Section: Anaesthesia

Original Research Article

STUDY OF NECK CIRCUMFERENCE TO THYROMENTAL DISTANCE RATIO(NC/TM) AS A PREDICTOR OF DIFFICULT INTUBATION IN OVERWEIGHT PATIENTS POSTED FOR ELECTIVE SURGERY UNDER GENERAL ANAESTHESIA

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ABSTRACT

Background: Among obese and non-obese individuals, the incidence of difficult laryngoscopy is similar (about 10%). But, there are more reports of difficult intubation among obese patients. This can be due to changes in upper airway present among them. This study evaluates neck circumference to thyromental distance ratio(NC/TM) as a predictor of difficult intubation in overweight patients posted for elective surgery under general anaesthesia.

Materials and Methods: Present study was single-center, prospective, observational study, conducted in patients of age 18-60 years, both the sexes, ASA class 1&2, BMI is >26.9 but <30, undergoing surgery under General Anaesthesia with tracheal intubation

Results: The distribution of area under the curve (AUC) differs significantly for NC, TMD and NC/TMD ratio for the prediction of difficult Laryngeal intubation from the reference value of 0.500 (P-value<0.05 for all). The distribution of area under the curve (AUC) is significantly higher for NC/TMD followed by TMD and NC for the prediction of difficult Laryngeal intubation. The sensitivity, specificity for NC, TMD and NC/TMD ratio for the prediction of difficult laryngeal intubation is 52.7, 51.2; 56.4, 56.7; and 68.1, 69.3 respectively. Out of all parameters to predict difficult intubation in overweight patients like NC, TMD and NC/TMD ratio of NC/TMD is most sensitive and specific indicator to predict difficult intubation in overweight patients. On univariate analysis, the higher Mallampati grades, lower TMD and higher NC/TMD ratio are significant determinants of incidence of difficult laryngeal intubation (p-value<0.05 for all). On multivariate analysis using logistic regression, higher NC/TMD ratio is the independent and significant determinant of incidence of difficult laryngeal intubation.

Conclusion: NC/TMD ratio can be considered a better reliable screening tool for predicting difficult intubation in overweight patients.

Keywords: Mallampati grades, neck circumference, thyromental distance, difficult laryngeal intubation, overweight patients.

INTRODUCTION

Implementation of anaesthesia begins with preoperative assessment and proper planning. Maintenance of a patent airway is a primary responsibility of the anaesthesiologist. Interruption of gas exchange for even a few minutes can result in catastrophic outcomes such as brain damage or

death.[1] Inability to maintain oxygenation among obese populations leads to complications which account for 30% of deaths.[2] Almost one third of deaths attributable solely to anaesthesia have been related to inability to maintain a patent airway and majority of airway related events involve brain damage or death.[2,3]

A closed claims analysis of adverse respiratory events in anaesthesia shows that 17%of cases were of difficult tracheal intubation with incidence of inadequate ventilation being 38% and esophageal intubation being 18 %.[3,4] The unanticipated difficult airway occurs with a low but consistent incidence in anaesthesia practice. Difficult direct laryngoscopy occurs in 1.5-8% of general anaesthetics and failed intubation occurs in 0.3- 1.3% of general anaesthetics.[5,6] Unexpected difficult intubation are probably the result of lack of accurate predictive tests for difficult intubation and inadequate preoperative examination of the airway.[7]

As per WHO8, individuals whose BMI is greater than or equal to 30 kg per meter square of body surface is termed obese. Among obese and non-obese individuals, the incidence of difficult laryngoscopy is similar (about 10%). But, there are more reports of difficult intubation among obese patients. This can be due to changes in upper airway present among them. There are some clinical predictors which indicates the risk of difficult airway in obese patients. Increased neck circumference, Mallampati grade 3 or 4 and diagnosis of obstructive sleep apnea syndrome (OSAS) are some of the factors related to difficult intubation.[5-7] This study evaluates neck circumference to thyromental distance ratio (NC/TM) as a predictor of difficult intubation in overweight patients posted for elective surgery under general anaesthesia.

MATERIALS AND METHODS

Present study was single-center, prospective, observational study, conducted in department of anesthesiology, at XXX medical college & hospital, XXX, India. Study duration was of 2 years (July 2017 to June 2019). Study was approved by institutional ethical committee.

