ANTICIPATION OF DIFFICULT AIRWAY BY NECK CIRCUMFERENCE TO THYROMENTAL DISTANCE RATIO

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ABSTRACT

INTRODUCTION

Unanticipated difficult intubation scenario is a major concern for anaesthetists which contributes to perioperative morbidity and mortality. Characteristics of difficult intubation indices like increased neck circumference (NC) and reduced thyromental distance (TM) when combined as a ratio can increase accuracy in predicting difficult intubation.

MATERIAL AND METHODS

This prospective, observational study was conducted at Universal College of Medical Sciences Teaching Hospital on 160 patients of ASA class I and II planned for surgery under general anaesthesia with endotracheal intubation. Airway indices measured were modified mallampati classification (MM), thyromental distance (TM), neck circumference (NC), and neck circumference to thyromental distance ratio (NC/TM).

RESULTS

NC/TM showed the highest sensitivity, specificity, PPV and NPV in the non-obese group (p <0.001) as compared to MM, NC and TM. In the obese group, NC/TM showed the highest sensitivity, PPV and NPV (p <0.001) as compared to NC and TM while the specificity was highest and similar to MM as compared to NC and TM.

CONCLUSION

Neck circumference to thyromental distance ratio is a better predictor of anticipating difficult intubation in both obese and non-obese patients compared to modified mallampati classification, thyromental distance and neck circumference.

KEYWORDS

Difficult intubation, Neck circumference, Thyromental distance

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INTRODUCTION

Unanticipated difficult intubation scenario is a major concern for anaesthetists which contributes to perioperative morbidity and mortality.[1,2] Complications related to difficult intubation can be injury to the airway and oral cavity (edema, bleeding, tooth breakage), increased stress response, hypertension, tachycardia, increased intracranial pressure and hypoxia leading to temporary or permanent neurological damage.[3]

The reliability of a single airway indices to predict a difficult airway is limited.[4] Increased neck circumference (NC) and reduced thyromental distance (TM) both are characteristic of difficult intubation indices, combining both parameters as a ratio can increase accuracy in predicting difficult intubation.[5]

Therefore, the objective of this study was to evaluate neck circumference to thyromental distance ratio (NC/TM) as a predictor of difficult intubation.

MATERIAL AND METHODS

This prospective, observational study was conducted at Universal College of Medical Sciences Teaching Hospital from January 2023 to December 2023 after obtaining ethical approval from the institutional review committee (UCMS/IRC/223/22). Written informed consent was taken from 160 ASA class I or II patients undergoing surgery under general anaesthesia with endotracheal intubation. Patients with upper airway pathology, ASA III or above, cervical spine pathology and pregnant patients were excluded from the study.

Pre anaesthetic evaluation was done one day before surgery. Airway indices measured were modified mallampati classification (MM), thyromental distance (TM), neck circumference (NC), and neck circumference to thyromental distance ratio (NC/TM). According to WHO: Asia Pacific perspective- Redefining obesity,[6] patients with a BMI of ≥25 kg/m^2 were assigned as obese and BMI < 25 kg/m^2 were assigned as non-obese. The thyromental distance was measured from the upper-most border of the thyroid cartilage up to the mentum measured with the neck extended. Neck circumference was measured at the level of the upper border of the cricoid cartilage in the upright and seated position. The ratio of neck circumference to thyromental distance was calculated from the measured thyromental distance and neck circumference. Modified Mallampati score was recorded with the patient sitting with his mouth at the level of the examiner's eye with the tongue protruding and allowing no phonation.

On the day of surgery, patients were kept in a supine position on the operation table with a pillow under the head. Monitors were attached for heart rate, blood pressure, SpO2 and ECG throughout the surgery. Pre-oxygenation was done followed by Inj Midazolam at 0.03 mg/kg. Analgesia was supplemented by Inj Fentanyl 2 mcg/kg IV and patients were induced by Inj Propofol IV in titrated dose till the loss of eyelash reflex. After induction, bag and mask ventilation was checked. Then, Inj Vecuronium 0.1 mg/kg was administered. Patients were ventilated manually with oxygen for 3 minutes. Laryngoscopy was done by an anaesthesiologist with more than 3 years of experience. A size 3 Macintosh laryngoscope blade was used on the first attempt. An endotracheal tube 7.5-8 mm ID was used for male and 7-7.5 mm ID for female.

