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ORIGINAL ARTICLE

Comparison of four airway assessment tools to predict difficult endotracheal intubation: A cross-sectional study to facilitate early-year residents in anesthesia training.

Sairah Sadaf[1], Waseema Afzal[2], Rafia Kousar[3]

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ABSTRACT… Objective: To assess four airway assessment tools to predict difficult airway to facilitate early year residents in anesthesia training. **Study Design:** Cross-sectional study. **Settings:** Sheikh Zayed Medical College & Hospital, Rahim Yar Khan. **Period:** September 2023 to October 2024. **Methods:** Enrolled 203 patients thru convenient sampling. Patients' airways were assessed using ULBT, MMT, TMD, and SMD; four bedside airway assessment methods. And results were compared with laryngoscopic view (Cormack-Lehane) in terms of sensitivity, specificity, PPV, NPV and Accuracy. **Results:** A total of 203 patients participated, with mean age 36 years, and mean BMI 27.3kg/m^2. ULBT, MMT, SMD, and TMD predicted difficult airway in 10.8%, 15.3%, 6% and 9.9% of the patients, respectively. While Cormack-Lehane view presented difficulty in 15.3% intubations. These four airway assessment tools revealed a wide range of sensitivities, from 15.1% to 54.8%. **Conclusion:** Among all four tests, ULBT and MMT are superior in efficacy as compared to TMD and SMD in identifying a potentially difficult airway.

Key words: Airway Assessment, Cormack-Lehane, Difficult Intubation, MMT, SMD, TMD, ULBT.

INTRODUCTION

In the field of Anesthesia, Endotracheal intubation is the standard of care during the administration of general anesthesia, in critical care and in emergency room (ER) to secure an airway. A meticulous airway assessment of surgical patients prior to endotracheal intubation is a critical component of the pre-anesthetic evaluation. Surgical patients under general anesthesia experience difficult intubation in 1-18% of cases.[1,2] Although advancements in the modern airway management devices have reduced the incidence of failed intubation to 0.52%-2[3-6], resource-constrained healthcare facilities in Pakistan often lack access to these advanced gadgets.[7] Thus a comprehensive approach to assess the airway before general anesthesia is crucial, one that should not entirely rely on advanced gadgets. Inadequate and inaccurate airway assessment by junior residents and house officers can significantly elevate chances of crisis and can lead to multiple attempts at intubation which may precipitate a cascade of adverse events, including hypoxemia (70% vs 11.8%); Aspiration (22% vs 1.9%); life threatening bradycardia (21 % vs 1.6%); and cardiac arrest (11% vs 0.7%).[8-11]

A variety of airway assessment tools, difficult airway management guidelines and difficult airway management devices have been developed to support anesthesiologists in predicting and managing challenging intubations.[12-17] However, the effective application of these resources depends on the anesthetists' ability to accurately identify and interpret key airway features.[18] Early detection of potential airway risks is necessary for the timely application of recognized protocols, such as those set by DAS.[19] Anticipating and preparing for potential crises allows for more effective management than reacting to it under

1. MBBS, FCPS, Associate Professor Anesthesia, ICU & Pain Medicine, Sheikh Zayed Medical College/ Hospital, Rahim Yar Khan. Pakistan
2. MBBS, FCPS, Senior Registrar Anesthesia, Nishtar Medical University/Hospital, Multan.
3. MBBS, FCPS, Assistant Professor Anesthesia & ICU, Sahara Medical College, Narowal, Pakistan.

Correspondence Address:
Dr. Sairah Sadaf
Department of Anesthesia, ICU & Pain Medicine, Sheikh Zayed Medical College/ Hospital, Rahim Yar Khan, Pakistan.
sairahbabar@live.com

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pressure.

Junior residents, in their early years, should prioritize proficiency in the basic bedside airway assessment techniques before advancing to complex instrumentation, all under careful supervision. This will not only reduce the risk of adverse patient outcomes, like hypoxia and cardiac arrest, but will also foster increased confidence and competence among early year residents navigating complex airway scenarios.[20,21]

Literature review has identified few studies that have evaluated individual airway assessment tools, There is limited research that has directly compared the efficacy of multiple tools in a single study in special regards to facilitate early year residents. To address this gap, the present study was designed to evaluate and compare four distinct yet affective and simple bedside airway assessment tools; Upper lip bite test (ULBT), modified Mallampatti (MMT), sterno-mental (SMD) and thyro-mental distances (TMD), to aid in predicting difficult glottis visualization for junior residents.

