

# Comparison of Incidence of Difficult Intubation between Obese and Nonobese Patients, and Comparison of Three Predictors of Difficult Intubation in Obese Patients

<sup>1</sup>Johann Mathew, <sup>2</sup>SK Gvalani

## ABSTRACT

**Background:** Anticipating a difficult airway is of prime importance to an anesthesiologist. Data available are inconclusive to say that tracheal intubation is more difficult in the obese. The deficiency occurring with individual factors can be avoided by adopting multiple airway assessment factors. In this study, we aim to compare the incidence of difficult intubation between obese and nonobese patients and compare three predictors of difficult intubation.

**Study design:** Prospective observational study.

**Materials and methods:** About 250 patients were assigned to two groups, obese and nonobese based on their body mass index. Preoperatively, neck circumference (NC), mouth opening, thyromental distance (TMD), neck extension, NC/TM ratio, Mallampati classification (MPC), and Wilson score (WS) were calculated. Difficulty of intubation was assessed using the intubation difficulty scale (IDS). All tracheal intubations were performed by anesthetists with more than 2 years of experience.

**Statistical analysis used:** Data analysis was done with the help of Statistical Package for the Social Sciences (SPSS) version 15, MedCalc version 11, and Epi data software. Qualitative data are presented with the help of frequency and percentage table, and association among various study parameters is done with chi-square test.

**Results:** The incidence of difficult intubation determined by the IDS ( $\geq 5$ ) was more frequent in the obese group (88.6% in obese vs 11.4% in nonobese). Of the three variables, WS was found to be statistically significant ( $p < 0.005$ ). Neck circumference to thyromental ratio is a new predictor for difficult tracheal intubation (DTI). But an NC/TM ratio of  $\geq 5$  gives high false positive for our population.

**Keywords:** Airway management, Difficult tracheal intubation, Obesity.

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**Conflict of interest:** None

## INTRODUCTION

Prediction of a difficult tracheal intubation is vital to an anesthesiologist to prevent complications. Data available are inconclusive to say that tracheal intubation is more difficult in the obese.<sup>1,2</sup> The deficiency occurring with individual factors can be avoided by adopting multiple airway assessment factors.<sup>3,4</sup> We compared the incidence of difficult intubation between obese and nonobese patients. We also compared three predictors of difficult intubation, the Mallampati score, the Wilson score (WS), and the neck circumference/thyromental distance (NC/TMD) ratio.<sup>5</sup>

## MATERIALS AND METHODS

This prospective observational study was approved by the Institutional Review Board of our institution, and all patients provided informed consent. About 250 patients, American Society of Anesthesiologists (ASA) 1 or 2 and between ages 18 and 60 years, who were undergoing surgery under general anesthesia with tracheal intubation were enrolled over a period of 2 years. The patients were assigned to two groups – obese and nonobese – based on their body mass index (BMI) (a BMI greater than 30 was considered obese). The patients undergoing general anesthesia without tracheal intubation, or those with an upper airway pathology (i.e., maxillofacial fractures, tumors, etc.), cervical spine fracture, and pregnancy were excluded.

Difficulty of intubation was assessed using the intubation difficulty scale (IDS)<sup>6</sup> and was recorded by a senior anesthetist. The IDS is graded as follows:

N1, number of additional intubation attempt

N2, number of additional operators

N3, number of alternative intubation technique

N4, Cormack and Lehane grading

Grade 1 – N4 = 0, Grade 2 – N4 = 1, Grade 3 – N4 = 2, Grade 4 – N4 = 3).

N5 = lifting force applied during laryngoscopy

<sup>1</sup>Ex-Resident, <sup>2</sup>Additional Professor and Head

<sup>1</sup>Department of Anesthesia, King Edward Memorial Hospital and Seth Gordhandas Sunderdas Medical College, Mumbai Maharashtra, India

<sup>2</sup>Department of Anesthesia, HBT Medical College and Dr RN Cooper Municipal General Hospital, Mumbai, Maharashtra, India

**Corresponding Author:** SK Gvalani, Additional Professor and Head, Department of Anesthesia, HBT Medical College and Dr RN Cooper Municipal General Hospital, Mumbai, Maharashtra India, Phone: +919920521161, e-mail: skgvalani@live.com

N5 = 0, if inconsiderable force applied; N5 = 1, if considerable force applied.

