

PHONATION-ENHANCED MODIFIED MALLAMPATI TESTING FOR DIFFICULT AIRWAY PREDICTION IN ADULTS AT SIUT: A PROSPECTIVE OBSERVATIONAL STUDY

Rajesh Kumar¹, Sagar Khurana^{2*}, Hiranand³, Muhammad Siddique⁴, Mansoor Chandio⁵,
Syed M Abbas⁶

¹Senior Lecturer, Sindh Institute of Urology and Transplantation, Karachi

^{2,3,5}Assistant Professor, Sindh Institute of Urology and Transplantation, Karachi

⁴Associate Professor, Sindh Institute of Urology and Transplantation, Karachi

⁶Professor, Sindh Institute of Urology and Transplantation, Karachi

¹kewalanirajesh@gmail.com, ²sagar.gkhurana@gmail.com, ³heranand75@gmail.com,

⁴muhammadsiddique2209@gmail.com, ⁵dr.mansoorhassan@gmail.com, ⁶smabbas69@hotmail.com

DOI:<https://doi.org/10.5281/zenodo.22725733>

Keywords

Difficult airway; Modified Mallampati Test; Phonation; Upper Lip Bite Test; Cormack-Lehane grade; Intubation

Article History

Received: 01 June 2026

Accepted: 23 August 2026

Published: 08 September 2026

Copyright @Author

Corresponding Author: *

Sagar Khurana

Abstract

Objective: To compare the Modified Mallampati Test (MMT) with and without phonation and the Upper Lip Bite Test (ULBT) against Cormack-Lehane laryngoscopic grading and intubation difficulty and to determine their diagnostic performance.

Study design: Prospective observational cross-sectional study.

Place and duration of the study: Department of Anesthesiology, Sindh Institute of Urology and Transplantation, over at least six months.

Methodology: Adults aged 18-65 years undergoing elective surgery under general anesthesia with endotracheal intubation were enrolled by non-probability consecutive sampling. Preoperative MMT without phonation, MMT with phonation and ULBT were recorded in 309 participants. Difficult laryngoscopy was Cormack-Lehane Grade III-IV. Difficult intubation was more than one attempt and/or use of a bougie, stylet or video aid. Diagnostic indices, receiver operating characteristic curves, correlations and paired McNemar comparisons were analyzed in SPSS version 26.

Results: Difficult laryngoscopy occurred in 31 (10.0%) participants and protocol-defined difficult intubation in 16 (5.2%). For difficult laryngoscopy, MMT without versus with phonation had sensitivity 90.3% versus 61.3%, specificity 72.7% versus 100.0%, accuracy 74.4% versus 96.1% and AUC 0.815 versus 0.806. For difficult intubation, corresponding values were sensitivity 93.8% versus 81.3%, specificity 69.6% versus 98.0%, accuracy 70.9% versus 97.1% and AUC 0.817 versus 0.896. The paired sensitivity difference was significant for difficult laryngoscopy ($p=0.004$) but not difficult intubation ($p=0.500$); specificity differences favored phonation for both outcomes ($p<0.001$). No ULBT Class III or IDS >5 case occurred.

Conclusion: MMT without phonation provided greater sensitivity, whereas phonation-enhanced MMT provided markedly greater specificity and overall accuracy.

INTRODUCTION

Unanticipated difficulty during direct laryngoscopy or tracheal intubation remains an important perioperative safety problem. Failure to recognize an at-risk airway may delay oxygenation, increase airway trauma and require urgent rescue techniques. Contemporary difficult-airway guidance emphasizes systematic assessment, planning, equipment availability and a strategy for failed attempts [1]. A comprehensive review of adult literature identified no single preoperative test which was consistently both sensitive and specific and significant intertrial variation existed across groups of patients and techniques [2].

The Modified Mallampati Test (MMT) is still popular because it is easy to perform, is inexpensive and does not involve any equipment. Its performance is affected by posture, mouth opening, tongue protrusion, observer technique and phonation. Airway ultrasound has been explored as an adjunct as the conventional clinical tests are only partly discriminating of difficult laryngoscopy [3]. Some systematic evidence indicates that sonographic measurements might provide some additional anatomic detail of utility but there is still a lack of a standardized protocol and cut-off for routine use in lieu of bedside examination [4].