The objective of this research is to provide junior residents with evidence-based data, thereby enhancing their ability to proactively identify and manage potential airway crises while using these simple bedside airway assessment methods.

METHODS

After obtaining institutional ethics committee approval (IRB number: 25/IRB/SZMC/SZH dated 19-09-2023), this cross-sectional study was conducted at Sheikh zayed medical college/ hospital rahim yar khan, from September 2023 to October 2024. A sample size of 100 patients was calculated keeping CI 95% and power of test 80% using accuracy of MMT vs ULBT (81.0% vs 94% respectively) from a previous study.[22] We increased the number of sample size to 200 to reduce the chances of error. After informed consent, 203 patients, aged between 18 to 65 years, of both genders, with ASA Class I or II, scheduled for an elective surgical procedure that required general anesthesia were enrolled by convenient sampling. Patients with BMI >30, pregnancy, rheumatoid arthritis, obvious airway or oral pathology were excluded from the study. Airway assessment of surgical patients was done before the surgery by a 1st year resident and was observed by a senior anesthetist.

For airway assessment, simple bedside airway assessments methods like Upper lip bite test (ULBT), modified mallampatti (MMT), sterno-mental (SMD) and thyro-mental distances (TMD) were used. (Figure-1)

ULBT essentially evaluates the extent of mandibular movement and dentures formation. Participants, seated with their heads in a neutral position, were instructed to bite their upper lip with the lower incisors as high as possible, after having a demonstration by the anesthetist. The Upper Lip Bite Test (ULBT) was used to predict intubation difficulty based on lower incisor positioning relative to the upper lip's vermilion border. Patients, whose incisors reached above (Class I) or below (Class II) the border, were predicted to have easier intubation, while those with no contact (Class III) were considered at risk for difficult intubation.

The MMT test was performed with a torch for proper visualization of oral cavity, requiring seated patients to maintain a neutral head position, mouths widely opened with protruded tongues, and without producing any sound. On the basis of oral cavity structures visualization, MMT has four classes. Class I: Soft palate, fauces, entire uvula, anterior and posterior tonsillar pillars visible, Class II: Soft palate, fauces, uvula visible. Class III: Soft palate and base of uvula visible. Class IV: Only hard palate visible. Categories I and II were interpreted as indicators of potentially easy intubation, while categories III and IV suggested a higher likelihood of challenging intubation.

Thyro-mental distance (TMD) and sterno-mental distance (SMD), the measurement from the mentum to the superior thyroid notch and from mentum to upper boarder of manubrium sterni with the neck fully extended, was obtained using a measuring tape in seated patients. Predictive test

evaluation and patient intubation were performed by two separate, blinded anesthetists to preserve blinding and to avoid bias.

On the day of surgery, established fasting protocols were observed for surgical pts and standard monitoring was attached to the participants; (electrocardiogram, automated blood pressure, pulse oximetry, end tidal carbon dioxide), and then general anesthesia was induced with standard drugs dosage. Inj Midazolam (0.05 mg/kg) was used for sedation, followed by pre-oxygenation for 3–4 minutes with 100% oxygen. Inj Propol (2mg/kg) induction was followed by Atracurium (0.5mg/kg). After 03 minutes of 100% oxygenation and face mask ventilation, with patients head in sniffing position, laryngoscopy was performed by a senior anesthetist without external laryngeal maneuver and grading was assigned to the laryngoscopic view using Cormack-Lehane (CL) classification. Grade 1: Full view of the vocal cords, Grade 2: Limited view of the vocal cords, with the posterior glottis and epiglottis seen, Grade 3: Only the epiglottis is visible, Grade 4: No visualization of the epiglottis or vocal cords. The patients were intubated with cuffed endotracheal tubes as per their body habitus. In case of CL grade 3 or 4, pt was managed as per difficult airway guidelines.