Inclusion Criteria

- Age 18-60 years, patients of both the sexes, ASA class 1&2, BMI is >26.9 but <30, undergoing surgery under General Anaesthesia with tracheal intubation, Willing to participate in present study

Exclusion Criteria

- Age<18 or>60 years, ASA class 3 & 4
- Patients with upper airway pathology like upper airway tumour or cervical spine injury.
- Patients who underwent only regional anaesthesia,
- Patients who had regional blocks alone,
- Patients who had surgery using laryngeal mask airway
- Patients not willing to participate for the study.

Study was explained to participants in local language & written informed consent was taken. Patients were assessed preoperatively through history taking, clinical examination and routine investigations. In addition these specific parameters are recorded:

1. **BMI:** weight (kg)/height (m2) - According to WHO normal range of BMI is 18.5-24.9. Overweight is BMI>25 Obesity is BMI >30.
2. **Neck circumference at the level of cricoid cartilage:** Neck circumference at the level of cricoid cartilage. Normal value is <34cm for females and <37cm for males
3. **Thyromental distance:** It is distance from thyroid notch to mentum with neck fully extended Normal value is approximately 7cm, if less than 3cm finger width associated with difficult intubation.
4. Ratio of Neck circumference/Thyromental distance was calculated. Normal ratio is <5, >5 suggests difficult intubation.
5. Modified Mallampati classification without phonation:

Intraoperative management: Basic monitors like Electrocardiography, pulse oximetry, noninvasive blood pressure (NIBP) and Etco2 was applied and intravenous access was obtained. Premedication in the form of inj Glycopyrrolate (4 micrograms/kg),inj ondansetron (0.1mg/kg), inj Midazolam(0.3/kg) and Fentanyl (2 micrograms/kg) was given. Patients were preoxygenated with 100% oxygen by Bains circuit for 3 minutes.

Intravenous induction in the form of inj Propofol(2mg/kg) and neuromuscular blockade was done using Succinylcholine(2mg/kg).Patients lungs will be ventilated for 100% oxygen till fasciculations wear off. Laryngoscopy was performed by senior Anaesthesiologist having experience of 5 years, using Macintosh blade 3or4 blade.

Intubation difficulty scale.(IDS)107

1. N1:number of additional intubation attempts.
2. N2:number of additional operators.
3. N3:number of additional intubation techniques used
4. N4:Laryngoscpy view as graded by Cormack and Lehane.
5. N5=1,if considerable
6. N6:needed to apply external laryngeal pressure for optimized glottis exposure.

a. N6=0,if no external pressure or only Selicks maneuver used

b. N6=1,if external laryngeal pressure is used

7. N7:Position of vocal cords at intubation

a. N7=0,if cords abducted or not visible

b. N7=1,if adducted.

IDS score is sum of N1-N7,a score of 0 indicates intubation under ideal conditions. Patients with IDS score of >5 and <5 were defined as difficult and easy intubation groups respectively. If Spo2 decreased to 90% during the intubation period, the event was recorded as hypoxic episode and the patient was ventilated manually or by laryngeal mask airway to optimize Spo2 around 100%.

Data was collected and compiled using Microsoft Excel, analyzed using SPSS 23.0 version. Frequency, percentage, means and standard deviations (SD) was calculated for the continuous variables, while ratios and proportions were calculated for the categorical variables. Difference of proportions between qualitative variables were tested using chi- square test or Fisher exact test as applicable. P value less than 0.5 was considered as statistically significant.

RESULTS

A total of 100 overweight cases who underwent tracheal intubation were divided into two arms, namely easy intubation group (IDS score less than 5) and difficult intubation group (IDS score greater than or equal to 5). Of 100 cases studied, there were 80 and 20 cases among easy and difficult intubation groups respectively. The following section presents the statistical analysis of several parameters studied.

Of 100 cases studied, 3 (3.0%) had IDS 0, 5 (5.0%) had IDS 1, 21 (21.0%) had IDS 2, 27 (27.0%) had IDS 3, 17 (17.0%) had IDS 4, 7 (7.0%) had IDS 5, 9 (9.0%) had IDS 6, 6 (6.0%) had IDS 7 and 5 (5.0%) had IDS 8. Of 100 cases studied, 80 (80.0%) had Easy Laryngeal intubation (IDS between 0 to 5) and 20 (20.0%) had difficult Laryngeal intubation (IDS between 6 to 8).

