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RESEARCH ARTICLE
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DIAGNOSTIC ACCURACY OF UPPER LIP BITE TEST AND PRAYER SIGN FOR THE DETECTION OF DIFFICULT INTUBATION BY TAKING CORMACK AND LEHANE GRADING AS GOLD STANDARD IN DIABETIC PATIENTS UNDERGOING ELECTIVE SURGERY

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ABSTRACT

Background: The Upper Lip Bite Test (ULBT) is a commonly used bedside assessment to predict difficult laryngoscopic intubation, yet its diagnostic accuracy remains debated. Various preoperative tests aim to identify difficult airways to reduce morbidity and mortality from unanticipated difficult intubations.

Objective: To compare the diagnostic accuracy of the Upper Lip Bite Test and Prayer Sign against the Cormack and Lehane grading system as the gold standard for detecting difficult intubation in diabetic patients undergoing elective surgery at a tertiary care hospital in Karachi.

Study Design: Cross-sectional study.

Materials and Methods: A total of 252 diabetic patients aged 30 to 80 years scheduled for elective surgery were assessed preoperatively using ULBT and Prayer Sign tests. Difficult intubation was confirmed intraoperatively using Cormack and Lehane grading. Sensitivity, specificity, positive predictive value, negative predictive value and overall diagnostic accuracy of both tests were calculated using SPSS version 19.

Results: The mean age was 51.9 ± 14.5 years, with 57% over 48 years. The mean diabetes duration was 5.8 ± 2.6 years, with 65.5% male. Difficult intubation (Cormack and Lehane grades III/IV) was observed in 77% of cases. ULBT demonstrated higher sensitivity (93.3% vs. 82.99%) and negative predictive value (78.33% vs. 59.76%), while Prayer Sign showed slightly better specificity (84.48% vs. 81.03%) and similar positive predictive values (94.71% vs. 94.27%). Overall accuracy favored ULBT (90.48% vs. 83.33%).

Conclusion: Both ULBT and Prayer Sign are effective for predicting difficult intubation in diabetic patients. Given its ease of use and higher accuracy, ULBT is recommended as a primary bedside test, alone or in combination with other assessments.

Keywords: Airway management, Upper Lip Bite Test, Prayer Sign, Difficult intubation, Cormack and Lehane

INTRODUCTION

A difficult intubation is defined as a situation in which a trained anesthesiologist is unable to successfully insert an endotracheal tube within three attempts or requires more than ten minutes to do so.[1] Failure to effectively manage a difficult airway is a significant contributor to anesthesia-related mortality, accounting for up to 30% of such deaths.[2] Reported rates of difficult intubation range from 1% to 3.6%, while complete failure of intubation occurs in approximately 0.05% to 0.3% of cases.[3,4]

Diabetic patients represent a notable high-risk group in this context. Nearly half of individuals with diabetes will require surgical intervention at some point in their lives. Among this population, the prevalence of difficult laryngoscopy has been found to be around 27% to 31%.[5,6] This elevated risk is largely attributed to biochemical changes associated with chronic hyperglycemia. In particular, the nonenzymatic glycosylation of collagen leads to its abnormal deposition in connective tissues and joints, resulting in a condition known as limited joint mobility (LJM) syndrome. One of the critical areas affected by LJM in diabetic patients is the atlanto-occipital joint. Reduced flexibility in this region impairs optimal head and neck extension during laryngoscopy, thereby increasing the likelihood of intubation challenges.[7]

Diabetes mellitus (DM) is the most frequently encountered endocrine disorder in clinical practice, with nearly half of all diabetic individuals requiring surgical procedures at some point in their lifetime.[8] Studies have shown that the likelihood of encountering a difficult intubation is significantly greater in diabetic patients compared to the general population. Although the precise pathophysiology behind limited joint mobility (LJM) syndrome remains unclear, it is believed to result from chronic hyperglycemia-induced tissue changes.[9,10] Specifically, persistent elevated blood glucose levels lead to nonenzymatic glycosylation of collagen and other connective tissue proteins, contributing to joint stiffness and reduced mobility—hallmarks of LJM often observed in individuals with longstanding diabetes.[11]

