Journal of Cardiovascular Disease Research

ISSN:0975 -3583,0976-2833 VOL14, ISSUE 04, 2023

Original research article

A study to predict the difficult laryngoscopy based on cormac lehane grading from the ratio of height to TMD in neurosurgery cases

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Abstract

The difficulty in achieving airway patency varies with anatomic and acquired individual patient factors. Thus performing an airway assessment preoperatively in identifying a patient for a potentially difficult intubation is of pivotal importance for the anaesthesiologist. Initially single preoperative airway assessment tests like mouth opening or Inter incisor gap (IIG), Head and neck movement (HNM), Modified mallampatti test (MMT), were used to predict difficult airway. A standard general anesthesia protocol was followed for all cases. All patients received premedication, inj midazolam 0.02 mg/kg, inj glycopyrrolate 0.01mg/kg and inj fentanyl 2 µg/kg intravenously, after attaching standard monitors. After preoxygenation with 100% O2 in each patient, anesthesia was induced with 5-7mg/kg of thiopentone sodium and 0.9 mg/kg of Rocuronium given intravenously to facilitate tracheal intubation after ensuring mask ventilation. Out of 212(81.53%) subjects with RHTMD less than 23.5cm, 5(1.92%) belonged to difficult intubation group. RHTMD more than 23.5cm was there in 48(18.4%) subjects and among them 34(13.07%) had difficult intubation and this is statistically significant with p value 0.001.

Keywords: Difficult laryngoscopy, cormac lehane grading, ratio of height to TMD

Introduction

An important responsibility of an anesthesiologist is to maintain a patent airway in anesthetized patients. The term "Airway" refers to the upper airway that is defined as the extrapulmonary air passage consisting of nasal and oral cavities, the pharynx including nasopharynx, oropharynx and hypopharynx and the larynx, trachea and the large bronchi [1].

Difficulty in intubation is usually associated with difficulty in exposing the glottis by direct laryngoscopy. This involves a series of manoeuvres like extending the head, flexion at lower cervical spine, adequate opening of mouth, left side displacement and lodgement of the tongue on the floor of the mouth and lifting the mandible forward [2].

The difficulty in achieving airway patency varies with anatomic and acquired individual patient factors. Thus performing an airway assessment preoperatively in identifying a patient for a potentially difficult intubation is of pivotal importance for the anaesthesiologist. Initially single preoperative airway assessment tests like mouth opening or Inter incisor gap (IIG), Head and neck movement (HNM), Modified mallampatti test (MMT), were used to predict difficult airway. But when it was realized that the visualization of larynx during intubation is affected by many factors, the concept of multivariate factors came into existence [3]. These include Mallampati test, inter-incisor gap, Sternomental distance (SMD), Thyromental distance (TMD), Upper lip bite test (ULBT) etc. to create a scoring system. By adapting these multivariate factors one can overcome the deficiency occurring with individual factors and anticipate difficult intubation with much better accuracy. Even with the use of multivariate factors there have been instances when a patient predicted to have difficult intubation had an easy intubation and vice versa. These methods are quickly and easily performed at the bedside, but unfortunately, their sensitivity and specificity for accurate prediction of difficulty with airway management is not the best [4].

Thus, the search for a predictive test that has ease of applicability, reliability and accuracy of prediction (discriminating power) continues. These bedside physical airway assessment tests have high inter-observer variability. So we conducted a study to evaluate the ratio of height to thyromental distance for the prediction of difficult laryngoscopy and intubation in neurosurgery operations.

Methodology

A standard general anesthesia protocol was followed for all cases. All patients received premedication, inj midazolam 0.02 mg/kg, inj glycopyrrolate 0.01mg/kg and inj fentanyl 2 µg/kg intravenously, after

ISSN:0975 -3583,0976-2833 VOL14, ISSUE 04, 2023

attaching standard monitors. After preoxygenation with 100% O2 in each patient, anesthesia was induced with 5-7mg/kg of thiopentone sodium and 0.9 mg/kg of Rocuronium given intravenously to facilitate tracheal intubation after ensuring mask ventilation. Laryngoscopy and endotracheal intubation was attempted with the patient's head and neck in optimal intubating position with a pillow under the occiput during intubation (sniffing position), using an appropriate size Macintosh curved blade for all patients by an anaesthesiologist having minimum two years of experience in clinical anaesthesia. The anaesthesiologist who performed the laryngoscopy and intubation was blinded to the study and the glottic view was graded using the Cormack and Lehane's classification as follows

Grade 1: A full view of glottis.

Grade 2:

2a) A part of cords are visible.

2b) Only the arytenoids or very posterior origin of the cords are visible.

