Orginal Article

Accuracy of Ratio of Height to Thyromental Distance in Predicting Difficult Visualization of Larynx

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Abstract

Introduction: Difficult laryngoscopy (DL) and intubation (DI) is a significant contributing cause in anaesthesia-related morbidity and mortality. To identify potentially difficult airways, a number of anthropometric measurements have been recommended. This study is aimed to evaluate the accuracy of Ratio of Height to Thyromental Distance (RHTMD) to predict difficulty in the visualization of the larynx in patients undergoing elective surgery under general anaesthesia.

Methods: We conducted a prospective, observational study including 94 patients of ASA PS I and II patients scheduled for elective surgery requiring general anaesthesia with endotracheal intubation. Preoperatively, airway assessments were performed including TMD and RHTMD. During intubation CL grading of the patient was noted by attending anaesthesiologist. TMD, RHTMD, CL gradings and other parameters measured were analysed using R programming language. The sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of RHTMD in predicting the difficult visualization of larynx during intubation was assessed.

Results: The total incidence of difficult laryngoscopy, defined by CL III and IV was 5.3%, and sensitivity, specificity, PPV, NPV and accuracy of RHTMD were 40%, 98%, 50%, 97% & 94% respectively. In ROC the area under the curve (AUC) was 0.937, 95% CI 0.854-1.0 indicating high diagnostic accuracy in predicting difficult visualization of the larynx.

Conclusion: RHTMD can be used as a bedside preoperative test for predicting difficult laryngoscopy with higher specificity, negative predictive value and accuracy.

Keywords: Difficult laryngoscopy; Height; Intubation; Larynx; Thyromental distance

INTRODUCTION

Airway management is integral component of general anaesthesia. Failure to secure and maintain the airway may lead to failed oxygenation and its consequences which may be catastrophic.[1] A difficult airway includes the clinical situation in which anticipated or unanticipated difficulty or failure is experienced by a physician trained in anaesthesia care, including but not limited to one or more of the following: facemask ventilation, laryngoscopy, and intubation, ventilation using a supraglottic airway, tracheal intubation, extubation, or invasive airway.[2]

The preoperative prediction of a difficult airway is crucial in anaesthetist's practice, as 85% of all mishaps regarding airway management result in permanent cerebral damage, and up to 30% of all anaesthetic deaths.[3] Hence, preoperative airway assessment and planning is essential for airway management. Among the different preoperative bedside airway assessment tests used, the ratio of height to thyromental distance (RHTMD) and the ratio of height to sternomental distance (RHSMD) have been taken as beneficial screening tests for the prediction of difficulty in laryngoscopy.[4] In addition to the measure of mandibular space (TMD), it also addresses the body proportions of the patient, hence, RHTMD is reported to have better predictability in airway assessment.[5] It is a simple bedside screening tool, without any additional cost, or any harm or discomfort to patients. It is believed to have better specificity, and higher accuracy, sensitivity, and negative predictive value (NPV).[5] We conducted this study to estimate the accuracy of RHTMD to predict difficult laryngoscopy in Nepalese population.

METHODS

This is prospective observational study conducted in Tribhuvan University Teaching Hospital (TUTH) and Manmohan Cardiothoracic Vascular and Transplant Centre (MCVTC) after obtaining ethical clearance from Institutional Review Committee (IRC), Institute of Medicine (IOM). The sample size calculated was 94, which was based on the study by Kaniyil et al.[6] The sampling method used was non probability sampling technique. Patients between the age of 16-65 years, ASA I and II, patient undergoing surgery in general anaesthesia requiring intubation were included in the study. Patient refusing to be the part of study, distorted anatomy of head and neck, cervical spine pathology, inability to stand, need for rapid sequence intubation, midline neck swellings, BMI > 30kg/m^2, known difficult airway were excluded from study. After explaining about the study, written informed consent was obtained who were willing to be the part of the study.