In diabetic individuals, abnormalities in collagen metabolism lead to the formation of increased cross-links, resulting in collagen fibers that are unusually stable, less soluble, and resistant to normal enzymatic breakdown.[12] These biochemical alterations contribute to connective tissue stiffness and joint immobility, although some studies suggest these changes may be at least partially reversible with appropriate metabolic control.[13] Collagen glycosylation typically begins in the fourth and fifth interphalangeal joints, often leading to an inability to bring the palms and fingers together in a praying position commonly referred to as the "prayer sign." This clinical finding is a useful indicator of limited joint mobility (LJM) in diabetic patients.[13] In a study conducted by Kute et al., the diagnostic performance of two common bedside airway assessment tools was evaluated. The upper lip bite test demonstrated a sensitivity of 34% and a specificity of 76.2%, whereas the prayer sign showed a higher sensitivity of 72.3% and specificity of 84.1% in predicting difficult intubation.[14]

Unanticipated difficult intubation poses a significant risk in anesthesia, with potentially serious outcomes. Early identification of patients with difficult airways is essential, particularly during preoperative assessments. Diabetes mellitus, the most common endocrine disorder faced by anesthesiologists, is associated with anatomical changes that increase the risk of difficult intubation due to limited joint mobility from chronic hyperglycemia. While various bedside tests are used to predict difficult airways, their accuracy in diabetic patients remains unclear. The Upper Lip Bite Test (ULBT) and Prayer Sign are simple, non-invasive tools that may offer reliable predictions in

this high-risk group. If proven effective, these tests could enhance preoperative planning, reduce anesthesia-related complications, and improve patient safety. Validating these tests in diabetic populations would also aid in clinician training and support the development of standardized protocols for airway management in our hospital setting.

MATERIALS AND METHODS

Diabetic patients undergoing elective surgery were enrolled from National Institute of Cardiovascular Diseases Karachi from January 2022 to December 2022. Permission from the institutional ethical review committee was obtained prior to the commencement of this cross-sectional study. Informed consent was obtained from all participants for inclusion in the sample and for the use of their data in research.

The sample size was calculated based on a prayer sign sensitivity of 72.3%, specificity of 84.1%, and a difficult intubation prevalence of 31% in diabetic patients. With a 10% margin of error for both sensitivity and specificity and a 95% confidence interval, the required sample size was determined to be 252 patients. Diabetic patients aged 30–80 years with ASA status II–III undergoing elective cardiac surgery were included. Exclusions applied to those with loose teeth, head and neck radiation, epilepsy, arrhythmias, cervical spine trauma, rheumatoid arthritis, thyroid disorders, pregnancy, COPD, asthma, or chronic renal failure.

A brief demographic history was recorded from each patient. During the pre-anesthetic evaluation and preoperative preparation, patients were assessed for difficult intubation using the Upper Lip Bite Test and Prayer Sign, and were labeled as having difficult intubation based on the operational definition. On the day of surgery, only experienced anesthesiologists (with five or more years of experience) were allowed to perform intubation.

In the operation theater, adequate intravenous access was confirmed. Standard monitoring was attached, including noninvasive blood pressure, invasive blood pressure, pulse oximetry, electrocardiogram, and end-tidal CO_2 ($ETCO_2$). Prior to induction of anesthesia, all patients were administered IV midazolam 2 mg, and IV fentanyl 1-2 µg/kg. Anesthesia was induced in all patients with IV etomidate 0.2-0.6 mg/kg, followed by IV atracurium 0.5 mg/kg. Laryngoscopy was performed after 3 minutes, with the patient's head placed in the sniffing position using a standard sized Macintosh blade. The laryngoscopic view on the first attempt at intubation was graded and recorded according to the Cormack and Lehane classification, as per operational definition. Patient then intubated with a suitable cuffed endotracheal tube which was secured with tape after bilateral equal air entry checked and ventilated as per protocol.

Data on quantitative variables (age, height, weight, BMI and duration of diabetes mellitus) and qualitative variables (gender, obesity and difficult intubation findings on the Upper Lip Bite Test, Prayer Sign, and Cormack and Lehane grade) were recorded.

