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Assessment of the airway by measuring some of the anatomical features to predict difficult direct laryngoscopy and intubation in adult male patients- A prospective study

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Introduction

The importance of the airway is emphasised and every anaesthesio logist has felt the cold panic when he or she first realizes that usual anatomic structures cannot be visualised. Airway management, including the aptitude to intubate, is a basic skill essential in the collection of any doctor. While any part of the respiratory tract is considered to be part of the airway, the difficult airway is focused on the upper airway, the portion of the respiratory tract that extends from the nares or mouth to the larynx. 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 and some are difficult to manage in both the aspects. Identification of a possible difficult airway can roll into motion a series of communications regarding pre parations that can help assist the establishment and maintenance of airway, as failure to do so can be life threatening. Direct laryngoscopy and tracheal intubation remains the method of choice for securing airway in most cases of general anaesthesia. The incidence of difficult laryngoscopy and tracheal intubation in various studies ranges from 0.1%- 13% in general anaesthesia and intubation failure occurred in 0.05%- 0.35% of cases. Difficult tracheal intubation has been variously defined as a procedure requiring excessive time, multiple attempted passages of the tracheal tube, or having to resort to specialised equipment. Respiratory events are the common cause for anaesthesia related morbidity, out

of which 85% are related to mistakes related to airway management resulting in permanent cerebral damage due to hypoxia and 30% of anaesthesia related deaths. Before patients undergo surgery with general anaesthesia, it is common practice to screen for a difficult airway including taking a medical history and identifying overt flags for the difficult airway, such as malformations or deformations. For the remaining apparently normal patients, there is still a risk of unanticipated difficult airway. As there is no single airway assessment test established, which can alone predict difficult laryngo scopy and intubation, in our study we compare various anatomical features that operate as predictors of difficult laryngoscopy and intubation in an attempt to find the best possible difficult airway predictor. There are many tests to predict difficult laryngoscopy and intubation. Our aim is to compare the ability of these tests to predict the visualisation of larynx and to predict difficult airway preoperatively. We undertook this study to compare the sensitivity, specificity, positive predictive value, negative predictive value and accuracy of these tests as methods of airway assessment for difficult laryngoscopy and intubations.

Aims and objectives

To study the sensitivity, specificity, positive predictive value, negative predictive value and accuracy of the following airway assessment tests to predict difficult airway.

1. Modified Mallampati test
2. Thyromental distance
3. Inter incisor gap
4. Upper lip bite test
5. Mandibulo-hyoid distance
6. Sterno-mental distance
7. Atlanto-occipital movement

Materials and methods

After obtaining institutional ethical committee approval and written consent, two hundred and fifty patients coming for different operative procedure are selected.

Study design

• Study type: observational, prospective study.

• Study duration: January 2020 to November 2021

• Study site: Civil hospital, Ahmedabad.

Subject selection

Inclusion criteria

• ASA Physical status I-III

• Patients posted for elective surgeries schedule to receive general anaesthesia (Orthopaedic, ENT and Ophthalmologic, abdominal, urologic and gynecological procedures.)

• Age between 18-55 years.

• BMI - 19.5-24.5

• Sex - male patients.

Exclusion criteria

• ASA status IV-V.

• Uncooperative and unwilling patients, not following verbal command.

• History of burns, trauma or surgeries to airway.

• Tumours or mass in the neck or the airway.

• Patients with restricted mobility at neck and mandible.

• Patients with inability to sit, edentulous or need awake intubation. Multiple screening tests will be done in pre-operative examination room. They are Modified Mallampati test, Thyromental distance, upper lip bite test, inter- incisor gap, Mandibulo - hyoid distance, sterno-mental distance, Atlantooccipital joint movement.

Modified Mallampati Test

- Class I: Visualization of the soft palate, hard palate uvula, anterior and the posterior pillars.
- Class II: Visualization of the soft palate, hard palate and uvula.

- Class III: Visualization of soft palate and hard palate and base of uvula.
- Class IV: Only hard palate is visible

Thyromental distance (Patil's test).

The distance between tip of the thyroid cartilage to the tip of the inside of

mentum is measured in neck fully extended position

- Class I: >6.5cm
- Class II: 6-6.5cms
- Class III:<6cms

Upper lip bite test

- Class I: If the lower incisors could bite the upper lip above the vermilion line.
- Class II: If the lower incisors could bite the upper lip below the vermilion line.
- Class III: If the lower incisors could not bite the upper lip.

Inter incisor gap (IID)

- Grade I -4 cm Grade II <4 cm

Mandibulo- hyoid distance

- Grade I: >6.0cm
- Grade II: 4.0cm to 6.0cm
- Grade III: <4.0cm

Sterno-mental distance

It was measured with the head fully extended on the neck with the mouth closed.

