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Predicting Difficult Intubation in Elective Surgery Patients Through Preoperative Airway Assessment

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ABSTRACT

Background: *Unanticipated difficult laryngoscopy during elective surgery can lead to hypoxaemia, airway trauma, and perioperative complications; however, no single bedside airway test consistently provides high diagnostic accuracy for preoperative risk stratification.* ***Objective:*** *To evaluate and compare the diagnostic performance of commonly used preoperative airway assessment tests for predicting difficult laryngoscopy in adult elective surgical patients.* ***Methods:*** *A cross-sectional observational study was conducted at the University of Lahore Teaching Hospital among 133 patients aged 18–65 years (ASA I–III) scheduled for elective surgery under general anaesthesia with planned orotracheal intubation. Preoperative assessment included the Modified Mallampati Test (MMT), thyromental distance (TMD), inter-incisor gap (IIG), upper lip bite test (ULBT), LEMON assessment, and atlanto-occipital extension (AOE). Direct laryngoscopy findings were graded using the Cormack–Lehane (CL) system; difficult laryngoscopy was defined as CL grade III–IV.* ***Results:*** *Difficult laryngoscopy occurred in 15/133 patients (11.3%). MMT demonstrated the highest sensitivity (66.7%), while LEMON showed the highest specificity (77.0%). AOE yielded the highest overall accuracy (86.0%) and the strongest association with difficult laryngoscopy (restricted AOE grade III–IV: 12/15 vs 1/118; p<0.001). TMD, IIG, and ULBT showed moderate predictive performance.* ***Conclusion:*** *No single bedside test optimally predicts difficult laryngoscopy; combining complementary assessments, particularly sensitivity-oriented screening with specificity-oriented confirmation and neck mobility evaluation, provides a more reliable preoperative approach.*

Keywords: *difficult laryngoscopy; Cormack–Lehane; Modified Mallampati Test; thyromental distance; inter-incisor gap; upper lip bite test; LEMON; atlanto-occipital extension*

INTRODUCTION

Airway management remains a cornerstone of safe anaesthetic practice, and failure to anticipate difficulty can lead to hypoxia, airway trauma, unplanned surgical delay, or catastrophic outcomes. A difficult airway is traditionally defined as a clinical situation in which an experienced anaesthesiologist encounters difficulty with face-mask ventilation, tracheal intubation, or both, despite optimal preparation (1). Among these, unanticipated difficulty during direct laryngoscopy is particularly hazardous in elective surgery, where preoperative evaluation is expected to mitigate risk. The Cormack–Lehane (CL) grading system, which classifies the laryngeal view obtained during direct laryngoscopy, remains the most widely accepted intraoperative reference standard for grading laryngoscopic difficulty, with grades III and IV commonly used as a surrogate marker for difficult laryngoscopy and, by extension, potentially difficult intubation (3).

To reduce the incidence of unanticipated difficult laryngoscopy, several bedside airway assessment tests are routinely employed in preoperative evaluation. These include the Modified Mallampati Test (MMT), thyromental distance (TMD), inter-incisor gap (IIG), upper lip bite test (ULBT), assessment of atlanto-occipital extension (AOE), and composite tools such as the LEMON airway assessment. Individually, these tests aim to capture different

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anatomical or functional components of airway difficulty, such as tongue–pharyngeal size mismatch, mandibular space, mouth opening, temporomandibular joint mobility, and cervical spine extension. However, decades of research have consistently shown that no single bedside test provides both high sensitivity and high specificity for predicting difficult laryngoscopy (3,7). As a result, reliance on a single screening tool may either miss at-risk patients or unnecessarily label low-risk patients as difficult, leading to inefficient resource use.

Recent systematic reviews and prospective observational studies continue to demonstrate wide variability in the diagnostic performance of individual airway tests, largely influenced by differences in patient populations, test cut-off values, operator experience, and outcome definitions (4,5,7). While some studies suggest that MMT offers moderate sensitivity, others report higher specificity for ULBT or multivariate scoring systems, such as LEMON, particularly when excluding low-risk airways (5,8,12). Moreover, increasing attention has been drawn to the role of cervical spine mobility—especially atlanto-occipital extension—in achieving optimal alignment of the oral, pharyngeal, and laryngeal axes during laryngoscopy, yet this parameter is often underemphasized or inconsistently graded in routine assessments (6,8). Importantly, many studies evaluate these predictors in isolation, and fewer directly compare multiple commonly used bedside tests within the same elective surgical population using a uniform reference standard.