The difficulty of intubation was assessed using the Intubation Difficulty Scale (IDS) which was graded as follows: N1, number of additional intubation attempts; 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 , N5-1 if considerable); N6, needed to apply external laryngeal pressure for optimized glottic exposure (N6-0 if no external pressure or only the Sellick manoeuvre was applied, N6-1 if external laryngeal pressure was used); N7, the position of the vocal cords at intubation (N7-0 if abducted or not visible, N7-1 if adducted). IDS score was the sum of N1 through N7. A score of 0 indicates intubation under ideal conditions while a score ≥ 5 indicates difficult intubation.[7]

Statistical Analysis

The sample size was calculated based on a study conducted by Rose et al[8] using the formula,

$$n = \frac{Z^2pq}{d^2}$$

Z= level of significance at 5% = 1.96
p = prevalence/incidence of difficult airway= 10.8
q= 1-p= 89.2
d= allowable error = 5%
After calculating, we got a sample size of 148.03. So, approximately 160 samples were taken in this study.

Data were entered and analyzed using SPSS vs.20. Descriptive as well as inferential statistics were used to analyze the data. In descriptive statistics, frequency, percentage, mean and standard deviation were used to analyze the data. In inferential statistics, the chi-square test was used to find the association between dependent and independent variables. An Independent sample t-test was used to find the mean difference between the two groups. ROC curve was used to find the sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV). Similarly, the ROC curve was used to predict the difficulty of intubation using different methods. A p value less than 0.05 was considered statistically significant.

RESULTS

Out of 175 patients, 160 patients were included in the study and were divided into two groups - Obese (Group O) and Non-obese (Group NO). 15 patients were excluded from the study due to patient refusal and use of laryngeal mask airway.

In the obese group, the number of patients was 67 with 76.1% female predominance while the non-obese group had 93 patients with 52.7 % of female patients as shown in Table 1. The mean age of patients in non-obese group was 43.48± 16.94 years and 45.39 ± 12.77 years in obese group.

Table 1. Gender distribution of study population in both groups

Group	Gender	Frequency	Percent
Non-obese	Female	49	52.7
	Male	44	47.3
Obese	Female	51	76.1
	Male	16	23.9

The ROC curve for MM, NC, TM and NC/TM was analyzed, the cutoff value was determined and sensitivity, specificity, PPV, NPV and AUC (area under the curve) were calculated as shown in Figure 1 for non-obese patients and Figure 2 for obese patients.