- Grade I: 12 or >12cm
- Grade II: <12cm

Atlanto-occipital joint movement

Measurement by simple visual estimate

- Grade I: >35 degree
- Grade II: 22-34 degree
- Grade III: 12-21 degree
- Grade IV: <12 degree

External laryngeal manipulation

laryngoscopist manipulates the thyroid cartilage with pressure directed posteriorly and cephalic until optimal visualisation is achieved, an assistant maintains laryngeal pressure while the intubator passes the tube into the trachea.

Use of stylet/ Bougie/ SGA

in case of failure to adequately visualise the larynx despite external manipulation of larynx, the operator will use a removable, malleable stylet, or an endotracheal tube over the bougie, or aSGA. If this fails, fiberoptic intubation was done. Difficult visualisation is classified based on Cormack and Lehane Laryngoscopic grades. Difficult intubation is described as grade 3 and grade

4 & easy visualisation is described as class 1 & 2 classification.

A difficulty scoring system was also devised to include the no of attempts, experience of the performer, use of additional manoeuvres and instruments to facilitate intubation and finally the Cormack Lehane grading as described by the person performing intubation.

- no. of attempts
- Senior vs junior anaesthetist:
- intubation by junior -1
- Intubation by senior -2
- use of additional manoeuvres and equipment: ELM-0, Stylet- 1, Bougie -2, FOI-3
- Cormack Lehane grade: 1 2 3 4 according to grade.

The score was calculated for each patient and they were classified into four categories based on the cumulative score.

- Grade I: Easy intubation: 3-4
- Grade II: Moderate difficulty: 5-6
- Grade III: Difficult intubation: 7-8
- Grade IV: Very difficult intubation: 9-11

Using this clinical data; sensitivity, specificity, positive predictive value and negative predictive value of each test are calculated. Patient's data and value of the airway predictors will be compared using appropriate test and 'p' value of 0.05 will be taken as significant.

Continuous variables will be expressed as mean standard deviation.

Appropriate statistical tests applied accordingly. Logistic regression done for multivariate analysis.

Observations and results

Table 1: Demographic data

	Mean +_ SD
Age (years)	36.91+_ 10.95
Height(cm)	159.83+_ 9.67
weight(kgs)	52.5+_7.65
BMI (kg/m2)	21.11+_1.54

There are no correlation between demographic data (age, weight, height and BMI) and incidence of difficult intubation in present study.

Table 2: Airway examination tests distribution.

Grade/ class	I	II	III	IV
Test	No. of patients			
Modified Mallampati	180	30	32	8
Thyromental distance test	212	30	8	-
Inter- incisor gap	190	60	-	-
Upper lip bite test	165	75	10	-
Mandibulo-hyoid distance	202	30	18	-
Sterno-mental distance	230	20	-	-
Atlanto-occipital extension	205	30	10	5

Table 3: Use of External laryngeal manipulation/Stylet/ Bougie/ Supraglottic airway.

	No. Of patients	Percentage
Simple dl	126	50.4%
Elm	60	24%
Stylet	56	22.4%
Bougie	6	2.4%
Fibreoptic. Intubation	2	0.8%

	No. Of Patients	No. Of Attempts	Failed Intubation
Junior anaesthetist	212	1-2	-
Senior anaesthetist	38	1-3	2

Table 4: Junior Vs Senior Anaesthetist

Table 5: Cormack & Lehane Grading.

Cormack & Lehane Grade	No. of patients	Percentage
Grade I	186	74.4%
Grade II	34	13.6%
Grade III	27	10.8%
Grade IV	3	1.2%

Total no. of patient in Cormack and Lehane grading I & II are easy intubation total 220 patients and total no. of patients in grade III and IV total 30 patients are true difficult intubation. We find the sensitivity, specificity, PPV, NPV of each pre-operative tests. P value <0.05 will be consider as a significant.

	Difficult	Easy	Total
Predicted difficult	True positive(a)	False positive(b)	(a+b)
Predicted easy	False negative(c)	True negative(d)	(c+d)
Total	(a+c)	(b+d)	(a+b+c+d)

- Sensitivity: (a/a+c) , Specificity: (d/b+d), Positive
- predictive value: (a/a+b), Negative predicted value: (d/c+d)
- Accuracy : (a+d)/(a+b+c+d)

Table 6: Cormack Lehane Vs Airway assessment tests.

