



Original Article

## COMPARISON OF PREDICTORS OF DIFFICULT INTUBATION

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### ARTICLE INFO

Received: 12<sup>th</sup> June 2015,

Accepted: 09<sup>th</sup> Aug 2015.

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### ABSTRACT

**Context:** Unanticipated difficult laryngoscopy and tracheal intubation always remain a primary concern for an anaesthesiologist as the failure to maintain a patent airway during induction of anaesthesia may lead to anaesthesia related morbidity and mortality. **Aims:** The aim of our study was to predict difficult intubation and to identify best predictor(s) among them and also to compare the sensitivity, specificity, positive predictive value, negative predictive value and accuracy of various airway parameters. Airway parameters taken in our study were Modified Mallampati Classification (MMT), Thyromental Distance (TMD), Sternomental Distance (SMD), Interincisor Gap (IIG), Upper Lip Bite Test (ULBT), Degree of Neck Extension (DNE), Anterior Subluxation of Mandible (ASM) and Protruding Teeth (PT). **Methods and Material:** 350 patients of ASA Grade 1 and 2 scheduled for various elective surgeries under general anaesthesia were included in our study and were assessed preoperatively for different airway parameters. Intraoperatively all patients were classified as difficult and easy intubation group according to Cormack and Lehane laryngoscopic view. Clinical data of each test was collected, tabulated and analyzed to obtain the sensitivity, specificity, positive predictive value and negative predictive value. **Results:** The upper lip bite test had the highest sensitivity (80%); Anterior subluxation of mandible had highest specificity (99.06%) and both of above were most accurate tests. The overall incidence of difficult intubation was 8.57%.

**Conclusion:** Upper lip bite test was the best predictor of difficult intubation and it should be included as a routine test along with Modified mallampati test in preanaesthetic evaluation.

### KEYWORDS

Difficult intubation, Upper lip bite test, anterior subluxation of mandible.

## INTRODUCTION

Difficult tracheal intubation is a major concern for an anaesthesiologist and contributes to perioperative morbidity and mortality<sup>[1]</sup>. The reported incidence of difficult laryngoscopy or endotracheal intubation varies from 1.5% to 13% in patients undergoing surgery<sup>[2]</sup>. So the ability to identify the patients at risk of difficult intubation using different airway parameters is important for an anaesthesiologist.

Anaesthesia in a patient with a difficult airway can lead to both direct airway trauma and morbidity from hypoxia and hypercarbia. Direct airway trauma occurs during the management of difficult airway while excessive physical force is applied to the patient's airway more than the usual force. However, morbidity is attributed because of normal interruption of gaseous exchange due to airway trauma even for a brief period of time leading to hypoxic injury and hypercarbia which may cause brain damage, adverse cardiovascular events with other life threatening complications<sup>[3]</sup>. So maintaining a patent airway is essential for adequate oxygenation and ventilation and failure to

achieve it, even for a brief period of time, can be detrimental for the patient.

Difficulty in intubation is usually associated with difficulty in viewing glottis by direct laryngoscopy which is defined by Cormack and Lehane<sup>[4]</sup> and widely used to identify difficulty in endotracheal intubation. The prediction of ease or difficulty in laryngoscopy and intubation is assessed by different airway parameters and many studies have been done to identify the best predictor among them<sup>[5]</sup>.

So the most common parameters employed for prediction are Mallampati criteria<sup>[6]</sup> later on modified by Samsoon and Young<sup>[7]</sup>, thyromental distance<sup>[8]</sup>, sternomental distance<sup>[9]</sup>, receding mandible, buck teeth, obesity, degree of Neck extension, upper lip bite test<sup>[10]</sup>, interincisor gap, grading of prognathism and mandibular ramus length etc. Recognition of difficult airway before anaesthesia allows time for optimal preparation, proper selection of equipments and technique

with participation of person experienced in difficult airway management.

