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PROSPECTIVE OBSERVATIONAL STUDY OF THYROMENTAL HEIGHT TEST AS A PREDICTOR OF DIFFICULT INTUBATION

Anaesthesiology

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ABSTRACT

Background: The ability to predict a difficult intubation permits us to take precautions to decrease the risk. At present, there are several predictors but sensitivity is mostly limited. The thyromental height test is an easy to do and non invasive test.Recent studies have reported the TMHT to be more accurate to predict difficult intubation, compared to more widely used purely anatomical measurements. **Aims:** This study aimed to evaluate the ability of thyromental height test (TMHT) in predicting difficult intubation and to compare TMHT as a predictor of difficult intubation with Mallampati classification (MPC), Sternomental distance (SMD) and Thyromental distance (TMD). **Study Design:** Prospective observational study. **Study Setting:** Preoperative preparation rooms and operation theatres of the institution where study was conducted. **Materials & Methods:** After obtaining approval from institutional ethics committee, a total of one hundred and twenty two consecutive male and female patients between the ages of 19 to 70 years scheduled to receive general anesthesia requiring endotracheal intubation for elective surgeries were invited for the study. **Statistical Analysis:** Data were analysed using SPSS software. Sensitivity, specificity, negative predictive values & positive predictive values of each parameter was calculated and compared. **Results:** Thyromental height, with an AUC of 0.954 and p value of <0.0001, had a sensitivity of 96.4%, specificity of 91.7%, positive predictive value of 93.5% and an accuracy of 93.74%.The cut off value of TMHT was derived to be 51.5mm. **Conclusion:** As per our study, TMHT is an effective parameter in predicting difficult intubation. Validation of the test will require further studies in more diverse populations. Past studies on airway parameters to predict difficult intubation have shown that combining two or more parameters is always more effective than a single parameter. Hence we conclude that the validity of Thyromental height test will further increase when combined with other widely used parameters i.e., Modified Mallampati test, sternomental distance, thyromental distance etc.

KEYWORDS

Difficult intubation, thyromental height test, observational study, validity

INTRODUCTION

Difficult endotracheal intubation under general anesthesia can cause intubation delay or failure, which can bring on fatal results.85% of all mistakes regarding airway management result in permanent cerebral damage. 30% of all anaesthetic deaths can be attributed to management of difficult airways. Securing the airway and providing adequate oxygenation and ventilation is crucial in patients having surgery under general anesthesia.Difficulties during airway management may cause complications including hypoxemia, aspiration, airway trauma, and even death.

The ability to predict a difficult intubation permits us to take precautions to decrease the risk. At present, there are several predictors but sensitivity is mostly limited. The thyromental height test is an easy to do and non invasive test. It is based on the height between the anterior border of the thyroid cartilage and the anterior border of the mentum, measured while the patient lies in the supine position with closed mouth.Recent studies have reported the TMHT to be more accurate to predict difficult intubation, compared to more widely used purely anatomical measurements.

Rationale of this study is to analyse the clinical performance and usefulness of a newer parameter, thyromental height test(TMHT) as a predictor of difficult intubation and compare with other predictors of difficult intubation like Mallampati classification (MPC), thyromental distance(TMD) and Sternomental distance(SMD). Through this study we also aim at finding the range of TMH below which, there is an association with difficult intubation. This prospective observational study will be conducted in 122 patients undergoing elective surgeries requiring general anaesthesia with endotracheal intubation in various operation theatres of our institution.

Aims & Objectives

The aim of this study was to know whether Thyromental height test (TMHT) can predict difficult intubation

Primary Objective

To evaluate the ability of thyromental height test to predict difficult intubation

Secondary Objective

To compare thyromental height test as a predictor of difficult intubation with Mallampati classification (MPC), Sternomental distance (SMD) and Thyromental distance (TMD).

MATERIALS & METHODS

The prospective observational study was approved by our Institutional Ethics Committee and written, informed consent was obtained from all patients enrolled. We studied 122 consecutive patients of American Society of Anesthesiologists (ASA) physical status I and II between the age group 19 and 70 years scheduled to receive general anesthesia requiring endotracheal intubation for elective surgeries posted in various operation theatres of our institution during the period of January 2021 to July 2021

Exclusion Criteria While Choosing Study Sample Were:

- Patients not willing to participate in study
- Obstetric patients
- Patients with head, neck and face deformities
- Patients with upper airway pathologies
- Patients with cervical spine fracture

After pre-anesthetic evaluation, investigator performed a standardised pre-operative assessment according to the case record form prior to the proposed surgery.

Tests Under Evaluation Were:

- Thyromental Height Test (TMHT) : the height between the anterior border of thyroid cartilage and anterior border of mentum measured using a depth gauge (INSIZE Electronic depth gage, INSIZE Co LTD, Suzhou New District, China) in millimeters, with patient in supine position and head in neutral position with mouth closed.

Fig 1. Measurement of TMHT

- Modified Mallampati Classification(MPC): oropharyngeal view was assessed using the modified Mallampati classification. Patients were assessed in sitting position with mouth maximally opened, tongue protruded and without phonation.

