THE INTUBATION CHALLENGE: COMPARING MODIFIED MALLAMPATI SCORE AND THYROMENTAL DISTANCE

Original Research

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Acknowledgement: The authors sincerely thank the anesthesia department staff for their cooperation in data collection.

Conflict of Interest: None   Grant Support & Financial Support: None

ABSTRACT

Background: Airway management is a cornerstone of safe anesthesia practice, and failure to anticipate a difficult airway can result in life-threatening complications. The Modified Mallampati Score (MMS) and Thyromental Distance Test (TMDT) are among the most widely used preoperative predictors. However, when used individually, their predictive accuracy remains variable. Combining these tests may improve diagnostic performance and support safer airway management in surgical patients.

Objective: To evaluate and compare the sensitivity, specificity, and predictive values of MMS and TMDT individually and in combination for predicting difficult intubation in apparently normal patients undergoing elective surgery.

Methods: This comparative observational study enrolled 150 patients with ASA physical status I or II scheduled for elective procedures under general anesthesia. Preoperative airway assessment was performed using MMS and TMDT, with Cormack–Lehane (CL) grading during laryngoscopy serving as the gold standard. Demographic data, surgical specialty, intubator experience, and the use of special equipment were recorded. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated for each test and their combination.

Results: MMS showed a sensitivity of 42.3%, specificity of 92.0%, PPV of 52.3%, and NPV of 88.4%. TMDT had a sensitivity of 23.07%, specificity of 92.0%, PPV of 37.5%, and NPV of 85.1%. The combined use of MMS and TMDT improved specificity to 98.4%, PPV to 66.7%, and maintained a high NPV of 84.8%, though sensitivity decreased to 15.4%. Difficult intubations were more frequent in females (80.8%) and general surgery cases (100%), while the use of special equipment was significantly associated with difficulty (p = 0.000).

Conclusion: While neither MMS nor TMDT alone offers both high sensitivity and specificity, their combined use enhances diagnostic accuracy and should be considered a valuable component of routine preoperative airway assessment.

Keywords: Airway management, Anesthesia, Difficult intubation, Elective surgery, Mallampati score, Preoperative assessment, Thyromental distance.

INTRODUCTION

Difficult intubation remains a critical challenge in anesthetic practice, contributing substantially to anesthesia-related morbidity and mortality. It is generally characterized by the need for multiple attempts, alternative devices, or additional assistance to achieve successful tracheal intubation, although definitions vary across clinical settings (1,2). Various classification systems, including the Cormack–Lehane grading and the Intubation Difficulty Scale (IDS), have been developed to standardize its assessment. According to the American Society of Anesthesiologists (ASA), difficult intubation is the second most common cause of anesthesia-related malpractice claims, underscoring its significant medicolegal implications (3). Reported incidence in the general population ranges between 1.5% and 8.5%, with notably higher rates in critical care environments (4). The consequences of unanticipated difficulty can be severe, leading to hypoxia, aspiration, cardiovascular collapse, brain injury, or even death, and evidence indicates that approximately 17% of airway-related injuries are linked to a failure to anticipate such difficulty (5,6). Despite advances in technology, including video laryngoscopes and supraglottic airway devices, conventional airway management techniques such as direct laryngoscopy and endotracheal intubation remain indispensable. This makes accurate preoperative airway assessment vital to patient safety. However, the predictive performance of commonly used bedside tests remains inconsistent, with many demonstrating low sensitivity, poor specificity, and considerable inter-observer variability (7). Among the most widely used are the Modified Mallampati Score (MMS) and the Thyromental Distance (TMD) test. MMS evaluates oropharyngeal visibility to gauge airway complexity, while TMD measures the distance from the thyroid notch to the mentum with the head fully extended.

A TMD of less than 6.0–6.5 cm (approximately three fingerbreadths) is generally considered indicative of potential difficulty, as it reflects limited mandibular space and reduced capacity to displace soft tissues during laryngoscopy (8,9). However, when applied individually, both MMS and TMD have shown variable accuracy across populations, with inconsistent sensitivity and specificity (10,11). Emerging evidence suggests that combining these assessment tools may improve diagnostic accuracy and reduce missed predictions of difficult intubation (12). While advanced modalities such as ultrasound or imaging-based airway evaluations offer promise, their availability is limited in many healthcare settings, especially in low-resource environments, where cost, equipment availability, and training constraints present significant barriers (13). This highlights the need for robust, simple, and reliable bedside tools that can be implemented widely and effectively. In light of these considerations, the present study aimed to evaluate and compare the predictive accuracy of MMS and TMD, both individually and in combination, for identifying difficult intubation in apparently normal patients. The objective was to address a key gap in local anesthetic practice, enhance the understanding of these tools' utility, and contribute to safer airway management strategies in resource-limited settings.

