Significance of Ratio of the Neck Circumference and Thyromental Distance as a Predictor of Difficult Intubation in Obese Patients

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ABSTRACT

Objective: To ascertain the diagnostic accuracy of raised neck circumference to thyromental distance ratio (NC/TMD) for difficulty in intubation among patients with obesity keeping grades III and IV of Cormack and Lehane's score as the gold standard.

Study Design: Cross-sectional validation study.

Place and Duration of Study: Anesthesiology Department, Combined Military Hospital Rawalpindi, from Jul to Dec 2017.

***Methodology*:** One hundred and thirty obese patients who had to undergo surgery under general anaesthesia were included in the study. All the patients underwent measurement of neck circumference to thyromental distance ratio, and raised neck circumference to thyromental distance ratio was noted. Difficult intubation was labelled according to the grades III and IV of Cormack and Lehane's score.

***Results*:** In this study, 130 cases were included. Fifty-eight patients were males, and 72 were females. Diagnostic accuracy of raised neck circumference to thyromental distance ratio for difficulty in intubation among patients who were obese, was recorded where sensitivity was 83.87%, and specificity was found to be 91.92%, positive predictive value as 76.47%, negative predictive value as 94.79%, the accuracy rate was calculated as 90%.

***Conclusion*:** Our study showed that difficulty in intubation is more frequent in patients who are obese and the neck circumference to thyromental distance ratio is a reliable method for foreseeing difficult intubation compared to other established predictors with cut off value of 5.0.

Keywords: Difficult intubation, Diagnostic accuracy, Obese, Neck circumference to thyromental distance ratio (NC/TMD).

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INTRODUCTION

Difficulty in tracheal intubation is a predominant challenge for anaesthesiologists and may lead to morbidity and mortality during surgery. Difficulty during intubation is one of the most frequently observed adverse events leading to anaesthesia malpractice claims.[1,2] Various attempts have been made to establish reliable predictors to avoid difficulty during intubation and difficulty in laryngoscopy.[3,4] Most airway difficulties happen during induction of anaesthesia when they are not assessed before induction of anaesthesia. Therefore, anaesthesiologists need to use their clinical skills to determine which patients will present difficulties with airway management. Various predictors have been developed to assess difficult intubation. Current predictors include the Mallampati score, thyromental distance (TM), Wilson Score, width of mouth opening etc.[5] but none of them has a significant diagnostic accuracy in clinical anaesthetic practice. All tests have their limitations, especially in obese patients. Pre-viously researchers have suggested that the reliability of predictors for difficulty in intubation by performing only one test is limited.[6] Thus, combining a couple of the most significant risk factors may improve the diagnostic value without causing more burden on the test.[7,8] Therefore, anesthesiologists are always searching for such predictors for difficult intubation. Some literature is available regarding the predictive value NC/TMD ratio, but these studies have shown considerable variation regarding its accuracy as a predictor for difficulty in intubation.[9]

According to Siyam *et al*, difficulty in intubation incidence in patients with obesity having sleep apnoea syndrome is 21.9%.[10]

We conducted this study to find out the accuracy of NC/TMD, which may be considered a new and very simple and easy test and can be performed at the bedside considering the hypothesis that the difficulty in intubation rate would be significant in patients with obesity as compared to patients who are not obese. However, the existing literature shows variation in

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sensitivity, specificity and predictive value with the scarcity of literature on the local level. NC/TMD will give evidence regarding its accuracy in predicting difficult intubation and will help anaesthesiologists in decision making for the use of NC/TMD to decrease the morbidity associated with difficult intubation. The objective of this study was to ascertain the diagnostic accuracy of raised NC/TMD ratio for difficult intubation among patients who are obese, keeping grades III and IV of Cormack and Lehane's score as the gold standard.

METHODOLOGY

It was a cross-sectional validation study conducted at Anaesthesiology Department, Combined Military Hospital Rawalpindi from July to December 2017. Patients were included through consecutive non-probability sampling. Calculation of sample size was done using the WHO calculator.[11] Study approval was taken from the Hospital Ethical Committee (No. 119/10/2020).

Inclusion Criteria: Obese patients of either gender with age 20 to 70 years undergoing anaesthesia were included in the study.

Exclusion Criteria: Individuals who had to undergo general anaesthesia without tracheal intubation, patients with an upper airway pathology (e.g. maxillofacial fractures and tumours) determined on history and examination, and patients with cervical spine fracture determined on history and x-rays cervical spine were excluded from the study.

