ADDIS ABABA UNIVERSITY, COLLEGE OF HEALTH SCIENCE DEPARTMENT OF ANESTHESIOLOGY, CRITICAL CARE AND PAIN MEDICINE.

PREDICTIVE ACCURACY OF BEDSIDE AIRWAY ASSESSMENT TESTS FOR DIFFICULT LARYNGOSCOPY AND INTUBATION AT TIKUR ANBESA SPECIALIZED HOSPITAL, ADDIS ABABA, ETHIOPIA FROM JANUARY 2023 TO MARCH 2024.

BY: HABTAMU MENGSTIE (MD), FINAL YEAR ANESTHESIOLOGY, CRITICAL CARE AND PAIN MEDICINE RESIDENT

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Abbreviations and Acronyms

ACCPM-Anesthesia Critical Care and Pain Medicine

ASA-American Society of Anesthesiologist

DI-Difficult intubation

DL-Difficult laryngoscopy

ETB-Ethiopian Birr

IID-Interincisor distance

MC-Mallampati class

MP- Mandibular protrusion

SMD- Sternomental distance

SPSS-Statistical Package for Social Sciences

TASH- Tikur Anbesa Specialized Hospital

TMD-Thyromental distance

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Abstract:

Background: Difficult laryngoscopy and intubation during anesthesia induction pose significant challenges to anesthesiologists, potentially leading to severe complications and even mortality(1).

Objective: To investigate the diagnostic accuracy and predictive factors of bedside airway assessment tests for difficult laryngoscopy and intubation among elective surgical patients.

Methods: Facility-based cross-sectional study design.

Result: The finding of the study revealed a magnitude of difficult laryngoscopy at 9% and difficult intubation at 6.7% among the study population. Age ≥65 years and ASA Class III were identified as potential risk factors for both difficult laryngoscopy and intubation.

Conclusion: Our study underscored the high specificity (100%) but low sensitivity (0%) of preoperative parameters, when used alone, in predicting difficult laryngoscopy and intubation, emphasizing the need for a nuanced approach to preoperative airway assessment. The results demonstrate the effectiveness of combined predictive tests, MMC+CL, for instance in improving the sensitivity (100%) and specificity (100%) of identifying difficult laryngoscopy.

Keywords:

Difficult laryngoscopy, Difficult intubation, Bedside airway assessment, Predictive accuracy, Tikur Anbesa Specialized Hospital, Ethiopia

1 Introduction

1.1 Background

Anesthesiologists frequently encounter challenging situations known as difficult airways, where conventional airway management techniques prove inadequate(2). Difficult airways encompass a spectrum of scenarios, including anticipated or unanticipated difficulties with mask ventilation, laryngoscopy, and tracheal intubation, among other airway interventions(1). Failure to promptly and effectively anticipate and manage difficult airways can lead to hypoxia, respiratory compromise, and even catastrophic outcomes, underscoring the critical importance of accurate preoperative assessment and preparation(1). In fact, failure in difficult airway management contributes to 30%–40% of anesthesia-related mortalities.

To mitigate these risks, preoperative assessments play a pivotal role, with various bedside airway tests utilized to predict difficult laryngoscopy and intubation(2).

Commonly employed preoperative measurements include the modified Mallampati class (MMC), interincisor distance (IID), thyromental distance (TMD), sternomental distance (SMD), and mandibular protrusion(2–5). These tests offer valuable insights into anatomical factors that may impede successful airway management and are generally inexpensive, straightforward, and simple to perform, making them accessible to anesthesia professionals of all levels(2). However, no single indicator of a difficult intubation is universally reliable(2).

While combining multiple parameters improves the sensitivity and specificity of preoperative bedside airway tests in predicting difficult laryngoscopy and intubation, significant variations in diagnostic efficacy exist across studies(2,4–6). These discrepancies may be attributed to differences in the incidence of difficult intubation, which, in turn, may be influenced by constitutional variations among patient populations(2,4–6).

1.2 Statement of the Problem

Difficult airway management presents a significant challenge in anesthesia practice, with profound implications for morbidity and mortality (7,8)). Maintaining a patent airway is paramount for ensuring adequate oxygenation and ventilation, as failure to do so, even momentarily, can precipitate life-threatening complications (9).Respiratory events constitute the most common anesthesia-related injuries, second only to dental damage (9)

Unanticipated difficult laryngoscopy and intubation elevates the risk of complications, ranging from mild sore throat to severe airway trauma, brain injury, and mortality (4). In a Danish cohort study to investigate the anesthesiologist's prediction of difficult airway management in clinical practice, 188064 patients registered in the Danish Anesthesia database were retrieved and of the 3391 difficult intubations, 3154 (93%) were unanticipated(10). When difficult intubation was anticipated, 229 of 929 (25%) had an actual difficult intubation(10). These adverse outcomes often stem from a lack of accurate predictive tests for difficult intubation and inadequate preoperative airway assessments (4). Moreover, the predictive values of bedside airway metrics vary across studies, reflecting differences in patient characteristics such as sex and race.

