A COMPARATIVE STUDY OF MODIFIED MALLAMPATI TEST, INTER-INCIZOR GAP, UPPER LIP BITE TEST, THYROMENTAL DISTANCE AND ALL IN COMBINATION AS PREDICTOR FOR DIFFICULT INTUBATION

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ABSTRACT

Background

Patients need to be assessed preoperatively in order to predict difficult intubation, because difficult or failed intubation is a serious cause of morbidity and mortality. Prediction of difficult intubation lowers these risks. Modified mallampati test, upper lib bite test, thyromental distance and inter-incisor gap are used to assess difficult intubation.

Objectives

To find and compare sensitivity, specificity, positive predictive value, negative predictive value of the tests alone and in combination.

Patients and Methods

We used randomized double blinded diagnostic trial for our study. We collected 130 patients of both gender who were aged more than 16 years and had an American Society of Anesthesiologists physical status of I, II, III. Moreover, the patients underwent elective and emergency operation and required tracheal intubation under general anesthesia. The study was performed at Sulaimani Teaching and Sulaimani Emergency Surgical hospitals. Furthermore, an anesthesiologist assessed the airway and documented the findings and another one did the induction. In addition, induction was standardized for all patients and the anesthesiologist recorded the Cormack and Lehane laryngoscopic view after intubation.

Results

We found that thyromental distance has higher sensitivity (42.9%) for predicting difficult intubation but combination of all the tests increased this percent to 71.4%. Moreover, upper lib bite test had higher specificity (95.7%) to predict easy intubation, even higher than in the combination of all tests. When we combined all of the tests, sensitivity increased significantly but specificity decreased.

Conclusion

Combinations of the tests together are better predictor of difficult intubation than using each test alone.

Keywords: *Cormack and Lehane laryngoscopic view, Difficult intubation, Inter-incisor gap, Mallampati test, Thyromental distance, Upper lip bite test.*

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INTRODUCTION

Endotracheal intubation is the safest way for establishing a safe upper respiratory tract patency and thus achieving the maintenance of anesthesia in the operating room. It also helps the patient's breathing and makes it controlled for patients who stop breathing in the intensive care or emergency unit [1, 2]. Moreover, a successful intubation is not always possible because of difficult anatomical traits or existing systemic diseases [1, 3]. Therefore, difficult intubation (DI) occurs at a rate of 1-13% and serious intubation difficulty occurs in 2-3% of these cases [1].

Difficult or failed endotracheal intubation is among the most serious causes of morbidity and mortality related to anesthesia [4]. Traumatic complications are quite common and some can be disfiguring and annoying to the patient; others, such as tension pneumothorax, are life-threatening [5]. Thence, preoperative assessment must be undertaken [6].

The reason for failed or inadequate airway management is reported to be due to bad or inadequate evaluation [7]. Thus, pre-operative evaluation of airway is mandatory in all surgical patients irrespective of anesthetic technique [8]. Furthermore, the practice guidelines for management of the difficult airway recommend acquiring an airway history and performing an examination prior to the initiation of anesthesia [9]. Predicting the DI makes it possible to change the method of anesthesia, prepare assistive devices and find an experienced individual, and it may reduce the risk of complications.

Many tests are available to direct the prediction of difficult intubation [10]. Assessment of difficult airway in patients begins with a history and physical examination [11]. Airway assessment will be done by taking history, clinical examination and specific airway assessment — modified mallampati test (MMT), upper lib bite test (ULBT), thyromental distance (TMD) and inter-incisor gap (IIG) [6].

The symptoms of upper airway obstruction, medical problems associated with increased DI, and anatomical factors may predispose DI. Moreover, specific assessments include: MMT, ULBT, TMD, Sterno-mental distance, head and neck movement, indirect laryngoscopy and various x-ray procedures are occasionally used. In addition, sometimes combination of tests, in which they used both history and examination, are used such as Wilson, El-Ganzouri, Arne, Murphy and Walls's (Lemon), and Naguib model [6] and this may increase the sensitivity [12].