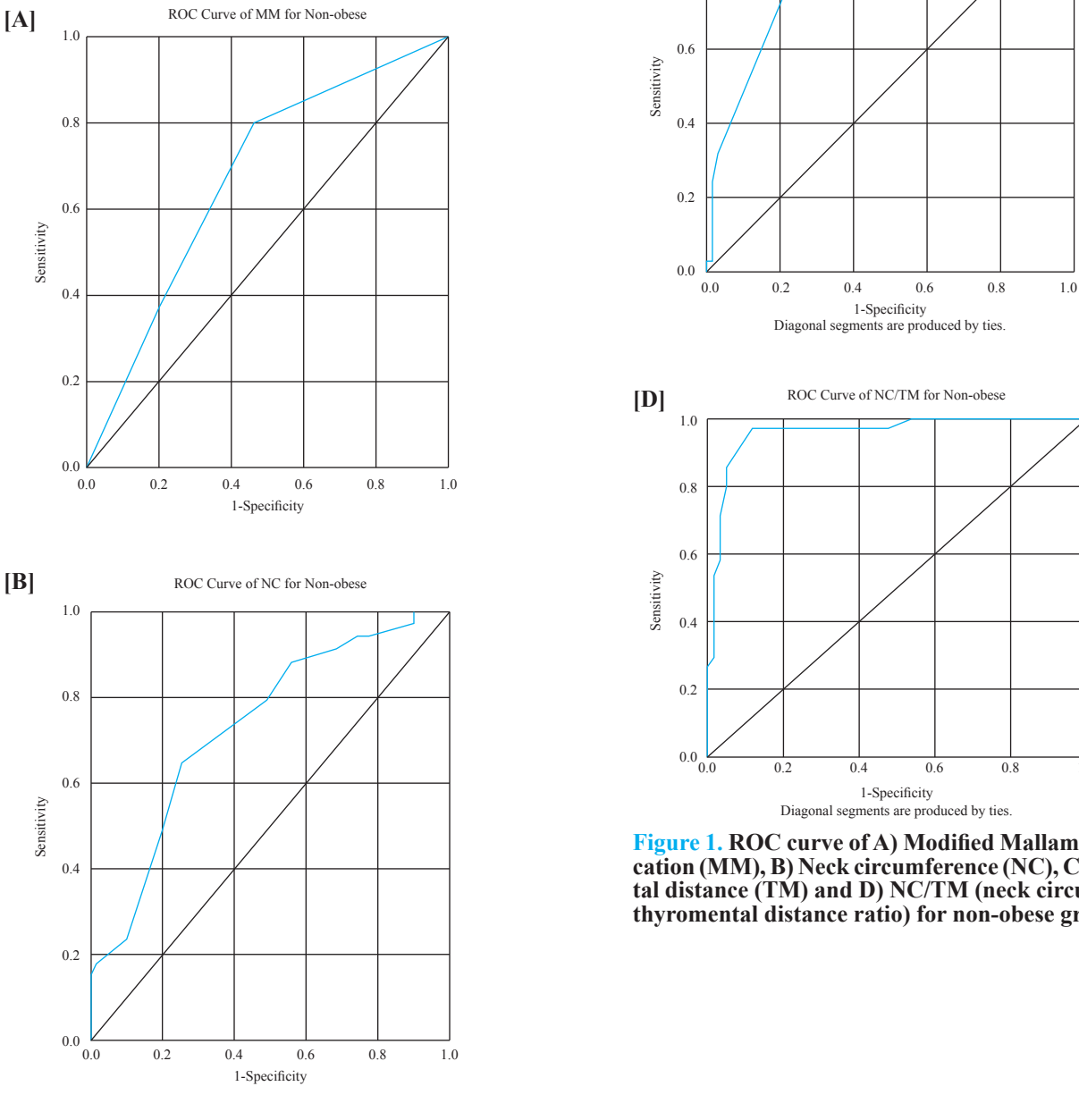

Figure 1. ROC curve of A) Modified Mallampati Classification (MM), B) Neck circumference (NC), C) Thyromental distance (TM) and D) NC/TM (neck circumference to thyromental distance ratio) for non-obese group

