Sensitivity of Palm Print, Modified Mallampati Score and 3-3-2 Rule in Prediction of Difficult Intubation

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ABSTRACT

Background: This study evaluated the performance of modified Mallampati score, 3-3-2 rule and palm print in prediction of difficult intubation.

Methods: In a prospective descriptive study, data from 500 patients scheduled for elective surgery under general anesthesia were collected. An anesthesiologist evaluated the airway using mentioned tests and another anesthesiologist evaluated difficult intubation. Laryngoscopic views were determined by Cormack and Lehane score. Grades 3 and 4 were defined as difficult intubation. Sensitivity, specificity, positive predictive value, negative predictive value and Youden index were determined for all tests.

Results: Difficult intubation was reported in 8.9% of the patients. There was a significant correlation between body mass index and difficult intubation (*P* : 0.004); however, other demographic characteristics didn't have a significant correlation with difficult intubation. Among three tests, palm print was of highest specificity (96.46%) and modified Mallampati of highest sensitivity (98.40%). In a combination of the tests, the highest specificity, sensitivity and Youden index were observed when using all three tests together.

Conclusions: Palm print has a high specificity for prediction of difficult intubation, but the best way for prediction of difficult intubation is using all three tests together.

Keywords: Difficult intubation, modified Mallampati score, palm print, 3-3-2 rule

Original Article

INTRODUCTION

Different methods for management of difficult intubation have been suggested and used in numerous studies;[1-3] however, these methods are partially effective in airway management and failure of ventilation and intubation is still the most frightening complication of anesthesia for physicians. Difficult intubation is reported to have incidence of 1.5-13% depending upon the patient population.[4] Elective evaluation of the airway is of great

importance especially in patients with expected difficult intubations; yet it is still uncertain whether correct prediction of difficult intubation is possible[5,6] or which characteristics should be considered.[7] Different studies have evaluated tests for prediction of difficult intubation most of which are of low sensitivity, specificity and positive predictive value (PPV) and are associated with significant false positivity for clinical use.[8-11] To facilitate the management of difficult intubation and to reduce the incidence of severe adverse outcomes, practice guidelines have been established. One important part of these guidelines is elective assessment and prediction of difficult intubation. Recognition is based on factors that are associated with difficult intubation, which can be used as pre-operative tests. Mallampati is the most used screening test for detection of difficult intubation.[12,13] Other tests include sternomental distance, thyromental distance, Wilson risk sum score, upper lip bit test, protrusion of mandible,[8] tooth morphology,[14] head extension,[14] mouth opening,[15] body mass index,[16] 3-3-2 rule,[17] and ultrasonography of neck soft tissue.[14,18-20] Reed *et al*. used LEMON method for prediction of difficult intubation in the emergency department.[21] Gupta *et al*. reported that palm print can help predict difficult intubation.[17] Some studies showed that palm print is a reliable test for prediction of difficult intubation in diabetic patients.[22,23] Patient with diabetes mellitus may have limitation in joint mobility due to non-enzymatic glycosylation of collagen and its deposition in joints, which leads to difficult airway management.[23,24] These changes also involve small joints of the hands leading to inability to approximate the palms and fingers of the hand, which can be assessed with palm print.[24] Therefore, in order to find an appropriate approach to the determination of difficult intubation and to help increase the safety throughout anesthesia management, in this study we decided to evaluate the sensitivity and specificity of three tests "palm print, Mallampati test and 3-3-2 rule" in prediction of difficult intubation in the general population.

METHODS

A prospective descriptive/double-blinded study was conducted at Nikookari Hospital: A teaching hospital-located in Tabriz, Iran within a period of 6 months from 2010 October to 2011 April. This study was approved by the ethics committee of Tabriz University of Medical Sciences, (date: 2010/6/12, President of ethics committee: Dr. Ostadrahimi. protocol number: 5/4/7841). Informed written consents were obtained from all patients. According that no similar study has been performed and the two performed studies are on diabetic patients, using the results of these studies for sample size calculation will cause bias. So, we performed this study as a cross-sectional study for a 6 month period (2011 October to 2011 April) and we included all the patients who had the inclusion criteria in this period.[22,24] About 500 adult male and female patients were visited for pre-operative management in the clinic of the hospital from Saturday to Wednesday 8:30 a.m.-16:00 p.m.

Notification

This is not a randomized study because all patients who were candidate to elective surgery and didn't have exclusion criteria were enrolled in this study.

Inclusion criteria

Patients scheduled to undergo elective ophthalmic surgeries and without hand deformity.

