

**NECK CIRCUMFERENCE TO THYROMENTAL DISTANCE RATIO IN COMPARISON  
WITH MALLAMPATI TEST: A STUDY TO PREDICT DIFFICULT INTUBATION****Dr. Samiksha Khanooja<sup>1\*</sup> and Dr. Madhusudan Upadya<sup>2</sup>**<sup>1</sup>MBBS, MD, Resident, Department of Anaesthesiology, Kasturba Medical College, Mangalore.<sup>2</sup>MBBS, MD, Professor, Department of Anaesthesiology, Kasturba Medical College, Mangalore.**\*Corresponding Author: Dr. Samiksha Khanooja**

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**ABSTRACT**

**Background:** Difficult visualization of larynx, which might lead to difficult intubation is a major concern for anesthesiologists. By utilizing different predictors for difficult airway assessment, the airway can be secured without adverse consequences. **Objectives:** This study was performed to assess and compare the ratio of the neck circumference to thyromental distance (NC/TMD) with modified Mallampati score in predicting difficult intubation. **Methods:** The incidence of difficult tracheal intubation in 288 patients were studied. Difficult intubation was determined using the intubation difficulty scale (IDS $\geq$ 5). The NC/TMD ratio was calculated and it was compared with the patient's modified Mallampati score to predict difficult intubation. Other factors like TMJ mobility, neck movement, presence of abnormal teeth etc were considered. **Statistical analysis:** The differences between the two predictors, modified Mallampati score and NC/TMD ratio were analysed using a Chi square test and Student's unpaired t-test. **Results:** Difficult intubation was reported in 18 out of 288 patients (6.25%). Multivariate analysis revealed that the modified Mallampati score and NC/TMD can be used independently to predict difficult intubation, (IDS $\geq$ 5). Among these two indices, NC/TMD showed the higher sensitivity and a negative predictive value. **Conclusion:** The NC/TMD is a reliable method for predicting difficult intubation like modified Mallampati score.

**KEYWORDS:** Airway management, laryngoscopy, tracheal intubation, Mallampati, NC/TMD.**INTRODUCTION**

Difficult visualization of larynx which might lead to difficult intubation is a major concern for anaesthesiologists and it contributes to perioperative morbidity and mortality.<sup>[1]</sup> Incidence is 1.5%-13% in patients undergoing surgery in clinical practice.<sup>[2]</sup> Difficult laryngoscopy (defined by poor glottic visualization) is synonymous with difficult intubation during surgery in most patients.<sup>[3]</sup>

Many predictors have been developed to predict difficult visualization and difficult intubation like history of obstructive sleep apnoea syndrome (OSAS), higher Mallampati score, increased age, male gender, short neck, the Wilson score etc. The modified Mallampati score<sup>[3]</sup> or increasing neck circumference (NC) is reported to be associated with difficult intubation.

When recognized before induction, all the difficult airways can be secured by the selected use of specialized tracheal intubation techniques. When unrecognized before attempts at intubation, the results can be catastrophic as spontaneous respiratory efforts are eliminated by muscle relaxants.

Our hypothesis is that the NC/TMD ratio might be useful when compared with the previously reported difficult intubation index like modified Mallampati score to predict the difficulty in intubation. Our aim was to evaluate and compare NC/TMD ratio as a predictor for difficult intubation with the established index – modified Mallampati score.

**MATERIALS AND METHODS**

Ethics committee approval was taken before starting the study and written informed consent were obtained from the patients involved in the study.

Two hundred and eighty eight patients belonging to ASA class I or II, who were undergoing surgery under general anaesthesia with tracheal intubation were enrolled for this descriptive study.

**Inclusion Criteria**

- Patients above the age of 18 years
- ASA physical status I, II
- Patients requiring general anaesthesia with tracheal intubation

**Exclusion Criteria**

- Patients younger than 18 years
- Those with upper airway pathology( i.e., maxillofacial fractures, tumors, etc)
- Pregnant patients
- Midline neck swellings
- Gross anatomical abnormality
- Cervical spine fracture

**EXPERIMENTAL DESIGN**

For recording NC/TMD ratio, each patient was placed in the supine position, with the head on a firm table. They were instructed to look straight ahead, keeping the head in the neutral position, closing the mouth and not allowing to swallow.

The neck circumference was measured at the level of cricoid cartilage i.e. at C5 – C6 level. It was measured with patient in neutral position.