Airway assessment tests, while valuable, are not infallible, as the dynamic nature of airway management during anesthesia induction can diverge significantly from preoperative evaluations. This inherent uncertainty complicates the task of predicting difficult laryngoscopy and intubation, underscoring the need for robust research and evidence-based practices.

Recent studies conducted at Black Lion Hospital revealed a significant incidence of difficult laryngoscopy (12.2%) and intubation (6.1%) (4). However, such data are lacking in our hospital and country, with limited standardized guidelines for preoperative testing. Moreover, the majority of studies on difficult laryngoscopy and intubation have been conducted in Western populations, limiting their generalizability to our anthropometrically distinct population. Therefore, there is an urgent need for comprehensive studies in our setting to address these critical gaps in knowledge.

1.3 Significance of the Study

Despite the fact that difficult airway management is a major cause of morbidity and mortality in anesthetic practice, adequate attention is not given for its prevalence and ways to improve the predictive ability of the bed side airway parameters has not been done in our Hospital(4).

This study is designed to determine the incidence of difficult laryngoscopy and intubation in Black Lion Hospital and also to determine the diagnostic accuracy of various bedsides tests for predicting difficult laryngoscopy and intubation in patients without any airway pathology.

Such studies will pave the way for evidence based local or national data on the magnitude of the problem and knowing about the predictive potential of the airway assessment tools will help anesthesia providers improve patient safety and the quality of anesthesia care.

By describing the validity of clinically useful preoperative tests for predicting difficult laryngoscopy and intubation in patients with seemingly normal airways, it can provide anesthesia providers and other concerned professionals with evidence-based information on the magnitude of difficult laryngoscopy and difficult intubation.

It can also be used as baseline data for further studies.

1.4 Literature Review

Anesthesia-related morbidity and mortality frequently stem from challenges encountered during endotracheal intubation, highlighting the significance of effectively predicting difficult airways. Studies spanning several decades have consistently emphasized the importance of predicting and managing difficult airways to ensure patient safety and optimize outcomes(5,6).

Literature reviews on crossectional studies conducted in our country revealed varying rates of difficult direct laryngoscopy and intubation, ranging from 2.5 % to 13.6 % of general anesthetics, underlining the need for vigilance and preparedness in anesthesia practice(3,4,6,8,11,12). These findings underscore the inherent complexity and variability of airway management, necessitating ongoing research and refinement of predictive models.

Preoperative patient assessment, encompassing factors such as mouth opening, Mallampati grading, thyromental distance, sternomental distance, and mandibular protrusion, has become standard practice(7). While individual parameters may lack sensitivity for detecting difficult

intubation, their absence often correlates with easier intubation, indicating their value as screening tools(12).

Recent studies conducted in diverse geographic regions, including China, South Korea, Nepal, India, and West Africa, have provided valuable insights into the incidence and predictive value of bedside airway assessments. These investigations have reported varying rates of difficult laryngoscopy and intubation, ranging from 2.3% to 14.9%, underscoring the need for region-specific data to inform clinical practice (4,11–17). These findings highlight the dynamic nature of airway management and underscore the importance of adapting clinical practice guidelines to local contexts.

A prospective observational study done on 2028 patients in china showed that the magnitude of difficult laryngoscopy as 6.5%, and difficult intubation was 2.3% (13), whereas another recent cross-sectional study conducted at Worabe on 141 elective surgical patients found that the magnitude of difficult laryngoscopy and intubation was 14.9% and 9.2%, respectively(3).

Another prospective crossectional study conducted on 263 patients in South Korea revealed the incidence of difficult laryngoscopy was 14.4%(17), HT/TMD ratio being the highest sensitive (80.0%) and ULBT the highest specific (95.2%)(17). This study is comparable with an Eastern Nepal study done on 314 Patients with incidence of difficult laryngoscopy 12%, difficult intubation 7% and MMT was found to be the most sensitive (83%)(16).

The incidence of difficult intubation was 10.2% in a recent crossectional comparative study conducted on 225 patients in India. However, the results of this investigation indicated that the sensitivity (95.5% vs. 95.4%), specificity (54.8% vs. 50.0%), positive predictive value (91.6% vs. 93.1%), and negative predictive value (39.1% vs. 39.1%) of MMT and ULBT were almost similar(2).

Furthermore, research exploring the diagnostic validity of clinical airway assessments has yielded mixed findings regarding sensitivity, specificity, and predictive values(8). While parameters like the modified Mallampati classification and interincisor distance have shown promise as predictors of difficulty, their performance may vary depending on patient population and clinical context(8,12,14). These discrepancies underscore the need for standardized assessment protocols and ongoing validation studies to optimize predictive accuracy.

Sternomental distance showed the greatest sensitivity (76%) and positive predictive value (54%) in a prospective observational study conducted in Turkey on 120 patients to determine the best test or tests for the prediction of difficult laryngoscopy and intubation(7). Neck circumference had a sensitivity of 74% and a positive predictive value of 53%. The sensitivity and positive predictive value of the combined neck circumference and sternomental distance were 62% and 42%, respectively(7).