The ULBT measures the degree of protrusion of the mandible and dental relationship and is typically considered positive if the lower incisors cannot bite the upper lip. Apparently normal adults have demonstrated limited to moderate discrimination for the two tests, ULBT and MMT, with the former having a high specificity but low sensitivity [5]. Some tests also differ in their diagnostic sensitivity in morbid obesity [6] and obstetric populations [7] and should be tested in the specific clinical context. Another recent meta-analysis found that there is no single best test for identifying a concussion, instead, there are variables associated with each type of test that make them more or less useful [8].

Phonation can raise the soft palate, which can alter the visible oropharyngeal anatomy, sometimes leading to misclassification of the MMT and also can fail to identify some challenging airways. There are limited regional data directly comparing

MMT phonated versus non-phonated and few regional data that include ULBT, Cormack-Lehane grading and Intubation Difficulty Scale (IDS). Other anatomical parameters such as age, BMI, etc, may further modify the laryngoscopic exposure [9]. This study compared MMT with and without phonation and ULBT against Cormack-Lehane grade and IDS and assessed sensitivity, specificity, predictive values, accuracy and receiver operating characteristic performance.

MATERIALS AND METHODS

A prospective observational cross-sectional study was conducted in the Department of Anesthesiology, Sindh Institute of Urology and Transplantation (SIUT), a tertiary care teaching hospital for a minimum period of six months. Adults between 18 and 65 years of age undergoing elective surgery under general anesthesia who needed endotracheal intubation were included in the study. A total of 309 participants were analyzed through non-probability consecutive sampling after written informed consent.

Participants with American Society of Anesthesiologists physical status I-III were included. Emergency surgery, airway tumors, abscesses or burns, mouth opening below 3 cm, cervical spine instability or limited neck mobility, maxillofacial abnormality or facial trauma, abnormal dentition and planned awake or rapid-sequence intubation were exclusion criteria. The institutional ethics committee approved the study. Participant identifiers were kept confidential and the analysis used coded records.

A single trained anesthesiologist performed the preoperative assessments in the pre-anesthesia area and did not participate in laryngoscopy or intubation. For MMT without phonation, the seated participant maintained a neutral head position, opened the mouth fully and maximally protruded the tongue without speaking. The assessment was repeated in the same position while the participant phonated "ah." Grades III-IV were considered positive. ULBT was classified as Class I-III; Class III was considered positive. Findings were entered on a structured proforma. After standard general anesthesia and neuromuscular blockade, an experienced

consultant anesthesiologist who was blinded to the preoperative assessments performed direct laryngoscopy with a Macintosh size 3 or 4 blade. Cormack-Lehane Grades III-IV defined difficult laryngoscopy. Difficult intubation was operationally defined as more than one attempt and/or use of a bougie, stylet or video aid. IDS was also recorded; an IDS above 5 represented moderate-to-major difficulty.

Data were analyzed in SPSS version 26. Categorical variables were summarized as frequencies and percentages. Normally distributed quantitative variables were expressed as mean $\pm$

standard deviation while non-normal variables were summarized with medians and interquartile ranges. Chi-square or Fisher's exact tests, independent-samples t tests, Mann-Whitney U tests, Kruskal-Wallis tests and Spearman correlations were used as appropriate. Two-by-two tables provided sensitivity, specificity, positive predictive value, negative predictive value and accuracy. Receiver operating characteristic analysis generated AUCs with 95% confidence intervals. McNemar tests compared paired sensitivities and specificities. A p-value below 0.05 was considered statistically significant.

RESULTS

374 eligible adults were enrolled and 65 were excluded leaving a final sample of 309 adults for analysis. (Figure 1).