For the purpose of this study, Positive predictive test results were defined as: MMT ≥ III, TMD ≤ 6.5 cm (classes II/III), SMD ≤ 13.5 cm (classes II-IV), and IIG ≤ 3.5 cm (class II). These thresholds were selected based on prior studies. Patients' age, gender, BMI, and Airway assessment results were noted on a predesigned performa.

Statistical Analysis

Statistical analysis was done with SPSS v. 26 to explore and organize the data. We performed a calculation of sensitivity (S), specificity (Sp), positive predictive value (PPV) and negative predictive value (NPV), and accuracy.

RESULTS

A total of 203 patients participated, 76(37.4%) males and 127(62.6%) females, with mean age 36 years (15-74) and mean BMI 27.3kg/m^2(19-30). ULBT predicted difficult airway in 10.8% of the patients. MMT indicated difficult airway in 15.3% patients. SMD and TMD pointed out difficult airway in 6% and 9.9% of the patients respectively. While CL view presented difficulty in 15.3% intubations. There was not a single case of failed intubation. All the tests were compared with Cormack-Lehane easy and difficult classes as shown in Table-I and sensitivity, specificity, PPV, NPV and Accuracy for each test were drawn manually by using standard formulae. The values between ULBT and MMT are comparable, indicating that both are valid tests as compared to other two tests. But among all four tests, ULBT showed superior validity with highest accuracy to predict difficult airway.

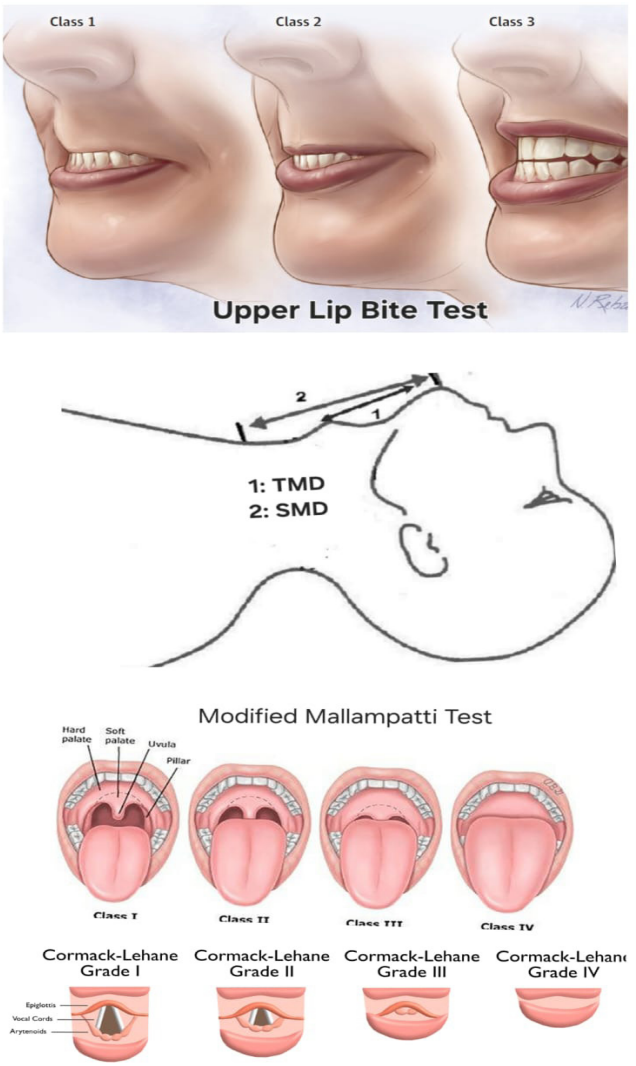

Figure-1

ULBT	CL				SN	SP	PPV	NPV	Accuracy
	Actual Easy		Actual Difficult						
Predicted Easy	**TN**	166	**FN**	15	51.6	96.5	72.7	91.7	89.66
Predicted Difficult	**FP**	06	**TP**	16					
MMT									
Predicted Easy	**TN**	158	**FN**	14	54.8	91.8	54.8	91.8	86.21
Predicted Difficult	**FP**	14	**TP**	17					
SMD									
Predicted Easy	**TN**	165	**FN**	26	16.12	95.9	41.66	86.38	83.72
Predicted Difficult	**FP**	07	**TP**	05					
TMD									
Predicted Easy	**TN**	157	**FN**	26	16.12	91.2	25.0	85.79	79.80
Predicted Difficult	**FP**	15	**TP**	05					

