leopald HJ, Eberhart. Christian Arndt: the reliability and validity of the upper lip bit test compared with the Mallampati Classification to predict difficult laryngoscopy: An external prospective Evaluation. Anaesth Analg 2005: 101: 284-9.
22. Frerk CM. Predicting difficult intubation. Anaesthesia 1991; 46(12):1005-8.
23. Caplan RA, Benumof JL, Berry FA et al. Practice guidelines for management of the difficult airway. A report by the American society of Anesthesiologists task force on management of the difficult airway: Anesthesiology 1993; 78: 597-602.
24. El-Ganzouri AR, Mc Carthy RJ, Tuman KJ, Tanck EN, Ivankovich AD. Preoperative airway assessment: predictive value of a multivariate risk index. Anesth Analg 1996; 82(6): 1197-204.
25. Brechner VL. Unusual problems in management of airways: Flexion extension mobility of cervical spine. Anesth Analg 1968; 47: 362-73.
26. Merah NA, Wong DT, Ffoulkes-Crabbe DJ, Kushimo OT, Bode CO. Modified Mallampati test, Thyromental distance and inter incisor gap are the best predictors of difficult laryngoscopy in West Africans. Can J Anaesth 2005; 52: 291-6.
27. Krobbuaban B, Diregpoke S, Kumkeaw S, Tanomsat M. The predictive value of the height ratio and Thyromental distance : four predictive tests for difficult laryngoscopy. Anaesth Analg 2005; 101: 1542-5.

28.Iohom G, Ronayne M, Cunningham AJ. Prediction of difficult tracheal intubation. Eur J Anaesthesiol 2003; 20:31-6.

29.Chou HC, Wu TL. Thyromental distance and Anterior larynx: misconception and misnomer? Anesth Analg 2003; 96: 1526-7.

30.Brodsky JB, Lemmens HJ, Brock Utne JG, Vierra M, Saidman LJ. Morbid obesity and tracheal intubation: Anaesth Analg 2002; 94:732-6.

31.Patil UV, Sterling LC, Zander HL. Fibreoptic endoscopy in anesthesia. Chicago: Year book Medical publishers, 1983: 79.

32.Matthew M, Hanna LS, Aldrete JA. Preoperative Indices to anticiopate difficult tracheal intubation. Anesth Analg 1989; 68: S187

33.Alireza S, Behrooz F, Ali R, Ali Asghar K. Comparison of upper lip bite test with measurement of thyromental distance for prediction of difficult intubations. Acta Anaesthesiol Taiwan 2008; 46 (2): 61-65.

34.Vander Linde JC, Roclofse JA, Steinkamp EC. Anatomic factors relating to difficult difficult intubation. S Afr Med J `1983; 63: 976-77.

35.Koay CK. Difficult tracheal intubation - analysis and management in 37 cases. Singapore Medical J 2009; 3903: a5.

36.Chohedri AH, Allahyari E, Tabari M. The upper lip bite test; prediction of difficult endotracheal intubation. Professional Med J 2005; 12(4): 440-45.

37.Hester CE, Dietrich SA, White SW. A comparison of preoperative airway assessment techniques: the Modified Mallampati and the upper lip bite test. AANA J 2007; 75: 177-82.

38.Vander Linde JC, Roclofse JA, Steinkamp EC. Anatomic factors relating to difficult difficult intubation. S Afr Med J `1983; 63: 976-77.