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Thyromental Height as a Predictor of Difficult Laryngoscopy

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Abstract

Introduction: Intubation and maintenance of the airway is one of the most important steps in anaesthesia practice and a fundamental responsibility of the anaesthesiologist. Airway assessment is an integral part of pre-anaesthetic evaluation to recognize a potentially difficult airway. A range of bedside screening tests are available to predict a difficult airway but with doubtful accuracy. Hence, identifying a single reliable predictor of difficult intubation is valuable. Hence, the present study aims to evaluate the usefulness of thyromental height test alone as a single predictor of difficult laryngoscopy in our population. *Methods:* After ethical clearance and taking informed consent, we conducted a randomized prospective observational study on 315 adult patients posted for elective surgical procedures under general anaesthesia with endotracheal intubation. Airway was assessed and Thyromental Height (TMH) was measured on the day before surgery. Intra – operatively laryngoscopy was performed and Cormack- Lehane'sgrading noted. The preoperative assessment data and laryngoscopy findings were used together to evaluate the accuracy of TMHT in predicting difficult laryngoscopy. *Results:* Mean TMH observed in our study was 52.80 mm. TMHT at cut off of 50 mm had high sensitivity of 82.3% and high negative predictive value of 96.7%, but with low specificity of 63.7% (P value 0.000). When the cut off revised to 48 mm, sensitivity and specificity had best compromise, sensitivity of test decreased to 64.7% and specificity increased to 79.7% (p value 0.002). *Conclusion:* The present study demonstrates the practicality of TMHT. It confirms the good sensitivity of TMHT for predicting difficult intubation, but validation will require further studies in more diverse patient population.

Keywords: Thyromental height; Cormack-Lehane grading; Difficult laryngoscopy.

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Introduction

Endotracheal intubation is one of the gold standard techniques for maintaining a definitive airway in the practice of clinical anaesthesia. Failure in maintaining the airway is an important cause of mortality and morbidity in anaesthesia [1]. The American society of anaesthesiologists closed claims database analysis has revealed that as many as 1/3rd of the anaesthesia related deaths are due to an inability to maintain a patent airway [2]. Difficult intubation is associated with serious

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complications and is the second most frequent proclaimed damaging event leading to anaesthesia malpractice claims [3].

Most airway catastrophes occur when difficult airway in not anticipated and accurate prediction of difficult airway can guide the preparation for its appropriate management [4]. Airway assessment is an integral part of preanaesthetic evaluation in order to recognise potential difficulty that may be encountered in managing a given airway. A range of screening tests are available to predict a difficult airway but with doubtful accuracy. The performance of these tests varies considerably between studies. These tests are not very sensitive or specific when they are used alone and many tests have to be employed in combination to predict a difficult airway with greater accuracy. Thus multi-factorial indices outperform a single test to predict difficult airway. These multi-factorial indices are cumbersome to apply in daily clinical practice. Hence, identifying a single predictor of difficult intubation can be valuable. Thus there is a need for a single test with high sensitivity, specificity and positive predictive value for identifying difficult airway.

A study done in a population in Iran has found that thyrometal height test (TMHT) alone can accurately predict difficult laryngoscopy [5]. The present study aims to evaluate the usefulness of TMHT as single predictor of difficult laryngoscopy in Indian population. The objective was to correlate TMHT to Cormack-Lehane laryngoscopy grading for prediction of difficult laryngoscopy.

Materials and Methods

This prospective observational study was conducted in adults of either gender aged 18-70 years after obtaining Ethical Committee approval and prior informed consent in subjects scheduled to undergo surgery under general anaesthesia with endotracheal intubation. Subjects with obvious airway malformations, need for rapid sequence intubation or awake intubation, cervical spine abnormalities and those with head and neck radiotherapy were excluded from the study. During the preanaesthetic evaluation a routine airway assessment was done along with the Thyromental height test. The thyromental height was measured as the distance between the anterior border of the thyroid cartilage and a tangential line drawn from the anterior border of the mentum with the patient lying supine with his/her mouth closed with the help of a depth gauge (Fig. 1).

Fig. 1: Thyromental height test (TMHT); Patient lying supine with mouth closed thyromental height is measured using a depth gauge.

A standard anaesthesia protocol was followed in all subjects. After instituting minimal mandatory monitoring, general anaesthesia was induced with fentanyl 2 mcg/kg and propofol 2 mg/kg. Muscle relaxation was facilitated with atracurium 0.5 mg/kg. Subjects were mask ventilated for 3 min with 100% oxygen following injection atracurium and laryngoscopy was performed with Macintosh direct laryngoscope blade size 3 in all subjects. The direct laryngoscopic view of the larynx was graded by Cormack-Lehane (CL) grading system from grade 1 to grade 4 (Grade 1: full visualisation of glottis; Grade 2: partial visualisation of glottis, only posterior commissure is seen; Grade 3: visualisation of only epiglottis; Grade 4: no laryngeal structures are visible). All attempts at laryngoscopy were performed by the same anaesthesiologist in all study subjects. Cormack-Lehane grade 1 & 2 was classified as easy laryngoscopy and grade 3 & 4 was classified as difficult laryngoscopy.

