Original Article

Comparison of Mallampati test with lower jaw protrusion maneuver in predicting difficult laryngoscopy and intubation

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Abstract

Background: Failure to maintain a patent airway is one of the commonest causes of anesthesia-related morbidity and mortality. Many protocols, algorithms, and different combinations of tested methods for airway assessment have been developed to predict difficult laryngoscopy and intubation. The reported incidence of a difficult intubation varies from 1.5% to 13%. The objective of this study was to compare Mallampati test (MT) with lower jaw protrusion (LJP) maneuver in predicting difficult laryngoscopy and intubation.

Materials and Methods: Seven hundred and sixty patients were included in the study. All the patients underwent MT and LJP maneuver for their airway assessment. After a standardized technique of induction of anesthesia, primary anesthetist performed laryngoscopy and graded it according to the grades described by Cormack and Lehane. Sensitivity, specificity, accuracy, and positive predictive value (PPV) and negative predictive value (NPV) were calculated for both these tests with 95% confidence interval (CI) using conventional laryngoscopy as gold standard. Area under curve was also calculated for both, MT and LJP maneuver. A $P < 0.05$ was taken as significant.

Results: LJP maneuver had higher sensitivity (95.9% vs. 27.1%), NPV (98.7% vs. 82.0%), and accuracy (90.1% vs. 80.3%) when compared to MT in predicting difficult laryngoscopy and intubation. Both tests, however, had similar specificity and PPV. There was marked difference in the positive and negative likelihood ratio between LJP and MT. Similarly, the area under the curve favored LJP maneuver over MT.

Conclusion: The results of this study show that LJP maneuver is a better test to predict difficult laryngoscopy and tracheal intubation. We recommend the addition of this maneuver to the routine preoperative evaluation of airway.

Key words: Airway, difficult intubation, lower jaw protrusion maneuver, Mallampati test

Introduction

Unanticipated difficult laryngoscopy and tracheal intubation always remain a primary concern for the anesthesiologist, as the failure to maintain a patent airway after the induction of general anesthesia is one of the most common cause of anesthesia-related morbidity and mortality.[1] Difficult laryngoscopy and tracheal intubation can cause soft-tissue damage,[2,3] bronchial intubation, laryngospasm, bronchospasm, inability to ventilate or intubate, hypoxic brain injury, and even death.[1,4,5] The reported incidence of a difficult laryngoscopy and tracheal intubation varies from 1.5% to 13% in patients undergoing elective surgery.[6] Because of potentially serious consequences of failed tracheal intubation, considerable attention has been focused on attempts to predict patients in whom laryngoscopy and intubation might be difficult,[5,7] and in this regard combination of different test and scores are developed, but none of them have proven to be totally reliable.[5,8,9]

Although difficult intubation is defined in a number of ways, but visualization obtained during laryngoscopy remains the mainstay of definition.[10] Cormack and Lehane defined the grade of laryngoscopic view and they are widely used to label the difficulty of tracheal intubation.[11,12]

Modified Mallampati test[13] (MT) is the most widely used tool in the armamentarium of an anesthesiologist for the assessment and prediction of difficult airway. The pitfalls associated with this MT are its low sensitivity[14,15] and poor interobserver reliability.[7,9,16]

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Lower jaw protrusion (LJP) maneuver is a well-established simple bedside maneuver for predicting difficult airways in number of studies. It has a relatively simple grading system in which patients were graded depending on the extent to which they could translate their temporo-mandibular joint to approximate their superior to inferior incisors.[17-19] Although the importance of jaw thrust during laryngoscopy has been described some 100 years back,[20] there are number of studies published in the last decade recommending the addition of LJP maneuver in the routine evaluation of airway examination.

The objective of our study was to compare the sensitivity and specificity of MT with LJP maneuver in predicting difficult laryngoscopy and tracheal intubation using Cormack and Lehane's criteria of intubation as the gold standard.

Materials and Methods

After obtaining approval from Ethics Review Committee of the hospital (reference number 703-Ane/ERC-07) and obtaining informed consent, 760 patients were enrolled in the prospective observational study, which was conducted at preoperative clinic, preoperative waiting area, and operating rooms of a tertiary care hospital. ASA I-III patients aged above 18 years of either sex who were scheduled for elective surgeries under general anesthesia requiring tracheal intubation were included in the study. Patients who were bed bound, edentulous, having oral pathology, obesity [body mass index (BMI) > 28 Kg/m^2], previous history of difficult intubations, Glasgow Coma Scale (GCS) 14 or below, those undergoing obstetric or emergency procedures, and those who refused consent were excluded from the study.

