RATIO OF HEIGHT TO STERNOMENTAL DISTANCE;
A COMPARISON OF COMMON UPPER AIRWAY TESTS FOR PREDICTING DIFFICULT LARYNGOSCOPY IN ELECTIVE SURGICAL PATIENTS

ORIGINAL
PROF-1930

DR. FARNOUSH FARZI, MD
Assistant Professor of Anesthesiology,
Department of Anesthesiology,
Guilan University of Medical Sciences, Rasht, Iran

DR. ALI MIRMANSOURI, MD
Assistant Professor of Anesthesiology
Department of Anesthesiology,
Guilan University of Medical Sciences, Rasht, Iran

DR. KAMBIZ FORGHANPARAST
Associate Professor of Microbiology
Department of Microbiology,
Guilan University of Medical Sciences, Rasht, Iran

Dr. Mehrsima Abdolahzade, MD
Assistant Professor of Anesthesiology

Dr. AhmadrezaShafai, MD
Anesthesiologist
Department of Anesthesiology,
Guilan University of Medical Sciences, Rasht, Iran

ABSTRACT… Background: Preoperative evaluation is important in predicting the risk of difficult airway management. Ratio of height to sternomental distance is a new test for predicting difficult laryngoscopy. **Design:** Analytical cross – sectional study. **Setting:** Guilan University of Medical Sciences, Rash-Iran. **Period:** 1st Oct, 2009 to 30th Dec, 2010. **Methods:** 470 consecutive patients scheduled for elective surgery undergoing general anesthesia and requiring endotracheal intubation. The tests that were used to predict difficult laryngoscopy included: mouth opening range, body mass index (BMI), thyromental distance, sternomental distance, and neck movement range, ratio of height to thyromental distance, ratio of height to sternomental distance and assessment of oropharyngeal view by modified Mallampati classification. After general anesthesia, glottic visualization was assessed during laryngoscopy using Cormack and Lehane classification. Multivariate analysis and 95 percent confidence interval with SPSS 14 statistical package were used to compare the results of study. **Results:** Neck movement range$\leqslant$ 80 degrees had the highest sensitivity and specificity. Then Mallampati class 3 or 4 and RHSMD $\geqslant$ 12.5 were valuable respectively. Odds ratio (95 percent confidence interval) of the neck movement range $\leqslant$ 80 °, Mallampati class 3 or 4, RHSMD $\geqslant$ 12.5 and RHTMD $\geqslant$ 23.5 were 17.7(9.57 – 49.76), 12.28 (7.6 – 47.04), 12.22 (22.8 – 76.6), 9.35 (2.29 – 10.52),5.6 (0.88 – 0.89), 3.78 (0.022 – 0.595) respectively. RHSMD had the least false negative value. Cut off point of RHSMD $\geqslant$ 12.5 and RHTMD $\geqslant$ 23.5 was not different between men and women. **Conclusions:** RHSMD is a useful and valuable clinical screening test for predicting difficult laryngoscopy.

Key words: Intubation Tracheal, Laryngoscopy

INTRODUCTION

The most important responsibility of an anesthesiologist is providing a secure airway[1]. Unsuccessfulness or failure in the airway management is the most important cause of morbidity and mortality in the patients undergoing general anesthesia[2,3]. In most patients difficult laryngoscopy is considered equal to difficult intubation[4]. The prevalence of difficult laryngoscopy in some studies is 1 – 4 percent and it is more likely to happen in the pregnant women[1]. The prevalence of difficult intubation has also been reported about 1.5 – 13 percent[5]. Preoperative evaluation and examination are valuable and helpful in identifying the cases of difficult laryngoscopy and intubation. A variety of examinations and measures are being used like: moth opening range, neck movement range, thyromental distance, sternomental distance, Mallampati class and etc. it is still not clear that which of the anatomic landmarks and clinical factors have more predictive value in airway assessment during preoperative evaluation[6,7]. Several studies have been performed considering one or several factors[8,9,10].

Measuring sternomental distance (SMD) is a test for predicting difficult laryngoscopy that varies with the patient's size[7]. Weather the predictive value of SMD for difficult laryngoscopy had adequate sensitivity and specificity or not is debatable[7,8,9,11,12]. In some studies SMD has been considered as strong predictor of difficult airway[13], as SMD $\leqslant$ 12.5 centimeter in one study[14] and SMD $\leqslant$ 13.5 in another one were found to be the best predictors of difficult airway in comparison with other

tests for airway assessment[15]. The ratio of height to thyromental distance (RHTMD) was considered as a useful screening test for predicting difficult laryngoscopy in two studies[16,17], but as far as we investigated, there hasn't been any study about measuring the ratio of height to sternomental distance (RHSMD) yet. As there are anatomic variations among different races and ethnicities, we designed a prospective study to determine the relationship between RHSMD and difficult laryngoscopy in Iranian patients, and to compare the predictive value of RHSMD with RHTMD, thyromental distance(TMD), SMD, Mallampati class, interincisor gap(IIG) and neck movement range in Iran.