METHODS

This descriptive cross-sectional study was conducted at the Department of Anesthesiology, Lady Reading Hospital, Peshawar, from June to November 2023, following approval from the institutional research ethics committee. All participants gave written informed consent prior to enrollment. The study included 150 surgical patients scheduled for elective procedures under general anesthesia requiring endotracheal intubation. The sample size was determined using Cochran's formula, assuming a prevalence of difficult intubation of 11%, a 95% confidence level, and a 5% margin of error. A non-probability convenience sampling technique was employed, with participants selected according to predefined inclusion and exclusion criteria to ensure appropriate representation of the target population. Patients above 15 years of age, classified as American Society of Anesthesiologists (ASA) Class I or II, and undergoing elective general surgery, ENT, orthopedic, gynecology/obstetrics, or urology procedures requiring endotracheal intubation were eligible for inclusion. Exclusion criteria comprised patients with maxillofacial trauma, edentulous status, the need for rapid sequence induction, cervical spine injuries, oral cavity tumors, limited mandibular mobility, thyroid swelling, uncooperative behavior, a body mass index (BMI) ≥ 30 kg/m², or age below 15 years. Preoperative airway assessment was performed for all participants using the Modified Mallampati Test (MMT) and the Thyromental Distance (TMD) measurement. For the MMT, patients were examined in a seated position, with their mouths maximally open and tongues protruded, under pen-torch illumination to visualize oropharyngeal structures. Mallampati Class I and II were categorized as predictive of easy intubation, while Class III and IV were considered predictive of difficult intubation. For the TMD, the distance between the thyroid notch and the mentum was measured with the patient sitting upright, mouth

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closed, and neck fully extended, using a rigid ruler. A measurement > 6.5 cm (Class I) indicated easy intubation, whereas 6–6.5 cm (Class II) and < 6 cm (Class III) were considered predictive of difficult intubation. For analytical purposes, TMD < 6.5 cm was taken as a threshold for predicting difficulty.

On the day of surgery, standard anesthetic monitoring, including pulse oximetry, electrocardiography, and non-invasive blood pressure measurement, was instituted. Anesthesia was induced with intravenous propofol (1.5–2.5 mg/kg), nalbuphine (0.1 mg/kg), and suxamethonium (1–1.5 mg/kg). In cases where difficult intubation was predicted preoperatively (Mallampati Class III/IV or TMD < 6.5 cm), inhalational induction was performed before administration of a muscle relaxant, to maintain spontaneous ventilation until the airway was secured. Direct laryngoscopy was carried out using a Macintosh laryngoscope, and the Cormack–Lehane (CL) grading was documented. CL Grade I and II were considered indicative of easy intubation, whereas Grades III and IV were classified as difficult. The CL grading served as the gold standard for comparison with MMT and TMD results. Data were recorded on a structured proforma including demographic variables, airway assessment findings, and intubation outcomes. Statistical analysis was performed using SPSS version 22. Descriptive statistics were used to summarize demographic data. Sensitivity, specificity, positive predictive value, and negative predictive value for MMT and TMD were calculated, with CL grading as the reference standard.

RESULTS

The study included 150 patients with ASA physical status I or II, scheduled for elective surgeries under general anesthesia. The sample comprised 38 males (25.2%) and 113 females (74.8%), with ages ranging from 15 to 65 years (mean 33.90 ± 12.90 years, median 34 years). The majority underwent general surgery (132 patients, 87.1%), followed by gynecology and obstetrics (14 patients, 9.9%), ENT (3 patients, 1.3%), and urology (1 patient, 0.7%). Most intubations were performed by anesthesia technicians (134 patients, 87.4%), followed by technologists (16 patients, 11.3%) and doctors (2 patients, 1.3%). Analysis of the Modified Mallampati Score (MMS) revealed no statistically significant association with gender, surgical specialty, intubating professional, years of experience, or use of special equipment (all p > 0.05). However, most difficult intubations were observed in females (75.2%), general surgery cases (90.5%), and procedures performed by technicians (76.2%). Special equipment use was higher in difficult cases (14.3%) compared to non-difficult cases (5.4%), but this difference did not reach statistical significance. A near-significant association was observed for intubating professionals with 7 years of experience (p = 0.056). For the Thyromental Distance Test (TMD), no significant associations were found with gender, surgical specialty, intubating professional, or years of experience (all p > 0.05). Most difficult intubations occurred in females (81.3%) and general surgery cases (93.8%), predominantly handled by technicians (87.5%). A statistically significant association was observed for the use of special equipment, which was required in 37.5% of difficult cases compared to 3.0% in non-difficult cases (p < 0.05).