-> Class I : soft palate, fauces, entire uvula, pillars are visible
-> Class II : soft palate, fauces, portion of uvula visible
-> Class III : soft palate, base of uvula visible
-> Class IV : only hard palate visible

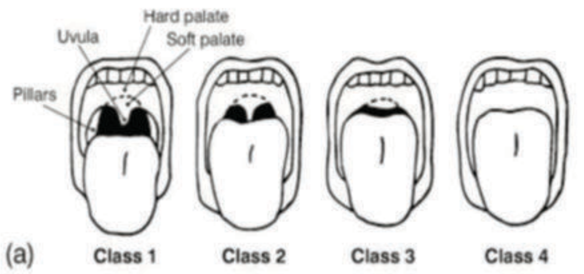

Fig 2. Modified Mallampati Classification

- Thyromental Distance (TMD) : measured between the thyroid prominence and the most anterior part of the mental prominence of the mandible with a tape measured as a distance in centimeters, with patient in supine position, head fully extended, mouth closed.
- Sternomental distance (SMD) : measured between the superior border of the manubrium sterni and the most anterior part of the mental prominence of the mandible with a tape measured as a distance in centimetres, with the patient in supine position, head fully extended, mouth closed.

After taking written, informed consent, patient was taken in and standard ASA monitors were attached. General anesthesia was induced via a combination of Fentanyl (2mcg/kg), IV Lignocaine (2mg/kg), Propofol (2mg/kg). Muscle relaxation was achieved by administering intravenous Rocuronium 1mg/kg.

The patient's head was placed in a sniffing postion and laryngoscopy was performed using a Macintosh #3 or #4 blade by an anaesthesiologist having experience of one year or more. The glottic view was classified according to Cormack-Lehane grading as follows:

- Grade I : visualisation of entire laryngeal aperture
- Grade II : visualisation of only posterior portion of laryngeal aperture
- Grade III : visualisation of only the epiglottis
- Grade IV : no visualisation of the epiglottis or larynx

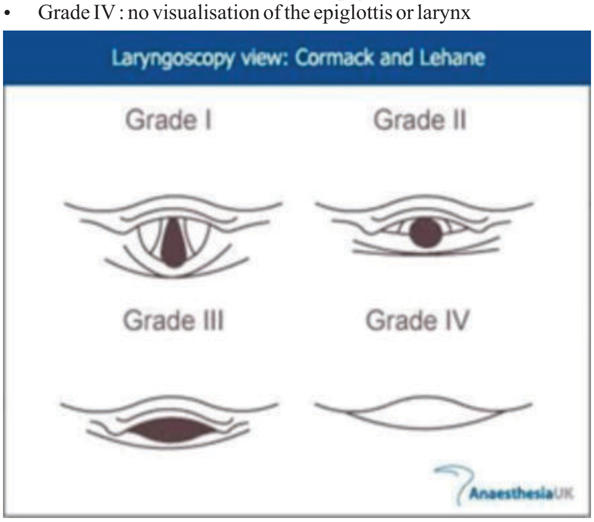

Fig 3. Showing CL Grading

Correct tube placement was confirmed by auscultation and capnography. Once intubation procedure was completed, general anaesthesia was maintained according to local standard of care. Additional medications were given as necessary.

A Difficult Intubation Was Defined As:

- CL grade III or IV
- More than two attempts required to achieve successful intubation with a conventional laryngoscope with Macintosh blade performed by an anaesthesiologist with an experience of 1 year or more.
- Requirement of a change in technique (different upper airway management device, different type of laryngoscope, bougie, etc.)
- Two failed intubation attempts undertaken by two experienced anaesthesiologists

Sample Size Calculation

In a study by Palczynski et al[1], the prevalence of difficult intubation was found to be 16.5%. The sensitivity and specificity of thyromental height test to predict difficult intubation was 70% each. Sample size was calculated according to formulas (Jones SR, Carley S, Harrison M. An introduction to power and sample size estimation. Emerg Med J. 2003;20(5):453-8.) as follows,

Sample size for sensitivity,

$$TP + FN = z^2 \times \frac{(SN(1 - SN))}{W^2}$$

Where, SN= sensitivity = 0.7 i.e. 70%, W = precision error = 0.2 i.e. 20%, and z = 1.96 i.e. critical value at alpha error of 5%,
TP+FN = 1.96 x 1.96 x 0.7 x 0.3 / 0.2 x 0.2 = 20.17
Sample size = TP+FN/P = 20.17/0.165 = 122.32 = 122 (rounded)

Sample size for specificity,

$$FP + TN = z^2 \times \frac{(SP(1 - SP))}{W^2}$$

Where, SP= specificity = 0.7 i.e. 70%, W = precision error = 0.2 i.e. 20%, and z = 1.96 i.e. critical value at alpha error of 5%,
TP+FN = 1.96 x 1.96 x 0.7 x 0.3 / 0.2 x 0.2 = 20.17
Sample size = TP+FN/1-P = 20.17/(1-0.165) = 24.16 = 25 (rounded)

Choosing the higher sample size of the two i.e. 122 will satisfy both conditions of specificity and sensitivity.

Thus, we enrolled 122 patients in the study to assess the sensitivity and specificity of thyromental height test to predict difficult intubation.

Statistical Analysis

The primary outcome of the study was to find the ability of Thyromental height test as a predictor of difficult . Data was entered in a Microsoft excel sheet and analyzed using SPSS version 21 software. Descriptive data was described as Mean$\pm$SD, frequencies or percentages.The sensitivity, specificity, negative predictive value and positive predictive value were calculated by preparing the cross-tables of the thyromental height test whether they have detected difficult intubation.

