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Evaluation of Palm Print Sign and Prayer Sign in Prediction of Difficult Laryngoscopy in Diabetic Patients

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Abstract

Background: Laryngoscopy or endotracheal intubation in diabetic patients due to impaired mobility of the Atlanto-occipital joint owing to non-enzymatic glycosylation in connective tissue has always been a problem. A difficult laryngoscopy can disrupt the intubation process; therefore, it is valuable to predict difficult laryngoscopy using some anatomical criteria before general anesthesia.
Objectives: The present study discussed the diagnostic value of two tests, palm print sign and prayer sign, in the prediction of laryngoscopy difficulty.
Methods: Design: A diagnostic test and cross-sectional analytical design were used in this study. Setting: The study population included 200 patients with type 2 diabetes who were candidates for surgery under general anesthesia. Before surgery, the patients were examined regarding the airway status, Mallampati classification, head extension rate, thyromental distance, body mass index, upper lip biting test, and two palm print sign and prayer sign tests. All the diagnostic tests were compared to the Cormack test result for difficult airways regarding their sensitivity and specificity in difficult laryngoscopy.
Results: The highest sensitivity was related to the Mallampati test, prayer sign test, and palm print sign test (100%). Furthermore, the mouth-opening test had the highest specificity (100%). The highest accuracy was reported for Mallampati, palm print sign, and prayer sign tests (> 86%).
Conclusions: Among the tests studied to predict difficulty in laryngoscopy in diabetic patients, Mallampati and palm print sign tests have good sensitivity, specificity, and accuracy. Studies with a larger sample size are suggested to obtain more accurate results.

Keywords: Intubation, Diabetic Patients, General Anesthesia

1. Background

Intratracheal intubation is one of the most common methods of airway control. One of the risk factors that increase laryngoscopic and intubation stress is the difficulty of intubation in some patients (1). In general, inadequate ventilation, esophageal intubation, and difficult endotracheal intubation are the most common causes of severe respiratory consequences in the field of anesthesia (2). It is important to consider the anatomical signs and clinical factors associated with a difficult airway in patients with a potentially difficult airway (3). These indices include the Mallampati test, measurement of the thyromental distance (TMD), and the degree of head extension. Most of these indices do not have enough sensitivity and specificity (4). To predict easy or difficult airways, a series of common predictive tests are used that are easy, free, and non-invasive (2, 3). The Mallampati grading test is one of these methods used to predict the severity of intubation, which has a sensitivity within the range of 42 - 81% (5, 6).

Diabetes is one of the most common endocrine diseases, which is especially important for the management of the airway for anesthesiologists. Diabetic individuals might be at greater risk for airway problems than the general population (1, 7, 8). Regarding the causes related to the underlying disease (i.e., diabetes), studies have shown that the presence of stiff joint syndrome or limited joint mobility, which is commonly observed in diabetic patients, can cause airway problems (6, 9). In some preliminary studies, the prevalence of airway problems in type 2 diabetic patients was reported to be 18.7%, compared to 2.5% in non-diabetic patients (10). In these studies, difficult laryngoscopy was defined as a three- or four-grade based on the Cormack-Lehane criteria (11).

Studies have also evaluated the relationship between difficult laryngoscopy and patients' ability to approach the palmar surfaces of their phalangeal joints, formerly

referred to as the "prayer sign" or the "palm print" sign. In palm print, the individual cannot extend the joints between the fourth and fifth fingers. This sign allows the evaluation of the laxity grade of the phalangeal joints, in this regard, the relationship between the rigidity of the palmar joint and involvement of cervical and laryngeal tissues in diabetic patients, which themselves lead to difficult airway and laryngoscopy (5). In some cases, even compared to the standard grading using the Mallampati grading, the use of the prayer sign is less sensitive. However, it has a similar specificity in determining the degree of difficult laryngoscopy in patients (12).

Due to the fact that intubation in diabetic patients is more difficult than in non-diabetic individuals, the accurate determination of the diagnostic value of prayer or palm print sign tests in the grading of difficult laryngoscopy in these patients is far more important than in non-diabetics. The problem is that there is still limited information about the sensitivity and specificity of these signs in the face of routine tests, such as the Mallampati test.

2. Objectives

This study aimed to assess two methods of palm print sign and prayer sign in diabetic patients and compare their degree of compatibility with the degree of laryngoscopy of the Cormack test.

