

Comparison of Positive Predictive value of Mallampati Test and Upper lip Bite test in Association with difficult intubation

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Abstract

Background: The upper lip bite test and Modified Mallampati Test are common bedside screening tests used to assess patient airway pre-operatively for possible difficult intubation, and guides anesthesiologists for better planning of airway management. For this sole purpose the evaluation of Positive predictive value and Comparison of both are essential and paramount for evidence-based airway assessment and management.

Objective: The study compares the Predictive performance of ULBT and MMT for Difficult Intubation in patients undergoing general Anesthesia.

Methods: This was an observational study where both tests were performed on 179 patients at Lady Reading Hospital, Peshawar. The primary outcome was difficult Intubation, defined as, more attempts required for intubation, takes more time than 10 seconds, and used advanced equipment for intubating the patient. Association was analyzed for ULBT and MMT against difficult intubation via Chi

Square at alpha level of 0.05, Predictive accuracy was analyzed via Receiver Operating Curve (ROC), predictive values (PPV) were manually calculated for each class of the ULBT and MMT.

Results: The incidence of difficult Intubation in the study was 7.8% (n=14), with statistically significant association of ULBT and MMT with difficult intubation (ULBT $\chi^2=25.09$, $p<0.001$; MMT $\chi^2=32.78$, $p<0.001$). The PPV for ULBT class III

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was 45.5% (n=5/11) and for MMT class IV it was 75% (n=3/4), MMC class III had 17.1% of PPV. As per ROC analysis, there was moderate and comparable diagnostic accuracy, ULBT Area under the Curve (AUC): 0.749 and MMT AUC: 0.755.

Conclusion: Both these tests' higher classifications are significantly associated with difficult intubation, MMC had highest single class (MMT Class IV) PPV, while ULBT had absolute greater number of difficult cases. The moderate AUC supports multimodal or multi-parameter approach as no single standalone test is highly reliable.

Introduction:

Difficult intubation is a major challenge for an anesthesiologist or first assistant of anesthesia during airway management or induction of general anesthesia for a procedure requiring secured airway. There are established criteria to classify an intubation as difficult one, which includes 3 Basic observations based on techniques applied for intubation. If there is more than one attempt by a trained anesthesiologist, or if they have used any accessory or instrument other than basic rigid laryngoscope including stylet or even bougie, or the attempt takes more than 60 Seconds, will be classified as difficult intubation (1).

There is one other method of classification known as Cormack-Lehane Classification which in a way helps anesthesiologist decide for potential difficult airway and the team has to prepare in advance according to it for patient safety and quality airway management (2).

Though other alternative tests also exist, making decisions and planning for airway management easier either in combination or alone, these are bedside screening tests for assessing whether the airway management will be easy or difficult. The predictive value may vary because of anatomic variations and airway issues in the patient. The tests or evaluation performed preoperatively before induction of anesthesia include Mouth opening with inter-incisor gap, anatomic aspects of oral cavity and tongue, Thyromental, sterno-mental and hyo-mental distance, neck mobility and neck circumference.(3)

It is paramount for anesthesiologists to securely manage the patient airway to avoid potential complications including hypoxia, aspiration, post-operative laryngospasm and intraoperative bronchospasm. Utilizing proper predictive tools enhances competence of anesthesia care providers in decision making for possible difficult airways and promptly acting in accordance with it. It has been reported that 1.3% to 13% of patients scheduled for General Anesthesia (GA) had clear signs of difficult airway and hence difficult laryngoscopy and intubation as well (4,5).

There is variation of difficult intubation in emergencies, which is reported to be between 3.0 and 4.0% (6). In at least 1% of cases, it was reported to have single laryngoscopy attempt in a difficult airway during intubation (6), whereas other study reported 1.8% of difficult airways required two or more attempts of laryngoscopy (7).

The major causes of encountered difficult airway, laryngoscopy, and intubation were lack of proper pre-operative assessments leading to unavailability of equipment to manage such airways, in-experience and poor techniques applied. There are congenital causes that may promptly identify the patient for difficult airway, these include Down Syndrome, Treacher Collins syndrome, Pierre Robin and Marfan's Syndrome. Other anomalies include achondroplasia, cystic hygromas, and encephalocele. These all have reduced jaw and neck movements restricting access to airway with simple rigid curved laryngoscopes, requiring more advanced equipment to secure the airway and intubate the trachea (8,9).

