Clinical Investigation

Sensitivity of palm print sign in prediction of difficult laryngoscopy in diabetes: A comparison with other airway indices

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ABSTRACT

Background and Aims: Diabetic patients are prone for the limited joint mobility syndrome. The atlanto-occipital joint involvement limits adequate extension of head and neck during laryngoscopy making intubation difficult. The collagen glycosylation starts in the fourth and fifth inter-phalangeal joints. The degree of inter-phalangeal involvement can be assessed by scoring the ink impression made by the palm of the dominant hand (palm print [PP] sign) The aim of our study was to evaluate the PP sign as a screening tool for predicting difficult laryngoscopy in diabetic patients. **Methods:** A total of 60 diabetic patients undergoing general anaesthesia with endotracheal intubation were assessed pre-operatively for their airway indices using the modified Mallampati test, thyromental distance, degree of head extension, the PP test and the prayer sign and their corresponding Cormack–Lehane scores were noted. Statistical analysis was performed using Fischer exact test. **Results:** Of the 60 patients, 15 had positive PP sign. Of the 13 difficult laryngoscopies encountered, 10 patients had a positive PP sign. PP sign was the most sensitive index in predicting difficult laryngoscopy. P =0.000 was obtained and considered as statistically significant. The sensitivity was 76.9%, specificity 89.4%, positive and negative predictive value 71.4% and 91.3% and accuracy 86.7%, respectively. The other signs were not significant in predicting difficult laryngoscopy. **Conclusion:** The PP test appears to be the most sensitive and specific in the prediction of difficult laryngoscopy in diabetic patients.

Key words: Diabetes, difficult intubation, limited joint mobility

INTRODUCTION

An intubation is called difficult if a conventionally trained anaesthesiologist needs more than three attempts or more than ten minutes for a successful endotracheal intubation.[1] It has been estimated that inability to successfully manage difficult airways has been responsible for as many as 30% of deaths attributable to anaesthesia.[2,3] The incidence of difficult and failed intubation has been reported to be 1-3.6% and 0.05-0.3%, respectively.[4] To anticipate difficult airway pre-operatively, many clinical indices have been devised, the commonly used ones being the modified Mallampati (MMP) test, the thyromental distance (TMD) and the degree of head extension (HE). Unfortunately, most of these have low sensitivity and specificity.[5-7] By examining features specific to a sub-population of patients, improved sensitivity of the test may be achieved.[4] About 50% of the diabetic patients undergo surgery sometime during their life.[8] The reported incidence of difficult laryngoscopy in diabetic patients approximate 27-31%.[4,9,10] This is due to the non-enzymatic glycosylation of collagen and its deposition in the joints resulting in 'limited joint mobility' (LJM) syndrome, which occurs in 25-45% of patients with long standing diabetes.[4,11] The atlanto-occipital joint involvement limits adequate extension of head and neck during laryngoscopy leading to intubation difficulties.[9,11,12]

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The exact mechanism of LJM syndrome is unknown, but evidence suggests that the syndrome may be another illustration of tissue glycosylation associated with chronic hyperglycaemia seen in diabetic patients.[10,13] Diabetic patients have an abnormality of collagen metabolism and increased cross-link formation as a result of which collagen fibrils are abnormally stable, relatively insoluble and resistant to the enzymatic degradation[10,14] These changes are potentially reversible.[10,15]

The collagen glycosylation starts in the fourth and fifth inter-phalangeal joints resulting in the patient not able to approximate the palms and fingers of the hands – the "prayer sign" [Figure 1].[9] The degree of inter-phalangeal involvement can be objectively assessed by scoring the ink impression made by the palm of the dominant hand "palm print (PP) sign" as proposed by Reissell *et al*.[4,10] [Figure 1] Hence, we decided to evaluate the ink impression made by the palm of the dominant hand as a screening tool for predicting difficult laryngoscopy in diabetic patients and then to compare the sensitivity, specificity, positive predictive value (PPV) and negative predictive values (NPVs) of the PP test with the commonly used airway predictors in their ability to predict difficult laryngoscopy in diabetic patients.

We also wanted to find out if there was any meaningful association between the duration of diabetes mellitus and difficult laryngoscopy.