Data were analyzed using SPSS Version 19. Mean ± SD or median (IQR) was reported for quantitative variables based on distribution, while frequencies and percentages were used for qualitative variables. Sensitivity, specificity, PPV, NPV, and diagnostic accuracy of the Upper Lip Bite Test and Prayer Sign were calculated using 2 × 2 contingency tables, with Cormack and Lehane grading as the gold standard. Effect modifiers (age, gender, obesity and diabetes duration) were controlled through stratification, followed by post-stratification analysis of diagnostic accuracy.

RESULTS

The mean age of diabetic patients undergoing elective surgery was 51.9 ± 14.5 years, with a range of 30 to 80 years and a median age of 50 years. The average height was 1.66 ± 0.12 meters (range: 1.4 to 1.87 meters), while the mean weight was 70.1 ± 8.2 kg, ranging from 53 to 89 kg, with a median of 70 kg. The average BMI was 25.35 ± 4.47 kg/m², ranging between 15.49 and 38.27, with

a median BMI of 24.68 kg/m². The duration of diabetes was 5.8 ± 2.6 years, with a minimum of 2 years and a maximum of 10 years; the median duration was 6 years in table 1.

Among diabetic patients undergoing elective surgery, 165 (65.5%) were male and 87 (34.5%) were female. A total of 143 (57%) patients were older than 48 years, while 109 (43%) were younger than 48 years. Regarding the duration of diabetes, 153 (61%) had diabetes for more than 5 years, whereas 99 (39%) had it for less than 5 years. Obesity was present in 72 (28.6%) patients, while 180 (71.4%) were not obese. The upper lip bite test was positive in 192 (76.2%) patients and negative in 60 (23.8%). The prayer sign test was positive in 170 (85.7%) and negative in 82 (14.3%) patients. According to the Cormack-Lehane grading, 194 (77%) patients were classified as "Yes" (difficult intubation) and 58 (23%) as "No" (easy intubation) in table 2.

The Upper Lip Bite Test (ULBT) was found to be a highly effective tool for predicting difficult intubation in diabetic patients undergoing elective surgery, when compared to the Cormack and Lehane grading as the gold standard. The test was positive in 181 (93.3%) patients with difficult intubation and in 11 (19%) patients with non-difficult intubation. Conversely, it was negative in 13 (6.7%) patients with difficult intubation and in 47 (81%) patients with non-difficult intubation. The diagnostic accuracy of the ULBT was notable, with a sensitivity of 93.3%, specificity of 81.03%, and accuracy of 90.48%. The positive predictive value was 94.27%, and the negative predictive value was 78.33%. Additionally, the positive likelihood ratio was 4.92, and the negative likelihood ratio was 0.08. The prevalence of difficult intubation in this population was 76.98% in table 3.

The Prayer Sign test was also found to be a useful predictor of difficult intubation in diabetic patients undergoing elective surgery, when compared with the Cormack and Lehane grading as the gold standard. The test was positive in 161 (83.0%) patients with difficult intubation and in 9 (15.5%) patients without it. It was negative in 33 (17.0%) patients with difficult intubation and in 49 (84.5) without. The test showed a sensitivity of 82.99%, specificity of 84.48%, and a statistically significant association with difficult intubation ($p < 0.001$). The positive predictive value was 94.71%, while the negative predictive value was 59.76%. The positive likelihood ratio was 5.35, and the negative likelihood ratio was 0.2. The prevalence of difficult intubation in the sample remained 76.98% in table 4.