Grade 3: Only the epiglottis is visible.

Grade 4: No glottis structure visible.

The Cormack and Lehane's Grades 3 and 4 was considered as difficult laryngoscopy.

Tracheal intubation was done with an appropriately sized endotracheal tube. If the intubation was found to be difficult, the anaesthesiologist would first perform an optimal external laryngeal manipulation46 to improve the glottic exposure. If this failed to improve the glottic view, the size of the blade was changed or a McCoy Blade used or a gum elastic bougie was employed as preferred by the anaesthesiologist. Endotracheal intubation was considered difficult, if Cormack and Lehane grading was III and IV32, 47 and this was the end of study. Patient's vital signs were monitored throughout the procedure. At the end of surgery patients were adequately reversed with Inj. Glycopyrrolate 0.01 mg/kg and Inj. Neostigmine 0.05 mg/kg and trachea was extubated after thorough oral suctioning. After stabilization, patients were shifted to the post anaesthesia care unit for further monitoring.

Inclusion criteria

1. Patients undergoing neurosurgery.
2. Patients of either gender of Age group of 20 to 60 years.
3. ASA grade I-II.
4. Patients willing to give informed consent to participate in the study.

Exclusion criteria

1. Patients with obvious distorted anatomy of head and neck.
2. Traumatic Cervical spine.
3. Inability to sit and stand.
4. Need of rapid sequence induction.
5. Patients with midline neck swellings.
6. Edentulous patients.
7. Uncooperative patients.
8. More than 2 attempts of intubation.

Results

Table 1: Distribution of Cormack-Lehane according to RHTMD

S. No.	RHTMD (cm)	Cormack lehane grade		Total
		Grade 1&3	Grade 2&4	
1.	<23.5	207	5	212
2.	>23.5	14	34	48

Chi square value: 138.611 p value: 0.001 DF:1

Out of 212(81.53%) subjects with RHTMD less than 23.5cm, 5(1.92%) belonged to difficult intubation group. RHTMD more than 23.5cm was there in 48(18.4%) subjects and among them 34(13.07%) had difficult intubation and this is statistically significant with p value 0.001.

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Table 2: Distribution of Cormack-Lehane according to TMD

S. No.	TMD (cm)	Cormack lehane grade		Total
		Grade 1&3	Grade 2&4	
1.	>6.5	214	19	233
2.	<6.5	7	20	27

Chi square value: 77.375 p value: 0.001 DF: 1

Out of the total 260 patients, 221 patients had easy laryngoscopies and among them 214(82.3%) patients had TMD more than 6.5 while 07(2.68%) patients had a value of less than 6.5. In the total 39 patients of difficult group, 19(7.30%) patients had a value of TMD more than 6.5cm and 20(7.69%) patients had a value of TMD less than 6.5 and it is significant with the p value of 0.001.

Table 3: Distribution of Cormack-Lehane according to SMD

SMD (cm)	Cormack lehane grade		Total
	Grade 1&3	Grade 2&4	
<12.5	193	34	227
>12.5	28	5	33

Chi square value: 0.055 p value: 0.814 DF:1

Out of 221 easy intubations, 193(74.21%) patients had SMD of less than 13.5 while 28(10.76%) had a value of more than 13.5. In the difficult group, 34 patients had a value of less than 13.5 and 05(1.92) had a value of SMD more than 13.5 and it is not significant with the p value of 0.814.

Table 4: Distribution of Cormack-Lehane according to MMT

S. No.	MMT Grade	Cormack lehane grade		Total
		Grade 1&3	Grade 2&4	
1	1	112	6	118
2	2	76	17	93
3	3	33	14	47
4	4	0	2	2

Chi square value: 29.277 p value: 0.001 DF:3

Out of 221 easy laryngoscopies, 127(43.06%) patients belonged to grade 1,76(29.22%) to grade 2,33(12.68%) to grade 3,and none of them belonged to grade 4. In the difficult group of 39 patients, 6(2.30%) patients belonged to grade 1, 17(6.53%) to grade 2, 04(05.38%) to grade 3 and 2 (0.76%) patients belonged to grade 4 and it is significant with the p value of 0.001.

Table 5: Distribution of Cormack-Lehane according to ULBT

S. No	ULBT (cm)	Cormack lehane grade		Total
		Grade 1&3	Grade 2&4	
1.	1	149	16	165
2.	2	68	20	88
3.	3	4	3	7

Chi square value: 12.021 p value: 0.002 DF:2

Out of 221 easy laryngoscopies, 149(57.3%) patients belonged to grade 1 of ULBT, 68(26.14%) to grade 2, 04 (1.53%) to grade 3.In the difficult group of 39 patients, 16(6.15%) patients belonged to grade 1, 20(7.69%) patients to grade 2, 03 (1.15%) patients to grade 3 and it is significant with the p value of 0.002.