3.4% of the 318 participants in a 2005 study done in West Africa had difficulty visualizing their larynx(18). The best predictor trio was MMT/TMD/IIG, with sensitivity, specificity, and positive predictive value of 84.6%, 94.6%, and 35.5%, respectively. weight, MMT, IIG, and TMD independently predicted DL(18).

A study of 212 patients at Gondar University found that 12.3%, 9%, and 0.47% of the cases had difficult laryngoscopy, difficult intubation, and failed intubation, respectively (12). It was discovered that, for both difficult laryngoscope and intubation, jaw slip grade C, mouth opening less than 3 cm, and Mallampati categories III and IV were balanced measures of sensitivity and specificity with high level of significance compared to others (P value 0.001)(12).

Difficulty in tracheal intubation occurred in 2.5% of cases overall in a prospective observational research conducted at Jimma University on 120 elective adult patients hospitalized for general, gynecologic, and orthopedic procedures(8). The sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of the tests were 0%, 98.3%, 0%, and 97.46% for BMI; 100%, 96.64%, 20%, and 100% for SMD;, 0%, 99.17%, 0%, and 100% for TMD; and, 100%, 99.14%, 75%, and 100% for MMT(8). Conversely, the mandibular protrusion test, stylet usage, neck mobility, and mouth opening were the airway characteristics shown to be the most sensitive tests and greater predictors of difficulty airway in a recent study done at Asella Teaching and Referral Hospital(14). The sensitivity and specificity for these variables were 92.4%, 92.3%, 76.9 and 69.2%, respectively. The airway parameters, on the other hand, with the greatest specificity were MP(93%), neck mobility(92.4%), and mouth opening(88.9%) respectively(14).

Recent studies have also investigated the combined predictive power of multiple airway assessment tests, demonstrating improved sensitivity and specificity when utilizing

comprehensive approaches. Combining tests such as Mallampati classification, thyromental distance, and interincisor distance has shown promise for predicting difficult intubation, highlighting the importance of a holistic approach to risk assessment (16).

At Tikur Anbesa Specialized Hospital, a facility-based cross-sectional research conducted on 242 patients revealed the magnitude of difficult laryngoscopy was 13.6%, and difficult intubation rate was 5%, but there were no cases of failed intubation(4). Mallampati classes III and IV, sternomental distance less than 12 cm, and Cormack and Lehane laryngoscopic grades III and IV were the independent predictors for difficult intubation(4). A strong correlation was observed between difficult intubation and mandibular protrusion B and C, Mallampati classes III and IV, and laryngoscopic grades III and IV (86.7%, 74.6%, and 57.4%, respectively)(4). The Cormack and Lehane laryngoscopic grades III and IV and the interincisor distance less than 4 cm have demonstrated superior sensitivity (83.3% and 66.7%, respectively) in comparison to other tests(4).

Additionally, the study demonstrated that compared to MMC and TMD or MMC and IID test combinations, the MMC and MP test combination has a higher sensitivity (78%) for DL. For DI, MMC and CL had the highest sensitivity and specificity (93% and 81.8%, respectively), whereas MMC + SMD showed higher specificity (82.9%) but lower sensitivity (66.2%) for DL. In cases of DI, MMC + IID showed superior sensitivity (86.1%), trailed by MMC + SMD(4).

Despite advancements in understanding, significant gaps persist, particularly in failed intubation instances and the predictive utility of combined assessment tools. Further research is needed to refine predictive models, validate screening protocols, and develop evidence-based practice guidelines tailored to diverse patient populations and clinical settings. By elucidating the combined predictive power of bedside airway assessments and addressing existing gaps in knowledge, this study aims to contribute to ongoing efforts to enhance patient safety and optimize outcomes in difficult airway management.

3 Objectives

3.1 General Objective

To assess the magnitude and diagnostic accuracy of bedside airway assessment tools for difficult laryngoscopy and intubation among surgical patients who undergo elective surgery under general anesthesia at Tikur Anbesa Specialized Hospital, Addis Ababa, Ethiopia.

3.2 Specific Objectives

- To assess the incidence of difficult laryngoscopy and intubation among surgical patients who underwent elective surgery under general anesthesia
- Determine the Diagnostic accuracy of bedside tests for predicting difficult laryngoscopy and intubation among surgical patients who underwent elective surgery under general anesthesia

4 Methods and materials

4.1 Study Design and Period

A facility-based cross-sectional study design conducted at Tikur Anbesa Specialized Hospital (TASH) from January to March 2024.

4.2 Study Area

TASH, located in the central part of Addis Ababa, Ethiopia, serves as the country's oldest and largest health training facility. With a total of 17 operation rooms, including facilities for emergency surgery, TASH handles a substantial number of surgical cases annually, ranging from cesarean sections and emergency procedures to multispecialty elective surgical procedures. The hospital's Department of Anesthesiology, Critical Care, and Pain Medicine is staffed with 15 consultant anesthesiologists and 71 residents (year 1-3).

4.3 Study Population

The study included all adult, 18 year and above, non-obstetric patients scheduled for elective surgery under general anesthesia with endotracheal intubation.

4.4 Eligibility Criteria

4.4.1 Inclusion Criteria: All elective surgical adult patients scheduled for surgery under general anesthesia with endotracheal intubation were included.

