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Thyromental Height - As a Predictor of Difficult Laryngoscopy

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

The fundamental responsibility of the anaesthesiologist and one of the most important steps in anaesthesia practice is the intubation and maintenance of the airway. The integral part of pre-anaesthetic evaluation to recognize a potentially difficult airway is the airway assessment. There are multitude of bedside screening tests which are helpful to predict a difficult airway but the accuracy is doubtful. Thus, pointing out a single reliable predictor of difficult intubation is important. Accordingly, this study aims to evaluate the practicality of thyromental height test alone as a sole predictor of difficult laryngoscopy in our present population. Ethical clearance was obtained and after taking an informed consent, a randomised prospective observational study was conducted on 315 adult patients who were posted for elective surgical procedures under general anaesthesia with endotracheal intubation. On the day before the surgery, airway was assessed and Thyromental height (TMHT) was measured. Laryngoscopy was performed intra-operatively and Cormack Lehane's grading was noted. The evaluation of the accuracy of thyromental height in predicting difficult laryngoscopy was done by comparing the preoperative assessment data and laryngoscopy findings. In our study, the mean thyromental height observed was 5.4cm. Thyromental height at cut off of 50mm had a high negative predictive value of 94.1% and high sensitivity of 72.5%, but with low specificity of 64.2% (P value 0.000). When the cut off was

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emended to 48mm, sensitivity of the test decreased to 56.2% and specificity increased to 79.8% (P value 0.002).The conducted study demonstrates the usefulness of thyromental height. It substantiates the good sensitivity of thyromental height for predicting difficult intubation. But, the validation will require further studies in more diverse patient population.

Keywords: Thyromental height; difficult laryngoscopy; Cormack-Lehane's grading.

1. INTRODUCTION

The fundamental responsibility of the anaesthesiologist and one of the most important steps in anaesthesia practice is the intubation and maintenance of the airway. The most remarkable cause of morbidity and mortality in anaesthesia practice is the failure in managing the airway [1]. All most all of the airway tragedies have occurred only when difficult airway was not anticipated [2]. Faultless prediction of difficult airway, guides the preparation for its management. Serious complications which might result in failed oxygenation has been associated with difficult intubation. Incidence of difficult laryngoscopy is reported in the range of 1.5-20% [3]. According to the American society of anaesthesiologists, brain damage or death has occurred in 85% of airway related events, and anaesthesia due to inability to maintain patent airway hold responsible for 1/3rd of the deaths [4]. Thus in unidentified cases, difficult intubation can be challenging for the anaesthesiologists. The second most frequent proclaimed damaging event is the difficult intubation leading to anaesthesia malpractice claims [5]. There is difficult or impossible mask ventilation in a patient with a difficult airway. This is one of the most critical emergencies faced in anaesthesia practice [6]. The integral part of pre-anaesthetic evaluation to recognize a potentially difficult airway is the airway assessment. Clinical examination and application of simple clinical tests aid in predicting most cases with a difficult airway [7]. Pre-operative prediction of patients with difficult airways can help anaesthesiologist in planning effective way of managing tracheal intubation by implementing special gadgets like fiberoptic bronchoscope, video laryngoscope etc [8,9,10,11]. There is a multitude of bedside screening tests that are helpful to predict a difficult airway but the accuracy is doubtful [12,13,14]. In order to assess difficult laryngoscopy, a range of clinical techniques have been used some of which are not sensitive or specific to anticipate difficult intubation [15,16]. Simple bed side physical examination using a single test or combination of different tests to predict difficult intubation has been tried by innumerable investigators [17,18,19]. The performance of these tests varies substantially between various studies. [20] While single measures are slightly outperformed by multifactorial indices, their accuracy is doubtful in predicting difficult laryngoscopy [18]. Thus, pointing out a single reliable predictor of difficult intubation is important. Thus a test with high sensitivity, specificity, and positive predictive value is essential. A study was done in Iran's population and it has been found out that the thyromental height test (TMHT) alone is an accurate predictor of difficult laryngoscopy [3]. Accordingly, this study aims to evaluate the practicality of the thyromental height test alone as a sole predictor of difficult laryngoscopy in our present population.