3. Methods

This cross-sectional analytical study was performed in Ghaem and Imam Reza hospitals in Mashhad, Iran, in 2020 on patients with type 2 diabetes who were candidates for various types of surgery under general anesthesia. The inclusion criteria included the age of over 18 years and diabetic patients undergoing surgery under general anesthesia. The exclusion criteria included noticeable anatomical changes (e.g., congenital and traumatic after surgery) of the face, neck, or hands and related factors, such as rheumatoid arthritis, large thyroid, the mass of mouth and neck, pharyngeal abscess or other possible causes of difficult intubation, and body mass index (BMI) > 35 kg/m^2. The patients who could not cooperate for any reason, including physical disability and poor mental state, were also excluded.

Before surgery, patients with a history of diabetes who were candidates for surgery under general anesthesia were assessed for airway conditions. The tests used in this study included the Mallampati classification, TMD, mouth-opening test, and upper lip biting test (ULBT). In addition to demographic characteristics, neck circumference and BMI were also determined and recorded.

For the measurement of TMD, the patient was in the supine position, with a 10 cm pillow under his/her head, and his/her neck was in the extension position. The distance between the thyroid notch and the tip of the chin protrusion was measured using a plastic ruler called TMD. This distance is divided into two groups; in one group, the TMD < 6.5 cm indicates the probability of difficult laryngoscopy, and in the other group, the TMD > 6.5 cm indicates the probability of easy laryngoscopy.

The ULBT is divided into three classes. Class I is the lower incisors that can bite above the upper lip line (probability of easy laryngoscopy). Class II is the lower incisors that can bite the upper lip. Class III is that lower teeth cannot bite the upper lip (probability of difficult laryngoscopy).

This study also examined the palm print sign and prayer sign. To assess the prayer sign, the patient was asked to place his/her hands together as in a prayer position; if there was a gap between the palms and the fingers, the test was positive and otherwise negative. To evaluate the palm print sign, the patient, while sitting, pressed the palm and fingers of one hand on a pad soaked in blue ink measured 25 × 16 cm for about 5 seconds, and after the hand was completely soaked in ink for 5 seconds, pressed them on the white paper which is located on a hard surface. Then, based on the recorded fingerprint on the paper, it was divided into four categories, which included class 0 (the effect of all interphalangeal is visible), class I (the fourth and fifth interphalangeal effect disappears), class II (the second to the fifth interphalangeal effect disappears), and class III (only fingerprints are visible). Classes II to III were considered positive.

On the day of surgery, after an intravenous line (IV) and complete monitoring, induction of anesthesia with midazolam, fentanyl, propofol, or thiopental sodium was performed, and an atracurium muscle relaxant was used to facilitate intubation. Laryngoscopy was performed with a Macintosh metal laryngoscope blade by an anesthesia assistant who had more than 2 years of intubation experience. Difficult laryngoscopy was defined in the present study using the Cormack test as grade III and higher. All diagnostic tests were compared to Cormack test results for difficult airways in terms of their sensitivity and specificity in difficult laryngoscopy.

3.1. Sample Size Calculation and Statistical Analysis

The sample size was calculated based on the data obtained from Hashim and Thomas (13), which reported a palm sign sensitivity of 77%. Considering alpha = 0.05, beta

= 0.2, and d = 0.15 p, the initial sample size was calculated at 57 patients using the following formula:

$n = (z_{1-\alpha/2})^2 p (1 - p)/d^2$

Then, it was divided by 0.3 (i.e., the estimated prevalence of diabetic patients who needed general anesthesia in the studied center), and the final sample size was calculated at 190 patients.

The data were analyzed using SPSS software (version 23). To determine the sensitivity, specificity, positive and negative predictive value, and diagnostic accuracy of the palm print sign and prayer sign in comparison to the usual tests, the cross-tabulation method was used to calculate these parameters. Diagnostic parameters were calculated based on the percentage.

3.2. Ethical Considerations

Ethical approval for this study (IR.MUMS.AC.REC.1398.674) was granted by the Ethics Committee of Mashhad University of Medical Sciences, Mashhad, Iran, on January 1, 2020.

4. Results

A total of 200 patients were included in this study. The mean age of the patients was 59.30 ± 11.90 years. Regarding gender distribution, 137 (68.5%) and 63 (31.5%) cases were male and female, respectively. The mean neck circumference was 43.13 ± 3.63 cm. Table 1 shows patients' mean weight, height, HbA1c, and blood sugar.

