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Evaluation of predictability of airway indices to detect difficult laryngoscopy in diabetic and nondiabetic patients receiving general anaesthesia with tracheal intubation

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ABSTRACT

Introduction: Difficult tracheal intubation remains one of the most common cause of morbidity and mortality related to anaesthesia. Diabetic patients are particularly prone to difficult laryngoscopy and intubation due to "Limited Joint Mobility syndrome". We evaluated various airway indices to know their predictability in detecting difficult laryngoscopy in diabetic and nondiabetic patients.

Materials and methods*:* After obtaining Institute Ethics Committee approval, a total of 80 patients including diabetics (40) and non-diabetics (40) were assessed pre-operatively for airway indices using Modified Mallampati (MMP) test, thyromental distance (TMD), head extension (HE), palm print grade (PPG), body mass index (BMI) and their corresponding Cormack-Lehane (CL) grades were noted. Statistical analysis performed using student's t test for quantitative data and chi-square test for qualitative data and compared between the groups. A p value of < 0.05 is considered as significant. Sensitivity, specificity, positive predictive value, negative predictive value was calculated for each of these airway indices.

Results: A significant difference in mean age (p=0.008), HE angles grades (p=0.048) was noted. 32.5% & 17.5% of diabetics and nondiabetic patients respectively had difficult laryngoscopy (p=0.196). In diabetics, PPG and BMI had highest sensitivity (53.85%) and MMP test had highest specificity (96.3%). In non-diabetics, PPG had the highest sensitivity (71.43%). MMP test and TMD had the highest specificity (96.97%).

Conclusions*:* In diabetics, sensitivity was highest for PPG, BMI whereas MMP test had highest specificity. In non-diabetics, sensitivity was highest for PPG whereas MMP test and TMD had highest specificity. Palmprint had highest sensitivity in both the groups..

Keywords: Airway indices; diabetics; difficult laryngoscopy; nondiabetics; predictability

INTRODUCTION

Management of the airway with induction of anaesthesia is the primary and unique responsibility of the anaesthesiologist. From the time of introduction of endotracheal intubation, several problems have occurred due to failed intubation. Closed claims analysis has found that the vast majority (85%) of airway related events involve brain damage and one third of mortality was attributable solely to anaesthesia [1]. This was related to inability to maintain a patent airway in these cases. Many methods have been introduced in the past to overcome these problems and identify the patients

who will be difficult to intubate. Important among those is the preoperative assessment of the airway in the patients posted for surgery. Many physical examination indices were developed to aid in the preoperative evaluation of all patients presenting for laryngoscopy and tracheal intubation. Although difficult laryngoscopy does not reflect difficult intubation, laryngoscopic view is considered an accepted method of comparing airway evaluation indices [1].

The link between diabetes mellitus and difficult laryngoscopy has been described in recent years. Fifty percent of the diabetic patients undergo surgery some time during their lifetime [2]. Diabetic patients are particularly prone to difficult laryngoscopy and intubation, the reported incidence being 27-31% [3, 4, 5]. This is due to non-enzymatic glycosylation of collagen and its deposition in the joints resulting in "Limited Joint Mobility" (LJM) syndrome [3, 6]. Joint involvement in diabetics is sometimes evaluated using a "palm test" which determines how much of a patient's palm of the dominant hand can contact a flat surface as proposed by Reissell et al [3, 5].

In the current study design, we intend to evaluate all the commonly used airway indices like Modified Mallampati (MMP) test, thyromental distance (TMD), head extension (HE), body mass index (BMI) along with palm print grade (PPG) in predicting difficult laryngoscopy in both diabetic and nondiabetic patients.

MATERIALS AND METHODS

This prospective observational study was conducted after obtaining approval from the Institute Ethics Committee and written informed consent from each study participant. All the methods in the study were performed in accordance with good clinical practice guidelines and declaration of Helsinki principles. Consecutive 80 adult patients including an equal number of diabetics who were on oral or injectable diabetes mellitus treatment for at least one year and nondiabetics, aged 18-65 years, of either sex, undergoing elective surgical procedures under general anaesthesia with tracheal intubation were included in the study. Patients with obvious anatomical variations (congenital, traumatic or post-surgical) of face, neck, palate or hands, coexisting factors like rheumatoid arthritis, large thyroid, cervical tumours and previous history of difficult intubation were excluded from the study.

On the day prior to surgery, patients were examined in the sitting position and following airway indices were assessed.

MMP test [7]:

Patients were asked to open the mouth fully and protrude the tongue as far as possible without vocalization and categorized as Class I (Faucial pillars, soft palate & uvula visualized), Class II (Upper portion of faucial pillars & uvula, soft palate & hard palate visualized), Class III (Base of the uvula, soft palate & hard palate visualized) and Class IV (Only hard palate visualized).