	Disease				
Test	Present	n	Absent	n	Total
Positive	True Positive	a=	False Positive	c=	a + c
Negative	False Negative	b=	True Negative	d=	b + d
Total		a + b		c + d	

Test

Results

Statistic	Formula	Value	95% CI
Sensitivity	$\frac{a}{a+b}$		
Specificity	$\frac{d}{c+d}$		
Positive Likelihood Ratio	$\frac{Sensitivity}{1 - Specificity}$		
Negative Likelihood Ratio	$\frac{1 - Sensitivity}{Specificity}$		
Disease prevalence	$\frac{a+b}{a+b+c+d}$	(*)	
Positive Predictive Value	$\frac{a}{a+c}$	(*)	
Negative Predictive Value	$\frac{d}{b+d}$	(*)	
Accuracy	$\frac{a+d}{a+b+c+d}$	(*)	

Table 1.0 showing generic cross tables and statistical analysis extrapolated to the parameters under evaluation, disease= difficult intubation.

Correlation between two quantitative variables were assessed using Pearson's correlation test for data with normal distribution or Spearmans rank correlation test for data which is not normally distributed.

Definition of Outcome Terms

- False positive: Predicted difficult intubation, but actually easy.
- False negative: Predicted easy, but actually difficult intubation
- Sensitivity: Percentage of correctly predicted difficult intubations as a proportion of all intubations that were difficult
- Specificity: Percentage of correctly predicted easy intubations as a proportion of all intubations that were easy.
- Positive Predictive Value: Percentage of correctly predicted difficult intubations as a proportion of all predicted difficult intubations
- Negative Predictive Value: Percentage of correctly predicted easy intubations as a proportion of all predicted easy intubations.
- Positive Predictive Value: Percentage of correctly predicted difficult intubations as a proportion of all predicted difficult intubations
- Negative Predictive Value: Percentage of correctly predicted easy intubations as a proportion of all predicted easy intubations.

Area under the receiver operating characteristic (ROC) curve for the TMHT, SMD, TMD and MMT were used to show predictive values of each parameter. Area under the curve and area under the ROC curve were used to calculate the ideal cutoff point for TMHT. In addition, the validity indices (sensitivity, specificity, positive predictive value, negative predictive value, odds ratios) and p values were calculated for each test. Sensitivity, specificity, positive predictive value, negative predictive value and confidence interval (CI) were calculated based on normality assumption as the prerequisite condition was met in most of the indices.

RESULTS

One hundred and twenty two ASA physical status I and II patients (70 males [57.3%] and 52 females [42.6%]) participated in the study. 10 patients (8.1%) had a CL grade III and the incidence of difficult intubation in this study was found to be 16.5%. There were no failed intubations in this study.

The values obtained for various parameters were plotted to obtain the ROC curve, graph sensitivity and specificity. Thyromental height, with an AUC of 0.954, had a sensitivity of 96.4%, specificity of 91.7%, positive predictive value of 93.5% and an accuracy of 93.74%.

Mallampati classification was found to have a sensitivity of 50%, specificity of 94.5%, positive predictive value of 64.4% and an accuracy of 87.2%. Thyromental distance showed a sensitivity of 25%, specificity of 83.3%, and accuracy of 87.62%. Sternomental distance showed a sensitivity of 78.2%, specificity of 75%, positive predictive value of 87.8% and an accuracy of 88.2%.

The cut off value of TMHT was derived to be 51.5mm.

DISCUSSION

Prediction of difficult intubation is of high clinical interest and several anatomical landmarks and multifactorial indices have been developed in the past. Unexpected difficult tracheal intubation has been recognized as a major contributory factor to anaesthetic-related morbidity and mortality. [14]The difficult airway could be regarded as a syndrome in itself, composed of very many individual 'rare diseases'. Airway management related hypoxia has been registered as a syndrome of interest in Oxford University's rare disease initiative. In 2000-2012, Joffe et al[2] found that, among the difficult intubation claims, preoperative predictors of difficult intubation were present in 76%. Therefore, the search for a predictive test that has ease of applicability and accuracy of prediction (discriminative power) persists.[16]

It has been observed that predictors such as weight, head and neck movement, jaw movement, receding mandible, buck teeth, modified Mallampati classification, TMD, SMD, mouth opening, and Wilson risk score are not foolproof to predict a difficult intubation. 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). Any test used should be easy to perform and interpret at the bedside. [12]

Etezadi et al. validated the use of TMHT in 2012. A few more studies followed; like that of [16]Jain et al., on CABG patients in 2017, [1]Palczynski et al. in 2017.

Demographic Data

In our study conducted in 122 patients, 57.3% were males and 42.7% females, which is a fairly homogenous sample population with respect to gender. The mean + SD for age group with difficult intubation was 50.17+10.53 with a median age of 53, p value <0.001. (Table 2.0)

BMI

Most patients with difficult intubation fell under the BMI range of 24.12+1.75 kg/sq.m with a median BMI of 23.9 kg/sq.m. (Table 2.0)

Incidence of Difficult Intubation

It should also be noted that most difficult intubations were performed by an anaesthesiologist with experience of an average of 4.5 years. This data owes to the fact that either in the event of a difficulty, there was a change in laryngoscopist from a less experienced personnel to a more experienced one or that in situations where a difficulty was suspected, intubations were directly done by a personnel with better experience.