METHODS

This prospective observational study was initiated after obtaining approval from the Institutional Review Board of the Hospital and the Ethical Committee. It included sixty patients who were diabetic for at least a year in the age group between 30 and 80 years and underwent elective surgery under general anaesthesia with endotracheal intubation from July to November 2012.

Figure 1: Positive palm print sign and positive prayer sign

Based on the study of Nadal *et al*. we assumed a sensitivity of 85% for PP sign in prediction of difficult laryngoscopy.[4] A sensitivity of 62% for HE was assumed in prediction of difficult laryngoscopy.[16] Assuming a minimum power of 80% and a 5% alpha error, the sample size was estimated to be 57.

Five airway indices were evaluated with respect to their ability to predict difficult laryngoscopy pre-operatively. Statistical analysis was carried out using Fischer exact test. A $P < 0.05$ was considered as significant. The parameters calculated for each airway predictor were sensitivity, specificity, PPV, NPV, and accuracy.

Patients with obvious anatomical variation of their face, neck, palate or hands and history of difficult intubation in the past were excluded from the study. Patients with coexisting diseases such as rheumatoid arthritis, oral malignancies and large neck masses were also excluded.

Pre-operatively, airway was assessed in every patient, while they were sitting upright in a chair using the MMP test,[17] TMD,[4] degree of HE (less or more than 35°), the prayer sign and PP test. The details of the method of assessing prayer sign and PP are given below. For prayer sign (10), the patient was asked to bring both his palms together as "namaste" and the categorised as positive (A gap observed between the palms). [Figure 1] or negative (no gap observed between the palms). For palm print test, the palm and fingers of the dominant hand of the patient was firmly pressed against a blue ink pad. The patients hand was then pressed firmly against a white sheet of paper on a hard surface (10), Grading was done as Grade 0 (all phalangeal areas visible), Grade 1(deficiency in the inter-phalangeal area of the fifth digit or both fourth and fifth), Grade 2 (deficiency in the inter-phalangeal areas of second to fifth digit-Figure 1), and Grade 3 (only the tips of digits seen).

The patients were positioned with a standard pillow under the head and general anaesthesia was induced with 1% propofol 2 mg/kg, and vecuronium 0.1 mg/kg.

At the end of 3 minutes, after full muscle relaxation laryngoscopy was performed by an anaesthesiologist who had completed two years of training, utilising a standard medium sized Macintosh blade in the normal intubating position. The laryngoscopist could try up to three attempts to acquire the best laryngeal view without external laryngeal pressure applied to the cricoid cartilage. The laryngoscopist assigned a laryngeal view class based on the criteria of Cormack–Lehane (CL).[18]

Grades 3 and 4 laryngoscopic views were considered as difficult laryngoscopy as no part of the glottis is visible. After laryngeal view was graded, patient was intubated with the appropriate sized endotracheal tube and placement confirmed clinically and by capnometry. Stylet, gum elastic bougie, long Macintosh curved blade, laryngeal mask airway (LMA) and i-gel airway were kept ready for emergency.

RESULTS

A total of sixty diabetic patients were studied during the study period. There were twenty three males and thirty seven females. The mean age of the study population was 56.3 years. The incidence of difficult laryngoscopy was 21.7% in our study. The mean duration of diabetes in our study was 6.7 years.

It was observed that the incidence of difficult laryngoscopy was higher as the duration of diabetes is increased. [Table 1] which was however statistically insignificant.

Of the sixty patients who were studied, thirteen had difficult laryngoscopies (CL Grades 3 and 4) twelve of them were intubated without any difficulty after optimal external laryngeal manipulation. One patient had a CL Grade of 4 and had to be intubated with a fastrach LMA guided endotracheal intubation.

Five airway indices were evaluated with respect to their ability to predict difficult laryngoscopy pre-operatively. The grading of the laryngoscopic view of the patients evaluated by modified Mallampatti grading is given in Table 2, TMD and HE are given in Table 3 and PP sign and prayer sign are given in Table 4. On statistical analysis using the Fischer exact test none of the commonly used airway predictors were found to have a significant association with difficult laryngoscopy ($P < 0.05$). The parameters calculated for each airway predictor (sensitivity, specificity, PPV, NPV, and accuracy) are shown in Table 5.