Two hundred eighty-five patients were considered for the study. However, only 130 patients with obesity who had a BMI of more than 30 kg/m^2 undergoing operation through general anaesthesia were finally included in the study after informed consent. Information regarding the demographic characteristics of patients was taken. All the patients underwent measurement of NC/TMD, which was measured by dividing mean neck circumference with mean thyromental distance. A ratio of more than 5.0 was taken as raised NC/TMD ratio.

Positioning of the patients was done with pillows kept beneath the head while the neck extended. All patients were monitored with pulse oximetry, ECG, and non-invasive arterial pressure. Individuals were allowed to breathe 100% oxygen by a face mask for greater than three minutes. All the tracheal intubation was executed by two anaesthesiologists with experience greater than two years, and both of them were blinded to the patients' assignment. Difficult intubation was labelled according to the grades III and IV of Cormack and Lehane's score.

Statistical Package for Social Sciences (SPSS) version 24.0 was used for the data analysis. Quantitative variables were summarized as mean ± SD and qualitative variables were summarized as frequency and percentages. Diagnostic parameters were calculated using a 2x2 table. Sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy were determined by using the standard formulas. The *p*-value of ≤0.05 was considered statistically significant. ROC and Likelihood ratio was measured.

RESULTS

One hundred and thirty patients fulfilling the inclusion criteria were included in the study. Age distribution showed that 51 individuals (39.23%) were between 20-40 years of age while 79 individuals (60.77%) were between 41-70 years; the mean age was found to be 46 ± 14.14 years. There were 58 (44.62%)

Table-I: Diagnostic accuracy of raised nc/tmd ratio for difficult intubation among obese individuals keeping grade III and IV of cormack and lehane's score as gold standard (n=130).

Raised Neck Circumference to Thyromental Distance Ratio	Grade III and IV of Cormack and Lehane's Score	
	Difficult Intubation (Positive)	Difficult Intubation (Negative)
Presence	26 (a)	8 (b)
Absent	5 (c)	91(d)

Table-II: diagnostic parameters of raised nc/tmd ratio for difficult intubation among obese individuals keeping grade III and IV of cormack and lehane's score as gold standard (n=130).

Diagnostic Parameters	Values
Sensitivity= True Positive/(True Positive + False Negative)	26/31 x 100 =83.87%
Specificity= True Negative /(True Negative + False Positive)	91/99 x 100 = 91.92%
Positive Predictive Value= True Positive/(True Positive + False Positive)	26/34 x 100 = 76.47%
Negative Predictive Value= True Negative/(True Negative +False Negative)	91/96 x 100 = 94.79%
Diagnostic Accuracy=(True Positive + True Negative)/All Patients	117/130 x 100 = 90%
Likelihood Ratio	
Positive	10.38
Negative	0.18

were males and 72 (55.38%) were females.

The frequency of difficult intubation among obese patients keeping grades III and IV of Cormack and Lehane's score as the gold standard showsed that 31 individuals (23.85%) had difficult intubation. In contrast, 99 (76.15%) had no findings of difficult intubation.

Diagnostic accuracy of raised NC/TMD ratio for difficult intubation among obese individuals keeping grade III and IV of Cormack and Lehane's score as the gold standard was recorded as shown in Table-I.

Sensitivity was 83.87%, while specificity was calculated as 91.92%. The positive predictive value was 76.47%, while the negative predictive value was 94.79%. The overall diagnostic accuracy rate was calculated as 90%, the likelihood ratio was calculated as 10.38 positive, and the negative likelihood ratio was 0.18, as shown in Table-II. The receiver operating characteristics (ROC) curve for raised NC/TMD ratio for difficult intubation among obese patients WAS shown in Figure.

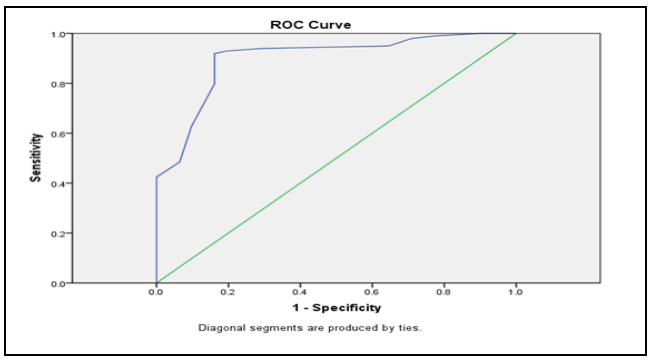

Figure: Diagonal segments are produce by ties.