**MATERIAL AND METHODS**

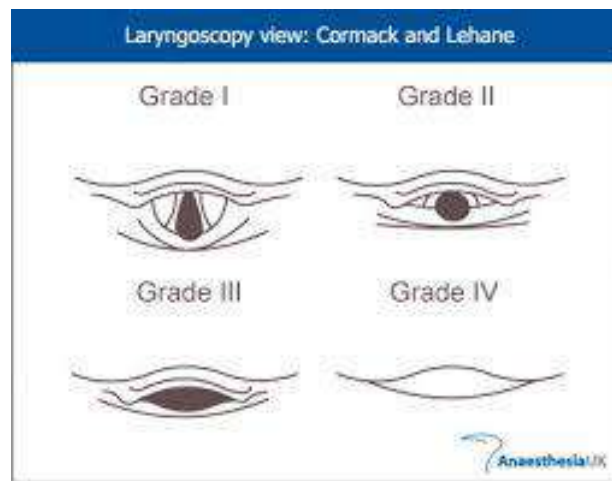
This prospective study was conducted in a tertiary care centre in Rajasthan, India, after obtaining approval from the ethical committee. Informed consent was obtained from 350 patients between the age group 18-65 years of either sex of ASA grade I & II, scheduled to receive general anaesthesia requiring tracheal intubation for various elective surgeries. Uncooperative patient, obstetric patients, patients with gross abnormalities of airway and cervical spine instability were excluded from the study (Table 1).

**Table 1. Methods of assessment of different airway parameters.**

AIRWAY PARAMETERS	METHOD OF ASSESSMENT
Modified-Mallampati classification	Class I: Faucial pillars, soft palate and uvula visible. Class II: Soft palate and base of uvula seen Class III: Only soft palate visible. Class IV: Soft palate not seen.
Thyromental distance	Straight distance from the notch of thyroid cartilage to the lower border of mentum with patient sitting, head fully extended and mouth being closed (cms).
Sternomental distance	Straight distance between the tip of sternal notch and tip of mentum with patient sitting, head in full extension and mouth being closed (cms).
Inter incisor gap	Straight Distance between the incisors with mouth fully open (cm) with patient in sitting position with mouth fully open.
Upper lip bite test	Class 1-lower incisors can bite the upper lip above the vermilion line. Class 2-lower incisors can bite the upper lip below the vermilion line. Class 3-lower incisors cannot bite the upper lip.
Degree of neck extension	Patient in sitting position, facing forward, The Axis of goniometer was placed at the ear lobe. Stationary limb and moving limb of goniometer were placed perpendicular to floor and base of nares respectively. Patient was asked to actively extend the neck with mouth being closed. The angle traversed by base of nares was measured with the help of a goniometer.
Anterior subluxation of mandible	Class I: Lower incisors lie anterior to upper incisors. Class II: Lower incisors in line with upper incisors. Class III: Lower incisors lie posterior to upper incisors.
Protruding teeth	None : normal teeth; 1: mild; 2: moderate; 3 : severe

In the operating room, standard monitoring was established (pulse oximetry, non-invasive blood pressure, electrocardiogram, capnography). A difficult airway cart was

kept at hand. The anaesthetist chooses an anaesthetic induction technique according to the pre-operative assessment; his/her own belief and any concomitant medical problems. Inj. succinylcholine 2 mg/kg was used to facilitate tracheal intubation, unless contraindicated. In that case inj. rocuronium 0.8 mg/kg was used. Then direct laryngoscopy was performed by an experienced anaesthetist of at least one year experience who was blinded to pre-operative assessment of patient. The patient's head was placed in sniffing position and laryngoscopy was performed using a Macintosh blade of appropriate size and glottic view was noted as per Cormack & Lehane's classification without applying external laryngeal pressure (Figure 1).



**Figure.1 Cormack and Lehane's classification of glottis exposure on direct laryngoscopy.**

**CORMACK- LEHANE'S CLASSIFICATION**

- GRADE 1:** Most of the glottis visible
- GRADE 2:** Only the posterior commissures, arytenoids of the glottis and the epiglottis visible
- GRADE 3:** No part of the glottis visible, only the epiglottis seen
- GRADE 4:** Not even the epiglottis seen.

Trachea was intubated with appropriate sized, cuffed endotracheal tube. The position of tube was confirmed by bilateral equal air entry. Patients in Cormack-Lehane grade I and II were considered in easy intubation group and grade III and IV were considered in difficult intubation group. Adjuvant manoeuvres such as BURP (Backward Upward Rightward Pressure); stylet were used to facilitate intubation, if required. Hemodynamic variables-pulse rate, blood pressure and SpO<sub>2</sub> were recorded before and after intubation. Any problem encountered during intubation such as failed intubation, dental injury, bradycardia or desaturation was recorded, if present. Any special instruments such as video laryngoscope, laryngeal mask airway or stylet, gum elastic bougie were also recorded, when used to facilitate difficult intubation.

The study was conducted in a blind fashion, as the pre-operative airway assessment of all patients was done by the person involved in the study so that there is no inter-observer variability. The laryngoscopy was performed by an experienced anaesthetist of more than 1 year experience in

anaesthesia who was unaware about the pre-operative assessment findings.