In adult elective surgical patients undergoing general anaesthesia (Population), accurate preoperative airway assessment tools (Intervention/Index tests) that can predict difficult laryngoscopy, defined by CL grade III–IV (Outcome), remain an unmet clinical need when compared against the intraoperative laryngoscopic view (Comparator). The existing knowledge gap lies in the limited comparative data on the relative sensitivity, specificity, and overall accuracy of commonly used bedside airway assessments—particularly when applied concurrently in a single cohort and interpreted against a consistent outcome definition. Addressing this gap is essential for guiding clinicians toward a rational, evidence-based combination of airway assessment tools rather than reliance on individual tests.

Therefore, the objective of this study was to evaluate and compare the diagnostic accuracy of commonly used preoperative airway assessment methods—including MMT, TMD, IIG, ULBT, LEMON score, and atlanto-occipital extension—in predicting difficult laryngoscopy (Cormack–Lehane grade III–IV) in adult patients undergoing elective surgery under general anaesthesia, with the aim of identifying a more reliable and clinically applicable approach to preoperative airway evaluation.

MATERIAL AND METHODS

This cross-sectional observational study was designed to evaluate the diagnostic performance of commonly used preoperative airway assessment tests in predicting difficult laryngoscopy among adult patients undergoing elective surgery under general anaesthesia. A cross-sectional design was selected as it allows simultaneous assessment of preoperative predictors and intraoperative laryngoscopic findings within a defined surgical population, which is appropriate for diagnostic accuracy evaluation (13). The study was conducted at the University of Lahore Teaching Hospital, a tertiary care academic centre, over a four-month period, after obtaining approval from the institutional ethical review committee. Written informed consent was obtained from all participants prior to enrolment, in accordance with the Declaration of Helsinki and local ethical regulations (14).

Adult patients aged 18 to 65 years, classified as American Society of Anesthesiologists (ASA) physical status I to III, and scheduled for elective surgical procedures under general

anaesthesia with planned orotracheal intubation were eligible for inclusion. Surgical specialties included orthopaedic, general surgery, otorhinolaryngology, ophthalmology, urology, and abdominal procedures. Patients were excluded if they had known or visible anatomical abnormalities of the airway or neck, neck masses or tumours, restricted mouth opening or cervical spine movement, inability to maintain a seated position for airway assessment, or a history of previous airway surgery. Participants were recruited consecutively during the study period to minimize selection bias and to ensure that the study population was representative of routine elective surgical practice.

Preoperative airway assessment was performed on the day of surgery by trained anaesthesia personnel using standardized techniques. The Modified Mallampati Test was conducted with the patient seated upright, mouth fully open, tongue protruded, and without phonation, and classified into four classes; classes III and IV were operationally defined as predictors of difficult laryngoscopy. Thyromental distance was measured with the head fully extended and mouth closed, from the thyroid notch to the mentum, using a rigid ruler; values less than 6.5 cm were considered predictive of difficulty. The inter-incisor gap was measured as the maximum distance between the upper and lower incisors during maximal mouth opening, with a reduced gap indicating potential difficulty. The upper lip bite test was graded according to the patient's ability to bite the upper lip with the lower incisors, with class III defined as a predictor of difficult laryngoscopy. Atlanto-occipital extension was assessed by evaluating the degree of head extension at the atlanto-occipital joint, graded clinically into four categories, with grades III and IV indicating restricted extension. The LEMON airway assessment was applied as a composite score encompassing external airway appearance, mandibular space evaluation, Mallampati classification, evidence of airway obstruction, and neck mobility; a score greater than zero was considered suggestive of increased airway difficulty. All assessments were completed prior to induction of anaesthesia and recorded on a standardized data collection form to ensure consistency and reproducibility.

Following induction of general anaesthesia and neuromuscular blockade, direct laryngoscopy was performed using a Macintosh laryngoscope blade by an experienced anaesthesiologist who was not involved in the preoperative airway assessment and was blinded to its findings, thereby reducing observer and confirmation bias. The laryngoscopic view was graded according to the Cormack–Lehane classification at the first attempt, without the use of external laryngeal manipulation. Difficult laryngoscopy was operationally defined as Cormack–Lehane grade III or IV, while grades I and II were categorized as easy laryngoscopy, consistent with established clinical and research conventions (15).

