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The Importance of Neck Circumference to Thyromental Distance Ratio (Nc/Tm Distance Ratio) as a Predictor of Difficult Intubation in Obese Patients Coming for Elective Surgery under General Anaesthesia in a Teritatry Care Hospital – A Prospective Observational Study

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Abstract

Background and objectives: This study was done to assess the ability of neck circumference to thyromental distance ratio (NC/TM distance ratio) for predicting difficult intubation among obese patients coming for surgery under general anaesthesia.

Patients and methods: After approval of institutional review board of Christian Medical College Vellore, 250 obese patients (body mass index greater than or equal to 30) within time frame of September 2014 and March 2015 was assessed preoperatively with the help of performa after obtaining informed consent. NC/TM distance ratio was calculated from the performa. Validated Intubation difficulty score (IDS score) for each obese patient was assessed intra operatively by the anaesthetist who performed intubation. The entire study population was divided into easy and difficult intubation groups based on the IDS score. IDS score greater than or equal to five was considered as difficult intubation. The study assessed the statistical significance of NC/TM distance ratio and difficult intubation by univariate and multivariate logistic regression analysis and its comparison with Mallampati score and neck circumference.

Results: Binary univariate logistic regression analysis of predictors of difficult intubation showed age, increased neck circumference, decreased thyromental distance, modified Mallampati test, NC/TMD ratio ≥ 5 as statistically significant variables that were associated with a difficult intubation ($p \leq 0.05$). Binary multivariate logistic regression analysis showed only neck circumference ($p=0.030$ [odd ratio 2.519(1.094-5.802)] and NC/TMD ratio ($p <0.001$ [odd ratio 23.680(10.638-52.713)] independently predicted difficult intubation. However NC/TMD ratio had higher specificity / PPV and larger AUC on an ROC curve compared to neck circumference. The incidence of difficult intubation among obese patients was 20.8 %.

Interpretation and Conclusions: Among obese patients, NC/TMD ratio can be considered as a better preoperative predictor of difficult intubation.

Keywords: Intubation; Obesity; Anaesthesia; Modified ,mallampati test; Thyromental distance; Neck circumference; NC/TM distance ratio

Introduction

Obesity may be defined as excess of fat in the body. The World Health Organization (WHO) defines an obese person as one who has a body mass index (BMI) greater than or equal to 30kg per square meter of body surface (BMI ≥ 30kg.m-2) [1]. As per Misra et al. [2] for Asians, the definition of obesity has been changed to BMI ≥ 25kg.m-2 for metabolic managements, but it doesn't affect the acute management of the airway so we are considering BMI ≥ 30kg.m-2 for airway assessment of obese patients.

Difficult intubation is the second most frequent damaging event leading to anaesthesia malpractice claims [3]. Most catastrophes have occurred when possible difficult airway was not recognized early [4]. In the last century, it became clear that the importance of prior assessment of airway as a mean to decrease complications in anesthesia. In view of all above mentioned findings several devices and techniques were developed a few decades ago, Cormack and Lehane scoring system, Mallampati test etc for predicting difficult intubation.

In obese individuals, the incidence of difficult laryngoscopy is similar to that of non-obese individuals (about 10%). Nevertheless, there are more reports on difficult intubation in

obese patients. Some clinical predictors are related to increased risk of difficult airway in obese patients. Mallampati's grade III or IV, large neck circumference, and previous diagnosis of obstructive sleep apnoea syndrome (OSAS) are factors related to difficult intubation in obese patients.

However, the neck circumference alone may not clearly indicate the amount of soft tissue at various topographic regions within the neck. Horner [5] and colleagues demonstrated that more fat was present in areas surrounding the collapsible segments of the pharynx in obese patients with OSA'S using magnetic resonance imaging (MRI) measurements. Ezri [6] and colleagues demonstrated that difficult laryngoscopy could be predicted in obese patients by quantifying the neck soft tissue at the level of the vocal cords and suprasternal notch using ultrasonography. They reported that the amount of pre tracheal soft tissue, quantified by ultrasound, was the only measure that fully distinguished an easy intubation from a difficult one. These results might explain why some obese patients are easy to intubate, whereas others not.