One day before the surgery, detail pre anaesthetic checkup was done which included detailed history, airway assessment, systemic examination and review of investigation. During airway assessment thyromental distance (TMD) was measured in centimetres, with a rigid ruler from the bony point of the mentum to the tip of the thyroid notch with the head fully extended and mouth fully closed. The height of the patient was also measured in centimetres. Then, the ratio (height in cm: TMD in cm) of height of the patient to thyromental distance (RHTMD) was calculated. RHTMD <25 as grouped as Easy-RHTMD and >25 was grouped as Difficult-RHTMD.On the day of surgery, standard preparation of the OT was done including difficult airway cart ensuring the availability fibreoptic bronchoscope for suspected case of a difficult airway. After ensuring the patient identity and performing the WHO surgical safety checklist, patients were shifted to the operation theatre, attached to standard monitors, IV access obtained in the non-dominant hand. Induction of general anaesthesia was done using standard drugs in doses as per the body weight of the patient (Inj. Fentanyl 2mcg/kg, Inj. Propofol in titrated dose of 1.5-2.5mg/kg). Muscle relaxant vecuronium 0.15 mg/kg was given after ensuring the adequacy of manual bag and mask ventilation. After 3 minutes of bag and mask ventilation, with the head in sniffing position, direct laryngoscopy was done with a Macintosh blade of appropriate size by the attending anaesthesiologists. Cormack-Lehane grade was assessed as follows by the intubating anaesthesiologist as grade I: full view of glottis, grade II: partial view of glottis or arytenoids, grade III: only epiglottis seen, grade IV: epiglottis not seen. Cormack-Lehane grades I and II were grouped as Easy visualization of the larynx (EVL) and Cormack-Lehane grades III and IV were grouped as Difficult visualization of the larynx (DVL).

Whenever intubation was not possible with conventional laryngoscopy, ASA guidelines for difficult airway were followed as per the decision of the attending anaesthesiologist. After endotracheal intubation further anaesthetic management was continued as per the requirements and standards decided by the attending anaesthesiologist. Data were collected in a proforma. Statistical analysis was done using R programming language. Descriptive summary of the study patients was presented by mean (SD) or median (IQR) and proportions. Sensitivity, Specificity, Positive Predictive Value (PPV), Negative Predictive Value (NPV), and accuracy were calculated using the standard formulae and p value of < 0.05 was considered statistically significant.

RESULTS

A total of 94 patients were included in our study. The demographic characters of study population are mentioned in the table 1.

Table 1. Demographic data of patients

Characteristics	Value
Gender n (%)	
Male	34(36.17%)
Female	60(63.82%)
Age (years), Mean ± SD	42.4 ± 11.4
Weight (kg), Mean ± SD	62.4 ± 9.8
Height (cm), Mean ± SD	159.4 ± 7.9
BMI (kg/m^2), Mean ± SD	24.6 ±3.3
ASA Status, n (%)	
ASA I	74 (78.7%)
ASA II	20 (21.3%)

The thyromental distance, ≤ 6.5 cm, was observed in 8

patients (8.51%) and > 6.5 cm was observed in 86 patients (91.4%). TMD among the study population was not normally distributed. The median TMD was 7.5cm and interquartile range of 1.0 cm and mean TMD was 7.6 ± 0.8. Similarly, out of a total 94 study population, RHTMD, <25 was observed in 90 patients (95.7%) and ≥25 was observed in 4 patients (4.3%). The mean RHTMD observed was 21.1 ± 2.08.

On direct laryngoscopy, CL grade I was recorded in 58 patients (61.7%), CL grade II was recorded in 31 patients (33%), and CL grade III was recorded in 5 patients (5.3%). No patients had CL grade IV.

Table 2. Cormack-Lehane Grading (N=94)

Cormack-Lehane Grade	Frequency(n)	Percentage(%)
Grade I	58	61.7
Grade II	31	33
EVL (Grade I and II)	89	94.7
Grade III	5	5.3
DVL (Grade III and IV)	5	5.3
EVL-Easy Visualization of Larynx; DVL: Difficult visualization of Larynx		

Comparison of TMD, RHTMD, and CL grading is shown in table 3.

Table 3. Distribution of difficult and easy TMD, RHTMD, and CL grade in study population

	TMD	RHTMD	CL grade
Difficult	8 (8.5%)	4 (4.3%)	5 (5.3%)
Easy	86 (91.5%)	90 (95.7%)	89 (94.7%)
TOTAL	94(100%)	94 (100%)	94 (100%)

Among the total, 4 patients were grouped as difficult based on RHTMD (> 25) among those falling in difficult group of RHTMD, 2 had true DVL (CL grade III and IV) whereas 2 had EVL (CL grade I and II). Likewise, among 90 patients grouped as Easy RHTMD (RHTMD < 25), 87 had true EVL whereas 3 had DVL. The relationship between RHTMD and CL grade was not statistically significant (p = 0.15). The comparison of RHTMD and CL grade is shown in table 4.