In patients undergoing surgery, DI varies from 1.5-13% [13]. Since the available literature does not have a standard definition of difficult airway, the American Society of Anesthesiologists (ASA) defined it as "the clinical situation in which a conventionally trained anesthesiologist experiences difficulty with mask ventilation, difficulty with tracheal intubation or both" [14-15] .Originally,ASA defined DI as requiring more than three attempts or taking longer than ten minutes to complete. Furthermore, a variety of techniques have been used to solve DI such as backwards and upwards pressure on the thyroid cartilage, using elastic bougie, fiberoptic bronchoscope, or laryngeal mask airway can be inserted and used as a conduit to pass a tracheal tube directly or via a fiberoptic scope . Difficult intubation may imply difficulty with visualizing the glottis, that is, direct laryngoscopy or difficulty with endotracheal tube placement due to laryngeal or tracheal distortion or narrowing. The distinction is important since difficult laryngoscopy does not preclude successful placement of the endotracheal tube, which may be passed without visualizing the glottis.Cormack-Lehane (CL) laryngoscopy in terms of the best view of the glottis during conventional laryngoscopy with a direct view and performed as a best attempt.

The optimal laryngeal view includes external manipulation. Moreover, Yentis and Lee added a modified version that subdivided grade 2 into grade 2a and 2b which is known as modified Cormack and Lehane classification. Cook's modification subdivided grade 3 depending on whether the epiglottis could be elevated from the posterior pharyngeal wall by using a bougie or introducer. The M-C and Lehane has four grades; full view of glottis (grade 1), a partial view of the glottis (grade 2a), only posterior portion of glottis or arytenoid cartilages (grade 2b), epiglottis can be lifted from the posterior pharyngeal wall (grade 3a), epiglottis cannot be lifted from the posterior pharyngeal wall (grade 3b), neither glottis or epiglottis can be seen (grade 4). Failure to intubate in itself is not a problem but failure to maintain oxygenation is catastrophic [9].

PATIENTS AND METHODS

We used randomized double blinded diagnostic trial for our study after approval of Kurdistan Board for medical Specialties. Sample size was calculated by statistics specialist based on equation for estimated sample size as 9% prevalence for DI and taking 5% as a degree of precision and it yielded about 130 subjects.

Inclusion criteria included either gender, age of above 16 years, ASA of I, II, III and patients undergoing elective and emergency surgery under GA and Mechanical ventilator. Moreover, patients were selected and consent from each patient was taken in the preoperative setting. Then, pre-operative assessment was performed and routine intraoperative care done. Exclusion criteria included pregnancies, edentulous patient, unable to open mouth, morbid obesity, bed ridden, history of goiter or thyroid surgery, neck mass,burn,scar and tumour , previous history of difficult intubation, spine problem such as ankylosing spondilitis,emergency case requiring rapid sequence induction, GCS 14 or less and if the patient refused to give consent were excluded.

Preoperatively, anesthesiologist assessed the airway and documented the height, weight, ASA, body mass index (BMI), MMT, ULBT, IIG and TMD. Moreover, ASA assessed according to ASA physical status classification and MMT measured by asking the patient to sit down on a chair at the eye level of examiner and asked to protrude his/her tongue as much as they can without saying Ahh. Thereafter, the examiner looked at the patient's mouth by using a torch, and then the patient was classified into four classes according to the visibility of pharyngeal structure as follows:

- Class I: soft palate, uvula, fauces, pillars visible.
- Class II: soft palate, uvula, fauces visible.
- Class III: soft palate, base of uvula visible.
- Class IV: only hard palate visible.

Upper lib bite test was measured by asking the patient to protrude lower jaw as much as they can and try to bit their upper lip, thence; we categorized ULBT into three classes:

- Class I: lower incisors can bite upper lip above vermilion line.
- Class II: lower incisors can bite upper lip below vermilion line.
- Class III: lower incisors cannot bite upper lip.

Thyromental distance was measured by a ruler and it measured the distance from the mentum of lower surface of mandible to the superior notch on the thyroid cartilage when the patient's neck was fully extended and in the upright sitting position. Moreover, there are three grades:

- Grade I: distance more than 6.5 cm.
- Grade II: distance between 6.5 and 6 cm.
- Grade III: distance less than 6 cm.

Furthermore, IIG was measured by a ruler and it measured the distance between upper and lower incisor in the midline of mouth after asking the patient to fully open their mouth as much as they can. Moreover, there are three grades:

- Grade 0: the distance is more than 5 cm.
- Grade 1: distance in between 4-5 cm.
- Grade 2: distance is less than 4 cm.