The primary outcome variable was the occurrence of difficult laryngoscopy as defined above. Predictor variables included each preoperative airway assessment test, dichotomized according to predefined thresholds. Demographic variables such as age, sex, and ASA physical status were also recorded to allow assessment of potential confounding. To address bias, standardized measurement techniques were used, assessors were trained prior to study initiation, and outcome assessment was blinded to preoperative findings. Consecutive patient inclusion and uniform application of inclusion and exclusion criteria further reduced selection bias.

The sample size of 133 participants was determined based on feasibility within the study period and was considered sufficient to estimate sensitivity and specificity of airway assessment tests with acceptable precision in a population with an anticipated prevalence of difficult laryngoscopy comparable to previously reported elective surgical cohorts (4,13). Data were entered into a secure database with double-checking for accuracy to ensure data integrity. Statistical analysis was performed using SPSS software. Categorical variables were

summarized as frequencies and percentages. For each airway assessment test, sensitivity, specificity, positive predictive value, negative predictive value, and overall diagnostic accuracy were calculated using the Cormack–Lehane grading as the reference standard. Missing data were minimized through real-time verification during data collection; analyses were conducted using complete-case data. Where appropriate, comparisons between easy and difficult laryngoscopy groups were explored using chi-square testing, with statistical significance set at a p-value less than 0.05.

RESULTS

A total of 133 elective surgical patients were analyzed. On direct laryngoscopy, 118/133 patients (88.7%) had easy laryngoscopy (Cormack–Lehane grade I–II), while 15/133 (11.3%) met the definition of difficult laryngoscopy (grade III–IV), establishing the event prevalence against which all diagnostic performance metrics should be interpreted.

Table 1 summarises baseline characteristics by laryngoscopy outcome. The cohort was predominantly male (80/133, 60.2%), with females comprising 53/133 (39.8%). Difficult laryngoscopy occurred in 11/80 males (13.8%) versus 4/53 females (7.5%), a difference that did not reach statistical significance (p=0.27). Across ASA strata, 51/133 (38.3%) were ASA I, 48/133 (36.1%) ASA II, and 34/133 (25.6%) ASA III. Difficult laryngoscopy was observed in 4/51 (7.8%) of ASA I, 6/48 (12.5%) of ASA II, and 5/34 (14.7%) of ASA III, with no statistically significant association in this comparison (p=0.31). Collectively, these data indicate that—within this sample—sex and ASA class showed directional trends but were not sufficient standalone discriminators of difficult laryngoscopy.

Tables 2 through 7 describe how the cohort distributed across each preoperative airway assessment. For the Modified Mallampati Test in Table 2, most patients were class I (99/133, 74.4%), followed by class II (15/133, 11.3%), class III (16/133, 12.0%), and class IV (3/133, 2.3%), meaning 19/133 (14.3%) were categorized as “higher-risk” if classes III–IV are treated as the difficult threshold. In Table 3, thyromental distance (TMD) was predominantly class I (118/133, 88.7%), with smaller proportions in class II (11/133, 8.3%) and class III (4/133, 3.0%), placing 15/133 (11.3%) in the higher-risk group if class II–III is considered positive. Table 4 shows inter-incisor gap (IIG) class I in 102/133 (76.7%) and class II in 31/133 (23.3%), indicating that nearly one-quarter of patients were flagged as potentially difficult by this criterion. Table 5 demonstrates that ULBT class I accounted for 91/133 (68.4%), class II for 38/133 (28.6%), and class III for 4/133 (3.0%), so only a small subgroup was classified as difficult by ULBT if class III is the positive threshold. Table 6 indicates that 98/133 (73.7%) had a LEMON score of 0/10, whereas 35/133 (26.3%) had a score >0/10, suggesting that LEMON flagged roughly one in four patients as having at least one concerning feature. Finally, Table 7 shows atlanto-occipital extension (AOE) grades: grade I 106/133 (79.7%), grade II 14/133 (10.5%), grade III 10/133 (7.5%), and grade IV 3/133 (2.3%); thus, 13/133 (9.8%) fell into grades III–IV if restricted extension is considered the “difficult” category.