Table 1. Demographic, Clinical Information, and Laboratory Findings of Patients with Type 2 Diabetes in the Current Study

Variables	Mean ± SD
Age (y)	59.30 ± 11.90
Weight (kg)	93.09 ± 16.17
Height (cm)	169.57 ± 17.42
Blood Sugar (mg/dL)	144.17 ± 32.32
HbA1c	5.92 ± 0.78

Abbreviation: SD, standard deviation.

In terms of BMI, 21 (10.5%), 71 (35.5%), and 108 (54%) patients were normal (BMI: 18.5 - 24.9 kg/m^2), overweight (BMI: 25 - 29.9 kg/m^2), and obese (BMI: 30 - 34.9 kg/m^2), respectively. Furthermore, the mean values of blood sugar and HbA1c were 144.17 ± 32.32 mg/dL and 5.92 ± 0.78, respectively. In terms of the tests used to determine laryngoscopic difficulty, firstly, regarding grading based on the Cormack test, grades I, II, and III/IV were determined in 51 (25.5%), 73 (36.5%), and 76 (38%) patients, respectively. Table 2 shows the frequency of clinical indicators of the airways. In comparison to the results of the Cormack scoring system, the diagnostic accuracy of each test in the present study was determined (Table 3). The highest sensitivity was related to the Mallampati test, prayer sign test, and palm print sign test (100%). The mouth-opening test had the highest specificity (100%).

Table 2. Frequency of Clinical Indicators of the Airways

Variables	No. (%)
Cormack test	
Grade 1	51 (25.5)
Grade 2	73 (36.5)
Grade 3	46 (23)
Grade 4	30 (15)
Mallampati test	
Grade 1	42 (21)
Grade 2	112 (56)
Grade 3	36 (18)
Grade 4	10 (5)
Thyromental distance (cm)	
< 6.5	97 (48.5)
> 6.5	103 (51.5)
Mouth opening test (cm)	
< 3	26 (13)
> 3	174 (87)
Upper lip biting test	
Grade 1	48 (24)
Grade 2	107 (53.5)
Grade 3	45 (22.5)
Palm print sign test	
Class 0	27 (13.5)
Class 1	42 (21)
Class 2	96 (48)
Class 3	35 (17.5)
Prayer sign test	
Positive	146 (73)
Negative	54 (27)

5. Discussion

Laryngoscopy or endotracheal intubation in diabetic patients due to the impaired mobility of the atlanto-occipital joint due to non-enzymatic glycosylation in connective tissue has always been a problem. In this regard, the use of some anatomical criteria even before general

Table 3. Diagnostic Values of Tests [a]

Tests	Cormack Test Result		Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
	a	b					
Mallampati test							
Class 3, 4	3	119	100	96.2	97.5	100	98.5
Class 1, 2	78	0					
Thyromental distance (cm)							
< 6.5	3	94	79	96.2	96.9	75.7	86
> 6.5	78	25					
Upper lip biting test							
Grade 3	39	6	32.8	92.6	86.7	48.4	57
Grades 1, 2	80	75					
Mouth opening test (cm)							
< 3	81	93	21.8	100	100	46.5	53.5
> 3	0	26					
Palm print sign test							
Grades 2, 3	12	119	100	85.2	90.8	100	94
Grades 0, 1	69	0					
Prayer sign test							
Positive	27	119	100	66.7	81.5	100	86.5
Negative	54	0					

Abbreviations: PPV, positive predictive value; NPV, negative predictive value.
[a] a: Grade 3, 4 (difficult laryngoscopy); b: Grade 1, 2 (easy laryngoscopy).

anesthesia of the patient can be difficult to predict laryngoscopy and therefore disrupt the intubation process.

However, even some of the used methods, especially on their own, have not been able to predict such a feature in these patients and have not had enough sensitivity, specificity, and diagnostic accuracy for such a prediction. In such cases, the use of the Cormack scoring system as a standard method in determining the accuracy of laryngoscopy has always been helpful. The Cormack-Lehane four-part classification system, introduced in 1984 to describe landscape during direct laryngoscopy, is widely used in clinical trials to manage patients with a difficult airway.