Cormack–Lehane (CL) classification analysis showed no significant association between intubation difficulty and gender or surgical specialty, although all difficult cases occurred in general surgery (100%). All difficult intubations were performed by technicians, but the association was not statistically significant. Significant associations were found between intubation difficulty and both years of experience and the use of special equipment. Professionals with 7 years (46.2%) and 30 years (50.0%) of experience accounted for the majority of difficult intubations. Special equipment was used in 23.1% of difficult cases compared to 3.2% of non-difficult cases (p = 0.000). A strong association was found between MMS and CL grading. Patients with MMS Class III or IV had a significantly higher rate of difficult intubations (42.3%) compared to 8.0% in patients with MMS Class I or II. The sensitivity, specificity, positive predictive value, and negative predictive value for MMS in predicting difficult intubation were 42.3%, 92.0%, 52.3%, and 88.4%, respectively. For TMD, the sensitivity in predicting difficult intubation was 23.07%, specificity 92.0%, positive predictive value 37.5%, and negative predictive value 85.1%, indicating low sensitivity but high specificity for identifying non-difficult cases. When combining MMS and TMD, the sensitivity dropped to 15.4% (4/26), while specificity increased to 98.4% (123/125). The positive predictive value was 66.7%, and the negative predictive value was 84.8%.

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Table 1: Association of Modified Mallampati Score with Factors Affecting Intubation Difficulty

Variable	Difficult Intubation	Not Difficult Intubation	p-value
Gender			
Male	5 (23.8%)	33 (25.4%)	P > 0.05
Female	15 (75.2%)	96 (74.6%)	
Surgical Procedure			
General Surgery	20 (90.5%)	113(87.7%)	P > 0.05
ENT	0 (0.0%)	2 (1.5%)	
Urology	0 (0.0%)	1 (0.8%)	
Gynae and Obs.	2 (9.5%)	13 (10.0%)	
Intubating Professional			
Doctor	0 (0.0%)	2 (1.5%)	P > 0.05
Technologist	5 (23.8%)	12 (9.2%)	
Technician	15 (76.2%)	117(89.2%)	
Years of Experience			
7	10 (47.6%)	54 (41.9%)	P > 0.05
9	1 (4.8%)	0 (0.0%)	
15	1 (4.8%)	11 (8.5%)	
20	4 (19.0%)	13 (10.0%)	
30	5 (23.8%)	52 (40.0%)	
Use of Special Equipment			
No	18 (85.7%)	123 (94.6%)	P > 0.05
Yes	3 (14.3%)	7 (5.4%)	

Table 2: Thyromental Distance Test Cross-tabulation

Variable	Category	Difficult (%)	Not Difficult (%)	P-Value
Gender of Patient	Male	3 (18.8%)	35 (25.9%)	P > 0.05
	Female	13 (81.3%)	100 (74.1%)	
Surgical Procedure	General Surgery	15 (93.8%)	118 (87.4%)	P > 0.05
	ENT	0 (0.0%)	2 (1.5%)	
	Urology	0 (0.0%)	1 (0.7%)	
	Gynae and Obs.	1 (6.3%)	14 (10.4%)	
Intubating Professional	Doctor	0 (0.0%)	2 (1.5%)	P > 0.05
	Technologist	2 (12.5%)	15 (11.1%)	
	Technician	14 (87.5%)	118 (87.4%)	
Years of Experience	7	9 (56.3%)	55 (40.7%)	P > 0.05
	9	0 (0.0%)	1 (0.7%)	
	15	1 (6.3%)	11 (8.1%)	
	20	3 (18.8%)	14 (10.4%)	
	30	3 (18.8%)	54 (40.0%)	
Use of Special Equipment	Yes	6 (37.5%)	4 (3.0%)	P < 0.05
	No	10 (62.5%)	131 (97.0%)	

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Table 3: Cormack and Lehane Cross-tabulation Results