Thyromental distance [8]:

The distance between the thyroid notch & the bony point on the mentum was measured with the patient's head fully extended on the neck and categorized as, Class I ($\geq$ 6cm) and Class II (< 6cm).

Head extension [9]:

With the patient in sitting position, a Frankfurt line [10] joining two reference points i.e., inferior margin of the left orbit (left orbitale) and upper margin of the external auditory meatus (porion) was drawn on the transparent sheet looking through the glass. Then the patient was asked to maximally extend his/her head on the neck and another line joining the same reference points was drawn and angle between the two lines was measured with protractor and categorized as Class I ($>35^0$), Class II ($22^0 - 35^0$), Class III ($12^0 - 21^0$) and Class IV ($<12^0$).

Palm print [3, 5]:

Palm and fingers of the right hand of the patient was painted with blue ink and patient was asked to press the hand against a white paper placed on a hard surface and categorized as Grade 0 (All the phalangeal areas are visible), Grade 1 (Deficiency in the interphalangeal areas of the 4th & 5th digits), Grade 2 (Deficiency in the interphalangeal areas of 2nd to 5th digits) and Grade 3 (Only the tips of the digits are seen).

BMI [weight (kg) / height (m^2)] [11]:

BMI was graded according to BMI cut-off points for public health action in Asians and categorized as Normal (18.5-22.9), Overweight (23-27.4), Obese

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(27.5-32.4), Severely Obese (32.5-37.4) and Morbidly Obese (≥ 37.5).

Patients with MMP class III and above, TMD class II, HE classes II and above, PPG I and above, obese, severely obese and morbidly obese patients were predicted to have difficult laryngoscopy.

Patients were kept nil per orally, 6 hrs for solids & 2 hrs for clear fluids. On the day of surgery, dose of antidiabetic agents was withheld. Morning fasting blood sugar was done, and an intravenous (IV) line was secured. Intubation was performed by an anesthesiologist with at least 6 months of experience. After shifting the patient to the operating room monitors like electrocardiogram (ECG), pulse oximetry (SpO_2), non-invasive blood pressure (NIBP) was connected. All patients were preoxygenated with 100% of O_2 for three minutes. The anesthesia induction drugs were inj. thiopentone 5mg/kg, inj. fentanyl 2mcg/kg and tracheal intubation was facilitated with inj. succinylcholine 1.5mg/kg. Laryngoscopy was performed using a standard medium size 3 Macintosh blade and laryngeal view class based on the Criteria of Cormack and Lehane (CL) was assigned [12]. Difficult intubation measures were taken and no external pressure on the larynx was applied during laryngoscopy.

Criteria of Cormack and Lehane [12] is categorized as Grade I (Entire glottis visible), Grade II (Only posterior portion of the glottis visible), Grade III (Only epiglottis visible), Grade IV (Not even epiglottis can be seen). Difficult laryngoscopy was defined as Cormack & Lehane Grade III and above.

Statistical Analysis:

We chose a convenience sampling of 40 each in diabetic and nondiabetic groups. The data was presented as number (%) and mean ± standard deviation (SD) or median with interquartile range (IQR25-75) as appropriate. All data were subjected to the Shapiro–Wilk test to check the normality of distribution. The continuous data between the groups were compared with student t test or Wilcoxon signed-rank test and the categorical data were compared with Chi-square test or Fisher exact test. All analysis was two tailed and $p < 0.05$ was considered statistically significant. The sensitivity, specificity, positive predictive value and negative predictive values of various airway indices were calculated by diagnostic test (2x2 table) separately for diabetic and nondiabetic patients. Software used were Microsoft Office Excel 2010, SPSS version 22 and MedCalc version 14.

RESULTS

In the present study, 80 consecutive patients which include an equal number of diabetic and nondiabetic patients were recruited. The mean age of diabetic patients was significantly high compared to nondiabetic patients (p=0.008). Both the groups were comparable in relation to gender distribution and mean BMI (Table 1). Mean duration of diabetes in diabetic group was 3.99 years. 32.5% & 17.5% of diabetics and nondiabetic patients respectively had difficult laryngoscopy (p=0.196). Number of patients with head extension angle < 35^0 were significantly high in diabetic group compared to the nondiabetic group (p=0.048). Also, a gradual fall in head extension angle was noted in diabetic patients with increasing age. But in non-diabetic patients, the head extension angle was not much affected until 60 years of age. There was no significant difference in MMP class, TMD, PPG, BMI and CL grades between the groups (Table 2).