2. METHODOLOGY

After obtaining ethical clearance and taking informed consent, a study was conducted at Saveetha medical college hospital between March 2021 and May 2021 on 400 adult patients who were posted for elective surgical procedures under general anaesthesia with endotracheal intubation. Only the patients fulfilling inclusion criteria were enrolled in this study. It is a prospective observational study. All the patients aged between 18 and 70 years of either sex were included in this study. Patients with obvious airway malformations, requiring awake intubation, history of radiotherapy for head and neck pathology, need for rapid sequence intubation under cricoid pressure, cervical spine pathology were excluded.

On the day before surgery, a thorough pre-anaesthetic check-up was done. All the demographic data like age, sex, height, body weight, body mass index were recorded. History of medical illnesses, medication, surgical procedures, drug allergy and general physical examination of the patient was considered for patient evaluation. The blood pressure and pulse rate of the patient were also noted. Systemic examination was done and American Society of Anaesthesiologist (ASA) grading was determined. Routine airway assessment was done.

The thyromental height test (TMHT) was performed with the patient lying in the supine position and with his/her mouth closed, the thyromental height that is, the height between the anterior border of the thyroid cartilage and a tangential line drawn from the anterior border of mentum was obtained in the pre-operative room. The height is measured with a depth gauge.

On the day of surgery, the patient was shifted to the operation theatre and an intravenous line was secured. ECG, non-invasive blood pressure, SpO2 monitors were connected and basal vitals were recorded. Inj. Midazolam (0.15mg/kg), and Fentanyl (2mcg/kg) IV were given after pre-oxygenation for 3 minutes. The induction agent used was Propofol (2mg/kg) I.V. Atracurium (0.5mg/kg) was used for facilitating muscle relaxation. The patients were mask ventilated with 100% O2 for 3 min.

At the end of 3 minutes, with the patient's head in sniffing position, laryngoscopy was performed by a conventionally trained anaesthesiologist using a Macintosh 3 or 4 blade. If no laryngeal view has been achieved, external, backward, upward and right laryngeal pressure (BURP) was applied and the view obtained was assigned a grading (I to IV) according to Cormack-Lehane's (C-L) criteria. The same anaesthesiologist carried out all of these attempts. The anaesthesiologist was unaware of the airway assessments.

Cormack and Lehane's grading are as follows:

Grade 1: Full visualization of the glottis.
Grade 2: Partial visualization of the glottis, only posterior commissure is seen.
Grade 3: Visualization of epiglottis only.
Grade 4: No laryngeal structures are visible.

Grade 3 and 4 are considered as difficult visualization whereas grades 1 and 2 are considered as easy visualization.

After confirming bilateral air equity, appropriately sized cuffed oral endotracheal tube was used to intubate the patients.

The accuracy of the thyromental height test in predicting difficult laryngoscopy was evaluated using the preoperative assessment data and laryngoscopy findings. The accuracy of the thyromental height test, the sensitivity, specificity, positive and negative predictive values were calculated.

The study carried out on the thyromental height test for prediction of difficult laryngoscopy has shown that the sensitivity of the thyromental height test when compared with the Cormack-Lehane grading to be 82.6%. Thus in reference to the above findings, with a precision of +/- 1%, power of study at 80% and alpha error of 5% the required sample size for the study was estimated to be 400.

Microsoft Excel was used to record the data collected from the study population. All the quantitative variables such as age, thyromental height, weight, etc., were described by employing descriptive statistics. Percentages with a 95% confidence interval were employed to describe the qualitative variables. Various indicators such as sensitivity, specificity, accuracy, positive predictive value, negative predictive value, likelihood ratio and odds ratio were calculated to test the efficacy between the different cut-off points for the thyromental height. The significance of difference for qualitative variables was tested using Fisher exact tests. A 'p' value of less than 0.05 was taken to denote a significant difference. All statistical analyses were performed using SPSS version 18.0(SPSS Chicago).

3. RESULTS

Table 1 shows the demographic data of the participants. A total of 400 patients (196 women [49%] and 204 men [51%], age 18-70 years) were included in the study. According to the CL grade 3 and grade 4 laryngeal views, a total of 40 (9.9%) patients were defined as difficult intubation. None of the patients had failed endotracheal intubation.