Moreover by review of literature, we found that increased neck circumference had good sensitivity and relatively low specificity as well as decreased thyromental distance had high specificity and low sensitivity for predicting difficult intubation preoperatively. So the hypothesis was that by taking the ratio between these two above indices a new predictor of difficult intubation with better statistical and clinical outcome can be generated. So, in this study we aspire to explore a preoperative predictor of difficult intubation, named ratio of neck circumference to thyromental distance which needs no special equipment, minimal time for performance and is not uncomfortable to patient. It is a non invasive test which has got better statistical significance compared to other indices.

So primary and secondary objectives of this study were

A. To assess the correlation between the ratio of neck circumference to thyromental distance (NC/TM distance ratio) and validated intubation difficulty score 7 (IDS SCORE) in obese patients coming for elective surgery under general anaesthesia.

B. To compare neck circumference/thyromental distance ratio (NC/TM distance ratio) with Mallampati score and neck circumference as reliable tests for predicting difficult intubation in obese patients.

C. To find out the incidence of difficult intubation among obese individuals coming for elective surgery under general anaesthesia

Materials and Methods

This was a Prospective observational study conducted in Pre Anaesthesia Clinic of department of Anaesthesiology of Christian Medical College and hospital, Vellore, during period of September 2014- March 2015. The inclusion criteria were age greater than 18 years, ASA class I, II, III, patients of both gender, Body mass index greater than or equal to 30kg/m2, Obstructive sleep apnoea patients., patients undergoing surgery under general anaesthesia with tracheal intubation. The exclusion criteria were age less than 18 years, ASA class greater than III, patients undergoing general anaesthesia without tracheal intubation and under regional anaesthesia, patients with upper airway pathology such as maxillofacial fractures, upper airway tumours or cervical spine fracture, obstetric patients, refusal of the patient.

Data collection

Data collection was done in two steps namely, preoperative assessment and intra operative assessment.

Preoperative assessment

Consists of performa with emphasis on

A) Demography of patient

B) Body mass index

C) Airway assessment variables includes

i. Neck circumference (cm) – measured using a measuring tape and at the level of cricoid cartilage.

ii. Thyromental distance (cm) - measured using a measuring tape and is defined as the distance from thyroid notch to mentum when neck is fully extended.

iii. The ratio of neck circumference to thyromental distance (NC/TM distance ratio)

iv. Modified Mallampati classification without phonation [8,9]

Intra operative assessment

Difficulty of intubation was assessed by anesthetist by filing up intubation difficulty score (validated IDS score) [7] after intubation. .Intubation difficulty score consist of seven variables from N1 to N7. The sum of N1 to N7 gives total IDS score. Any score of greater than or equal to five was considered to be difficult intubation and score less than five considered to be easy intubation.

Protocols for intubation

a. ASA standard monitors, additional monitors as per need for patient or by jurisdiction of anaesthetist allotted for the case.

b. Intravenous access.

c. Pre oxygenation for three minutes with 100 % oxygen.

d. Head positioning: standard position. Pillow under the head with neck extended.

e. Any position change other than standard position will get additional points. (For example, Ramping/stacking/ change in standard position).

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f. The laryngoscope (Macintosh Blade size 3 for a woman, size 4 for a man) is introduced in to the right hand side of the mouth. The tongue is swept to left and the tip of the blade is advanced until a fold of skin/cartilage is visualized at twelve o' clock.

g. Any extra technique other than standard direct larngoscopy will get additional points (For example, use of Boogie/Glide scope/Fibre optic intubation / Video assisted intubation.)

h. First attempt of intubation to be done by anesthetist of at least three years of experience in anaesthesia and airway management

Guidelines To Fill Up Intubation Difficulty Score Sheet:

N1	❖ N1 represents the number of additional intubation attempts • Score zero for first attempt • One point each for supplement entary attempts
N2	N2 represents the number of additional persons directlyattempting Intubation (Not assisting intubation) • Score zero for first • One operator Onepoint each for supplementary operators
N3	N3 represents number of alternative techniques used. • Score zero for standard technique • One point each for alternative techniques ✓ Standard technique means pillow under the head and Macintosh size 3 for woman and 4 for men ✓ Alternative technique includes 1. Positioning of patient (Ramping/Stacking) 2. Change of materials (Blade, ET tube, Addition of stylette,Bougie) ❖ 3. Change in approch (Nasotracheal/orotracheal) 4. Use of special instruments (Fibre optic, Glide scope, Vedio assisted, intubation through alryngeal mask)
N4	❖ N4 represents the laryngoscopic view as defined by cormack and Lehane
N5	❖ N5 represents the lifting force applied during laryngoscopy • N5=zero if little effort is necessary • N5=one if subjectively increased lifting force is necessary. (This notion is based on operators impression that an abnormal amount of forve was used compared with routine practice)
N6	❖ N6 represents the need to apply external laryngeal pressure for optimized glottis exposoure
N7	❖ N7 represents the position of vocal cords at intubation • N7=zero if abducted or not visible • N7=one if adducted(impediment to tube passage)

