https://africanjournalofbiomedicalresearch.com/index.php/AJBR
Afr. J. Biomed. Res. Vol. 27 No. 3 (October 2024); 1012-1019

Research Article

Neck Circumference to Thyromental Distance Ratio: A New Predictor of Difficult Intubation

Dr. Keerthi P[1], Dr. Smitha S.[2], Dr. Vikas Kn[3], Dr. Gourishankar Reddy Manne[4*]

[1]Senior Resident, Department of Critical Care Medicine, MS Ramiah Medical College, Bangalore, Karnataka.
[2]Assistant Professor Department of Critical Care Medicine, M S Ramiah Medical College, Bangalore, Karnataka.
[3]Associate Professor, Department of Critical Care Medicine, MS Ramiah Medical College, Bangalore, Karnataka.
[4]Associate Professor, Department of Emergency Medicine, BGSGIMS, Kengeri, Bengaluru, Karnataka.*

ABSTRACT

Introduction: Anaesthesiologists should have the ability to recognize the risk of difficult endotracheal intubation even in patients who have apparently normal airways. Though there is no one best test for preoperative prediction of difficult airway, ongoing research takes place to device an easy bedside test that is highly specific and sensitive.

In this study we evaluate the ability of the parameter "Ratio of Neck circumference to Thyromental Distance (RNCTMD)" for predicting ease or difficulty in intubation.

Materials and Methods: An Observational study done prospectively in 100 patients of ASA grade I and II. They were assessed and graded for Ratio of Neck Circumference to thyromental distance (RNCTMD), Thyromental distance (TMD), Neck circumference (NC), Modified mallampatti test(MMT), Inter incisor gap(IIG),

Hyomental Distance (HMD), Sternomental Distance (SMD), Body Mass Index(BMI) using standard techniques and correlated with Intubation difficulty scale(IDS).

Results: RNCTMD showed high sensitivity and NPV, IIG with high specificity and PPV. RNCTMD with a p value of 0.000 has been found to have higher statistical significance.

ROC curve in this study for RNCTMD showed that cut off 4.85cm can predict difficulty in intubation more accurately.

Conclusion: Ratio of neck circumference to thyromental distance is found to be a better predictor of difficulty intubation compared to the other independent airway assessment parameters.

Keywords: Predicting difficult intubation, Ratio of neck circumference to thyromental distance.

Author for correspondence*: *Dr. Gourishankar Reddy Manne*, *Email:* *gaurishviz010@gmail.com

Received: 30.10.2024 Accepted: 30.10.2024

DOI: https://doi.org/10.53555/AJBR.v27i3.3320

INTRODUCTION:

Airway management is one of the most important responsibilities of an anaesthesiologist. Anaesthesiologist should develop the ability to identify the risk of difficult tracheal intubation even in patients who have apparently normal airways.[1] Fortunately, difficulty in intubation is uncommon with a reported incidence ranging from 1.5 to 13% .[3-12]The morbidity and occurrence of deaths is maximum during mismanagement of difficult airway, which has lead to 30% of all anaesthetic deaths[13]. The key cause for difficult intubation occurs due to difficulty in visualisation.[2] The incidence of visualisation of larynx by laryngoscopy and intubation that is difficult is found to have considerable variation.[15]

There are numerous studies which describes the scheme for predicting the difficult airway by means of single risk factor or by multiple risk factors.[3,10,12,16]Prediction of difficult intubation

is done by several bedside screening tests. Most of these tests requires patient cooperation for the accurate assessment. Though there is no one best test for preoperative prediction of difficult airway, ongoing research takes place to device an easy bedside test that is highly specific and sensitive.Hence a quick and easily performable test, which is reliable is required and should have high sensitivity (to identify majority of cases with difficult airway) and high specificity (when used as a routine false positive rates will be low).

In this study we evaluate the ability of the parameter"RATIO OF PATIENTS NECK CIRCUMFERENCE TO THYROMENTAL DISTANCE (RNCTMD)" for predicting ease or difficulty in intubation. This study aims at evaluating the reliability of ratio of neck circumference to the thyromental distance(RNCTMD) in comparison to other conventional factors used in airway assessment using IDS which is a validated score for rating difficult intubation.18,25

Materials and Methods:

After the approval of institutional ethics committee, 100 patients of age group 18-60 years, of either sex who undergo elective surgeries belonging to ASA class I and II have been included in this study.