The patients were then instructed to extend the head maximally, taking care that the shoulders were not lifted while extending the head. The straight distance from the anterior-most part of the mentum to the thyroid notch was measured and was defined as the thyromental distance (in centimeters).

The ratio of the NC to TM (NC/TMD) were calculated from these measurements.

Modified Mallampati score was recorded with the patient sitting with his mouth at the level of examiner's eye with tongue being protruded and allowing no phonation.

**Modified Mallampatti classification without phonation**

- Class I: soft palate, fauces, uvula, and pillars visible
- Class II: soft palate, fauces, and uvula visible
- Class III: soft palate and the base of uvula visible
- Class IV :soft palate not visible,

**Other parameters measured include**

- a) The presence or the absence of the impaired temporomandibular joint mobility (inability to move the lower teeth in front of the upper teeth or retrognathia)
- c) Limited neck movement (inability to extend and flex the neck to a range around 90 degree)
- d) The presence or absence of abnormally protruding upper teeth

The primary outcome measured in this study include the prediction of difficult intubation by as defined by Intubation difficulty score using the following indices, modified Mallampatti and NC/TMD.

In the operating theatre, the patients were positioned with pillows under the head with neck extended. Each patient was monitored routinely with an electrocardiogram, pulse oximetry and non-invasive arterial pressure.

Patients were administered 100% oxygen through a face mask for more than 3 min. Patients were premedicated with 1 milligram midazolam and 2 microgram per kilogram fentanyl according to weight. Anaesthesia was induced with propofol (2mg/kg) and rocuronium (0.7mg/kg). Cricoid pressure was applied as described by Selick<sup>[5]</sup> when requested by the intubator for a better view at laryngoscopy. A size 3 Macintosh laryngoscope blade was used for the first laryngoscopy in each case. All tracheal intubations were performed by anaesthesiologists with more than 2 years of experience. The laryngoscopic view will be graded according to Cormack and Lehane's scale which is as Grade 1: the vocal cords were completely visible, Grade 2: only the arytenoids were visible, Grade 3: only the epiglottis was visible, Grade 4: epiglottis was not visible.

**Difficulty of intubation was assessed using the IDS. 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, N4=0; grade 2, N4=1; grade 3, N4=2; grade 4, N4=3);
- N5, lifting force applied during laryngoscopy (N5=0 if inconsiderable and N5=1 if considerable);
- N6, needed to apply external laryngeal pressure for optimized glottic exposure (N6=0 if no external pressure or only the Sellicks manoeuvre was applied and N6=1 if external laryngeal pressure was used);
- N7, position of the vocal cords at intubation (N7=0 if abducted or not visible and N7=1 if adducted)

The two groups of patients were classified further according to the IDS score. Those with an IDS score of  $\geq 5$  and  $< 5$  were defined as the difficult and easy groups, respectively.

**DATA ANALYSIS**

With 95% confidence level and 80% power, taking reference value as 13.8, our sample size (n) came as 288.<sup>[4,6]</sup> The differences between the two predictors, modified Mallampati score and NC/TMD ratio was analysed using a Chi square test, Student's unpaired t-test.

**RESULTS**

The study done on 288 patients included 147 male (50.0%) and 141 female (49.1%) patients. We observe that there is slight male preponderance in the study. (Fig 1)

The prediction of difficult intubation by modified Mallampati test (MP) and actual IDS (intubation difficulty scale) was compared. 10 out of 62 patients with Modified Mallampati Class  $\geq 3$  had IDS  $\geq 5$ , while 8 of 226 of patients with Modified Mallampati Class 1 and 2 had IDS  $\geq 5$ .

52 out of 62 patients with Modified Mallampati Class  $\geq 3$  had  $IDS < 5$ , while 218 out of 226 of patients with Modified Mallampati Class 1 and 2 had  $IDS < 5$

The sensitivity of modified Mallampati test for predicting Difficult intubation (by using IDS) was 55% and specificity was 81.34% (Table 1). The test has a positive predictive value of 18.03%, Negative predictive value of 96.04%. (Table 2)

#### NC/TMD vs IDS

The prediction of difficult intubation by NC/TM and actual IDS (intubation difficulty scale) were also compared. 17 out of 151 patients with  $NC/TMD \geq 5$  had  $IDS \geq 5$ , while 1 out of 137 patients with  $NC/TMD < 5$  had  $IDS \geq 5$ .