Sample size calculation and statistics

As per two studies done on difficult intubation among obese patients (Kim et al. [10] and Abdel et al. [11]) following details of NC/TM distance ratio were taken into consideration to calculate sample size.

Cut off values for NC/ TM distance ratio	Kim et al. [10]	Abdel et al. [11]
Sensitivity	89	100
Specificity	83	82
P value	< 0.001	0.004
Confidence interval	95 %	95 %

The incidence of difficult intubation among obese individuals ranges from 15-22 percent. The incidence of difficult intubation with a BMI greater than 30 has been reported in a meta-analysis by Shiga et al. [12] and Juvin et al. [13] were 15.8 % (95% CI, 14.3–17.5%) and 15.5 % respectively. Another 3study by Voyagis et al. [14] examining 1833 intubations among obese patients showed 20.2 % difficult intubation among them. As per Castro et al. [15] (examined 482 obese patients), incidence was 20.75 %.

The pilot study conducted for three days in our department by the investigator, incidence was found to be around 22% .Hence for this current study, incidence of difficult intubation was taken as 22 % for the calculation of study population.

So sample size for the current study can be calculated by using reference from above mentioned studies and pilot study done by investigator. The values taken were sensitivity of 90 percent, specificity of 83 percent, confidence level of 95 percent, allowable error between 0.1 to 0.05 and prevalence of 22 percent.

Based on 95% CI of true sensitivity with a allowable error of 0.1, sample size was calculated using the formula [16]

$$N = \frac{TP + FN}{P}$$

$$TP + FN = Z^2 X \frac{[SN(1-SN)]}{W^2}$$

$$TP + FN = (1.96)^2 X \frac{[0.90(1-0.90)]}{(0.05)^2} = 138.29$$

P = 0.22

$$N = \frac{TP + FN}{P} = \frac{138.29}{0.22} = 628$$

{N = Sample size, TP = True positive, FN = False negative, SN = Sensitivity, SP = Specificity Z = confidence interval (i.e. for 95%, Z = 1.96), P= Prevalence, W = Accuracy (allowable error)

Based on 95% CI of true sensitivity with a allowable error of 0.05, sample size was calculated using the formula

$$TP + FN = (1.96)^2 x \frac{[0.83(1-0.83)]}{(0.1)^2} = 54.2$$

$$TP + FN = Z^2 X \frac{[SN(1-SN)]}{W^2}$$

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$$TP + FN = (1.96)^2 X \frac{[0.90(1-0.90)]}{(0.05)^2} = 138.29$$

P = 0.22

$$N = \frac{TP + FN}{P} = \frac{138.29}{0.22} = 628$$

To achieve precision of 10 % for specificity we need the total sample size below using the formula

$$N = \frac{TP + FN}{(1 - P)}$$

$$TP + FN = Z^2 X \frac{[SP(1 - SP)]}{w^2}$$

P = 0.22

$$TP + FN = (1.96)^2 x \frac{[0.83(1-0.83)]}{(0.1)^2} = 54.2$$

$$N = \frac{TP + FN}{(1 - P)} = \frac{54.2}{0.78} = 70$$

So as to achieve a 95% CI of true sensitivity (true positive) with a allowable error between 0.05 and 0.1 and to achieve precision of 10 % for specificity (true negative), it was decided to keep a sample size of 250 obese patients with tracheal intubation for the current study.

Data analysis according to objectives of study

The study population as per sample size was divided into easy intubation group (IDS score < 5) and difficult intubation (IDS score ≥ 5) groups. Entered variables of all patients into both arms as body mass index, neck circumference, thyromental distance, Mallampati score, NC/TM distance ratio.