Table 1: Descriptive Statistics of Demographic and Clinical Characteristics of Diabetic Patients Undergoing Elective Surgery

Descriptive Statistics	Mean ± SD	Range (Min–Max)	Median
Age (years)	51.9 ± 14.5	30 – 80	50
Height (meters)	1.66 ± 0.12	1.4 – 1.87	1.64
Weight (kg)	70.1 ± 8.2	53 – 89	70
BMI (kg/m²)	25.35 ± 4.47	15.49 – 38.27	24.68
Duration of Diabetes (years)	5.8 ± 2.6	2 – 10	6

Table 2: Distribution of Demographic and Clinical Parameters in Diabetic Patients Undergoing Elective Surgery

Parameters	Category	N(%)
Gender	Male	165 (65.5%)
	Female	87 (34.5%)
Age	< 48 years	109 (43%)
	> 48 years	143 (57%)
Duration of diabetes	< 5 years	99 (39%)
	> 5 years	153 (61%)
Obesity	Yes	72 (28.6%)

	No	180 (71.4%)
Upper lip bite test	Yes	192 (76.2%)
	No	60 (23.8%)
Prayer Sign test	Yes	170 (85.7%)
	No	82 (14.3%)
Cormack Lehane (difficult intubation)	Yes	194 (77%)
	No	58 (23%)

Table 3: Comparison of the diagnostic accuracy of Upper lip bite test for the detection of difficult intubation by taking Cormack and Lehane grading as gold standard in diabetic patients undergoing elective surgery

ULBT Result	**Cormack & Lehane: Difficult (Yes)**	**Cormack & Lehane: Not Difficult (No)**	**Total**
Positive (Yes)	181 (93.3%)	11 (19%)	192 (76.2%)
Negative (No)	13 (6.7%)	47 (81%)	60 (23.8%)
Total	194 (100%)	58 (100%)	252 (100%)
Upper lip bite test (ULBT)			
Parameter	**Value [95% CI]**		
Sensitivity	93.3% (95% C.I: 88.81% to 96.38%)		
Specificity	81.03% (95% C.I: 68.59% to 90.13%)		
Positive Likelihood Ratio	4.92 [2.89 to 8.39]		
Negative Likelihood Ratio	0.08 [0.05 to 0.14]		
Difficult intubation prevalence (*)	76.98% (95% C.I: 71.29% to 82.03%)		
Positive Predictive Value (*)	94.27% (95% C.I: 90.61% to 96.56%)		
Negative Predictive Value (*)	78.33% (95% C.I: 67.82% to 86.11%)		
Accuracy (*)	90.48% (95% C.I: 86.16% to 93.80%)		

Table 4: Comparison of the diagnostic accuracy of prayer sign test for the detection of difficult intubation by taking Cormack and Lehane grading as gold standard in diabetic patients undergoing elective surgery

Prayer Sign	**Cormack & Lehane: Difficult (Yes)**	**Cormack & Lehane: Not Difficult (No)**	**Total**
Positive (Yes)	161 (83.0%)	9 (15.5%)	170 (67.5%)
Negative (No)	33 (17.0%)	49 (84.5%)	82 (32.5%)
Total	194 (100%)	58 (100%)	252 (100%)
p-value	< 0.001		
Prayer Sign	**Value [95% CI]**		
Sensitivity	82.99% (95% C.I: 76.95% to 87.99%)		
Specificity	84.48% (95% C.I: 72.58% to 92.65%)		
Positive Likelihood Ratio	5.35 [2.92 to 9.78]		
Negative Likelihood Ratio	0.2 [0.14 to 0.28]		
Difficult intubation prevalence (*)	76.98% (95% C.I: 71.29% to 82.03%)		
Positive Predictive Value (*)	94.71% (95% C.I: 90.72% to 97.03%)		
Negative Predictive Value (*)	59.76% (95% C.I: 51.64% to 67.37%)		
Accuracy(*)	83.33% (95% C.I: 81.4% to 85.2%)		

DISCUSSION

Assessment of the airway and prediction of difficulty in laryngoscopy is done by most anaesthesiologists during the pre-operative check-up. Management of airway and maintaining the airway during anaesthesia is the prime responsibility of an anaesthetist and in order to provide safe anaesthesia it is mandatory to have a reliable tool for the assessment of airway prior to the surgery.[15] The basic responsibility of an anesthesiologist is the sustainment of a patent airway. Undoubtedly, the leading cause of death and permanent brain damage during anesthesia is difficult or failed tracheal intubation. The reported occurrence of difficult laryngoscopy and tracheal intubation ranges from 1.5% to 13% in patients undergoing general anesthesia. Failure to handle difficult airways contributes 30% to 40% of all anesthetic deaths.[16]