4.4.2 Exclusion Criteria: Patients with known airway difficulties due to trauma, congenital, or acquired abnormalities compromising the airway were excluded. Additionally, critically ill patients, those unable to cooperate for airway assessment, and individuals with upper airway pathology, neck mass, or cervical spine injury

4.5 Sample Size Determination and Sampling Technique

The sample size was determined using the formula for estimating proportions in a population, with adjustments made for a 10% non-response rate.

Sample Size Determination

$$n = (Z_{a/2})^2 \frac{pq}{e^2}$$

Where, n=sample size

Z is the critical value of the desired confidence level (95%=1.96)

e=margin of error (3%)

p= is the estimated proportion of an attribute that is present in the population

q=1-p, we take p value as 0.05(from a recent study done at TASH)

So sample size was 203. When we add 10% non-response rate, total sample size was 223.

Consecutive sampling was employed to include all eligible patients during the study period. From the average values of the previous surgery, 700 patients were operated on elective schedule for 3 months. The sampling interval; K was determined using: K=N/n; 700/223 =3

4.6 Study Variables

Dependent variables: difficult laryngoscopy and difficult intubation.

Independent variables: sociodemographic factors, ASA physical status, airway-related variables, and anesthesia-related factors.

4.7 Operational Definitions

Difficult Laryngoscopy: it is not possible to visualize any portion of the vocal cords after multiple attempts at laryngoscopy corresponding to CL grade 3 or grade 4 (19).

Difficult Intubation; tracheal intubation requiring 4 or more attempts or takes 10 minutes or more.

Failed Tracheal Intubation; tracheal intubation fails after multiple attempts(19).

Class Definition

ASA 1: normal healthy patient .No systemic disease

ASA 2: patients with mild systemic disease (no functional limitations)

ASA 3: patients with severe systemic disease (some functional limitations)

ASA 4: patients with severe systemic disease that is a constant threat to life (functionality incapacitated)

ASA 5: moribund patient who is not expected to survive without the operation ASA 6: brain-dead patient whose organs are being removed for donor purposes

E: if the procedure is an emergency, the physical status is followed by “E” (for example, “2E”)

Cormack and Lehane laryngoscopic grade:

Difficulty in laryngoscopy can be classified according to the view obtained during direct laryngoscopy into 4 grades. These 4 grades of laryngoscopic views were defined by Cormack and Lehane (1984):

Grade I—visualization of entire laryngeal aperture.

Grade II—visualization of only posterior commissure of the laryngeal aperture.

Grade III—visualization of only epiglottis.

Grade IV—visualization of just the soft palate.

Mallampati class (MMC):

Mallampati classification correlates tongue size to pharyngeal size. This test is performed with the patient in the sitting position, head in a neutral position, the mouth wide open, and the tongue protruding to its maximum.Classification is assigned into four classes I–IV:

Class I: visualization of the soft palate, fauces, uvula, and anterior and the posterior pillars.

Class II: visualization of the soft palate, fauces, and uvula.

Class III: visualization of soft palate and base of uvula.

Class IV: only hard palate is visible. Soft palate is not visible at all.

Interincisor distance (IID): it is the distance between the upper and lower incisors.

Thyromental distance (TMD): it is defined as the distance from the mentum to the thyroid notch, while the patient's neck is fully extended.

Sternomental distance (SMD): it is the distance from the suprasternal notch to the mentum and measured with the head fully extended on the neck with the mouth closed

4.8 Data Collection Procedures

Data were collected using a semi-structured questionnaire adapted from previous studies. Trained anesthesia residents conducted the data collection process, obtaining oral informed consent from each participant. Airway assessments were performed on patients scheduled for

surgery under general anesthesia with endotracheal intubation, while Laryngoscopic grading was reported by the person who do the laryngoscopy and intubation and utilizing observational data collection techniques.

4.9 Data Analysis Procedures

Data analysis was conducted using SPSS version 25 software. A p-value of less than 0.05 was considered statistically significant, with sensitivity, specificity, odds ratio, and 95% confidence intervals calculated using crosstabs in SPSS.

4.10 Data Quality Assurance

Data collectors underwent training, and the questionnaire was tested on 5% of the calculated sample size to ensure accuracy. Close supervision and daily checks were conducted to ensure data accuracy, consistency, and completeness.

4.11 Ethical Considerations

Ethical clearance and support were obtained from relevant institutional review boards, with verbal informed consent obtained from participants. Participant confidentiality was strictly maintained, and ethical guidelines were adhered to throughout the study.

