Evaluation of Thyromental Height Test for Predicting Difficult Laryngoscopy in Morbid Obese Patients Candidate for Bariatric Surgery: An Observational Study

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Abstract- Upper airway management in morbid obese patients undergoing bariatric surgery is a major challenge during induction of anesthesia. Bed side Thyromental Height Test (TMHT) is an easy and valid predictor for prediction of difficult airway in non‐obese patients, but its precision in morbid obese patients haven't been evaluated yet. The purpose of present study is to find the accuracy of TMHT for the prediction of difficult laryngoscopy in morbid obese patients undergoing bariatric surgery. The present prospective observational study was performed on 95 morbid obese patients at Sina hospital during 2020. Preoperative exams of patients include the assessment of Mallampati classification, thyromental height, thyromental, sternomental and interincisor distances. After induction of anesthesia, the laryngoscopy view was evaluated using the Cormack Lehane classification, and the relationship between these tests to prediction of difficult laryngoscopy view based on the Cormack Lehane degrees (grades 3,4) were evaluated. A total of 95 morbid obese patients with a mean BMI of 44.7±5.6 kg/m2.were included in the study. 67.3% of them were women. The incidence of difficult laryngoscopy (C & L III, IV) was 16.8%. TMHT less than 56.5 mm, with 98% positive predictive value and 93% accuracy was the best predictor of difficult intubation in these patients. The accuracy of thyromental, sternomental and interincisor distance, with cut off value less than 51.5 mm, 89.5 mm, 41.5 mm respectively was less than TMHT in prediction of difficult laryngoscopy in morbid obese patients. In morbid obese patients with a BMI greater than 40, thyromental height less than 56.5 mm with 98% positive predictive value and 93% accuracy is the best predictor for difficult laryngoscopy view.

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Introduction

Bariatric surgery is one of the most common procedures in patients with morbid obesity. Excess adipose tissue in the face and neck, makes upper airway management difficult in these patients. Mask ventilation is often difficult and visualization of vocal cords during laryngoscopy even by a trained anesthesiologist becomes difficult (1). The frequency of difficult intubation in these patients up to 20% have been reported (2). Evaluation of the upper airway before anesthesia induction in reducing the risk of difficult intubation is very important.

Some preoperative tests such as mouth opening, sternomental distance, thyromental distance and Mallampati airway classification, can be done to predict difficult laryngoscopy and tracheal intubation. The TMHT is an easy, bedside and fast test that was first designated in 2013 as a new good predictive value in assessing difficult airway (3).

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This test measures the vertical distance between the anterior border of the mentum and the thyroid cartilage. It also represents the dimensions of the submandibular space and anterior position of the larynx (4). The validity of the TMHT, as an acceptable predictor of difficult laryngoscopy with high positive and negative predictive value were approved in many clinical studies (5-8). Due to the increase in subcutaneous fat of the face and neck in morbid obese patients and the changes that occur in the physical dimensions of their upper airway, the use of TMHT will be very important in predicting the difficult airway. Therefore, this study was designed to evaluate the accuracy of TMHT in prediction of difficult airway in morbid obese patients undergoing general anesthesia for bariatric surgeries.

Materials and Methods

This is an observational trial that was performed in Sina University hospitals, from May 2020 till May 2021, after approval by the Ethical Committee of Tehran University of Medical Sciences (IR.TUMS.MEDICINE.REC.1398.954, Date: April 04 2020).

Before starting anesthesia, written consent was obtained with the explanations given to the patients about the study.

Ninety-five morbid obese patients, (BMI>40) candidate for elective bariatric surgeries under general anesthesia with aged 20-60 years, were included in in this study.

Exclusion criteria were any abnormality or pathology in the oral cavity, head and neck that limit the evaluation. The airway of all patients was evaluated before the start of anesthesia by a member of the research team who did not participate in induction of anesthesia, laryngoscopy and evaluation of laryngeal view. To evaluate the airway, the following tests were performed.

The thyromental distance (TMD) as the distance from the mentum to the thyroid notch with the head fully extended by ruler. Sternomental distance (SMD), the distance from the suprasternal notch to the mentum and is measured with the head fully extended on the neck and the mouth closed by ruler. when the patients are, in the supine position and mouth closed, TMHT was measured as the vertical distance between the anterior border of the thyroid cartilage and the anterior border of the mentum with an electronic depth gauge. To evaluate the modified Mallampati test (MMT), patients were graded while sitting in a chair with their mouths wide open and their tongues protruding. Then the oropharyngeal view is graded into four different classes as follow:

Class I – soft palate, uvula, and pillars visible
Class II – soft palate and uvula visible
Class III – soft palate and base of the uvula visible
Class IV - soft palate not visible at all.