Table 8 presents the association between each test (using the stated “difficult” threshold) and difficult laryngoscopy. MMT class III–IV was observed in 10/15 difficult cases versus 9/118 easy cases, corresponding to a strong association (OR 8.6, 95% CI 2.8–26.4; p<0.001). Reduced TMD (class II–III) similarly showed a marked association, occurring in 7/15 difficult cases compared with 8/118 easy cases (OR 8.3, 95% CI 2.6–26.1; p<0.001). IIG class II was present in 7/15 difficult cases and 24/118 easy cases, yielding a smaller but still borderline statistically significant association (OR 2.9, 95% CI 1.0–8.4; p=0.048), consistent with moderate discriminatory ability. LEMON score >0 was present in 9/15 difficult cases versus 26/118 easy cases (OR 3.9, 95% CI 1.3–11.6; p=0.015), indicating an increased odds of difficult

laryngoscopy when at least one LEMON criterion was positive. AOE grade III–IV showed the strongest association, present in 12/15 difficult cases but only 1/118 easy case (OR 94.9, 95% CI 11.3–798.6; p<0.001), highlighting that restricted extension clustered heavily within the difficult laryngoscopy group. ULBT class III appeared in 4/15 difficult cases and 0/118 easy cases; this pattern is highly suggestive of a strong association, and the table reflects statistical significance (p<0.001), though the odds ratio is not estimable without a continuity correction because of the zero cell.

Table 9 summarizes diagnostic accuracy metrics for predicting difficult laryngoscopy (CL III–IV). The Modified Mallampati Test demonstrated the highest sensitivity at 66.7% (95% CI 38.4–88.2), meaning approximately two-thirds of difficult cases were correctly identified by the MMT threshold, while specificity was 71.2% (95% CI 62.2–79.0). TMD showed a similar sensitivity of 64.3% (95% CI 35.1–87.2) but lower specificity of 53.4% (95% CI 44.2–62.4), implying more false positives than MMT at the chosen cut-off. IIG had sensitivity 49.1% (95% CI 23.7–74.9) and specificity 62.3% (95% CI 53.2–70.7), consistent with moderate performance. ULBT demonstrated sensitivity 44.0% (95% CI 19.1–72.4) and specificity 66.1% (95% CI 57.0–74.3), reflecting a trade-off where fewer difficult cases were detected but a larger proportion of easy cases were correctly classified. LEMON had low sensitivity at 26.7% (95% CI 7.8–55.1) but the highest specificity at 77.0% (95% CI 68.5–84.1)

Table 1. Baseline characteristics stratified by laryngoscopy outcome

Variable	Total (n=133)	Easy laryngoscopy (n=118)	Difficult laryngoscopy (n=15)	P value
Age, years (mean ± SD)	—	—	—	—
Male sex, n (%)	80 (60.2)	69 (58.5)	11 (73.3)	0.27
Female sex, n (%)	53 (39.8)	49 (41.5)	4 (26.7)	
ASA I, n (%)	51 (38.3)	47 (39.8)	4 (26.7)	0.31
ASA II, n (%)	48 (36.1)	42 (35.6)	6 (40.0)	
ASA III, n (%)	34 (25.6)	29 (24.6)	5 (33.3)	

Table 2. Modified Mallampati Test (MMT) distribution

MMT class	Total n (%)
Class I	99 (74.4)
Class II	15 (11.3)
Class III	16 (12.0)
Class IV	3 (2.3)

Table 3. Thyromental distance (TMD) classification

TMD class	Total n (%)
Class I	118 (88.7)
Class II	11 (8.3)
Class III	4 (3.0)

Table 4. Inter-incisor gap (IIG) classification

IIG class	Total n (%)
Class I	102 (76.7)
Class II	31 (23.3)

Table 5. Upper lip bite test (ULBT) classification

ULBT class	Total n (%)
Class I	91 (68.4)
Class II	38 (28.6)
Class III	4 (3.0)

Table 6. LEMON airway assessment score

LEMON score	Total n (%)
0/10	98 (73.7)
>0/10	35 (26.3)

Table 7. Atlanto-occipital extension (AOE) grading

AOE grade	Total n (%)
Grade I	106 (79.7)
Grade II	14 (10.5)
Grade III	10 (7.5)
Grade IV	3 (2.3)

Table 8. Association between airway assessment tests and difficult laryngoscopy

Airway test (difficult category)	Difficult CL (n=15)	Easy CL (n=118)	Odds ratio (95% CI)	p-value
MMT III–IV	10	9	8.6 (2.8–26.4)	<0.001
TMD class II–III	7	8	8.3 (2.6–26.1)	<0.001
IIG class II	7	24	2.9 (1.0–8.4)	0.048
ULBT class III	4	0	—	<0.001
LEMON score >0	9	26	3.9 (1.3–11.6)	0.015
AOE grade III–IV	12	1	94.9 (11.3–798.6)	<0.001