Variable	Category	Difficult (%)	Not Difficult (%)	P-Value
Gender of Patient	Male	5 (19.2%)	33 (26.4%)	0.443
	Female	21 (80.8%)	92 (73.6%)	
Surgical Procedure	General Surgery	26 (100%)	107 (85.6%)	0.236
	ENT	0 (0.0%)	2 (1.6%)	
	Urology	0 (0.0%)	1 (0.8%)	
	Gynae and Obs.	0 (0.0%)	15 (12.0%)	
Intubating Professional	Doctor	0 (0.0%)	2 (1.6%)	0.104
	Technologist	0 (0.0%)	17 (13.6%)	
	Technician	26 (100%)	106 (84.8%)	
Years of Experience	7 years	12 (46.2%)	52 (41.6%)	0.016
	9 years	1 (3.8%)	0 (0.0%)	
	15 years	0 (0.0%)	12 (9.6%)	
	20 years	0 (0.0%)	17 (13.6%)	
	30 years	13 (50.0%)	44 (35.2%)	
Use of Special Equipment	Yes	6 (23.1%)	4 (3.2%)	0.000
	No	20 (76.9%)	121 (96.8%)	

Table 4: Relationship Between Mallampati Score and Cormack and Lehane Classification for Intubation Difficulty

Mallampati Score	Cormack and Lehane (Difficult) (n, %)	Cormack and Lehane (Not Difficult) (n, %)	Total (n, %)
MT III & IV (Difficult)	11 (42.3%)	10 (8.0%)	21 (13.9%)
MT I & II (Not Difficult)	15 (57.7%)	115 (92.0%)	130 (86.1%)
Total	26 (100%)	125 (100%)	151 (100%)

Table 5: Thyromental Distance (TMD) and Cormack and Lehane Classification for Intubation Difficulty

Thyromental Distance (TMD)	Cormack and Lehane (Difficult) (n, %)	Cormack and Lehane (Not Difficult) (n, %)	Total (n, %)
< 6.5 cm (Difficult)	6 (23.1%)	10 (8.0%)	16 (10.59%)
> 6.5 cm (Not Difficult)	20 (76.9%)	115 (92.0%)	135 (89.40%)
Total	26 (100%)	125 (100%)	151 (100%)

Table 6: Combination of Mallampati and TMD in Predicting Intubation Difficulty

Combination of Mallampati and TMD	Cormack and Lehane (Difficult) (n, %)	Cormack and Lehane (Not Difficult) (n, %)	Total (n, %)
Difficult	4	2	6 (3.97%)
Not Difficult	22	123	145 (96.03%)
Total	26	125	151 (100%)

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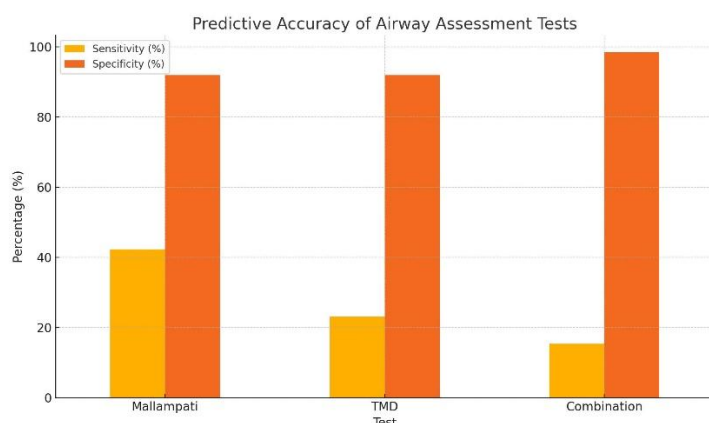INSIGHTS-JOURNAL OF HEALTH
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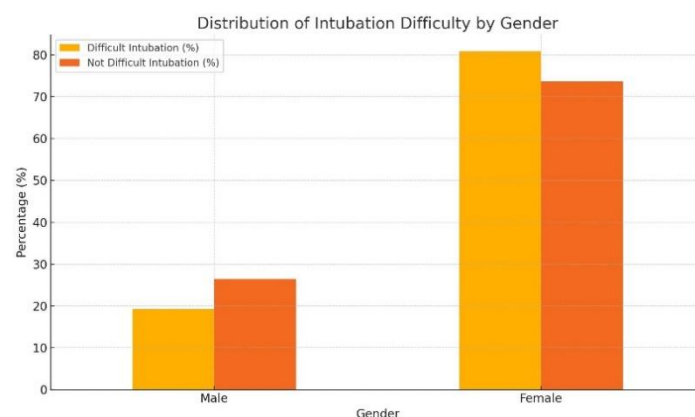Figure 1 Prediction Accuracy of Airway Assessment Test