Detailed examination and routine investigations including laboratory tests (complete blood count , haemoglobin , serum chemistry profile and urine analysis), ECG , Chest X-ray will be taken if indicated. Following preoperative evaluation, written informed consent taken from each patient and preanesthetic airway assessment done.

PRE ANESTHETIC AIRWAY ASSESSMENT :

Inter Incisor Gap : Patient in sitting position with wide opened and the distance between tip of the two incisors measured with the scale.

Grade I: >4cm

Grade II: </= 4cm

Inter incisor gap of <4cm (grade II) considered as difficult intubation[19,24]

Modified mallampatti test(MMT):Patient is asked to perform maximal mouth opening with tongue protrusion without making any noise in the sitting posture.

Class I: soft palate, faucial pillars and uvula seen.

Class II: soft palate and faucial pillars seen .

Class III: soft palate seen .

Class IV: only hard palate seen

Class III and IV considered as difficult intubation [19,24]

Thyromental distance:In upright posture, patient is seated. With a closed mouth, head and neck extension is advised and the patient is asked to extend as much as possible. Measurement of distance , that is straight from the outer surface of tip of mentum till thyroid notch is taken.

Grade I: > 6.5cm

Grade II: 6 - 6.5cm

Grade III: < 6cm.

Thyromental distance of less than 6.5cm considered as difficult intubation[19,24]

HyoMental Distance:In upright posture, patient is seated. With a closed mouth, head and neck extension is advised and the patient is asked to extend as much as possible. Measurement of distance , that is straight from the outer surface of tip of mentum till hyoid is taken.

Grade I: >6cm

Grade II: 4-6cm

Grade III: < 4cm

Hyomental distance of less than 6cm considered as difficult intubation[2,15]

Sternomental Distance:In upright posture, patient is seated. With a closed mouth, head and neck extension is advised and the patient is asked to extend as much as possible. Measurement of distance , that is straight from the upper border of manubrium till mentum is taken.

Grade I: >12.5cm

Grade II: <12.5cm

Sternomental distance of less than 12.5cm considered as difficult intubation.[2,14,15,17]

Neck Circumference: Measured at the level of cricoid cartilage, mouth closed.

Grade I: <40cm

Grade II: >40cm

Neck circumference greater than 40cm considered as difficult intubation.[2,38]

Body Mass Index:

Weight in kg/Height in m^2

Class I: <25kg/m^2

Class II: >25kg/m^2

Body Mass Index greater than 25kg/m^2 considered as difficult intubation.[34,35]

Ratio of Neck circumference to Thyromental Distance(RNCTMD):

Thyromental distance is measured in upright and sitting position. With a closed mouth, head and neck extension is advised and the patient is asked to extend as much as possible. Measurement of distance , that is straight from the outer surface of tip of mentum till thyroid notch is taken.

Neck circumference of patient is measured in cms, at the level of cricoid cartilage and mouth closed.

The ratio of Neck circumference to thyromental distance is calculated using the formula Neck circumference(in cms)/TMD(in cms)

Grade I RNCTMD : <5

Grade II RNCTMD : >5

Grade II considered as difficult intubation.[18]

Standardised anaesthetic protocol to be followed in all the patients. Pre-Oxygenation done with 100% oxygen and induced with propofol(2 mg/kg) IV and vecuronium (0.1 mg/kg) IV to facilitate endotracheal intubation. Patient's head in the sniffing position, with a Macintosh #3 laryngoscope blade endotracheal intubation done by an anaesthesiologist (at least two years experience). External laryngeal pressure is permitted for endotracheal tube insertion as per requirement. Difficult intubation in this study was assessed using Intubation Difficulty Scale(IDS)[18,35]