Table 1: Distribution of cases according to difficulty of intubation.

IDS	Status	No. of cases	% of cases
0 to 5	Easy	80	80.0
6 to 8	Difficult	20	20.0

The mean ± SD of age of cases studied in Easy and Difficult laryngeal intubation group was 48.3 ± 11.4 years and 50.2 ± 10.1 years respectively. The distribution of mean age of cases studied did not differ significantly between two study groups (P-value>0.05).

The mean ± SD of BMI of cases studied in Easy and Difficult laryngeal intubation group was 28.88 ± 0.91 kg/m2 and 29.08 ± 1.11 kg/m2 respectively. The distribution of mean BMI of cases studied did not differ significantly between two study groups (P-value>0.05).

Table 2: Distribution of mean age according to intubation difficulty score.

	Laryngeal Intubation Difficulty Score				P-value
	Easy (n=80)		Difficult (n=20)		
	Mean	SD	Mean	SD	
Age (years)	48.3	11.4	50.2	10.1	0.485^{NS}
BMI (kg/m2)	28.88	0.91	29.08	1.11	0.401^{NS}

The sex distribution of cases studied did not differ significantly between two study groups (P-value>0.05).

Table 3: The sex distribution of cases studied according to intubation difficulty score.

	Laryngeal Intubation Difficulty Score				
	Easy (n=80)		Difficult (n=20)		P-value
Sex	n	%	n	%	
Male	42	52.5	12	60.0	0.547^{NS}
Female	38	47.5	8	40.0	
P-values by Chi-Square test. P-value<0.05 is considered to be statistically significant. NS-Statistically non-significant.					

The mean ± SD of NC of cases studied in Easy and Difficult laryngeal intubation group was 35.09 ± 5.77 cm and 38.82 ± 3.07 cm respectively. The distribution of mean NC is significantly higher among the cases with difficult intubation compared to cases with easy intubation (P-value<0.05).

The mean ± SD of TMD of cases studied in Easy and Difficult laryngeal intubation group was 9.74 ± 2.62 cm and 5.96 ± 1.87 cm respectively. The distribution of mean TMD is significantly lower among the cases with difficult intubation compared to cases with easy intubation (P-value<0.001).

The mean ± SD of NC/TMD ratio of cases studied in Easy and Difficult laryngeal intubation group was 3.89 ± 1.39 and 6.98 ± 2.30 respectively. The distribution of mean NC/TMD ratio is significantly higher among the cases with difficult intubation compared to cases with easy intubation (P-value<0.001).

Table 4: Distribution of various bed side parameters according to intubation difficulty score.

	Laryngeal Intubation Difficulty Score				
	Easy (n=80)		Difficult (n=20)		P-value
Parameters	Mean	SD	Mean	SD	
NC (cm)	35.09	5.77	37.82	3.07	0.044*
TMD (cm)	9.74	2.62	5.96	1.87	0.001***
NC/TMD	3.89	1.39	6.98	2.30	0.001***
P-values by independent sample t test. P-value<0.05 is considered to be statistically significant. *P-value<0.05, ***P-value<0.001.					

The distribution of area under the curve (AUC) differs significantly for NC, TMD and NC/TMD ratio for the prediction of difficult Laryngeal intubation from the reference value of 0.500 (P-value<0.05 for all). The distribution of area under the curve (AUC) is significantly higher for NC/TMD followed by TMD and NC for the prediction of difficult Laryngeal intubation. Based on the ROC analysis, the optimal cut-offs of NC, TMD and NC/TMD ratio measurements for the prediction of difficult Laryngeal intubation is 36.75 cm, 8.25 cm and 3.50 respectively with area under the curves being 0.624, 0.868, 0.914 respectively.

Table 5: Distribution of area under the ROC curves (AUC) for all bed side for the prediction of difficult Laryngeal intubation.