A study to evaluate the thyromental height in predicting difficult laryngoscopy has shown the sensitivity to be 82.6% [5]. Expecting similar results with precision of ± 1%, power of study at 80% and an alpha error 5% the required sample size was estimated to be 315 subjects. The data collected from the study population were analysed with statistical software SPSS version 18.0. To test the efficacy between the different cut-off points for the thyromental height, various indicators such as sensitivity, specificity, accuracy, positive predictive value, and negative predictive value were calculated. Mcnemars test was used to compare the efficacy of TMHT to CL grading.

Results

Table 1: Demographic variables

Variable	n=315
Age (years)*	43.37 ± 14.54
Gender (male/female)†	159/156
Height (cm)*	162.6 ± 7.9
Weight (kg)*	65.3 ± 7.3
BMI (kg/m2)*	24.72 ± 2.74

* Data presented as Mean ± SD; † number

Table 2: Distribution of easy and difficult laryngoscopy in study population

Laryngoscopy		Number of subjects	Total
Easy (%)	CL grade 1	131 (41.6)	281 (89.2)
	CL grade 2	150 (47.6)	
Difficult (%)	CL grade 3	34 (10.8)	34 (10.8)
	CL grade 4	0 (0)	

Table 3: Efficacy of TMHT at cut-off of 48 mm

TMHT (n)	Difficult laryngoscopy [CL grade 1 & 2; n (%)]	Easy laryngoscopy [Cl grade 3 & 4; n (%)]
< 48mm (79)	22 (27.8) [TP]	57 (72.1) [FP]
> 48mm (236)	12 (5) [FN]	224 (94.9) [TN]

Table 4: Efficacy of TMHT at cut-off of 50 mm

TMHT (n)	Difficult laryngoscopy [CL grade 1 & 2; n (%)]	Easy laryngosocpy [CL grade 3 & 4; n (%)]
< 50mm (130)	28 (21.5) [TP]	102 (78.4) [FP]
> 50mm (185)	6 (3.2) [FN]	179 (96.7) [TN]

