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Comparison of Ratio of The Neck Circumference To Thyromental Distance, Mallampati Score, wilson Score As Predictor of Difficult Intubation in Obese Patients

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Abstract:
Context: *Unanticipated difficult airway is a major cause of mortality and morbidity.*
Aims: *To compare ratio of neck circumference/thyromental distance (NC/TM), Mallampatti grade and Wilson score, using intubation difficulty scale (IDS), in predicting difficult intubation and to estimate the prevalence of difficult intubation in obese population.*
Methods And Material: *197 ASA grade I,II obese patients(BMI≥25kg/m^2) were assessed for NC/TM, mallampatti grade and Wilson score. Difficult intubation was determined using IDS≥5. These parameters were compared to determine the diagnostic accuracy of individual tests and the combination of three. Statistical* ***Analysis Used:*** *SPSS (version 18.0) software was used for the analysis .Diagnostic significance of predictors was assessed by ROC curve analysis. A two-sided (α=2) p<0.05 was considered statistically significant. Results: NC/TM have the highest diagnostic accuracy and largest area under curve (AUC=0.860, Z=7.74, p<0.001) with largest sensitivity (74.07% CI=53.7-88.8) and specificity (92.94% CI=88.0-96.3). The diagnostic accuracy of Combination (NC/TM + Mallampati grading + Wilson score) was found to be significant (AUC=0.867, Z=8.08, p<0.001) with highest sensitivity 85.19% (95% CI=66.3-95.7) but low specificity 76.47% (95% CI=69.4-82.6) than the NC/TM. The obese patients showed 13.7% prevalence of difficult intubation.*
Conclusions: *NC/TM>4.9 fairly predicted difficult intubation in obese Asian patients. Combination of tests increases the diagnostic value.*
Keywords: *Difficult intubation, Mallampatti grade,Obesity, Wilson score*

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I. Introduction

The Mallampati score[1,2] Wilson score[3] or Thyromental distance(TM)[4] or neck circumference(NC)[5,6] are known parameters of difficult intubation. Obese patients may present as unanticipated difficult airway, have short neck with large neck soft tissue. However, spatial distribution of soft tissue is important and is represented in ratio of neck circumference to thyromental distance(NC/TM). This ratio has been proposed as a better method of predicting difficult intubation in obese population.[7] We aimed to compare three parameters in predicting difficult intubation in obese patients using the intubation difficulty scale (IDS).[8] The secondary objective is to find the prevalence of difficult intubation in obese patients.

I. Subjects And Methods

After getting approval from local ethical committee, this observational study was conducted in operating theatres and department of anaesthesiology of a university hospital. All patients provided informed consent. One hundred and ninety seven adult patients, ASA grade I and II, age ≥18 years and ≤76 years, planned for surgery under general anaesthesia with their airway secured by tracheal intubation, were enrolled in the study over a period of ten months. Patients with obvious upper airway pathology/abnormal anatomy (like cleft lip and/or palate, ankylosing spondylitis, facial bone fracture, goiter etc), age <18 and >76 years, patient undergoing general anaesthesia without tracheal intubation were excluded. Only obese patients were included and according to Asian obesity criteria,[9] obesity was defined as body mass index(BMI)≥25kg/m^2.

Parameters measured:

i. NC: measured at the level of cricoid, perpendicular to long axis of the neck (in cms).

ii. TM: measured from the superior thyroid notch to the lower edge of the middle of the chin with the neck extended (in cms).
iii. Ratio of NC/TM was calculated.
iv. Mallampati grade[1] (Class I: soft palate, fauces, uvula, and pillars visible, Class II: soft palate, fauces, and uvula visible, Class III: soft palate and base of uvula visible, Class IV: soft palate not visible)
v. Wilson score:[3] the presence or absence of impaired temporomandibular joint mobility (inability to move the lower teeth in front of the upper teeth or retrognathia), limited neck movement (inability to extend and flex the neck to a range around 90^0), the presence or absence of abnormally protruding upper teeth were also recorded.