In the operation room, routine monitors were attached and Lactated ringer was started at 2 ml/kg/hr through a 20 G intravenous cannula. Patients were pre-oxygenation for three to four minutes with 100% oxygen. Thereafter, general anesthesia (GA) was induced with fentanyl (1 mcg/kg) and propofol (1.5-2 mg/kg) after checking appropriate mask ventilation followed by giving muscle relaxant i.e. rocuronium (0.6 mg/kg). Then, the patient was ventilated with oxygen and sevoflurane for three minutes. At the end, the head of the patient was placed in the optimum sniffing position i.e. neck flexed on the chest by head elevation with a head ring and head extension at atlanto-occipital joint by tilting the head backward with the hand of the operator to bring oral, pharyngeal, and laryngeal axes in line for proper glottis visualization. After fully opening of the mouth, laryngoscopy was performed by using Macintosh blade of three or four by an anesthesiologist who were blinded from preoperative assessment. Laryngoscopic view was graded without the use of external laryngeal maneuver. The Cormack-Lehane grading system was used to determine the glottis view:

- Grade 1: Most of the glottis visible

- Grade 2: Only the posterior part of glottis and epiglottis visible
- Grade 3: Only epiglottis visible
- Grade 4: Not even epiglottis seen.

The CL grade 1 and 2 were considered easy laryngoscopy, whereas CL grade 3 and 4 as difficult. Moreover, the use of external pressure, number of attempts to put ETT, SPO2, pulse rate after putting ETT were recorded.

The analysis was performed by using IBM SPSS (Statistical Package for the Social Sciences version 21) statistical program. Moreover, Paired t test was used to compare the pre/post-anesthesia values such as SPO2 and pulse rates. The laryngeal view put as gold standard to find the parameters of screening (Sensitivity, specificity, PPV, NPV, and accuracy) based on the false positive (FP), true positive (TP), false negative (FN), and true negative (TN). Furthermore, a P value of 0.05 was used as a cut off point for the significance of statistical tests. In addition, sensitivity was the probability of detection of DI by tests and specificity was the percentage of people that are easily intubation who are correctly identified as not having the DI.

RESUTS

The genders of the patients included in this study were 58.5% female and 41.5% male. The age groups included: 13-17 years old (8.5%), 18-35 years old (62.3%), 36-50 years old (22.3%), and 51-77 years old (6.9%). Moreover, ASA groups were 36.9% of ASA I, 15.4% of ASA II, 43.9% of ASA IE, and 3.9% of ASA IIE. Furthermore, the BMI groups included underweight (7.7%), normal weight (43.1%), overweight (26.9%), and obese (22.3%). Although in some of them an external laryngeal pressure was applied or stylet was used, there was no failed tracheal intubation. In addition, intubation was successful with one attempt in 96.5% of patients, while the remaining (3.8%) needed more than one trial.

Preoperatively, the results of airway assessment by using MMT were as follows: 27.9% was grade I, 56.9% was grade II, and 15.3% was grade III. Thence, grade I and II (110 patients) were assumed to have easy intubation (EI), but grade III (20 patients) was assumed to have DI. Moreover, 101 out of 110 patients who were predicted to have easy intubation by MMT were actually had EI, and five out of the 20 patients who were predicted to have DI were actually had DI (Table 1, 2).

The preoperative assessment of the patients by using ULBT resulted in 78 patients (60%) of class I, 46 patients (35.3%) of class II and remaining 6 patients (4.6 %) of class III. Moreover, class I and class II were assumed to predict EI and class III DI. In addition, 111 out of 124 patients who were predicted to have EI had it and only 1 out of the 6 patients who were predicted to be DI had it .

Furthermore, the preoperative assessment of the patients by using TMD resulted in 88 patients (67.6%) of grade 0, 27 patients (20.7%) of grade1, and 15 patients (11.54 %) of grade 2. The grade 0 and 1 were assumed to predict EI. Moreover, 107 out of 115 patients who were predicted to have EI by TMD had it and only 6 out of 15 patients who were predicted to have DI had it .