N1: number of additional intubation attempt

N2: number of additional operators
N3: number of alternative intubation techniques used
N4: laryngoscopic view as defined by Cormack and Lehane (N4 1: full exposure of glottis anterior and posterior commissure; N4 2: anterior commissure not visualised; N4 3: Epiglottis only; N4 4: no glottic structure visible)
N5: lifting force applied during laryngoscopy (N5 0: if inconsiderable and N5 1: if considerable
N6: needed to apply external laryngeal pressure for optimised glottic exposure (N6 0: if no external pressure or only the Sellick manoeuvre was applied and N6 1: if external laryngeal pressure was used)
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. Those with an IDS score of >5 and <5 were defined as the difficulty and easy groups respectively.[18,35]
The preoperative data of BMI,Inter Incisor Gap, Modified Mallampatti Test, Thyromental Distance, Hyomental Distance, Sternomental Distance, Neck Circumference compared with Neck circumference to Thyromental Distance and difficulty in intubation are correlated to evaluate the sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of each test according to standard formulas. A statistical package SPSS version 17.0 will be used to do the analysis ,p <0.05 will be considered as significant.

RESULTS:

In our present study it is found that the incidence of difficult intubation is 16%(16 out of 100 patients). 14 out of 25(56%) patients with RNCTMD grade II(less than 5cm) had difficulty in intubation. RNCTMD showed high sensitivity and NPV, IIG with high specificity and PPV. RNCTMD with p value of 0.000 have higher statistical significance. ROC curve in this study for RNCTMD showed that cut off 4.85cm can predict difficulty in intubation more accurately.

		Count	Column N %
NC	Difficult	15	15.0%
	Easy	85	85.0%
	Total	100	100.0%
TMD	Difficult	20	20.0%
	Easy	80	80.0%
	Total	100	100.0%
RNCTMD	Difficult	25	25.0%
	Easy	75	75.0%
	Total	100	100.0%
HMD	Difficult	20	20.0%
	Easy	80	80.0%
	Total	100	100.0%
SMD	Difficult	19	19.0%
	Easy	81	81.0%
	Total	100	100.0%
IIG	Difficult	5	5.0%
	Easy	95	95.0%
	Total	100	100.0%
MMT	Difficult	44	44.0%
	Easy	56	56.0%
	Total	100	100.0%
IDS	Difficult	16	16.0%
	Easy	84	84.0%