DISCUSSION

Difficulty in airway management is a significant cause of morbidity and mortality in anaesthesiology practice, so airway management is one of the most important goals of anaesthesiologists. Identification of patients with risk of problems with airway management is key to proper care, which is especially true for obese patients as airway management issues are frequently reported.[12] Unanticipated intubation difficulty can be a challenge for anaesthesiologists, so numerous researchers have tried to predict difficult intubation by applying various bedside methods. Preoperative assement of anatomical landmarks and clinical factors helps detect potentially difficult laryngo-scopies.[13,14] We planned this study to determine the accuracy of NC/TMD is a new and very simple and easy test and can be performed at the bedside. However, the existing literature shows variation in sensitivity, specificity and predictive value with the scarcity of literature on the local level.

In this study, out of 130 cases, 51 (39.23 %) were found between 20-40 years of age, whereas 79 (60.77%) were found between the age of 41-70 years; the mean was calculated as 46.0 ± 14.14 years, 58 (44.62%) were male, and 72 (55.38%) were females. Gender distribution was comparable to another international study done by Kim *et al,* in which males were less in number (43%) as compared to females (57%).[7] According to our findings; there was more difficulty in intubation among obese individuals as compared to patients who were not obese. The frequency of difficult intubation among obese patients keeping grades III and IV of Cormack and Lehane's score as the gold standard shows that 31 individuals (23.85%) had difficult intubation. The diagnostic accuracy of raised NC/TMD ratio for difficult intubation among obese patients keeping grade III and IV of Cormack and Lehane's score as the gold standard was recorded where sensitivity was 83.87%, specificity 91.92%, positive predictive value 76.47%, negative predictive value 94.79%, the accuracy rate was calculated as 90%, like-lihood ratio was calculated as 10.38 positive while negative likelihood ratio was 0.18.

In a previous study conducted by Hirmanpur *et al,*[4] sensitivity, specificity, and positive and negative predictive value of NC/TMD for difficult intubation was 71.7%, 70.2%, 17.4% and 96.6%. In contrast, sensitivity, specificity, positive predictive and negative predictive value of NC/TMD in another recent international study was found to be 56%, 76%, 28% and 91%, respectively, which were not comparable to our study.

Another study reported a sensitivity, specificity, positive predictive and negative predictive values of 88.2%, 83.0%, 45.5% and 97.8%, respectively.[7] The findings of our study showed agreement with the study showing higher specificity and sensitivity, while Naim *et al,* reported an even higher sensitivity of 100% with a specificity of 82%; these findings are higher than recorded in our study.[15] In another study, NC/TM ratio showed higher sensitivity (92.31%), higher negative predictive value (93.75%) and higher area under the curve (AUC=0.73) on the ROC curve as compared to the MMC score and also found that NC/TM ratio was a statistically significant independent risk factor of difficult intubation (i.e. *p*-value <0.029, odds ratio 4.52).[16] In another study conducted by

Khanooja *et al,* in 2016, it was concluded that NC/TM ratio was a good predictor of difficult intubation than the malampatti score.[17] We also agreed with Siyam *et al,* where the difficulty in intubation incidence in obese patients having sleep apnoea syndrome is 21.9%.[10]

Previous research has suggested that the NC is considered an independent risk factor for intubation difficulty in obese individuals,[18,19] but the NC itself may not precisely determine soft tissue amount at different topographic regions in the neck. It was established that more fat was found in regions around the collapsible segments of the pharynx in obese individuals with OSAS by measurements on magnetic resonance imaging (MRI).[8] Ezri *et al,*[20] described that difficulty in laryngoscopy could be foreseen in obese individuals by quantifying soft neck tissue at vocal cords level and suprasternal notch with ultrasonography. They demonstrated that pretracheal soft tissue amount, as per quantification by ultrasound, was the only factor that would be able to distinguish between a difficult laryngoscopy from an easy one completely. These findings may explain why some obese individuals can be easily intubated while others cannot. NC/TMD ratio may demonstrate better than NC itself the distribution of fat within the neck. Moreover, the NC/TMD ratio needs to be evaluated further to ascertain whether there is a correlation between this ratio and the amount of soft tissue per quantification by ultrasound or MRI. It should be done in future studies. However, our findings confirmed its accuracy in predicting difficult intubation and are helpful for anaesthesiologists in decision making for the use of NC/TMD to decrease the morbidity associated with difficult intubation.

CONCLUSION

Our study concluded that difficulty during intubation is more frequent in obese individuals. The NC/TMD ratio is a more reliable method for foreseeing difficulty in intubation than other established predictors, with a cut off value of 5.0.

Conflict of Interest: None.

Authors' Contribution

SQ: Direct contribution, AK,: NAM,: MSM: Intellectual contribution.

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