In addition, the preoperative assessment of the patients by using IIG resulted in 55 patients (42.3%) of grade 0, 65 patients (50%) of grade 1 and 10 patients (7.69 %) of grade 2. The grade 0 and 1 were assumed to predict EI. Moreover, 116 out of 120 patients who were predicted to have EI by IIG had it and three out of 10 patients were predicted to have DI by IIG had it .

Finally, 87 out of 91 patients who were predicted to have EI by the combination of all the four tests had it and 10 out of 39 patients who were predicted to have DI had it ,above date were collected in Table 1, 2.

Table 1. Relationship of DI by CL grade with MMT, TMD, ULBT and IIG each alone and in combination.

Difficulties by the tests		Difficulty by CL grade		Total	P-value
		Yes	No		
MMT	Yes	5	15	20	0.03
	No	9	101	110	
ULBT	Yes	1	5	6	063
	No	13	111	124	
TMD	Yes	6	9	15	<0.001
	No	8	107	115	
IIG	Yes	3	7	10	0.04
	No	11	109	120	
Combination of MMT, ULBT, TMD, IIG	Yes	10	29	39	<0.001
	No	4	87	91	

Table 2. Prediction of DI by all the tests and in a combination.

Tests	MMT	ULBT	TMD	IIG	All the tests together
P-value	0.03	0.63	<0.001	0.04	<0.001
Sensitivity	35.7%	7.1%	42.9%	21.4%	71.4%
Specificity	87.1%	95.7%	92.2%	94%	75%
PPV	25%	16.7%	40%	30%	25.6%
NPV	91.8%	89.5%	93%	90.8%	95.6%
TP	5	1	6	3	10
TN	101	111	107	109	87
FP	15	5	9	7	29
FN	9	13	8	11	4
Accuracy	85.5%	86.2%	86.9%	86.2%	76.4%

DISCUSSION

In order to decrease the morbidity and mortality due to DI, we need to assess the airway preoperatively. Airway assessment is performed by taking history and clinical examination in addition to specific tests. Moreover, there are a lot of tests, but none of the tests were fully ideal to predict all the difficultly intubated patients. In our study, we found that TMD had higher sensitivity (42.9%) for predicting DI than other tests (MMT, ULBT and IIG). But the combination of all the tests increased sensitivity to (71.4%).

A study that used ULBT, MMT, and TMD in Various Combinations for 400 patients concluded that all three screening tests for DI have only poor to moderate discriminative power when used alone and combinations of the tests add some incremental diagnostic value . Another study that took 300 patients showed better sensitivity for individual TMD and ULBT tests and combination of the tests increases the chance of prediction of DI . Furthermore, another study that took 300 patients showed all the four predictive tests i.e. MMT, TMD, SMD and IIG for DI had only poor to moderate discriminative power when used alone but combination of MMT and TMD adds some incremental diagnostic value [(9)].

In contrary, a study showed that MMT might be considered the best test regarding its high sensitivity. However, in cases with high susceptibility of DI and in patients with high Mallampati scores, palm print and 3-3-2 i.e. three fingers between the patients' teeth (patients' mouth should be opened adequately to allow the placement of three fingers between upper and lower teeth), three fingers between the tip of the jaw and the beginning of the neck (under the chin), and two fingers between the thyroid notch and the floor of mandible (top of the neck), may considered as additional screening tests in detection of true DI because of high PPVs. However, further studies are required to evaluate the value of palm print in prediction of DI [(21)].

For the specificity of the tests, ULBT had higher results (95.7%) to predict easy intubation, even higher than of the combination of all tests. The study of Khan supports the use of ULBT as a measure for EI [(22)]. Another study showed that ULBT can be used as a simple bedside screening test for prediction of difficult intubation, but it should be combined with other airway assessment tests for better airway predictability [(23)]. In our study, we found that TMD had higher accuracy (86.90%) than other tests, and accuracy will decrease to (76.40%) if we combine all of the tests together. In addition, when we combined all of the tests together, the sensitivity increased significantly but the specificity and accuracy will decrease (Table 2).

In conclusion, the combination of all the tests is important because they significantly decrease the morbidity and mortality that happen because of missing patient's DI.

We recommend relying on all the tests preoperatively to assess the airway of patients.

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