

Evaluation of Modified Mallampati Score with Neck Circumference and Thyromental Distance to Predict Difficult Intubation in Non-obese Patients

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ABSTRACT

Introduction: Preoperative diagnostic validity of airway assessment help for prediction of difficult airway. Several models were established for prediction of difficult intubation. In this study, we aim to predict difficult intubation in non-obese patients from various airway predictive indices such as modified mallampati grade, neck movement (NM), neck circumference (NC), thyromental distance (TM), NC/TMD.

Material and Methods: Total 121 patients with 18-72 years of age, ASA grade I or II, scheduled for elective surgery that required general anaesthesia. Difficulty of intubation was assessed using the IDS for each non-obese patient. The study population was divided into two groups Easy (IDS <5) and Difficult intubation (IDS ≥5). Preoperative assessments included Mouth Opening (MO), modified mallampati grade, neck movement (NM), neck circumference (NC), thyromental distance (TM), NC/TMD. 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 curve (AUC) was calculated.

Results: The weight (59.74±7.76 kg and 65.00±5.92 kg) and BMI (21.51±1.79 and 23.8157±1.09) were significantly different in between easy and difficult intubation. The Mouth Opening, NC, TMD, and NC/TMD were significantly independent risk factor for difficult intubation. NC/TMD was showed higher sensitivity, specificity, positive predictive value (PPV) and a negative predictive value (NPV) with third large area under the curve (AUC) on the ROC curve.

Conclusions: This study shows that the NC/TMD ratio can be considered as a better predictor of difficult intubation in non-obese patients.

Keywords: Airway Assessment; Difficult Intubation; Modified Mallampati Test; Thyromental Distance; Neck Circumference

Previous studies reported that the difficult intubation was significantly associated with increased age, male, obstructive sleep apnoea syndrome (OSAS), high Mallampati score, short neck, and the Wilson score.⁴⁻⁶ The Mallampati grade score and increasing neck circumference (NC) are significantly correlated with difficult intubation particularly in obese patients.^{6,7} However, none of these have more sensitivity and specificity for accurate diagnostic of difficult intubation.

However, the neck circumference only may not clearly show the quantity of soft tissue within the neck. Horner et al. (1989) and colleagues demonstrated that more fat was present in areas surrounding the collapsible segments of the pharynx in obese patients with OSA'S using magnetic resonance imaging (MRI) measurements.⁸ Ezri et al. (2003) demonstrated that difficult laryngoscopy could be predicted in obese patients by quantifying the neck soft tissue at the level of the vocal cords and suprasternal notch using ultrasonography.⁹ They demonstrated that the quantity of pre tracheal soft tissue, observed by ultrasound, was the only measure that completely established the easy intubation from a difficult one. These outcomes might elucidate why non-obese patients are not easy to intubate whereas other not. Several bedside screening tests such as Mallampati classification, mouth opening, thyromental distance, upper lip bite and head-neck mobility have been used for predicting the difficult intubation.^{2,10-12} Even though they are quite simple, most of them require patient's cooperation in order to be performed properly and thus assessed correctly. In present study we aim to evaluate the combination of

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How to cite this article: Bharat Bhushan Yadav, Vinayak Mishra, Jaishri Bogra, Archana Agarwal, Sudhir Rai, Abhishek Prakash.

Evaluation of modified mallampati score with neck circumference and thyromental distance to predict difficult intubation in non-obese patients. International Journal of Contemporary Medical Research 2019;6(3):C16-C20.

DOI: <http://dx.doi.org/10.21276/ijcmr.2019.6.3.26>

INTRODUCTION

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. Various scoring indices for determination of difficult intubation based on many parameters such as single or combined parameter have been proposed over time.²⁻⁴

modified mallampati score with neck movement (NM), neck circumference (NC), thyromental distance (TM), NC/TMD factor to predict difficult intubation in non-obese patients.