MATERIALS AND METHODS

After approving research proposal in the ethic committee of Guilan University of Medical Sciences and obtaining written consent from each patient, this research was carried out as an analytic cross – sectional study in the hospitals of Guilan University of Medical Sciences. The sampling method was simple and consecutive.

All patients, aged over 18 with an ASA class I or II who were candidates of an elective surgery, were offered participation.

Patients were excluded from participation if rapid sequence induction or awake intubation was needed, or in the presence of pregnancy, loose dentures, skeletal abnormalities which affected the height like kyphoscoliosis , and significant airway abnormalities like head and neck tumors, cleft lips, head and trauma. Finally, 470 patients participated in the study.

The day before surgery, the patients were visited by a senior anesthesiology assistant and necessary examination and investigation was performed and a part of the questionnaire was completed.

The examinations that were used to predict difficult airway included: mouth opening range, TMD, SMD, body mass index (BMI), neck movement range, Mallampati class, weight and height. Standard approaches were used to assess each of them.

Mouth opening range was assessed by measuring the interincisor gap (IIG) by a soft fabric meter in centimeters[9]. Maximum range of neck movement (NM) was calculated by Wilson approach. Patients head was completely extended backward and one pencil was put on his/her forehead vertically, then without any change in the pencil's position, head flexed completely toward the chest. The pencil's movement produced an angle which was measured and classified as more than 80 degrees and less or equal to 80 degrees[6].

SMD was measured as the distance between the bonny point of the chin until upper sternal notch while the head was completely extended backward and the mouth was closed.

TMD was measured as the distance between the bonny point of the chin until the thyroid cartilage palpable prominence, having the head fully extended backward and the mouth closed[9] all the measurements were in centimeters by a soft fabric meter.

Assessment of the oropharyngeal view was performed by modified Mallampati classification. In the sitting position, the patient was asked to open his/her mouth maximally and protrude her/his tongue as much as possible without making any sound: Class 1 if soft palate, faucial pillars and uvula were visible; Class 2 if soft palate and uvula were visible; Class 3 if only soft palate and the base of uvula were visible; Class 4 if soft palate isn't visible and only hard palate is visible[4].

Height was measured in centimeters and weight was measured in kilograms by a digital standard scale. The BMI, the ratio of height to TMD (RHTMD) and the ratio of height to SMD (RHSMD) were calculated and filled in to the questionnaire.

On the day of surgery an intravenous line was introduced. Standard monitorings including electrocardiography, pulseoximetry and non – invasive blood pressure were provided for the patients. The same anesthetic regimen was used for providing general anesthesia in all patients. Midazolam 0.04 mg/kg and fentanyl 2 µ/kg were administered for premedication. Induction of anesthesia was performed by thiopental 5 mg/kg and muscle relaxation was provided by atracurium

0.5 mg/kg. Bag – mask ventilation was performed for three minutes until adequate muscle relaxation was achieved (having no response to 50 mA stimulation with single twitch or train of four modes in monitoring with a nerve stimulator. Then an anesthesiologist, who was blinded to data, determined the laryngoscopic grade on the basis of Cormack and Lehane criteria using a laryngoscope with a number 3 Macintosh blade. Then the patient was intubated and the questionnaire was completed.

The preoperative assessment data and the laryngoscopic findings were used to evaluate the predictive value of each test in difficult laryngoscopy. The sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of each test were calculated. In addition, receiver operating characteristic (ROC) curves were used to identify the optimal predictive cut off point, for RHSMD AND RHTMD measurement, interincisor gap, SMD and TMD.

In this study, multivariate analysis and 95% confidence interval with SPSS 14 statistical package were used to compare the results. The diagnostic performance of each test was also assessed by summary ROC curves. ROC curves were constructed.

RESULTS

470 patients, 250 male and 220 female, who were candidates for elective surgery under general anesthesia were approached for this study. Demographic characteristics of the patients are presented in the table – I.

The laryngoscopic grade was recorded on the basis of Cormack and Lehanescoreand grades III and IV were considered as difficult laryngoscopy. There were one hundred cases of difficult laryngoscopy and no case of failure in laryngoscopy was encountered. The achieved cut of point for RHTMD was equal to or more than 23.5 (Table – III and Figure - 1) and it was equal to or more than 12.5 for RHSMD (Table – IV and Figure – 1). These measures were the similar in both two sexes (Tables V, VI, VII, VIII and Figures – 2, 3).