Table-I. Comparison between different tests and Cormack-Lehane classes

***SN= sensitivity, SP=specificity, PPV=positive predictive value, NPV=negative predictive value, TN= true negative, TP=true positive, FP=false positive, FN= false negative**

DISCUSSION

Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) are crucial for evaluating the clinical utility of airway assessment tools. Sensitivity rules out false negative while Specificity eliminates false positives. A high sensitivity means it won't miss people with a difficult airway. While a high specificity means it won't label an easy airway as a difficult.

PPV shows the probability that a positive test result accurately predicts a difficult airway, while NPV shows the probability that a negative result accurately predicts an easy airway. These values, when analyzed together, determine the tools' reliability in guiding clinical decisions for airway management, ultimately impacting patient safety by minimizing complications from failed intubations.

Our study, evaluated four airway assessment tools, and revealed a wide range of sensitivities, from 15.1% to 54.8%, indicating varying ability to correctly identify difficult airways. Specificities were generally high, ranging from 91.2% to 96.5%, suggesting good performance in ruling out difficult airways. In Sensitivity ULBT (51.6%) performed better than both TMD (16.17%) and SMD (16.12%) in detecting actual difficult airways. This means ULBT was more likely to correctly identify patients with potentially difficult intubations. In Specificity all four tests demonstrated high specificity (91.2% to 96.5%). This means they were all good at correctly identifying patients who did not have difficult airways. Overall ULBT shows better sensitivity then TMD and SMD. There is a commendable overall accuracy, ranging from 79.8% to 89.66%, indicating potential value of these tools as screening instruments. While sensitivities varied, highlighting the need for careful interpretation, the high specificities suggest these tools are effective at ruling out difficult airways. This data provides a strong foundation for using these tools as part of a comprehensive airway assessment strategy, potentially contributing to improved patient safety when combined with clinical judgment and other

relevant factors.

A study performed on more than seven thousand patients, Compared the TMS score's sensitivity of 66.1% and specificity of 92.5%[23] which correlates with our results of MMT and ULBT i.e. sensitivity more than 50% and specificity more than 90%, indicates some of these assessment tools demonstrate lower sensitivity, suggesting a potential for missed difficult airways, which warrants careful consideration in clinical practice. In contrast, the Maharashtra study, with a smaller sample of 181 patients, found the Modified Mallampati Test (MMT) superior to the Upper Lip Bite Test (ULBT), reporting a sensitivity of 88.23% and specificity of 89.02%.[24] The significantly higher sensitivity of MMT in the Maharashtra study compared to our results highlights the variability across different patient populations, suggesting that local prevalence and patient characteristics may influence test performances. In our study ULBT showed superiority over all the tests performed in regards of specificity and accuracy.

A study of 150 subjects comparing the Modified Mallampati Test (MMT) and Thyro-mental Height Test (TMHT) reported TMHT with a sensitivity of 93.33% and specificity of 91.43%, both significantly higher than our sensitivity results.[25]

In contrast, a prospective study of 104 patients with a 10.6% difficult intubation incidence found the Upper Lip Bite Test (ULBT) to have a considerably higher sensitivity (90.9%) and specificity (95.7%) than the Modified Mallampati Test (MMT).[26] This aligns with our study results where ULBT shows superiority over MMT in regards of specificity and accuracy.

CONCLUSION

After a thorough review we reached the conclusion that ULBT and MMT in combination can identify difficult airway cases more efficiently than as individual tests. Both are superior in efficacy as compared to TMD and SMD in identifying a potentially difficult airway and will facilitate the early year anesthesia residents as a simple and effective bed side method which requires no sophisticated instrumentation.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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AUTHORSHIP AND CONTRIBUTION DECLARATION	
1	**Sairah Sadaf:** Conception, analysis, interpretation of data drafting, final approval, agreement to be accountable.
2	**Waseema Afzal:** Drafting of the work, agreement to the accountable.
3	**Rafia Kousar:** Manuscript writing.