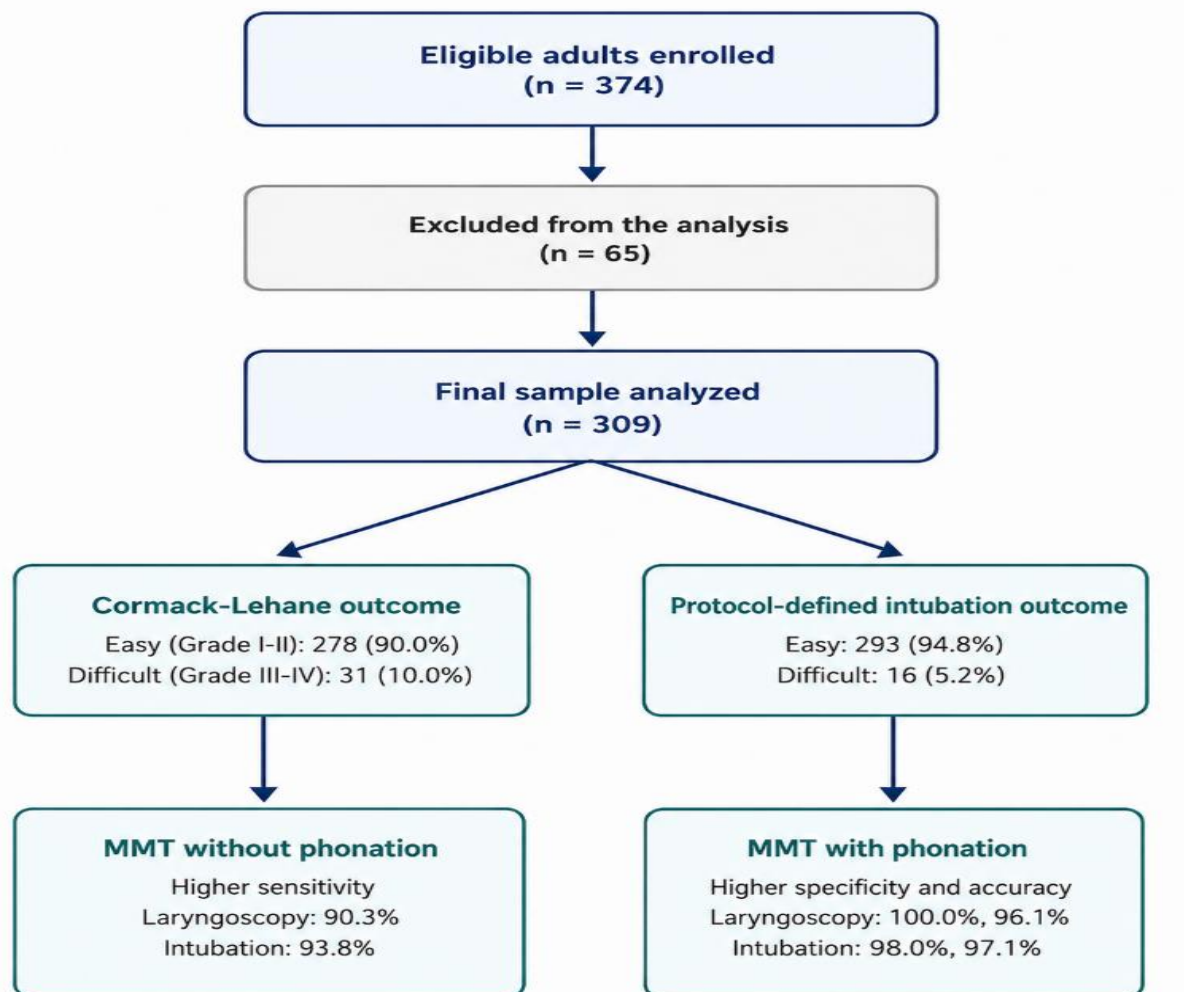


Figure 1. Study flow and principal outcome groups.

Mean age was 40.20 ± 14.213 years; 167 (54.0%) were male. Mean BMI was 25.056 ± 2.711 kg/m², with 158 (51.1%) participants in the normal category, 138 (44.7%) overweight and 13 (4.2%) obese. ASA physical status was I in 170 (55.0%), II in 131 (42.4%) and III in 8 (2.6%) participants (Table 1).

Without phonation, MMT Grade III-IV occurred in 104 (33.7%) participants, compared with 19

(6.1%) with phonation. ULBT was Class I in 222 (71.8%) and Class II in 87 (28.2%); no Class III was observed. Cormack-Lehane Grades III-IV occurred in 31 (10.0%). Protocol-defined difficult intubation occurred in 16 (5.2%). The mean IDS was 2.36 ± 0.637 , with values from 1 to 5; no IDS >5 case occurred.