According to the Cormack-Lehane classification, the glottal entrance view during direct laryngoscopy is divided into four subgroups. However, in cases with high grades of this system, the possibility of performing a laryngoscopy is difficult. Even in grade II of this system, difficulty in performing laryngoscopy is reported; therefore, the use of new grading systems for such a purpose is recommended. On the other hand, it is not possible to predict the difficulty of laryngoscopy before performing it in this method, and it is not possible to predict the performance of such a procedure until the laryngoscope enters and observes or does not observe the glottis. Therefore, researchers have been looking for preferably anatomical indices that can predict the difficulty of this procedure even before the patient enters the operating room and undergoes anesthesia. In this regard, various tests, such as the Mallampati test, TMD (> 6.5 cm with probability of easy laryngoscopy), ULBT, mouth opening (> 3 cm with probability of easy laryngoscopy), and two palm print sign and prayer sign test are presented, each with its own diagnostic accuracy in predicting the ease of laryngoscopy.

What was discussed in the present study was the value and diagnostic value of these tests, especially the two recent tests in comparison to the Cormack grading system in predicting the difficulty of laryngoscopy. The results of the present study provided significant points in the use of these tests; however, it should be borne in mind that the test will be valuable if it has an acceptable sensitivity and specificity at the same time.

In this study, among the mentioned tests, two tests of biting the upper lip and opening the mouth due to very low sensitivity were not valuable in evaluating and predicting laryngoscopic difficulty. Among the other four tests, the highest sensitivity was related to the Mallampati test,

palm print sign test, and prayer sign test. Nevertheless, based on the available evidence, the Mallampati test also had some limitations. For example, how the patient is placed in bed and even the patient's sighing and breathing pattern can affect the diagnostic sensitivity and accuracy of this test. Considering that the palm print sign and prayer sign tests are not affected at all by the other mentioned factors, they can be the most practical and reliable tests in such evaluation. In different studies, the sensitivity and specificity of the palm print sign and prayer sign tests have been evaluated, and almost all studies emphasized the effectiveness of these two tests.

In the study of Hashim and Thomas (13), the sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of the palm print test were 76.9%, 89.4%, 71.4%, 91.3%, and 86.7%, respectively, very similar to the results of the present study. In the study of Vani et al. (14), the palm print sign test has the highest sensitivity (equal to 75%). In the study of Nadal et al. (15), similar to the current study, the palm print sign test had the highest sensitivity of 100%. In the study by Reissell et al. (16), there was a linear correlation between laryngoscopic difficulty and the palm print sign test classification. In the study of Baig and Khan (12), contrary to the findings of the present study, the sensitivity of the prayer sign test and the Mallampati test was 29.6% and 79.3%, respectively. However, both tests had low specificity in his study.

The summary of the studies indicated the value of the palm print sign test in predicting the difficulty of laryngoscopy. Regarding the difficulty of laryngoscopy in diabetic patients, the frequency mentioned in different studies has been very different. In the present study, this frequency is equal to 59.5% and within the range mentioned in other studies.

In the study by Vani et al. (14), the incidence of laryngoscopy was 16%, which is much lower than in the present study. In the study by Reissell et al. (16), the overall incidence of laryngoscopy was 31%, which is lower than in the current study. In the study by Erden et al. (10), the incidence of laryngoscopy was 18.75% and 2.5% in diabetic and non-diabetic groups, respectively. In addition, in the study by Baig and Khan (12), a total of 35% of patients had difficult laryngoscopy. It seems that the higher degree of difficulty in laryngoscopy, in addition to underlying disorders in the patient (e.g., diabetes and laryngopharyngeal duct disorders), depends mainly on the experience of the relevant anesthesiologist. According to the limitations of the present study, further studies with more observations are needed for these purposes.

5.1. Conclusions

To conclude, among the tests studied to predict difficulty in laryngoscopy in diabetic patients, Mallampati and palm print sign tests have good sensitivity, specificity, and accuracy. Studies with a larger sample size are suggested to obtain more accurate results.

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Footnotes

Authors' Contribution: Amirreza Vakilian: Acquisition of data, writing the manuscript and performing the study. Masoomeh Tabari: Study concept and design, supervision of the study, editing the manuscript and performing the study. Maryam Emadzadeh: Analyzing the data and editing the manuscript. Ghasem Soltani: Supervision of the study and writing the manuscript.

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