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EVALUATION OF AIRWAY INDICES FOR PREDICTING DIFFICULTY IN ENDOTRACHEAL INTUBATION IN PATIENTS WITH DIABETES MELLITUS

Anaesthesiology

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ABSTRACT

Background: The need to predict potentially difficult tracheal intubation has received more importance but with limited success. The present study was conducted to assess various airway evaluation indices used to predict difficult airway in Indian patients with diabetes mellitus. **Methods:** This prospective, observational study was carried out in 85 patients at a tertiary care hospital in Western India. All patients underwent thorough airway assessment using modified Mallampati classification, mouth opening, upper lip bite test, thyromental distance, head extension, palm print, prayer sign and body mass index. Preoperative data of the various airway indices were co-related with difficult intubation to evaluate the sensitivity, specificity, positive predictive value and negative predictive value of each test. **Results:** Overall, the best indicator to predict difficult intubation in patients with diabetes was the palm print (58.7% sensitive; 94.9% specific; 75.3% accurate) followed by Mallampati score (50% sensitive; 94.9% specific; 70.6% accurate) and prayer sign (54.3% sensitive; 89.7% specific; 70.6% accurate). There was a significant association between prediction of difficult intubation and occurrence of complications during intubation in patients with diabetes. **Conclusion:** Even though all airway indices have their place in an anesthesiologists' armamentarium, the palm print is an ideal predictor of difficult intubation in patients with diabetes, followed by the Mallampati score and the prayer sign.

KEYWORDS

Diabetes, difficult intubation, difficult laryngoscopy, palm print, Malampatti, prayer sign.

INTRODUCTION

Difficult airway is defined as the critical phase wherein well-trained anesthesiologists are unable to visualize the upper airway, making ventilation of the patient with facemask or an endotracheal tube difficult.[1] The 'stiff joint syndrome', or 'limited joint mobility', a known chronic complication in individuals with diabetes mellitus, further complicates ventilation in such patients.[2] As a result, in comparison to the general population, patients with diabetes seem to be at an increased risk for a difficult airway.[3]

In diabetes, limited joint mobility of the atlanto-occipital joint motion is commonly observed on account of glycosylation of collagen in and around the cervical vertebrae, which, over a period of time, limits the head and neck extension during laryngoscopy. Difficulty in intubation can also occur due to stiffened pharyngeal soft tissues, particularly the epiglottis.[4-6]

Prediction of difficult intubation using specific clinical findings continues to remain a point of debate among researchers. Though numerous individual physical examination findings have been reported to be predictive, none of them are singularly reliable in excluding the probability for a difficult intubation. Collagen glycosylation is usually first noted in the fourth and fifth interphalangeal joints resulting in the inability to approximate the palms and fingers of the hand, in spite of maximal effort. Several studies have identified the palm print test to objectively assess the degree of interphalangeal joint involvement.[3,5-7] Another test that measures the mobility of these joints is the prayer sign, which assesses the ability to press the palms appropriately together.

Another easily performed individual bedside clinical assessment of difficult intubation is the upper lip bite test. Despite a variety of tests aiding in identifying a case of potential difficult intubation, the inability to bite the upper lip with the lower teeth seems a better predictor.

Assuming a difficult intubation prevalence of 10%, the inability to bite the upper lip increases the likelihood of experiencing a difficult intubation to >60%. Other known helpful individual tests include hyomental distance and impaired mandibular protrusion.[5]

The requisite to predict potentially difficult tracheal intubation has received more importance but with limited success. A number of anatomical and pathological variables have been identified and suggested to be valuable in anticipating a difficult airway. Nevertheless, these factors are confined owing to wide variations in the incidence of difficult intubation, inter-observer variability and inadequate statistical power of the currently measured variables.

This study was conducted to assess the various airway evaluation indices used to predict difficult airway in Indian patients with diabetes mellitus and to study their positive predictive value for predicting difficulty in endotracheal intubation. The secondary objective was to identify complications, if any, in case of difficult endotracheal intubation in such patients.

MATERIALS AND METHODS

This hospital-based, prospective, observational study was carried out between February 2015 and February 2016 in 85 patients at a tertiary care hospital in Western India. This study was conducted according to the Principles of the Declaration of Helsinki and local regulatory laws, and was initiated only after obtaining an approval from the local Institutional Ethics Committee. A signed informed consent was obtained from each patient after explaining the purpose of the study in their native language prior to enrolment.