Patient's airway was assessed by the principal investigator at either of the above-mentioned areas. Cormack and Lehane's criteria of laryngoscopy were taken as gold standard and MT and LJP maneuvers as under study methods. The MT was performed with the patient in the sitting position, head neutral, mouth wide open, tongue protruded to its maximum, and patient not phonating. Classification was assigned into one of the four grades [Table 1]. Out of the four grades of modified MT, grades I and II were considered as predictors of "Easy" laryngoscopy and intubation, while grades III and IV as predictors of "Difficult" laryngoscopy and tracheal intubation. The LJP maneuver was performed by asking the patient to protrude his or her lower jaw as much as possible beyond the upper jaw. Patient was then assigned to one of the three grades of mandibular protrusion[16] [Table 2]. LJP grade A was considered as predictor of "Easy" and grade B and C as predictors of "Difficult" laryngoscopy and tracheal intubation. Cormack and Lehane's classification of difficult intubation was also classified as "Easy" (grades I and II) or "Difficult" (grades III and IV). All this information was recorded in a prescribed proforma. Biometric patient data including age, sex, weight, height, BMI, ASA status, and surgical specialty was also noted.

Patient was then transferred to operating room and head ring was placed below the head with routine monitors [Electrocardiography (ECG), Non Invasive Blood Pressure (NIBP), Pulse Oximetry (SpO_2)] were applied. After obtaining baseline readings, an intravenous access was maintained with Lactated Ringer's solution. Patient was preoxygenated with 100% oxygen for 3 min. Anesthesia was induced with fentanyl 2 μg/kg, propofol 2 mg/kg, and atracurium 0.5 mg/kg. Patients' were then manually ventilated for 3 min using circle system; during this period, anesthesia was maintained with 50% N_2O in O_2 and isoflurane (≤0.5-1%). An anesthetist with an experience of more than 2 years, blinded to the result of LJP maneuver, was asked to perform laryngoscopy and intubation. This was graded according to Cormack and Lehane's criteria and was documented on a separate form along with the duration of laryngoscopy and number of attempts to successful tracheal intubation. For laryngoscopy, Macintosh blade of size 3 was used, while tracheal intubation was done using polyvinylchloride orotracheal tube of size 7-mm ID and 8-mm ID for females and males, respectively.

Sample size was calculated in order to obtain a power of 80% and level of significance of 5% using area under curve (AUC) between 0.55 to 0.90 and a difference of 0.1 in the area considering the difficulty of 10%. All the relevant data were analyzed by using SPSS version 14.0. Percentages were generated for qualitative variable like gender and compared by Chi-square test. For quantitative variables like age, height, weight, and gender, mean and standard deviation were computed and compared by using *t*-test. Sensitivity, specificity, accuracy, and positive and negative predictive values were calculated for MT and LJP maneuver with 95% confidence

Table 1: Modified Mallampati test[5,6]

Grade I	Visualization of the soft palate, fauces; uvula, anterior and the posterior pillars
Grade II	Visualization of the soft palate, fauces and uvula
Grade III	Visualization of soft palate and base of uvula
Grade IV	Only hard palate is visible. Soft palate is not visible at all

Table 2: Lower jaw protrusion maneuver[16]

Grade A	Lower incisors can be brought anterior to the upper incisors
Grade B	Lower incisors can only be protruded edge to edge with upper incisors
Grade C	Lower incisors cannot be protruded edge to edge with upper incisors

interval (CI) using laryngoscopic view as gold standard. AUC was also computed by receiving operative curve (ROC). A $P < 0.05$ was taken as significant.

Results

Seven hundred and sixty patients were enrolled and completed the study. There was a predominance of female participant (55.5% vs. 44.5%). The mean values of weight, height, and BMI of study patients were within normal range with no significant effect on airway examination. Other biometric details are shown in Table 3.

More than 90% of participants had an "Easy" grade of Mallampati, while nearly 9% have a "Difficult" Mallampati grade. Similarly, 69.6% of the patients enrolled in the study had "Easy" grade of LJP test and 30.4% patients as "Difficult" grade [Table 4].