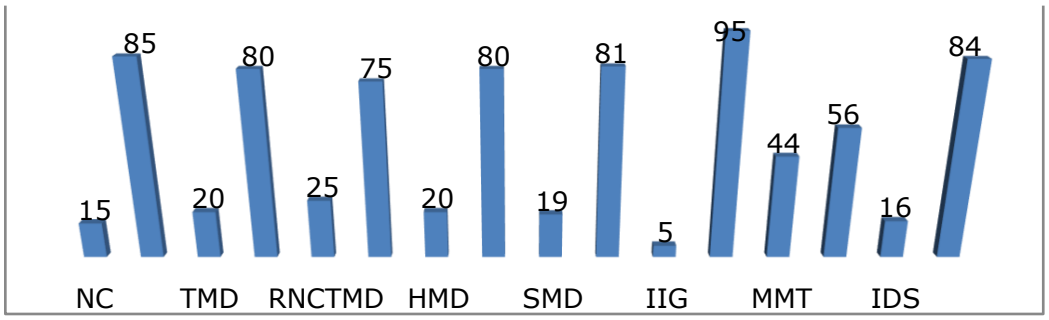
Total	100	100.0%

Table 1. comparision of airway assessment tests

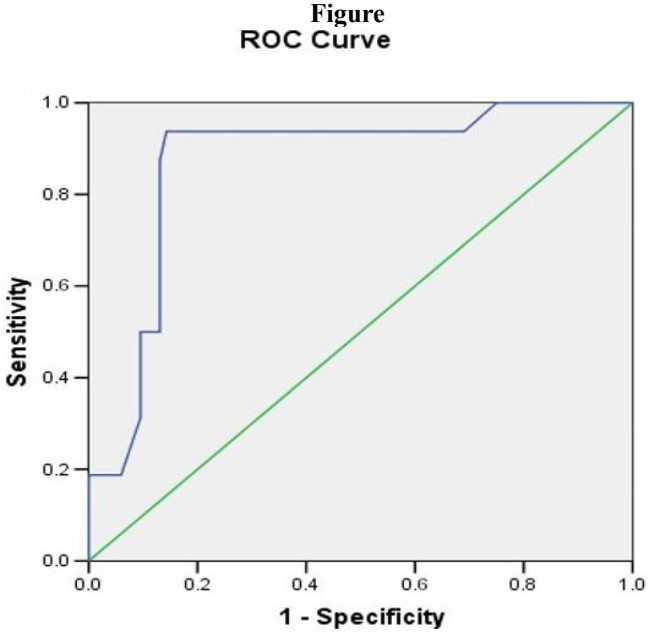
NC - Neck circumference; TMD - Thyromental Distance; RNCTMD - Ratio of Neck circumference To Thyromental Distance;HMD - HyoMental Distance; SMD - SternoMental Distance; IIG - Inter Incisor Gap; MMT - Modified Mallampatti Test;IDS - Intubation Difficulty Score

Table 2. Comparison of Various Predictive Testes

Parameter	Sensitivity(%)	Specificity(%)	PPV(%)	NPV(%)	ACCURACY(%)	p value
BMI	62.50	82.14	40.00	92.00	79.00	0.000
NC	43.75	90.48	46.67	89.41	83.00	0.000
TMD	56.25	86.90	45.00	91.25	82.00	0.000
HMD	56.25	86.90	45.00	91.25	82.00	0.000
SMD	56.25	88.10	47.37	91.36	83.00	0.000
IIG	25.00	98.81	80.00	87.37	87.00	0.000
MMT	75.00	61.90	27.27	92.86	64.00	0.006
RNCTMD	87.50	86.90	56.00	97.33	87.00	0.000



Figure



Diagonal segments are produced by ties.

Area Under the Curve

Test Result Variable(s): RNCTMD

Area	Std. Error	Asymptotic Sig.	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
.870	.048	.000	.777	.963

Coordinates of the Curve
Test Result Variable(s): RNCTMD

difficult if Greater Than Equal To(a)	Sensitivity	1 – Specificity
2.500	1.000	1.000
3.550	1.000	.940
3.650	1.000	.929
3.750	1.000	.881
3.850	1.000	.821
3.950	1.000	.810
4.050	1.000	.750
	.938	.690
4.150	.938	.679
4.225	.938	.643
4.275	.938	.560
4.350	.938	.536
4.450	.938	.310
4.550	.938	.226
4.650	.938	.190
4.725	.938	.167
4.775	.938	.143
4.850	.875	.131
4.980	.813	.131
5.130	.750	.131
5.300	.625	.131
5.450	.500	.131
5.950	.500	.095
6.500	.375	.095
6.650		

6.750	.313	.095
6.850	.188	.060
6.950	.188	.024
7.020	.188	.012
7.320	.188	.000
7.900	.063	.000
9.200	.000	.000

DISCUSSION:

Peri-operative incidence of difficult intubation is 1.5-8.5%, according to the literature.[30]The Unwanted outcomes happens due to an unanticipated difficult airway. Hence it is very important to pre operatively recognise the possibility of difficult intubation. There are several screening tests for difficult intubation but the value is limited when a single test is used.[1,28] There are also several scoring systems incorporating several variables[12].

In our study the difficulty in intubation is assessed using Intubation Difficulty Score. It is a blend of subjective and objective criteria that permit a qualitative and quantitative approach to the progressive nature of difficult intubation. So IDS score appears to be the best indicator of Total Intubation Difficulty.[25]

Though the purpose of this study is to predict the diagnostic validity of Ratio of neck circumference to thyromental distance as a parameter in the assessment of airway, other independent airway assessment variables like Neck Circumference(NC), Thyromental Distance (TMD), Hyomental Distance(HMD), Sternomental Distance(SMD),Interincisor Gap(IIG), Modified Mallampatti test (MMT) and Body Mass Index(BMI) are taken into account to produce comparable results.

In our study, the cut off for BMI is 25kg/m^2 [34, 35] and has a sensitivity of 62.50% , specificity of 82.14%, PPV of 40.00% and NPV of 92.00%. Brodsky et al[33] conducted study on 100 morbidly obese patients and concluded that obesity alone is not predictor of difficult intubation. Lundstrom et al [34]conducted study on 91,332 patients and concluded that BMI has sensitivity of 54% and specificity of 52% , PPV of 60%, NPV of 95%.