Table 1. Demographic, clinical and airway assessment characteristics (n=309)

Characteristic	Category/summary	Value
Age, years	Mean $\pm$ SD	40.20 ± 14.213
Age group	18-30 years	94 (30.4%)
	31-45 years	107 (34.6%)
	46-60 years	73 (23.6%)
	61-65 years	35 (11.3%)
Gender	Male	167 (54.0%)
	Female	142 (46.0%)
BMI, kg/m ²	Mean $\pm$ SD	25.056 ± 2.711
BMI category	Normal	158 (51.1%)
	Overweight	138 (44.7%)
	Obese	13 (4.2%)
ASA status	I	170 (55.0%)
	II	131 (42.4%)
	III	8 (2.6%)
MMT without phonation	Grade I	12 (3.9%)
	Grade II	193 (62.5%)
	Grade III	85 (27.5%)
	Grade IV	19 (6.1%)
MMT with phonation	Grade I	199 (64.4%)
	Grade II	91 (29.4%)
	Grade III	19 (6.1%)
	Grade IV	0 (0.0%)
ULBT	Class I	222 (71.8%)

Characteristic	Category/summary	Value
	Class II	87 (28.2%)
	Class III	0 (0.0%)
Cormack-Lehane grade	I	155 (50.2%)
	II	123 (39.8%)
	III	30 (9.7%)
	IV	1 (0.3%)
Difficult laryngoscopy	Grade III-IV	31 (10.0%)
Protocol-defined difficult intubation	>1 attempt and/or adjunct	16 (5.2%)
IDS	Mean $\pm$ SD; range	2.36 $\pm$ 0.637; 1-5

Values are n (%) unless otherwise specified. ASA, American Society of Anesthesiologists; BMI, body mass index; IDS, Intubation Difficulty Scale; MMT, Modified Mallampati Test; ULBT, Upper Lip Bite Test.

MMT grade correlated with Cormack-Lehane grade both without phonation ($\rho=0.614$, $p<0.001$) and with phonation ($\rho=0.615$, $p<0.001$). ULBT class had a weaker correlation ($\rho=0.286$, $p<0.001$). IDS correlated with non-phonated MMT ($\rho=0.252$, $p<0.001$), phonated MMT ($\rho=0.263$, $p<0.001$) and ULBT ($\rho=0.115$, $p=0.043$). IDS distributions differed across non-phonated MMT grades ($H=32.299$, $p<0.001$) and phonated grades ($H=32.476$, $p<0.001$) (Table 3).

For difficult laryngoscopy, MMT without phonation yielded 28 true positives, 3 false negatives, 76 false positives and 202 true negatives. Sensitivity was 90.3%, specificity 72.7%, PPV 26.9%, NPV 98.5%, accuracy 74.4% and AUC 0.815 (95% CI 0.745-0.885; $p<0.001$). With phonation, there were 19 true positives, 12 false negatives, no false positives and 278 true negatives;

sensitivity was 61.3%, specificity 100.0%, PPV 100.0%, NPV 95.9%, accuracy 96.1% and AUC 0.806 (95% CI 0.699-0.914; $p<0.001$) (Table 2).

For protocol-defined difficult intubation, sensitivity, specificity, PPV, NPV, accuracy and AUC were 93.8%, 69.6%, 14.4%, 99.5%, 70.9% and 0.817 (95% CI 0.734-0.900; $p<0.001$) without phonation and 81.3%, 98.0%, 68.4%, 99.0%, 97.1% and 0.896 (95% CI 0.782-1.000; $p<0.001$) with phonation. McNemar testing showed different paired sensitivity for difficult laryngoscopy ($p=0.004$) but not difficult intubation ($p=0.500$); specificity differed for both outcomes ($p<0.001$). Median age was 39 (IQR 23) years in easy and 49 (IQR 21) years in difficult laryngoscopy ($p<0.001$). Mean BMI was 24.712 ± 2.5315 versus 28.142 ± 2.3125 kg/m² ($p<0.001$) and ASA status was associated with laryngoscopy outcome ($p=0.009$).

Table 2. Diagnostic performance of airway assessment tests

Outcome and test	TP/FN	FP/TN	Sensitivity / specificity	PPV / NPV	Accuracy	AUC (95% CI); p-value
Difficult laryngoscopy - MMT without phonation	28 / 3	76 / 202	90.3% / 72.7%	26.9% / 98.5%	74.4%	0.815 (0.745-0.885); $p<0.001$

Difficult laryngoscopy - MMT with phonation	19 / 12	0 / 278	61.3% / 100.0%	100.0% / 95.9%	96.1%	0.806 (0.699-0.914); p<0.001
Difficult laryngoscopy - ULBT Class III	0 / 31	0 / 278	0.0% / 100.0%	- / 90.0%	90.0%	0.500 (0.393-0.607); p=1.000
Difficult intubation - MMT without phonation	15 / 1	89 / 204	93.8% / 69.6%	14.4% / 99.5%	70.9%	0.817 (0.734-0.900); p<0.001
Difficult intubation - MMT with phonation	13 / 3	6 / 287	81.3% / 98.0%	68.4% / 99.0%	97.1%	0.896 (0.782-1.000); p<0.001
Difficult intubation - ULBT Class III	0 / 16	0 / 293	0.0% / 100.0%	- / 94.8%	94.8%	0.500 (0.355-0.645); p=1.000

