Original Article

Comparison of Thyromental Height Test (TMHT) with Modified Mallampati Score, Thyromental Distance, Neck Circumference, Neck Extension and Inter Incisor Gap, as a Predictor of Difficult Laryngoscopy: A Prospective Study

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ABSTRACT

Introduction: Anticipating and preparing for difficulty in airway management is crucial. There are many bedside physical examination indices available for prediction of difficult laryngoscopy and intubation. These tests are easy to perform and cost effective. We have tried to evaluate the role of Thyro Mental Height Test (TMHT) as a simple bedside difficult airway predictive test and compared it with Modified Mallampati test (MMT), Thyro Mental Distance (TMD), Neck Circumference (NC), Neck Extension (NE) and Inter Incisor Gap (IIG). We hypothesized that TMHT is more accurate than MMT, TMD, NC, NE and IIG.

Method: 100 consecutive patients aged between 18-65 years of ASA grade 1 and 2 requiring GA for elective surgery were assessed for airway evaluation with TMHT, MMT, TMD, NC, NE and IIG. After anaesthesia induction the best laryngoscopic view which lead to intubation was assigned as grade of 1 to 4 according to Cormack Lehane grading. Grade 3 and 4 were considered difficult.

Results: Sensitivity of TMHT, MMT, TMD, NC, NE and IIG were 91.67 %, 75%, 25%, 25%, 50% and 58.33%, respectively. Highest sensitivity of TMHT means it is a good test to predict difficult intubations. Specificity of TMHT, MMT, TMD, NC, NE and IIG were 92.05 %, 88.64%, 72.73%, 16%, 70.45%, 86.36%, respectively. Highest specificity of TMHT means it is a good test to predict easy intubations. Accuracy of TMHT (92%) was higher than other tests, which testifies that the TMHT carries lower false positive and negative values in predicting a difficult laryngoscopic view.

Conclusion: Our study demonstrated that the Thyromental Height Test (TMHT) is the best predictive test for difficult laryngoscopy out of all the predictive tests evaluated.

Key words: Difficult airway, prediction, bedside tests, TMHT, MMT, TMD, NC, NE, IIG.

INTRODUCTION:

Airway serves a dynamic and important physiological role in the human body. Air passage is required for the delivery of filtered and humidified respiratory gas to the alveoli. During anaesthesia, an anaesthesiologist uses this air passage to deliver anaesthetic gases to the alveoli. Airway access can be gained by an endotracheal tube or other airway devices that are introduced directly into the patient's upper or lower airway passage. Anaesthesiologist should ensure adequate gas exchange for patient.[1]

Upper airway is an extraordinary complex anatomical region. Anticipating and preparing for difficulty in airway management is crucial. Detection of possible difficult airway is very important. Unanticipated difficult tracheal intubation is a significant source of morbidity and mortality in anaesthetic practice. Difficult laryngoscopy and intubation can even cause hypoxic damage to brain. Failure to maintain oxygenation for more than a few minutes could result in anoxic brain injury and death. Difficulties with airway management remain among the leading causes of serious perioperative problems. About 30-40 % of deaths in anaesthesia are because of inability to manage difficult airway.[2]

Tracheal intubation with the help of endotracheal tube that traverses the vocal cords providing continuity from anaesthesia circuit to trachea is considered to be the 'Gold Standard' of airway management because it isolates respiratory tract from GI system hence there is minimum risk of gastric content.[3] An airway evaluation including history, physical examination and other demographic tests, should be performed for all patients who are undergoing general anaesthesia. A difficult airway is a situation where conventionally trained anaesthesiologist experiences difficulty for mask ventilation of upper airway, difficulty with tracheal intubation or both. Knowledge of difficult airway predictors can alert anaesthesiologist and one can do better management, optimal patient preparation, proper technique and equipment selection. This leads to successful airway management and avoids more traumatic methods of securing the airway from being adopted.[4] There are many bedside physical examination indices available for prediction of difficult laryngoscopy and intubation. These are modified Mallampati score, thyromental distance, hyomental distance, sternomental distance, thyrosternal distance, neck circumference, neck extension, inter incisor gap, upper lip bite test, thyromental height test. These tests are easy to perform and cost effective. But no single test is 100% predictor of difficult laryngoscopy and intubation.[5]