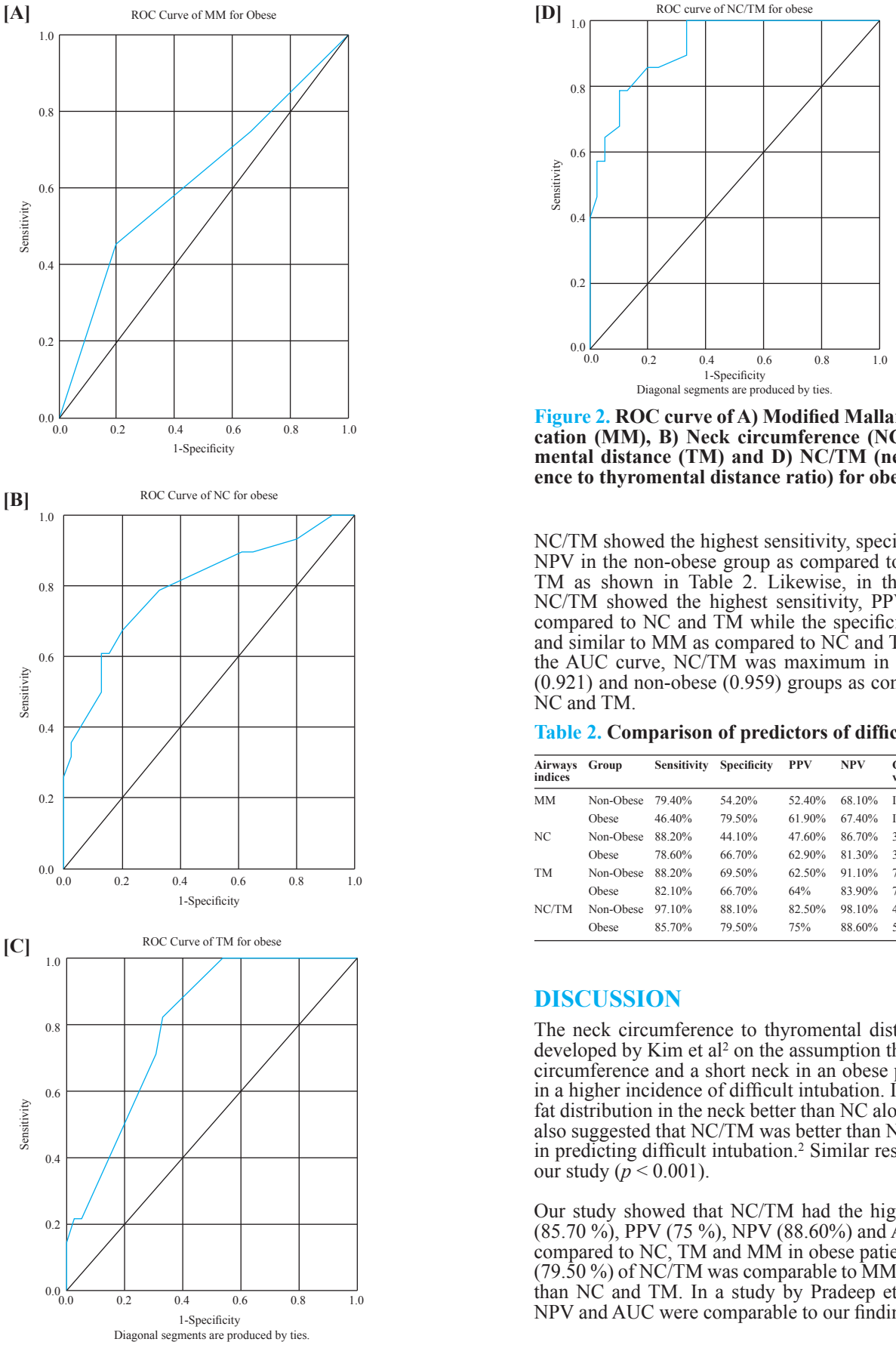

Figure 2. ROC curve of A) Modified Mallampati Classification (MM), B) Neck circumference (NC), C) Thyromental distance (TM) and D) NC/TM (neck circumference to thyromental distance ratio) for obese group

NC/TM showed the highest sensitivity, specificity, PPV and NPV in the non-obese group as compared to MM, NC and TM as shown in Table 2. Likewise, in the obese group NC/TM showed the highest sensitivity, PPV and NPV as compared to NC and TM while the specificity was highest and similar to MM as compared to NC and TM. In terms of the AUC curve, NC/TM was maximum in both the obese (0.921) and non-obese (0.959) groups as compared to MM, NC and TM.