Table 9. Diagnostic accuracy of airway assessment tests for predicting difficult laryngoscopy (CL III–IV)

Test	Sensitivity % (95% CI)	Specificity % (95% CI)	PPV %	NPV %	Accuracy %
MMT	66.7 (38.4–88.2)	71.2 (62.2–79.0)	52.6	82.4	82.0
TMD	64.3 (35.1–87.2)	53.4 (44.2–62.4)	38.9	76.8	63.2
IIG	49.1 (23.7–74.9)	62.3 (53.2–70.7)	29.0	79.5	67.0
ULBT	44.0 (19.1–72.4)	66.1 (57.0–74.3)	50.0	76.2	65.0
LEMON	26.7 (7.8–55.1)	77.0 (68.5–84.1)	25.7	77.9	71.0
AOE	20.0 (4.3–48.1)	75.4 (66.7–82.8)	46.2	70.4	86.0

supporting its role as a more “rule-in / rule-out depending on threshold” tool rather than a sensitive screen at the dichotomization used. AOE showed sensitivity 20.0% (95% CI 4.3–48.1) with specificity 75.4% (95% CI 66.7–82.8); despite low sensitivity, the table reports the highest overall accuracy (86.0%), which in a low-prevalence setting can be driven by correct classification of the majority easy cases.

Across tests, the predictive values reflect the underlying prevalence: PPVs are generally modest (e.g., 25.7% for LEMON; 29.0% for IIG), while NPVs are higher (typically ~70–80%),

meaning a negative test result is more reassuring than a positive test is confirmatory in this cohort.

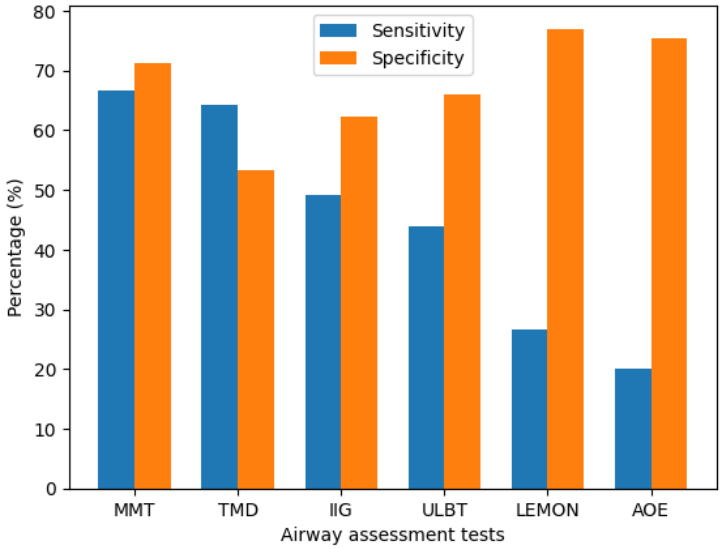

Figure 1 Diagnostic Trade-off Gradient Between Sensitivity and Specificity Across Preoperative Airway Assessment Tools

The figure illustrates a comparative gradient of sensitivity and specificity for six commonly used preoperative airway assessment tools against the reference standard of difficult laryngoscopy (Cormack–Lehane grade III–IV). A clear inverse pattern is observed across tests, highlighting clinically meaningful trade-offs between detection and exclusion capability. The Modified Mallampati Test demonstrates the highest sensitivity (66.7%) alongside moderate specificity (71.2%), supporting its role as an initial screening tool. Thyromental distance shows comparable sensitivity (64.3%) but lower specificity (53.4%), indicating a higher false-positive burden. In contrast, composite or mobility-focused assessments shift toward specificity: the LEMON score exhibits high specificity (77.0%) with markedly reduced sensitivity (26.7%), while atlanto-occipital extension shows the lowest sensitivity (20.0%) yet sustained specificity (75.4%), explaining its high overall accuracy in a low-prevalence setting. Intermediate tests such as inter-incisor gap and upper lip bite test occupy a mid-spectrum position, with balanced but modest performance. Collectively, the gradient pattern reinforces that no single test optimally balances sensitivity and specificity; instead, clinically effective airway prediction depends on combining a sensitive screening test with a more specific confirmatory assessment to align diagnostic strategy with patient safety priorities.