The above measured variables were expressed as mean (standard deviation). Binary univariate logistic regression analysis of above variables to find out significant variables and non significant variables affecting outcome (outcome here was difficult intubation)

Binary multivariate logistic regression analysis (forward-wald analysis) of significant variables of univariate analysis in each patient group to find independent risk factors for difficult intubation. This test was done to determine the power of the screening test which independably influence intubation difficulty. Receiver operating characteristic curve (ROC curve) analysis of each significant variable was done.

Results

A total of 328 obese patients were assessed for our study between September 2014 and March 2015 and among them, 250 patients who underwent endotracheal intubation were recruited for the study after obtaining informed consent. The patients excluded were those who underwent only regional anaesthesia, those who had regional blocks alone, those who had surgery using laryngeal mask airway and not willing to participate for the study. Entire 250 obese patients who underwent tracheal intubation were divided into two arms, namely easy intubation group (IDS score less than 5) and difficult intubation group (IDS score greater than or equal to 5). There were 52 patients among difficult intubation group and 198 patients under easy intubation group. The following are the results.

Demographic data

Table 1: Demographic characteristics of the study population.

Factors	Total Obese Patients n = 250	Group 1 (Easy intubation group) n= 198	Group 2 (Difficult intubation group) n = 52
Male	98 (39.2%)	77 (38.9%)	21 (40.4%)
Female	152 (60.8%)	121 (61.1%)	31(59.6 %)
Age (mean ± standard deviation)	45.62 years (± 13.23)	44.33 years (±13.19)	50.52 (± 12.27)
Weight (mean ± standard deviation)	80.54 kg (± 10.90)	79.90 kg(±10.76)	82.99 kg (±11.18)
Height (mean ± standard deviation)	157.23 cm (± 9.63)	157.03 cm (±9.51)	157.98 cm (± 10.1)
BMI (mean ± standard deviation)	32.55 kg/m2 (± 3.21)	32.37 kg/m2(±3.05)	33.28 kg/m2(±3.68)
ASA 1	95 (38%)	81 (40.9%)	14 (26.9%)
ASA 2 and 3	155 (62%)	117 (59.1%)	38 (73.1%)
Previous history of difficult intubation	2 (0.8%)	0	2 (3.8%)

The baseline data comparing age, gender, weight, height, ASA status, BMI, between easy intubation group and difficult intubation group are tabulated below. Here easy intubation group (IDS<5) is referred as group 1 and difficult intubation group (IDS≥5) as group 2 (Table 1).

38.9 % of patients in Group 1 (easy intubation group) were males and 40.4 % of patients in Group 2 (difficult intubation group) were males. The mean age of patients in group 1 was 44.33 years and group 2 was 50.52 years. The mean weight of patients in Group 1 was 79.90kg and group 2 was 82.99kg. The

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mean height of patients in Group 1 was 157.03cm and group 2 was 157.98cm. For group 1 and 2, mean BMI was of 32.37kg/m2 and 33.28kg/m2 respectively. 40.9% patients in group 1 belonged to ASA grade 1 while the rest were categorized as ASA 2 or 3. 26.9% of patients in group 2 belonged to ASA grade 1 and the rest belonged to ASA class 2 or 3. The history of difficult intubation was not noted among patients in easy intubation group and 3.8 % in difficult intubation group.

The surgical procedures performed included thyroidectomies, neck dissections, mastectomies, laparotomies, neurosurgery and cardiothoracic surgery. The commonest were thyroidectomies and mastectomies.

Results of primary objective

The primary objective was to assess the importance of NC/TM distance ratio to predict difficult intubation among obese patients. Differences between the difficult intubation and easy intubation groups were analyzed using a binary univariate logistic regression model to determine the significant risk factors for difficult intubation. (This test is used to differentiate between significant variables and non significant variables affecting outcome).

Table 2: Binary univariate logistic regression analysis of factors related to difficult intubation (IDS ≥ 5). * Significant correlation as P value ≤ 0.05.