Table 4. Comparison of RHTMD Prediction (Cut-off ≥ 25) and Cormack-Lehane Grade (N=94)

	Laryngoscopy by CL grade				
		Difficult	Easy	Total	p-value
RHTMD	Difficult ≥ 25	2 (TP)	2 (FP)	4	0.15
	Easy < 25	3 (FN)	87 (TN)	90	
	Total	5	89	94	

TP: True Positive, FP: False Positive, TN: True Negative, FN: False Negative

Table 5. Diagnostic Accuracy of RHTMD (Cut-off ≥ 25) for Predicting Difficult Laryngoscopy (N=94)

	Sensitivity	Specificity	PPV	NPV	Accuracy
RHTMD	40%	98%	50%	97%	94%

PPV: Positive Predictive Value, NPV: Negative Predictive Value

Receiver Operating Characteristics (ROC) curve analysed for evaluating the ability of RHTDM for predicting difficult visualization of the larynx. The Area under the curve (AUC) was 0.937, 95% CI 0.854-1.0 indicating high diagnostic accuracy in predicting difficult visualization of the larynx.

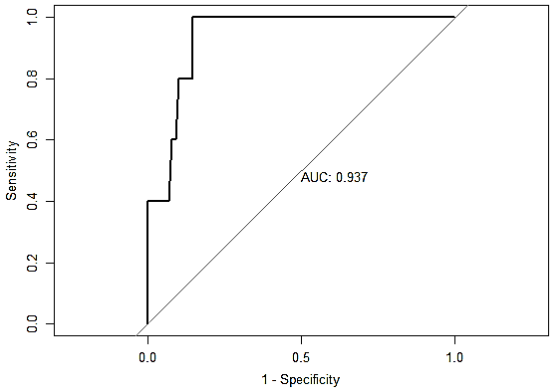

Figure 1. AUC of RHTMD

DISCUSSION

This study was conducted to estimate the accuracy of RHTMD in predicting difficult visualization of the larynx based on the Cormack-Lehane grades. Schmitt et al.[5] introduced RHTMD, as a better predictor of difficult laryngoscopy than TMD. RHTMD takes into consideration the body proportions of the patient rather than a single measurement as TMD,

hence RHTMD is considered to be a better predictor than TMD. In our study, RHTMD of $\geq$ 25, assumed as a difficult group, was observed in 4 patients (4.3%), and RHTMD of $<$ 25, which was assumed as an easy group was observed in 90 patients (95.7%). In our study we found RHTMD was 40% sensitive, 98% specific with 50% of positive predictive value, 97 % of negative predictive value and 94 % of accuracy. Similarly, this study also found that the diagnostic accuracy of RHTMD in predicting the difficult visualization of the larynx was high as denoted by the value of area under the curve (AUC) 0.937, 95% CI 0.854-1.0.

