Original Research Article

Difficult Airway Assessment Score for Prediction of Difficult Intubation in Pre-Operative Assessment

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Abstract

Background: Maintaining a patent airway in anesthetized patients undergoing any procedure or surgery is very important for an anaesthesiologist. The vast majority of the airway-related events, especially inability to maintain patent airway, involve brain damage or death. Several independent bedside tests have been designed to predict a difficult airway or intubation but many have not gained popularity due to practical difficulties. So a new scoring system of Difficult Airway Assessment score based on ratio of patient's height to thyromental distance, upper lip bite test, head and neck movements, modified mallampati test and neck circumference was developed.**Objectives:**To determine the diagnostic validity of Difficult Airway Assessment score in predicting difficult intubation defined by Intubation difficulty scale.**Methods:**This prospective study was conducted among 300 patients aged between 18 and 65 years with ASA physical status I, II and III who underwent elective surgeries under general anaesthesia with endotracheal intubation at a tertiary care centre. Patients with history of burns, trauma or surgeries to airway, any obvious airway anomalies, inability to sit, edentulous or need awake intubation were excluded from the study. The Difficulty Airway Assessment Scoring system was devised with the airway parameters of Modified Mallampati test, Upper Lip Bite Test, Ratio of Height to Thyromental Distance, Neck Circumference and Head and Neck Movements. Each airway parameter was assessed pre-operatively and assigned a score of 0, 1, 2 depending on the severity and summated all the individual scores. Wilson score was also calculated for all the subjects. The difficulty in intubation was assessed with Intubation difficulty scale.**Results:**Out of 300 patients, the incidence of difficult intubation was 12%. Modified Mallampati test had the highest sensitivity (61.1%) and head and neck movements had the highest specificity (95.5%). Upper lip bite test and head and neck movements had highest Positive predictive value (42.9%) and likelihood ratio (5.5). Accuracy was highest for head and neck movements followed by Upper Lip Bite Test and RHTMD. Difficult airway assessment score with cut off >=3 had a sensitivity of 88.9%, specificity of 82.6%, PPV of 41%, NPV of 98%, likelihood ratio of 5.1 and the accuracy was 83.3%.**Conclusion:**Difficulty airway assessment score constructed using Modified Mallampati test, Upper Lip Bite Test, Ratio of Height to Thyromental Distance, Neck Circumference and Head and Neck Movements has a good predictive accuracy and was very much better compared to individual parameters.

Keywords: Difficulty airway assessment score**,** difficult intubation, Modified Mallampati test, Upper Lip Bite Test, Thyromental Distance, Neck Circumference.

Introduction

Maintaining a patent airway in anesthetized patients undergoing any procedure or surgery is very important for an anaesthesiologist. If securing the airway was failed or there is any hindrance in gas exchange, for even a few minutes, can reflect out in dangerous outcomes such as brain damage or even death. Closed claim analysis found that under anesthesia the vast majority of the airway-related events, especially inability to maintain patent airway, involve brain damage or death.[1] The Mallampati classification has been used for a long time for predicting difficult endotracheal intubation. It was reported that Mallampati class III and IV have a significant correlation with predicting difficult endotracheal intubation.[2] Mallampati classification is based on observation of the pharyngeal s structures with the mouth fully open and tongue maximally protruded.Khan et al. introduced upper lip bite test (ULBT) as a simple and effective method for predicting difficult intubations in 2003.[3] If the patient has a receeding mandible, or a buck teeth, or if the patient cannot open his/her mouth very well, the ULBT class appears high and signifies difficult intubation. It is used especially in emergency patients where detailed airway evaluation cannot be done prior to surgery in the operating room before anaesthesia. Thyromental distance (TMD) is a measure of mandibular space and helps in determining how readily the laryngeal axis will fall in line with the pharyngeal axis when the atalanto – occipital joint is extended. measurement of TMD originated as a quantitative assessment of "receding jaw".[4] The Ratio of height to thyromental distance (RHTMD) has been shown to be a more specific predictor for difficult intubation than TMD. Schimitt et al suggested that the RHTMD has a better accuracy in predicting a difficult laryngoscopy than the thyromental distance (TMD) alone.[5]Lavi et al classified its study population into normal and obese according to their BMI and they found that the intubation difficulty scale (IDS) was significantly