Recent studies have shown a newer indice, Thyromental Height Test (TMHT) to be of valuable addition to the parameters of airway assessment. We have tried to evaluate the role of TMHT as a simple bedside difficult airway predictive test and compared it with modified Mallampati score, thyromental distance, neck circumference, neck extension and inter incisor gap. In this study, we compared the sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of thyromental height test with modified Mallampati score, thyromental distance, neck circumference, neck extension and inter incisor gap.[6]

METHODS

The study was conducted over a 15-month period as a prospective, observational, single blind evaluation at a tertiary teaching hospital, and was approved by the Hospital Ethics Committee. After obtaining informed consent, 100 patients, American Society of Anesthesiologists grade I–II, aged 18–65 years presenting for various elective surgeries under general anaesthesia were recruited. Patients with a body mass index >35 kg/m^2, those with neuromuscular disorders, craniofacial abnormalities, abnormal dentition, and unable to sit up were excluded.

Participants were premedicated with injection glycopyrrolate 10mcg/kg and analgesic given as per surgery. Preoperative airway assessments were done by a single researcher. TMHT was performed using a digital depth caliper and measured between the anterior border of the thyroid cartilage (on the thyroid notch just between the two thyroid laminae) and the anterior border of the mentum (on the mental protuberance of the mandible), with the patient lying supine with a closed mouth. A neutral position of head and neck was maintained with a pillow beneath the head. A digital depth gauge was used to measure the height. A height less than 50 mm was considered to be a predictor of difficult laryngoscopy.

The modified Mallampati score (Samsoon and Young's modification) was assessed in a sitting posture, with the mouth fully opened, the tongue protruded, and without phonation. The IIG was assessed in a sitting position with the back supported and asking the patient to widely open the mouth. A cutoff less than 4.5 cm was considered as a predictor of difficult laryngoscopy. TMD was measured as a straight line using a ruler between the upper border of the thyroid cartilage and the bony point of mentum, a measurement of <6.5 cm was considered to be a predictor of difficult laryngoscopy. A neck circumference above 37.5 cm at the level of thyroid cartilage was deemed as a predictor of difficult laryngoscopy. Neck extension was measured in the sitting position and facing forward with the shoulder and spine supported. Participants were asked to extend the neck without moving shoulders, with the mouth closed. The angle traversed between the external auditory canal to the tip of the nose was measured using a goniometer, and movements less than 90 degrees were considered to be significant.

After applying standard monitoring, anaesthesia was induced with fentanyl 1–2 µg/kg IV, propofol 1.5–2 mg/kg IV and endotracheal intubation was facilitated with muscle relaxation with atracurium 0.5 mg/kg IV. Neuromuscular blockade was assessed after 3 min of mask ventilation using a single twitch response from a peripheral nerve stimulator. Laryngoscopy was accomplished in a sniffing position using a #3 or #4 Macintosh blade by a group of anaesthetists who had at least 3 years of experience. They were blinded to the TMHT assessment. Laryngoscopic view without backward-upward-rightward pressure manoeuver was graded as per the modified Cormack–Lehane (CL) scale from I–IV (Grade I: full view of the vocal cords, Grade IIa: partial view of the vocal cords, Grade IIb; only arytenoids and epiglottis seen, Grade III: only epiglottis visible, Grade IV: neither the epiglottis nor glottis visible). Grade I and IIa were categorised as easy visualisation and grade IIb and above were categorised as difficult visualisation. All the difficult laryngoscopies were visualised by external laryngeal pressure and intubations done using bougie or McCoy blade. The gradings were noted by the same investigator doing the intubation.

Data of the preoperative bedside screening tests and laryngoscopic visualisation were used together to assess and validate the TMHT in predicting difficult laryngoscopy.Statistical analysis was performed using SPSS version (Version 19.0, SPSS Inc; Chicago, IL, USA). The sensitivity, specificity, PPV, NPV for each airway assessment tool were calculated and the data were analysed using the Student's t-test, Fisher's exact test, and Yates Chi-square test and Independent t-test for intergroup comparison (Open EPI Software). Statistical significance was defined as $P < 0.05$.