Table 1: Comparison of duration of diabetes in years based on CL grading

Duration of diabetes in years	Difficult (3, 4)		Easy (1, 2)		χ^2	*P* value
	Count	Percentage	Count	Percentage		
<10	9	17.6	42	82.4	3.24	0.072
≥10	4	44.4	5	55.6		
Mean±SD	8.5±4.6		6.2±2.4			

Chi square test; *P*>0.05. SD – Standard deviation; CL – Cormack-Lehane

Table 2: Association of MMP score and CL grading

MMP	CL grading				*P* value
	Difficult (3, 4)		Easy (1, 2)		
	Count	Percentage	Count	Percentage	
Difficult	3	23.1	15	31.9	0.736
Easy	10	76.9	32	68.1	

P>0.05 Fisher's exact test, MMP III and IV – Difficult; MMP I and II – Easy. MMP – Modified Mallampati; CL – Cormack-Lehane

Table 3: Association of TMD and HE-Head extension with CL grading

Screening tool	CL grading				*P* value
	Difficult (3, 4)		Easy (1, 2)		
	Count	Percentage	Count	Percentage	
TMD-difficult	2	15.4	15	31.9	0.314
TMD-easy	11	84.6	32	68.1	
HE difficult	5	38.5	22	46.8	0.755
HE easy	8	61.5	25	53.2	

P>0.05 Fisher's exact test. TMD Thyromental distance; TMD<6 cm – Difficult; TMD>6 cm – Easy *P*>0.05 Fisher's exact test. HE – Head extension. HE<35° – Difficult; HE>35° – Easy. CL – Cormack-Lehane

Table 4: Association of PP and PS with CL grading

Screening tool	CL grading				*P* value
	Difficult (3, 4)		Easy (1, 2)		
	Count	Percentage	Count	Percentage	
PP sign difficult	10	76.9	5	10.6	0.000
PP sign easy	3	23.1	42	89.4	
PS positive	8	61.5	25	53.2	0.755
PS negative	5	38.5	22	46.8	

Fisher's exact test; *P*<0.05. PP – Palm print PP Grade 2 and 3 – Difficult; PP Grade 0 and 1 – Easy.; Fisher's exact test; *P*>0.05 PS Prayer Sign CL – Cormack-Lehane

Table 5: Sensitivity, specifity, positive predictive value, negative predictive value and accuracy of the various Airway Indices

Parameter	MMP	TMD	HE	PP	Prayer
Sensitivity	23.1	15.4	38.5	76.9	61.5
Specifity	68.1	68.1	53.2	89.4	46.8
PPV	16.7	11.8	18.5	71.4	24.2
NPV	76.2	74.4	75.8	91.3	81.5
Accuracy	58.3	56.7	50	86.7	50

MMP – Modified Mallampati; TMD – Thyromental distance; HE – Head extension; PP – Palm print; PPV – Positive predictive value; NPV – Negative predictive value

Palm print sign was the most significant ($P = 0.000$), sensitive (76.9%) and most specific (89.3%) index in predicting difficult laryngoscopy in our study. The prayer sign was the next most sensitive (61.5%), but not statistically significant.

The MMP grade was found to have no significance in predicting difficult intubation in our study. HE was also insensitive, but TMD was the least sensitive airway index in predicting difficult laryngoscopies.

DISCUSSION

Pre-operative identification of those patients at risk of difficult laryngoscopy assumes importance in order to formulate an appropriate strategy for the induction of anaesthesia and intubation. Diabetes is the most common endocrine disorder the anaesthesiologist has to tackle. The changes in the LJM syndrome usually begin in the metacarpo-phalangeal and proximal inter-phalangeal joints of the fifth finger and gradually extend laterally. As a result, the patient will not be able to approximate the palm and fingers of the hands[10,13] Reissell *et al*. have speculated that glycosylation of the joints of the larynx and cervical vertebral region may be responsible for the increased incidence of difficult intubation.[10] The joint limitation is painless and non-disabling. No relationship has been found between the LJM syndrome and sex, race, or control of diabetes.