Neck Circumference has a poor sensitivity of 43.75% and PPV of 46.67% , with good specificity of 90.48% and NPV of 89.41% in our present study. Nadia et al[35] concluded that in obese patients NC has sensitivity of 54.10% , specificity of 66.20%, PPV of 21.30% and NPV of 89.50%.Our present study is almost comparable to the study conducted by Nadia et al. Reason for these contrary findings may be due to different cut off values(44.1cm)[35,38]

In our study TMD has a sensitivity of 56.25% , specificity of 86.90%, PPV of 45.00% and NPV of 91.25% which is almost similar to that of Krobbuaban et al[22] . He concluded that TMD has sensitivity of 52%, specificity of 71%, PPV of 21% and NPV 91%. The variation in values may be due to different cut off values (5.5-7cm).14,18,21,35

HMD has a sensitivity of 56.25% , specificity of 86.90%, PPV of 45.00% and NPV of 91.25% in our present study. Nevena et al[36] conducted study on hyomental ratio and HMD in predicting difficult intubation and found to have sensitivity of 75.9% and specificity of 61.5%. Difference in these values is due to the cut off value (5.3cm) of HMD in the latter study.

In present study, SMD has a sensitivity of 56.25% , specificity of 88.10%, PPV of 47.37% and NPV of 91.36% and our study can be compared with that of Srinivasa et al[29] with sensitivity of 57.14%, specificity of 84.62%, PPV of 66.67 and NPV of 78.57%. In our study cut off for SMD was 12.5cm as suggested by Bhavdip et al[17] where SMD is having specificity of 92.7% and NPV of 99.13%.

IIG has a sensitivity of 25.00% , specificity of 98.81%, PPV of 80.00% and NPV of 87.37% in our study. Javaher et al[37] compared sensitivity and specificity of different tests to determine difficult intubation in 448 patients and concluded that IIG has sensitivity of 31.5%, specificity of 84.3%, PPV of 15.7% and NPV of 93.0% and are in good agreement with our present study.

In our present study MMT is having a sensitivity of 75.00% , specificity of 61.90%, PPV of 27.27% and NPV of 92.86% and is similar to study conducted by Shah et al[23], where MMT is having sensitivity of 70.15%, specificity of 61.02%, PPV of 22.60% and NPV of 92.65%. Safavi et al[26]compared the ratio of patient's height to TMD with the MMT and the upper lip bite test in predicting difficult laryngoscopy and observed that MMT had a specificity of 46.9% and PPV of 8.2% and is contrary to the result that is observed in our study. This can be due to high inter-observer variations, that can be attributed to patient's un cooperation, phonation effect and absence of clear differentiation between class II and class III as well as class III and class IV.

Our study demonstrated good sensitivity (87.50%) and specificity of 86.90% and with PPV of 56.00% and NPV of 97.33% for RNCTMD. The overall accuracy is 87.00%. Nadia et al[35] compared difficulty in intubation in obese and non – obese patients using IDS score and concluded that, in obese ratio has sensitivity of 91.70%, specificity of 95.10% , PPV of 75% and NPV of 98.50% and in non obese ratio has sensitivity of 75.00%, specificity of 92.90%, PPV of 45.00% and NPV of97.90%. Kim et al[18] concluded that in obese patients RNCTMD has sensitivity of 88.2%, specificity of 83.0%, PPV of 45.5% and NPV of 97.8%.These results are almost similar with our study. But, in our study there is no comparison between obese and non – obese patients.

In our present study RNCTMD has high sensitivity and NPV compared to other parameters. Whereas IIG is having high specificity and PPV. Both are having similar overall accuracy. Both IIG and RNCTMD are found to be simple and effective means for predicting difficult airway by preoperative assessment as per our study. . RNCTMD with p value of 0.000 have higher statistical significance.ROC curve in this study for

RNCTMD showed that cut off 4.85cm can predict difficulty in intubation more accurately.