**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 (paired and unpaired) for quantitative data, p<0.05 was considered as significant. Sensitivity, Specificity, positive and negative predictive value and accuracy for each airway predictor were calculated according to standard formula. Data were entered and analysed with the help of Microsoft Excel.

**RESULTS**

350 patients for elective surgery under general anaesthesia were taken in our study. Out of 350 patients, 306 patients were in ASA grade 1(87.42%) and 44 in ASA grade 2 (12.57%).

We had 30 patients out of 350, who had CL grade 3 and 4, so the incidence of difficult intubation in our study is 8.57% (Table 4).

Table 2 shows the predictive analysis of frequency of different airway parameters.

**Table 2. Predictive analysis of frequency of different airway parameters.**

AIRWAY PARAMETERS	GROUP	FREQUENCY
Modified mallampatti test	Class I & II	85.14%
	Class III & IV	14.86%
Thyromental distance	TMD ≤ 6.5 cm	10.86%
	TMD > 6.5 cm	89.14%
Sternomental distance	SMD < 13.5 cm	6.28%
	SMD > 13.5 cm	93.78%
Inter-incisor gap	IIG < 4 cm	3.43%
	IIG > 4 cm	96.57%
Upper lip bite test	ULBT Class III	10.29%
	ULBT Class I & II	89.71%
Degree of neck extension	DNE < 20°	4%
	DNE > 20°	96%
Anterior subluxation of mandible	ASM Class II & III	5.14%
	ASM Class I	94.86%

**Table 3. Sensitivity, specificity, positive predictive value, negative predictive value and accuracy of different airway parameters.**

Name of the test	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value	Accuracy
Modified Mallampati test	60%	89.38%	34.61%	95.97%	86.86%
Thyromental Distance	20%	90%	18.75%	92.30%	84%
Sternomental Distance	20%	95%	27.27%	92.68%	88.57%
Inter-Incisor Gap	20%	95%	50%	92.89%	91.42%
Upper Lip Bite test	80%	96.25%	66.66%	98.08%	94.85%
Degree of Neck extension	16.67%	97.19%	35.71%	92.56%	90.29%
Anterior Subluxation of Mandible	50%	99.06%	83.33%	95.48%	94.86%
Protruding teeth	20%	91.6%	11.76%	91.97%	80.29%

Sensitivity, specificity, positive predictive value, negative predictive value and accuracy of individual variables are depicted in Table 3. The MMT had a sensitivity of 60% but low positive predictive value (34.61%). However it had high negative predictive value (95.97%) ruled out chances of most unanticipated difficult intubation. TMD, SMD and IIG all 3 tests had a sensitivity of 20% with TMD had very low positive predictive value (18.75%) as compared to SMD (27.27%) and IIG (50%). IIG and SMD also had high specificity (95%). The DNE and PT had very low sensitivity, 16.67% and 20% respectively but had high specificity of 97.19% and 91.6% respectively. However both of above tests had low positive predictive values, 35.71% and 11.76% respectively. TMD (92.30%), SMD (92.68%), IIG (92.89%), DNE (92.56%) and PT (91.97%) all had low negative predictive values as compared to ULBT (98.08%) and ASM (95.48%). ULBT had a positive predictive value of 66.66% and ASM had a sensitivity of 50%.

**Table 4. Distribution of Cormack and Lehane’s laryngoscopic grading.**

GROUP	GRADES	NO. OF PATIENTS	TOTAL (%)
EASY INTUBATION	GRADE 1	203	320(91.4%)
	GRADE 2	117	
DIFFICULT INTUBATION	GRADE 3	30	30(8.57%)
	GRADE 4	0	

In our study Upper lip bite test (ULBT) had highest sensitivity (80%) and negative predictive value (98.08%) and anterior subluxation of mandible (ASM) had highest specificity (99.06%) and positive predictive value (83.33%). Upper lip bite test (94.85%) and anterior subluxation of mandible (94.86%) showed highest accuracy (Table 3).

**DISCUSSION**

The Maintenance of a patent airway is the prime responsibility of an anaesthesiologist. Failure to maintain adequate gas exchange, even for a few minutes, leading to hypoxia can result in catastrophic outcomes such as brain damage and death.<sup>[12]</sup>

The difficulty in achieving a patent airway varies with anatomic and other individual patient factors. The identification of the patient with difficult airway is vital in planning the anaesthetic management so that endotracheal intubation and ventilation can be done safely. Accurate preoperative prediction of potentially difficult intubation can help in reducing the incidence of catastrophic complications by alerting the anaesthesia personnel to take additional precautions.<sup>[22]</sup>

A good predictive test should have high sensitivity, specificity, positive and negative predictive values. Also it should be simple enough to allow routine clinical use during preoperative evaluation and versatile so as to be applicable to different ethnic groups, gender and age. However high sensitivity is desirable as it will identify most patients in whom intubation will truly be difficult.