Patients aged ≥18 years, of either gender, with diabetes mellitus for duration of >5 years, scheduled for surgery under general anesthesia and requiring endotracheal intubation were included in the study. Patients with obvious anatomical deformity (congenital, traumatic, postsurgical origin) of face, neck, palate and hands, those with co-existing rheumatoid arthritis, large thyroid, or airway trauma or those undergoing emergency surgeries were excluded.

Detailed pre-anesthetic evaluation comprised of a thorough history and physical examination. Relevant investigations as per institution practice were evaluated. All patients underwent thorough airway assessment in the sitting position. The patient (with a normal neck) was placed in the "sniffing" position, with the head extended at the atlanto-occipital joint while the neck was relatively flexed. The airway indices evaluated in this study were Mallampati classification (modified by Samsoon & Young), mouth opening (interincisor gap), upper lip bite test (ULBT), thyromental distance, head extension, palm print, prayer sign and body mass index (Appendix 1).

General anesthesia technique used:

On the day of the surgery, the dose of anti-diabetic agents was withheld, six hours of fasting was ensured, morning fasting blood sugar (FBS) was done and an IV line was secured. The anesthesia machine was checked and intubation assist devices like laryngeal mask airway (LMA)/intubating laryngeal mask airway (ILMA)/ proseal laryngeal mask airway (PLMA), flexi-tip, gum elastic bougie, airways were kept ready. In the operating room, standard monitoring (including cardioscope, pulse oximeter, non-invasive blood pressure (NIBP) and end tidal carbon dioxide (Etco2) were employed. Patients were pre-oxygenated with 100% oxygen. Patients received

premedication with Inj. Glycopyrolate 0.2 mg IV, Inj. Midazolam 1 mg IV & Inj. Fentanyl 2ug/kg IV. Induction was done with Inj. Propofol 1.5 to 2 mg/kg until centralization of eyeballs. After confirming mask ventilation, patients were paralyzed with Inj. Atracurium 0.6 mg/kg. Laryngoscopy was done after 3 minutes with patient's head in morning air sniffing position using the standard appropriately sized Macintosh blade.

Intubation technique used:

The laryngoscope, with a curved blade, was grasped with the left hand. The tip of the laryngoscope blade was inserted into the right side of the patient's mouth and smoothly advanced inward while keeping pressure against the tongue. The blade was used to trap and push the tongue to the left as the blade was simultaneously moved to the midline, "clearing a path" for the gaze. The blade was inserted all the way up to the vallecula, until the epiglottis was visualized. The laryngoscope handle was lifted to raise the tongue, jaw, and epiglottis as a unit; the vocal cords were ensured to be visualized. The endotracheal tube was inserted into the right side of the patient's mouth, and advanced so that the tip reached the vocal cords without letting the body of the tube block the view. The endotracheal tube was continued to advance through the vocal cords until the cuff passed through them and into the trachea. The tube was advanced an additional 2 to 3 cm, until the black line was at the level of the cords.

The laryngeal view was graded according to Cormack and Lehane as below:

- Grade I – Visualization of entire laryngeal aperture.
- Grade II – Visualization of only posterior commissure of laryngeal aperture.
- Grade III – Visualization of only epiglottis.
- Grade IV – Visualization of just the soft palate.

The patients' trachea was intubated with an appropriate size endotracheal tube; correct placement of tube was confirmed by auscultation of chest and capnography. In case of difficulty, maneuvers and gadgets like the use of external laryngeal manipulations (EML), change in position of head, use of different size and type of laryngoscope blade, intubating bougie, and intubation by a more experienced anesthesiologist was ensured.

The intubation was performed by a senior consultant in anesthesiology with more than 10 years of experience in the field of anesthesia. Intubation xwas predicted to be difficult in patients with Mallampati classification (modified class III and above), mouth opening was restricted, ULBT grade was class II and above, thyromental distance was >6 cm, head extension was class III and above, palm print was grade II and above, prayer sign was positive or when BMI was >35kg/m^2. The intubation was considered difficult when the Cormack Lehane grade was III and above, intubation not possible in 2 attempts, or when an intubation assist device was required. Patients were monitored from sedation to 10 minutes after intubation; complications, if any, were recorded.