5 Results

5.1 Socio-demographic Data

Table 1: presents a detailed breakdown of the demographic characteristics and the prevalence of difficult laryngoscopy and intubation among surgical patients who underwent elective surgical procedures at Tikur Anbesa Hospital from January to March 2024

Patient characteristics		Frequency (%)	Difficult Laryngoscopy (DL)		Difficult Intubation (DI)	
			No n(%)	Yes n(%)	No n(%)	Yes n(%)
Age	18-64	193(86.5)	176(91.2)	17(8.8)	182(94.3)	11(5.7)
	≥65	30(13.5)	27(90)	3(10)	25(83.3)	5(16.7)
Sex	Male	113(50.7)	101(89.4)	12(10.6)	104(92.0)	9(9.0)
	Female	110(49.3)	102(92.7)	8(7.3)	103(93.6)	7(6.4)
ASA status	I	75(33.6)	70(93.3)	5(6.7)	71(94.7)	4(5.3)
	II	128(57.4)	117(91.4)	11(8.6)	118(92.2)	110(7.8)
	III	17(7.6)	13(76.5)	4(23.5)	15(88.2)	2(11.8)
	IV	3(1.3)	3(100)	0	3(100)	0

Among the 223 patients included in the study, the majority (86.5%) were aged between 18 and 64 years, reflecting the predominance of adult patients in the elective surgery population. Further analysis revealed that patients aged 65 years and above exhibited a higher magnitude of difficult laryngoscopy (10%) and intubation (16.7 %) compared to their younger counterparts.

5.2 Magnitude of Difficult Laryngoscopy and Intubation in the Study Area

The prevalence of difficult laryngoscopy was 9%, indicating that approximately one in ten patients encountered challenges during laryngoscopic visualization of the vocal cords. Similarly, the prevalence of difficult intubation was 6.7%, suggesting that a considerable proportion of patients experienced difficulty in the placement of an endotracheal tube. Notably, there was one case of failed intubation observed during the study period, highlighting the potential risks associated with airway management in surgical settings.

5.3 Predictors of Difficult Laryngoscopy and Intubation:

Table 2: provides a comprehensive overview of the distribution of preoperative airway parameters with difficult laryngoscopy and intubation among surgical patients who underwent elective surgical procedures at Tikur Anbesa Hospital from January to March 2024

Predictor		Frequency, n (%)	Difficult Laryngoscopy (DL)		Difficult Intubation (DI)	
			No n(%)	Yes n(%)	No n(%)	Yes n(%)
MMC	I and II	214(96.0)	198(92.5)	16(7.5)	198(92.5)	16(7.5)
	III and IV	9(4.0)	5(55.6)	4(44.4)	9(100)	0
IID	≥4 cm	208(93.3)	194(93.3)	14(6.7)	196(94.2)	12(5.8)
	<4 cm	15(6.7)	9(60)	6(40)	11(73.3)	4(26.7)
MP	A	191(85.7)	180(94.2)	11(5.8)	178(93.2)	13(6.8)
	B and C	32(14.3)	23(71.9)	9(28.1)	29(90.6)	3(9.4)
TMD	≥6 cm	214(96.0)	198(92.5)	16(7.5)	201(93.9)	13(6.1)
	<6 cm	9(4.0)	5(55.6)	4(44.4)	6(66.7)	3(33.3)
SMD	≥12 cm	209(93.7)	196(93.8)	13(6.2)	196(93.8)	13(6.2)
	<12 cm	14(6.3)	7(50)	7(50)	11(78.6)	3(21.4)
CL	I and II	203(91)	203(100)	0	189(93.1	14(6.9)
	III and IV	20(9)	0	20(100)	18(90)	2(10)

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From the total of 223 patients, 214/223 (96%) were found to be MMC I and II, of which only 7.5% of them had difficult laryngoscopy and difficult intubation.

15(6.7%) patients had IID <4 cm of whom 6(40%) had difficult laryngoscopy and 4(26.7%) had difficult intubation. Out of 20 patients with CL grade III and IV, 2 had difficult intubation.

Only 14.3 % of the patients had MP grade B and C, from which 28.1 % had difficult laryngoscopy and 9.4 % had difficult intubation.

Patients with modified Mallampati class (MMC) III and IV demonstrated a higher incidence of difficult laryngoscopy (44.4%), suggesting that increasing oropharyngeal obstruction may be associated with greater difficulty in visualizing the glottic structures during laryngoscopy. Interestingly, none of these patients experienced difficult intubation, indicating that while they may present challenges in laryngeal visualization, subsequent intubation may still be feasible. In contrast, the majority (96%) of patients classified as MMC I and II experienced relatively fewer difficulties in both laryngoscopy and intubation, suggesting that a favorable oropharyngeal anatomy may facilitate smoother airway management in these individuals.

5.4 Predictive Values for Difficult Laryngoscopy and Intubation:

Table 3: present the sensitivity, specificity, positive predictive values (PPV), and negative predictive values (NPV) for preoperative parameters against difficult laryngoscopy among elective surgical patients in Tikur Anbesa Hospital from January to March 2024

Parameter	Sn (%)	Sp (%)	PPV (%)	NPV (%)	AUC	p value	95% CI		Accuracy
MMC	0.0	1.0	NaN	0.98	0.500	0.003	0.69	3.52	0.98
TMD	0.0	1.0	NaN	0.98	0.48	0.0001	1.08	3.53	0.98
IID	0.0	1.0	NaN	0.98	0.50	0.003	0.69	3.52	0.98
SMD	0.0	1.0	NaN	0.98	0.98	0.0001	1.34	3.97	0.98
MP	0.0	1.0	NaN	0.98	0.98	0.002	0.54	2.58	0.98

