

Diagnostic Accuracy of Upper Lip Bite Test Versus Modified Mallampati for Predicting Difficult Airway in Patients coming for Surgery in a Tertiary Care Hospital

Diagnostic Accuracy of ULBT Versus MMT for Difficult Airway

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ABSTRACT

Objective: This study aimed to compare the diagnostic accuracy of the ULBT and MMT for predicting difficult laryngoscopy when using the Cormack and Lehane (CL) grading system as the gold standard.

Study Design: Cross-sectional validation study

Place and Duration of Study: This study was conducted at the Shifa International Hospital, Islamabad, during October 2025 till March 2026.

Methods: This study conducted on 211 patients undergoing elective surgery under general anesthesia. Pre-operative airway assessments like MMT and ULBT were performed by the primary investigator. During surgery a second anesthesiologist did laryngoscopy and recorded the CL grade. Diagnostic accuracy indices such as the sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and overall accuracy were calculated and compared for both tests.

Results: Difficult airways (CL grade 3) were seen in 22 patients (10.4%). The ULBT had a superior diagnostic performance compared to the MMT across all indices. ULBT had a sensitivity of 86.4%, specificity of 96.3% and accuracy of 95.3% (AUC 0.887). In contrast, the MMT showed lower sensitivity (77.3%), specificity (82.5%) accuracy (82.0%; AUC 0.804), with a notably low PPV (34.0%) indicating a high false-positive rate.

Conclusion: Upper Lip Bite Test proved to be a more accurate and reliable bedside predictor of difficult laryngoscopy than the Modified Mallampati Test.

Key Words: Airway, Intubation, Laryngoscopy, Upper Lip Bite

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INTRODUCTION

Despite the tremendous advances in anesthesia techniques and equipment, the occurrence of a difficult airway during intubation still leads to serious anesthesia-related injuries and is the most common cause of anesthesia malpractice claims.^{1,2} According to the 2022 American Society of Anesthesiologists Practice Guideline for Management of the Difficult Airway, difficult airways can be further divided into seven types: difficult facemask ventilation, difficult laryngoscope, difficult supraglottic airway ventilation,

difficult or failed tracheal intubation, difficult or failed tracheal extubation, difficult or failed invasive airway, and inadequate ventilation.³ The incidence of difficult intubation as high as 1–18% is still a difficult situation for clinical anesthesiologists.^{4,5} The worst-case situation is "cannot intubate cannot oxygenate (CICO)", and up to one-third of anesthesia-related deaths are due to failure to intubate and ventilate, so this deserves our utmost attention. The occurrence of a difficult airway can lead to tracheal or esophageal injury, aspiration, and severe hypoxemia, which can cause irreversible brain damage and lead to death.⁶ Unfortunately, there is still no consensus on the best method to assess a difficult airway.⁷ Many researchers have attempted to predict difficult intubation by using simple bedside physical examinations, such as the upper lip bite test (ULBT) and the modified mallampati test (MMT).⁵ It has been reported that ULBT appears to be a useful bedside test for predicting difficult airways with moderate sensitivity and high specificity, with higher accuracy than MMT.^{8,9} Any test needs to be proven over and over again. In some studies, assessment of ULTB was a better or moderate predictor to difficult

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airway than MMT.^{8,10} but in some studies ULBT is not superior to MMT.¹¹ Kar S et al 2022[12] reported the occurrence of difficult intubation was found to be 10.2% (23/225 patients) and the sensitivity, (95.5% vs. 95.4%), specificity (54.8% vs. 50.0%), positive predictive value (91.6% vs. 93.1%), and negative predictive value (39.1% vs. 39.1%) were almost comparable between modified Mallampati test and upper lip bite test. Wang LY 2022 et al¹¹ reported the incidence of difficult airway was 13.5% and the sensitivity, specificity and accuracy for ULBT was 11.59%, 93.96%, 81.33% for MMT 62.32%, 69.29%, 66.2%.

The purpose of this study was to find the simplest and most intuitive strategy for predicting difficult intubation during direct laryngoscopy in patients who did not have risk factors for difficult airways, as well as to evaluate the utility of the modified Mallampati test and upper lip bite tests in this regard.