If there's any swelling, deformities or burns due to any reason including radiation, it makes the airway more difficult to manage. Infection of the upper respiratory tracts, trauma and hematoma of the facial region, oral cavity or airway at any anatomic location makes it obvious sign of difficult intubation. A patient with medical history

of stridor or air hunger sound, hoarseness sound, not be able to lay down in supine are also signs for directing anesthesia care provider for possible compromised airway (10). Management of such difficulties has associated complications which may make the patient more vulnerable to morbidities and mortality, putting stress on the anesthesia care provider and decreasing patient satisfaction. This also increases the anxiety of the patients and may add up to increased hospital stay and delayed recovery. Complications include Hypoxia, laryngeal trauma due to multiple attempts, oral cavity and oropharyngeal trauma, lips injury, Uvula Damage, Arytenoid dislocations, Hemodynamic changes, and increase chances of pulmonary aspiration and aspiration pneumonitis (11).

As there are greater probabilities of complication in managing difficult airway, putting patients at high risk of morbidities and mortalities. This makes it paramount for anesthesia care providers to implement available bedside screening tests to promptly evaluate the extent of difficulty that could possibly alleviate the predisposing risk of complications. This study provides evidence-based information on Mallampati test and Upper lip bite tests for the positive predictive value for better planning and decision-making process.

Research Gap:

Previous research has worked on the single test in comparison to Standard Cormack and Lehane Classification of glottic view (12), and another study worked on Mallampati and ULBT for their classes in association with encounter difficulty, a cross section descriptive study, conducted in Peshawar (13). In this study we are aiming to assess the positive predictive value of both these bedside screening tests in patients who have presented for surgeries that were performed under GA requiring tracheal intubation.

Research Objective:

This research objective was to evaluate the Mallampati test and Upper lip Bite test on individual patients so to assess the positive predictive value of both tests separately in every individual patient included in the study.

Material and Methods:

This cross-sectional study was performed at LRH, hospital Peshawar, where 179 patients were included in the study of ages between 18 to 60 years, ASA class I and II. Obvious signs and symptoms of difficult airway, parturient women, edentulous patients were excluded from the study. Data collection were done on pre-validated data sheets which have three components, one for classifying the patient's airway according to Mallampati test, second component included Upper lip bite tests assessment, and third component was to record three parameter of basic understanding of difficult intubation, more than one attempt, use of special equipment for assistance, taking more than 10 seconds for intubation. This criterion was utilized to identify difficult airway cases.

Data Analysis:

Data was analyzed through SPSS version 22, where descriptive statistics were tabulated for age, gender, Mallampati classification and upper lip bite gradings. Cross tabs were generated for manual retrieval and calculation of Positive predictive values (PPVs) for both the tests where airway being difficult was considered as positive outcome. Later both the predictive values were compared, and inferences were made in accordance. The confidence level for this study is 95% with margin of error of 5% keeping significance level of 0.05. ROC curve analysis was also implemented for understanding and comparisons of the sensitivity of each test.

Results:

The mean age of total 179 patients was 33.82 years with standard deviation of 12.71 years with max age of 60 years and minimum age of individual recorded was 18 years. Total of n=81 (45.3%) were males and n=98 (54.7%) were females included in this study. All individuals' airway were assessed via both Modified Mallampati Classification (MMC) and Upper Lip Bite Test (ULBT), of which the higher grades for MMC that is MMC Class III and MMC Class IV, in cumulative, were total n=39 (21.8%) of total 179, and the higher class of ULBT, Class III were n=11 (6.1%) of the cases. There were at least n=14 (7.8%) cases of difficult intubation, remaining n=165 (92.2%) cases were of easy intubation requiring no assistance, or multiple attempts and were intubated within first 10 seconds. (Table 1 and 2).

Table 1: Age and Descriptive Statistics

Descriptive Statistics	Range	Min.	Max.	Mean	Std. Dev.
Age(yrs.)	42	18	60	33.82	12.711

Table 2: Demographics

Variable(s)		Frequency	Percent	Cumulative %age
Gender	Male	81	45.3	45.3
	Female	98	54.7	100.0
ULBT	Class I	64	35.8	35.8
	Class II	104	58.1	93.9
	Class III	11	6.1	100.0
MMC	Class I	62	34.6	34.6
	Class II	78	43.6	78.2
	Class III	35	19.6	97.8
	Class IV	4	2.2	100.0
Difficult Intubation	Yes	14	7.8	7.8
	No	165	92.2	100.0
	Total	179	100.0	