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higher in obese patients.[6] Further studies have shown that it is the amount of tissue in the neck which correlates more with difficult intubation than BMI.[7] [8] Neck Circumference (NC) roughly correlates with the amount of tissue in the neck and is a useful and easily performed bedside test that helps the anaesthesiologist in the assessment of airway.Several independent bedside tests have been designed to predict a difficult airway or intubation. A recent Cochrane review concluded that none of the common bedside screening tests were well suited for detecting unanticipated difficult airway.[9]Several scores, which are a combination of the independent tests, have been described to assess the airway. But the scores have not gained popularity as bedside tests because they have been perceived to be cumbersome to perform at the bedside. Also, studies have proved that there is varying degree of inter-observer variability in pre-operative airway tests. Wilson score is one of the bedside test which was accepted widely due to its validity and easy administration.[10] Adnet et al. created an intubation difficulty scale (IDS) which had objective categories on difficulty of an endotracheal intubation after it was performed avoiding subjective variations.[11]

In this prospective study, a new scoring system of Difficult Airway Assessment score based on ratio of patient's height to thyromental distance, upper lip bite test, head and neck movements, modified mallampati test and neck circumference was developed. The diagnostic validity of Difficult Airway Assessment score in predicting difficult intubation was assessed by comparing with Wilson score and Intubation difficulty scale.

Materials and Methods

Study Setting & Participants

The prospective study was conducted among patients who underwent elective surgeries under general anaesthesia with endotracheal intubation at a tertiary care centre, Trichy. Patients with age between 18 and 65 years with American Society of Anaesthesiologists (ASA) physical status I, II and III were included in the study. Patients with history of burns, trauma or surgeries to airway, any obvious airway anomalies, inability to sit, edentulous or need awake intubation were excluded from the study. After obtaining approval from Institutional Ethics Committee, the study was conducted after getting written and informed consent from each participant. .

Sample Size & Sampling

According to Bhavdip Patel et al [12] study, the sensitivity of various parameters for assessing difficult intubation ranged widely from 28.6% to 100% and the incidence of difficult intubation was 8.1%. So considering an average estimated sensitivity for difficult intubation and airway assessment (Sn) as 50% with a precision (d) of 20% and 95% confidence interval (Z1-α/2 = 1.96) and prevalence of difficult intubation (p) as 8.1%, the sample size is calculated as $N = Z^2_{1-\alpha/2} * Sn * (1 - Sn) /p * d^2 = 303.45$. Rounded down, the sample size required was taken as 300. Systematic sampling of subjects was done to select them randomly. Every 5^{th} patient attending pre-operative assessment for elective surgery with general anaesthesia was selected.

Study Procedure

Pre-Operative assessment

Preoperative assessment was done by the principal investigator in the pre anaesthesia check-up room. A thorough preoperative evaluation was done on the day before surgery to select patients satisfying the inclusion criteria. Routine preoperative investigations were done. The following parameters were assessed in the pre-operative assessment.

1. Height & Weight

The height of the subject was measured with the patient erect and barefoot on a flat surface against a solid wall and the height is measured with a metal tape to exact cm. The weight of the subject is measured with a bathroom weighing scale to nearest 0.5 kg.

2. Modified Mallampati Test Score

Modified Mallampati Test (MMT) was performed with patient sitting, head in neutral position and patient asked to open mouth maximally and to protrude the tongue without phonation. The visibility of the faucial pillars, soft palate and uvula noted. MMT score was assessed by the investigator at eye to eye level with the patient according to the following categories

Class I:Soft Palate, faucial pillars and uvula are visualised

Class II:Soft Palate, Fauces, uvula visible.

Class III:Soft Palate, base of uvula visible.

Class IV:Soft Palate is not visible.

