Original Article

Comparison of upper-lip bite test with other four predictors for predicting difficulty in intubation

N. Hemanth, T. Rajasekhar, Swami Devi Prasad Ilapanda, Prabhu Gnapika Putta, Pabba Shravani, Dyva Manogna, M. H. Rao

Department of Anesthesiology and Critical Care Medicine, Sri Venkateswara Institute of Medical Sciences, Tirupati, Andhra Pradesh, India

Abstract

Background: Unanticipated difficult tracheal intubation remains a primary concern of anaesthesiologists. The aim of the present study was to compare upper-lip bite test (ULBT) with other four predictors namely modified Mallampati test (MMT), thyromental distance (TMD), sternomental distance (SMD) and interincisor distance (IID) for predicting difficulty in intubation.

Methods: Airway assessment indices were evaluated and compared in 60 American Society of Anesthesiologists physical status Grade I and II patients undergoing general anaesthesia at a tertiary care teaching hospital in South India. The cut-off points for defining the difficult intubation (DI) were as follows: for ULBT, Class III; MMT, Classes 3 and 4; TMD <6 cm; SMD <11 cm and IID <3.5 cm. Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) were calculated for each of the predictive tests.

Results: DI was observed in 26.7% of all patients studied. Sensitivity, specificity, PPV, NPV and accuracy for ULBT were 6.3%, 97.7%, 50%, 74.1% and 73.3%, respectively, whereas those for MMT were 25%, 86.4%, 40%, 76% and 70%, respectively. MMT showed 50% sensitivity and 84.5% specificity in assessing difficulty in intubation when compared with ULBT, whereas all the other methods have shown 0% sensitivity. MMT is a better predictor of difficulty in intubation when compared with ULBT due to its high sensitivity, better specificity, PPV and accuracy.

Conclusions: No single airway predictor was accurate in predicting DI. A combination of at least two or more airway predictors has to be analysed to arrive at a near-ideal difficult airway prediction.

Keywords: Airway predictors, difficult airway, modified Mallampati test, upper-lip bite test

Address for correspondence: Dr N. Hemanth, Associate Professor, Department of Anesthesiology and Critical Care Medicine, Sri Venkateswara Institute of Medical Sciences, Tirupati, Andhra Pradesh, India.
E-mail: hemanthn1973@gmail.com

INTRODUCTION

The fundamental responsibility of an anaesthesiologist is to maintain adequate gas exchange in the patient. For this to be done, the patient's airway must be managed so that it is almost continuously patent. It has been estimated that inability to manage difficult airways (DAs) successfully is responsible for as many as 30% of deaths totally attributable to anaesthesia.[1,2] Difficult laryngoscopy (a Grade III or IV Cormack Lehane view)[3,4] is synonymous to difficult intubation (DI) in the majority of patients. The need to predict a potentially DI has received great importance as it plays

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a vital role in bringing down morbidity and mortality. Some pre-operative DA intubation predictors are Mallampati test,[5] modified Mallampati test (MMT),[4] Atlanto occipital joint extension,[1,6] thyromental distance (TMD),[7] sternomental distance (SMD),[8] mandibulo-hyoid distance,[9] interincisor distance (IID)[10] and upper-lip bite test (ULBT),[11] a modification of the temporomandibular displacement test.

The present study was designed to determine the ability to predict difficult/easy visualisation of larynx in a study population by comparing ULBT with four other predictors, i.e., MMT, SMD, TMD and IID.

MATERIAL AND METHODS

A prospective study was conducted on 60 American Society of Anesthesiologists physical status[12] (ASA) Grade I and II adult patients (18–60 years of age group) scheduled to receive general anaesthesia with endotracheal intubation. The study was conducted in various surgical operation theatres of a tertiary care teaching hospital in South India. The study was approved by the institute's Ethics committee. A written informed consent was obtained from all participants in the study. In all the patients selected for the study, a detailed pre-anaesthetic assessment was performed. Pre-operative airway examination was performed by an anaesthesiologist not involved in the study. The various airway predictors measured were MMT, ULBT, SMD, IID and TMD. MMT Classes 1 and 2, ULBT I and II, SMD Class I (>11 cm), IID >3.5 cm and TMD Class I (>6 cm) were considered as predictors of easy intubation.

