IS RHTMD A NEW PREDICTOR FOR ASSESSMENT OF DIFFICULT INTUBATION IN NON-OBESE PATIENTS?

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ABSTRACT

BACKGROUND

The recognition of difficult intubation during pre-operative check-up is very important for the anaesthesiologist. Various anatomical parameters assist in predicting difficult intubation. Till date, there are no predictors available to precisely assess the risk of difficult intubation, pre-operatively.

Therefore, we aim to identify the adequacy of predictors for preoperative assessment of difficult intubation.

MATERIALS AND METHODS

After ethical approval of Institutional Ethics Committee, a total of 200 non-obese patients (Body mass index less than or equal to 30) were recruited in this prospective observational study after obtaining informed consent. Mouth Opening (MO), Modified Mallampati Grading (MMG), neck circumference (cm), Thyromental Distance (TM), Sternomental Distance (SM), Neck Movement (NM), Neck Circumference (NC) and Ratio of Height to Thyromental Distance (RHTMD) were measured pre-operatively. In each patient, validated Intubation Difficulty Score (IDS score) was assessed intraoperatively by the anaesthetist. All patients were divided into two groups on the basis of easy (IDS score < 5) and difficult intubation (IDS score ≥ 5). Multivariate logistic regression analysis including all variables was used to create a predictive model.

RESULTS

Laryngoscopy was difficult in 12.0% of the patients. The MO, MMG, NM, NC, TM, SM, NC/TM were significantly different in between easy and difficult intubation. The Area Under Curve (AUC) in ROC for the TM, SM, NC/TM, RHTMD and MPC were 0, 270, 0.138, 0.848, 0.807 and 0.699, respectively. Among all indices, NC/TM and RHTMD were found to have high sensitivity and specificity. NC/TM was showing maximum area under the curve on ROC curve (AUC) followed by RHTMD.

CONCLUSION

Among non-obese patients, NC/TMD ratio and RHTMD can be used for better predictor of difficult intubation, pre-operatively.

KEY WORDS

Airway Management; Intubation; Laryngoscopy; Risk Assessment; Intubation Difficulty Scale.

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BACKGROUND

Airway management is a major concern to anaesthesiologist and can contribute to perioperative mortality and morbidity if not managed in time.^[1] Upto 30% of anaesthetic deaths have been stated in cases of compromised poorly managed airway. Hence, the recognition of this problem during pre-operative anaesthetic check-up is of headmost importance for the anaesthesiologist. Many scoring indices for determination of difficult intubation or difficult laryngoscopy based on various parameters either as a single parameter or in combination have been proposed over time.^[2-4] Mallampati grading² was based on the visibility of anatomical structures of oral cavity,

which underwent modification by Samsoon and Young in 1987.^[3] Similarly, Wilson et al (1988) developed a score based on various physical factors.^[4] But none of these scores were found to have similar diagnostic accuracy, their results varied in different studies. As a result, there are no predictors available single or in combination, which can precisely assess the risk of difficult intubation pre-operatively. Therefore, we aim to compare the adequacy of various parameters used for assessment of difficult intubation and to identify the parameter with highest specificity and sensitivity.

MATERIALS AND METHODS

After obtaining Institutional Ethics Committee approval, this prospective, observational study was carried out over a duration of two years at Dr. Ram Manohar Institute of Medical Sciences, Lucknow. This study was conducted in 200 patients (18 - 72 years of age) without obvious airway pathology. All patients belonged to the American Society of Anesthesiology (ASA) class I or II and were scheduled for elective surgery that required general anaesthesia. Pregnant women, obese patients, patients with congenital deficiencies or airway with difficult anatomy were excluded.

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All patients were assessed on the day before surgery by a single observer. Airway assessment was performed pre-operatively based on clinical screening tests and noted.

Following Parameters were Assessed-

Mouth Opening (MO), Modified Mallampati Grading (MMG), Neck Movement (NM), Neck circumference (cm) at the level of cricoid cartilage was evaluated. HM distance (cm) is the distance between hyoid bone and mentum. TMD is distance from mentum to thyroid notch and Sternomental distance (cm) was measured as distance between upper border of sternomanubrial joint to the mentum. Measurement of all the above three distances were done in extended neck position.