Variables	Odds ratio	95.0% C.I of odds ratio		*p* value
		Lower	Upper	
Age	0.964	0.941	0.948	0.003*
Weight	0.975	0.940	1.002	0.072
Height	0.990	0.959	1.022	0.526
Body mass index	0.925	0.849	1.008	0.075
Gender	1.065	0.571	1.985	0.844
ASA classification	0.532	0.271	1.045	0.067
Experience of the anaesthetist	0.870	0.581	1.304	0.501
NC ≥ 41 cm in males and ≥ 35 cm in females72	4.157	2.089	8.273	< 0.001*
TMD ≤ 7 cm in males and ≤ 6.5 cm in females	9.131	3.862	21.588	< 0.001*
MP score III or IV	3.396	1.797	6.418	< 0.001*
NC/TMD ≥5	28.095	12.778	61.775	< 0.001*
Previous history of difficult intubation	6.39	_	_	0.999

The different variables compared were the following: age, height, weight, gender, body mass index, ASA classification, and history of difficult intubation, experience of the anesthetist, Mallampati score, neck circumference, thyromental distance and NC/TMD ratio. Among these variables, age, neck circumference, thyromental distance, Mallampati score and NC/TMD ratio were the only statistically significant variables that were associated with a difficult intubation (IDS≥ 5) as shown in table below (Table 2).

Table 3: Binary multivariate logistic regression analysis performed in each patient group to determine the independent risk factors of DI (forward-Wald analysis)

Variable	*β*	SD	Odds Ratio	95.0% C.I of Odds Ratio		*p* value
				Lower	Upper	
NC ≥ 41 cm in males and ≥ 35 cm in females	0.924	0.426	2.519	1.094	5.802	0.030*
NC/TMD ≥5	3.165	0.408	23.680	10.638	52.713	<0.001**
Constant	-5.013	0.824	0.007			<0.001

* Significant correlation as P value ≤ 0.05. ** Highly significant correlation as P value ≤ 0.01.

For more accurate results we performed binary multivariate logistic regression (forward-Wald) analysis in each patient group to determine the independent risk factors for difficult intubation in each group. This test is concerned for detection of the power of each risk factor (age, neck circumference, thyromental distance, Mallampati score, NC/TMD ratio) to independently influence the outcome (here the outcome was the intubation difficulty) as shown in table below (Table 3).

Results of secondary objectives

Table 4: Comparison of the predictors of DI (Values expressed as percentage)

Test	Sensitivity	Specificity	PPV	NPV	Area Under Curve of ROC
NC ≥ 41 cm in males and ≥ 35 cm in females	75.0	58.1	32.0	89.8	0.649
TMD ≤ 7 cm in males and ≤ 6.5 cm in females	32.7	94.9	63.0	84.3	0.784
MP score III or IV	63.5	66.2	33.0	87.3	0.648
Previous history of DI	3.8	100	100	79.8	_
Weight	75	15.2	18.8	69.8	_
NC/TMD ratio ≥ 5	76.9	89.4	65.6	93.7	0.850

The first secondary objective was to compare NC/TMD ratio with other preoperative predictors of DI. The following table shows sensitivity/ specificity/ NPV/PPV and ROC curve analysis of various tests (Table 4).

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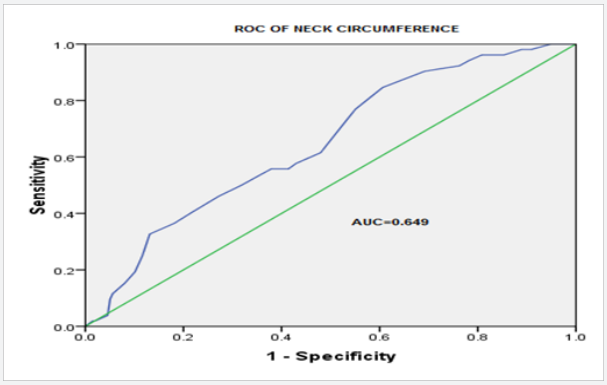

Figure 1:

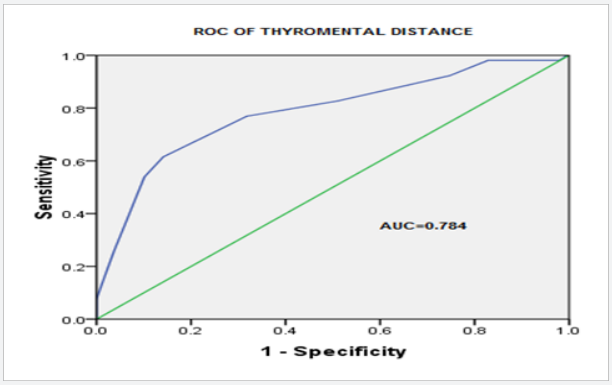

Figure 2:

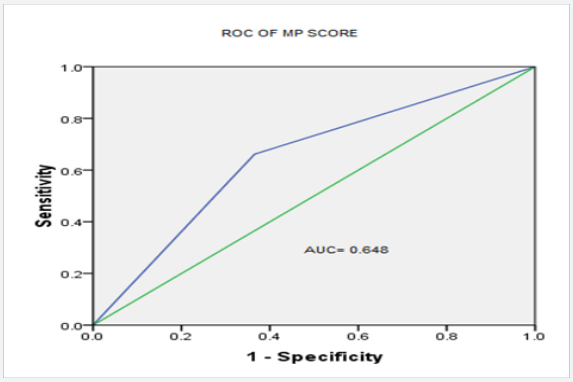

Figure 3:

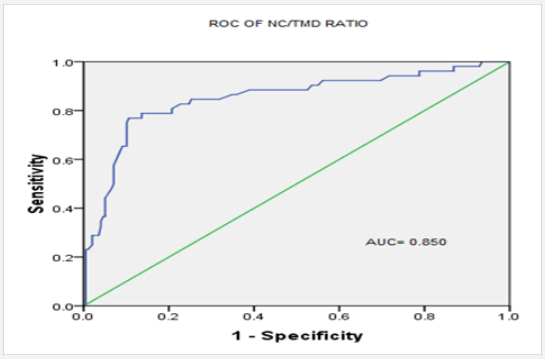

Figure 4:

The following are the ROC Curve for various predictors of DI (Figure 1-4).

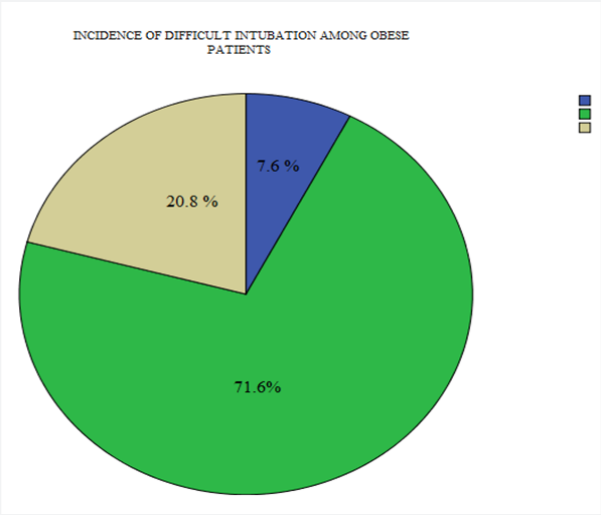

Figure 5:

The next secondary objective was to find out incidence of difficult intubation among obese population. The difficulty of intubation was determined using IDS scale. A score of zero indicates easy intubation, score between zero to five denotes slight difficulty, score greater than or equal to five shows moderate to major difficulty and score infinity shows impossible intubation. The following pie diagram illustrates the incidence of DI among obese patients (Figure 5).

Subanalysis

Table 5: Sub analysis.

Variables (Values Expressed as Percentage)		Variables (Values Expressed as Percentage)	Easy Intubation Group	Difficult Intubation Group
Experience of the anaesthetist who performed intubation	3-5 years	54.0	57.4	41.2
	5-9 years	30.0	24.9	49.0
	> 9 years	16.0	17.8	9.8
Intubation done by first attempt	Yes	91.2	97.0	69.2
	No	8.8	3.0	30.8
Intubation done by first operator	Yes	92.0	95.5	78.8

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Intubation done by first operator	Yes	92.0	95.5	78.8
	No	8.0	4.5	21.2
Alternative techniques used	1	37.6	38.4	34.6
	2-3	30.4	23.2	57.7
	> 3	1.2	0.5	3.8
	Not used	30.8	37.9	3.8
C and L grade	Grade 1 and 2	86.4	98.0	42.3
	Grade 3 and 4	13.6	2.0	57.7
Use of lifting Force	Yes	13.6	2.0	57.7
	No	30.4	18.2	76.9
Use of external laryngeal pressure	Yes	56.4	46.0	96.2
	No	43.6	54.0	3.8

The following are the sub analysis of the study which is illustrated in the Table 5.