After adequate pre-operative fasting, patients were wheeled into the operating room and standard ASA monitoring was done. After adequate pre-oxygenation and pre-hydration, patients were subjected to standard anaesthesia induction regimen of midazolam 0.03 mg/kg IV, fentanyl 1–2 μg/kg and propofol 2.5 mg/kg IV, and then paralysed using succinylcholine 1.5 mg/kg intravenously. Sixty seconds later, glottic visualisation was attempted with Macintosh no. 3 laryngoscope blade by the principal investigator. Glottic visualisation was assessed by Cormack and Lehane grading,[3] and an appropriate sized endotracheal tube was inserted, position checked and fixed. Endotracheal intubation was considered truly difficult if Cormack and Lehane laryngoscopy grade[3] is III or IV, if more than three attempts at tracheal intubation were made or when laryngoscopy and intubation duration was longer than 10 min, if any special manoeuvres/fibre-optic intubation was used to facilitate tracheal intubation and if the anaesthesiologist was not able to intubate.

Statistical analysis

All the observations were collected and tabulated on Microsoft Excel spreadsheet, and all the entries were double-checked for data entry errors. Continuous variables are presented as mean ± standard deviation and categorical variables are presented as counts and percentages. Chi-square test and Fisher's exact test were performed to test the differences in frequency between groups of different methods in comparison to gold standard method. Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) for different DA predictors were calculated with the help of IBM SPSS Statistics for Windows, version 20.0 (IBM Corp., Armonk, NY, USA).

RESULTS

In the present study, a total of 60 cases were recruited. The mean age of the study population was 39.5 ± 11.2 years. Among the study population, 41.7% were males and 58.3% were females. The mean weight of the study group was 57.78 ± 9.04 kg and body mass index was 23.17 ± 3.30 kg/m^2.

Majority of the patients belonged to Class II according to ULBT (81.7%), MMT (63.3%) and CML grading (38.3%) and Class I according to SMD (100%), TMD (96.7%) and IID (98.3%) [Table 1].

Table 1: Distribution of different classes of airway predictors

Type of test	Class/grade	Number of patients (*n*=60), *n* (%)
ULBT	Class I	9 (15)
	Class II	49 (81.7)
	Class III	2 (3.3)
MMT	Class 1	12 (20)
	Class 2	38 (63.3)
	Class 3	10 (16.7)
	Class 4	0
SMD	Class I (≥11 cm)	60 (100)
	Class II (<11 cm)	0
TMD	Class 1 (≥6 cm)	58 (96.7)
	Class 2 (<6 cm)	2 (3.3)
IID	Class 1 (≥3.5 cm)	59 (98.3)
	Class 2 (<3.5 cm)	1 (1.7)
CML grading	Class I	21 (35)
	Class II	23 (38.3)
	Class III	16 (26.7)
	Class IV	0

ULBT=Upper-lip bite test; MMT=Modified Mallampati test; SMD=Sternomental distance; TMD=Thyromental distance; IID=Interincisor distance; CML=Cormack and Lehane

MMT has more true - positives (4) and least false - negatives (12), whereas SMD has more true negatives (44) and least false- positives [Table 2]. True positive: A difficult endotracheal intubation that had been predicted to be difficult. This included: ULBT Class III; MMT Classes 3 and 4; SMD Class II, TMD Class II and IID Class 2 with Cormack and Lehane laryngoscopic view grading III and IV. False positive: An easy intubation that had been predicted to be difficult. This included: ULBT Class III; MMT Classes 3 and 4; SMD Class II, TMD Class II and IID Class 2 with Cormack and Lehane laryngoscopic view grading I and II. True negative: An easy intubation that had been predicted to be easy. This included: ULBT Classes I and II; MMT Classes 1 and 2; SMD Class I, TMD Class I and IID Class 1 with Cormack and Lehane laryngoscopic view grading I and II. False negative: A DI that had been predicted to be easy. This included: ULBT Classes I and II; MMT Classes 1 and 2; SMD Class I, TMD Class I and IID Class 1 with Cormack and Lehane laryngoscopic view grading III and IV.