Table 1. Demographic profile of cases studied

	Male (n=204)		**Female (n=196)**	
	Mean	**SD**	**Mean**	**SD**
Age(yrs)	42.25	13.52	42.32	13.97
Height(cms)	163.38	6.78	155.51	7.92
Weight(kgs)	65.32	13.47	58.33	11.46
BMI	22.86	4057	23.67	6.01

The mean age of males is 42.25years and that of females is 42.32years. Mean height of males is 163.38cm and that of females is 155.51cm. Mean weight of males is 65.32kgs and of females is 58.33kgs. Mean BMI of males is 22.86kg/m^2 and of females is 23.67kg/m^2.

Table 2. Statistical Parameters of height, weight and BMI of the study population

Variable	Range	Mean	SD
Height(cms)	130 - 180	161.9	6.9
Weight(kgs)	45 - 90	66.1	6.9
BMI(Kg/m^2)	15.37 - 35.97	23.89	2.67

The mean height and weight of the cases were 161.9 cm (range 130 - 180cm; SD 6.9) and 66.1kg (range 45 - 90 Kg; SD-6.9), respectively. The mean BMI was 23.89 (range 15.37 - 35.97 kg/m^2).

Table 3. Distribution of Cormack- Lehane grading in study population

Cormack-Lehane grading	Cases	%
I	154	38.6
II	206	51.5
III	40	9.9
IV	0	0
Total	400	100.0

Out of 400 study cases,154 cases have C-L grade I, 206 cases have C-L grade II, 40 cases have C-L grade III and none have C-L grade IV.

Table 4. Number of Attempts at Laryngoscopy among the study population

No. of Attempts	Cases	
	No	**%**
1	271	67.7
2	125	31.3
3	4	1
Total	400	100%

Table 5. Distribution of easy and difficult laryngoscopy in study population

Laryngoscopy	Cases	
	No	**%**
Easy (CL - I, II)	349	87.4
Difficult (CL - III,IV)	51	12.6
Total	400	100

In our study on 400 patients, 349 patients had easy laryngoscopy and 51 patients had difficult laryngoscopy. So total patients with difficult laryngoscopy are 51 which gives an incidence of 12.6%.

Table 6. Calculated cut off value of thyromental height (mm) that shows the best range of sensitivity and specificity.

Cut off value for the T hyromental Height (mm)	Sensitivity	1- Specificity
45.50	0.826	0.441
46.50	0.808	0.382
47.50	0.797	0.353
48.50	0.758	0.235
49.50	0.740	0.235
50.50	0.637	0.176
51.50	0.587	0.176
52.50	0.520	0.147
53.50	0.491	0.147
54.50	0.448	0.118
55.50	0.409	0.88

At a cut off value of 50.0 mm, sensitivity is 72.5% and the specificity is 64.2%.

Table 7. Distribution of thyromental height at cut off of 50mm in the study population

Thyromental height (TMHT)	Cases	
	No	**%**
<50mm	162	40.4
>50mm	238	59.6
Total	400	100
Range (mm)	32 - 73	
Mean	51.70	
SD	8.21	

Out of 400 study patient population, 162 patients had TMHT <50mm and 238 patients had TMHT >50mm.

Table 8. Distribution of thyromental height at cut off of 48mm in the study population

Thyromental height (TMHT)	Cases	
	No	**%**
<48mm(Difficult)	97	24.3
>48mm(Easy)	303	75.7
Total	400	100
Range (mm)	32 - 73	
Mean	51.70	
SD	8.21	

Table 9. Efficacy of thyromental height test at 50 mm and 48mm cut off:

Thyromental height test	Ease of Laryngoscope as per Cormack - Lehane's grading				P value
	Difficult (CL-III,IV) (n=51)		Easy (CL-I,II) (n=349)		
	No	%	No	%	
Difficult <50mm	37	22.8	125	77.2	0.000
Easy >50mm	14	4.4	224	95.6	
Difficult <48mm	27	28.3	71	71.7	0.002
Easy >48mm	21	6.8	281	93.2	

Table 10. Comparative efficacy of TMHT at 50 mm and 48mm cut off

Parameters	Thyromental height test 50mm cut off	Thyromental height test 48mm cut off
True positive	37	27
False positive	125	71
True negative	224	281
False negative	14	21
Sensitivity%	72.5	56.2
Specificity%	64.2	79.8
Positive predictive value%	22.8	27.5
Negative predictive value%	94.1	93.0
Accuracy%	65.2	77.0
P value	0.000	0.002

For prediction of difficult airway, on comparison of efficacy and predictive value of TMHT, in our population, it had a high specificity of 79.8% and a high negative predictive value and better accuracy at a cut off of 48mm.