In the present study, we evaluated the diagnostic accuracy of the Upper lip bite test and Prayer Sign test in predicting difficult intubation among diabetic patients undergoing elective surgery, using the Cormack and Lehane grading system as the gold standard. Our findings demonstrated that the ULBT vs. Prayer Sign had a sensitivity of (93.3% vs. 82.99%), specificity of (81.03% vs. 84.48%), positive predictive value of (94.27% vs. 94.71%), and negative predictive value of (78.33% vs. 59.76%), with an overall accuracy of (90.48% vs. 83.33%). These results are in contrast to the findings of Baig et al. (2014), who reported significantly lower sensitivity of Prayer Sign (29.6%) and suggested that it was inferior to the Mallampati test in predicting difficult intubation.[19]

Our findings are more closely aligned with those of Uysal et al. (2020), who found the Palm Print Test (PPT) to have a sensitivity of 94.4%, specificity of 69.2%, PPV of 89.5% and NPV of 81.8% in diabetic patients.[18] Like the Prayer Sign, the PPT assesses limitations in joint mobility-a common complication of diabetes mellitus, thereby increasing its reliability in assessment of challenging airway. The relatively higher specificity (84.48%) and PPV (94.71%) observed in our study suggest that the Prayer Sign can be an equally valuable to Palm Print Test, if not superior, tool in diabetic populations. In comparison, Qamar et al. (2022) assessed the Upper Lip Bite Test (ULBT) in a broader surgical population and reported a PPV of 74.1%.[20] While useful, this is notably lower than the PPV of ULBT 94.27% reported in our study, indicating a potentially greater reliability of this test in diabetic patients when assessing difficult intubation.

Similarly, Dawood et al. (2021) evaluated multiple airway tests including Modified Mallampati Test (MMT), ULBT, and thyromental distance (TMD). Among individual tests, ULBT showed a sensitivity of 77.78% and specificity of 93.18%, PPV of 60.87%, MMT showed 66.67% sensitivity, 96.97% specificity and PPV of 75% while TMD showed sensitivity of 55.56%, specificity of 94.97%, PPV of 58.82% for detection of difficult airway.[21] Although ULBT had a higher sensitivity (93.3%) and PPV (94.27%) in our study, underscoring its utility as a standalone predictive tool in diabetic patients. Vani et al. (2022) found the palm print test to be the most sensitive among various indices (75% sensitivity), reinforcing the concept that joint mobility tests are better predictors in diabetes-related difficult intubation.[22] However, their study did not evaluate ULBT and Prayer Sign specifically. The higher sensitivity (93.3%) of upper lip bite test in our study again highlight its potential superiority within this patient group.

Finally, the high overall accuracy of 90.45% reported by Bukhari et al. (2018) for ULBT is comparable to the accuracy of 90.48% seen with upper lip bite test in our cohort. However, ULBT relies on patient cooperation and dentition status, whereas Mallampati score may have wrong judgement due to absence of vocalization, providing practical advantages of ULBT in the preoperative setting.[17]

Our study adds to the growing body of evidence supporting the value of physical signs related to limited joint mobility, particularly in diabetic patients. The Upper lip bite test, due to its high sensitivity offers a simple and reliable screening tool for anticipating difficult intubation. Compared to other assessment methods in the literature, it demonstrates comparable or superior diagnostic performance, especially in populations at higher risk due to diabetic complications. The study's strengths include a well-defined diabetic patient population and use of the Cormack and Lehane grading as a reliable gold standard for difficult intubation. Limitations include a single-center design

and relatively small sample size, which may affect generalizability. Additionally, the study did not compare Upper lip bite test and Prayer Sign directly with other airway assessment tests in the same cohort.

CONCLUSION

The Upper Lip Bite Test (ULBT) demonstrated superior diagnostic accuracy compared to the Prayer Sign in predicting difficult intubation among diabetic patients. Due to its high sensitivity, ease of use, and bedside applicability, ULBT is a reliable standalone screening tool. Its use is recommended either independently or alongside other clinical tests to enhance airway assessment.

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