Table 2: Laryngoscopic view versus pre-operative difficult airway predictors

Predictive test	TP	FN	FP	TN
ULBT	1	15	1	43
MMT	04	12	6	38
SMD	0	16	0	44
TMD	1	15	1	43
IID	0	16	1	43

ULBT=Upper-lip bite test; MMT=Modified Mallampati test; SMD=Sternomental distance; TMD=Thyromental distance; IID=Interincisor distance; TP=True positive; FP=False positive; TN=True negative; FN=False negative

Sensitivity in predicting DI was found to be more with MMT (25%), whereas specificity was found more with SMD (100%). Both ULBT and TMD had high PPV (50%), whereas MMT had high NPV (76%). Accuracy was found to be high with TMD (75%) [Table 3].

Of all these predictor tests, MMT was found to have high sensitivity (25%) and NPV (76%) but poor specificity (86%). SMD was found to have high specificity (100%) but poor PPV. ULBT was found to have high PPV (50%) [Table 4].

Table 4: Comparison between various pre-operative difficult intubation predictors

Variable	Predictor
Sensitivity	MMT>ULBT>TMD>SMD>IID
Specificity	SMD>ULBT>TMD>IID>MMT
PPV	ULBT>TMD>MMT>IID>SMD
NPV	MMT>ULBT>TMD>SMD>IID

ULBT=Upper-lip bite test; MMT=Modified Mallampati test; SMD=Sternomental distance; TMD=Thyromental distance; IID=Interincisor distance; PPV=Positive predictive value; NPV=Negative predictive value

With reference to ULBT, MMT was found to have high sensitivity (50%), PPV (100%) and NPV (98%), and SMD was found to have high specificity (100%) [Table 5].

Table 5: Sensitivity, specificity, positive predictive value and negative predictive value of different tests with reference to upper-lip bite test

Airway predictive test compared vis-à-vis ULBT	Sensitivity	Specificity	PPV	NPV
MMT	50	84.48	100	98.0
SMD	0	100	0	96.67
TMD	0	96.55	0	96.55
IID	0	98.28	0	96.61

ULBT=Upper-lip bite test; MMT=Modified Mallampati test; SMD=Sternomental distance; TMD=Thyromental distance; IID=Interincisor distance; PPV=Positive predictive value; NPV=Negative predictive value

With the above observations, we conclude that MMT is more reliable in assessing difficulty in intubation with reference to ULBT.

DISCUSSION

Predicting DI can reduce anaesthesia-associated morbidity and mortality.[13] In order to be clinically useful, a test predicting DI must be easily applicable at the bedside and must give reliable results. No test has 100% sensitivity, and

Table 3: Sensitivity, specificity, positive predictive value and negative predictive value of various airway predictors in predicting difficult intubation *vis-à-vis* laryngoscopic view

Laryngoscopic view	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
ULBT	6.25 (0.16-30.23)	97.73 (87.98-99.94)	50 (1.26-98.74)	74.14 (60.96-84.74)	73.3
MMT	25 (7.27-52.38)	86.36 (72.65-94.83)	40 (12.16-73.76)	76 (61.83-86.94)	70
SMD	0 (0.0-20.59)	100 (91.96-100)	-	73.33 (60.34-83.93)	73.3
TMD	6.25 (0.16-30.23)	97.73 (87.98-99.94)	50 (1.26-98.74)	74.14 (60.96-84.74)	75
IID	0 (0.0-20.59)	97.73 (87.98-99.94)	0.0 (0.00-97.50)	72.88 (59.73-83.64)	71.66

PPV=Positive predictive value; NPV=Negative predictive value; ULBT=Upper-lip bite test; MMT=Modified Mallampati test; SMD=Sternomental distance; TMD=Thyromental distance; IID=Interincisor distance

there will always be some patients with unpredicted DI. A test to predict DI should have high sensitivity so that it will identify most patients in whom intubation will truly be difficult. It should also have a high PPV so that only a few patients can be actually intubated easily and subjected to the protocol for management of a DI.