The duration of diabetes and age attained are important variables in development of the LJM syndrome.[19] However in our study, only four patients with duration of diabetes more than ten years had difficult laryngoscopy. However, nine patients with duration of diabetes less than ten years were also difficult to intubate. To establish a statistical significance larger sample sizes are warranted. In the study by Nadal *et al*., duration of diabetes more than ten years was found to be a sensitive indicator of difficult laryngoscopy.[4] Only two patients with duration less than ten years had difficult laryngoscopy. Vani *et al*. in a similar study found that the mean duration of diabetes and incidence of difficult intubation was 5.3 years and 16%, respectively.[16] However, a mere observation in our study was that the incidence of difficult laryngoscopy was increased slightly with the duration of the diabetes, but no significant association could be made out.

Nadal *et al*. in a similar study found the PP test to be 100% sensitive.[4] A PP Grades 2 or 3 was presumed to predict difficult laryngoscopy (CL Grades 3 and 4). Of the sixty patients, fifteen had PP Grade 2 or 3. Of the total thirteen difficult laryngoscopies that we encountered ten patients had PP Grades 2 or 3. PP seems to be a good tool for prediction of difficult intubation as the score is quantitative in nature, and hence the classification of the test is precise and has low inter-observer variability. The prayer sign was the next most sensitive on the list [Table 5] though not significant [Table 4]. It could be inferred that the prayer sign being a very simple and easy test can be very often made use of in diabetic patients as an indication to do PP test. Eight of the ten patients who had difficult laryngoscopy and were predicted so with PP test had a positive prayer sign.

In the study by George and Jacob the results were comparable to our study.[20] He compared a set of diabetics and non-diabetics. The PP test was most sensitive (76.7%) and most specific (89.3%). The MMP test was the next sensitive (56%) followed by prayer sign (54.5%) and HE (50%). TMD had a sensitivity of 0. Following PP, MMP test was next specific (61.9%) followed by prayer sign (52.5%) and HE (48.8%). Body mass index was the most sensitive index in obese non-diabetics in predicting difficult airway, but PP sign was most significant in diabetics.

Vani *et al*. in a similar study found that PP was the most sensitive test (75%) followed by HE (62.5%), MMP (25%) and TMD (90.5%).[16] However, TMD was most specific (95.2%) followed by MMP (90.5%), PP (69%), and HE (61.9%).

The limitation of this study was that laryngoscopic view was used to evaluate the airway indices. Although difficult laryngoscopy does not mirror difficult intubation, laryngoscopic view it is an accepted method of comparing airway evaluation indices.[21] Furthermore, a false positive airway evaluation test may result in extra caution and additional preparation subjecting the patient to unnecessary procedures. However, the advantage is that it is always preferable to a false-negative airway evaluation, which may result in disaster, particularly in a diabetic patient where diabetic neuromuscular dysfunction, high residual gastric volume and hyperacidity increase the risk of pulmonary aspiration during induction of anaesthesia.[22,23] Shiga *et al*. in a meta-analysis showed that specificity and sensitivity of each test in prediction of difficult intubation is not ideal, but if we use these tests together, specificity and sensitivity

will significantly increase[24] Mehmoodpoor *et al*. also found the utitility of of combination of multiple tests for predicting difficult intubation.[25]

A multicentric study including a larger number of diabetics could be done to increase the power of the study and confirm our observations regarding LJM syndrome.

CONCLUSIONS

The the PP test appears to be the most sensitive and specific tool in the prediction of difficult laryngoscopy in diabetic patients more than other airway predictors. The LJM syndrome being a painless disorder with minimal disability is often unnoticed at the time of proposed surgery unless specifically looked for. A simple bedside test would be to observe the patient's hand for thick, waxy skin, placing the patient's hands in "prayer" position and assessing the degree of inability to oppose the inter-phalangeal joints of the fingers. If prayer sign appears positive, a PP could be taken. This could be used as a tool for predicting difficult airway and improving patient care.

Even though, there was no significant association between the duration of diabetes and difficult laryngoscopy a mere observation showed that the incidence of difficult laryngoscopy was increased with increased diabetic age.

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