Table 2. Comparison of predictors of difficult intubation

Airways indices	Group	Sensitivity	Specificity	PPV	NPV	Cut off value	AUC	P value
MM	Non-Obese	79.40%	54.20%	52.40%	68.10%	III	0.675	0.05
	Obese	46.40%	79.50%	61.90%	67.40%	III	0.625	0.97
NC	Non-Obese	88.20%	44.10%	47.60%	86.70%	34.5	0.732	<0.001
	Obese	78.60%	66.70%	62.90%	81.30%	37.5	0.795	<0.001
TM	Non-Obese	88.20%	69.50%	62.50%	91.10%	7.75	0.843	<0.001
	Obese	82.10%	66.70%	64%	83.90%	7.75	0.797	<0.001
NC/TM	Non-Obese	97.10%	88.10%	82.50%	98.10%	4.93	0.959	<0.001
	Obese	85.70%	79.50%	75%	88.60%	5.13	0.921	<0.001

DISCUSSION

The neck circumference to thyromental distance ratio was developed by Kim et al[2] on the assumption that a large neck circumference and a short neck in an obese patient resulted in a higher incidence of difficult intubation. It represents the fat distribution in the neck better than NC alone. Their result also suggested that NC/TM was better than NC or TM alone in predicting difficult intubation.[2] Similar result was seen in our study ($p < 0.001$).

Our study showed that NC/TM had the highest sensitivity (85.70 %), PPV (75 %), NPV (88.60%) and AUC (0.921) as compared to NC, TM and MM in obese patients. Specificity (79.50 %) of NC/TM was comparable to MM but was higher than NC and TM. In a study by Pradeep et al, specificity, NPV and AUC were comparable to our findings.[9] Qureshi et

al also had similar findings in terms of sensitivity and PPV of NC/TM in obese patients.[10]

In non-obese patients, NC/TM had the highest sensitivity (97.10 %), specificity (88.10 %), PPV (82.50 %), NPV (98.10%) and AUC (0.959) as compared to NC, TM, MM. Pradeep et al had similar findings in non-obese patients with comparable sensitivity, specificity, NPV and AUC.[9] Rose et al findings were also comparable in terms of specificity and NPV to our study.[8]

NC as an independent predictor of difficult intubation has been studied in previous studies in obese and non-obese patients.[11,12] Our study also showed that it helps in anticipating difficult intubation in both groups ($p<0.001$). Higher sensitivity and NPV with low specificity and PPV were observed in both groups which were comparable to the findings of Pradeep et al.[9] Manayaliul et al findings regarding NC in obese patients also showed similar sensitivity and NPV value while specificity and PPV were low.[13] Rose et al showed low sensitivity, specificity and PPV with high NPV in both obese and non-obese patients.[8]

Our study showed that TM was found to be a good predictor of difficult intubation in both groups ($p<0.001$) with high sensitivity and NPV. Rose et al showed that TM in obese patients had high sensitivity, specificity and NPV while non-obese patients had high specificity and NPV.[8] Pradeep et al showed high sensitivity, PPV and NPV in obese patients and high sensitivity and NPV in non-obese patients.[9] Manayaliul et al showed high specificity and high NPV in obese patients.[13]

In our study, modified mallampati classification in obese and non-obese patients was unable to predict difficult airway (obese, $p = 0.97$ and non-obese, $p = 0.05$). At a cut-off of class III, AUC was 0.675 in non-obese and 0.625 in obese patients which was the lowest among other measured airway indices. The ability to predict difficulty may be reduced in obese patients by mallampati due to the limited jaw mobility. While NC/TM is not affected by jaw movement.[2] Lee et al conducted a meta-analysis that showed that the mallampati value was poor in predicting difficult intubation.[14]

LIMITATIONS

According to the experience of anaesthesiologists, difficulty in intubation may vary, thereby resulting in variable IDS scores. Measurement of Modified Mallampati classification, thyromental distance and neck circumference may be subjected to inter-observer variability.

CONCLUSION

NC/TM ratio is a better predictor of anticipating difficult intubation in obese and non-obese patients compared to modified mallampati classification, thyromental distance and neck circumference.

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