Parameter	Optimal Cut- Off Based on ROC	AUC ± SE	95% CI of AUC	P-value
NC (cm)	36.75 cm	0.624 ± 0.062	0.502 – 0.746	0.048*
TMD (cm)	8.25 cm	0.868 ± 0.035	0.799 – 0.938	0.001***
NC/TMD	3.50	0.914 ± 0.028	0.859 – 0.970	0.001***
*P-value<0.05 (Statistically significant), ***P-value<0.001 (Statistically significant). Reference value = 0.500. SE – Standard Error.				

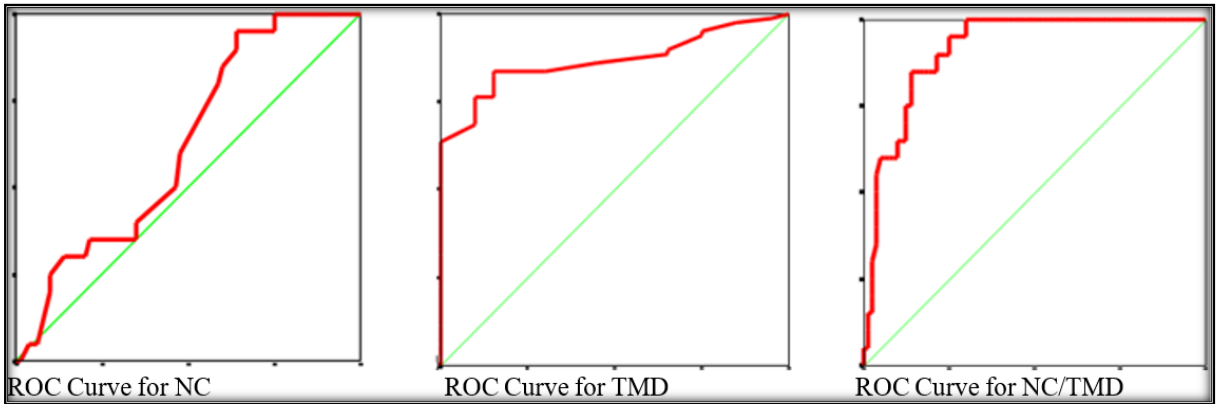

Figure 1: Distribution of area under the ROC curves (AUC) for all bed side for the prediction of difficult Laryngeal intubation.

The sensitivity, specificity for NC, TMD and NC/TMD ratio for the prediction of difficult laryngeal intubation is 52.7, 51.2; 56.4, 56.7; and 68.1, 69.3 respectively.

Table 6: The distribution of measures of diagnostic efficacy measures [Sensitivity and Specificity] for the prediction of difficult laryngeal intubation.

Parameters (Cut-off)	Sensitivity (%)	Specificity (%)
NC (cm) (>36.75 cm)	52.7	51.2
TMD (cm) (<8.25 cm)	56.4	56.7
NC/TMD (>3.50)	68.1	69.3

On univariate analysis, the higher Mallampati grades, lower TMD and higher NC/TMD ratio are significant determinants of incidence of difficult laryngeal intubation (p-value<0.05 for all).

Table 7: Univariate analysis of incidence of difficult laryngeal intubation.

Risk factors (Variables included in the model)		Odds Ratio (OR)	95% CI for Odds Ratio	P-value
Age Group (years)	<50 years	1.00	--	--
	>50 years	1.43	0.77 – 3.03	0.099NS
Sex	Female	1.00	--	--
	Male	1.39	0.45 – 2.14	0.396NS
ASA Grades	Grade I	1.00	--	--
	Grade II	0.69	0.26 – 1.87	0.471NS
BMI	27.00 – 27.99 kg/m2	1.00	--	--
	28.00 – 30.94 kg/m2	1.66	0.69 – 3.41	0.200NS
Mallampati Grades	1 to 2	1.00	--	--
	3 to 4	19.52	5.14 – 74.16	0.001***
NC	<36.75 cm	1.00	--	--
	>36.75 cm	1.16	0.44 – 3.09	0.764NS
TMD	>8.25 cm	1.00	--	--
	<8.25 cm	14.52	2.13 – 28.69	0.001***
NC / TMD	<3.50	1.00	--	--
	>3.50	18.89	6.14 – 35.99	0.001***

[Odds Ratio = 1: Reference Category].
Dependent variable: Difficult laryngeal intubation.
*P-value<0.05, **P-value<0.01, ***P-value<0.001, NS: Statistically Non-Significant.