METHODS

A cross-sectional validation study was conducted in the Department of Anesthesiology, Shifa International Hospital, Islamabad, during October 2025 till March 2026, with the objective of determining the diagnostic accuracy of the Upper Lip Bite Test (ULBT) and Modified Mallampati Test (MMT) for predicting difficult airways in patients undergoing surgery, using the Cormack and Lehane (CL) grading system as the gold standard. Difficult airway was defined as the clinical situation in which a conventionally trained anesthesiologist experienced difficulty with face-mask ventilation of the upper airway, difficulty with tracheal intubation, or both. The sample size was calculated on the basis of a previous study by Kar et al. [18], which reported an occurrence of difficult intubation of 10.2% (23/225 patients), with sensitivity of 95.5% and 95.4% and specificity of 54.8% and 50.0% for MMT and ULBT, respectively, when compared with the Cormack and Lehane classification. A total of 211 patients were required to estimate the diagnostic accuracy of ULBT and MMT with a 9% margin of error and a 95% confidence interval. Consecutive sampling was used for patient recruitment. Patients aged 18 to 70 years, with ASA physical status I to III, who were scheduled for elective surgery requiring general anesthesia with laryngoscopy and endotracheal intubation for orthopedic, thoracic, neurosurgical, or general surgical procedures were included. Patients with limited mouth opening, BMI >35 kg/m², a history of burns or trauma to the airway, inability to stand erect or sit, edentulous patients, tumors or masses involving the cervical or facial regions, limited cervical movement due to conditions such as rheumatoid arthritis or cervical disc disorders, pregnant women, and patients undergoing emergency surgery were excluded. On the day before surgery, the primary investigator, an anesthesiologist, visited the enrolled patients and recorded relevant

information, including type of surgery, age, gender, weight, height, BMI, ASA physical status, medical history, ULBT grade, and MMT grade, on a structured data collection proforma. The Modified Mallampati Test was performed with the patient in a sitting position by asking the patient to open the mouth maximally and protrude the tongue without phonation, and the oropharyngeal structures were visualized using a torch or flashlight. The Upper Lip Bite Test was performed by asking the patient to bite the upper lip with the lower incisors and was graded as Grade I when the lower incisors could bite the upper lip above the vermilion line, Grade II when the lower incisors could bite the upper lip below the vermilion line, and Grade III when the lower incisors could not bite the upper lip. ULBT Grades I and II were considered predictive of easy intubation, whereas Grade III was considered predictive of difficult intubation. On the day of surgery, a second anesthesiologist with more than five years of anesthesia experience performed direct laryngoscopy after induction of anesthesia and sufficient muscle relaxation and assessed the laryngoscopic view using a Macintosh laryngoscope with a size 3 or 4 blade. The CL grade obtained during direct laryngoscopy was considered the gold standard for determining difficult laryngoscopy. In the operating room, routine monitoring, including non-invasive arterial blood pressure, electrocardiography, and oxygen saturation, was applied. Patients were preoxygenated with 100% oxygen for three minutes. General anesthesia was induced according to the discretion of the primary anesthesiologist, and the use of a non-depolarizing muscle relaxant was also determined by the primary anesthesiologist according to routine clinical practice. Anesthesia was maintained using a 50:50 oxygen and nitrous oxide or air mixture with isoflurane or sevoflurane, and ventilation was performed by bag-mask ventilation until the patient was completely paralyzed. The patient's head was placed in the sniffing position before laryngoscopy. For assessment of MMT against the CL classification, MMT Grades III and IV were considered a positive test result for difficult laryngoscopy and CL Grades III and IV were considered positive for difficult laryngoscopy. The collected data were entered and analyzed using appropriate statistical software. Continuous variables were summarized using mean and standard deviation, while categorical variables were presented as frequencies and percentages. The association between the airway assessment tests and CL grades was assessed using the Chi-square test or Fisher's exact test where appropriate, and diagnostic accuracy measures were reported with 95% confidence intervals. A p-value of <0.05 was considered statistically significant.

RESULTS

The sample comprised 130 men (61.6%) and 81 women (38.4%). Most patients were ASA class II (49.3%), followed by ASA I (39.8%) and ASA III (10.9%). On

the Cormack-Lehane gold standard, 22 patients (10.4%) had a difficult airway (grade 3); MMT classified 50 patients (23.7%) as difficult, and ULBT classified 26 patients (12.3%) as difficult.