Table 4: present the sensitivity, specificity, positive predictive values (PPV), and negative predictive values (NPV) for preoperative parameters against difficult intubation among elective surgical patients in Tikur Anbesa Hospital from January to March 2024

Parameter	Sn (%)	Sp (%)	PPV (%)	NPV (%)	Area	p value	95% CI		Accuracy
MMC	0.0	1.0	NaN	0.91	0.50	0.99	-10758.45	107540.55	0.911
TMD	0.0	1.0	NaN	0.91	0.61	0.026	0.19	3.103	0.911
IID	0.0	1.0	NaN	0.91	0.50	0.005	0.64	3.72	0.91
SMD	0.0	1.0	NaN	0.91	0.60	0.140	-0.41	2.90	0.911
MP	0.0	1.0	NaN	0.91	0.46	0.40	-0.79	1.96	0.911

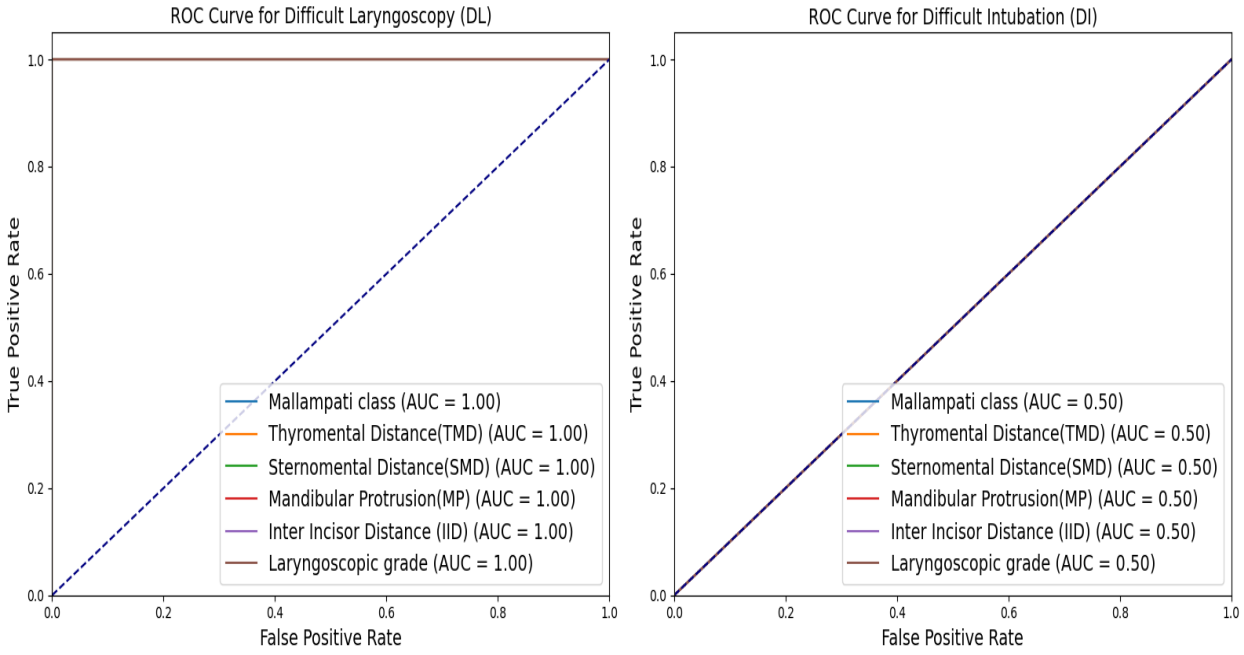

Figure 1: ROC curve for Difficult Laryngoscopy and Difficult Intubation

Despite the variation in sensitivity and specificity across different parameters, the overall diagnostic accuracy of bedside tests for predicting difficult laryngoscopy and intubation remained relatively high, as evidenced by the area under the curve (AUC) values ranging from

0.48 to 0.98. However, it is important to note that all parameters exhibited a sensitivity of 0.0 for difficult laryngoscopy and intubation, indicating a potential limitation in their ability to detect these outcomes. Nevertheless, the high specificity values suggest that these parameters may serve as reliable indicators of a favorable airway anatomy, thereby aiding clinicians in identifying patients at lower risk of encountering airway difficulties.

5.5 Combination of Two Preoperative Tests

Table 5: explores the sensitivity and specificity of combined preoperative tests for difficult laryngoscopy and intubation among elective surgical patients in Tikur Anbesa Hospital from January to March 2024

Parameters	Sn(%)		Sp(%)	
	DL	DI	DL	DI
MMC+IID	1.0	0.0	1.0	1.0
MMC+MP	1.0	0.0	1.0	1.0
MMC+SMD	1.0	0.0	1.0	1.0
MMC+TMD	1.0	0.0	1.0	1.0
MMC+ CL	1.0	1.0	1.0	0.0