The sample size was calculated considering 30% correlation between all the airway indices at 80% power and 5% level of significance using the formula $N = [(Z_\alpha+Z_\beta)/C]^2 + 3$. Demographic data are presented as mean, standard deviation and range and evaluated using the student's *t*-test. Preoperative data of the various airway indices were co-related with difficult intubation results to evaluate the sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of each test according to standard formulas. Data was collected and analyzed using Microsoft Excel 2007 and SPSS version 17.

RESULTS

Baseline characteristics of the 85 patients with diabetes included in the present study are summarized in Table 1. At baseline, the mean weight of our patients was 71.04 ± 12.76 kg (range, 46.20 – 114.40), mean height was 1.60 ± 0.09 m (range, 1.40 –1.84), mean BMI was 27.71 ± 4.87 kg/m^2 (range, 17.17 – 49.51), and mean duration of diabetes mellitus was 12.07 ± 6.70 years (range, 6 – 35). Most of the patients, i.e., 78.8% each, had comorbidities and diabetic complications. Sixty percent patients were in ASA grade II while 40% in ASA grade III. Predictions of difficult intubation was in 29.4% patients as per Mallampati score, in 25.9% patients as per ULBT, in 22.4% patients as per neck movement class, and in 34.1% patients as per Palm print grade. Clinically, difficult intubation was predicted in 52.9% subjects. Difficult intubation, i.e. Cormack Lehane Grade ≥3, was predicted in 54.1% patients. Nearly 45% patients required external laryngeal manipulation. Intubation was achieved in <2 mins in majority (98.8%) of our patients; it took ≥2 minutes to achieve intubation in only one patient. There was a need to use an intubation assist device in 51.8% patients. A change in the position of the head during intubation was required in 23.5% patients. Intubation was achieved in the first attempt in majority (96.5%) of the patients, while ≥2 attempts were required in the remaining 3.5% patients.

Table 2 illustrates the distribution of patients according to the Cormack and Lehane Grading for predicting difficult intubation using the different indices.

The best indicator identified in predicting difficult intubation in patients with diabetes was the Palm Print, followed by the Mallampati score and the Prayer Sign (Table 3).

The most common complications noted in our study were hypertension (21.2%), hypotension (3.5%) and desaturation (2.4%). There was a significant association between prediction of difficult intubation and occurrence of complications during intubation (P 0.0004) (Figure 1).

Table 1: Baseline characteristics of study population

Parameter	Value
Age (years), mean ± SD (range)	59.29 ± 10.98 (37 – 81)
Gender, n (%)	
Males	49 (57.6%)
Females	36 (42.4%)
MPC grade, n (%)	
I	12 (14.1%)
II	48 (56.5%)
III	24 (28.2%)
IV	1 (1.2%)
Mouth opening, n (%)	
Normal	2 (2.4%)
Restricted	83 (97.6%)
ULBT, n (%)	
I	63 (74.1%)
II	21 (24.7%)
III	1 (1.2%)
Thyromental distance, n (%)	16 (18.8%)
<6 cm	69 (81.2%)
>6 cm	
Neck movement class, n (%)	
I	24 (28.2%)
II	42 (49.4%)
III	19 (22.4%)
Palm print grade, n (%)	27 (31.8%)
0	29 (34.1%)
I	29 (34.1%)
II	
Prayer Sign, n (%)	56 (65.9%)
Negative	29 (34.1%)
Positive	
BMI, n (%)	6 (7.1%)
>35 kg/m^2	33 (38.8%)
≤35 kg/m^2	
Cormack Lehane Grading	
I	6 (7.1%)
II	33 (38.8%)
III	42 (49.4%)
IV	4 (4.7%)

Abbreviations: BMI, body mass index; MPC, Mallampati classification; TMD, thyromental distance; ULBT, Upper lip bite test.

Table 2: Distribution of patients as per the Cormack and Lehane Grading for predicting difficult intubation using the various indices

Parameter predicting difficult intubation	Cormack And Lehane Grade ≥3	
	No	Yes
MPC		
No (N=60)	37 (94.9%)	23 (50%)
Yes (N=25)	2 (5.1%)	23 (50%)