3. Ratio of Height to Thyromental distance (RHTMD)

Thyromental distance (TMD) was measured as the distance from the thyroid notch to the end of the chin, using a scale, when the patient extended his/her neck. Then RHTMD was calculated as RHTMD = Height (cms) / TMD (cms)

4. Head and neck movement range (HNM)

It was measured as described in the study by Wilson et al by making the patient extend their neck as much as possible. Then, while holding a pen vertically to the patient's forehead, a notepad held against the side of the patient's face parallel to the pen. Then the patient's neck is flexed as much as possible. If the pencil was parallel to the bottom side of the notepad, it was recorded as 90^o. If the pencil was lower than the bottom side of the notepad, it was recorded as more than 90^o, if pencil was higher than the bottom side, it was recorded as less than 90^o

5. Upper lip bite test (ULBT)

The upper lip bite test (ULBT) was performed as described by Khan et al. The patient is observed in the sitting position and asked to take a bite of the upper lip with the lower incisors as far as possible and classified according to the following criteria:

Class I-lower incisors can bite upper lip above the vermillion line

Class II-lower incisors can bite upper lip below the vermillion line

Class III-lower incisors cannot bite the upper lip

6. Subluxation of the mandible (SLux)

The patient was made to protrude the lower incisors as forward as possible. If the lower incisors were anterior to the upper incisors, then SLux > 0; if the lower incisors were equal to the upper incisors, then SLux = 0; and if the lower incisors failed to reach the upper incisors and remain posterior, then SLux < 0.

7. Inter incisor gap (IG)

Each patient was made to maximally open their mouth and the distance between the upper and lower incisors was measured. In the edentulous patient the distance between upper and lower gingiva was measured.

8. Receding mandible

The severity of receding mandible was estimated on subjective three-point scale (0 = normal: 1 = moderate; 2 = severe).

9. Buck teeth

The severity of buck teeth (long upper incisors) was also estimated on a subjective three-point scale (0 = normal, 1 = moderate, 2 = severe).

10. Neck circumference (NC)

It was measured with a tape at the level of thyroid cartilage, with head in neutral position.

Preoperative preparation

The patients were kept nil per oral for 8 hours. They were given orally Ranitidine 150mg, Metoclpramide 10mg and Alprazolam 0.25mg at 10pm on the night prior to surgery. Written informed consent was obtained from all patients who participle in the study.

Anaesthetic technique

After shifting to the operation theatre, pre induction monitors were connected. Datex Ohmeda Cardiocap monitor was used for monitoring which consisted of non-invasive blood pressure(NIBP) monitor, 5 lead Electro-cardiogram (ECG) and Pulse oximeter. Iv cannula of appropriate gauge was secured in non-dominant hand under local anaesthesia and fluid was given according to Holliday Segar formula. Pre oxygenation was done with 100% oxygen with a fitting facemask at a flow rate of 6 litre/minute for 3 minutes and premeditated with fentanyl 2 µg/kg, midazolam 0.03mg/kg and glycopyrrolate 10 µg/kg iv before induction. Anaesthesia was induced with iv propofol, dose titrated according to loss of verbal response. After loss of response to verbal commands and ensuring adequate mask ventilation, neuromuscular blockade was achieved with vecuronium 0.1mg/kg iv and lungs were ventilated with bag and mask. Preservative free iv lignocaine 1.5 mg/kg was given 90 seconds before intubation. After ventilating with mask with sevoflurane 2% and oxygen for 3 minutes after induction, direct laryngoscopy was performed with head in sniffing position, using Macintosh blade size ¾ by an anesthesiologist (secondary investigator) who was blinded to pre-operative airway assessment done by the primary investigator. Endotracheal intubation was confirmed using capnography and ausulation of bilateral lung fields. Post intubation monitoring included end tidal carbon dioxide and respiratory gas analyser. Case was continued and anaesthesia was maintained by the secondary investigator. The primary investigator was not a part of laryngoscopy. The whole intubation process was scored by the second investigator using 7 measuring variables of the Intubation Difficulty Scale (IDS).

Operational Definitions

Difficulty Airway Assessment Scoring system

Each airway parameter assessed in pre-operative assessment was assigned a score of 0, 1, 2 depending on the severity. The Difficulty Airway Assessment Scoring system was devised as show in the fig. and summated all the individual scores.

Table 1: Difficulty Airway Assessment Scoring system with individual parameters

Airway Assessment factors	Score		
	0	1	2
Modified Mallampati Test Score	Class I	Class II	Class III-IV
RHTMD	< 23.5cm	> 23.5cm	
Upper lip bite test	Class I	Class II	Class III
Head and neck movements	> 90°	90°	< 90°
Neck circumference	< 43cm	> 43cm	

Wilson Score

For all the subjects, Wilson score was also calculated using the following parameters and scored 0,1 or 2 according to their grading. The total score ranged from 0 – 10.