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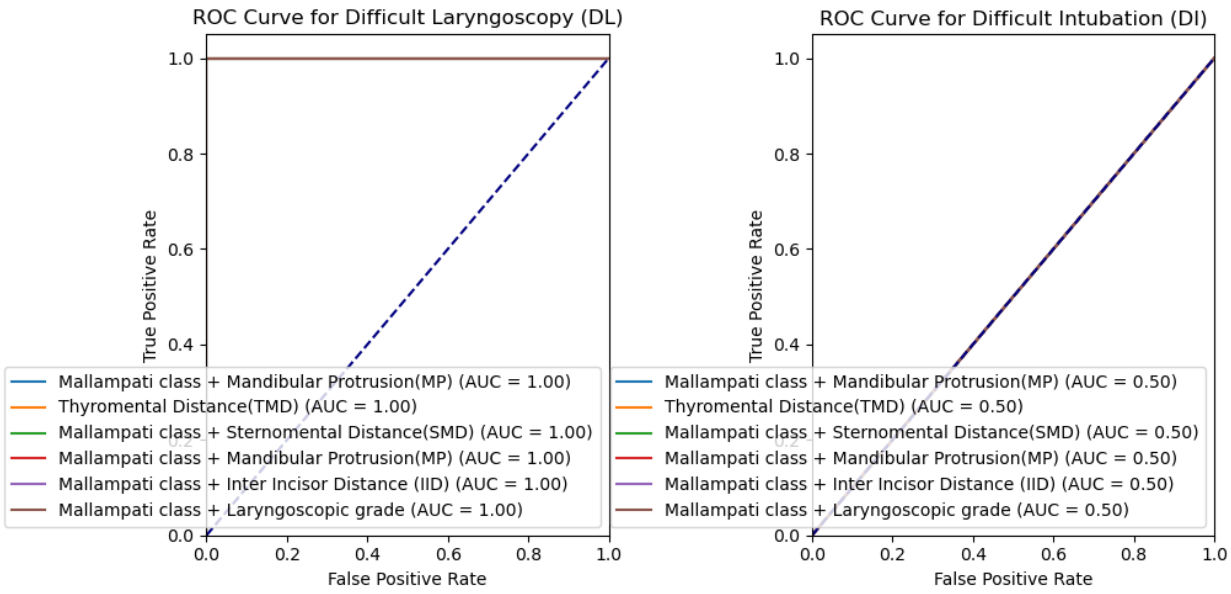

Figure 2: ROC curve for DL and DI with the combined parameters

Combinations such as MMC + CL demonstrated high sensitivity and specificity for predicting difficult laryngoscopy, suggesting that integrating multiple bedside tests may enhance the predictive accuracy compared to individual tests alone. This underscores the importance of a multimodal approach to preoperative airway assessment, wherein clinicians can leverage the synergistic effects of different parameters to optimize risk stratification and decision-making in the perioperative setting.

6 DISCUSSION

Our study revealed a 9% prevalence of difficult laryngoscopy and a 6.7% prevalence of difficult intubation among elective surgical adult patients. This indicates that a significant portion of the surgical population may face challenges with airway management. This finding is comparable with previous study done in the same facility which showed the magnitude of difficult laryngoscopy as 12.2% and difficult intubation as 6.1%(6).

Another study done in Gondar University Hospital with comparable sample size also revealed the incidence of difficult laryngoscopy, difficult intubation, and failed intubation as 12.3%, 9%, and 0.47%, respectively(12).

Our finding is slightly higher than studies done on 2028 patients in China With 6.5% of difficult laryngoscopy and 2.3% of difficult intubation (13) and other studies done in west Africa, 3.4%

cases of DL (18) and Jimma,2.5% cases of DI(8). This discrepancy could be due to differences in patient demographics, clinical practices, or the experience levels of the clinicians performing the procedures. However, our finding is lower than those found in studies done in South Korea, 14.4% DL(17) and TASH, 13.6% DL(4).

Age emerged as a notable risk factor, with patients aged 65 and above experiencing higher rates of difficulty (10% DL and 16.7% DI). This aligns with the broader understanding that physiological changes associated with aging can impact airway anatomy and function, thus increasing the risk of complications during airway management. Similarly, a previous study conducted at TASH revealed the magnitude of difficult laryngoscopy and intubation was higher in the age group of ≥65 years (35% DL and 6% DI)(4).

44.4% of the patients with MMC III and IV() experienced difficult laryngoscopy but none of them were difficult for intubation indicating not only anatomical considerations but also dynamic factors during the intubation process, which might not be fully captured by static pre-assessment tools..

The predictive values for difficult laryngoscopy and intubation showed high specificity (100%), NPV (98% for DL and 91% for DI) but low sensitivity and PPV (0%). This suggests that while the preoperative parameters are good at ruling out patients who will not have difficulties, they are not as effective at identifying those who will. This finding is in line with recent studies done in Gondar(12) and TASH(4).

Our study shows that combinations like MMC+IID, MMC+MP, MMC+SMD, and MMC+TMD have perfect sensitivity (1.0 or 100%) for DL but zero sensitivity for DI. Conversely, MMC+CL showed perfect sensitivity (100%) for both DL and DI. The literatures also emphasize the effectiveness of combined predictive tools. For instance, a study from Gondar University found that combining jaw slip grade, mouth opening, and Mallampati categories provided balanced measures of sensitivity and specificity(12). More studies are needed to understand why certain combinations fail to predict DI and to develop or identify additional parameters that could enhance the predictive accuracy for DI.