AUC, area under the receiver operating characteristic curve; CI, confidence interval; FN, false negative; FP, false positive; NPV, negative predictive value; PPV, positive predictive value; TN, true negative; TP, true positive. Dash indicates that PPV was not estimable because ULBT Class III was absent. The high crude ULBT accuracy reflects an all-negative classification.

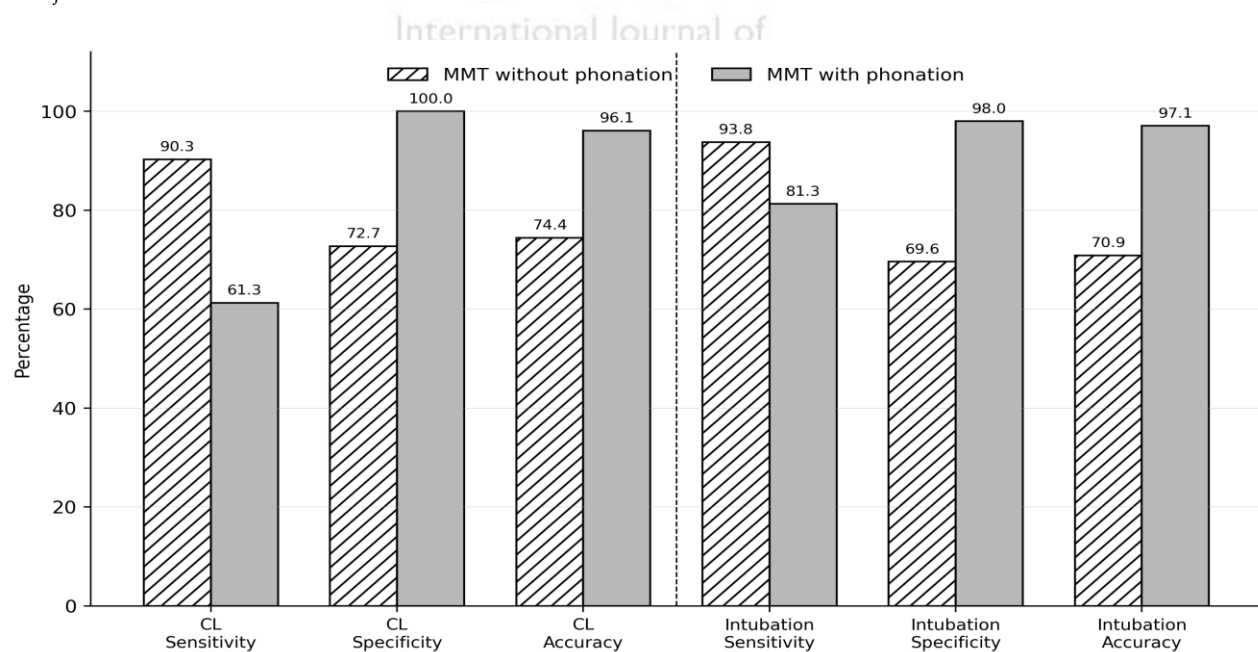


Figure 2. Sensitivity, specificity and accuracy of MMT with and without phonation for difficult laryngoscopy and protocol-defined difficult intubation.

Table 3. Correlation, paired-comparison and associated-factor analyses

Analysis	Comparison	Statistic/result	p-value
Ordinal correlation	MMT without phonation vs Cormack-Lehane	Spearman rho=0.614	<0.001
Ordinal correlation	MMT with phonation vs Cormack-Lehane	Spearman rho=0.615	<0.001
Ordinal correlation	ULBT vs Cormack-Lehane	Spearman rho=0.286	<0.001