The upper lip bite test classification for difficult intubation revealed that the higher the class of ULBT the higher positive predictive value (PPV) of difficult intubation, as this study reports 45.5% PPV for ULBT Class III with n=5 cases in total 14 Difficult intubations. There was a significant association between ULBT and difficulty cases for airway securing via endotracheal tube with Chi squared value of 25.08 and p value <0.001. (Table 3)

Table 3: ULBT class X Difficult Intubation Cross Tab and Positive Predictive Value (PPV)

Difficult Intubation		Yes	No	Total	PPV
Upper lip bite Test Classification	Class I	1	63	64	1.6%
	Class II	8	96	104	7.7%
	Class III	5	6	11	45.5%
Total		14	165	179	
Pearson Chi Squared Value				25.08	
df.				2	
Asymp. Sig. (2 Sided)				<0.001	

Modified Mallampati classification (MMC) are categorized into 4 major classes, with degree of freedom (df) of three, calculating positive predictive values for each class separately. That provided 75% of PPV for MMC class IV, showing more probability of difficult intubation when classified as class IV MMC, while there is moderate PPV of 17.1% with MMC Class III. The results show highly significant association between higher classes of MMC and Observed Difficult Cases as the p value is <0.001 with high Chi Squared value of 32.78 (Table 4).

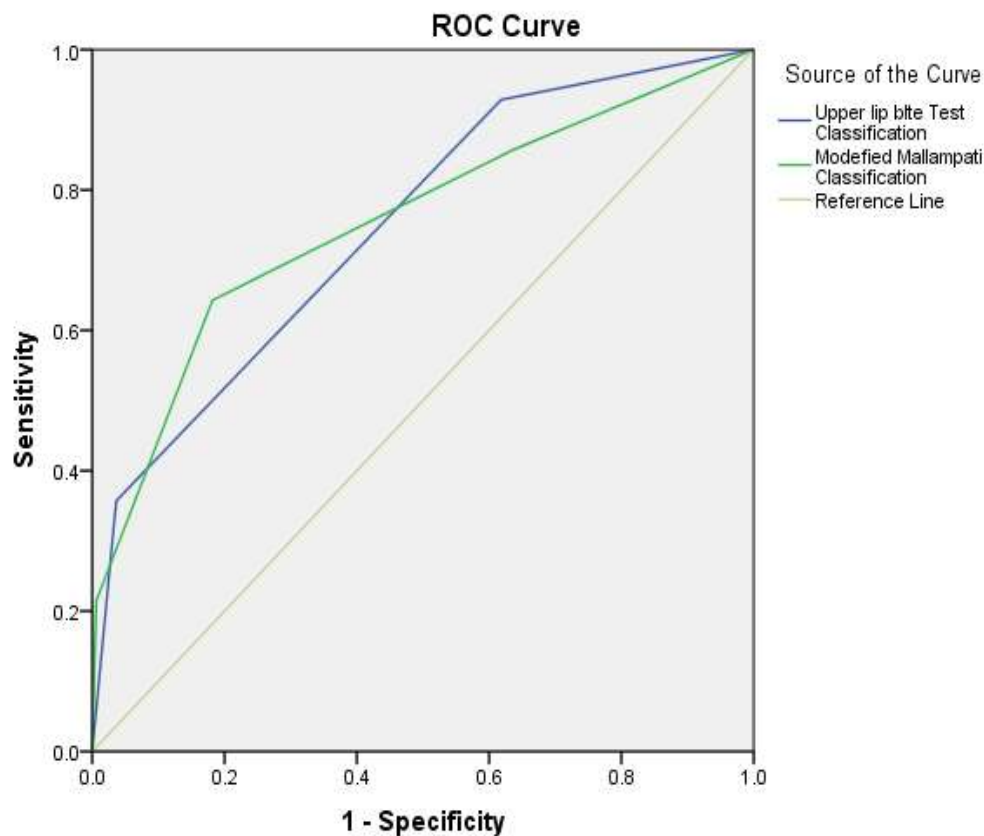
Table 4: Modified Mallampati Classification (MMC) X Difficult Intubation Cross Tab and Positive Predictive Value (PPV)

Difficult Intubation		Yes	No	Total	PPV
Modified Mallampati Classification	Class I	2	60	62	3.2%
	Class II	3	75	78	3.8%
	Class III	6	29	35	17.1%
	Class IV	3	1	4	75.0%
Total		14	165	179	
Pearson Chi Squared Value				32.78	
df				3	
Asymp. Sig. (2 Sided)				<0.001	