A thorough medical history was obtained and complete preanaesthetic checkup of the patient was done before the surgery and written informed consent was obtained. Height and weight was used to calculate BMI. For each patient, selected variables that may predict difficult intubation was collected by an anaesthesiologist.
In the operating room, patients were positioned supine with the head elevated and neck extended in the sniffing position. Each patient was routinely monitored by an electrocardiogram, pulse oximetry, and noninvasive arterial blood pressure. Premedication with intravenous midazolam(0.3µg/kg), fentanyl(1.5µg/kg) was done. Patients breathed 100% oxygen by facemask for a minimum of 3minutes. Anaesthesia was then induced with 2mg/kg propofol followed by 1mg/kg succinylcholine, for facilitation of endotracheal intubation. Cricoid pressure was applied as described by Sellick[10]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 were performed by anaesthetists with more than 2 years of experience and they were blinded to the assignment of the patient. IDS was assessed. If SpO2 decreased to <90% during the intubation period, the event was recorded as a hypoxic episode.

Difficulty of intubation was assessed using the IDS, which was recorded by senior anaesthetist.
Intubation Difficulty Scale (IDS) validated by Adnet and colleagues,[8] is an objective scoring system to assess intubation difficulty. IDS evaluates seven variables associated with difficult intubation. They are as follows:
N1: number of additional intubation attempts
N2: number of additional operators
N3: number of alternative intubation techniques used
N4: laryngoscopy view as defined by Cormack and Lehane (grade1, N4=0; grade 2, N4=1; grade 3, N4; grade 4,N4=3)
N5: lifting force applied during laryngoscopy (N5=0 if considerable and N5=1 if considerable)
N6: need to apply external laryngeal pressure to improve glottis pressure
N7: position of the vocal cords at intubation (N7=0 if abducted or not visible and N7=1 if adducted).
The IDS score is the sum of N1 through N7. A score of 0 indicated intubation under ideal conditions, upto 5 indicated slight difficulty, >5 indicated moderate to major difficulty.
In the next phase of the study, parameters of patients with difficult intubation were compared to the parameters of patients with easy intubation.

II. Results

Continuous data were summarized as Mean ± SD (standard deviation) while discrete data in %. The discrete groups were compared by chi-square (χ^2) test. Diagnostic significance of predictors of difficult airway was assessed by ROC (receiver operating characteristic) curve analysis. Demographic risk factors for difficult intubation were assessed by binary logistic regression (adjusted) analysis. A two-sided (α=2) $P<0.05$ was considered statistically significant. SPSS (version 18.0) software was used for the analyses. The demographic characteristics (gender, age, weight, height, BMI, IDS, NC and TM) of study population patients are summarized in Table 1. Among patients, mostly were females (51.3%). The obese patients showed 13.7% prevalence of difficult intubation, determined by IDS≥5. The prevalence was higher in females (15.8%) than males (11.5%) but the difference was insignificant (11.5% vs. 15.8%, χ^2=0.80; p=0.371). (Table 2)

Characteristics	**Statistics**
Gender: Males Females	96 (48.7%) 101 (51.3%)
Age (yrs)	43.08 ± 13.54 (16-76)
Weight (kg)	70.57 ± 8.86 (54-98)
Height (cm)	158.99 ± 7.26 (144-180)
BMI (kg/m^2)	27.88 ± 2.67

	(25.00-38.95)
IDS (score)	3.22 ± 1.72 (1-11)
NC (cm)	33.76 ± 4.32 (26-46)
TM (cm)	8.14 ± 0.93 (4.5-10.0)