Table No.1: Frequency and percentage distribution of categorical variables (N = 211).

Category	Frequency	Percent (%)
Gender – Male	130	61.6
Gender – Female	81	38.4
ASA – I	84	39.8
ASA – II	104	49.3
ASA – III	23	10.9
Cormack-Lehane grade 1	137	64.9
Cormack-Lehane grade 2	52	24.6
Cormack-Lehane grade 3	22	10.4
MMT grade 1	105	49.8
MMT grade 2	56	26.5
MMT grade 3	44	20.9
MMT grade 4	6	2.8
ULBT grade 1	111	52.6

ULBT grade 2	74	35.1
ULBT grade 3	26	12.3

Tables 2a and 2b present the 2×2 contingency tables of MMT and ULBT against the Cormack-Lehane gold standard (grade 3 = difficult airway).

Table 2a: 2×2 contingency table: MMT vs Cormack-Lehane gold standard.

	CL Difficult	CL Easy	Total
MMT Difficult	17	33	50
MMT Easy	5	156	161
Total	22	189	211

Table 2b: 2×2 contingency table: ULBT vs Cormack-Lehane gold standard.

	CL Difficult	CL Easy	Total
ULBT Difficult	19	7	26
ULBT Easy	3	182	185
Total	22	189	211

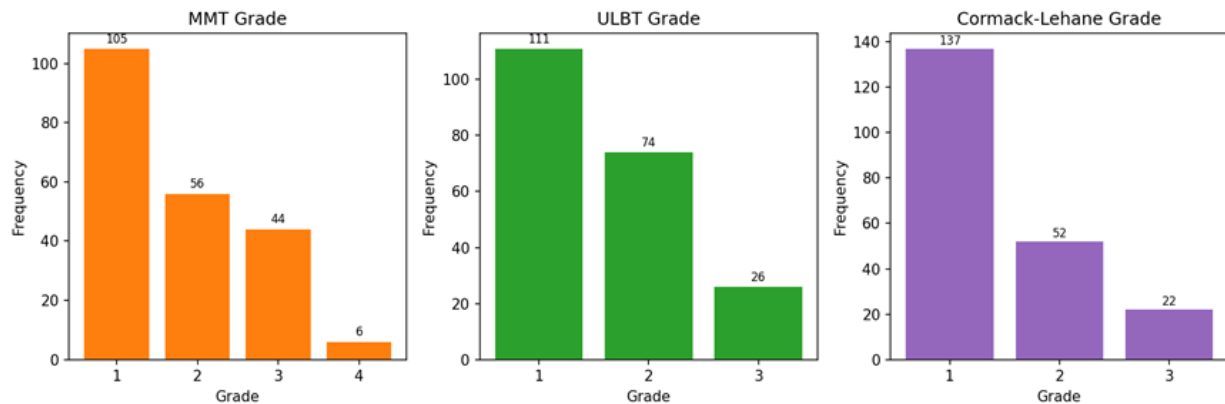


Figure No.1: Frequency distribution of MMT, ULBT and Cormack-Lehane grades.

Table No.3: Diagnostic accuracy of MMT and ULBT against the Cormack-Lehane gold standard (95% CI, Wilson score method).

Test	Sensitivity % (95% CI)	Specificity % (95% CI)	PPV % (95% CI)	NPV % (95% CI)	Accuracy % (95% CI)
MMT	77.3 (56.6–89.9)	82.5 (76.5–87.3)	34 (22.4–47.8)	96.9 (92.9–98.7)	82 (76.2–86.6)
ULBT	86.4 (66.7–95.3)	96.3 (92.6–98.2)	73.1 (53.9–86.3)	98.4 (95.3–99.4)	95.3 (91.5–97.4)

Overall, ULBT outperformed MMT on every diagnostic index. ULBT achieved a sensitivity of 86.4% (95% CI 66.7–95.3), specificity of 96.3% (95% CI

92.6–98.2), PPV of 73.1%, NPV of 98.4% and overall accuracy of 95.3% (95% CI 91.5–97.4). MMT achieved a lower sensitivity of 77.3% (95% CI 56.6–89.9),

specificity of 82.5% (95% CI 76.5–87.3), a notably lower PPV of 34%; reflecting a high false-positive rate (33 of 189 true-easy airways misclassified as difficult) and an overall accuracy of 82% (95% CI 76.2–86.6).