The ratios of NC/TM and Ratio of Height to Thyromental Distance (RHTMD) were calculated. In the operation theatre, the patient was placed supine and head in the sniffing position with the use of pillows such that the external auditory meatus and the sternal notch are aligned in same line. Patient was induced with propofol (2 mg/kg) and neuromuscular agent atracurium (0.5 mg/kg) was then given to all patients. After 3 - 5 mins, laryngoscopy was performed using a laryngoscope with a Macintosh curved blade. Laryngoscopy was performed by senior resident in all cases, since ours is a teaching institute.

The assessment of difficult intubation was done as per intubation difficulty scale, which was recorded by the senior anaesthetist who was blinded to the study.^[5]

The Grading of IDS has been done as follows-

- N1: Number of added intubation attempts.
- N2: Number of added operators.
- N3: Number of alternative intubation methods.
- N4: Laryngeal view as described by Cormack and Lehane's grading (Grade 1= N4-0; Grade 2= N4-1; Grade 3= N4-2; Grade 4= N4-3).^[6]
- N5: Force applied to lift larynx during laryngoscopy (N5-0 if inconsiderable and N5-1 if considerable).
- N6: External laryngeal pressure needed for improving laryngeal exposure (N6-0 if no external pressure or only the Sellick manoeuvre was required and N6-1 if external laryngeal pressure was applied).
- N7: Position of the vocal cords during intubation (N7-0 if vocal cords are abducted or not visible and N7-1 if vocal cords are adducted). The IDS score is the total sum of N1 through N7.

A score of 0 means intubation under optimal conditions. The sample population in our study was described further into two groups according to the IDS (intubation difficulty score). Those with an IDS score of ≥ 5 were characterised as difficult and < 5 as easy respectively.

Statistical Analysis

SPSS version 10.0 was used for statistical analysis. Data was presented as mean (standard deviation, range). Multivariate analysis was used to predict independent risk factors. Receiver Operating Characteristic Curve analysis (ROC analysis) was performed for the airway assessment tests. The area under the ROC curve (AUC) was calculated and p-value < 0.05 was considered significant. The sensitivity, specificity, Positive Predictive Value (PPV) and Negative Predictive Value (NPV) was also calculated.

RESULTS

In our study, data from 200 patients who were scheduled for surgery under general anaesthesia was evaluated. Table 1 shows the demographic features and airway profile of the study population. Out of 200 patients 24 patients showed difficulty in intubation, which was measured according to Intubation Difficulty Scale (IDS). Hence, incidence was found out to be 12%.

Based on difficulty scale, patients were divided into two groups: easy if scoring is below 5 and difficult if above and equal to 5. Two groups were compared for demographic variables and various airway clinical parameters. Binary univariate logistic regression analysis was used to compare above variables between two groups (Table 2). Variables like MO, TM, SM, NC/TMD, RHTMD ($p < 0.001$) were found to be significant in relation to group with IDS > 5 .

Table 3 shows Binary multivariate logistic regression (Forward-Wald) analysis for finding independent risk factors. From this analysis, we found that three variables were considered significant for assessment of difficult intubation. First variable RHTMD was found to be of statistical significance as an independent risk factor with odds ratio of 37 and p-value= 0.001.

Other independent predictor was NC/TM ratio (OR=14) and p-value= 0.001. Figure 4 shows the ROC curve for various variables like NC/TM, RHTMD and MMG. ROC curve is a statistical graph to represent the sensitivity and specificity of any test and for what extent the test is diagnostic. Diagnostic accuracy is directly proportional to area under curve. It was found that RHTMD had larger area under the curve than Mallampati score. AUC 0.807 while AUC for NC/TMD came out to be 0.848, which was more than Mallampati and RHTMD. Table 4 shows the sensitivity, specificity and PPV of various variables. The cut-off values of various variables like TM, SM, NC/TM and RHTMD are also shown. Above these cut-off values, the test becomes most sensitive and most specific. Cut-off value of RHTMD was 21.6.