Patients younger than 18-year-old, with obvious malformations of the airway (temporomandibular joint or cervical spine movement restriction, receding jaw or protruding incisors, micrognathia, macroglossia, short muscular neck, morbid obesity, tumors of tongue/epiglottis/larynx, trismus and burn or contracture on the face or neck), history of difficult intubation or hand deformity due to injury, arthritis and congenital deformities were excluded from the study. Pre-operative airway assessment in all patients was performed by another anesthesiologist who was not involved in the research project to avoid inter-observer variability. Palm print was performed in a sitting position. The palm and fingers of the right hand were painted using a pad and brush soaked in blue ink. Patients were instructed to let the painted hand rest on a plain white paper by its own weight [Figure 1]. Scoring was performed as following:

Score 0: All pharyngeal spaces are visible. Score 1: Deficiency in interphalangeal space of 4th and/or 5th fingers. Score 2: Deficiency in Interphalangeal spaces of second to fifth fingers. Score 3: Only the tips of fingers were seen.[22]

Figure 1: A sample of a palm print obtained from a patient with grade 1

3-3-2 rule was performed as following:

3: Three fingers between the patients' teeth (patients' mouth should be opened adequately to allow the placement of three fingers between upper and lower teeth). 3: Three fingers between the tip of the jaw and the beginning of the neck (under the chin). 2: Two fingers between the thyroid notch and the floor of mandible (top of the neck).[17,21]

Oropharyngeal view was assessed by Mallampati score. While seated, each patient was asked to open the mouth maximally and protrude the tongue without phonation.[12] The test was classified as following: (1) good view of the soft palate, fauces, uvula and tonsillar pillars. (2) Pillars are obscured by the base of the tongue but soft palate, uvula and fauces are visible. (3) Soft palate is visible. Mallampati sign was assessed once in each patient, except those in whom two or more evaluations were required to confirm the classification assignment. Demographic characteristic of patients, head and neck movement and body mass index were measured in all patients. All patients underwent induction of anesthesia with fentanyl 1 μg/kg, midazolam 1 mg, propofol 1-1.5 mg/kg and atracurium 0.4 mg/kg. Intubation was performed with the patient adequately anesthetized and fully relaxed on the operating room table. A peripheral nerve stimulator with the train of four (TOF) ratio was used in cases in which there was doubt about the relaxation. TOF ratio of zero was considered as proper for intubation. The head was placed in the "sniffing" position and laryngoscopy was performed with a Macintosh No. 3 blade by the anesthesiologist assigned to the case. The actual degree of difficulty in intubation is subjective to some extents making the quantification quite challenging. The most frequently-used system in quantifying the degree of difficulty in intubation is that of Cormack-Lehane score,[25] based on the extent to which laryngeal and glottic structures can be seen. Hence, glottic visualization was assessed by Cormack-Lehane score as following: Grade 1: Full view of glottis, Grade 2: Partial view of the glottis or arytenoids, Grade 3: Only epiglottis and Grade 4: Neither glottis nor epiglottis. Grade 1 and 2 are considered as easy intubation and Grade 3 and 4 as difficult intubation. Numbers of laryngoscopic attempts and intubation time (the time from inserting laryngoscope to mouth to inflating tube cuff) were also noted. The anesthesiologist who intubated the patients was unaware of the airway evaluations performed by the other anesthesiologist pre-operatively. Furthermore, the anesthesiologist who performed the palm print, Modified Mallampati score and 3-3-2 rule was unaware of the laryngoscopic grading (Cormack-Lehane score), which was performed at intubation phase. Neither the patients nor the intubator were aware of the pre-operative airway assessment of patients. All measurements were recorded on a form not seen by the anesthesiologist who subsequently performed the intubation. Statistical analysis was performed using SPSS for Windows version 18 (SPSS Inc, Chicago, IL, USA). Data were analyzed by Chi-square and *t*-test. Sensitivity, specificity, PPV and negative predictive value of each test were calculated. $P < 0.05$ was considered significant.

RESULTS

Demographic characteristic of patients, data about difficult intubation scores, laryngoscopy and intubation time are shown in Table 1. Prevalence of difficult intubation was 8.9%. *t*-test analysis showed that there is a significant correlation between body mass index and difficult intubation based on Mallampati test ($P < 0.005$). Sensitivity, specificity, PPV and negative predictive value of Mallampati test for detection of difficult intubation were 86.36%, 81.8%, 31.67% and 98.40% respectively. 3-3-2 rule was of sensitivity, specificity, PPV and negative predictive value of 26.67%, 94.46%, 92.96% and 42.86%, respectively.

Palm print was of sensitivity, specificity, PPV and negative predictive value of 13.64%, 94.46%, 91.98% and 27.27%, respectively. Table 2 presents statistical analysis of different methods in predicting difficult intubation. No cases of Grade 4 Mallampati were reported.