N6 = need to apply external laryngeal pressure for optimized glottic exposure.

N6 = 0, if no external pressure applied; N6 = 1, if external pressure applied;

N7 = position of vocal cords at intubation

N7 = 0, if abducted; N7 = 1, if adducted

The IDS score is the sum of N1 through N7. A score of 0 indicates intubation under ideal conditions. Those with an IDS score of  $\geq 5$  and  $< 5$  were defined as difficult and easy respectively.

Preoperative investigations were done appropriately for the patients. A previous history of difficult intubation, BMI, (NC, cm) at the level of cricoid cartilage, mouth opening (cm), and (TMD, cm) with the neck extended were noted. The ratio of NC/TM was calculated from these measurements. Other relevant variables, such as the modified Mallampati classification (MPC) without phonation (Class 1: Soft palate, fauces, uvula, and pillars visible; Class 2: Soft palate, fauces, and uvula visible; Class 3: Soft palate and base of uvula visible; Class 4: Soft palate not visible), 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), and the presence or absence of abnormal protruding upper teeth were also recorded. Wilson score was then calculated. All tracheal intubations were performed by anesthetists with more than 2 years of experience (Table 1).

Before the patient was brought to the operation theater, informed consent and adequate starvation was confirmed. In the operation theater, an 18-gauge intravenous access was secured. The patients were positioned with pillows under the head with neck extended. Each patient was monitored with an electrocardiograph, pulse oximeter, noninvasive blood pressure, and capnometer. The patients were preoxygenated with 100% oxygen through face mask. The patients were induced with propofol

2 mg/kg and succinylcholine 2 mg/kg. After successful intubation, laryngoscope was withdrawn and breathing circuit was connected to the tube. Successful intubation was confirmed by appearance of mist in endotracheal tube, chest movements, auscultation, and capnometry.

## RESULTS

Data from 125 obese and 125 nonobese patients were analyzed. No intubation failure occurred in the study. The incidence of difficult intubation determined by the IDS ( $\geq 5$ ) was more frequent in the obese group (88.6% in obese *vs* 11.4% in nonobese).

Mallampati score, WS, and NC/TM were compared in obese patients to predict difficulty in intubation. Of the three variables, WS was found to be statistically significant ( $p < 0.005$ ).

Wilson score had a specificity of 97.8% and area under curve (AUC) of 0.789; MPC had a sensitivity of 45.1%, specificity of 63.8%, and AUC of 0.723; and NC/TM had a sensitivity of 90.3% and AUC of 0.631 (Table 2 and Graph 1A to C).

## DISCUSSION

Many preoperative tests to predict difficult airway are available, but they are far from ideal. The ideal predictor would be easy to perform with a high degree of sensitivity and specificity. It should have a high positive predictive value with few false positive predictions. The accurate preoperative diagnosis of difficult tracheal intubation will result in lower rates of anesthetic complications, particularly in obese patients.

It is believed that airway access is more difficult in obese than in nonobese patients due to the anatomic changes resulting from excess weight. In obese patients, there is a reverse relationship between weight and pharyngeal area due to fat deposition on cervical structures.<sup>7</sup> Thus, difficult intubation, sometimes defined as inadequate glottic exposure to direct laryngoscopy, seems to be more prevalent in patients with higher BMI.

In our study, of the 35 patients that were found to be difficult, 31 patients belonged to the obese group. The incidence of difficult tracheal intubation in the obese was