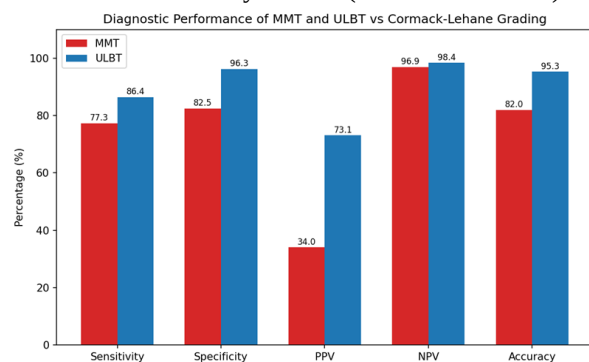


Figure No. 2: Diagnostic performance metrics of MMT vs ULBT (sensitivity, specificity, PPV, NPV, accuracy).

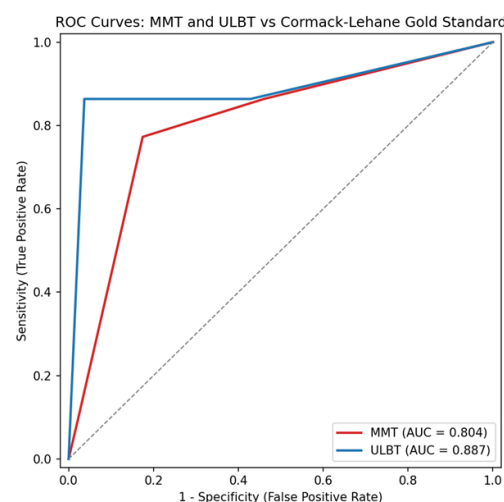


Figure No. 3: ROC curves for MMT and ULBT against the Cormack-Lehane gold standard.

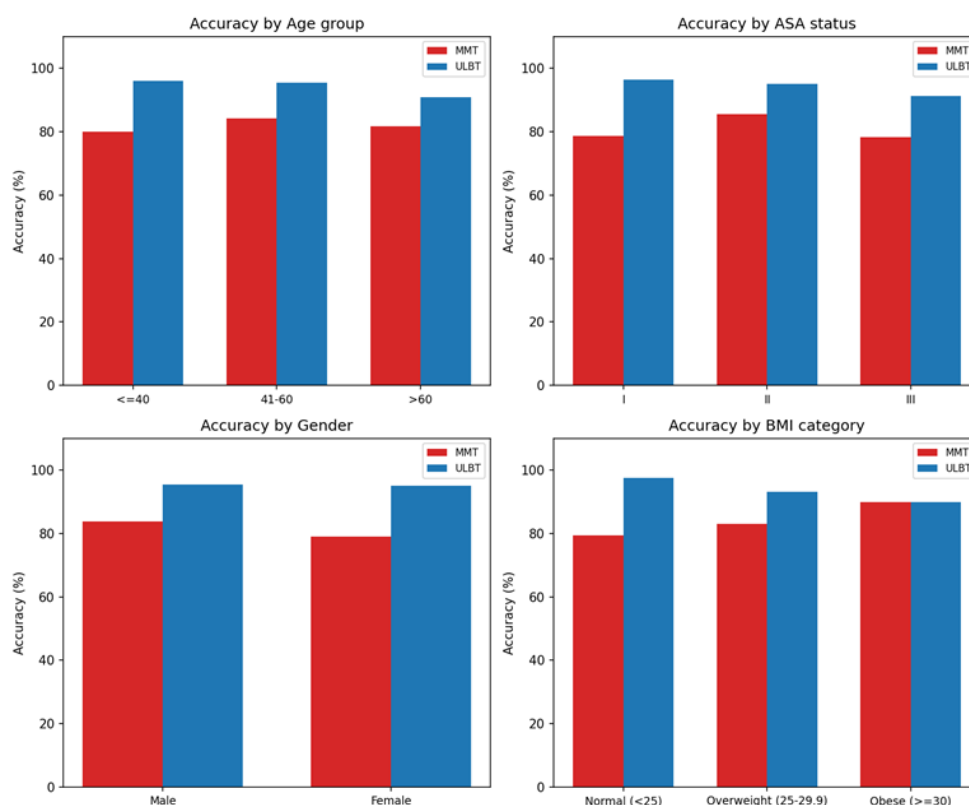


Figure No.4: Stratified accuracy of MMT and ULBT by age group, ASA status, gender and BMI category.