In the present study, the sensitivity of ULBT was only 6.25% [Table 3]. This is in contrast to the results obtained in some studies,[11,14,15] wherein they found a sensitivity of 76.5%, 91.5% and 87.5%, respectively. The lower sensitivity of ULBT in our study can be explained due to the low incidence of ULBT Class III (one out of sixty patients) [Table 1]. We found that repeated demonstrations were required for the patients to perform ULBT, and a few still failed to understand the procedure in spite of our efforts. Also in some, there was a reflex movement of the upper lip in the reverse direction over the upper teeth, which may alter the point of meeting of vermilion line with lower incisors. In the same individual measured, the ULBT may vary according to the effort applied by the patient. The specificity of ULBT in our study was 97.3% [Table 3], which is similar to reports from other studies (88.7%),[11] (92.5%)[16] and (97%).[17]

We found 100% specificity for SMD in predicting easy intubation [Table 3]. This is in contrary to the values obtained by Khan *et al*.[18] wherein they obtained 70%. This difference can be explained based on the different racial characteristics of the study population. In addition, in our study, the cut-off point for SMD was 11 cm, whereas in another[18] study, it was 13 cm.

In the present study, sensitivity and specificity for TMD were 6.25% and 97.73%, respectively [Table 3]. In a study,[19] a sensitivity of 55% and a specificity of 88% was reported. Another study[18] reported a sensitivity of 73% and a specificity of 82.2%. This wide variation in the reported sensitivity in various studies may be because of incorrect evaluation of the measurement from inner or outer mentum and anthropometric peculiarities. In our study, all the patients' airway was evaluated by a single anaesthesiologist unlike in other studies, wherein two or more than two anaesthesiologists were involved in assessing the airway, which might have contributed to the interobserver variability, leading to variable positivity.

The NPV of ULBT, MMT, SMD, TMD and IID was almost similar in our study i.e., 74.14%, 76%, 73.3%, 74.14% and 72.88%, respectively [Table 3]. Naithani *et al*.[20] observed NPV for the above-said airway parameters as 98.3%, 96.7%, 90.5%, 91.7% and 94.7%, respectively. In contrast, Khan *et al*.[18] reported NPVs for ULBT, SMD, TMD and IID as 98.8%, 98.8%, 98.3% and 97.8%, respectively. This discrepancy in the results obtained by us may be due to different yardsticks defined by us as the cut-off points for predicting DI. Furthermore, in our study, both the pre-operative prediction and laryngoscopic view observation were done by final-year postgraduate students, which might have led to the above variations. Furthermore, the number of patients involved in our study was 60, which was considerably less than the study population in the other groups.

To the best of our knowledge, no study till date had compared ULBT with other predictors of DI directly. We attempted to check the efficacy of ULBT versus other airway predictors in predicting difficulty in intubation directly. We found no agreement between the groups. Of all these tests, TMD had a fair agreement of 0.375 with ULBT in predicting DI. We also found that all the tests (MMT, SMD, TMD and IID) are almost equally efficacious in predicting easy intubation as evidenced by higher specificity and higher NPV [Table 3]. In an ideal scenario, a test to predict DI should have higher sensitivity so that it will identify most patients in whom intubation will truly be difficult.[21] It should also have a high PPV so that only few patients with airways actually easy to intubate are subjected to protocol for the management of DA.[22] Finally, it should have high NPV to correctly predict the ease of laryngoscopy and intubation. However, as seen in our study and in numerous other published studies, till date, there is no ideal predictor for pre-operative evaluation of DA. Therefore, we suggest that a combination of various airway assessment methods is better than a single DA predictor in predicting the ease of intubation for improving the sensitivity rates.

The present study is not without limitations: (i) small sample size of sixty patients; (ii) no specialised population group such as paediatric and obstetric patients were included in the study, which might have altered our findings; (iii) patients of ages between 16 and 60 years only were included in this study; (iv) combination of two or three more predictors might have been a better alternative than comparing a single predictor; and (v) the present study is a single-centre study, and these observations merit validation in several centres in different parts of the country.

We conclude that no single airway predictor is sufficient for predicting DI. A combination of two or more airway predictors has to be analysed to arrive at a near-ideal airway prediction model. Till then, the search for an ideal pre-operative airway prediction parameter remains utopian in predicting DI.

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Conflicts of interest
There are no conflicts of interest.

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