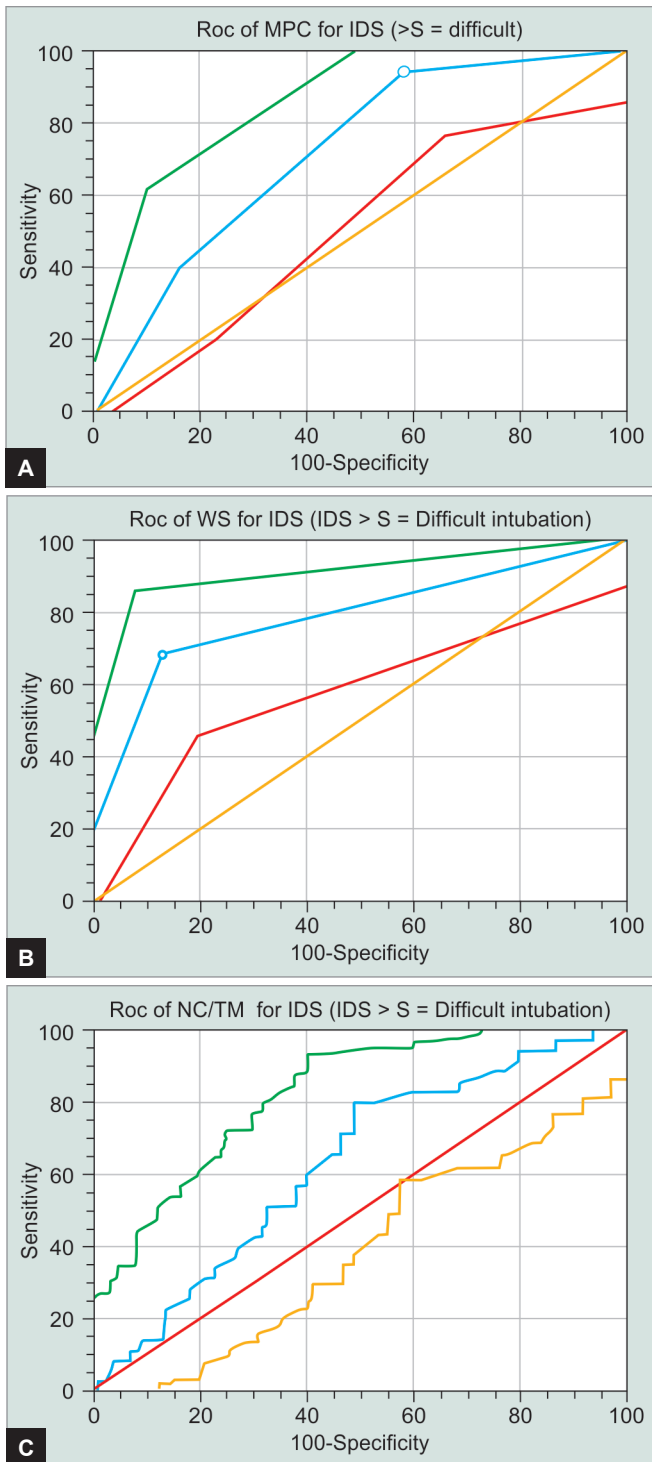
**Table 1:** Patient characteristics (the values are expressed as mean)

	Obese	Nonobese
Age	44.65	37.36
Sex (M/F)	77/48	66/59
Weight	85.16	64.16
Height	1.63	1.67
Body mass index	32.06	23.06
Neck circumference (cm)	41.28	33.42
Thyromental distance (TMD)	6.79	7.1
Mallampati score III–IV (n)	48	0
Wilson score $\geq 2$ (n)	10	0

**Table 2:** Tests for difficult intubation (values expressed as percentages)

Test	Sensitivity	Specificity	PPV	NPV
WS	25.8	97.8	80	80
MPC	45.1	63.8	29.1	77.9
NC/TM	90.3	8.5	24.5	72.7

NC/TM: Neck circumference to thyromental ratio; MPC: Mallampati classification; PPV: Positive predictive value; NPV: Negative predictive value; WS: Wilson score



**Graph 1A to C:** Receiver operating characteristic (ROC) curves of different screening tests for difficult intubation. Each characteristic curve is expressed as a solid line. AUC: Area under curve

24.8 and 3.2% in the nonobese. This further reiterates that difficult tracheal intubation is more common in the obese than in the nonobese.