Ordinal correlation	MMT without phonation vs IDS	Spearman rho=0.252	<0.001
Ordinal correlation	MMT with phonation vs IDS	Spearman rho=0.263	<0.001
Ordinal correlation	ULBT vs IDS	Spearman rho=0.115	0.043
IDS across grades	MMT without phonation	Kruskal-Wallis H=32.299	<0.001
IDS across grades	MMT with phonation	Kruskal-Wallis H=32.476	<0.001
Paired sensitivity	Difficult laryngoscopy: without vs with phonation	McNemar exact	0.004
Paired specificity	Easy laryngoscopy: without vs with phonation	McNemar chi-square=74.013	<0.001
Paired sensitivity	Difficult intubation: without vs with phonation	McNemar exact	0.500
Paired specificity	Easy intubation: without vs with phonation	McNemar chi-square=81.012	<0.001
Age and laryngoscopy	Easy 39 (IQR 23) vs difficult 49 (IQR 21) years	Mann-Whitney U=2663.000	<0.001
BMI and laryngoscopy	Easy 24.712 ± 2.5315 vs difficult 28.142 ± 2.3125 kg/m ²	t=-7.214	<0.001
ASA status and laryngoscopy	ASA I: 10/170; ASA II: 21/131; ASA III: 0/8 difficult	chi-square=9.358	0.009
BMI and intubation	Easy 24.886 ± 2.6092 vs difficult 28.175 ± 2.7285 kg/m ²	t=-4.899	<0.001

ASA, American Society of Anesthesiologists; BMI, body mass index; IDS, Intubation Difficulty Scale; IQR, interquartile range; MMT, Modified Mallampati Test; ULBT, Upper Lip Bite Test.

DISCUSSION

The study evaluated three bedside airway assessments against direct laryngoscopic exposure and procedural intubation difficulty. Non-phonated MMT detected a greater proportion of difficult cases, whereas phonation sharply reduced false-positive classifications and produced higher specificity and accuracy. The 10.0% frequency of difficult laryngoscopy was lower than the 15.4% reported in a Pakistani elective-surgery cohort, in which ULBT showed substantially greater sensitivity than MMT [10]. Differences in case mix, observer technique and the distribution of positive ULBT grades may explain the contrasting test profiles.

Earlier Pakistani evidence also found that ULBT had greater overall accuracy and predictive values than Mallampati assessment in a tertiary hospital population [11]. In the present sample, no participant had ULBT Class III. ULBT classified every participant as negative, yielding an apparently high specificity and overall percentage agreement that mainly reflected the low outcome prevalence rather than useful discrimination. Its

positive predictive value and threshold validity could not be estimated. This absence of Class III also meant that combining ULBT with phonated MMT did not add information beyond phonated MMT alone.

The direction of the phonation effect closely matches the most directly comparable recent study: MMT without phonation was more sensitive, whereas phonated MMT was more specific and more accurate for both laryngoscopy and intubation [12]. Phonation improves visualization of the soft palate and can move patients from Grade III-IV to Grade I-II. In this dataset, the positive rate fell from 33.7% without phonation to 6.1% with phonation. That shift explains the reduction in false positives but also the fall in sensitivity for difficult laryngoscopy. Clinically, non-phonated assessment may be preferable when minimizing missed difficulty is the priority while phonated assessment may reduce unnecessary labeling of patients as difficult. International comparisons remain variable. One tertiary-care study reported broadly comparable diagnostic behavior between MMT and ULBT

[13], whereas an evaluation of multiple screening tests found that no bedside test alone had consistently strong discrimination; ULBT tended to provide high specificity and PPV while other measures contributed greater sensitivity [14]. The present results reinforce the same principle but also demonstrate why prevalence and category distribution must be inspected before interpreting accuracy. A test that produces no positive classifications cannot establish meaningful diagnostic validity, even when its specificity or crude accuracy appears high.

Older age, greater BMI and ASA status were associated with difficult laryngoscopy in the secondary analyses. Both difficult laryngoscopy and difficult intubation per protocol were clinically significant for the BMI difference. The same has been demonstrated in obese surgical patients: There have been studies investigating associations of laryngoscopic difficulty with combinations of Mallampati grade, neck dimension and thyromental measurement but BMI alone has not always been a good predictor [15]. Other recent bedside indices have been found to be more discriminating than the standard MMT for selected populations [16]. These findings will support the use of demographic and anatomical contexts instead of being dependent on a single oral examination.

In the future imaging-based assessments can complement multimodal approaches. In prospective airway ultrasound studies, quantitative anatomical measurements have been correlated with a difficulty in laryngoscopy [17] and increased BMI has been correlated with difficulty in the airway in ultrasound cohorts [18]. Recent studies exploring the tongue-to-oral-cavity ratios [19] and skin-to-epiglottis distance and multivariable clinical scores [20] have shown that complex measures can be more accurate than standalone bedside tests and that radiological-clinical models can be even more accurate [21]. These methods involve equipment, training and external validation, they are a logical pathway to follow for patients with incongruent test results.