Parameter	Mean	±SD
Age (year)	45.2	15.8
Sex ratio (male/female)	106/94	-
Weight (kg)	58.65	14.31
Height (cm)	156.97	10.30
BMI (kg/m ²)	23.90	5.30
Mouth Opening	2.87	0.32
Mallampati Grade (I/II)	145/47	-
Neck movement (NM) A/R	180/20	-
Neck circumference (NC)	35.77	5.02
Hyomental distance (HM)	5.1	0.92
Thyromental distance (TM)	7.21	1.25
NC/TMD	5.10	1.10
NC/SM	2.38	0.56
Ratio of height to thyromental distance	22.45	4.31
Intubation Difficulty Scale (IDS)	2.02	2.55
Table 1. Patient Characteristics		

Data are represented as mean $\pm$ SD, n (%) and ratio, SD=Standard deviation.

Parameter	Easy (IDS <5) (n=176)	Difficult (IDS >5) (n=24)	P-value
Age (year)	44.56±16.20	49.50±11.93	0.181
Sex ratio (male/female)	93 (52.84%)/83 (47.16%)	13 (54.17%)/11 (45.83%)	0.855
Weight (kg)	57.97±13.44	63.58±19.14	0.071
Height (cm)	157.18±10.42	155.46±9.39	0.445
BMI (kg/m ²)	23.57±5.02	26.23±6.67	0.021*
Mouth Opening	2.93±0.23	2.40±0.49	<0.001*
Mallampati Grade (I/II)	135/38	10/9	0.02*
Neck Movement (NM) A/R	161/15	18/6	0.025*
Neck Circumference (NC)	35.31±4.76	39.17±5.62	<0.001*
Hyomental Distance (HM)	5.19±0.87	4.40±0.94	0.003*
Thyromental Distance (TM)	7.33±1.20	6.30±1.29	<0.001*
NC/TMD	4.92±0.95	6.4±1.31	<0.001*
Ratio of Height to Thyromental Distance (RHTMD)	21.74±3.78	24.75±3.81	<0.001*

Table 2. Binary Univariate Logistic Regression comparing patients with an IDS Score < 5 (Easy) and patients with an IDS Score ≥ 5 (Difficult) Parameters

*=Significant (p= <0.05).

Variables	β	SE	Wald	P	OR	95% CI	
						Lower	Upper
NC/TMD	2.643	0.819	10.405	0.001*	14.049	2.820	69.983
RHTMD	3.611	0.651	30.794	<0.001*	37.00	10.335	132.461
BMI	0.086	0.038	5.107	0.024*	1.090	1.012	1.175

Table 3. Binary Multivariate Logistic Regression (Forward -Wald) Analysis performed in each patient group to determine the Independent Risk Factors for Difficult Intubation

*=Significant (p= <0.05).

Figure 1. Receiver Operating Characteristic (ROC) Curve Analysis of Five different Screening Tests for Difficult Intubation. Receiver Characteristic Curve has been expressed as a Solid Line. AUC: Area Under the Curve; NC/TM Ratio: the Ratio of the Neck Circumference to Thyromental Distance; RHTMD: Ratio of Height to Thyromental Distance

Test	Sensitivity	Specificity	PPV	NPV
TM ≤ 6.5 cm	62.5	66.67	93.22	19.51
NC/TM ≥ 5.0	78.4	75.0	98.6	36.7
RHTMD > 21.6	81.2	83.3	97.3	37.7
Mallampati Score III or IV	89.8	75.0	96.3	50.0

Table 4. Test for Difficult Intubation. Data presented as Percentages. TM, Thyromental Distance; NC/TM, Ratio of Neck Circumference to Thyromental Distance; RHTMD, Ratio of Height to Thyromental Distance, PPV, Positive Predictive Value; NPV, Negative Predictive Value

DISCUSSION

In this observational study, the incidence of difficult intubation was observed to be 12%. Various studies showed variable results. The incidence varied between 7 - 17%.^[7,8] The study by Garg and Dua et al (2015) showed the incidence of 24.6%.^[7] The variability in incidence could be due to many factors like different anatomical measurements among different population, use of different blades, expertise in laryngoscopy and degree of muscle relaxation.