After completion of the upper airway assessment and placement of blood pressure monitoring, pulse oximeter and EKG, pre-oxygen delivery to patients with 100% oxygen was started for 3 minutes. Anesthesia was then induced intravenously midazolam (Aburaihan.phara.co) 0.01 mg/kg, fentanyl (Caspian Tamin.co) 1 µg/kg, propofol (fresenius kabi.co) 1.5 mg/kg and atracurium (Caspian Tamin.co) 0.5 mg/kg lean body weight. Ventilation of patients was maintained by mask until compilation of paralysis by disappearance of train‐of‐four on the peripheral nerve stimulator.

Direct laryngoscopy was performed by an experienced anesthesiologist with a Macintosh laryngoscope. The laryngeal view of patients was determined by using Cormack–Lehane (CL) grading system from I-IV.

Grades I and II (full view or partially view of glottis) were categorized as easy laryngoscopy, and grades III and IV (only epiglottis or hard palette view) as difficult laryngoscopy.

external manipulation of cricoid was used in difficult cases to obtain the best view. The primary outcomes of this study were the detection of cut‐off value of the TMHT as a predictor of difficult laryngeal view in morbid obese patients. We also assessed the sensitivity, specificity, positive and negative predictive values of each test to predict difficult laryngoscopy. The accuracy of the TMHT as a predictor of difficult intubation in morbid obese patients was assessed and compared with those of the TMD, MO and STM in the prediction of difficult intubation as a secondary outcome.

Statistical analysis

According to our previous study and 88% sensitivity of thyromental height test in predicting difficult airway in non-obese patients, this study was conducted in morbidly obese patients. The necessary sample size was calculated by consideration that the incidence rate of difficult laryngoscope view in the morbid obese patients is near 16% (9). As a result, a minimum number of one hundred patients were required for a study power of 90% and an alpha error of 0.05.

After gathering the data, statistical analysis was

performed using the statistical package for the social science (SPSS) program, version 23 (Chicago, IL, USA). For analysis the Student's t‐test, Fisher's exact test, and Chi‐square test as appropriate was used. Statistical significance was defined as $P<0.05$. To describe quantitative variables, mean and standard deviation have been used. Qualitative variables were expressed as frequency and frequency percentage. The accuracy, sensitivity and specificity, positive predictive value and negative predictive value for each airway predictor was found with Cormack and Lehane.

The diagnostic accuracy of the upper air way assessment tests was compared by measuring the area under the receiver operating characteristic curve (ROC) with 95% confidence interval. Predefined cut‐off values were used to formulate the ROC curve.

Results

At the end of study, a total number of 95 morbid obese patients (31 male/64 females) individuals who met the inclusion criteria completed the study.

The mean age of patients was 29.51±6.31 years, and BMI 44.7±5.6 kg/m^2.

The rate of difficult laryngoscopy was 16.8%. All patients were intubated. 79 patients were intubated in the first laryngoscopy attempt and the rest of them (16 patients) needed a second laryngoscopy attempt. There were significant differences in the mean variables between the two groups, with and without difficult laryngoscopy based on the Cormack–Lehane grading system (Table 1).

Table 1. The value of each parameter based on laryngoscopy view

Variable	Easy 79(83.2%)	Difficult 16(16.8%)	*P*
Mouth opening.mm	48.41±12.81	42 ± 6.56	0.035
Thyromental distance.mm	59.33±4.28	43.25 ± 8.09	<0.001
Thyromental height.mm	63.16± 4.69	49.6 ± 4.89	<0.001
Sterno mental mm	93.45±9.19	82.90 ±9.1	0.004
Modified Mallampati grade	I-II	III, IV	0.001

MO, MMD, TMHT and STM values were used to construct the ROC curve and this curve was used to evaluate the prediction of cases with difficult laryngoscopy view (Figure 1).

TMHT and TMD had the best value and ability to predict difficult laryngoscopic view. The AUROC curve for the TMHT, TMD, STM and MO was 0.97, 0.94,75 and 0.68; at cut‐off values >56, >51, >59 and >41 mm respectively (Table 2).