Table 6: Distribution of Cormack-Lehane according to Neck circumference

S. No	Neck circumference (Grade)	Cormack lehane grade		Total
		Grade 1&3	Grade 2&4	
1.	1	199	26	225
2.	2	22	13	35

Chi square value: 13.611 p value: 0.001 DF:1

Out of 221 easy laryngoscopies, 199 (20.38%) patients had a neck circumference of less than 40cm, while 22(8.46%) had a value of more than 40cm. In the Difficult group, 26(10%) had a value of less than 40cm and 13(05%) had a value of more than 40cm and it is significant with the p value of 0.001.

ISSN:0975 -3583,0976-2833 VOL14, ISSUE 04, 2023

Table 7: Distribution of Cormack-Lehane according to IIG

S. No.	IIG (in cm)	Cormack-Lehane grading		Total	X2 value
		Grade 1 & 2 (Easy)	Grade 3 & 4 (Difficult)		
1.	<4	190(73.07)	30(11.53)	220 (84.61)	2.54 P value: 0.111
2.	>4.5	30(11.52)	10(03.84)	40(15.39)	Not Sigficant Df:1

Out of 220 easy laryngoscopies, 190 (73.07%) patients had IIG of more tha4cm, while 30(11.52%) had a value of less than 4cm. In the Difficult group of 40 patients, 30(11.53%) patients had a value of more than 4cm and 10(03.84%) patients had a value of less than 4cm.

Table 8: Sensitivity and specificity of individual parameters for predicting difficult laryngoscopy

S. No.		Sensitivity	Specificity	PPV	NPV
1.	RHTMD	87.2	92.8	68	97.6
2.	ULBT	33.3	75.6	19.4	86.5
3.	SMD	12.8	87.3	15.2	85
4.	IIG	23.1	86.9	23.7	86.5
5.	Neck circumference	35.9	88.7	35.9	88.7
6.	MMT	41.0	84.6	32	89
7.	TMD	51.3	96.8	74.1	91.8

RHTMD has the highest sensitivity (87.2%), specificity (92.8%), NPV of 97.6% and moderate PPV of 68% among all the other parameters.
TMD has the highest sensitivity of 96.8% with the low sensitivity of 51.3%. SMD had the least sensitivity of 12.8% among all the other parameters predicted for difficult laryngoscopy.

Discussion

Among the studied tests, the RHTMD had the highest sensitivity and the highest Negative predictive value (NPV), while TMD had the highest specificity and Positive predictive value (PPV). Except for RHTMD, the rest of the tests had a low sensitivity, while all of them had a low PPV and a high NPV, in agreement with the existing literature. Theoretically, a perfect predictor is characterised by high sensitivity and high specificity, in order to identify almost every patient at risk with minimal false positive predictions. In clinical practice, anaesthesiologists are mostly concerned for the unanticipated difficult airway (false negative predictions), which may find them unprepared. On the other hand, false positive predictions, although disturbing, distressing and inconvenient, have no life-threatening sequelae. Consequently, the most significant clinical problem is the false negative predictions; thus, intubations predicted to be easy, proved to be difficult later. Sensitivity and NPV are statistical measures of a test performance incorporating the false negative predictions in their calculation formula. Among the tests studied, the above- mentioned characteristics apply best to RHTMD as a single predictor of difficult laryngoscopy. With this background we aimed to evaluate the ratio of height to thyromental distance as a better independent bedside predictor of difficult laryngoscopy in comparison to MMT, TMD, ULBT, SMD, IIG and neck circumference.
The RHTMD calculation is based on precise measurement of patient's TMD and height, so making interobserver variations highly unlikely when using this test (on the contrary to significant interobserver variations found with the MMT, which has been controversial). Many patients involuntarily phonate during assessment of the MMT score, which may considerably alter the Mallampati classification.
RHTMD >25cm, introduced by Schmitt *et al*., has better predictive value for predicting difficult laryngoscopy than TMD as it allows for individual's body proportions which are not allowed in TMD. RHTMD is related to body size and proportion and suggested that it might not apply to other races. The cut off value for RHTMD in other studies were different (23.5 and 17.1) in different populations.
Schmitt proposed an RHTMD of 25 or more for prediction of difficult laryngoscopy in Caucasians. Krobbuaban *et al*. [5] had a cut off of 23.5 in Thai patients. Honarmand *et al*. [6] had a cut off of 22.7 in Iranian population and Liaskou *et al*, [7] had 18.4 cut off in Greek patients. In the Indian population, there were studies that used 25 as cut off and others that used 23.5. All these studies did not have large numbers, (one had recruited 200 cases and the other 250, Another study with 330 patients had a value of 24.9 ± 4 for RHTMD) and the calculated statistical values may have differed (could be) due to racial differences. However, they had good sensitivity and specificity for RHTMD and further investigation is required to determine the significance of ethnicity.
In our study the distribution of Cormack lehane grading to RHTMD showed significant co relation with difficult laryngoscopy in 48(18.4%) patients out of the total 260 study population, among them 5(1.92%) patients belonged to RHTMD less than 23.5cm and 34(13.07%) patients belonged to RHTMD more than 23.5cm and this is statistically significant with p value 0.001. RHTMD ≥23.5 was taken as a determining