RESULTS

Sample size was 100 patients and classified into 2 groups prospectively based on their Cormack-Lehane grading, **GROUP E** (Easy laryngoscopy and intubation), Patients with C-L grades I and II were considered in this group. **GROUP D** (Difficult laryngoscopy and intubation), Patients with C-L grades III and IV were considered in this group. Out of 100 patients, 88 patients were classified into Group E rest 12 patients were classified into group D. Group E: N - 88 , Group D: N – 12

The incidence of difficult laryngoscopy was 12%, of which 11 had CL grade 3 and 1 had CL grade IV view and there were no failed intubations. With BURP (backward, upward, rightward pressure) manoeuvre 4 of the 12 patients had an improvement in their views. A bougie/stylet was used to facilitate intubation in 12 of these difficult laryngoscopies. A single attempt intubation was accomplished in 76 patients and the remaining 12 required two attempts.

Table 1: Demographic data of the patients

Patient Characteristics	Easy Group Mean±SD/n (%)	Difficult Group Mean±SD/n (%)
Age(years)	35.19±13.26	40.75±6.60
Height(cm)	156.23±3.59	160.58±4.15
Weight(kg)	56.67±5.59	72.58±7.27
Gender		
Male	38.63%	50%
Female	61.36%	50%

SD: Standard deviation

Table 2: Comparison Between C-L Grades and Five Preoperative Predictors (TMHT, MMT, TMD, NC, NE AND IIG)

Test	Easy	Difficult	Total	P Value
TMHT				
Easy	81	11	92	0.0001
Difficult	7	1	8	
MMT				
Easy	76	3	79	0.0001
Difficult	12	9	21	
TMD				
Easy	80	9	89	0.137
Difficult	8	3	11	
NC				
Easy	7	9	16	0.0001
Difficult	81	3	84	
NE				
Easy	62	6	68	0.154
Difficult	26	6	32	
IIG				
Easy	73	5	78	0.001
Difficult	15	7	22	

Our results suggest that, as a single test, TMHT at a 50 mm cut-off had the highest sensitivity, specificity, PPV, NPV and was the most accurate when compared with modified Mallampati score, IIG, TMD, NC, and neck extension. Modified Mallampati score was close to TMHT in terms of sensitivity and specificity which was followed by IIG.

DISCUSSION

Analysis of demographic profile: Demographic profile was analyzed for any statistical significance in the mean.

Age distribution: We included patients in the age group of 18-65 years in our study. Mean age of patient in Group E was 35.19±13.26 and in Group D was 40.75 ± 6.60 years. Thus, age wise distribution of patients was comparable in all the groups. P value (0.157) as calculated by the independent t test was insignificant (p value>0.05). There was no statistically significant difference in terms of age distribution between both the groups.

Weight distribution: The mean and standard deviation of weight showed a significant difference among both the groups. P value (0.0001) as calculated by the independent t test was significant (P value<0.05). Based on weight distribution, the patients in both the groups showed a significant difference. So, this concludes that the weight had a significant contribution to the occurrence of difficult intubation.

This result is comparable with the study conducted by W. H. Kim et al.[7] It was a prospective observational study. The incidence of difficult tracheal intubation in 123 obese (BMI≥27.5 kg m22) and 125 non-obese patients was compared. Difficult intubation was determined using the intubation difficulty scale (IDS≥5). It was concluded that obese patients had a difficult intubation.

The TMHT observations from our study are comparable to the original data from an Iranian population (314 patients), and subsequent data from an Indian population (345 patients) utilising similar cut-off at 50 mm.[16] The sensitivity 91.67%, specificity 92.05%, PPV 61.11% and NPV 98.78% of TMHT from our study is comparable to the original Iranian study done by Etezadi et al[8] that produced the corresponding values as 82.6%, 99.35%, 90.45% and 98.6% respectively and also comparable to the study done by Jain N., S. Das et al[9] that produced the corresponding values as 75%, 97%, 73%, and 97% respectively. Also comparable to the study done by K. Venkata Rao et al[10] that produced the corresponding values as 84.62%, 98.97%, 88%, and 98.63% respectively and also comparable to the study done by Nurullah M. et al [11] that produced 92.7% sensitivity, 93.5% specificity, 85.4% positive predictive values and 97.8% negative predictive value.