Table 2: Wilson scoring system with individual parameters

Criterion		Score	
	0	1	2
Weight	< 90	90-110	> 110
Head and neck movements	> 90°	90°	< 90°
Jaw movement	IG > 5cm or SLux > 0	IG < 5cm and SLux= 0	IG < 5cm and SLux < 0
Receeding Mandible	Normal	Moderate	Severe
Buck teeth	Normal	None	Severe

Intubation Difficulty Scale (IDS)

The difficulty in intubation was assessed by the Intubation Difficulty Scale and was considered gold standard for assessing the validity of new scoring system of Difficulty Airway Assessment Score. IDS score is calculated as N1 to N7 as shown in the fig.1. and summated all scores of N1 to N7. The total score > 5 is considered as difficult intubation.

Statistical Analysis

Data was entered in MS excel sheet and analysed using SPSS software version 21. Continuous variables were represented in mean and standard deviation and categorical variables were represented in frequencies and percentages. The validity of the screening test was represented as sensitivity, specificity, positive predictive value and negative predictive value. The cut off value of the screening test for predicting the outcome variable is determined using ROC curve. p-values less than 0.05 were considered statistically significant.

Calculating method	
N_1	Every additional attempt adds 1 point
N_2	Each additional operator adds 1 point
N_3	Each alternative technique adds 1 point: repositioning of the patient, change of materials (blade, ET tube, addition of a stylette), change in approach (nasotracheal/orotracheal) or use of another technique (fibroscopy, intubation through a laryngeal mask)
N_4	Apply Cormack grade for 1st oral attempt. For successful blind intubation: $N_4 = 0$
N_5	Increased lifting force during laryngoscopy adds 1 point. For normal lifting force: $N_5 = 0$
N_6	External laryngeal pressure to improve glottic exposure adds 1 point
N_7	Position of vocal cords during laryngoscopy (abduction: $N_7 = 0$, adduction: $N_7 = 1$)

Fig 1: Intubation Difficulty Scale (IDS)

Results

Out of 300 patients included in the study, 113 (37.7%) were males and 187 (62.3%) were females. The mean age of the study population was 37.2 (± 10) years ranged from 18 to 64 years with majority (45%) in 31 – 40 years age group. 99 (33%) of the individuals were in class III & IV Mallampati class, 48 (16%) had >=23.5cm

RHTMD, 49 (16%) were in class III of Upper lip bite test, 21 (7%) had <= 90° range of head and neck movements, 126 (42%) had >= 43 cm neck circumference. 36 (12%) had incidence of difficult intubation according to intubation difficulty scale. (Table 3)

The diagnostic validity of all the five parameters constituting the difficult airway assessment score namely Modified Mallampati test, Upper Lip Bite Test, Ratio of Height to Thyromental Distance, Neck Circumference and Head and Neck Movements and their comparision had been shown in table 4.

The diagnostic validity of difficult airway assessment score for predicting difficult intubation with cut off at scores 2,3 and 4 were calculated and depicted in table 5 and compared with the diagnostic validity of Wilson score with cut off more than or equal to 2.

Table 3: Demographic characteristics of the study population

	Frequency / Mean (± S.D.)	**Percentage / Range**
Age		
<= 30 years	59	19.7%
31- 40 years	135	45.0%
41- 50 years	73	24.3%
> 50 years	33	11.0%
Overall (years)	37.2 (± 10)	18 - 64
Sex		
Male	113	37.7%
Female	187	62.3%
BMI		
<25	66	22%
25-29.9	70	23.3%
>30	164	54.7%
Overall	30.1 (± 5.6)	22.4 – 38.5
Modified Mallampati Score		
III & IV	99	33%
I & II	201	67%
RHTMD		
>= 23.5	48	16%
< 23.5	252	84%
Upper lip bite test		
III	49	16%
I & II	251	84%
Head and neck movements		
<= 90°	21	7%
> 90°	279	93%
Neck circumference		
>= 43 cm	126	42%
< 43 cm	174	58%
IDS Score		
> 5	36	12%
<= 5	264	88%

