

Diagnostic Accuracy of Neck Circumference and Thyromental Distance Ratio for Assessing Difficult Intubation in Obese Patients: a Validation Study

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ABSTRACT

Various tools for airway assessment are include Mallampati score, upper lip bite test, Wilson scoring and extent of mouth opening; none have high investigative precision especially in obese patients.

Objectives: To assess the diagnostic accuracy of neck circumference and thyromental distance ratio for assessing difficult intubation in obese patients using intubation difficulty score as gold standard.

Setting: Department of Anesthesiology in East and West operation theatres of Mayo hospital Lahore.

Duration: 12 months (From Oct 2015 – Oct 2016)

Sample Size: 220 obese patients

Methods: Patients undergoing elective surgery were enrolled. Height, weight and body mass index was documented. At the cricoid cartilage level, the neck circumference was measured. All tracheal intubations were conducted by a three-year-experienced anaesthesiologist who was unaware of the study's findings. Cormack and Lehane's grading system was used to rate the laryngoscopy image. Difficult intubation was assessed according to intubation difficulty scoring.

Results: The diagnostic accuracy of neck circumference and thyromental distance ratio in assessment of difficulty intubation (DI) among obese patients was 47%, sensitivity 85% and specificity of 37%.

Conclusion: NC/TM ratio was a good interpreter in assessing difficult intubation in obese patients. This variable can be incorporated in our preoperative assessment for difficult intubation (DI). It is simple, requires very less time and is economical.

Keywords: Airway management, obese, difficult intubation, neck circumference, laryngoscopy, tracheal intubation.

INTRODUCTION

It is the responsibility of anesthesiologist to maintain airway and ensure adequate ventilation during the course of general anaesthesia.¹ Maintaining ventilation with facemask or artificial airway device can be tough especially in patients with atypical facial features. Difficult intubation or ventilation is usually seen in patients with abnormal facial features like receding mandible, sunken cheeks, edentulous buck teeth, large bull neck, narrow mouth opening, obesity or facial or neck pathology.²

An intubation is considered hard if it takes more than three tries or more than ten minutes for a normally trained anesthesiologist to achieve a fruitful endotracheal intubation. Restricted laryngoscopic view of vocal cords is presented according to Cormack-Lehane's scoring. Various alternative techniques and adjuncts are required for this intubation.² Unable to intubate and ventilate can result in inadequate oxygen delivery to brain resulting in hypoxic brain injury or even brain death.³

Maintenance of airway in obese patients is demanding. Obese individuals are more prone to have short, swollen necks, making mask ventilation and direct laryngoscopy more difficult. Partially obstructed airways are more likely due to the greater volume of soft tissues in the upper airway.⁴ Adequate preoperative assessment and

planning regarding airway management is necessary. Various tools for airway assessment have been devised which include Mallampati score.^{2,3} History of obstructive sleep apnea syndrome (OSAS)⁴, short neck, improved age, male sex and high BMI⁵ (>30kg/m²) are contributory factors in airway difficulty.⁶ But none have high diagnostic accuracy especially in obese patients.⁵

The purpose of the study was to establish a predictor which is easy to perform and has high sensitivity and specificity especially in obese patients. This would establish a predictor which was easy to perform, had few predictors and had high sensitivity and specificity. So far no study has been conducted in Pakistan regarding this topic so I tested its accuracy in my population. Studies are available in the literature on neck circumference and thyromental distance separately but I could find only one study based on this ratio. So my study added bulk to the already existing literature.

MATERIALS AND METHODS

In this cross sectional validation study designed to assess the diagnostic accuracy of neck circumference and thyromental-distance ratio in predicting difficult intubation in obese patients using intubation difficulty score, patients of age 18-60 years of either gender and of ASA class 1 or 2

undergoing elective surgery. Estimated sample size was 220 cases with expected sensitivity 88% with 10 % margin of error and 83% specificity with 6% margin of error with a prevalence of difficult intubation in obese taken as 13 %.