In contrast, study conducted by Sagar Siddanagouda et al[12] produced sensitivity, specificity, NPV and accuracy of TMHT, 50%, 57.14%, 94%, 56.6% respectively which was way below the results obtained by Etezadi et al.[8] This variation in results may be due to the following reasons. 1. As all the patients were examined in supine position which inherently leads to cervical extension, the degree of extension with mouth closed depends on how cooperative was the patient. If patients extend his head further there was increase in TMHT, thereby creating false negative test. 2. Slight flexion of neck during assessment may lead to increase false positive results, as in that study[12] in which out of the sixty patients, they encountered 24 false positive results which resulted in low specificity and accuracy of TMHT.[3] Ideal position to assess airway in TMHT test is still not clear. Having said all the above reasons, we think this is a simple inexpensive easily done test to assess the airway provided ideal position to do TMHT as patient lying supine with his/her head in neutral position i.e. resting the head on the occiput, looking straight at the ceiling.

In our study TMHT shows high sensitivity (91.67%), so that it identifies most patients in whom intubation will truly be difficult and high positive predictive value (61.11%), so that only few patients with airways easy to intubate are subjected to the protocol for management of a difficult airway.

Table 3: Diagnostic validity profiles of airway assessment tests for predicting difficult laryngoscopy

Test	Sensitivity	Specificity	Ppv	Npv	Accuracy
TMHT	91.67%	92.05%	61.11%	98.78%	92.00%
MMT	75.00%	88.64%	47.37%	96.30%	87.00%
TMD	25.00%	72.73%	11.11%	87.67%	67.00%
NC	25.00%	16.00%	03.45%	64.00%	16.96%
NE	50.00%	70.45%	18.75%	91.18%	68.00%
IIG	58.33%	86.36%	36.84%	93.83%	83.00%

(PPV – Positive predictive value; NPV – Negative predictive value; TMHT – Thyromental height test; MMT – modified Mallampati test; IIG – Inter incisor gap; TMD – Thyromental distance; NC - Neck circumference; NE – Neck extension)

Though the sensitivity and specificity of modified Mallampati score in our study (75% and 88.64%) are comparable with that of an earlier meta-analysis by Shiga et al.[13] (49% and 86%, respectively), recent data shows that modified Mallampati score is a poor predictor of difficult laryngoscopy and intubation. Mallampati assessment is susceptible for incorrect evaluation and gross inter-observer variability.

At a 4.5 cm cut-off, our sensitivity and specificity of IIG (58.33% and 86.36%) are reasonably comparable to that of the previously published data (42% and 97%, respectively).[14] TMD (<6.0 cm) and neck circumference (>37.5cm) had the least sensitivity and PPV, implying that both these predictors cannot be used individually for predicting difficult laryngoscopy. TMD has been the most questioned of all the bedside tests. A meta-analysis comprising 35 studies including 50,760 patients.[13] concluded that the diagnostic value of TMD was unsatisfactory due to wide range in sensitivity, possibly due to different cut-off points (4– 7 cm). Neck extension (90^0) also had low sensitivity and PPV. Although cervical spine movements greater than 90 degrees has been contemplated warranting easy laryngoscopy and intubation.[15,] gross inter-observer variability and access to goniometer limit its clinical utility.

So, comparing the above parameters, TMHT comes out to be a better predictor of difficult laryngoscopy over modified Mallampati test, TMD, neck circumference, neck extension and IIG. TMHT may have a role in physically and mentally disabled patients, as well as in those who cannot cooperate for other tests such as the modified Mallampati score and upper lip bite test. Also, we found out that TMHT is easy to perform and very convenient to use as a bedside test.

The findings of our study are limited by several limitations:

First, our study was limited to patients scheduled for elective surgery and results of this study are applicable to these patients only. Second, we investigated single measures, but combination of multiple measures might further increase sensitivity. Third, the TMHT is usually measured using a semi-electronic device (Digital depth gauge) and there is a potential for certain inter-observer variability. Fourth, patients were examined in supine position with his/her head in neutral position; if patient extend his head further, there is increase in TMHT and thereby creating false negative test and slight flexion of neck during assessment may lead to increase false positive results.

CONCLUSION

Thyromental Height Test (TMHT) could easily predict 91.67% of difficult laryngoscopy and intubations (sensitivity) and 92.05% of easy laryngoscopy and intubations (specificity). Moreover, 61.11% of the laryngoscopy and intubations declared as easy were, in fact, found to be easy (positive predictive value), whereas 98.78% of the laryngoscopy and intubations predicted to be difficult were, in fact, difficult (negative predictive value) while attempting laryngoscopy and intubation. Our study demonstrated that the Thyromental Height Test (TMHT) is the best predictive test for difficult laryngoscopy out of all the predictive tests evaluated.

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