Receiver Operating Curve (ROC) with its Area under the Curve (AUC) for both the tests were run through SPSS, which resulted in 0.794 AUC for ULBT, with p value= 0.002, suggesting significantly better than just a chance with slight differences when compared to MMC for its area of 0.755 at p value of 0.002. A grading of ULBT above ULBT class 1 showed more specificity (96.4%) while classes above MMC class I showed more Sensitivity (85.7%). (Table 5, Fig. 1)

Table 5: Area Under the Curve with ROC for ULBT and MMC

Test Result Variable(s)	Area	Std. Error	Asymptotic Sig. ^b	95% Confidence Interval	
				Lower Bound	Upper Bound
Upper lip bite Test Classification	.749	.069	.002	.613	.884
Modified Mallampati Classification	.755	.078	.002	.602	.907



Diagonal segments are produced by ties.

Figure 1: ROC Curve; ULBT compared with MMC

Discussion:

This study aimed to assess the predictive values of both bed side airway assessment tools, Upper Lip Bite Test (ULBT) and Modified Mallampati Classification (MMC) for predicting difficult intubation and their comparison via ROC and AUC for assessment of sensitivity and specificity. The study age distribution of the included patient showed 65.4% of the sample within 18-35 years of age, presenting with more challenges as per their airway changes with the age progression.

There were 58.1% of patients classified as ULBT class II and 43.6% as MMC Class II. The high-risk classification was seen in 6.1% of patients (ULBT class III) and in 19.6% of patients with MMC class III, and 2.2% of patients with MMC class IV. There was highly significant association of ULBT and MMC with Difficult Intubation ($p < 0.001$). MMC class IV and ULBT class III showed higher proportion of difficult cases, suggesting higher classes or grades of both these assessment tools have more correlation with increased intubation difficulties.

The diagnostic accuracy was assessed with ROC and AUC for both tools, which has provided AUC of 0.749 for ULBT and 0.755 for MMC, indicating moderately similar ability of discrimination for difficult intubations with statistically high significance ($p = 0.002$) affirming tests performance was better than just a chance. Studies on pediatric population have reported that both MMC (86.4% sensitivity) and ULBT (72.7% Sensitivity) are good screening test and somewhat comparable accuracy (90.8%) (14).

There is stronger possibility of difficulties in airway management for MMC class IV with PPV of 75%, while ULBT class II had 45.5% of PPV for difficulties. This comes at cost of sensitivity, as 3 out of 14 are classified as MMC class IV, and 5 out of 14 are classified as ULBT Class III, identifying more cases suggesting more probability of recognizing higher risks with ULBT in broader population. This pattern is supported by other comparative studies including study conducted in 2019, comparing both test directly, with Higher PPV (71.87%) for ULBT and 33.33% for MMC (15). Another study also reported higher PPV and Specificity in Obese patients for ULBT compared to MMC (16).

These moderate variations and moderate sensitivities and specificities at higher grades suggest that both tool alone are not sufficient predictors, as aligned with existing literature, enforcing multi-parameters for airway assessment would help in pre-operative airway evaluation and preparing for possible complications. ULBT turns up with better balance of sensitivity, specificity and PPV compared to MMC according to most of the studies (15,16).

The higher Chi squared value (ULBT 25.09 and MMC 32.74) with $p < 0.001$, is suggestive of high association with difficult intubation, but the moderate AUC and PPV differences have shown that neither test is alone reliable for screening of airway, as aligned with other studies (17).

Limitations:

The study is inclusive of 179 patients, which yielded only 14 difficult cases, this limits its generalizability. A retrospective study or inclusion of more samples in given population with multiple screening tools would help in avoidance of selection bias, and confounding variables like BMI, Neck circumference or history of Obstructive Sleep Apnea are to be addressed as well.

Conclusion:

In conclusion the results are contributive to existing literature, as ULBT is valuable screening tool with superior predictive nature for difficult intubation as compared to MMC because of higher specificity and PPVs. However, the moderate difference in predictive powers as confirmed by AUCs, confirms multi-Parameter approaches towards airway assessment.

Ethical Consideration:

All the aspects of Ethical research were observed, confidentiality was maintained, no harm to the patients were done, as these test are basic screening test that can be assessed by directing the patients, no treatment was withheld and no test treatments were provided to the patient.

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