In diabetic group, MMP class had significant association with CL grades (p=0.031). Other airway indices did not have a significant association with difficult laryngoscopy (p>0.05). In the nondiabetic group, only PPG had significant association with ease of laryngoscopy assessed by CL grading (0.011) (Table 3).

In diabetic group, PPG (53.8%) and BMI (53.8%) were found to be more sensitive in predicting difficult laryngoscopy, followed by MMP (30.77%) and HE angles (30.77%). TMD (7.69%) was found to be the least sensitive predictor of difficult laryngoscopy. Specificity was highest for MMP test (96.3%) followed by TMD (92.59%), HE angles (81.48%), PPG (74%) and BMI (62.96%) (Table 4).

In the nondiabetic group, PPG (71.43%) had highest sensitivity followed by MMP, BMI and TMD. Specificity was highest for MMP (96.97%) and TMD (96.97%) followed by HE angle, PPG and BMI (Table 5).

DISCUSSION

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To predict which of the diabetic (40) and nondiabetic (40) patients would prove to be difficult to intubate, various airway indices were assessed during the preoperative check-up and these findings were correlated with the ease of laryngoscopy based on the criteria of Cormack and Lehane.

In the present study, 32.5% & 17.5% of diabetics and nondiabetic patients respectively had difficult laryngoscopy. Studies of Beebe et al.,[13] Vani et al.,[14] Hashim et al.,[15] Hogan et al.,[4] and Reissell et al.,[5] have reported 13%, 16%, 21.7%, 32% and 31% incidence of difficult Laryngoscopy respectively in diabetic patients.

In the present study, the mean duration of diabetes in diabetic group was 3.99 years. Mean duration of diabetes was 3.8 years and 4.3 years in patients with easy and difficult laryngoscopy, respectively. Even though statistically not significant, mean duration of diabetes was more in patients with difficult laryngoscopy than in patients with easy laryngoscopy (p=0.73). In the studies done by Vani et al.,[14] George et al.,[10] and Hashim et al.,[15], the mean duration of diabetes were 5.3 years, 4.8 years and 6.7 years, respectively. In Nadal et al.,[3] study, the duration of diabetes more than ten years was found to be a sensitive indicator of difficult laryngoscopy.

In the present study, MMP test and PPG had significant association with CL grade in diabetic and nondiabetic patients, respectively. In Hashim et al.,[15] study, none of the indices like MMP, TMD, HE and prayer sign had significant association with difficult laryngoscopy. In Ravindra et al.,[16] study, significant association was noted between higher grades of various airway indices like MMP, HE, BMI, PPG, prayers sign and difficult laryngoscopy in diabetic patients. In nondiabetic patients, higher grades of MMP, BMI, TMD had a positive association with difficult laryngoscopy.

In the present study, in diabetics, sensitivity was highest for PPG and BMI, followed by MMP, HE angles and TMD. Specificity was highest for the MMP test followed by TMD, HE angles, PPG and BMI. In the nondiabetic group, PPG had highest sensitivity followed by MMP, BMI and TMD. Specificity was highest for MMP and TMD followed by HE angle, PPG and BMI.

In Vani et al.,[14] study, in diabetics, it was found that sensitivity was highest for PPG (75%) followed by HE angle (62.5%), MMP test (25%), TMD (25%). Specificity was highest for TMD (95.2%) followed by MMP (90.5%), PPG (69%), and HE angle (61.9%).

In George et al.,[10] study, in diabetics, sensitivity was highest for PPG (76.7%) followed by MMP (56%), prayer sign (54.5%) and HE angle (50%). Specificity was highest for PPG (89.3%) followed by MMP (61.9%), prayer sign (52.5%), HE angle (48.8%). BMI was the most sensitive index in obese nondiabetics in predicting difficult airway, but PPG was most significant in diabetics.

In Hashim et al.,[15] study, in diabetics, sensitivity was highest for PPG (76.9%) followed by HE angle (38.5%). Specificity was highest for PPG (89.4%) followed by MMP test (68.1%).

In Ravindra et al.,[16] study, in diabetic patients, sensitivity was highest for MMP (78.7%), whereas specificity was highest for palmprint sign (93.7%). In nondiabetic patients, sensitivity was highest for MMP (72.7%), whereas specificity was highest for prayer sign (96.6%).

We conclude that, in diabetic patients, palmprint and BMI were the best predictors of difficult laryngoscopy, followed by MMP test and HE angle. In nondiabetics, PPG was the best predictor of difficult airway followed by MMP test and BMI. PPG alone appears to be a better indicator in both diabetic and nondiabetic patients.