In this study, 12 out of 122 intubations were difficult, giving an incidence of 16.5% , which is on the higher side compared to previous studies. Bilgin and Ozyurt[52] reported an incidence of 8%, Benumof[4] reported on many cases where difficult endotracheal intubation occurred in 1-4% of cases, Safavi et al.[3] reported an incidence of 6.8%. Shiga et al. [9] reported an incidence of 5.8%, Etezadi et al[12] , reported 7.3%, Jain et al.[16], in a similar study reported an incidence of 9.3%. [18]Cormack and Lehane's study showed an incidence as low as 1%.

In our study, the prediction of difficult laryngoscopy was done by MMT, TMD, SMD and TMHT during preoperative assessment and correlating it to CL laryngoscopy grading at intubation. MMT class III and IV, TMD < 6.5 cm, SMD < 12.5 cm and CL grade III and IV were considered as predictors of difficult intubation. TMHT < 50mm was considered predictive of difficult intubation.

Modified Mallampati Test

MMT is a widely performed predictive bed side test. It may estimate the size of the tongue relative to the oral cavity and may possibly indicate whether displacement of the tongue by the laryngoscope blade is likely to be easy or difficult. In addition, it assesses whether the mouth can be opened adequately to permit intubation. In our study, 38.2% patients had MPC grade I, 55.7% had MPC grade II, 9.8% patients had MPC grade III and no patient with MPC grade IV. The sensitivity was 21.09%, specificity 90.54%, positive predictive value 64.43% and accuracy 87.2% with confidence interval (CI) of 79.94% to 92.56%. (Table 3.0)

In the study by Etezadi et al[12], MMT showed sensitivity of 21%, specificity of 80.41%, positive predictive value of only 8%. Jain et al[16] found sensitivity of 53%, specificity of 81%, positive predictive value of 22%. Palczynski et al. [1] found a sensitivity of 25%, specificity of 87%, PPV of 26% for MMT.

Thyromental Distance

TMD is yet another widely used, easy-to-measure bedside test. However, the measurement is a surrogate for inadequate head extension rather than dimension of submandibular space. It also reflects whether displacement of tongue by the laryngoscope blade will be easy or difficult. In our study, TMD showed a sensitivity of 25%, specificity of 83.3%, accuracy of 87.62% (Table 6.0). Etezadi et al.[12] found its specificity as 80%, sensitivity as 26%. Jain et al.[16] found sensitivity to be 22% and specificity to be 98%, all of which were comparable to our study. Palczynski et al. [1] found the sensitivity to be 50%, specificity to be 36%.

Sternomental Distance

SMD, a commonly used measurement in clinical practice, is repeatedly reported to be a non adequate sole predictor of difficult intubation. It is an indicator of head and neck mobility. Contrary, a combination of several sole measures including SMD appears to be more reliable. In our study, SMD had a sensitivity of 33.3%, specificity of 99%, PPV of 87.8%.Palczynski et al. [1] found sensitivity of 60%, specificity of 41%, PPV of 19% (Table 5.0). Etezadi et al.[12] found its sensitivity to be 13%, specificity 91.4%, PPV 10.7%. Jain et al.[16] found its sensitivity to be 19%, specificity to be 97.5% and PPV to be 43%. According to our study, SMD has a high specificity and PPV but poor sensitivity.

Thyromental Height Test

The TMHT is an already long known technique, but recently gained popularity again.We had used a cutoff value of 50mm as used by Etezadi et al.,[12] Jain et al.[16], and Palczynski et al. [1]

We found TMHT to have a sensitivity of 66.7%, specificity of 99%, PPV of 93.54%, NPV of 93.77% and an of 93.74% (Table 4.0). Etezadi et al.[12] reported a sensitivity of 83%, specificity of 99.3%, PPV of 90.4%.Palczynski et al.[1] reported a sensitivity of 70%, specificity of 70%, PPV of 17%. Jain et al.[16] reported sensitivity of 75%, specificity of 97%, PPV of 73%. The cutoff value obtained according to the ROC curve was 51.5mm. The area under the curve (AUC) for TMHT was 0.954 with a CI of 0.88 to 1.0 (Fig 6.0). Our results were comparable with that of Etezadi et al.

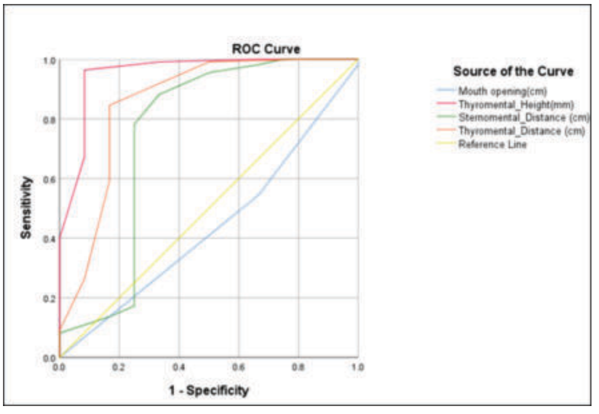

Fig 6.0 ROC Curve for TMHT, SMD and TMD

Cormack-Lehane Grade

It was considered as the gold standard in predicting difficult intubation in our study.Out of our study population, 50% had CL grade I, 46.7% had CL grade II and 8.19% had CL grade III. We did not encounter any CL grade IV in our study.