The study was carried out in Department of Anesthesiology at East and West operation theatres of Mayo Hospital Lahore. Study was completed in six months' time commencing from approval of synopsis. Non-probability consecutive sampling technique was used. Any case having surgery with general anesthesia without tracheal intubation was done, those with upper airway pathology, cervical spine pathology, arthritis or fracture, or with thyroid surgery were excluded from the study.

Intubation was called difficult if a conventionally trained anesthesiologist needs more than 3 attempts or more than 10 min for a successful endotracheal intubation. Patients with body mass index 30kg/m^2 were considered obese. Thyromental distance defined as the distance from the tip of the mandible to the thyroid notch with patient's neck fully extended while patient was supine. Alignment of these two axes was difficult if the thyromental distance is < 3 finger breadths or < 7 cm in adults. Neck circumference measured at level of cricoid cartilage a value of 40 cm in men and 36 cm in women was considered the cutoff point for obesity. Intubation difficulty score ≥ 5 was defined as difficult intubation and < 5 as easy intubation. Diagnostic accuracy was defined as the proportion of individuals who were correctly identified as having or not having difficult intubation.

All patients' height and weight were recorded and their body mass index calculated. Patients were divided into 2 groups; obese and non-obese. For all patients neck circumference was measured at the level of cricoid cartilage. The thyromental distance (cm) was measured with neck extended. Monitoring was attached to each patient, which included ECG, pulse oximetry and non-invasive arterial pressure. Patients were pre oxygenated with 100% oxygen via facemask for more than 3 minutes. After standard induction with injection propofol 2 mg/kg, injection suxamethonium 1.0 mg/kg, all tracheal intubations were performed by anesthesiologist of 3 years of experience who was blinded to the results of study. The laryngoscopy view was graded according to Cormack and Lehane's scoring. Difficult intubation was assessed according to intubation difficulty scoring. (refer to annexure) Data was entered in data entry form.

Data analysis SPSS version 19 was used to enter and analyze data. The quantitative variables like age were described as mean and standard deviations, for qualitative variable like gender and diagnosis were described as percentage. The diagnostic accuracy, sensitivity, specificity, negative and positive predictive values were calculated using by 2×2 contingency table keeping intubation difficulty scoring as gold standard.

RESULTS

In study 220 obese patients with body mass index of more than 30 and above were studied. There was no patient that was excluded from the study. There were 161 cases of ASA class 1 (74.54%) and 55 (25.46%) cases of ASA class 2. Out of these 101 (55.91%) were male and 119 (54.34%)

were female.

Mean for body mass index was 34.41, standard deviation of 3.58. For neck circumference / thyromental distance ratio, mean was 5.43 with a standard deviation of 0.61. Thirty nine patients were found to be true positive i.e they had difficult intubation and were predicted to have difficult intubation. True negative patients were 64 i.e they had easy intubation who were predicted to have easy intubation.

Using a 2×2 table, diagnosis accuracy and other details were calculated. Data analysis showed that sensitivity and specificity was 85 % and 37%, respectively with diagnostic accuracy of 47%. The incidence of difficulty intubation in our study was 17.73%. Positive predictive value and negative predictive values calculated were 26.17% and 90.14% .The diagnostic odd ratio was calculated as 3.25.

Table 1: showing Body Mass Index – BMI and details of Neck Circumference /Thyromental Distance Ratio

Variables	Mean	SD
Body mass index – BMI	34.41	3.58
Neck circumference / thyromental distance ratio	5.43	0.61
Cormack Lehane Scoring	No.	Percentage (%)
1	130	59.09
2	41	18.64
3	40	18.18
4	9	4.09

Table 2 showing 2×2 table for the calculation of diagnostic accuracy of neck circumference / thyromental distance ratio (NC/TM)