CONCLUSION:

We conclude that Ratio of neck circumference to thyromental distance is found to be a better predictor of difficulty intubation compared to the other independent airway assessment parameters. We also conclude that IIG is having high specificity and PPV. Whereas RNCTMD is having high sensitivity and NPV for predicting difficulty in intubation.

Reference

Shiga T, Wajima Z, Inoue T,Sakamoto A. Predicting difficult intubation in apparently normal patients. Anaesthesiology 2005;103;429-437

Benumof JL. Difficult Laryngoscopy : obtaining the best view .Can J anaesthesia 1994;41: 361-5

Arne J,Descoins P, Fusciardi J,Ingrand P,Ferrier B ,Aries J.Preoperative assessment for difficult intubation in general and ENT surgery:Predictive value of a clinical multivariate risk index.Br J Anaesth 1998;80:140-6

Langeron O,Masso E,Huraux C, Guggiari M ,Bianchi A,Coriat P et al.Prediction of difficult mask ventilation.Anesthesiology 2000;92:1229-1236

Rose DK,Cohen MM.The airway: problems and its predictions in 18,500 patients .Can J anaesthesia 1994;41:372-83.

Rocke D A ,Murray WB, Rout CC ,Gouws E.Relative risk analysis of factors associated with difficult intubation in obstetric anesthesia. Anesthesiology 1992;77:67-73.

Butler PJ ,Dhara SS. Prediction of difficult laryngoscopy : an assessment of Thyromental distance and mallampatti predictive tests.Anaesth Intensive care 1992;20:139-42

Frerk CM .Predicting difficult intubation.Anaesthesia.1991;46:1005-8

Lewis M , keramati S, Benumof JL, Berry CC .What is the best way to determine oropharyngeal classification and mandibular space length to predict difficult laryngoscopy? Anesthesiology 1994;81:69-75.

Oates JDL,Macleod AD,Oates PD,Pearsall FJ,Howie JC,Murray JD:Comparison of two method sfor predicting difficult intubation.Br J anaesth 1991;66:305-9.

Savva D .prediction of difficult tracheal intubation.Br J anaesth 1994;73: 149-53.

Wilson ME , Spiegelhalter D ,Robertson JA, Lesser P.Predicting difficult intubation.Br J anaesth 1988;61:211-6.

Caplan RA, posner KL, Ward RJ, Cheney FW. Adverse respiratory events in anesthesia: a closed claim analysis. Anesthesiology 1990: 72: 828-33.

Smitha prakash, Amitabh kumar, shyam bhandari Parul mullick, Rajvir singh,Anoop raj googia difficult laryngoscopy and intubation in indian population-an assessment of anatomical and clinical risk factors Indian journal of anesthesia 2013(57)569-575.

Klock PA, benumof JL,Definition and incidence of Difficult airway :Hagberg CA Benumof's airway management @2nd edition, mosby elsevier p.2007,p215-33.

El Ganzuori AR, McCarthy RJ, tuman KL, Tanck EN Ivankovich AD:Preoperative airway assessment :predictive value of a multivariate risk index. Anaesth Analgesia 1997;84: 419-421.

Bhavdip patel, Rajiv khandekar, Rashesh diwan, Ashok shah Validation of modified mallampatti with addition of thyromental and sternomental distance in predictingdifficult intubation in adults. Indian journal of anesthesia 2014(58)171-175.

kim.W.H.,AhnH.J,.LeeC.J,.ShinB.S,.KoJ.S,ChoiS.J,and ryuS.A. Neck circumference to thyromental distance ratio as a new predictor of difficult intubation in obese patients. British journal of anesthesia 2011(5)743-748.

Allahaery E, GhaemeiS.R, Azemati.S comparison of six different methods for predicting difficult intubation IRCMJ 10(3);197-204.

Chara L, Eleftherios V, Maria M, Anastasia T, Chryssoula S Anatomic features of the neck as predictive markers of difficult direct laryngoscopy in men and women: A prospective study. Indian journal of anesthesia 2014(58)176-182.

Schmitt H.J., KirmseM, Radespeil-Troger.M Ratio of Patient's Height to Thyromental Distance Improves Prediction of Difficult Laryngoscopy (Anaesth Intensive Care 2002; 30: 763-765).