Our study showed that TMHT could be a more accurate predictor of difficult laryngoscopy than other single anatomical measures. One advantage of the TMHT is the use of an inexpensive, easily applicable instrument for measurement of an objective quantity (distance between anterior surfaces of the mentum and thyroid cartilage). The anatomical difference and measurement errors may affect the test results. For example, the assurance of a proper horizontal alignment may require the use of a bubble device such as those on carpentry levels.

Limitations

- The study population was limited to patients scheduled for elective, non emergent surgeries. Thus the results are only applicable to these patients.
- Determination of the best cutoff point for use of TMHT as a predictor of difficult intubation, and its analysis, as a measure of prediction, have both been performed on the same population; this may explain the good statistical results calculated for TMHT in comparison with other tests.
- We investigated single measures only, but combination of multiple measures might further increase sensitivity.
- TMHT is usually measured with a semi electronic device and there is a potential for any learning effect, and certain inter-observer variability, especially if a depth gauge is not used.
- This study intended to proof, that the TMHT is a reliable test, but results of this study has been proven by other major studies.

Key Message: TMHT is an easy and effective bedside test to assess difficult airway. Cut off value is 51.5mm. Its effectiveness increases if combined with other parameters.

Abbreviations

- ASA - American Society of Anaesthesiologists
- CI- Confidence interval
- cm- centimetres
- CT - Computed Tomography
- DI - Difficult intubation
- DL- Difficult laryngoscopy
- DMV- Difficult mask ventilation
- LET- Laryngoscopic examination test
- mm- millimetres
- MMT - Modified Mallampati Test
- MPC- Mallampati Classification
- NPV- Negative predictive value
- PPV- Positive predictive value
- RHTMD- Ratio of height to thyromental distance
- SMD - Sternomental distance
- TMD - Thyromental distance
- TMHT- Thyromental height test
- ULBT- Upper lip bite test

CONCLUSION

Thyromental height test is a simple , easy to perform and non-invasive test involving the measurement of external anatomical parameters to predict difficult intubation in patients scheduled for intubation during elective surgeries. The appropriate cutoff value obtained was 51.5 mm. Validation will require further studies in more diverse populations. Past studies on airway parameters to predict difficult intubation have shown that combining two or more parameters is always more effective than a single parameter. Hence we conclude that the validity of Thyromental height test will further increase when combined with other widely used parameters i.e., Modified Mallampati test, sternomental distance, thyromental distance etc.

Table 2.0 Showing Mean Values Of Each Parameter For Difficult Intubation ; BMI= Body Mass Index.

	NO (N=110)	Yes (N=12)		NO (N=110)	Yes (N=12)	
	Mean ± SD	Mean ± SD	p Value	Median (IQR)	Median (IQR)	p Value
Age(years)	34.16± 9.211	50.17± 10.53	<0.001	50 (28-40)	53(40.5-58)	<0.001
Height(cm)	161.13± 7.017	163.58± 8.426	0.261	167.5(156-165)	164.5(156.5-171)	0.352
Weight(kg)	59.06± 5.973	64.83± 8.768	0.003	73 (55-61.25)	63(57-69.5)	0.021
Mouth opening(cm)	3.764± 0.2684	3.833± 0.2462	0.391	4 (3.5-4)	4(3.5-4)	0.404
BMI(kg/sq.m)	22.6751 ±1.2018	24.1167± 1.75387	<0.001	22.5(21.775-23.6)	23.9(22.45-25.9)	0.007
Thyromental_ Height(mm)	54.08± 1.409	49.5± 1.784	<0.001	54 (53-55)	49(48-50.75)	<0.001
Sternomental_ Distance (cm)	15.2± 1.262	13.833± 1.9228	<0.01	15 (14.5-16)	13.25 (12.125-5.875)	0.005
Thyromental_ Distance (cm)	7.905± 0.6262	6.908± 0.7077	<0.001	8 (7.5-8.5)	6.75 (6.5-7)	<0.001
Experience of anaesthesio-logist performing laryngoscopy (years)	2.12± 0.324	5.83± 3.881	<0.001	2 (2-2)	4.5 (3-9)	<0.001

Table 3.0 Statistical Analysis Of Modified Mallampati Test (MMT)

	Difficult intubation			
MMT anticipation of difficult intubation	Yes	No		p value
Yes	6(50%)	6(5.5%)	12	<0.001
no	6(50%)	104(94.5%)	110	
	12	110	122	
Statistic	Value	95% CI		
Sensitivity	50.00%	21.09% to 78.91%		
Specificity	94.55%	88.51% to 97.97%		
Positive Likelihood Ratio	9.17	3.50 to 23.99		
Negative Likelihood Ratio	0.53	0.30 to 0.93		
Disease prevalence (*)	16.50%			
Positive Predictive Value (*)	64.43%	40.90% to 82.58%		
Specificity	90.54%	84.44% to 94.41%		
Accuracy (*)	87.20%	79.94% to 92.56%		

Table 4.0 Showing Statistical Analysis Of Thyromental Height Test (TMHT)