MATERIAL AND METHODS

After obtaining Institutional Ethics Committee approval, this prospective, observational study was carried out at Hind Institute of Medical Sciences, Lucknow. This study was conducted in 121 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 scheduled for elective surgery that required general anaesthesia. Pregnant women, patients with congenital deficiencies or airway with difficult anatomy was excluded. Difficulty of intubation was assessed using the IDS, which was recorded by the senior anaesthetist.¹³ The IDS is graded as follows: N1, number of additional intubation attempt; N2, number of additional operators; N3, number of alternative intubation techniques used; N4, laryngoscopic view as defined by Cormack and Lehane (grade 1, N4¼0; grade 2, N4¼1; grade 3, N4¼2; grade 4, N4¼3); N5, lifting force applied during laryngoscopy (N5¼0 if inconsiderable and N5¼1 if considerable); N6, needed to apply external laryngeal pressure for optimized glottic exposure (N6¼0 if no external pressure or only the Sellick manoeuvre was applied and N6¼1 if external laryngeal pressure were used); and N7, position of the vocal cords at intubation (N7¼0 if abducted or not visible and N7¼1 if adducted).¹⁴ The IDS score is the sum of N1 through N7. A score of 0 indicated intubation under ideal conditions. The two groups of patients were classified further according to the IDS score. Those with an IDS score of ≥ 5 and < 5 were defined as the difficult and easy groups, respectively.

Mouth Opening (MO), Modified Mallampati Grading (MMG), Neck Movement (NM), Neck circumference (cm) at the level of cricoid cartilage were evaluated. TMD is distance from mentum to thyroid notch. Measurement of all the above three distances were done in extended neck position.

In the operating theatre, the patients were positioned with pillows under the head with the neck extended. Each patient was monitored routinely with an electrocardiogram, pulse oximetry, and non-invasive arterial pressure. Patients breathed 100% oxygen through a facemask for more than 3 min. Anaesthesia was then induced with sodium thiopental (5 mg kg⁻²²) and rocuronium (0.7 mg kg⁻²²). Cricoid pressure was applied as described by Sellick when the intubator requested this for a better view at laryngoscopy. A size 3 Macintosh laryngoscope blade was used for the first laryngoscopy in each case. All tracheal intubations was performed by two anaesthetists with more than 2yr of experience and they were blinded to the assignment of the patient. If SpO₂ decreased to, 90% during the intubation period, the event was recorded as a hypoxic episode. The laryngoscopic view was graded according to Cormack and Lehane's scale: grade 1, the vocal cords was completely visible; grade 2, only the arytenoids

was visible; grade 3, only the epiglottis was visible; and grade 4, the epiglottis was not visible.^{14,15}

STATISTICAL ANALYSIS

SPSS version 10.0 was used for statistical analysis. All data were 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 curve (AUC) was calculated. The p-value < 0.05 was considered significant. The specificity, sensitivity, positive predictive value and negative predictive value were also analyzed.

RESULTS

In this study total 121 patients data were analyzed. We were not found any intubation failure during study. The demographic data such as age, gender, weight, height, BMI, mouth opening, mallampati grade, neck movement (NM), neck circumference (NC), thyromental distance (TM), NC/TMD and intubation difficulty scale (IDS) were shown in Table 1.

The patients were divided into two groups [Group 1: Easy (IDS < 5) n=17 and Group 2: Difficult intubation (IDS ≥ 5) n=104]. The mean age of patients in group 1 (easy intubation group) was 45.80 ± 13.34 years and group 2 (difficult intubation group) was 51.00 ± 10.37 years. Total 58.68% and 64.71% of patients were males in group 1 and group 2, respectively. The mean weight (59.74 ± 7.76 kg and 65.00 ± 5.92 kg), mean height (166.39 ± 7.57 cm and 165.06 ± 6.24 cm) and BMI

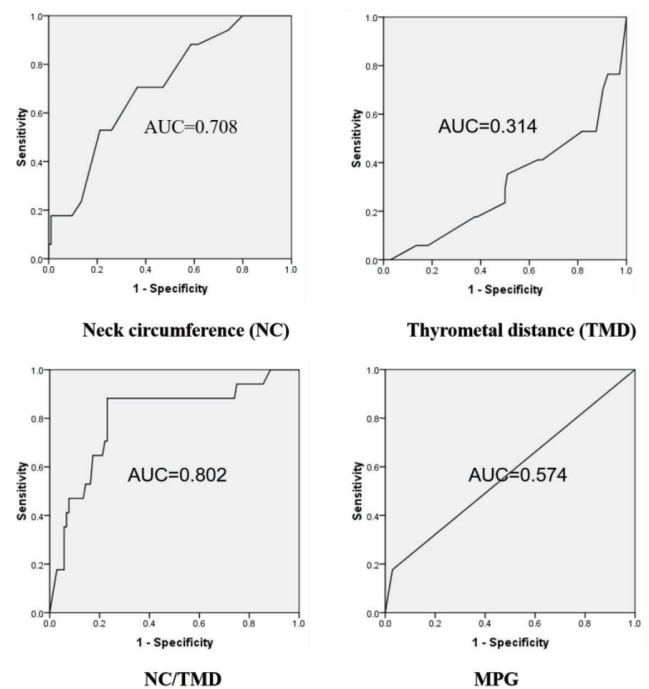


Figure-1: Receiver operating characteristic (ROC) curve analysis of NC, TMD, NC/TMD and MPGs screening tests for difficult intubation. Each receiver characteristic curve is expressed as a solid line. AUC: area under the curve; NC/TMD ratio: the ratio of the neck circumference to Thyromental distance