Our study had 350 patients of either sex posted for elective surgeries under general anaesthesia. It demonstrates that difficult intubation was associated with male and older age but no association was found with weight. An association between difficult laryngoscopy and older<sup>[9,11,12,13]</sup> and heavier patients has been reported.<sup>[9]</sup> Osteoarthritic changes and poor dentition may be responsible for the age-related increase in difficult laryngoscopy.<sup>[14]</sup> A significant proportion of difficult tracheal intubations has been found in males<sup>[14]</sup>, attributed to differences in neck fat deposition between the sexes<sup>[15]</sup>. Obesity has been found to be a risk factor for difficult intubation<sup>[12,14]</sup> while other investigators<sup>[16,17,18,19]</sup> found no such association, similar to our study. Though patients in difficult intubation group were heavier than those in the easy intubation group, but we did not find weight to be a significant risk factor for difficult laryngoscopy, which could be due to lower mean weight in study population.

We defined difficult intubation as Cormack and Lehane laryngoscopic grade III and IV. The incidence of difficult intubation in our study was 8.57%. We had no failed intubation. Among the studies in the Indian population, Krishna *et al.*<sup>[20]</sup> reported an incidence of 8.5%, which was very similar to our study. However, they graded Cormack scores as the best view obtained with optimal laryngeal manipulation.

Modified Mallampati classification is one of the commonest methods used to predict difficult airway. This classification depends upon relative size of tongue in relation to the oral cavity. The most important factor which has an influence on the Mallampati classification is inter-observer variability, phonation and pregnancy. In our data, Modified Mallampati test had a sensitivity of 60%, where as it was 77.3% and 85.7% in a study by Arun K. Gupta *et al.*<sup>[16]</sup> and Udit Nathani *et al.*<sup>[19]</sup> respectively. The most important problem with Modified Mallampati's test is its high false positive rate (i.e. low positive predictive value 34.61%). Hence, it makes the anaesthesiologist over cautious. Almost 65% of times anaesthetists are unnecessarily prepared to face a difficult intubation. But the advantage of the test is its low false negative rate (i.e. a high negative predictive value – 95.97%) which rules out the chances of most of unanticipated difficult intubation. It identifies easy intubation more easily rather than difficult intubation.

Upper lip bite test, a popular test proposed by Zahid Khan *et al.* in 2003 tests the ability of a patient to protrude his jaw and then bite his upper lip. Basically this test assesses the TMJ function or more precisely anterior subluxation of mandible and protruding teeth. As we had both factors in our study, it is the anterior subluxation of mandible that is more important than protruding teeth. We considered Upper lip bite test grade 3 (i.e. inability to bite upper lip with lower set of teeth) as predictor of difficult intubation. Our study had a high sensitivity and specificity of 80% and 96.25% respectively. We had similar results as Khan *et al.*<sup>[10]</sup> and Udit Nathani *et al.*<sup>[19]</sup>.

Anterior subluxation of mandible was another important factor which indicates the range of jaw movement. This test had highest specificity and positive predictive value of 99.06% and 83.33% respectively and had a low sensitivity of 50%.

Accuracy of ASM test as well as upper lip bite test was similar i.e. 94.86%. A recent study by Haq *et al.*<sup>[21]</sup> had a sensitivity, NPV and accuracy of 95.9%. 98.7% and 90.1% respectively.

The Limitations in our study were that we examined airway predictor test as single test. Using them in combination would have been more informative. If the study would have been conducted in a specialised population group like in obstetric patients, obese patients, geriatric patients or sex-specific group, the effect of these factors on the study could have been statistically significant. The result of our study may be different in different ethnic population. We considered body weight rather than body mass index which is a better predictor of difficult airway.

## CONCLUSION

This prospective study tests the efficacy of various parameters of airway assessment as predictors of difficult intubation and we found that difficult intubation was more common in older patients and males. The incidence of difficult intubation was 8.57%. Upper lip bite test was the best predictor of difficult intubation. Upper lip bite test is a very good screening test (sensitivity 80%), hence it should be included as a routine PAC test along with Modified Mallampati test. Anterior subluxation of mandible was a highly specific test (specificity 99.06%) and had sensitivity of 50%. It identifies most of the easy intubations. Upper lip bite test and anterior subluxation of mandible were the most accurate tests with highest accuracy among others (94.86%).

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