Table 4: Diagnostic validity of individual airway assessment factors

	MMT	**ULBT**	**HNM**	**NC**	**RHTMD**	**Hierarchy**
Sensitivity	61.1	58.3	25	44	55.6	MMT>ULBT>RHTMD>NC>HNM
Specificity	70.8	89.4	95.5	58	89.4	HNM>ULBT=RHTMD>MMT>NC
PPV	22.2	42.9	42.9	13	41.7	ULBT=HNM=RHTMD>MMT>NC
NPV	93	94	90.3	89	93.7	ULBT>RHTMD>MMT>HNM>NC
PLR	2.1	5.5	5.5	1.1	5.2	ULBT=HNM>RHTMD>MMT>NC
NLR	0.5	0.5	0.8	1	0.5	NC>HNM>MMT=ULBT=RHTMD
Accuracy	69.7	85.7	87	57	85.3	HNM>ULBT>RHTMD>MMT>NC

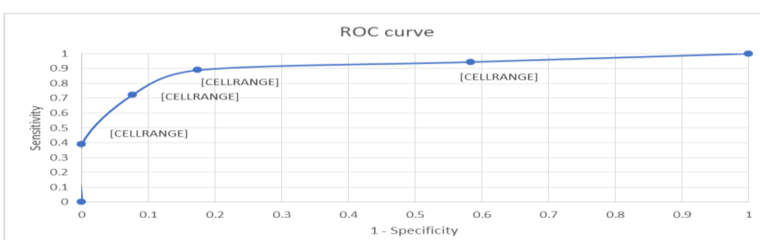

Fig 2: ROC curve for determining cut off of Difficult airway assessment score for predicting difficult intubation

Table 5: Diagnostic validity of difficult airway assessment score with various cut off and comparision with Wilson score

Difficult Airway Assessment Score	IDS Score		Seensitivity	Specificity	PPV	NPV	Likelihood ratio	Accuracy
	> 5 (Difficult intubation)	<= 5 (Easy Intubation)						
Cut off score as 2								
>=2	34	154	94.4%	41.7%	18.1%	98.2%	1.6	48%
< 2	2	110						
Cut off score as 3								
>=3	32	46	88.90%	82.60%	41%	98.20%	5.1	83.30%
< 3	4	218						
Cut off score as 4								
>=4	26	20	72.20%	92.40%	56.50%	96.10%	9.5	90%
< 4	10	244						
Wilson score								
>=2	16	77	44.40%	70.80%	17.20%	90.30%	1.52	67.67%
<2	20	187						

Discussion

Difficult airway is one of the strenuous situation encountered by anaesthesiologists. Though many clinical bed side tests have been proposed preoperatively for detecting patients who may end up with difficult laryngoscopy, unfortunately, there is still no test or group of tests that can accurately predict difficult laryngoscopy. Predictive test for difficult intubation can be grouped into individual indices and scoring systems. Preoperative airway assessment test should be highly sensitive to predict maximum number of patients with difficult laryngoscopy correctly, and highly specific to predict easy laryngoscopy also.

The reported incidence of difficult airway varies from 1.3 to 18% in general population. In the present study, out of 300 patients, 36 had difficult intubation and the incidence of difficult intubation was 12% which is comparable to that observed by earlier studies. Shah et al [13] showed almost similar result of 13.95% difficult intubation, Patel et al [12] with a slightly reduced incidence of 8.1%, Vidhya et al [14] depicted 16% difficult intubation and Seo et al [15] showed 11.8% incidence.

The present study elucidated that Modified Mallampati Test (MMT) had a sensitivity of 61.1%, specificity of 70.8%, PPV of 22.2%, NPV of 93%, likelihood ratio of 2.1 and accuracy of 69.7%. These results were similar to the results shown by Shah et al[13]. It presented MMT with sensitivity of 70.15%, specificity of 61.02%, PPV of 22.6%, NPV of 92.65%. Bhavdip Patel et al[12] studied difficult intubation with MMT and depicted a sensitivity of 28.6%, specificity of 93%, PPV of 18.2%, NPV of 96% and accuracy of 89.6%. Various other studies also show very low sensitivity and PPV with moderate and high specificity and NPV values. Hence MMT alone can't be used to predict difficult airway.