There was no grade IV intubation. The mean intubation time in our study was 21.08 ± 7.57 s.

When the "Easy" grades of Mallampati were compared with Cormack and Lehane's grades, there were 17.9% participants who have actually difficult laryngoscopic grades, i.e., grades III and IV of Cormack and Lehane, while out of 71 patients that were predicted by MT as having difficult grades of laryngoscopy and intubation, only 32.2% found to have easy grade of Cormack and Lehane [Table 4].

Similarly, when "Easy" grades of LJP were compared with Cormack and Lehane's grades of intubation, only 1.3% were found to have difficult grades of intubation, while out of 231 patients that were predicted to have difficult intubation grades, nearly 29.4% of patients were actually found to have easy grade according to Cormack and Lehane, as shown in Table 4.

Statistical measures used to describe the predictive values for LJP maneuver and MT in predicting difficult intubations are shown in Table 5.

Using McNemar's test and with a 95% CI, statistically significant differences were observed between these two predictive tests ($P < 0.05$) showing higher level of sensitivity (95.9%) and accuracy (90.1%) for LJP maneuver than MT, which has a sensitivity and accuracy of 27.1% and 80.3%, respectively.

Discussion

Prediction of difficult laryngoscopy and tracheal intubation has been the primary focus of many research papers and many time tested methods have been developed to avoid difficult intubation and its related complications.[6,13] Problems with tracheal intubation can range from minor complications as mild soft-tissue damage, transient, and uncomplicated hypoxia to more severe effects leading to severe airway damage[5] to hypoxic brain injury and death.[1,4,5] Because of these potentially serious consequences of failed tracheal intubation, considerable attention has been focused on attempts to predict patients in whom laryngoscopy and intubation will be difficult.[15-19] Difficult intubation is defined in a number of ways, but an unanticipated poor laryngoscopic view is mainstay of definition.[10] Although many advances have been made and many time-tested methods, for example MT, sternomental distance, interincisor gap, upper lip bite test, thyromental distance alone or in combination, have been used to overcome the conundrum of an unanticipated difficult laryngoscopy and tracheal intubation but none of them are totally reliable.[8,9,14]

Objective of our study was to compare the sensitivity and specificity of MT with LJP maneuver in predicting difficult

Table 3: Demographic and anesthetic observations of the patients (*n*=760)

Variables	Overall statistics	Cormack and Lehane's		*P* values
		Easy (I and II) *n*=590	Difficult (III and IV) *n*=170	
Age (years)	43.44±14.93	40.97±14.22	52.03±14.18	0.0005
Weight (kg)	65.04±10.74	65.04±10.94	65.06±10.03	0.98
Height (cm)	163.01±8.69	163.40±8.73	161.63±8.44	0.019
BMI (kg/m^2)	24.38±2.86	24.26±2.91	24.81±2.63	0.025
Duration of laryngoscopy (min)	21.08±7.57	17.73±4.11	32.69±4.83	0.0005
Gender† (%)				
Male	338 (44.5)	268 (45.4)	70 (41.2)	0.326
Female	422 (55.5)	322 (54.6)	100 (58.8)	
Number of attempts† (%)				
1	705 (92.8)	586 (99.3)	119 (70)	0.0005
2	53 (7)	4 (0.7)	49 (28.8)	
3	02 (0.3)	0 (0)	2 (1.2)	

Data are presented as mean±SD or number (%), †Chi-square test used for qualitative, Independent t-test used for quantitative observation, BMI=Body mass index

Table 4: Laryngoscopic view of all patients with respect to Mallampati, LJP and Cormack (*n*=760)

Predictors		Cormack and Lehane's			Total (%)
		Easy		Difficult	
		I *n*=522	II *n*=68	III *n*=170	
Mallampati					
I	Easy	317	25	43	385 (50.7)
II		191	32	81	304 (40)
III	Difficult	14	10	39	63 (8.3)
IV		0	1	7	8 (1.1)
Lower jaw protrusion grade					
A	Easy	490	32	7	529 (69.6)
B	Difficult	32	32	105	169 (22.2)
C		0	4	58	62 (8.2)