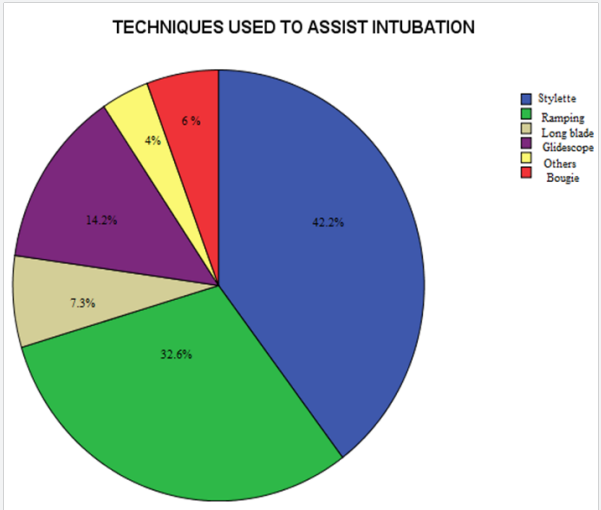

Figure 6:

The following pie diagram depicts various techniques/ instruments used for assisting intubation among obese patients. The term "others" denoted use of fibreoptic intubation, Macoy, small size endotracheal tube and C-MAC (Figure 6).

Discussion

This study was done among obese patients to identify the significance of NC/TMD ratio as a difficult intubation predictor, its comparison with standard DI predictors and also to calculate incidence of difficult intubation among them. Following are the discussion of the analyzed data.

Discussion of demographic data

Analysis of demographic data revealed that difficult intubation was more common among females (59.6 %). Most of the patients of difficult intubation group belongs to ASA classification 2 and 3 (73.1 %). The co- morbid condition common among obese patients were in order of essential hypertension, diabetes mellitus and hypothyroidism. More than fifty percent of obese patients were diagnosed to have essential hypertension. Significance of the previous history of difficult intubation was not able to assess since, it was not well documented previously or patient was unaware of it.

Discussion of primary objective

Binary univariate logistic regression analysis of predictors of DI revealed age, neck circumference, thyromental distance, Mallampati score and NC/TMD ratio were associated with difficult intubation. (Table 2). Following that multivariate logistic regression analysis found only neck circumference and NC/TMD ratio as independent risk factors of DI. (Table 3). As per literature review four studies have been done to identify the importance of NC/TMD ratio namely Kim et al. [10], Adbel et al. [11] Castro et al. [15], Anahita et al. [17].The following table provides statistical importance of NC/TMD ratio by comparing above mentioned studies and present study of the author (Table 6).

Table 6: Comparison of present study and other studies with reference to NC/TMD ratio.

	Current Study	Kim et al. [10]	Abdel et al [11]	Castro et al. [15]	Anahita et al. [17]
Year	2015-2016	2011	2014	2013	2014
Sample size	250	123	50	482	657
Study population	Obese patients	Obese patients	Obese with OSA	Obese patients	Obsteric patients
Sensitivity (%)	76.9	88.2	100.0	High	71.7

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Specificity (%)	89.4	83.0	82.0	High	70.0
PPV(%)	65.6	45.5	_	_	17.0
NPV (%)	93.7	97.8	_	_	97.0
Area under ROC curve	0.850	0.865	0.95	_	0.685
p value	< 0.001	< 0.001	0.004	<0.001	<0.001
Odds ratio	23.680	5.942	26.73	_	5.967

The above table can be summarized as follows;

This study was done on 250 obese patients while other studies were done on less number of patients. All studies found out NC/TMD ratio as statistically significant ($p \leq 0.05$) .Our study also found NC/TMD ratio (p value-<0.001, [odd ratio 23.680 (10.63-52.71)] as an independent risk factor of DI which was correlating with other studies. However our study recorded lower value of sensitivity as compared to Kim et al and Abdel et al and higher value as compared to Anahita et al. [17]. (study not done on obese patients). The PPV of our study was higher as compared to all other studies. Specificity/AUC/NPV and other values were comparable with other studies.