Our study revealed ULBT as a predicting test with sensitivity 58.3%, specificity 89.4%, PPV 42.9%, NPV 94%, Positive LR 5.5 and accuracy 85.7%. The results were slightly different from the studies by Khan et al[3] which showed higher predictive values of Sensitivity 76.5%, specificity 88.7%, PPV 28.9%, NPV 98.4%, likelihood ratio 6.76 and accuracy of 88%. Other studies show a low sensitivity for ULBT similar to the current study. Eberhart et al[16] deduced the predictive values of ULBT with sensitivity, specificity, PPV, NPV, likelihood ratio, accuracy of 28.2%, 92.5%, 33.6%, 90.6%, 3.78 and 84.9% respectively. Hester et al [17] assessed ULBT as a predictive test for difficult intubation and showed sensitivity, specificity, PPV and accuracy of ULBT as 55%, 97%, 83%, 90% respectively. Shah et al[13] elucidated the predictive parameters of ULBT namely sensitivity, specificity, PPV, NPV and likelihood ratio of 74.63%, 91.53%, 58.82%, 95.7% and 31.76.

RHTMD, introduced by Schmitt et al [5] has better predictive value in predicting difficult laryngscopy than TMD as it allows for individual's body proportions which are not allowed in TMD. In our study RHTMD yielded a sensitivity of 55.6% and a specificity of 89.4% with positive and negative predictive value of 41.7% and 93.7% respectively. Compared to other studies, the sensitivity was slightly lower and specificity was higher with predictive values almost similar. Azim Honarmand et al [18] depicted predictive power of RHTMD with sensitivity, specificity, PPV, NPV and likelihood ratio of 64.7%, 82.42%, 38.8%, 93.2%, 3.68 respectively. The sensitivity, specificity, PPV, NPV and likelihood ratio of RHTMD deduced by Krobbuaban et al [19] was 77%, 66%, 24%, 95% and 2.26 respectively. Shah et al [13] shown RHTMD as a good predictive test for difficult intubation with sensitivity, specificity, PPV, NPV and likelihood ratio of 71.64%, 92.01%, 59.26%, 95.24% and 8.96 respectively. The RHTMD has some limitations because it depends on accurate measurement of patients TMD and height that lessens the simplicity of this method. Also, the cut-off point of RHTMD for prediction of difficult laryngoscopy is race dependent, we consider RHTMD >=23.5 cm as a cut off for difficult intubation suggested by Krobbuaban et al.

Head and neck movements, in predicting difficult intubation, had a sensitivity of 25% and specificity of 95.5% with PPV 42.9%, NPV 90.3%, likelihood ratio 5.5 and accuracy of 87% which almost matches with Seo et al[15] which shows 25%, 94.4%, 37.5%, 90.39%, 86.22% of sensitivity, specificity, PPV, NPV and accuracy respectively. Shah et al[13], with slight difference matches with the present study findings, depicts sensitivity, specificity, PPV and NPV of 7.46%, 93.95%, 16.67% and 86.22% respectively. In the present study, the patients with obvious airway anomalies had been excluded which included obvious limitation of neck extension. Many patients belonged to obese category with short neck which might have resulted in falsely identifying patients as having limited head and neck movements. We assessed head and neck movements based on the method described in the study by Wilson et al. Accounts measurement can be done with a goniometer only. All these reasons might have contributed to lower sensitivity for HNM in our study.

Brodsky et al [20] studied morbidly obese patients and found Neck circumference as a significant predictor of difficult intubation. The study depicted that the probability of a difficult intubation was approximately 5% for neck circumference of 40 cm. while the probability increased up to 35% at a neck circumference of 60 cm. Gonzalez et al [7] compared obese and lean individuals for difficult intubation and determined neck circumference as more than 43 cm as a cut off for predicting difficult intubation with sensitivity, specificity, PPV and NPV of 92%, 84%, 37% and 99%. The present study predicted difficult intubation with neck circumference more than or equal to 43 cm as a cut off and the sensitivity, specificity, PPV and NPV of 44.4%, 58.3%, 13% and 88.5% respectively. It is not only the neck circumference but also the amount of per tracheal soft tissue that matters, as demonstrated in obese patients by the use of ultrasound.[8] Gender related anatomic difference may also be significant. In current study, men had a significantly larger neck circumference than women and similar findings have been reported by Brodsky et al.Comparing the individual parameters in difficult airway assessment scoring, Modified Mallampati test had the highest sensitivity (61.1%) and head and neck movements had the highest specificity (95.5%). Predictive value and likelihood ratio were higher for upper lip bite test and head and neck movements had an equal score. Accuracy was highest for head and neck movements followed by Upper Lip Bite Test and RHTMD. This shows that no single test can be better in predicting difficult intubation. Various studies have also shown that a scoring system is better than individual parameters in predicting difficult intubation.[21] Hence a new scoring system for assessing difficult airway and intubation was developed by the authors. The new score, Difficult Airway Assessment score was designed with Modified Mallampati test, upper lip bite test, neck circumference, RHTMD (ratio of height to thyromental distance) and head and neck movements. The individual parameter scores were calculated in three categories as 0,1 and 2 and the total score ranges from a minimum of 0 to a maximum of 8.