The incidence of difficult laryngoscopy was 5.3% in our study, which is comparable with the reported incidence of 1.5%–13%.[7–9]predictive reliability is unclear. Because the ratio of height to thyromental distance (RHTMD A study done in Nepal by Khatiwada et al. found 3.8% of the patients had difficult intubation.[10]though it is not the exact measure of intubation difficulty. Our objectives were to find out the better predictor of difficult laryngoscopy amongst the routinely used tests and also to find the ability of difficult laryngoscopy to predict difficult intubation.\nMETHODS: This prospective, observational study involved 314, ASA I/II adult patients requiring endotracheal intubation. Measurement of sternomental, thyromental and inter-incisor distances and gradings of mandibular protrusion and modified Mallampati were done. Statistical values including sensitivity and specificity of these tests were calculated to find the better predictor of difficult laryngoscopy. Cormack and Lehane laryngoscopy grade III/IV was defined as difficult laryngoscopy. Requirement of >3 attempts for endotracheal intubation was defined as difficult intubation.\nRESULTS: The sensitivity of the Modified Mallampatti Test for predicting difficult laryngoscopy was highest, 83% compared to other tests. Total 12 (3.8% The wide range of incidence reported in studies could be due to several reasons such as lack of uniformity in the practice of laryngoscopy and intubation as in head and neck positioning, application of Sellick's manoeuvre, external laryngeal manipulation, multiple attempts, type of blade used, and varying skill of anesthesiologist.[9] Similar study by Kaniyil et al.[6] concluded that among the 4 indices (RHTMD, thyromental distance, modified Mallampati test, and upper lip bite test), RHTMD was the single best test with a sensitivity of 62.5%, specificity of 96.1%, PPV of 47.6%, and NPV of 97.9%. CM et al[4] showed that RHTMD had a sensitivity of 62.5%, specificity of 100%, PPV of 100%, and NPV of 91.43%. Our study also showed that RHTMD has high specificity and high NPV which was comparable with other studies. A false positive result is important because a predicted difficult airway necessitates alternate approaches for airway management, which often require more time and resources at the cost of patient discomfort.

A prospective observational study by Safavi et al.[11] in 2011 compared RHTMD with MMT and ULBT in predicting difficult laryngoscopy showed there was no significant difference between the AUC of the ROC for the ULBT (0.709) and the RHTMD (0.711) score. The MMT was the most sensitive of the single tests with a sensitivity of 87.37%. The ULBT was the least sensitive of the single tests with a sensitivity of 66.01 but had the highest specificity and PPV compared with the other two tests. The RHTMD had the highest NPV and the AUC of ROC curve among single predictors which was in line with our study. In a study conducted by Shah et al.[12] 480 adult patients were assessed and graded for ULBT, RHTMD, TMD, MMT, IIG (Inter incisor gap), and HNM (Head and neck movement) and correlated with the Cormack and Lehane grade. ULBT and RHTMD had the highest sensitivity, specificity, positive predictive value, negative predictive value, and likelihood ratio, i.e., 74.63%, 91.53%, 58.82%, 95.7%, 31.765 and 71.64%, 92.01%, 59.26%, 95.24%, 8.96 respectively. The result of RHTMD is almost similar to our result i.e. high specificity and negative predictive value. They concluded that ULBT is the best predictive test for difficult laryngoscopy in apparently normal patients, but RHTMD can also be used as an acceptable alternative.

Similarly, a study by Schmitt et al.[13] showed AUC of RHTMD was significantly greater ($P < 0.007$) when compared to TMD, indicating a more accurate prediction by the RHTMD. A ratio of 25 for the RHTMD was found to be the optimal cut-off value to predict difficult laryngoscopy. When the sensitivity of both tests was 0.81, the RHTMD had a significantly greater specificity (0.91) than the TMD (0.73) and they concluded that RHTMD should be used instead of the TMD for prediction of difficult laryngoscopy. Our study also showed that RHTMD alone has the highest specificity and accuracy and can be reliably used for the prediction of difficult laryngoscopy. A study by Puneeth Kumar et al,[14] the AUC for RHTMD was 0.875 (0.730–1.000) which is comparable to our study indicating RHTMD to be a better predictor of difficult visualization of larynx. Similarly, another study by Shiva Kumar et al revealed AUC for RHTMD to be 0.87 which is also comparable to our study.[15]

We assume that there may be variability in the observer and performance while performing the laryngoscopy and CL grading, measuring the height and thyromental distance could have produced bias in our result. We did not include obstetrics patients, elderly and children in the study which could be our limitation. We did not analyse other airway assessment tests in our study which we assume to be the limitation of our study.

RHTMD can be used as a useful bedside screening test for preoperative prediction of difficult laryngoscopy in the general population. More studies with larger sample sizes in different populations are suggested for the documentation of our results. The safe outcome of anaesthesia continues to be an important goal for every anaesthesiologist. Unfortu-

nately, there is still no test or group of tests that can predict 100% of difficult laryngoscopies. Even though the internal validity in the present study seems adequate, it may not be applicable to all subgroups of the general population.

CONCLUSION

RHTMD can be used as a bedside preoperative test for predicting difficult visualization of larynx with higher specificity, negative predictive value, and accuracy.

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