On multivariate analysis using logistic regression, higher NC/TMD ratio is the independent and significant determinant of incidence of difficult laryngeal intubation; the association is independent of age, sex and BMI (p-value<0.01).

Table 8: Multivariate logistic regression analysis of incidence of difficult laryngeal intubation.

Variables included in the model		Odds Ratio (OR)	95% CI for Odds Ratio	P-value
Age Group (years)	<50 years	1.00	--	--
	>50 years	1.96	0.92 – 2.95	0.053NS
Sex	Female	1.00	--	--
	Male	1.41	0.58 – 1.77	0.345NS
BMI	27.00 – 27.99 kg/m2	1.00	--	--
	28.00 – 30.94 kg/m2	1.58	0.34 – 2.49	0.224NS
NC / TMD	<3.50	1.00	--	--
	>3.50	2.97	1.98 – 5.07	0.009**

[Odds Ratio = 1: Reference Category]. Dependent variable: Difficult laryngeal intubation.
*P-value<0.05, **P-value<0.01, ***P-value<0.001, NS: Statistically Non-Significant.

DISCUSSION

Difficult visualization of larynx is a major cause of difficult intubation in many patients. Therefore, preoperative identification of those patients at risk for difficult laryngoscopy is important in adopting safer alternative strategies for the induction of anesthesia and intubation so that mortality and morbidity related to hypoxia, hypoxemia, acidosis and cardiac arrest can be minimized.

The BMI of cases studied in easy and difficult laryngeal intubation group in this study was 28.8±0.91 kg/m2 and 29.08± 1.11 kg/m2 respectively. Difference was not statistically significant (P value>0.05).

Hirmanpour A et al,[9] conducted study on 650 patients with BMI>30 kg/m2 showed that 30.2± 6.8 and 32.2± 5.5 was the mean BMI for easy and difficult visualization of larynx group which was statistically significantly which does not correlate with the present study results as our sample size is small and BMI range is different.

Previous studies that reported a 2.6–13% incidence of difficult intubation in lean and obese patients, respectively.[8-10] This finding is not comparable with the present study findings as our sample size is small and BMI is in different range.

Srinivasan and Kuppuswamy et al,[10] conducted a study on 354 patients showed that Fifty- one patients had difficult laryngoscopy with CL Grade II b and III with incidence of 14.4% of DI (difficult intubation) which is a similar finding to the present study results.

Hirmanpour A et al,[9] conducted a study on 650 patients with BMI>30 kg/m2 showed that the mean ± SD of TMD of cases studied in Easy and Difficult laryngeal visualisation group was 6.4±1.1 and 6.9±0.9 respectively (P-value <0.001). The mean ± SD of NC of cases studied in Easy and Difficult laryngeal visualisation group was 38.3±2.8 and 36.4±3.0 respectively (P-value <0.001). The mean ± SD of NC/TMD ratio of cases studied in Easy and Difficult laryngeal visualisation group was 6.1±1.3 and 5.3±0.9 respectively (P-value <0.001). These findings were partially comparable with the present study findings.

As per San Lee et al,[11] who studied 250 patients with intubation difficulty, their neck circumferences were significantly increased (P = 0.014). Moreover, 70% of the patients with difficult intubations had neck circumferences ≥ 40 cm and 35% of the patients with easy intubation had a neck circumference ≤40 cm. Thus, the factor that maximally influenced the intubation difficulty was the thickness of the neck. They concluded that if the Mallampati score is III or IV and the neck circumference is greater than or equal to 40 cm, then it can be predicted that intubation will be difficult, which is comparable with our study.

As per Brodsky et al,[12] who studied on hundred obese patients, neither obesity nor increased body mass index predicted problems with tracheal intubation. Increased neck circumference was the only patient risk factor that did have a significant effect on the probability of intubation difficulty (P =0.02). The logistic regression model predicted that the odds of a problematic intubation in a particular patient with a neck circumference 1 cm larger than that of another patient are 1.13 (95% CI, 1.02 to 1.25) times the odds of the patient with a 1-cm smaller neck circumference. With a neck circumference of 40 cm and 60 cm, the probability of a problematic intubation was approximately 5% and 35 % respectively, which is again comparable with our study.