Table 1: Demographic characteristics (Mean ± SD, n=197) of obese patients

Characteristics	**N (%)**
NC/TM: Mean ± SD (range)	4.23 ± 0.87 (2.9-8.2)
Mallampatti grading: 1 2 3 4	 68 (34.5%) 95 (48.2%) 28 (14.2%) 6 (3.0%)
Wilson score: 0 1 2 3 4 5 6	 79 (40.1%) 92 (46.7%) 9 (4.6%) 7 (3.6%) 5 (2.5%) 3 (1.5%) 2 (1.0%)
Intubation: Easy Difficult	 170 (86.3%) 44 (13.7%)

Table 2: Frequency distribution of predictors of difficult intubation in obese patients Numbers in parenthesis indicates the range (min-max)

The diagnostic significance of all three predictors NC/TM, mallampati grade, Wilson score and the combination of three parameters was found to be significant (P<0.001). Table 3 shows the diagnostic significance and table 4 compares the diagnostic accuracy among variables.

Predictor	**Criterion (cutoff value)**	**Sensitivity (95% CI)**	**Specificity (95% CI)**	**AUC**	**p value**	**+LR**	**-LR**	**+PV**	**-PV**
NC/TM	>4.9	74.07 (53.7-88.8)	92.94 (88.0-96.3)	0.860	p<0.001	10.49	0.28	62.5	95.8
Mallampatti	>2	59.26 (38.8-77.6)	89.41 (83.8-93.6)	0.808	p<0.001	5.60	0.46	47.1	93.3
Wilson score	>1	40.74 (22.4-61.2)	91.18 (85.9-95.0)	0.720	p<0.001	4.62	0.65	42.3	90.6
Combination	>0	85.19 (66.3-95.7)	76.47 (69.4-82.6)	0.867	p<0.001	3.62	0.19	36.5	97.0

Table 3: Diagnostic significance of predictors of difficult intubation in obese patients

+LR:Positive likelihood ratio, -LR:Negative likelihood ratio, +PV:Positive predictive value, -PV:Negative predictive value

Comparisons	**Difference (AUC)**	**Z**	**p value**
NC/TM vs. Mallampatti	0.052	0.83	0.408
" vs. Wilson score	0.140	2.10	0.035
Mallampatti vs. Wilson score	0.088	1.28	0.199

Table 4: Comparison of diagnostic accuracy between predictors

III. Discussion

It has been seen in previous studies that obesity has an effect on intubation difficulty. In our study of 197 obese patients we found that prevalence of difficult intubation was 13.7% (higher in females than males with an insignificant difference p<0.05). No intubation was impossible in this series. Laryngoscopies were possible for all patients. Previous studies have reported a variable effect of BMI on incidence of difficult intubation. Some have reported that the magnitude of BMI had no influence.[11,12] while others found a high incidence of difficult intubation in obese patients,[2,5,6,13,14,15,16]with more and statistically significant difficulty in males versus females,[17,18]which was in contrast to the result found in our study. This is

explained probably by increased fatty tissue and more distribution of this fat in the neck in females compared to males. The need for a clinically relevant definition of difficult intubation prompted us to use the IDS[8] score, which improved the reliability of identifying difficult tracheal intubation. Since, IDS score combines various factors and reflects all courses of intubation,[19] whereas the Cormack Lehane grade[20] only considers the moments of the laryngoscopic view, we preferred IDS over Cormack Lehane grade. Many studies used different criteria, which may be one of the reasons for the different results.