Figure 2 Distribution of Intubation Difficulties by Gender

DISCUSSION

This study evaluated the predictive performance of the Modified Mallampati Score (MMS) and the Thyromental Distance Test (TMDT) in identifying difficult intubations and explored their association with patient characteristics, surgical context, operator experience, and use of specialized equipment. The findings demonstrated that both MMS and TMDT exhibited high specificity, with the combination of these tests further enhancing specificity, thereby supporting the concept that multifactorial airway assessment increases predictive accuracy. The results were consistent with previously published evidence, where MMS has been reported to demonstrate high specificity (85–90%) but only moderate sensitivity in predicting difficult intubations, a pattern mirrored in the current study with a specificity of 92% and sensitivity of 42.3% (14). Similarly, TMDT in this cohort showed high specificity (92%) but low sensitivity, aligning with earlier reports that highlighted its utility in reliably ruling out difficult intubations while acknowledging its limitations in detecting all difficult cases (15). The strong correlation between higher MMS classes and difficult Cormack–Lehane grades in this study further supports earlier findings that restricted oropharyngeal visibility is a strong predictor of challenging glottic views (16). Gender-based trends revealed a higher prevalence of difficult intubations among female patients, which corresponds with previous work attributing this to anatomical variations such as smaller airway dimensions and higher Mallampati grades in females (17,18). Although this association was not statistically significant in the present analysis, the consistency of this trend with prior research suggests it warrants consideration in preoperative risk assessment. Surgical type also appeared relevant, with general surgery cases demonstrating the highest rates of difficult intubation across all assessment methods. This parallels reports indicating that surgical positioning, procedural requirements, and perioperative factors can influence airway complexity (19,20). The role of operator experience was evident, with most difficult intubations occurring in cases managed by technicians, particularly those with intermediate levels of experience (7 years). This observation aligns with prior research emphasizing the importance of advanced airway training and the potential influence of skill level on both the detection and management of airway difficulty (21). The significantly higher use of special equipment in difficult intubations in this study reflects established recommendations advocating the availability and readiness of advanced airway devices when a difficult airway is anticipated (22).

A key strength of this study lies in its direct comparison of MMS and TMDT against the gold-standard Cormack–Lehane classification in a real-world surgical population, along with an analysis of the impact of combining assessment tools. The use of objective, pre-defined criteria for each test also strengthens the validity of the findings. Furthermore, the inclusion of operator and procedural variables adds contextual depth to the analysis, providing insights into practical factors influencing airway management. However, several limitations must be acknowledged. The non-probability convenience sampling limits generalizability to broader populations. The sample was drawn from a single tertiary-care hospital, which may introduce institutional bias in patient demographics and airway management protocols. The absence of blinding for the laryngoscopist to preoperative airway assessment results could have introduced observer bias. Additionally, certain potentially relevant variables, such as BMI distribution, neck circumference, or history of previous difficult intubation, were not assessed and may have provided further predictive value. The study also did not evaluate inter-observer variability, which is a known limitation in airway assessment tools. Future studies could benefit from multicenter recruitment to enhance external validity, the inclusion of additional airway assessment parameters, and the application of blinded intubation assessments to minimize

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bias. Prospective designs incorporating newer modalities, such as ultrasound airway assessment, could further refine prediction models In summary, the findings reinforced the clinical utility of MMS and TMDT, particularly in ruling out difficult intubations, while highlighting the enhanced predictive performance of combining these assessments. Integration of such composite tools, along with consideration of operator experience, surgical context, and equipment preparedness, may contribute to safer and more effective airway management strategies in diverse surgical settings.

CONCLUSION

This study concluded that no single airway assessment tool can independently provide both high sensitivity and specificity for predicting difficult intubation. However, combining the Thyromental Distance Test with the Modified Mallampati Score enhances predictive reliability, particularly by improving specificity and positive predictive value. Integrating these assessments into routine preoperative evaluation can strengthen airway risk prediction, support timely preparation for advanced airway management, and ultimately contribute to safer anesthetic care.

AUTHOR CONTRIBUTION

Author	Contribution
Amir Khan	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Immad Ul Islam	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Zabih Ullah	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Muhammad Abdullah Saleem	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Muhammad Rizwan	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Syed Numan Shah	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Fahim Ullah	Contributed to study concept and Data collection Has given Final Approval of the version to be published
Ahmad Ullah*	Writing - Review & Editing, Assistance with Data Curation

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