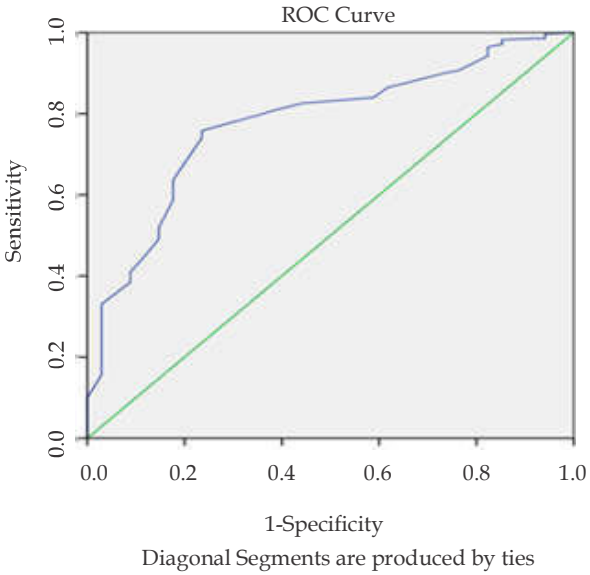

Fig. 2: ROC curve of TMHT at cut-off of 50 mm

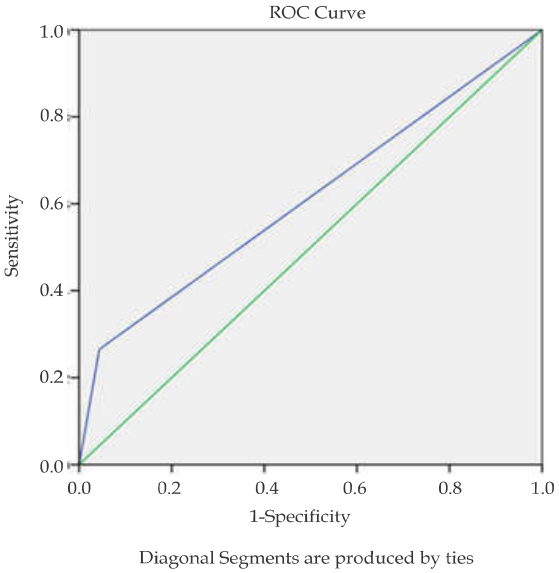

Fig. 3: ROC curve at TMHT at cut-off of 48mm

Table 5: Comparative efficacy of TMHT at 50 mm and 48 mm cut-off

Parameter	TMHT 50 mm cut-off	TMHT 48 mm cut-off
True positive (n)	28	22
False positive (n)	102	57
True negative (n)	179	224
False negative (n)	6	12
Sensitivity (%)	82.3	64.7
Specificity (%)	63.7	79.7
Positive predictive value (%)	21.5	27.8
Negative predictive value (%)	96.7	94.9
Accuracy (%)	65.7	78.09
P value	0.000	0.002

The demographic parameters of the study subjects have been shown in table 1. The laryngoscopic grading as noted during direct laryngosocpy in the study population has been shown in table 2. Of the 315 study subjects 281 had easy laryngoscopy and 34 had difficult laryngoscopy, thus resulting in an incidence of 10.8% of difficult laryngosocpy.

Receiver operating characteristic (ROC) curve analysis for prediction of difficult laryngoscopy was done with TMHT test at cut-off values of 50 mm and 48 mm. In the ROC curve analysis, on the x-axis we plot 1-specificity and on y-axis we plot sensitivity. At a cut-off value the area under curve (AUC) was 0.778 i.e., 77.8%. At a cut-off value of 50 mm sensitivity was 82.3% and specificity was 63.7%. At a cut-off value of 48 mm the AUC was 0.611 i.e., 61.1%. At a cut-off value of 48 mm the sensitivity was 64.7% and specificity was 79.7%, which were closer to each other.

TMHT at cut off of 50 mm, for prediction of difficult laryngoscopy, has high sensitivity of 82.3% and low specificity of 63.7%, low positive predictive value of 21.5%, high negative predictive value of 96.7% and accuracy of 65.7% with p value <0.000. TMHT at 48 mm cut off, had low sensitivity of 64.7%, but high specificity of 79.7% and high negative predictive value of 94.9% and accuracy of 78.09% with p value < 0.002. On comparision of efficacy and predictive value of TMHT for prediction of difficult airway, in our population, it had high specificity of 79.7% and high negative predictive value and better accuracy at cut off of 48 mm.

Discussion

Unanticipated difficult airway is a major concern for anaesthesiologists. Difficult or failed tracheal intubation is well recognized as a major cause of morbidity and mortality in anaesthetic practice as per ASA closed claim audit [2]. Unanticipated difficult intubation is a risk to the patient's life and a challenge to the skill of the anaesthesiologist. Many anatomical characteristics and pathological conditions (like Pierre Robin syndrome, Ludwig's angina) have been suggested to be useful in anticipating difficult intubation by altering or distorting the regional anatomy of the airway. In the absence of pathological conditions, radiographic methods are time consuming and cannot be used routinely for prediction of the difficult intubation.

The need to predict potentially difficult tracheal intubation with an accurate marker, even before laryngoscopy, has received more importance but with limited success. Predicting difficult airway pre- operatively aids not only in managing the intubation time better, but also decreases airway management related morbidity. It is seen that weight, head and neck movement, jaw movement, receding mandible, buck teeth, modified Mallampati classification, thyromental distance, sternomental distance, mouth opening and Wilson risk score are commonly used, but are not foolproof to predict a difficult intubation [6].

Hence, there is a need for a test, which is (a) quick and easy to perform; (b) is highly sensitive (so that majority of difficult cases can be identified); and (c) highly specific (so that false-positive rate will be low when the test is used routinely) d) and have minimal false positive and false negative values [7]. There is still no available single standard method that meets the criteria or a consensus regarding the reliability of the ideally preferred tests [8,9]. Recently, thyromental height test (TMHT) has been proposed as one of the highly sensitive and specific bedside tests to predict difficult airway.

Etezadi *et al.* [5] suggested that TMHT is a promising single anatomical measurement technique with high sensitivity, specificity, PPV and NPV. In our study, the prediction of difficult laryngoscopy was done by measuring thyromental height and correlating it to Cormack Lehane's grading at intubation. Cormack- Lehane grade III and IV are considered as difficult intubation and CL gradeI and II as easy intubation. Out of 315 cases studied, we found 134 patients had CL- gradeI, 150patients had CL- II, 34 patients had CL- III, and none have CL- IV.