The distribution of area under the curve (AUC) differs significantly for NC, TMD and NC/TMD ratio for the prediction of difficult Laryngeal intubation from the reference value of 0.500 (P-value<0.05 for all).

The study done by Anahita et al,[13] on 200 patients with BMI> 30 kg/m2 showed that AUC of the receiver operating curve for NC, TMD, and NC/TMD scores was [AUC=0.691.,95%CI,0.654-0.726], [AUC=0.606.,95%CI,0.567-0.643], [AUC=0.689, 95% CI, 0.625-0.724] respectively. This finding is again partially comparable with the present study findings as the study subjects are different for both the group.

Hirmanpour A et al,[9] conducted a study on 650 patients with BMI> 30 kg/m2 showed that area under curve (AUC) of the receiver-operating characteristic (ROC) for RHTMD, NC, TMD, and NC/TMD score

([AUC = 0.627, 95% CI, 0.589-0.664], [AUC = 0.691; 95% CI, 0.654-0.726], [AUC = 0.606; 95% CI, 0.567-0.643], [AUC = 0.689;95% CI, 0.625-0.724], respectively) which is again a partially correlating finding with the present study as the findings mentioned in the above study is only comparable with the NC score variable.

In the present study, the sensitivity, specificity for NC, TMD and NC/TMD ratio for the prediction of difficult laryngeal intubation is 52.7, 51.2; 56.4, 56.7; and 68.1, 69.3 respectively.

Study conducted by Kim et al,[14] in 241 patients with BMI>28 kg/m2 showed that the sensitivity, specificity for TMD and NC/TMD ratio for the prediction of difficult laryngeal intubation is 59,91 and 88,83 respectively which partially correlates with the present study findings. The study also showed NC/TMD ≥5 for predicting IDS gave sensitivity of 88.2% and specificity of 83.0%. Though, this study also assessed other predictors like neck circumference/sternomental distance, Sternomental distance, Wilson score and history of difficult intubation.

Hirmanpour A et al,[8] conducted a study showed that the sensitivity and specificity for NC and NC/TMD was 49.06&89.07 and 71.7&70.2 respectively. These findings are partially comparable with the present study findings.

On univariate analysis, the higher Mallampati grades, lower TMD and higher NC/TMD ratio are significant determinants of incidence of difficult laryngeal intubation (p- value<0.05 for all). Basil Paul Manayaliul.,15 conducted a study showed that Binary univariate logistic regression analysis of predictors of difficult intubation showed age, increased neck circumference, decreased thyromental distance, modified Mallampati test, NC/TMD ratio ≥ 5 as statistically significant variables that were associated with a difficult intubation ($p \leq 0.05$) which is a comparable finding with the present study findings

On multivariate analysis using logistic regression, higher NC/TMD ratio is the only independent and significant determinant of incidence of difficult laryngeal intubation (p- value<0.01) whereas, the association is independent of age, sex and BMI as these parameters did not show statistically significant association.

Hirmanpour A et al,[9] conducted a study showed that using the multivariate analysis, they found that NC, RHTMD, and NC/TMD have the highest odds ratio for prediction of difficult laryngoscopy. Basil Paul Manayaliul,[15] conducted a study showed that Binary multivariate logistic regression analysis showed only neck circumference (p=0.030 [odd ratio 2.519(1.094-5.802)] and NC/TMD ratio (p <0.001 [odd ratio 23.680(10.638-52.713)] independently predicted difficult intubation which is again partially comparable with the present study results.

Methods to predict difficult airway can be achieved by various screening tests such as x rays, CT scan and MRI scan. But these are time consuming, costly and impractical for population screening.[16,17] Bedside tests are simple, quick and more practical than the screening tests.

CONCLUSION

On univariate analysis, the higher Mallampati grades, lower TMD and higher NC/TMD ratio are significant determinants of incidence of difficult laryngeal intubation (p- value<0.05 for all). On multivariate analysis using logistic regression, higher NC/TMD ratio is the independent and significant determinant of incidence of difficult laryngeal intubation. NC/TMD ratio can be considered a better reliable screening tool for predicting difficult intubation in overweight patients. It provided better sensitivity/specificity. PPV (positive predictive value) an AUC (area under curve) compared to other predictors.

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