	Difficult intubation		
Thyromental Height anticipation of difficult intubation	Yes	No	
Yes	8(66.7%)	1(0.9%)	9
No	4(33.3%)	109(99.1%)	113
Total	12	110	122
Statistic	Value	95% CI	
Sensitivity	66.67%	34.89% to 90.08%	
Specificity	99.09%	95.04% to 99.98%	
Positive Likelihood Ratio	73.33	10.01 to 537.37	
Negative Likelihood Ratio	0.34	0.15 to 0.75	
Disease prevalence (*)	16.50%		
Positive Predictive Value (*)	93.54%	66.42% to 99.07%	
Negative Predictive Value (*)	93.77%	87.11% to 97.10%	
Accuracy (*)	93.74%	87.87% to 97.32%	

Table 5.0 Showing Statistical Analysis Of Sternomental Distance (SMD)

	Difficult intubation		
Sternomental distance anticipation of difficult intubation	Yes	No	
Yes	4(33.3%)	1(0.9%)	5
No	8(66.7%)	109(99.1%)	117
Total	12	110	122
Statistic	Value	95% CI	
Sensitivity	33.33%	9.92% to 65.11%	
Specificity	99.09%	95.04% to 99.98%	
Positive Likelihood Ratio	36.67	4.45 to 302.07	
Negative Likelihood Ratio	0.67	0.45 to 1.00	
Disease prevalence (*)	16.50%		
Positive Predictive Value (*)	87.87%	46.79% to 98.35%	
Negative Predictive Value (*)	88.27%	83.44% to 91.82%	
Accuracy (*)	88.24%	81.16% to 93.37%	

Table 6.0 Showing Statistical Analysis Of Thyromental Distance (TMD)

	Difficult intubation		
Tyro-mental distance anticipation of difficult intubation	Yes	No	
Yes	3(25%)	0	3
No	9(75%)	110(100%)	119
Total	12	110	122
Statistic	Value	95% CI	
Sensitivity	25.00%	5.49% to 57.19%	
Specificity	100.00%	96.70% to 100.00%	
Positive Likelihood Ratio	Not Calculated		
Negative Likelihood Ratio	0.75	0.54 to 1.04	
Disease prevalence (*)	16.50%		
Positive Predictive Value (*)	100.00%		
Negative Predictive Value (*)	87.09%	82.96% to 90.34%	
Accuracy (*)	87.62%	80.44% to 92.89%	

Table 7.0 Showing AUC For TMD, TMHT and SMD

Area Under the Curve					
Test Result Variable (s)	Area	Std. Error a	Asym -ptotic Sig.b	Asymptotic 95% Confidence Interval	
				Lower Bound	Upper Bound
Thyromental_Height (mm)	0.954	0.038	0.000	0.880	1.000
Sternomental_Distance (cm)	0.747	0.106	0.005	0.540	0.954
Thyromental_Distance (cm)	0.855	0.075	0.000	0.707	1.000
a. Under the nonparametric assumption					
b. Null hypothesis: true area = 0.5					