Etezadi *et al.* [5] suggested that TMHT has high sensitivity of 82.6%, high specificity of 99.31%, PPV of 90.47% and NPV of 98.63% and accuracy of 98.08% at a cut-off value of 50 mm. In our study, range of TMH measured was 32-73mm. The mean

of TMHT was 52.80 mm. In our study, we have taken the TMHT cut-off value of 50 mm as taken by Etezadi et al. At 50 mm cut off, 130 cases were found <50 mm and 185 cases were >50 mm TMH. Inour study at cut off of 50 mm TMH, true positives, false positives, true negatives, false negativesdetected by the test are 28, 102, 179 and 6 respectively. Sensitivity of 82.3%, specificity of 63.7%, positive predictive value of 21.5% negative predictive value of 96.7%, and accuracy of 78.09% were obtained with TMHT at a cut off of 50 mm.

In our study, specificity and accuracy of the test are not the same as Etezadi *et al.* [5] study, but we found that TMHT has both high sensitivity of 82.3% and high NPV of 96.7% at 50 mm cut off.

A similar study was done by Nilesh *et al.*[10] In their study of thyromental height test for prediction of difficult laryngoscopy in patients undergoing coronary bypass graft surgery, it showed sensitivity of 75%, specificity of 97%, PPV of 73%, NPV of 97% and accuracy of 95% at cut off of 50 mm. In our study TMHT at cut off of 50 mm showed sensitivity of 82.3%, specificity of 63.7%, positive predictive value of 21.5% and negative predictive value of 96.7%, and accuracy of 78.09%. Our study showed good sensitivity of 82.3%, and good NPV of 96.7%, but specificity, PPV and accuracy are lower than Nilesh *et al.* [10] study at cut off of 50 mm. Nilesh *et al.* [10] revised TMHT and found best compromise between sensitivity and specificity of test at cut-off 52.17 mm. At this cut off, it showed an increased sensitivity to 81.25% and specificity to 92.3%. In our study, we found best compromise between sensitivity and specificity of TMHT at cut off of 48 mm, and it showed a sensitivity of 64.7% and specificity of 79.7% which are lower than Nilesh *et al.* [10] study at cut off 52.17.

One more study was done by Selvi *et al.* [11] in Turkey. In their study on evaluation of the reliability of pre-operative descriptive airway assessment in difficult laryngoscopy in prediction of the Cormack-Lehane score compared the predictive values of different airway assessments tests (Modified Mallampati Test (MMT), Upper Lip Bite Test (ULBT), and Thyromental distance measurement test (TMD) including thyromental height measurement test. In their study, TMHT has both high sensitivity (91.89%) and high NPV (98.63)%, however specificity and PPV values significantly decreased (52.2%, 14.7%, respectively) at the 50 mm cut off point.

They have revised the cut off value to 43.5 mm, where they found best compromise between sensitivity (64.86%) and specificity (78.02%). But at 43.5 mm cut-off of TMHT they detected lower sensitivity and better specificity. In our study TMHT at cut off of 50 mm showed sensitivity of 82.3%, specificity of 63.7%, and positive predictive value of 21.5% and negative predictive value of 96.7%. Compared to Selvi et al. study, in our study, TMHT at cut off of 50 mm has lower sensitivity, comparable NPV and better specificity and positive predictive value. But in our study, best compromise between sensitivity (64.7%) and specificity (79.7%) was found at 48 mm. TMHT at cut off of 48 mm in our study showed lower sensitivity and better specificity when compared to 50 mm.

So, when we revised the TMH cut-off to 48 mm we detected 79 patients, <48 mm TMH and 236 patients >48 mm TMH. True positives, true negatives, false positives, false negatives detected by TMHT at 48 mm cut off are 22, 57, 224, and 12 respectively. Specificity of the test increased to 79.7% and accuracy was improved to 78.09% at 48 mm cut off in our study population. On comparison of efficacy of TMHT at 50 mm and 48 mm, specificity and accuracy are better at 48 mm but sensitivity is better at 50mm cut off of TMH.

Contrary to Etezadi *et al.* [5] and Selvi *et al.* [11] and Nilesh *et al.* [10] results, we couldn't verify the same efficiency of TMHT at either 50 mm or 48 mm. Efficacy of TMHT to predict difficult laryngoscopy also depends on patient's race and anatomical variations of airway. It must be mentioned that anatomical differences and measurement errors may affect the results.

According to our study in clinical practice, a TMH value smaller than 50 mm can be used as an early warning system, alerting the clinician to the probability of difficult intubation due to high sensitivity of 82.3% and this will identify most patients in whom intubation will be difficult in reality. It can be predicted that the patients with TMH value greater than 50 mm will have easy intubation since NPV value is 96.7%.

The present study demonstrates the practicality of TMHT in predicting difficult intubation which has a good sensitivity and negative predictive value, but validation will require further studies in more diverse patient population with regard to race, age, sex, which may result in more revealing results.

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