Parameter	Mean	±SD	Median	Minimum	Maximum
Age (year)	46.53	13.06	49.00	20.00	74.00
Gender (male/female)	82 (76.8%)/ 39 (32.2%)	-	-	-	-
Weight (kg)	60.4793	7.73	61.00	35.00	73.00
Height (cm)	166.21	7.39	167.00	149.00	185.00
BMI (kg/m ²)	21.8317	1.892	22.15	14.76	24.98
Mouth Opening	2.80	0.52	3.00	0.00	3.00
Mallampati Grade I/II	113 (93.3%)/8 (6.7%)	-	-	-	-
Neck movement (NM) A/R	109 (90.1%)/12 (9.9%)	-	-	-	-
Neck circumference (NC)	35.73	5.25	35.00	24.00	51.00
Thyrometal distance (TM)	7.14	1.26	7.00	4.50	10.00
NC/TMD	5.16	1.24	4.84	2.67	8.89
Intubation Difficulty Scale (IDS)	2.61	2.78	2.00	0.00	12.00

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

Table-1: Patient characteristics

Parameter	Easy (IDS <5) (n=104)	Difficult (IDS ≥5) (n=17)	p-Value
Age (year)	45.80±13.34	51.00±10.37	0.126
Sex ratio (male/female)	71(68%)/33(32%)	11(65%)/6(35%)	0.771
Weight (kg)	59.74±7.76	65.00±5.92	0.009
Height (cm)	166.39±7.57	165.06±6.24	0.488
BMI (kg/m ²)	21.51±1.79	23.8157±1.09	<0.001*
Mouth Opening	2.88±0.37	2.29±0.94	<0.001*
Mallampati Grade (I/II)	101(97%)/3(3%)	14 (82%)/3(18%)	0.128
Neck movement (NM) A/R	95(91%)/9(9%)	14/3	0.250
Neck circumference (NC)	35.15±4.98	39.24±5.62	0.003*
Thyrometal distance (TMD)	7.26±1.20	6.39±1.39	<0.008*
NC/TMD	4.96±1.07	6.39±1.54	<0.001*

*=Significant (p<0.05)

Table-2: Binary univariate logistic regression comparing patients with an IDS score (<5 for easy and ≥5 for difficult intubation)

Variables	β	SE	Wald	P	95% CI	
					Lower	Upper
NC	0.15	0.05	7.94	0.005	1.05	1.28
TMD	1.26	0.54	5.48	0.019	1.23	10.12
NC/TMD	0.74	0.19	14.61	<0.001	1.43	3.05

*=Significant (p<0.05)

Table-3: Binary multivariate logistic regression (forward-Wald) analysis performed in each patient group to determine the independent risk factors for difficult intubation in each population

Test	Sensitivity	Specificity	PPV	NPV
TC>35.5	54.8%	70.6%	91.9%	20.3%
TMD≤6.5 cm	71.2%	58.8%	91.4%	25.0%
NC/TMD≥5.0	85.6%	88.2%	97.8%	50.0%
Mallampati Grade (MPG)	97.1%	17.6%	87.8%	50.0%

Table-4: Difficult Intubation

(21.51±1.79 and 23.8157±1.09) were found in group 1 and group 2 respectively. The weight and BMI were significantly associated with difficult intubation as shown in Table 2.

We also assess the various importance risk factors for difficult intubation such as mouth Opening, Mallampati Grade (I/II), Neck movement (NM) A/R, Neck circumference (NC), Thyrometal distance (TMD), and NC/TMD. Binary logistic regression was used to analyzed the risk factors for difficult

intubation. The Mouth Opening, NC, TMD, and NC/TMD were significantly correlated with difficult intubation (Table 2).