DISCUSSION

The present study evaluated the diagnostic performance of commonly used preoperative airway assessment tests for predicting difficult laryngoscopy in adult elective surgical patients and demonstrates several clinically relevant findings. The overall prevalence of difficult laryngoscopy in this cohort was 11.3%, which is consistent with rates reported in similar elective surgical populations and supports the external plausibility of the data (16,17). Within this context of relatively low event prevalence, the study highlights the inherent limitations of relying on a single bedside airway test and reinforces the principle that airway prediction is best approached through a multimodal assessment strategy.

Among the individual tests examined, the Modified Mallampati Test exhibited the highest sensitivity (66.7%), indicating that it correctly identified approximately two-thirds of patients who ultimately experienced difficult laryngoscopy. This finding aligns with prior literature

reporting moderate sensitivity for Mallampati classification, particularly when higher classes are grouped together as predictors of difficulty (12,18). However, the specificity of MMT in this study was modest (71.2%), reflecting a non-negligible rate of false-positive classification. Clinically, this reinforces the role of MMT as a screening tool rather than a definitive predictor, as overestimation of airway difficulty may lead to unnecessary preparation or escalation but is generally safer than under-recognition.

Thyromental distance demonstrated a sensitivity comparable to MMT but lower specificity, consistent with previous reports indicating that TMD alone is vulnerable to measurement variability and population-specific anatomical differences (7,19). The moderate performance of inter-incisor gap and upper lip bite test observed in this study further supports existing evidence that tests focused on a single anatomical dimension—such as mouth opening or mandibular protrusion—capture only one aspect of the complex mechanics involved in laryngoscopy (20). Notably, ULBT class III was present exclusively among patients with difficult laryngoscopy, suggesting high discriminatory value in extreme cases, although its low prevalence and limited sensitivity restrict its standalone utility.

The LEMON airway assessment demonstrated the highest specificity (77.0%) among all tests, albeit at the cost of low sensitivity (26.7%). This pattern is consistent with previous studies that have shown composite airway scores to be more effective in ruling out difficulty rather than serving as sensitive screening instruments (5,21). In practical terms, a negative LEMON assessment provides reassurance that difficult laryngoscopy is unlikely, whereas a positive score should prompt heightened vigilance rather than certainty of difficulty. This finding is particularly relevant in elective settings, where resource allocation and planning must balance safety with efficiency.

Atlanto-occipital extension emerged as the strongest predictor in terms of association with difficult laryngoscopy, with an exceptionally high odds ratio and the highest overall diagnostic accuracy. Despite its low sensitivity, restricted atlanto-occipital movement was rarely observed in patients with easy laryngoscopy, underscoring the critical role of cervical spine mobility in achieving optimal laryngoscopic alignment (22,23). The high accuracy observed for AOE is largely driven by its ability to correctly classify the majority of easy cases in a low-prevalence population, a phenomenon well recognized in diagnostic research (24). Nevertheless, the strength of association suggests that assessment of neck extension should be emphasized more consistently in routine preoperative evaluation.

Taken together, these findings support a tiered approach to airway assessment. Tests with higher sensitivity, such as the Modified Mallampati Test and thyromental distance, may be best suited for initial screening, ensuring that most potentially difficult airways are identified. These can then be complemented by more specific assessments—such as LEMON score and atlanto-occipital extension—to refine risk stratification and guide preparation strategies. This combined approach is consistent with contemporary airway management recommendations and aligns with emerging evidence that multivariate or composite models outperform single predictors (6,25).

The study has important clinical implications. In elective surgical practice, where time allows for comprehensive evaluation, structured use of multiple airway assessment tools can enhance anticipation of difficulty, reduce unplanned airway interventions, and improve patient safety. However, the findings should be interpreted in light of certain limitations. The single-centre design may limit generalizability, and the relatively small number of difficult laryngoscopy cases reduces precision for some estimates, particularly sensitivity. Additionally, while blinding was used to reduce observer bias, subtle operator-dependent factors during laryngoscopy may still influence outcomes.

In conclusion, this study reinforces that no single preoperative airway assessment test reliably predicts difficult laryngoscopy with both high sensitivity and specificity. The Modified Mallampati Test offers the greatest sensitivity, the LEMON score provides strong specificity, and atlanto-occipital extension demonstrates exceptional discriminatory power for identifying high-risk cases. A combined, structured assessment incorporating multiple complementary tests offers the most clinically robust strategy for predicting difficult laryngoscopy in elective surgical patients.