REFERENCES

1. Palczynski P, Bialka S, Misiolek H, Copik M, Smelik A, Szarpak L, et al. (2018) Thyromental height test as a new method for prediction of difficult intubation with double lumen tube. PloS ONE 13(9): e0201944
2. AM Joffe, M. Aziz, Karen B. Domino. Management of difficult tracheal intubation: a closed claims analysis. Anesthesiology. 2019 Oct; 131(4):818-829
3. Safavi M, Honarmand A, Zare N. A comparison of the ratio of patient's height to thyromental distance with the modified Mallampati and the upper lip bite test in predicting difficult laryngoscopy. Saudi J Anaesth 2011;5:258-63
4. Suk-Hwan Seo, Jeong-Gil Lee, Soo-Bong Yu, Doo-Sik Kim, Sie-Jeong Ryu and Kyung-Han Kim. Predictors of difficult intubation defined by the intubation difficulty scale (IDS): predictive value of 7 airway assessment factors. Korean J Anaesthesiol. 2012 Dec; 63(6): 491-497
5. Ruetzler K, Guzzella SE, Tscholl DW, Restin T, Cribari M, Turan A, et al. Blind intubation through self pressurized, disposable supraglottic airway laryngeal intubation masks: An international, multicenter, prospective cohort study. Anesthesiology. 2017; 127(2):307-316. PMID: 28570294
6. Peterson GN, Domino KB, Caplan RA, Posner KL, Lee LA, Cheney FW. Management of the difficult airway: a closed claims analysis. Anesthesiology 2005; 103(1): 33-39. PMID: 15983454
7. Cook T M, Woodall N, Harper J, Benger J, Fourth National Audit p. Major complications of airway management in the UK: results of the Fourth National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society. Part 2: intensive care and emergency departments. Br J Anaesth. 2011; 106(5):632-642. PMID: 21447489
8. Cook T M, Woodall N, Frerk C, Fourth National Audit P. Major complications of airway management in the UK: results of the Fourth National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society. Part 1: anaesthesia. Br J Anaesth. 201@; 106(5):617-631. PMID: 21447488
9. Shiga T, Wajima Z, Inoue T, Sakamoto A.Predicting difficult intubation in apparently normal patients: a meta-analysis of bedside screening test performance. Anesthesiology 2005; 103(2): 429-437. PMID:16052126.
10. Khan ZH, Mohammadi M, Rasouli MR, Farrokhnia F, Khan RH. The diagnostic value of the upper lip bite test combined with sternomental distance, thyromental distance, and interincisor distance for prediction of easy laryngoscopy and intubation: a prospective study. Anesth Analg. 2009; 109(3):822-824. PMID: 19690252
11. Arné J, Descoins P, Fusciardi J, Ingrand P, Ferrier B, Boudigues D, et al. Preoperative assessment for difficult intubation in general and ENT surgery: predictive value of a clinical mutlivariate risk index. British J Anaesth 1998; 80(2): 140-146. PMID: 9602574
12. Etezadi F, Ahangari A, Shokri H, Najafi A, Khajavi MR, Daghigh M, et al. Thyromental height: a new clinical test for prediction of difficult laryngoscopy. Anesth Analg. 2013; 117(6):1347-1351. PMID: 24257384
13. Hanouz JL, Bonnet V, Buléon C, Simonet T, Radenac D, Zamparini G, et al. Comparison of the Mallampati Classification in sitting and supine position to predict difficult tracheal intubation: a prospective observational cohort study. Anesth Analg. 2018; 126(1):161-169. PMID: 28537983
14. Pandit JJ, Heidegger T. Putting the 'point' back into the ritual: a binary approach to difficult airway prediction. Anaesthesia. 2017 Mar; 72(3):283-288. PMID: 27891606
15. Nørskov AK, Wetterslev J, Rosenstock CV, Afshari A, Astrup G, Jakobsen JC, et al. Effects of using the simplified airway risk index vs usual airway assessment on unanticipated difficult tracheal intubation-a cluster randomized trial with 64,273 participants. Br J Anaesth. 2016; 116(5):680-689. PMID: 27106972
16. Jain N, Das S, Kanchi M. Thyromental height test for prediction of difficult laryngoscopy in patients undergoing coronary artery bypass graft surgical procedure. Ann Card Anaesth. 2017; 20(2):207-211. PMID: 28393782
17. Merli G, Guarino A, Della Rocca G, Frova G, Petrini F, SorbellonM, et al. Recommendations for airway control and difficult airway management in thoracic anesthesia and lung seperation procedures. Minerva anestesiologica 2009; 75(1-2):59-78;9-96. PMID: 18987567
18. Cormack RS, Lehane J. Difficult tracheal intubation in obstetrics. Anaesthesia 1984; 39(11): 1105-1111. PMID: 6507827
19. Akhlaghi M, Abedinzadeh M, Ahmadi A, Heidari Z. Predicting difficult laryngoscopy and intubation with laryngoscopic exam test: A new method. Acta medica Iranica 2017; 55(): 453-458. PMID: 28918615
20. Schroeder RA, Pollard R, Dhakal I, Cooter M, Aronson S, Grichnik K, et al. Temporal trends in difficult and failed tracheal intubation in a regional community anesthetic practice. Anesthesiology. 2018; 128(3):502-510. PMID: 29189209
21. el-Ganzouri AR, McCarthy RJ, Tuman KJ, Tanck EN, Ivankovich AD. Preoperative airway assessment: predictive value of a multivariate risk index. Anesthesia and analgesia 1996; 82(6): 1197-204. PMID: 8638791
22. Qudaisat IY, Al-Ghanem SM. Short thyromental distance is a surrogate for inadequate head extension, rather than small submandibular space, when indicating possible difficult direct laryngoscopy. Eur J Anaesthesiol. 2011; 28(8):600-606. PMID: 21610502
23. Al Ramadhani S, Mohamed LA, Rocke DA, Gouws E. Sternomental distance as the sole predictor of difficult laryngoscopy in obstetric anaesthesia. British journal of anaesthesia 1996; 77(3): 312-316. PMID: 8949801
24. Prakash S, Mullick P, Bhandari S, Kumar A, Gogia AR, Singh R. Sternomental distance and sternomental displacement as predictors of difficult laryngoscopy and intubation in adult patients. Saudi J Anaesth. 2017; 11(3):273-278. PMID: 28757825
25. Mallampati SR, Gatt SP, Gugino LD, Desai SP, Waraksa B, Freiberger D, Liu PL. A clinical sign to predict difficult tracheal intubation: a prospective study. Can Anaesth Soc J 1985;32:429-34
26. Braz LG, Braz DG, Cruz DS, Fernandes LA, Módolo NS, Braz JR. Mortality in anesthesia: a systematic review. Clinics (Sao Paulo) 2009; 64:999-1006
27. Wilson ME, Spiegelhalter D, Robertson JA, Lesser P. Predicting difficult intubation. Br J Anaesth 1988;61:211-6
28. Oates JD, Macleod AD, Oates PD, Pearsall FJ, Howie JC, Murray GD. Comparison of two methods for predicting difficult intubation. Br J Anaesth 1991;66:305-309
29. Jonathan L. Benumof. Management of the difficult adult airway witn special emphasis on awake tracheal intubation. Anesthesiology 1991; 75:1087-1110
30. Khan ZH, Kashfi A, Ebrahimkhani E. A comparison of the upper lip bite test (a simple new technique) with modified Mallampati classification in predicting difficulty in endotracheal intubation: a prospective blinded study. Anesth Analg 2003;96:595-9
31. Practice guidelines for management of the difficult airway: An updated report by the American Society of Anaesthesiologists Task Force on management of the difficult