In our study, NC/TMD and RHTMD were found to be independent factors for assessment of difficult intubation. While analysing results of ROC curve, greater area under curve was found for NC/TMD followed by RHTMD and Mallampati score. Though sensitivity, specificity, positive and negative predictive values of the RHTMD were more than NC/TMD, i.e. 81.2%, 83.3%, 97.3% and 37.7% respectively, while sensitivity of NC/TMD is 75%, specificity 78.4% with PPV of 98.6 and NPV of 36.7%. Cut-off value was 5 in our study, which corroborates with other studies. Our results are consistent with the results of study by Schmitt et al (2002). They reported that RHTMD has good predictive value for predicting difficult laryngoscopy than TMD.^[9] AUC of RHTMD was greater than TMD alone. Neck circumference at the thyroid cartilage is an important prognosticator of difficult laryngoscopy in both obese and non-obese in many researches.^[10,11] In recent studies, especially in obese patients and in obstructive sleep apnoea patients, NC/TMD is emerging as a good alternative to predict difficult intubation.^[12,13]

Similarly, in their study by Naim et al (2014), they concluded that NC/TM ratio had sensitivity of 100% and a negative predictive value of 82% than the Mallampati score with sensitivity of 90% and specificity of 61%.^[12] Similarly, Kim et al (2011) considered NC/TMD to be a better predictor in obese patients than already existent ones.^[13] They concluded that NC/TMD is a better indicator than either the NC or TMD alone. The reason in difference of sensitivity and specificity could be that probably our study did not include the obese patients. Regarding Mallampati grading, many of the previous studies have shown different sensitivities and specificities. Mallampati was found to be an independent predictor.^[14] Mallampati score has good sensitivity of 89.6%, but low specificity of 75% as compared to RHTMD. This result is consistent with the study of Anna Lee et al (2006). They concluded that the Mallampati tests have limited accuracy in predicting the difficult airway and thus are not valuable screening tests in non-obese patients.^[14]

Rationale behind variability of results for Mallampati in various studies as well as in our study could be because of observer's variability, so results may vary with different observer. Phonation during examination also alters the score.

While in RHTMD measurement, RHTMD is based on precise measurement method of individual body proportions. So it could be a sturdy indicator.

We found that ratio of NC/TMD and RHTMD were better predictors of difficult intubation compared to other predictors. For RHTMD, value of 25 was found to be the optimal cut-off value to predict difficult laryngoscopy in Caucasian population, while cut-off in our study was 21.6.^[9] In one of the studies done by Krishna et al (2005) which was done in Indian population, cut-off value was 21.3 cm.^[15] Balakrishnan and Chockalingam (2017) in their study concluded a cut-off value of 17.1,^[16] which was lower than our study population and in other Indian studies.^[15,17,18] Probably, their study had predominantly female population and used TMD cut-off at (9.03 ± 1.2) , which was 6.5 in our population. So it can be concluded that it could be a better predictor than TMD or Mallampati in Indian population too, though cut-off values have come out to be lower than Caucasians or western population. But larger sample size is required to come to an absolute value of cut-off.

Limitations of Study

In many recent trials, RHTMD is found to be a good indicator.^[8,9] But it has few limitations too. It is not a simple method to do. One needs to do accurate measurement of patient's height and thyromental distance. Moreover till now cut-off values are race dependent, the cut-off value may not be applicable to other population. So we tried to find out in Indian population, specifically north Indian population. More studies are required from different places of India with adequate sample size to come to any absolute value of cut-off, because Indian population itself includes diversity of races.

CONCLUSION

These two predictors NC/TMD and the ratio of patient's height to thyromental distance have a better predictive value than the thyromental distance or Mallampati grading for difficult intubation. If subjected to further researches with large sample size, RHTMD can be a new indicator with absolute cut-off value, especially in non-obese patients.

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