Stratified by Age group

Table No. 4: Diagnostic accuracy of MMT and ULBT vs Cormack-Lehane, stratified by age group.

Subgroup	Test	N	Sens. %	Spec. %	PPV %	NPV %	Acc. %
≤40	MMT	100	77.8	80.2	28	97.3	80
≤40	ULBT	100	77.8	97.8	77.8	97.8	96
41-60	MMT	89	72.7	85.9	42.1	95.7	84.3

41-60	ULBT	89	90.9	96.2	76.9	98.7	95.5
>60	MMT	22	100	80	33.3	100	81.8
>60	ULBT	22	100	90	50	100	90.9

Stratified by ASA status

Table No.5: Diagnostic accuracy of MMT and ULBT vs Cormack-Lehane, stratified by asa status.

Subgroup	Test	N	Sens. %	Spec. %	PPV %	NPV %	Acc. %
I	MMT	84	62.5	80.3	25	95.3	78.6
I	ULBT	84	87.5	97.4	77.8	98.7	96.4
II	MMT	104	91.7	84.8	44	98.7	85.6
II	ULBT	104	91.7	95.7	73.3	98.9	95.2
III	MMT	23	50	81	20	94.4	78.3
III	ULBT	23	50	95.2	50	95.2	91.3

DISCUSSION

The superiority of ULBT over MMT observed in this cohort (accuracy 95.3% vs 82.0%; AUC 0.887 vs 0.804) is in line with the tests' original validation. Khan et al said that the ULBT and reported a accuracy of 88%, sensitivity of 76.5% and specificity of 88.7% for the test. These figures broadly in line with the present results¹⁰.

In a small, blinded comparison, Hester and colleagues found the ULBT outperformed MMT on every index. Sensitivity (55% vs 11%), specificity (97% vs 75%) and accuracy (90% vs 64%) a gap even larger than the one observed here in our study¹³. Within a South Asian population comparable to us, Ali et al. evaluated 324 patients in a Pakistani tertiary-care hospital. They have similarly reported significantly higher accuracy, PPV and NPV for ULBT over MMT but they did not find a significant difference in specificity between the two tests¹⁴.

Taken together, these studies support the general direction of the present findings: ULBT is a more discriminating single bedside test than MMT for anticipating difficult airway. A systematic review done by Moslemi F, et al. pooled 27 prospective studies of the ULBT against Cormack-Lehane. They have found that ULBT accuracy exceeds 85% in 24 of the 27 studies and specificity exceeded 85% in all but one, closely matching the 95.3% accuracy and 96.3% specificity obtained in the present dataset; however, ULBT sensitivity exceeded 70% in only 11 of the 27 pooled studies, indicating that the 86.4% sensitivity found here sits toward the favourable end of the reported range⁸. ULBT has been seen as a good predictor in other study too¹⁵.

Another systematic review and meta-analysis by Wang et al., synthesised 227 studies (686,089 patients) on multiple difficult-airway prediction methods. This was a huge study and reported pooled sensitivity/specificity of 0.39/0.86 for MMT and 0.52/0.84 for ULBT¹⁶.

Against this benchmark, both tests in our study were better on sensitivity (MMT 77.3% vs pooled 39%; ULBT 86.4% vs pooled 52%), while specificity was comparable.

CONCLUSION

Upper Lip Bite Test proved to be a more accurate and reliable bedside predictor of difficult laryngoscopy than the Modified Mallampati Test. While both tests have limitations, the ULBT's higher specificity and lower false-positive rate make it a valuable adjunct for pre-operative airway assessment. Given the variable performance of these tests in broader literature, a combined-test strategy is recommended for enhanced predictive accuracy in clinical practice.

Author's Contribution:

Concept & Design or acquisition of analysis or interpretation of data:	Asma Zareen, Muhammad Zameer Rajput
Drafting or Revising Critically:	Asma Zareen, Muhammad Ashraf
Final Approval of version:	All the above authors
Agreement to accountable for all aspects of work:	All the above authors

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