ISSN:0975 -3583,0976-2833 VOL14, ISSUE 04, 2023

factor for predicting a poor laryngeal view with high sensitivity of 87.2%, specificity 92.8% and NPV of 97.6%, which is comparable to studies conducted by Krobbuaban *et al*., [5] and Krishna *et al*., [2] in which RHTMD > 23.5 was taken as a risk factor for predicting difficult laryngoscopy with high sensitivity, specificity and NPV of 77%, 66%, 95% and 29.4%, 93%, 94% respectively.

The TMD or Patil's test is found to have a wide range of cut off value (5.5-7cm) in literature. TMD can have a high inter-observer variability as the definition is not clear whether to measure the distance from thyroid notch to the inner or outer aspect of mentum. Arguably, the inner measurement should be taken as TMD, which is an indication of "mandibular space". In a meta-analysis, it was found that a thyromental distance of ≤6.0 cm slightly improved the prediction of difficult intubation [3]. We did not attempt to define cut-off values for TMD, SMD or RHTMD in this study as the sample size was not large enough to determine the cut-off threshold values.

In our Study distribution of TMD with Cormack lehane grading showed significant co relation with difficult laryngoscopy in 20 (7.69%) patients with TMD <6.5 and 19 (7.30%) patients with TMD >6.5cm, out of the total 39 (15%) patients of difficult group among the total 260 patients population. However we found a high specificity of 96.8% but a low sensitivity of 51.3% for TMD, similar to other reports by Shah PJ *et al*., [8], in which the specificity was 98.06% and sensitivity was 07.46%, which is unacceptable.

Khan *et al*., [9], introduced ULBT which depends on jaw subluxation and presence of buck teeth as a simple and effective method for predicting difficult intubations. In our study distribution of Cormack lehane grading according to ULBT showed correlation with difficult laryngoscopy in 39 patients out of the total 260 patients and among them 16(6.15%) patients belonged to grade 1, 20(7.69%) patients to grade 2, 03(1.15%) patients to grade 3 and it is statistically significant with the p value of 0.002. Although, ULBT had high specificity (75%), it fails as a diagnostic test with its lowest sensitivity of 33.3%. ULBT have a high inter-observer reliability because of its precise and easy demarcation between the classes. High specificity of ULBT in our study was comparable with other previous reports from the studies conducted by Shah P J *et al*., and Kaniyil *et al*., [2], in which the specificity was 91.53% and 99.3% respectively. The sensitivity is in accordance with the study by kaniyil *et al*., [2], in which it was 25% and lower than the sensitivity of 74.63% reported by Shah P J *et al*., [8], which could be due to population differences Apart from this racial difference, another limitation of ULBT is that it cannot be applied to edentulous patients.

Though Samsoon and Young's modification of the Mallampati test based on oropharyngeal structures has been in use for more than two decades, it has many limitations. The absence of a definite demarcation between class II and III and between class III and IV, the effect of phonation and patient's cooperation leads to high inter-observer variability and decreased reliability.10 In our evaluation, although the distribution of Cormack lehane's grading to MMT showed significant co relation with difficult laryngoscopy in 6 (6.14%) patients belonging to difficult group out of the total 260 patients, MMT had a low sensitivity (41%) and PPV (32%), with an acceptable specificity (84.6%), which is similar to study conducted by kaniyil *et al*., [2], in which the sensitivity was 68.8%, PPV was 12.9% and specificity was 73.9%.

Conclusion

In conclusion, several studies have evaluated different clinical risk factors, alone or in combination, for a useful method to predict difficult intubation. Our results suggest that RHTMD may be a useful as a better independent bedside screening test for preoperative prediction of difficult laryngoscopy. Since the etiology of difficult airway is multifactorial, integration RHTMD with other commonly used predictive tests would be helpful to improve prediction of difficult airway.

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