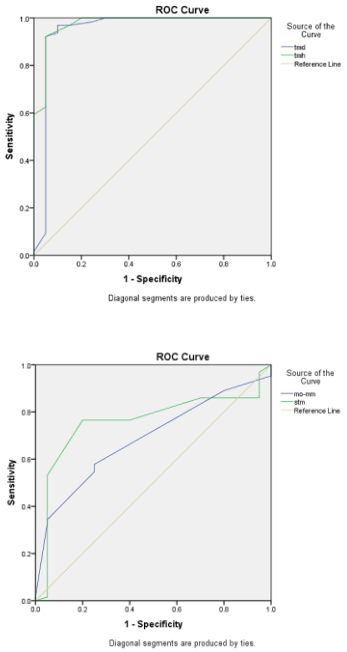

Figure 1. Receiver operating characteristic curve (ROC) comparison of the airway assessment tests

Table 2. MO, TMD, TMHT and STM test values for difficult laryngoscopy prediction

Variable	AUC	95%CI	Cutoff	Sensitivity	Specificity	Positive Predictive Value	Negative predictive Value	Accuracy
Mouth opening	0.686	0.566-0.806	41.5	57.8%	75.0%	88%	35.7%	62%
Thyromental distance	0.945	0.854- 1	51.5	96.9%	90.0%	96.87%	90.0%	95.2%
Thyromental height	0.974	0.935- 1	56.5	92.2%	95.0%	98.3%	95.0%	92.85%
Sterno mental distance	0.75	0.642-0.875	89.5	76.6%	80.0%	92.0%	51.0%	77.38%

According to Table 2, TMHT test with cutoff point =56.5 mm, 95% sensitivity, positive predictive value at 98% and accuracy at 93% had a high ability to predict difficult laryngoscopy in morbid obese patients. Modified Mallampati grade >II was also another predictor of difficult laryngoscopy in these patients.

Discussion

The aim of this study was to determine the accuracy of upper airway tests, especially TMHT, in predicting difficult laryngoscopy view in morbid obese patients undergoing bariatric surgeries.

According to the preliminary results of this study, the TMHT with cutoff point less than 56.5 mm has a high predictive value in prediction of difficult laryngoscopy view in morbid obesity surgeries.

For the first time in the study of Etezadi *et al*., TMHT with at least 50 mm was shown as a very sensitive test in determining difficult laryngoscopy in non-obese patients (4).

Excessive accumulation of fat under the skin of the face and neck of obese patients makes ventilation masks difficult and may lead to small throat area and insufficient glottis exposure to direct laryngoscopes, which increases the prevalence of difficult laryngoscopy (10-11).

In non-obese patients, the incidence of difficult laryngoscopy 8.6% and the incidence of difficult intubation 3.3% has been reported (12). In morbid obese patients of this study the incidence of difficult laryngoscopy reached to 16.8%.

In the study by Lundstrøm *et al*., obesity with a BMI greater than 35 was reported as a risk factor for difficult intubation (Odds ratio >1.5), so the higher the BMI, the greater the risk for intubation (13).

The present study is confirmed the accuracy and superiority of TMHT over other upper airway tests such as the thyromental distance (TMD), modified Mallampati test (MMT), and sternomental distance (SMD) tests in predicting difficult laryngoscopy.

The TMHT has high specificity (95%) and high positive predictive value (98%) that means in 98% of the morbid obese patients in whom the TMHT predicted difficult laryngoscopy, the laryngoscopy truly would be difficult. The high negative predictive value of this test (95%) means in 95% of patients in whom the TMHT predicted no difficulty in airway, the laryngoscopy would be easy. These findings are consistent with the results of previous studies (14).

The validity of TMHT in laryngoscopy prediction has been evaluated in many studies, but its value and validity are still debated. Accuracy is how close a measure value is to the true value. In our study TMHT has accuracy near 93% in prediction of difficult airway, that means in 100 patients with difficult airway, TMHT is expected to correctly diagnose 93 cases.

Of course, it is better to use several tests in screening patients to find the difficult laryngoscopy and intubation, and one test alone cannot predict problem definitively.

In the study by Ittichaikulthol *et al*., Modified Mallampati score >2 and thyromental distance <6 together have a sensitivity of about 88.3 in predicting difficult intubation (15).

In this study, we compared the accuracy of the TMHT with other upper airway evaluation tests, but did not examine the combination of several tests, which may be a limitation of our study. Another limitation of the study is that our statistical population was Iranian and perhaps in anthropometric terms these results cannot be generalized to other nations. And the fact that the study population was small and if it would be done with a larger population in several centers, the results may be more accurate.

In morbid obese patients, TMHT with the cutoff

value <56.5 mm has a high positive predictive and accuracy in prediction of difficult laryngoscopy. Also Modified Mallampati grade >II was another predictor of difficult laryngoscopy in these patients.

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