CONCLUSION

In adult elective surgery patients undergoing general anaesthesia, difficult laryngoscopy occurred in 11.3% of cases and no single bedside airway assessment achieved a clinically ideal balance of sensitivity and specificity; the Modified Mallampati Test demonstrated the greatest sensitivity, the LEMON assessment showed the highest specificity, and atlanto occipital extension provided the strongest discriminatory signal for identifying high-risk airways, supporting the clinical need for a structured, multimodal preoperative airway evaluation strategy to improve anticipation of difficulty and enhance perioperative safety.

REFERENCES

1. Benumof JL. Management of the difficult adult airway. With special emphasis on awake tracheal intubation. Anesthesiology. 1991;75(6):1087-1110.
2. Heidegger T, Ghulam A, Bischoff M, Luedi MM. Beyond Artificial Intelligence: A Critical Appraisal From An Airway Management Perspective. Anesth Analg. 2025;140(5):1111-1113.
3. Mallampati SR, Gatt SP, Gugino LD, Desai SP, Waraksa B, Freiberger D, et al. A clinical sign to predict difficult tracheal intubation; a prospective study. Can Anaesth Soc J. 1985;32(4):429-434.
4. 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.
5. Trambadia DN, Yadav P. Preoperative assessment to predict difficult airway using multiple screening tests. Cureus. 2023;15(10).
6. Bicalho GP, Bessa RC Jr, Cruvinel MGC, Carneiro FS, Castilho JB, Castro CHV. A prospective validation and comparison of three multivariate models for prediction of difficult intubation in adult patients. Braz J Anesthesiol. 2023;73(2):153-158.
7. Tsai Y-CM, Russotto V, Parotto M. Predicting the Difficult Airway: How Useful Are Preoperative Airway Tests? Curr Anesthesiol Rep. 2022;12(3):398-406.
8. Alemayehu T, Sitot M, Zemedkun A, Tesfaye S, Angasa D, Abebe F. Assessment of predictors for difficult intubation and laryngoscopy in adult elective surgical patients at Tikur Anbessa Specialized Hospital, Ethiopia: A cross-sectional study. Ann Med Surg. 2022;77:103682.
9. Sangeetha A, Ramanikanth S. Prediction of difficult intubation using bedside sonographic airway measurements in elective surgical patients. IAIM. 2021;8:79-85.
10. Harjai M, Alam S, Rastogi S, Kumar S. Effectiveness and validity of preoperative ultrasonographic airway assessment and clinical screening tests to predict difficult laryngoscopy: a prospective, observational study. Cureus. 2023;15(7).

11. Sotoodehnia M, Khodayar M, Jalali A, Momeni M, Safaie A, Abdollahi A. Prediction of difficult laryngoscopy/difficult intubation cases using upper airway ultrasound measurements in emergency department: a prospective observational study. BMC Emerg Med. 2023;23(1):78.

12. Harjai M, Alam S, Bhaskar P. Clinical relevance of Mallampati grading in predicting difficult intubation in the era of various new clinical predictors. Cureus. 2021;13(7).

13. Kamal K, Rani D, Ahlawat G, Bansal T. Prediction of difficult endotracheal intubation by different bedside tests: An observational study. Bali J Anesthesiol. 2023;7(1):8-12.

14. Benjawaleemas P, Oofuvong M, Kitsiripant C, Jitpakdee W, Dilokrattanaphichit N, Juthasantikul W, et al. Clinical predictors for perioperative anticipated and unanticipated difficult intubation: a matched case-control study. Sci Rep. 2025;15(1):9078.

15. Trambadia DN, Yadav P. Preoperative assessment to predict difficult airway using multiple screening tests. Cureus. 2023;15(10).

DECLARATIONS

Ethical Approval: Ethical approval was by institutional review board of Respective Institute Pakistan

Informed Consent: Informed Consent was taken from participants.

Authors' Contributions:

Concept: MSK, AA, AAk, SHD, TRU, IU; Design: MSK, AA, AAk, SHD, TRU, IU; Data Collection: MSK, AA, AAk, SHD, TRU, IU; Analysis: MSK, AA, AAk, SHD, TRU, IU; Drafting: MSK, AA, AAk, SHD, TRU, IU

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