Mouth Opening		
No (N=83)	39 (100%)	44 (95.7%)
Yes (N=2)	0 (0%)	2 (4.3%)
ULBT		
No (N=63)	34 (87.2%)	29 (63%)
Yes (N=22)	5 (12.8%)	17 (37.0%)
TMD >6 cm		
No (N=69)	38 (97.4%)	31 (67.4%)
Yes (N=16)	1 (2.6%)	15 (32.6%)
Neck Movement		
No (N=66)	38 (97.4%)	28 (60.9%)
Yes (N=19)	1 (2.6%)	18 (39.1%)
Palm Print		
No (N=56)	37 (94.9%)	19 (41.3%)
Yes (N=29)	2 (5.1%)	27 (58.7%)
Prayer Sign		
No (N=56)	35 (89.7%)	21 (45.7%)
Yes (N=29)	4 (10.3%)	25 (54.3%)
BMI (>35 kg/m^2)		
No (N=81)	38 (97.4%)	43 (93.5%)
Yes (N=4)	1 (2.6%)	3 (6.5%)

Abbreviations: BMI, body mass index; MPC, Mallampati classification; TMD, thyromental distance; ULBT, Upper lip bite test.

Table 3: Sensitivity Analyses Of The Various Indices For Predicting Difficult Intubation

Parameters	Sensitivity	Specificity	PPV	NPV	Accuracy
MPC	50.0%	94.9%	92.0%	61.7%	70.6%
Mouth Opening	4.3%	100.0%	100.0%	47.0%	48.2%
ULBT	37.0%	87.2%	77.3%	54.0%	60.0%
TMD	32.6%	97.4%	93.8%	55.1%	62.4%
Neck Movement	39.1%	97.4%	94.7%	57.6%	65.9%
Palm Print	58.7%	94.9%	93.1%	66.1%	75.3%
Prayer Sign	54.3%	89.7%	86.2%	62.5%	70.6%
BMI	6.5%	97.4%	75.0%	46.9%	48.2%

Abbreviations: BMI, body mass index; MPC, Mallampati classification; PPV, positive predictive value; NPV, negative predictive value; TMD, thyromental distance; ULBT, Upper lip bite test.

DISCUSSION

Preoperative identification of diabetic patients who are at high risk of difficult laryngoscopy is crucial to plan a pertinent strategy for induction of anesthesia and intubation. There is no distinct singular test that can predict a difficult intubation, especially in the ever-growing high-risk diabetic population. There is a need for a test, which is quick and easy to perform, is highly sensitive (so that most difficult cases can be identified), highly specific (to reduce the rate of false positives when used routinely), and could be used for bedside interpretation.

Most of the patients studied in diabetic populations across the world[1,7-11] had a mean age belonging to the same age group, i.e. 50-60 years, as noted in our study. The mean duration of diabetes was higher in our study compared to that reported by Baig MMA et al, Hashim KV et al, Gondane SR et al, and Uysal AI et al; 27% patients with diabetes analyzed by Priya K et al had duration of diabetes of >10 years.[6,7,9-11] We recorded a prevalence of 54.1% of difficult intubation in patients with diabetes, which is higher than the incidence reported in previous literature.[1,6,9-11] This could be attributed to higher mean age and duration of diabetes of our study population.

Limited cervical joint mobility along with limited atlanto-occipital joint motion may make laryngoscopy and intubation difficult in diabetics. The prevalence of 'limited joint mobility syndrome' has been reported to vary between 21% and 63% in those with long standing diabetes mellitus.[2,12] In an effort to predict which of these diabetics would prove to be difficult to intubate we tried to evaluate the various airway indices in this subset of patients during the preoperative check-up and correlate those findings with the ease of intubation. In the present study, the palm print was observed to be the most accurate with sensitivity of 58.7%, specificity of 94.9% and overall accuracy of 75.3%, followed by Mallampati classification and prayer sign (Table 3). While the least accurate tests in predicting difficult Intubation were the mouth opening test and BMI.

Previously, Vani VV et al assessed the ink impression made by the palm of the dominant hand as a screening tool for difficult laryngoscopy in patients with diabetes. Similar to our findings, of all the indices, the highest sensitivity was observed with the palm print test (75%), which was followed by head extension <35 and modified Mallampati grade >I, thyromental distance <6 cm and modified Mallampati grade >II. Though thyromental distance <6 cm was highly specific (95.2%), it was the least sensitive (25%). Two or more indices were found to be abnormal in 87% patients with difficult laryngoscopy. Though the authors found the palm print test as the most sensitive index, they advocated achieving better prediction of difficult laryngoscopy by preoperatively assessing multiple airway indices.[8] Baig MMA et al compared the prayer's sign and Mallampati test in evaluating difficult intubation in 357 patients with diabetes. As noted in our study, nearly 60% patients were in ASA-II, 39.2% in ASA-III and 0.8% in ASA-VI. Prayer's sign had lower sensitivity (29.6; 95% CI, 21.9-38.5) than the Mallampati test (79.3; 95% CI, 70.8-85.7) while there was no significant difference amongst the specificity of both tests. Moreover, as compared to the Mallampati test, the prayer's sign demonstrated significantly lower accuracy, PPV and NPV. The authors concluded the Mallampati test as a better choice for preoperative airway assessment.[9] In another similar study, Hashim KV and Thomas M estimated the palm print sign as a screening tool in predicting difficult laryngoscopy in patients with diabetes. The palm print sign was found to be the most sensitive (76.9%) in predicting difficult laryngoscopy, with specificity of 89.4%, PPV 71.4%, NPV 91.3% and accuracy 86.7%, followed by the prayer's sign.[10]