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TABLES

Table 1: Demographic profile

Demographic characteristic	Diabetics (n=40)	Nondiabetics (n=40)	*p* value
Mean age in years (±SD)	52.50(± 8.518)	47.2(±8.925)	0.008
BMI (kg/m^2)	24.71(±4.57)	23.24(±4.939)	0.171
Gender, n Male/Female	18/22	18/22	1

Data is represented as mean±SD or frequency.

SD: standard deviation, BMI: body mass index

n = number of patients.

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Table 2: Comparison of airway indices between diabetics and nondiabetics

Airway indices	Diabetics n (%)	Non-diabetics n (%)	*p* value
MMP class			0.646
Class I and II	35 (87.5%)	36 (90%)	
Class III and IV	5 (12.5%)	4 (10%)	
TMD (cm)			1
Class I (≥ 6)	37 (92.5%)	38 (95%)	
Class II (< 6)	3 (7.5%)	2 (5%)	
HE angles class			0.048
Class I	31 (77.5%)	38 (95%)	
Class II, III and IV	9 (22.5%)	2 (5%)	
PPG			0.58
Grade 0	26 (65%)	29 (72.5%)	
Grade 1, 2 and 3	14 (35%)	11 (27.5%)	
BMI (kg/m^2)			0.88
<27.5	27 (67.5%)	30 (75%)	
≥27.5	13 (32.5%)	10 (25%)	
CL grade			0.196
Grades I and II	27 (67.5%)	33 (82.5%)	
Grades III and IV	13 (32.5%)	7 (17.5%)	

MMP: Modified Mallampati class, TMD: Thyromental distance, HE: Head extension, PPG: Palm print grade, BMI: Body mass index, CL: Cormack and Lehane grade.

n = number of patients.

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Table 3: Comparison of airway indices and Cormack and Lehane grades in diabetics and nondiabetics

Airway indices	Cormack and Lehane grades							
	Diabetics (n=40)				Non-diabetics(n=40)			
	Grade I and II (%)	Grade III and IV (%)	Total (%)	*p* value	Grade I and II (%)	Grade III and IV (%)	Total (%)	*p* value
MMP class								
Class I and II	26	9	35 (87.5%)	0.031	32	4	36 (90%)	*0.13*
Class III and IV	1	4	5 (12.5%)		1	3	4 (10%)	
TMD (cm)								
Class I (≥ 6)	26	11	37 (92.5%)	1	32	6	38 (95%)	0.323
Class II (< 6)	2	1	3 (7.5%)		1	1	2 (5%)	
HE angles class								
Class I	23	10	33 (82.5%)	0.662	32	7	39 (97.5%)	1
Class II, III and IV	4	3	7 (17.5%)		1	0	1 (2.5%)	
PPG								
Grade 0	20	6	26 (65%)	0.155	27	2	29 (72.5%)	0.011
Grade 1, 2 and 3	7	7	14 (35%)		6	5	11 (27.5%)	
BMI (kg/m^2)								
<27.5	19	8	27 (67.5%)	0.722	26	4	30 (75%)	0.338
≥27.5	8	5	13 (32.5%)		7	3	10 (25%)	

MMP: Modified Mallampati class, TMD: Thyromental distance, HE: Head extension, PPG: Palm print grade, BMI: Body mass index, CL: Cormack and Lehane grade. n = number of patients.

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Table 4: Sensitivity, specificity, positive predictive value and negative predictive value of airway indices in diabetic patients

Airway indices	Sensitivity	Specificity	PPV	NPV
MMP test	30.77%	96.30%	80.00%	74.29%
TMD	7.69%	92.59%	33.33%	67.57%
HE angles	30.77%	81.48%	44.44%	70.97%
PPG	53.85%	74%	50%	76.92%
BMI	53.85%	62.96%	41.18%	73.91%

MMP: Modified Mallampati class, TMD: Thyromental distance, HE: Head extension, PPG: Palm print grade, BMI: Body mass index, PPV: Positive predictive value, NPV: Negative predictive value.

Table 5: Sensitivity, specificity, positive predictive value and negative predictive value of airway indices in nondiabetic patients

Nondiabetic Patients	Sensitivity	Specificity	PPV	NPV
MMP grade	42.86%	96.97%	75%	88.89%
TMD	14.29%	96.97%	50%	84.21%
HE angles	0.00%	93.94%	0	81.58%
PPG	71.43%	81.82%	45.45%	93.10%
BMI	42.86%	78.79%	30%	86.67%

MMP: Modified Mallampati class, TMD: Thyromental distance, HE: Head extension, PPG: Palm print grade, BMI: Body mass index, PPV: Positive predictive value, NPV: Negative predictive value.

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