134 out of 151 patients with  $NC/TMD \geq 5$  had  $IDS < 5$ , while 136 out of 137 of patients with  $NC/TMD < 5$  had  $IDS < 5$ . The sensitivity of NC/TMD for predicting Difficult intubation (by using IDS) was 94.44% and specificity was 85.81% (Table 3). The test had a positive predictive value of 11.26%, Negative predictive value of 99.88% (Table 4).

#### Statistical Terms

- True positive = a difficult intubation that had been predicted to be difficult.
- False positive = an easy intubation that had been predicted to be difficult.

- True negative = an easy intubation that had been predicted to be easy.
- False negative = a difficult intubation that had been predicted to be easy.
- Sensitivity = the percentage of correctly predicted difficult intubations as a proportion of all intubations that were truly difficult, i.e

$$\frac{\text{True Positives}}{(\text{True Positives} + \text{false negatives})}$$

- Specificity = the percentage of correctly predicted easy intubations as a proportion of all intubations that were truly easy, i.e

$$\frac{\text{True Negatives}}{(\text{True negatives} + \text{false positives})}$$

- Positive predictive value = the percentage of correctly predicted difficult intubations as a proportion of all predicted difficult intubations, i.e

$$\frac{\text{True positives}}{(\text{True positives} + \text{false positives})}$$

- Negative predictive value = the percentage of correctly predicted easy intubations as a proportion of all predicted easy intubations, i.e

$$\frac{\text{True negatives}}{(\text{True negatives} + \text{false negatives})}$$

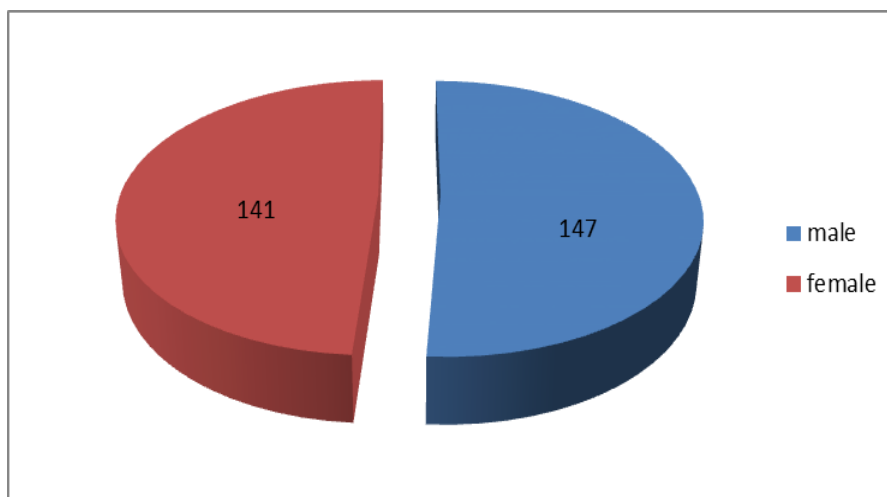


Fig. 1: Demography

Table 1: Diagnostic validity of modified Mallampati for predicting difficult intubation (by IDS)

			IDS score		Total
			<5	$\geq 5$	
MP	1	Count	99	1	100
		%	36.9%	5.9%	35.1%
	2	Count	119	7	126
		%	44.4%	47.1%	44.6%
	3	Count	50	8	58
		%	17.9%	35.3%	18.9%
	4	Count	2	2	4
		%			

		%	.7%	11.8%	1.4%
	Total	Count	270	18	288
		%	100.0%	100.0%	100.0%

**Table 2 Predictive value of modified Mallampati for predicting difficult intubation (by IDS)**

TP(n)	TN(n)	FP(n)	FN(n)	Sensitivity(%)	Specificity(%)	PPV	NPV
10	218	52	8	55.0	81.3403	18.	96.04

**Table 3; Diagnostic validity of NC/TM for predicting difficult intubation (by IDS)**

Quality of NC/TMD for predicting difficult intubation (by IDS)					
			NC/TMD ratio		
			<=5	>5	Total
idrgrp2	<5	Count	136	134	270
		%	99.27%	88.7%	94.0%
	>5	Count	1	17	18
		%	0.63%	11.3%	6.0%
	Total	Count	137	151	288
		%	100.0%	100.0%	100.0%

**Table 4; Predictive value of NC/TM for predicting difficult intubation (by IDS)**

TP(n)	TN(n)	FP(n)	FN(n)	Sensitivity(%)	Specificity(%)	PPV	NPV
17	136	134	1	94.44	50.37	11.26	99.88

## 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. Difficulty in intubation is usually described using IDS (intubation difficulty scale). IDS  $\geq 5$  describing difficult intubation. Previous studies that reported a 2.6–13%<sup>[7]</sup> incidence of difficult intubation in lean and obese patients, respectively. In our study, the intubation was difficult (IDS  $\geq 5$ ) in 18 (6.25 %) of the 288 patients. No failed tracheal intubations occurred. The incidence of 6.25% is consistent with the incidence reported in literature.