4. DISCUSSION

Unexpected difficult airway has always been a major concern for anaesthesiologists [21]. Serious complications particularly failed oxygenation has occurred due to difficult intubation [22,23]. As per ASA closed claim audit, the significance of difficult or failed tracheal intubation is well acknowledged as a major cause of morbidity and mortality in anaesthetic practice [24].

Numerous anatomical characteristics and pathological conditions like Pierre Robin syndrome and Ludwig's angina have been suggested to be useful in assessing predicted difficult intubation by altering or distorting the regional anatomy of the airway [25,26,27,28].

Unexpected difficult intubation is a risk to the patient's life and is a challenge to the anaesthesiologist [29]. In the absence of pathological conditions, radiographic methods cannot be used routinely for the prediction of difficult intubation as it is time-consuming [30,31].

The necessity to anticipate potentially difficult tracheal intubation with an accurate marker, even before laryngoscopy, has received more significance but the success is limited [32]. Pre-operative prediction of difficult airway helps not only in managing the intubation time better, but also decreases morbidity related to airway management [33,34,35].

It is seen that weight, jaw movement, head and neck movement, buck teeth, receding mandible, Modified Mallampati classification, sternomental distance, thyromental distance, mouth opening and Wilson risk score are commonly used, but are not foolproof to anticipate difficult intubation [36,37,38].

Thus, there is a necessity for a test, which is (a) easy and quick to perform, (b) highly sensitive (so that most of the difficult airway cases can be identified), (c) highly specific (so that false positive rate will be low when the test is used routinely), (d) have the least false positive and false negative values [39,40]. A single standard method is still not available that meets the criteria or a consensus regarding the reliability of the ideally preferred tests [41,42]. Lately, the thyromental height test (TMHT) has been put forward as one of the highly sensitive and specific bed side tests to predict difficult airways [3].

Etezadi et al. [3] substantiated the use of the thyromental height test. They proposed that, there is a close relation between small thyromental height and the occurrence of difficult laryngoscopy. In their study, an optimal cut-off value of 50mm was chosen. They observed that the test had high sensitivity, high specificity, high PPV, high NPV and high accuracy (82.66%, 99.31%, 90.47%, 98.63% and 98.08%) respectively at 50mm cut off. We also took a cut-off value of 50mm at which sensitivity, specificity, PPV, NPV and accuracy are (72.5%, 64.2%, 22.8%, 94.1% and 65.2%) respectively. In our study, 162 patients had TMH < 50mm and 238 patients had > 50mm. 12.6% of patients had difficult laryngoscopy (C-L grade 3 and 4) and 87.4% of patients had easy laryngoscopy(C-L grade 1 and 2). The sensitivity and NPV results of our study are comparable to the study conducted by Etezadi et al, but specificity, PPV and accuracy are remarkably lower.

An optimal cut-off value of 48 mm was chosen in our study. At this cut-off, the test had a sensitivity, specificity, PPV, NPV, and accuracy of 56.2%, 79.8%, 27.5%, 93.0%, and 77.0% respectively. At 48mm, specificity, NPV and accuracy results of our study are comparable to Etezadi et al study. But, sensitivity and PPV are comparatively less. We found that 97 patients had TMH <48mm and 303 patients had TMH >48mm. In the total 400 patients studied, true positives, false positives, true negatives and false negatives detected by the test are 27, 71, 281, and 21 respectively.

In contradiction to Etezadi et al study, we couldn’t substantiate the same efficiency of the test at 50mm or 48mm, however the test has high sensitivity, high NPV at 50mm, high specificity, high NPV at 48mm and less PPV at 50mm and 48mm.