Comparatively, other research has emphasized the utility of ultrasonography parameters in predicting difficult airway management(20). This suggests that incorporating ultrasonographic assessments could potentially improve the predictive accuracy of preoperative evaluations.

Lastly, this study found that the combination of two preoperative tests, such as MMC and Cormack-Lehane grading, increased sensitivity and specificity for predicting difficult laryngoscopy. This supports the notion that a multimodal approach to preoperative airway assessment is beneficial. It also aligns with other researches advocating for the integration of multiple bedside tests to enhance predictive accuracy.

7 Strengths and limitations of the study

The strength of the study includes the effort to compare its findings with those from different regions and contexts, including China, West Africa, South Korea, and Ethiopia, offering a broader perspective on the incidence of DL and DI. The study also conducted a thorough analysis of various combinations of predictive tools for both difficult laryngoscopy (DL) and difficult intubation (DI), providing valuable insights into their effectiveness.

Limitations included variations in airway management techniques among residents conducting the procedures, as well as the lack of standardized cutoff values for preoperative airway parameters, which may have impacted data interpretation. Additionally, differences in experience and equipment availability may have influenced results.

8 Conclusion

Our study underscored the high specificity (100%) but low sensitivity (0%) of preoperative parameters, when used alone, in predicting difficult laryngoscopy and intubation, emphasizing the need for a nuanced approach to preoperative airway assessment. While these parameters are effective in ruling out patients unlikely to face difficulties, they may not reliably identify those who will.

The results demonstrate the effectiveness of combined predictive tests, MMC+CL, for instance in improving the sensitivity (100%) and specificity (100%) of identifying difficult laryngoscopy. These findings are consistent with existing literature, which advocates for the use of multiple assessment tools to enhance predictive accuracy. Caution is advised when relying solely on

combinations such as MMC+IID, MMC+MP, MMC+SMD, and MMC+TMD. While these combinations are effective for predicting DL, they fail to predict DI, which can lead to unforeseen challenges during intubation.

9 Recommendation

By highlighting both the successes and limitations of these combinations, it underscores the importance of a holistic approach in preoperative assessments. The findings advocate for the integration of robust tools like MMC+CL, which show superior predictive capability for both DL and DI, potentially improving clinical decision-making and patient safety. Hence, Utilizing Comprehensive Combinations for Predicting DL and DI is recommended.

10 References

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11 Annexes

11.1 Informed consent sheet

Addis Ababa University School of medicine Subject information sheet

Hi, my name is ----------, I am here on behalf of Dr. Habtamu Mengstie., a student in Addis Ababa University School of medicine, department of anesthesiology, critical care and pain medicine. He is conducting a research thesis on “diagnostic accuracy of bedside airway assessment tests for predicting difficult laryngoscopy and intubation and its magnitude at TASH, Addis Ababa Ethiopia from December June 2023 to May 2024”. He has got formal permission from Addis Ababa University School of medicine and TASH officials to conduct the study.

You are selected to participate in this study. There will be no direct benefit by participating in this study, but in the future information gathered by this study will helps policy makers, programmers and researchers to give appropriate attention on issues of interest and design specific treatment options.

The information will be kept confidential by using only code numbers and locking the data. Only the members of the study team will have the access to the non-coded data and the data will not be used for purposes other than the study. Your willingness and active participation is very important for the success of this study. If you need any further information or explanation regarding the study, you can have this address to contact.

Name: Dr. Habtamu Mengstie Tel- +251975458306 Email-mengstiehabtmu@gmail.com

Would you be willing to participate(encircle and fill the spaces)

Yes No

Thank you for your participation!

11.2 Questionnaire

Part I: Identification

Card No …… Age:…. yrs. Sex: male female

ASA status: I II III IV V

Part II: Airway characteristics

1. Interincisor distance: A. less than 4cm/ 3 patients' fingers

B. greater than or equal to 4cm/ 3 patient's fingers

2. Mallampatti class: I II III IV

3. Mandibular protrusion class: A B C

4. Thyromental distance: A. less than 6cm B. greater than or equal to 6cm

5. Sternomental distance: A. less than 12cm B. greater than or equal to12cm

6. Cormack & Lehane laryngoscopic grade: I II III IV

7. External laryngeal pressure: A. applied B. not applied

8. Number of attempts for intubation: I II III IV

9. Time taken to intubate the patient:

A. less than 10 minutes

B. greater than or equal to 10 minutes

10. Intubation: A. Failed B. Successful

11. Qualification of the anesthetist who performed the intubation:

A. under graduate student B. MSc in Anesthesia student year….

C. BSc Anesthetist D. MSc Anesthetist

E. anesthesiology resident year….. F. Anesthesiology consultant

Part III: Anesthetic Technique

1. Premedication used (if any)…… …….

2. Drug used for induction …….

3. Drug used for muscle relaxation ……

4. Type and size of laryngoscopy blade ……

5. External laryngeal pressure: A. applied

B. not applied