Cormack and Lehane's grade IV, not observed in patients. TP=46, FP=25, FN=124, TN=565 for Mallampati, TP=163, FP=68, FN=7, TN=522 for LJP Grade, LJP=Lower jaw protrusion

Table 5: Predictive values for MMT and LJP and their combinations to predict the difficult laryngoscopy and tracheal intubation

	Mallampati	LJP
Sensitivity	27.06% (20.94, 34.19)	95.88% (91.75, 97.99)
Specificity	95.76% (93.82, 97.11)	88.47% (85.65, 90.81)
PPV	64.79% (53.18, 74.88)	70.56% (64.39, 76.07)
NPV	82% (79.96, 84.69)	98.56% (97.29, 99.36)
Accuracy	80.39% (77.42, 83.06)	90.13% (87.81, 92.05)
Likelihood ratio (+)	6.38 (5.26, 7.74)	8.32 (8.08, 8.57)
Likelihood ratio (–)	0.76 (0.74, 0.77)	0.046 (0.035, 0.061)
Area under the curve	61.4% (0.56 to 0.66)	92.2% (0.89 to 0.95)

95% confidence interval was computed by Wilson method, LJP=Lower jaw protrusion, PPV=Positive predictive value, NPV=Negative predictive value, MMT=Modified mallampati test

laryngoscopy and intubation using Cormack and Lehane's criteria of intubation as a gold standard. We could not find any study in which MT has been compared with LJP maneuver in nonobstetric and nonobese South Asian population.

The reported incidence of a difficult laryngoscopy and endotracheal intubation varies from 1.5% to 13% in patients undergoing surgery.[6] This variation in incidence might be due to different reference standard for difficult intubation among studies which were based on Cormack and Lehane's intubation grades, number of laryngoscopic attempts, and use of backward upward rightward pressure maneuver.[6]

In our study, we examined the airway of 760 patients who required general anesthesia and elective intubation and found the incidence of difficult intubation to be 22.4%, which is higher compared to previous studies. The probable reasons for this may be the use of more strict criteria for difficult intubation, as described by intubation grades III and IV of Cormack and Lehane's grading rather than using only grade IV as difficult intubation or relying upon Cook's modification of Cormack and Lehane's grading.[11] Another reason for this higher incidence could be the avoidance of external pressure during intubation. Majority of intubations (82.2%) in our study were done by an anesthetist with an experience of more than four years and none by an anesthetist with less than two years experience. Nevertheless, our reported incidence is quite comparable to the one reported by Bergler *et al.*, i.e., 20.2%.[12]

The high incidence of difficult LJP observed in our study can be attributed to the different classification used in our study wherein we collated grade B and grade C as difficult contrary to the classification used by Eberhart *et al.*[9] However if we also translate difficult as per Ebehart *et al*'s classification, the incidence of difficult LJP in our study would also be 8.2% which is very similar to Eberhart *et al.* [9].

The sensitivity of MT in our study is 22.4% which is quite comparable to that demonstrated by Vani *et al.*[14] who found it to be 25%. Siddiqui *et al.*[21] found the sensitivity of MT to be higher (42%) in his study, while other authors have found even higher sensitivities. This shows the wide interobserver variability, an issue which has been confirmed by Hilditch *et al.*,[7] Eberhart *et al.*,[9] and Karkouti *et al.*[15] who have shown poor interobserver reliability for MT. Sensitivity of LJP maneuver in our study was very high (95.6%), which is in contradiction with the work by James *et al.*[17] and Sava *et al.*[18] who have found the sensitivity to be 14.9% and 29.4%, respectively. This wide variation can also be attributed to interobserver variability and needs further evaluation. The accuracy of both tests is high and unchanged by their combination, similar to James *et al.*[17] By assessing the AUC, Table 5, LJP comes out to be a better predictor of difficult laryngoscopy and tracheal intubation.

The main strength of our study was that the LJP maneuver and MT were performed for the assessment of airway by primary investigator, which reduced the risks of interobserver variation and increased the reliability of the tests. We have not evaluated obstetric patients in our study where the incidence of unanticipated difficult intubation was quite high as compare to general population and as such there is a need to develop a more reliable predictive test in future in that specific specialty.

In conclusion, MT is the most commonly used test for the prediction of difficult laryngoscopy and tracheal intubation but with limited accuracy. We, therefore, recommend the addition of LJP maneuver to the routine preoperative evaluation of airway.

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