		Intubation difficulty scoring		Total
		>5	<5	
NC/TM	≥ 5	True positive 39	False positive 110	149
	<5	False negative 7	True negative 64	71
Total		46	174	220

$$\text{Sensitivity: } a / (a+c) = 85 \%$$

$$\text{Specificity: } d / (b+d) = 37\%$$

$$\text{Diagnostic accuracy: } (TP+TN) / (TP+TN+FP+FN) = 47\%$$

$$\text{Positive predictive value: } a / (a+b) = 26.17\%$$

$$\text{Negative predictive value: } d / (c+d) = 90.14\%$$

$$\text{Diagnostic Odd Ratio: } (TP/FN) / (FP/TN) = 3.25$$

DISCUSSION

Endotracheal intubation is the most important skill during intubation and resuscitation. Difficulty in intubation is encountered in many situations. So adequate preoperative assessment and arrangement is important to prevent compromise in patient management. Difficult mask ventilation and intubation is suspected in obese patients, due to increased neck soft tissue.

In this study it was observed that obese patients had difficult mask ventilation and intubation as compared to non-obese patients. Diagnostic accuracy of 47% showed

that difficult intubation can be assessed by NC/TM ratio. This research determined the investigative precision of thyromental distance ratio in prediction of difficult intubation and accuracy of neck circumference in obese patients. This ratio combines two perimeters which are easy to perform rather than single one. According to diagnostic accuracy and odd ratio that is calculated it is an appropriate simple test for assessing difficult intubation in obese patients.

According to results of our study, sensitivity was 85%, Specificity was 37% and diagnostic accuracy was 47%. Incidence was 17.73%. Progressive predictive value 26.17%, undesirable predictive value 90.14% and diagnostic odd ratio were 3.25. The results show that this ratio has significant diagnostic accuracy for assessing difficult intubation in obese patients.

In a study by W. H. Kim et al using neck circumference to thyromental distance ratio as a indicator of difficult intubation, the occurrence of difficult intubation in obese patients was 13.8% while in our study it was 17.73 %. Males were 46 as compared to 77 females in a total of 123 patients assessed in this study. ¹ Our study had almost equal males and females.

Kim. Et al reported sensitivity of NC/TM ratio ≥ 5 of 88.2 % as compared to 85% in our study and specificity was 83% as compared to 37% in our study. The progressive and undesirable predictive values were 45.5% and 97.8 % in this study while in our study it was 26.17% and 90.14%. The sensitivity and negative predictive values were a little similar to this study. But specificity and positive predictive values were quite higher in Kim et al study.

In Kim et al¹ study 123 obese patients were studied while we studied 220 patients. Diagnostic odd ratio was 3.25 in our study and for NC/TM in this study was 5.942. As odd ratios were higher than one in both studies it showed that this ratio had effective test performance.

According to some previous studies, these predictors are unable to prove strong risk factors in assessing difficult intubation in obese patients. Obstructive sleep apnea (OSA) was not a risk factor for difficult intubation in morbidly obese individuals, according to Neligan et al.⁴

OSA was found to be present in 68 percent of the 180 individuals investigated. The average body mass index (BMI) was 49.4 kg/m². Six patients required three or more tries to intubate, representing a 3.3 percent difficult intubation rate. Difficult laryngoscopy was reported 8.3% of the time. NC and difficult intubation (odds ratio 1.02, 95 percent confidence interval 0.93-1.1), OSA diagnosis and difficult intubation (P = 0.09), and BMI and difficult intubation (odds ratio 0.99, 95 percent confidence interval 0.92-1.06, P = 0.8) had no connection. ⁴ The odd ratio is much less in this study than ours and incidence is also low i.e 3.3 % for difficult intubation. This study concludes that obesity and neck size have minimal bearing on the difficulty of intubation.