IDS was kept as a continuous measure as all scores were 5 or lower. These findings are consistent with the correlation observed with both MMT methods

where higher pre-operative grades were correlated with greater procedural complexity; the traditional IDS >5 outcome could not be assessed. Originally, the IDS was designed as a seven-component progressive score [22] and not as a simple threshold. Fully reporting its distribution is important to retain useful information, although it is not comparable to studies that used IDS >5 as the primary endpoint due to the absence of moderate-to-major difficulty.

This study was limited by its single-center, consecutive sample and relatively small numbers of difficult laryngoscopies and intubations. The results of this investigation are not necessarily applicable to video laryngoscopy, emergency airway management, obstetric practice or known anatomical abnormalities where direct laryngoscopy with Macintosh blades has been studied. Complete threshold-based validation was not possible for ULBT class III and IDS>5. There were no external validation or follow-up assessment and high confidence intervals for some diagnostic estimates were obtained due to the low level of events.

CONCLUSION

In adults undergoing elective surgery at SIUT, MMT without phonation was the more sensitive screening approach while phonation-enhanced MMT was substantially more specific and more accurate for both difficult laryngoscopy and protocol-defined difficult intubation. Older age, higher BMI and ASA status were associated with difficult laryngoscopy and higher BMI was also observed in difficult intubation.

REFERENCES

- Apfelbaum JL, Hagberg CA, Connis RT, Abdelmalak BB, Agarkar M, Dutton RP, et al. 2022 American Society of Anesthesiologists Practice Guidelines for Management of the Difficult Airway. *Anesthesiology*. 2022;136(1):31-81. doi: 10.1097/ALN.0000000000004002; PMID: 34762729.

- Wang Z, Jin Y, Zheng Y, Chen H, Feng J, Sun J. Evaluation of preoperative difficult airway prediction methods for adult patients without obvious airway abnormalities: a systematic review and meta-analysis. *BMC Anesthesiol.* 2024;24(1):242. doi: 10.1186/s12871-024-02627-1; PMID: 39020308.
- Carsetti A, Sorbello M, Adrario E, Donati A, Falcetta S. Airway ultrasound as predictor of difficult direct laryngoscopy: a systematic review and meta-analysis. *Anesth Analg.* 2022;134(4):740-750. doi: 10.1213/ANE.0000000000005839; PMID: 34914641.
- Giordano G, Alessandri F, Zulian A, Bilotta F, Pugliese F. Pre-operative ultrasound prediction of difficult airway management in adult patients: a systematic review of clinical evidence. *Eur J Anaesthesiol.* 2023;40(5):313-325. doi: 10.1097/EJA.0000000000001805; PMID: 36748275.
- Wang LY, Zhang KD, Zhang ZH, Zhang DX, Wang HL, Qi F. Evaluation of the reliability of the upper lip bite test and the modified Mallampati test in predicting difficult intubation under direct laryngoscopy in apparently normal patients: a prospective observational clinical study. *BMC Anesthesiol.* 2022;22(1):314. doi: 10.1186/s12871-022-01855-7; PMID: 36217124.
- Richa F, El-Hage C, Chalhoub V, Yazbeck P. Prediction of difficult laryngoscopy and/or intubation among morbidly obese patients: upper lip bite test versus modified Mallampati classification. *J Perioper Pract.* 2024;34(11):347-356. doi: 10.1177/17504589231206903; PMID: 38112112.
- Moslemi F, Khan ZH, Alizadeh E, Khamnian Z, Eftekhari N, Hosseini MS, et al. Upper lip bite test compared to modified Mallampati test in predicting difficult airway in obstetrics: a prospective observational study. *J Perioper Pract.* 2023;33(4):116-121. doi: 10.1177/17504589211045231; PMID: 34791944.
- Benavides-Zora D, Jaramillo MC, Townsley MM, Franco V, Gonzalez S, Hoyos C, et al. Diagnostic performance of airway ultrasound for the assessment of difficult laryngoscopy: a systematic review and meta-analysis. *J Cardiothorac Vasc Anesth.* 2023;37(7):1101-1109. doi: 10.1053/j.jvca.2023.02.036; PMID: 37012134.
- Yuan J, Ye H, Tan X, Zhang H, Sun J. Determinants of difficult laryngoscopy based on upper airway indicators: a prospective observational study. *BMC Anesthesiol.* 2024;24(1):157. doi: 10.1186/s12871-024-02543-4; PMID: 38658856.
- Ali ST, Samad K, Raza SA, Hoda MQ. Ratio of height to thyromental distance: a comparison with Mallampati and upper lip bite test for predicting difficult intubation in Pakistani population. *J Pak Med Assoc.* 2021;71(6):1570-1574. doi: 10.47391/JPMA.1215; PMID: 34111074.
- Ali MA, Qamar-ul-Hoda M, Samad K. Comparison of upper lip bite test with Mallampati test in the prediction of difficult intubation at a tertiary care hospital of Pakistan. *J Pak Med Assoc.* 2012;62(10):1012-1015. PMID: 23866436.
- Yirga S, Samuel H, Markos Z, Yohannes W. Comparison of modified Mallampati test with and without phonation for prediction of difficult laryngoscopy and intubation among adult surgical patients: cross-sectional study. *Ann Med Surg (Lond).* 2025;87(1):85-92. doi: 10.1097/MS9.0000000000002836; PMID: 40109585.
- Kar S, Senapati LK, Samanta P, Satapathy GC. Predictive value of modified Mallampati test and upper lip bite test concerning Cormack and Lehane's laryngoscopy grading in the anticipation of difficult intubation: a cross-sectional study. *Cureus.* 2022;14(9): e28754. doi: 10.7759/cureus.28754; PMID: 36211112.
- Trambadia DN, Yadav P, Sargunraj A. Preoperative assessment to predict difficult airway using multiple screening tests. *Cureus.* 2023;15(10): e46868. doi: 10.7759/cureus.46868; PMID: 37954823.