Our study is almost identical to the study done by Nilesh et al. [43] in sensitivity and NPV. But specificity, PPV, and accuracy are lower at 50mm cut off. Nilesh et al studied the efficacy of the thyromental height test in patients undergoing coronary bypass graft surgery. In their study, they had taken a cut-off value equal to 50mm. On 345 patients, 9.3% had difficult laryngoscopy and 90.7% patients had easy laryngoscopy. They found that 33 patients had TMH <50mm and 312 patients had >50mm. True positive, false positive, true negative, and false negative results detected by the test were found to be 24, 9, 304, and 8, respectively. It showed sensitivity of 75%, specificity of 97%, PPV of 73%, NPV of 97% and accuracy of 95%. In our study, at cut off value of 48mm, the results obtained are all similar to Nilesh et al study at 50mm. But, PPV is lesser in our study.

We are able to verify the efficiency of TMHT at 50mm, with respect to sensitivity and NPV, but the specificity of the test is better at 48mm which is similar to Nilesh et al study. But in contradiction to their study, PPV is poor in our study at 50mm and 48mm.

Selvi et al. [44] assessed the reliability of the thyromental height measurement test for prediction of difficult laryngoscopy in Turkish people. They compared the predictive values of various airway assessment tests (Modified Mallampati Test (MMT), Upper Lip Bite Test (ULBT), and Thyromental distance measurement test (TMD) along with thyromental height test. They found that TMHT has high sensitivity (91.89%) and high NPV (98.63%). However, specificity and PPV values are significantly decreased (52.2% and 14.7% respectively) at the 50mm cut off point. Sensitivity (72.5%), specificity (64.2%) and NPV (94.1%) at 50mm cut off observed in our test are comparable to Selvi et al study.

They found the best compromise between sensitivity and specificity when they revised the cut off value of TMHT to 43.5mm. Sensitivity (64.86%), specificity (78.02%), PPV (20.87%) and NPV (96.13%) at this cut off are also comparable to our revised cutoff of 48mm. In their study among 451 patients, the test detected 24 true positives, 91 false positives, 323 true negatives, 13 false negatives at 43.5mm cut off. In comparison to Etezadi et al study, they couldn’t verify the same efficiency of TMHT at either 50mm or 43.5mm. However, it could be verified with our study at both 50mm and 48mm cut off values.

As there are several anatomical variations of the airway with respect to age, sex and body habitus, there occur varying results at different cut-off points compared to earlier studies. The efficacy of TMHT to predict difficult laryngoscopy also relies on the patient’s race and variations in airway anatomy. It is a must to mention that the results might be affected by anatomical differences and measurement errors.

Sensitivity is better at 50mm cut-off but specificity and accuracy are better at 48mm on comparison of the efficacy of TMHT at 50mm and 48mm. As we are concerned with difficult laryngoscopy more than easy laryngoscopy, the test which detects more true positives and fewer false negatives than more true negatives has more clinical applicability. In accordance with our study, a TMH value less than 50 mm can be used as an early warning system to alert the clinician about the probability of difficult intubation due to high sensitivity of 72.5%. This will point out most patients in whom intubation would be difficult in reality. As the NPV value is 94.1%, it can be predicted that the patients with TMH values greater than 50 mm will have easy intubation.

No morbidity, mortality or complication was recorded among the study population short after the end of general anaesthesia.

5. CONCLUSION

Airway screening tests should be simple, convenient and practical. Despite the fact that their validity is variable and their ability to predict unexpected difficult intubations remains restricted, they are a crucial tool for anaesthesiologists. This study demonstrates the practicality of TMHT in predicting difficult intubation which has good sensitivity and negative predictive value. But validation of this study would require further studies in the more diverse patient populations with regard to age, sex and race which may result in more revealing results. Further studies with a larger sample size and different methodology concerning age, sex and race dependent variables are required to evaluate this test.

ETHICAL APPROVAL AND CONSENT

After obtaining ethical clearance and taking informed consent, a study was conducted at Saveetha medical college hospital between March 2021 and May 2021 on 400 adult patients who were posted for elective surgical procedures under general anaesthesia with endotracheal intubation

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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