DISCUSSION

Ability to evaluate and manage the airway and keep it open in critical situations has always been of great importance for the physicians of all eras.[26-30] Expertise in airway management is necessary for anesthesiologists and inability to maintain a patent airway may be life threatening.[31-37] "No intubate-no ventilate" is the most frightening complication of anesthesia practice.[26,28] Many authors described different methods for difficult intubation management;[3,38,39] however, pre-operative prediction and diagnosis of difficult intubation can help anesthesiologists practice more safely. Therefore, the importance of difficult intubation prediction tests or scores is increasing. Different indices are being considered as prediction of difficult intubation such as thyromental distance, upper lip bite test, Mallampati score, mouth opening 3-3-2 rule, atlanto-occipital joint extension, mandibular space, inter-incisor distance, mandibulo-hyoid distance, LEMON airway assessment method,[21,40] micrognatia, prayers sign, obesity and previous history of sleep apnea most of which fail to identify many patients with difficult intubation.[17,41] In an effort to predict, which patients are prone to difficult intubation, we evaluated the validity of palm print test, 3-3-2 rule and modified Mallampati in difficult intubation prediction.

The original and modified Mallampati test is routinely used to predict difficult intubation, but there is controversy regarding its validity.[12,13,42] However, the accuracy of Mallampati test is poor to good based on reference test. As 3-3-2 rule uses inter-incisor distance, hyomental distance and distance from thyroid to mouth,[17] we used this test as a predictive test for difficult intubation. Palm print was first described as a difficult intubation prediction test in diabetics with a good sensitivity. This score is quantitative in nature, which makes the classification of test easier and more precise and has low inter-observer variability. Different studies showed that Palm print has a sensitivity

Table 1: Patients' demographic data and their risk factors for difficult intubation

Parameter	Airway classification based on Cormack and Lehane views during laryngoscopy		
	Normal	Difficult	*P* value
Age (year)	62.1±16.8†	61.9±15.03	0.951
Sex (F/M)	214/233	22/22	0.904
BMI (kg/m^2)	25.7±4.3	27.7±5.8	0.004
Dentures (%)	23 (52.2)	21 (47.7)	0.669
Long incisor (%)	45 (10.08)	7 (15.9)	0.171
Big tongue (%)	2 (0.44)	2 (4.5)	0.445
Face trauma (%)	2 (0.44)	0	0.828
Impaired neck movement (%)	3 (6.8)	35 (8.04)	0.544
More than once laryngoscopy (%)	10 (2.3)	6 (13.9)	0.001
Intubation time (s)	12.09±3.8	14.5±8.2	0.001
Failed laryngoscopy	0	0	-

†Mean±SD. BMI=Body mass index

Table 2: Sensitivity, specificity, positive and negative predictive value and Youden index of the tests in the determination of difficult intubation

Airway assessment tests	Sensitivity %	Specificity %	PPV %	NPV %	Positive likelihood ratio	Youden index
Mallampati	86.36	81.8	31.67	98.40	4.76	0.68
3-3-2 rule	26.67	94.46	42.86	92.96	7.53	0.21
Palm print	13.64	96.46	27.27	91.98	3.85	0.1
Mallampati +3-3-2 rule	20.45	99.78	90	92.80	92.45	0.2
Mallampati +palm print	24.54	99.8	91.50	92.98	122.7	0.24
3-3-2 rule +palm print	24.45	98.87	92.07	91.09	21.63	0.23
Mallampati +3-3-2 rule+palm print	90.09	99.78	80	91.85	41.09	0.89
BMI	62.7	48.07	10.55	92.9	1.21	0.1

BMI=Body mass index, PPV=Positive predictive value, NPV=Negative predictive value

of 75-100% in prediction of difficult intubation in diabetic patients respectively.[22,24,41,43] Sensitivity and specificity of palm print in this study was 13.64% and 96.46%, respectively. The lower rate for sensitivity compared to other studies may be due to this fact that our patients were both diabetics and non-diabetics, but in other studies the population was only diabetic patients. The prevalence of difficult intubation was 8.9% in this study, but there was not any case with failure of intubation, which is near to report of Khan *et al*.[44]

In this study, Mallampati had the highest sensitivity while palm print had the highest specificity and 3-3-2 had the highest PPV value in prediction of difficult intubation. 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.[45] In our study, when using three tests together, the sensitivity and specificity increased (Youden index: 0.89). An ideal predictive test should have both high sensitivity and specificity. The tests with high derived index values result in high PPVs and low sensitivity and an increased incidence of false negative predictions. In other words, tests with low score values are associated with high sensitivity and reduced false negative.

Limitations

Our study was not a multi-center study and due to our limitation only ophthalmological surgeries were included. The sample size was low. Considering the fact that most of our patients were the elderly patients and edentulous, edentulous patients were not excluded as a variable that may independently affect the predictability of difficult intubation. Furthermore, our study was a double-blinded study involving two anesthesiologists, one evaluating airway and the other evaluating difficult intubation. Although inter-observer variation was minimized, how these two people can represent all anesthesiologists is unknown

CONCLUSIONS

As tests with low sensitivity might result in life-threatening complications in difficult intubation management, it seems that Mallampati score might be considered the best test regarding its high sensitivity score. However, in cases with high susceptibility of difficult intubation and in patients with high Mallampati scores, palm print and 3-3-2 may be considered as additional screening tests in detection of true difficult intubations because of high PPVs. However, further studies are required to evaluate the value of palm print in prediction of difficult intubation.

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