Difficult airway assessment score in predicting difficult intubation was assessed with various cut off scores. When the cut off was taken more than or equal to 2, the sensitivity was 94.4% but the specificity was low as 41.7%. PPV was very low of 18% with a high NPV of 98%. The likelihood ratio was 1.6 and the accuracy was moderate with 83.3%. This shows cut off >=2 can identify almost all difficult intubations but many false positives are the drawback. When the cut off was taken more than or equal to 4, the sensitivity was moderate as 72.2% but the specificity was good of 92.4%. PPV was average with 56.5% with a high NPV of 96%. The likelihood ratio was very high of 9.5 and the accuracy was high with 90%. Thus with a cut off >=4 can eliminate easy intubations as much as possible but with high false negatives. When the cut off was taken more than or equal to 3, the sensitivity and specificity was good with 88.9% and 82.6%. PPV was average with 41% with a high NPV of 98%. The likelihood ratio was good with 5.1 and the accuracy was 83.3%. Thus with a cut off >=3 can identify difficult intubations as well as eliminate easy intubations to a maximum possible extent with least false negatives and false positives. ROC curve for determining the cut off score for predicting difficult intubation has been shown in the fig. which shows >=3 is the best cut off in difficult airway assessment score for predicting difficult intubation with maximum sensitivity and specificity.The present study also evaluated the Wilson score for the same population. On comparision of Difficult airway assessment score (DAAS) with cut off of >=3 with Wilson score, sensitivity of DAAS was very high 88.9% compared with 44.4% in Wilson score and specificity was also high with 82.6% compared to 70.8% in Wilson score. Positive predictive value was only 17.2% in Wilson score whereas it was 41% in DAAS. 98.2% NPV in DAAS score almost matches with the 90.3% NPV of Wilson score. The accuracy and likelihood ratio of DAAS outperformed Wilson score. Accuracy was 83.3% in DAAS compared to 67.67% in Wilson score. Likelihood ratio was 5.1 in DAAS compared to 1.52 in Wilson score. Thus it is very evident that the validity of the Difficult airway assessment score with cut off more than or equal to 3 is much better than Wilson score.Seo et al [15] designed a new score for predicting difficult intubation named Total Airway Score (TAS) which included the following factors: Mallampati classification, the thyromental distance, the head & neck movement, BMI, the severity of buck teeth, the inter incisor gap, and the ULBT. The predictive accuracy of TAS was 94.1% which was slightly higher than DAAS (83.3%). The sensitivity of TAS was low (69.4%) compared to DAAS but specificity was higher (97.4%). PPV was higher in TAS (78%) compared to 41% in DAAS and NPV almost matches between the two scores. Thus DAAS score has almost similar validity in predicting difficult intubation compared to TAS score.The five individual parameters taken in DAAS score had their own level of predictive validity but when the 5 parameters are combined to form a Difficult Airway Assessment scoring system, and cut off score taken as >=3, it turned out to be a highly sensitive and specific predictor of difficult intubation and superior to Wilson score.

Conclusion

Modified Mallampati test, Upper Lip Bite Test, Ratio of Height to Thyromental Distance, Neck Circumference and Head and Neck Movements when used as an independent predictor for difficult intubation had its own predictive validity but failed to meet the criteria for an ideal predictive test. When these parameters were combined to derive Difficulty airway assessment score, the predictive accuracy was very much better compared to individual parameters.

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