Another research involved 136 individuals with a mean BMI of 34 ± 3.4 kilograms/meter². There were 87% with simple intubation, 10.3% with difficult intubation, and 2.2 percent with difficult intubation (IDS 5).⁷

According to study by Liaskou Chara et al⁸ neck circumference, thyromental distance and sternomental distance were found to be poor indicators for difficult

laryngoscopy. In this study neck circumference sensitivity for difficult intubation was 68.9% and specificity 44.6%. The progressive and destructive predictive values were 15.4% and 91.1%. Thyromental distance has sensitivity 34.9%, specificity 83.9%, positive predictive values 23.8% and negative predictive value 89.9%. In our study Sensitivity is 85 %, specificity 37%, diagnostic accuracy is 47%, positive predictive value is 26.17%, negative predictive value is 90.14% and diagnostic odd ratio is 3.25. The sensitivity and positive predictive values are much lower in this study as compared to ours. In our study there was very less difference amongst gender variation. Difficult intubation in males was 54.9% and in females was 54.3 %.

According to Hirmanpour A, et al⁶ in the study 'In compared to four predictor tests for difficult laryngoscopy in obstetric patients planned for caesarean birth, the ratio of neck circumference to thyromental distance had a higher predictive value for difficult laryngoscopy.' difficult laryngoscopy (Score 3 or 4) occurred in 53 (8.06%) patients. In this study NC, and NC/TMD were the utmost useful interpreters with specificities of 89.07, and 70.2 and accuracies of 85.8, and 70.3, respectively. According to our study results sensitivity was 85 %, Specificity was 37% and diagnostic accuracy was 47%. Incidence was 17.73%. Diagnostic accuracy was much higher in this study but our study also showed significant diagnostic odd ratio.

Among the tests, the upper lip bite test had the best diagnostic test accuracy features. Given the scarcity of accessible data, additional research is required to create tests with high sensitivities and to evaluate their application for screening problematic face mask breathing and unsuccessful intubation.⁹

A research including 1,015 individuals with a BMI of 34.2 looked at the predictive effectiveness of several DI models. Easy intubation, minor DI, and DI were observed in 81 percent, 15.8 percent, and 3.2 percent of patients, respectively. Based on the findings of a multivariate analysis, clinically relevant obesity variables (specifically, BMI, MMT, and the ratio of NC to TM) were utilised to develop a DI prediction model. Nonetheless, the best model had just a reasonable predictive performance.¹⁰

Siriussawakul A, et al validated the intubation difficulty scale (IDS) in obese individuals. 552 obese patients were enlisted. The overall performance of the IDS for moderate DI with a cutoff value of 2 demonstrated 100% sensitivity and 92% specificity; IDS score of 5 indicated DI with sensitivity and specificity of 100 percent and 100 percent, respectively. The IDS is still a useful technique for detecting DI in obese people. A score of 2 or higher is considered as an appropriate cutoff point to indicate some DI, while a score of 5 or above is recommended as an acceptable cutoff point to show DI.¹¹

Our study had various limitations. Study was not blinded completely. The anesthetist could judge patients characteristics when they entered operation theatre before intubation was done. Obese patients were usually intubated in ramp and sniffing position already. Intubation could have been difficult if position was not made adequate beforehand. Macintosh no 3 blade was used for all patients which should have been adjusted initially according to various patients. Various anesthetists with more than 3 years' experience were used which also created difference

in skill level. Due to large number of patients it was difficult to use a single anesthetist for all intubations. This study only showed diagnostic accuracy and didn't compare this ratio with other perimeters. So it cannot be justified that this proportion is a better predictor than other methods for assessing for difficult intubation.

Recommendations: The study only tests diagnostic accuracy and doesn't compare NC/TM ratio with other perimeters. Later this study can be modified to allow comparison of this ratio with other perimeters e.g mallampati or upper lip bite test. It can also be studied on a higher sample size to get even better evaluation of reliability for this ratio for difficult intubation in obese patients.

CONCLUSION

The proportion of neck circumference and thyromental distance showed diagnostic accuracy of 47 % for difficult intubation in obese patients. The incidence was 17.73% which is quite significant as compared to previous studies. Ratio of neck circumference and thyromental distance is a noble interpreter in assessing difficult intubation in obese patients. This variable can be incorporated in our preoperative assessment for difficult intubation. It is simple, requires very less time and is economical as well.

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