Discussion of secondary objective

The most commonly and routinely used preoperative difficult intubation predictors in our preanaesthesia clinic are in order of modified Mallampati test, thyromental distance followed by neck circumference. However as per literature review mentioned earlier, none of the above parameters assured all features of a screening test namely high sensitivity, specificity and PPV. Analysis of Table 3 showed only neck circumference (p=0.03) and NC/TMD ratio (p= <0.001) as independent risk factors of difficult intubation. However NC/TMD ratio showed better specificity (58.1 vs 89.4) / PPV (32.0 vs 65.6) /AUC (0.649 vs 0.850) as compared to neck circumference alone. The other parameters like Mallampati score, thyromental distance were associated with difficult intubation, but were not independent risk factors of DI. So our study strongly recommends measurement of neck circumference and NC/TMD ratio as a difficult airway predictor among obese patients.

With respect to increased neck circumference as a preoperative predictor of difficult intubation, our study correlated with findings of Gonzalez et al. [18] Ezri et al. [6] and Brodsky et al. [19] However our study recorded low sensitivity for neck circumference as compared to Gonzalez et al. [18] (92% vs 75%).

As per literature review, incidence of difficult intubation varied from 11 % to 22 %. There are not many Indian/Asian studies published about this. In our study all the intubations were done by anaesthetist who had minimum three years of clinical experience. Our study recorded incidence of DI among obese population as 20.8%. The following table shows comparison of various studies with present study with relevance to incidence of DI among obese patients (Table 7).

Table 7: Incidence of difficult intubation among obese patients.

Study done among obese patients	Incidence of difficult intubation among obese patients (Expressed as percentage)
Current study	20.8
Shailaga et al. [20]	11.0
Kim et al. [10]	13.8
Gonzalez et al. [18]	14.3
Juvin et al. [13]	15.5
Shiga et al. [12]	15.8
Rita et al. [21]	17.0
Fotopoulou et al. [22]	20.0
Voyagis et al. [14]	20.2
Castro et al. [15]	20.75

Discussion of subanalysis

All the obese patients were intubated by anaesthetist who had more than three years of clinical experience in anaesthesia. As enumerated in Table 5, the clinical experience of the anaesthetist seem comparable between the two groups and around 50 % of anaesthetist who intubated study patients had experience between 3- 5 years. The most commonly used material/equipment to aid intubation among obese patients was in order of stylette, ramping and glidescope respectively. Thirty percent of obese patients were intubated with the help of stacking/ramping. The use of indirect laryngoscopes among obese patients was as high as 18 percent. Among easy intubation group, most of the intubations were done by first attempt (91.2 %) and first operator (92.0 %) respectively. More operators and attempts were needed to intubate difficult intubation group. The Cormack and Lehane grading were 3 and 4 in 57.7 % of patients among difficult intubation group and 2 % among easy intubation group. Most of the patients required considerable lifting force and external laryngeal pressure for optimal visualization of vocal cords among difficult intubation group.

Conclusion

The study concluded with the following results as, NC/TMD ratio can be considered as better bedside screening tool for predicting difficult airway among obese patient in view of following reasons i) Present study on obese Indian population showed NC/TMD ratio as independent risk factor of difficult intubation which correlated with studies done on western

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population. ii) It provided better sensitivity / specificity/ PPV and AUC of ROC compared to other predictors. iii) Bed side screening tool. iv)Cheap, noninvasive, less time consuming. v) Anesthetist and patient friendly. The study also recommend increased neck circumference as a guide to identify difficult intubation and also not promote using of modified Mallampati test and decreased thyromental distance as a standalone predictor of difficult intubation among obese patients.

Limitations /Bias and Effort Done to Overcome it

1. IDS score may vary with experience of anaesthetist. (IDS score could have been increased if patient was intubated by anaesthetist who had less experience in airway management)

2. Subjective variability in Mallampati scoring system, measurement of neck circumference and thyromental distance

3. All the cases were not intubated by the senior anaesthetist of the operation list.

4. Use of indirect laryngoscopy for intubation eg: use of Glidescope, Fibreoptic scopy etc

Efforts done to overcome first bias

Intubation done by anaesthetist who had more than three years of experience. IDS scoring done by the anaesthetist without informing the purpose of the study. (Not completely blinded study since we were not able to completely hide the purpose of the study to the anaesthetist who performed intubation)

Effort to overcome second bias

Preoperative performa (including Mallampati score and measurement of neck circumference and thyromental distance) were collected by principal investigator or first co-investigator only.

Effort to overcome third bias

Investigator confirmed that all patients were intubated by anaesthetist who had at least three years of experience.

Effort to overcome fourth bias

Use of IDS score for indirect scopy is not validated, but can be used as per review of literature [23- 26].

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