- Sharma V, Yadav HP, Prakash A, Yadav N, Kumar M, Abbas H. Assessment of different indices as predictors of difficult airway in obese patients. *Cureus*. 2024;16(2): e55005. doi: 10.7759/cureus.55005; PMID: 38414514.
- Suryawanshi CM, Bhatia J. Acromio-Axillo-Suprasternal Notch Index performance in predicting difficult visualization of the larynx: an observational prospective study. *Cureus*. 2024;16(8): e66706. doi: 10.7759/cureus.66706; PMID: 39262532.
- Ning L, Zhu X, Li HC, Zhou SJ, Zhang QW, Zou HY, et al. A quantitative study of airway ultrasound in predicting difficult laryngoscopy: a prospective study. *Chin J Traumatol*. 2023;26(6):351-356. doi: 10.1016/j.cjtee.2023.09.005; PMID: 37838578.
- Waindeskar V, Padala SRAN, Jain S, Kiran M, Mandal P, Pakhare AP. Prediction of the difficult airway by pre-operative ultrasound-based measurement of airway parameters: a prospective observational study. *Indian J Anaesth*. 2023;67(9):785-790. doi: 10.4103/ija.ija_464_23; PMID: 37829770.
- Nandi S, Panda A, Mishra N, Rao PB, Srinivasan A. Evaluation of the predictive value of tongue height to oral cavity height ratio and anterior neck soft tissue measurements for difficult laryngoscopy in patients with unanticipated difficult airway: a prospective observational study. *Indian J Anaesth*. 2025;69(9):918-925. doi: 10.4103/ija.ija_1360_24; PMID: 40880958.
- Karimbanakkal F, Rajesh MC, Bau SP. Comparison between El-Ganzouri risk index and sonologically measured skin-to-epiglottis distance for predicting difficult laryngoscopy: a prospective observational study. *Indian J Anaesth*. 2025;69(4):380-385. doi: 10.4103/ija.ija_896_24; PMID: 40687962.
- Li J, Tian Y, Wang M, Fang J, Zhang H, Yue F, et al. Radiological indicators and a novel combined predictive model for anticipating difficult laryngoscopy in cervical spondylosis patients: a prospective cohort study. *BMC Anesthesiol*. 2024;24(1):446. doi: 10.1186/s12871-024-02826-w; PMID: 39623345.
- Adnet F, Borron SW, Racine SX, Clemessy JL, Fournier JL, Plaisance P, et al. The intubation difficulty scale: proposal and evaluation of a new score characterizing the complexity of endotracheal intubation. *Anesthesiology*. 1997;87(6):1290-1297. doi: 10.1097/00000542-199712000-00005; PMID: 9416711.