The binary logistic regression were also used for analysis in NC, TMD and NC/TMD to determine the difficult intubation risk factors as shown in Table 3. The NC, TMD and NC/TMD variables were significant independent risk factor for difficult intubation.

The ROC curves of NC, TMD, NC/TM, and MP were shown

in Figure 1. The cut-off points for difficult intubation were the $TC \geq 35.5$ cm, $TMD \leq 6.5$, $NC/TMD \geq 5.0$ and Mallampati score of III or IV. NC/TMD was showed higher sensitivity, specificity, positive predictive value (PPV) and a negative predictive value (NPV) with third large area under the curve (AUC) on the ROC curve.

The sensitivity, specificity, NPV and PPV were used to analysis the NC, TMD, NC/TMD, and Mallampati grade (MPG) tests (Table 4). These test were demonstrate the accuracy of risk factors.

DISCUSSION

Various research studies and meta-analysis are trying to determine the method or combination best methods for predicting difficult intubation. Assessment of airway included physical examination, medical history, clinical and other tests. Successful identifications of physical features are help in the management of difficult airway management.¹⁶ The rate of difficult intubation (Cormack and Lehane grade 3 or 4 view) in patients with apparently normal airways was determined by two recent meta-analysis to be 5.8%.¹⁷ The difficult intubation was shown that tests such as mouth opening Mallampati score, sternomental distance, and thyromental distance. These test offered poor (20%) to moderate (62%) sensitivity and moderate (82%) to good (97%) specificity.

In present demonstrated that the increasing weight and BMI were significantly associated with difficult intubation. Various studies reported that the BMI does not offer any predictive value for difficult intubation.^{5,17,18,19} Difficult tracheal intubations had been significantly found in higher proportion obesity patients.^{16,17,20} Previously in a cohort study the weight was found to be significant independent risk factor for difficult intubation.¹⁹

In present study, NC/TMD was found to be independent factors for difficult intubation. Although the ROC curve analysis, larger area under curve was found for NC/TMD followed by NC and TDM in non-obese patients. However sensitivity, specificity, positive and negative predictive values of the NC/TMD was more, i.e. 85.6%, 88.2%, 97.8% and 50.0% respectively. Cut-off value was 5 in our study, which corroborates with other studies. Similarly, Naim et al. (2014) reported that the 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%.²¹ A similar study considered NC/TMD to be a well predictor in obese patients either the NC or TMD alone.²² In our study, NC/TM and Mallampati score sensitivity and specificity could be that maybe that we did not include the obese patients. Previously, various studies demonstrated that the Mallampati grading shown different sensitivities and specificities, found to be an independent predictor. Anna Lee et al. (2006) shows that the Mallampati score tests have limited accuracy for the predicting difficult airway.²³ Therefore, this screening test is not a valuable for non-obese patients.

Brodsky et al. (2002) previously identified neck circumference (NC) as an independent predictor of difficult

intubation.⁵ The risk of difficult intubation with increasing NC. Gonzalez et al. (2008) studied difficult intubation (defined as an IDS score of more than 5) prospectively, in 131 lean and obese patients.⁷ NC greater than 43cm was an independent predictor of difficult intubation and increased the risk of difficult intubation by 37%. Conversely, the predictive value of neck circumference in 180 obese patients, finding no association between neck circumference and difficult intubation.²⁴ The BMI of more than 35 kgm² to be an independent predictor of difficult and failed intubation after observing a cohort of 91 332 consecutive patients.¹⁹ Juvn et al. (2003) compared 263 lean and obese individuals and found a higher incidence of difficult intubation in the obese individuals.¹⁸ Conversely, Brodsky et al. (2002) conducted a study of 100 morbidly obese patients and did not find obesity to be an independent predictor of difficult intubation.⁵ Ezri et al. (2003) reported that the more pre-tracheal soft tissue present at the vocal cords was a good identification of easy and difficult intubation in obese patients.⁹

CONCLUSION

In this study we found a 16.34% incidence of difficult intubation. The predictors NC/TMD have a better predictive value than the NC or Mallampati grading for difficult intubation. The NC/TMD ratio (≥ 5.0) shows moderate to high sensitivity, specificity, positive predictive value and negative predictive value. Thus, we consider a preoperative value of NC/TMD ratio ≥ 5.0 to be a better predictor of difficult intubation in non-obese patients.

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Source of Support: Nil; **Conflict of Interest:** None

Submitted: 01-02-2019; **Accepted:** 16-02-2019; **Published:** 20-03-2019