	Cormack & Lehane grading		
	Difficult intubation (grade iii, iv)	**Easy intubation (grade i & ii)**	**Total**
Mmp			
Predicted difficult intubation. (class iii & iv)	28(a)	12(b)	40(a+b)
Predicted easy intubation (class i & ii)	2(c)	208(d)	210(c+d)
Thyromental distance			
Predicted difficult (grade ii & iii)	26(a)	12(b)	38(a+b)
Predicted easy (grade i)	4(c)	208(d)	212(c+d)
Inter- incisor gap			
Grade 2 (predicted difficult)	12 (a)	48 (b)	60 (a+b)
Grade 1 (predicted easy)	18(c)	172(d)	190(c+d)
ULBT			
Predicted difficult (grade iii)	8(a)	2(b)	10(a+b)
Predicted easy(grade i + ii)	22(c)	218(d)	240(c+d)
Mandibulo- hyoid distance			
Predicted difficult (grade ii & iii)	15(a)	33(b)	48(a+b)
Predicted easy(grade i)	15(c)	187(d)	202(c+d)
Stern omental distance			
Predicted difficult (grade ii)	12(a)	8(b)	20(a+b)
Predicted easy(grade i)	18(c)	212(d)	230(c+d)
Atlanto-occipital extension			
Predicted difficult (grade iii, iv)	10(a)	5(b)	15(a+b)
Predicted easy(grade i, ii)	20(c)	215(d)	235(c+d)

Table 7 : Reliability of different clinical airway assessment tests.

Test	Sensitivity (%)	Specificity (%)	Ppv (%)	Npv (%)	Accuracy (%)	P value	Odds ratio
MMT	93.3	94.5	70	99	94.4	0.0075	242
Inter-incisor distance	40	78.1	20	90.5	73.6	0.00022	112
ULBT	26.6	99	80	90.8	90.4	0.000045	2.38
Thyro- Mental distance	86.6	94.5	68.4	98.1	93.6	0.0455	39.6
Mandibulo - hyoid Distance	50	85	31.3	92.5	80.8	0.009375	5.6
Sterno mental Distance	40	96.3	60	92.17	89.6	0.049860	17.6
A-o Distance	33.33	97.7	66.66	91.48	90	0.0027	21.5

Table 8: Comparison of various airway assessment tests.

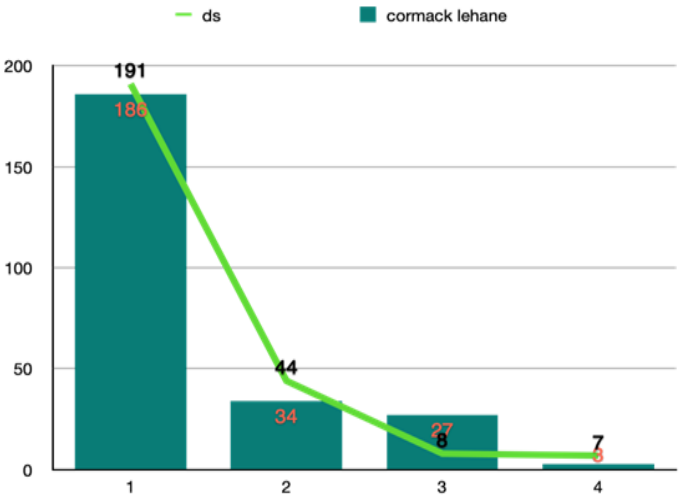
Parameters	Airway assessment tests
Sensitivity	MMT>TMD>MHD>IID=SMD>AOE
Specificity	ULBT>AOE>SMD>MMT=TMD>M
PPV	ULBT>MMT>TMD>AOE>SMD>M
NPV	MMT>TMD>MHD>SMD>AOE>UL
Accuracy	MMT>TMD>ULBT>AOE>SMD>M

Table 9: Difficulty scoring system.

Grade	Difficulty score	No. Of patients
I	Easy intubation (3-4)	191
II	Moderate difficulty (5-6)	44
III	Difficult intubation (7-8)	8
IV	Very difficult intubation (9-11)	7

The above table shows the grading according to difficulty score that includes operator related factors like number of attempts and intubation done by whom and also the use of additional equipment.

Graph 1: Cormack Lehane vs Difficulty scoring



The above graph compares the difficulty in intubation based on Cormack Lehane grading and the difficulty scoring system.

Summary and conclusion

In conclusion, several studies have evaluated different clinical risk factors, to predict a difficult Laryngoscopic view; however, none has produced a simple formulation for documentation and interpretation that has a high sensitivity and a low false negativity.

Since no single anatomical factor can be used to predict a difficult intubation. No single airway test can provide high index of sensitivity and specificity for prediction of difficult airway.

Therefore it has to be a combination of multiple tests. Combination of tests will increase the sensitivity and specificity and decrease chances of false positive and negative predictive values which enables a more accurate prediction of difficult airway.

Thus it is eminent that all clinical parameters be assessed pre operatively. It must be recognized, however that some patients with a difficult airway will remain undetectable despite the most careful preoperative airway evaluation.

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Abbrevations

DL: Direct laryngoscopy

MMT : Modified Mallampati classification

ULBT : Upper lip bite test

TMD : Thyromental distance

IID : Inter incisor distance

MHD: Mandibulo-hyoid distance

SMD : Stern omental distance

AOE: Atlanto-occipital joint extension

ELM: External laryngeal manipulation

FOI: Fiberoptic intubation

NPV : Negative predictive value

PPV :Positive predictive value

ASA :American society of anesthesio logist