Gondane SR et al compared different clinical parameters of airway assessment and their capability in predicting difficult laryngoscopy and intubation in patients with diabetes to non-diabetics. Difficult laryngoscopy (indicated by Cormack-Lehane grade III and IV) had a strong correlation with duration of diabetes (66.7% patients with >10 years of diabetes had difficult intubation; 75.8% patients <10 years of diabetes had easy laryngoscopy). Among diabetics, while the Mallampati classification was found as a more sensitive predictor (80.77%), the palm print index was more specific (97.06%). The palm print and head extension were equally sensitive (57.70%) in predicting difficult laryngoscopy. The specificity of the prayer's sign was 88.24%. The Mallampati classification had the least specificity among patients with diabetes. The palm print index had the highest PPV (93.75%), while the least was that of the Mallampati classification (51.22%). The highest NPV was that of the prayer sign (83.33%).[11]

In another similar study, Priya K et al compared the sensitivity and specificity of the palm print test with the Modified Mallampati test, thyromental distance, and head extension angle in their ability to predict difficult laryngoscopy in 267 patients with diabetes. The palm print sign demonstrated 83.3% sensitivity, 91.2% specificity, 84.2% PPV, 90.6% NPV, and an accuracy of 88.38%. As a predictor of difficult laryngoscopy, the Mallampati test was more sensitive (80.77%) the palm print index was more specific (97.06%).[7] Shalini SR et al compared the palm print and modified Mallampati tests in the assessment of difficult intubation in 100 elderly patients (51, diabetics; 49, non-diabetics), and found the palm print test to have the highest sensitivity (76% vs 69%) and NPV (76% vs 73%) compared to the modified Mallampati test in predicting difficult laryngoscopy and intubation in elderly diabetic patients.[13]

Recently, Uysal AI et al compared the efficacy of the palm print test with other indices in predicting difficult intubation by determining their positivity thresholds. The authors found a statistically significant (p=0.000) relationship between the palm print test and Cormack-Lehane assessment classification, unlike indices like regulation of diabetes, sternomental distance, upper lip bite test, and prayer sign. Similar to previous study findings, the palm print test was the most sensitive (0.944), specific (0.692), and had the highest PPV (0.895) and NPV (0.818). The least sensitive index (0.361) in predicting difficult intubation were the Mallampati test and the prayer sign, whereas the least specific was the thyromental distance (0.308).[6]

Complications during intubation was observed in 25.9% (desaturation, 2.4%; hypotension, 3.5%; hypertension, 21.2%) patients; there was a significant association between prediction of difficult intubation and occurrence of complications during intubation (p<0.05). In the study by Uysal AI et al ~47% patients had diabetic complications (neuropathy, nephropathy, hepatosteatosis, retinopathy or peripheral circulatory disorders). However, there was no significant association between diabetic complications and palm print test predictivity.[6]

Gondane SR et al observed no complications in their study.[11]

Most previous literature, similar to the present study, suggested the palm print test as an easy-to-perform, viable, most sensitive and specific airway index for preoperative airway assessment of patients with diabetes.[6,7,14]

In conclusion, clinically, we generally find that diabetic patients are difficult to intubate. Although all airway indices have their place in an anesthesiologists' armamentarium, the palm print is an ideal predictor of difficult intubation, followed by the Mallampati score and the prayer sign, in patients with diabetes. It must be still be acknowledged that some patients with a difficult airway will continue to remain undetected despite vigilant preoperative airway evaluation. As a result, anesthesiologists must always be prepared with an array of pre-formulated and practiced plans for airway management in the event of an unanticipated difficult airway.

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