Krobbuaban, Diregpoke, Kumkeaw and Tanomsat. conducted a study to compare the Predictive Value of the Height Ratio and Thyromental Distance: Four Predictive Tests for Difficult Laryngoscopy. (Anesth Analg 2005;101:1542-1545).

Shah PJ, Dubey KP, yadav JP. predictive value of upper lip bite test and ratio of height to thyromental distance with other multivariate airway assessment tests for difficult laryngoscopy in apparently normal patients.J anesthesia and clinical pharmacology;2013;29;191-5.

Cormack RS, Lehane J. Difficult tracheal intubation in obstetrics. Anaesthesia1984 Nov;39(11):1105-11

Adnet F, Borron SW, Racine SX, Clemessy JL, Fournier JL, PlaisanceP, et al. The Intubation Difficulty Scale (IDS): Proposal and evaluation of a new score characterizing the complexity of endotracheal intubation. Anesthesiology 1997 Dec;87(6):1290-7

Safavi M, Honarmand A, Zare N. A comparison of the ratio of patient's height to thyromental distance with the modified Mallampati and the upper lip bite test in predicting difficult laryngoscopy. Saudi J Anaesth 2011;5:258-63

American society of anesthesiologists. Practice Guidelines for Management of the Difficult Airway An updated report; Anesthesiology, 2013, V 118;1-20.

Lee A, Fan LT,Gin T, Kamarkar MK, Ngan Kee WD. A systematic review(meta-analysis) of the accuracy of mallampatti tests to predict the difficult airway. Anaesth analg 2006;102:1867-68.

Srinivasa S , Vrinda Oza, Vasantha Kumar, Vandana Parmar and V.A. Chhaya Assessment of difficult airway predictors for predicting difficult laryngoscopy and intubation IJBAR (2014) 05 (07)

Finucane, Brendan T., Tsui, Ban C.H., Santora, Albert. Principles of Airway Management, 4th ed. 2011, Evaluation of the airway

Juvin P1, Lavaut E, Dupont H, Lefevre P, Demetriou M, Dumoulin JL, Desmonts JM. Difficult tracheal intubation is more common in obese than in lean patients. Anaesthesia analogue 2003; 97:595–600

Ezri T, Gewürtz G, Sessler DI, Medalion B, Szmuk P, Hagberg C, Susmallian S. Prediction of Difficult Laryngoscopy in Obese

Patients by Ultrasound Quantifi- cation of Anterior Neck Soft Tissue. Anae- sthesia 2003 Nov; 58(11): 1111–1114.

Brodsky JB1, Lemmens HJ, Brock-Utne JG, Vierra M, SaidmanLJ.: Morbid obesity and tracheal intubation. Anaesthesia analogue 2002 Mar;94(3):732-6

Lars H. Lundstrøm, Ann M. Møller,Dr.Med.Sci.Charlotte Rosenstock, .Jørn Wetterslev,.High Body Mass Index Is a Weak Predictor for Difficult and Failed Tracheal Intubation: A Cohort Study of 91,332 Consecutive Patients Scheduled for Direct Laryngoscopy Registered in the Danish Anesthesia Database Anesthesiology 2 2009, Vol.110, 266-274.

Nadia Rose, Dr Maya G, Dr Anil Sathyadas. Comparison of Difficult Intubation and Neck Circumference to Thyromental Distance Ratio, in Obese and Non-Obese: A Clinical Study JMSCR Vol 05 march 2017 Issue 03 Page 19670-19679

NevenaKalezić, MirkoLakićević,BiljanaMiličić, MarinaStojanović, VeraSabljak, and DejanMarkovi. Hyomental distance in the different head positions and hyomental distance ratio in predicting difficult intubation 2016 Aug; 16(3): 232–236.

Javaher Foroosh Zadeh F and 2 Safaii Sara comparison of the sensitivity and specificity of different tests to determine difficult intubation. Volume 4, Issue 9, 36-42 aug 2015

Brodsky JB1, Lemmens HJ, Brock-Utne JG, Vierra M, SaidmanLJ.: Morbid obesity and tracheal intubation. Anaesthesia analogue 2002 Mar;94(3):732-6