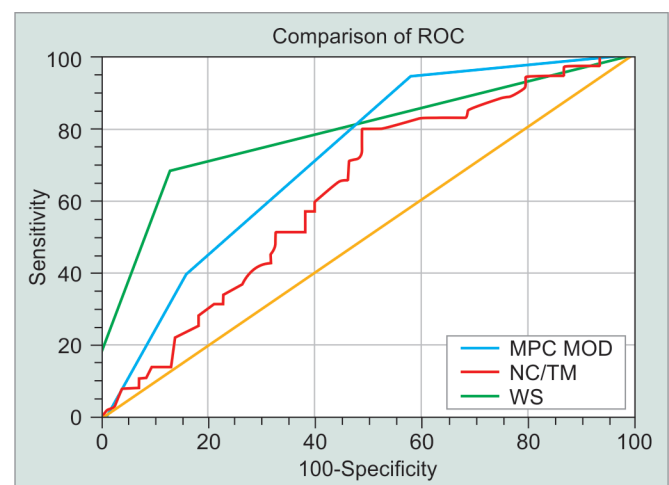
To predict difficulty in intubation in obese patients, we compared MPC, WS, and the ratio of NC to TMD (Graph 2).

Of 125 obese patients, 31 proved to be difficult by IDS. Mallampati classification had a true positive value of 14 out of 31 and a false negative value of 17 out of 31; 17

difficult tracheal intubations were missed by MPC and the clinical significance of this high value is obvious. The modified Mallampati test, though in use for many years, has limitations. The absence of definite demarcations in the classification and the effect of phonation on the classification lead to higher interobserver variability.<sup>8</sup> Another limitation of MPC is that it does not assess neck mobility, which is an important predictor of difficult intubation. Again, the clinical predictive value of MPC may be reduced in obese patients as the jaw mobility is often limited by a mass effect. Previous studies have suggested that the value of screening tests for difficult intubation is limited when a single test is used. Therefore, systems like WS have combined individual tests or risk factors to add some incremental diagnostic value.

Wilson score had a true positive value of 8 out of 31 and a false negative value of 23 out of 31; 23 difficult tracheal intubation (DTI) were not detected by WS; and the false negative value for WS was even higher than that of MPC. However, there are factors other than those mentioned in WS that contribute to difficult intubation. Also, as these scores contain multiple risk factors, they are more time consuming to perform.

Neck circumference and TMD are two predictors that are characteristic of obese patients, thick, and short neck.<sup>9</sup> Thus, combining two of the most valuable risk factors may increase the diagnostic value while not increasing the burden of test significantly. The above two parameters were combined as a ratio on the assumption that obese patients with both a large NC and a short neck might be more difficult to intubate than patients with a large NC or a short neck alone. In our study, NC/TM  $\geq 5$  was taken as cut off for difficult intubation. This ratio had a true positive value of 28 out of 31 and a



**Graph 2:** Receiver operating characteristic (ROC) curves for NC/TM, WS, and MPC. The cutoff points for difficult intubation were MPC 3 or 4, WS  $\geq 2$ , and NC/TM  $\geq 5$ ; NC/TM: Neck circumference to thyromental ratio; WS: Wilson score; MPC MOD: Modified Mallampati classification

false negative value of 3 out of 31. This means that only 3 out of 31 potential DTI were missed. The drawback of this ratio was the high number of false positive (86 out of 114). This translates into an unacceptable number of false alarms for the anesthetist. An increased NC or shortened TM will affect the cutoff value of the NC/TM ratio. Kim and his colleagues got a mean value of 8.9 for TM, whereas in our study it went down to 6.79. This low value of TM in our population could explain the high false positives that were recorded with NC/TM ratio in our study.

This study had limitations as it was not blinded completely. The IDS score could have been increased intentionally if the anesthetist knew the purpose of the study. As the anesthetist could recognize the patients' characteristics in the operation theater, it was impossible to maintain complete blindness to this study.

In conclusion, difficult intubations defined by IDS scores were more common in obese patients. Although WS showed highest specificity, negative predictive value, and largest AUC of the three predictors, it gave a poor sensitivity. While NC/TM was sensitive, it lacked specificity. Neither of the three predictors proved to be the best to predict difficult intubation in obese patients. An increase in the cutoff value of NC/TM from 5 to 6 would perhaps reduce the number of false positives in the Indian population, considering the lower mean value of TM in our study group.

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