At present time, no single predictive index has high diagnostic significance, thus several risk factors had been combined together to form multivariate risk index systems. However, as these scores contain multiple risk factors, they are more time consuming to perform. Thyromental distance(TM),[4] Neck circumference(NC),[5,6] MPG grade, Wilson score, all had been seen to be increasingly associated with the incidence of difficult intubation. However, the clinical value of bedside screening tests for predicting difficult intubation remains limited. NC/TM which had been developed by Kim and colleagues[7] as a new index of difficult intubation on the assumption that obese patients with both a large neck circumference and a short neck might be more difficult to intubate than patients with a large neck circumference or a short neck alone. Though it has been seen that the amount of soft tissue vary at various topographic regions within the neck, but single parameter to determine this aspect contributing to difficult laryngoscopy is unclear. Neck soft tissue at the level of vocal cords has been controversial in predicting difficult laryngoscopy in obese patients.[21,22]These results might explain why some obese patients are easy to intubate whereas others are not.NC/TM might represent the distribution of fat in the neck better than NC or TM alone. In keeping with the results reported by Kim and colleagues,[7] we found that the ratio of NC/TM >4.9 was a risk factor for difficult intubation in obese patients. The diagnostic accuracy was significantly higher than Wilson score while it did not differed between NC/TM and Mallampatti grading, and Mallampatti grading and Wilson score.

MPG grade and Wilson score both had been shown in various studies to be a significant test in predicting difficulty in intubation of obese patients.[2,3,5,6,11,13,17,25] However, the clinical predictive value of MPG and Wilson score may be reduced in the obese patients as the jaw mobility is often restricted by the mass effect. On the other hand, NC/TM is relatively free from this effect. This was in contrast to some other studies where MPG score was found to be of limited value in predicting difficult intubation.[23,24]

The weak point of certain meta-analysis is the fact that sometimes the complete data from the original articles are not available or they may be of different quality due to dissimilar criteria used. Gonzalez H and colleagues[6] also found that problematic intubation was associated with increasing neck circumference, high BMI and MPG grade ≥3.Wilson score had the lowest sensitivity amongst three predictors and specificity higher than MPG grade while lower than NC/TM.

We also evaluated whether combination of these three valuable risk factors might increase the diagnostic value while not increasing the burden of test significantly. Previous studies have suggested that the value of screening tests for difficult intubation is limited when a single test is used.[24,25]Various combinations of independent predictors of difficult laryngoscopic visualisation led to formation of multivariate risk indices.[3,25,26] Thus, a combination of individual tests or risk factors may add some incremental diagnostic value in comparison with the value of each test alone.[25] We found in our study that combination of all three parameters(NC/TM, MPG grade, Wilson score) had highest sensitivity as compared to any one predictor alone in predicting difficult intubation in obese patients. Thus the diagnostic accuracy of combination was higher than both MPG grade and Wilson score while comparable with NC/TM.

Evaluation of the diagnostic accuracy of these three predictors to see the gender difference revealed that though all were overall significant, diagnostic accuracy of NC/TM had lower sensitivity in males but equal specificity compared to females,MPG grade showed lower sensitivity and specificity in obese females for predicting difficult intubation, and Wilson score showed higher sensitivity but low specificity in males.The combination of three predictors showed lower sensitivity and specificity in males than females.

IV. CONCLUSION

Finally, this study had several limitations. First, as it was impossible to maintain blindness of study group and the anaesthetists who perform the intubation though were unaware of the purpose of this study but it was not blinded completely as IDS score could have been increased intentionally if the anaesthetist knew the purpose of this study. Secondly, the patient's position , sniff position initially for all patients in our study, might have influenced the incidence of difficult intubation. Recent study revealed that the appropriate initial position for intubation in obese patients is the ramped position rather than the sniff position.[27]Thirdly, there were several hypoxaemic episodes during intubation, which may be more important than the incidence of difficult intubation defined by the IDS score in the clinical situation. Fourthly, 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.

Furthermore, all tracheal intubations were performed by anaesthetists with 2 years of experience, shorter experience in anaesthesia may increase the incidence of difficult intubation in obese patients. Also, the Sellick maneuver[10] has been reported to cause upper airway obstruction and more difficult intubation over difficult laryngoscopy. Since we applied sellick maneuver where it was necessary, thus it might have affected the conclusions. In conclusion, ratio of NC/TM is a better predictor in predicting difficult intubation in obese patients compared to mallampati and Wilson score. Thus, preoperative value of ≥5.0 could be a good single predictor of difficult intubation in obese patients.

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