airway. Anesthesiology 2003;98:1269-77
32. Benumof JL. Intubation difficulty scale: Anticipated best use. Anesthesiology 1997;87:1274-6
33. Shailaja S, Nichelle S.M, Shetty AK, Hegde BR. Comparing ease of intubation in obese and lean patients using intubation difficulty scale. Anesthesia: Essays and Researches. 2014;8(2)
34. Sanyal R, Ray S, Chakraverty P, Bhattacharya MK. Comparison of airway assessment by Mallampati classification and Cormack and Lehane grading in Indian population. Indian Journal of Clinical Anaesthesia. 2019;6(1):140-142
35. Tham EJ, Gildersleve CD, Sanders LD, Mapleson WW, Vaughan RS. Effects of posture, phonation and observer on Mallampati classification. Br J Anaesth 1992;68:32-8
36. T.S Yildiz, F. Korkmaz, M. Solak, K. Toker et al. Prediction of difficult tracheal intubation in Turkish patients: a multi-center methodological study. Eur J Anaesth. 2007;24:1034-1040
37. Caplan RA, Posner KL, Ward RJ, Cheney FW. Adverse respiratory events in anesthesia: A closed claims analysis. Anesthesiology 1990;72:828-33
38. Benumof JL, Scheller MS. The importance of transtracheal jet ventilation in the management of the difficult airway. Anesthesiology 1989;71:769-778
39. Benumof JL. Difficult Laryngoscopy:obtaining the best view. Can J Anaesth 1994;41(5):361-365
40. Langeron O, Masso E, Huraux C, Guggiari M, Bianchi A, Coriat P, et al. Prediction of difficult mask ventilation. Anesthesiology 2000;92:1229-36
41. Butler PJ, Dhara SS. Prediction of difficult laryngoscopy:An assessment of thyromental distance and Mallampati predictive tests. Anaesth Intensive Care 1992;20:139-42
42. Savva D. Prediction of difficult tracheal intubation. Br J Anaesth 1994;73:149-53
43. Huzefa SN, Ramesh K. Comparative study between modified Mallampati and extended Mallampati and Thyromental distance in predicting difficult intubation in obese individuals. Indian J Anaesth 2017;4(1)
44. Crosby ET, Cooper RM, Douglas MJ, Doyle DJ, Hung OR, Labrecque P et al. The unanticipated difficult airway with recommendations for management. Can J Anaesth 1998;45:757-76
45. Frerk CM. Predicting difficult laryngoscopy. Anaesthesia 1991;46:1005-8
46. Schmitt HJ, Kirmse M, Radespiel-Troger M. Ratio of patient's height to thyromental distance improves prediction of difficult laryngoscopy. Anaesth Intensive Care 2002;30:763-5
47. Sharma D, Prabhakar H, Bithal PK, Ali Z, Singh GP, Rath GP, et al. Predicting difficult laryngoscopy in acromegaly: A comparison of upper lip bite test with modified Mallampati classification. J Neurosurg Anesthesiol 2010;22:138-43
48. Badawi-Fayad J, Cabanis EA. Three-dimensional Procrustes analysis of modern human craniofacial form. Anat Rec 2007;290:268-76
49. Karkouti K, Rose DK, Ferris LE, Wigglesworth DF, Meisami-Fard T, Lee H. Inter-observer reliability of ten tests used for predicting difficult tracheal intubation. Can J Anaesth 1996;43:554-9
50. Savva D, Maroof M. Letter to the editor: Predicting difficult endotracheal intubation. Anesth Analg 1996;83:1129-35
51. Rose K, Cohen MM. The airway: Problems and predictions in 18,500 patients. Can J Anaesth 1994;41(5):372-83
52. Bilgin H, Ozyurt G. Screening tests for predicting difficult intubation. A clinical assessment in Turkish patients. Anaesth Intensive Care 1998;26:382-386
53. Hanley JA, McNeil BJ. The meaning and use of the area under a receiver operating characteristic (ROC) curve. Radiology 1982;143:29-36
54. Aitkenhead AR. Injuries associated with anaesthesia. A global perspective. Br J Anaesth 2005;95:95-109
55. Tse JC, Rimm EB, Hussain A. Predicting difficult endotracheal intubation in surgical patients scheduled for general anesthesia: A prospective blind study. Anesth Analg 1995;81:254-8
56. Iohom G, Ronayne M, Cunningham AJ. Prediction of difficult tracheal intubation. Eur J Anaesthesiol 2003;20:31-6
57. Krishna HM, Agarwal M, Dali JS, Tampal P. Role of ratio of patient's height to thyromental distance for prediction of difficult airway in Indian population. J Clin Pharmacol 2005;21:257-60
58. Samsoon GL, Young JR. Difficult tracheal intubation: A retrospective study. Anaesthesia 1987;42:487-90
59. Ezri T, Weisenberg M, Khazin V, Zabeeda D, Sasson L, Shachner A, et al. Difficult laryngoscopy: Incidence and predictors in patients undergoing coronary artery bypass surgery versus general surgery patients. J Cardiothorac Vasc Anesth 2003;17:321-4
60. Hogan K, Rusy D, Springman SR. Difficult laryngoscopy and diabetes mellitus. Anesth Analg 1998;67:1162-5