### Sensitivity and specificity of NC/TMD and MMT

The ideal test for IDS prediction should have 100% sensitivity and 100% specificity; however, sensitivity and specificity are inversely proportional to each other. Optimal cut offs used in our study to calculate the sensitivity and specificity were NC/TMD  $\geq 5$ , modified Mallampati  $\geq 3$  (difficult intubation) and IDS  $\geq 5$  (difficult intubation).

In our study, overall sensitivity and specificity of diagnostic predictors was relatively comparable. While using modified Mallampati for predicting IDS showed sensitivity of 55.0%, the specificity of this test was as high as 81.34%. On the other hand using NC/TMD for predicting IDS showed sensitivity of as high as 94.44% and specificity of 50.37%.

These findings are consistent with the study of W.H Kim *et al*<sup>[8]</sup> which showed sensitivity of 58.8% and specificity of 89.60% in using mallampati grade 3 or 4 to predict IDS. Whereas using NC/TMD  $\geq 5$  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.

Various studies that assessed the sensitivity, specificity and predictive values of different diagnostic predictors have come across variable findings and this was largely due to the different diagnostic criteria adopted by the investigators.

Mathew *et al*<sup>[9]</sup> demonstrated that patients with TMD of <6cm and horizontal length of mandible <9cm showed good correlation with MMT grade III and IV and had a higher probability of difficult intubation.

In a Frerk study<sup>[6]</sup> MMT had sensitivity (81%) and specificity (81.5%) whereas TMD  $\leq 7$ cm had sensitivity (90.9%) and specificity (81.5%). In a study by Kuriakose *et al*<sup>[10]</sup>, MMT had sensitivity (81.8%), PPV (61.76%), specificity (75.15%). TMD had a sensitivity of 66.23%, specificity of 75.79% and PPV of 57.3%. Author concluded that modified Mallampati Test predicts difficult intubation more accurately than others among independent predictors. Previous studies reported that the NC is an independent risk factor for difficult intubation in obese patients.

However, the NC alone may not clearly indicate the amount of soft tissue at various topographic regions within the neck. Horner and colleagues<sup>[11]</sup> demonstrated that more fat was present in areas surrounding the collapsible segments of the pharynx in obese patients with OSAS using magnetic resonance imaging (MRI) measurements.

In another study conducted by Khan *et al.* in a group of 200 patients to predict the efficacy of upper lip bite test in predicting difficult mask ventilation it was found that the negative predictive value for this test in predicting difficult mask ventilation was higher than the history of snoring and neck circumference. It was 86% compared to 83% and 81% for other test respectively.<sup>[12]</sup>

In a study on 50 obstructive sleep apnea patients, comparing neck circumference to thyromental distance ratio as a predictor of difficult intubation along with other predictors like neck circumference, Mallampatti score, BMI, it was found that NC/TMD strongly correlated with difficult intubation with *p* value less than 0.01 while the correlation with Mallampatti classification was weaker. NC/TMD had higher sensitivity and negative predictive value which was similar to our findings.<sup>[13]</sup>

In another multivariate analysis validation of modified Mallampatti test was done with thyromental distance and sternomental distance to predict difficult intubation in adults it was found that MMT had a high specificity. The validity of combination of MMT, SMD and TMD as compared to MMT alone was very high in predicting difficult intubation in adult patients<sup>[14]</sup> which was almost comparable to our findings.

The limitations for the study includes, first, it was not blinded completely. The IDS score could have been increased intentionally if the anaesthesiologist knew the purpose of this study. Furthermore, a Macintosh No.3 laryngoscopic blade was used for the first laryngoscopy in each case; it may be inappropriate for some patients as a first choice. The size of the blade should have been chosen by the operator case by case.

## CONCLUSIONS

This study have demonstrated that no one individual test has proven to be adequate in predicting difficult airway. However, the application NC/TMD may be superior to Modified Mallampatti classification in predicting difficult airway as it had a higher sensitivity and negative predictive value.

**CONFLICT OF INTEREST:** None.

**ACKNOWLEDGEMENT:** None.

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