Neck movement range equal to or less than 80 degrees,

Table-I. Demographic data of all patients and distribution of laryngoscopic view

Category	Value
Men n (%)	250 (53.2)
Women n (%)	220 (46.8)
Age [yrs.] [mean ± SD]	45.67± 13.41
Weight [kg] [mean ± SD]	72.75± 11.77
Height [cm] [mean ± SD]	166.7 ± 5.88
BMI [mean ± SD]	26.17 ± 3.96
Slim BMI ? 18.5] n (%)	33 (6.8)
Average [BMI = 18.5 - 25] n (%)	158 (33.8)
Overweight [BMI = 25 - 30] n (%)	195 (41.5)
Obese [BMI ≥ 30] n (%)	84 (17.9)
TMD (cm) [mean ± SD]	7.29 ± 2.7
≤ 6.5 n(%)	183 (38.9)
> 6.5 n (%)	287 (61.1)
SMD (cm) [mean ± SD]	13.17 ± 0.76
≤12.5 n (%)	106 (22.6)
> 12.5 n (%)	364 (77.4)
RHTMD [mean ± SD]	22.97 ± 2.36
RHSMD [mean ± SD]	12.46 ± 1.14
Interincisor Gap [mean ± SD]	4.2 ± .67
≤ 3.5 n(%)	114 (24.3)
> 3.5 n(%)	356 (75.7)
Neck Movement	
≤ 80 degrees	91 (19.4)
> 80 degrees	379 (80.6)
Mallampati Class n(%)	
1	221 (47.1)
2	179 (38.1)
3	64 (13.5)
4	06 (1.3)
Laryngoscopic View n (%)	
I	206 (43.8)
II	164 (34.9)
III	91 (19.4)
IV	09 (1.9)

BMI = body mass index; TMD = thyromental distance; SMD = sternomental distance; RHTMD = ratio of height to thyromental distance; RHSMD = ratio of height to sternomental distance

Mallampati class 3 and 4 and RHSMD equal to or greater than 12.5 were considered as strong predictors of difficult airway respectively. IIG ⩽ 3.5 cm, SMD⩽ 12.5 cm and RHTMD ⩾ 23.5 were respectively the next valuable indicators in predicting difficult airway.

Statistical indexes including sensitivity, specificity, false negative, false positive and Odds ratio were calculated for each test and are presented in this part (Table – II).

In this study neck movement range equal to or less than 80 degrees had the most sensitivity, specificity and Odds ratio, and Mallampati class 3 and 4, RHSMD⩾ 12.5 followed that, but RHSMD had the least false negative. TMD⩽ 6.5 cm and BMI⩾ 30 had no statistical value in predicting difficult airway (Table – II).

The ratio of height to thyromental distance (RHTMD) was calculated. After calculating sensitivity and specificity, cut off point for RHTMD was 23.5 which had the highest sensitivity and specificity.

The ratio of height to sternomental distance (RHSMD) was calculated. After calculating sensitivity and specificity, cut off point for RHSMD was 12.5 which had the highest sensitivity and specificity.

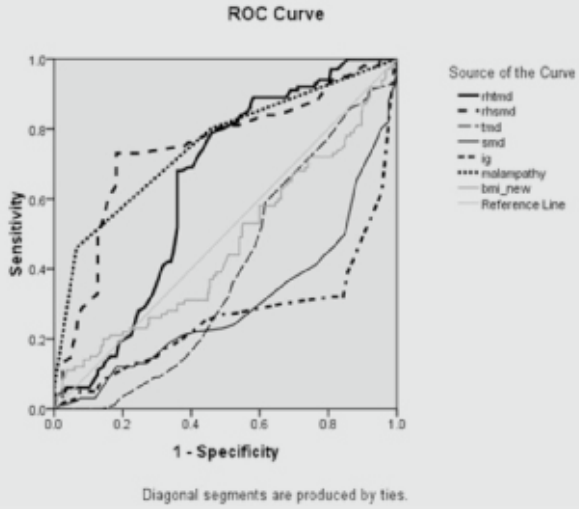

Fig-1. Receiver operating characteristic (ROC) curve for the ratio of height to thyromental distance (rhtmd), ratio of height to sternomental distance (rhsmd), thyromental distance (tmd), sternomental distance (smd), interincisor gap (ig), Mallampati Class, body mass index (bmi)in predicting difficult tracheal intubation in all patients.

Table-II. Accuracy of risk factors in predicting difficult laryngoscopy

Risk factor	TP	TN	FP	FN	Sens (%)	Spec (%)	PPV (%)	NPV (%)	Odds ratio	CI 95%	P-value
IIG ≤ 3.5	61	317	53	39	61	85.7	53.5	89	9.35	2.29- 10.59	0.001
TMD ≤ 6.5	41	228	128	67	41	61.6	22.4	79.4	1.11	0.711-1.57	Ns
SMD ≤ 12.5	50	314	56	50	50	84.9	47.2	86.3	5.6	0.088-0.809	0.02
NM ≤ 80°	61	340	30	39	61	91.89	67	89.7	17.7	9.57-49.76	<0.0001
MPC = 3 or 4	46	346	24	54	46	93.5	65.7	86.5	12.28	7.6-47.04	<0.0001
BMI ≥ 30	21	307	63	79	21	82.9	25	79.5	1.29	0.43-3.57	ns
RHTMD ≥ 23.5	68	237	133	32	68	64.1	33.8	88.1	3.78	0.022-0.595	0.01
RHSMD ≥ 12.5	73	303	67	27	73	81.9	52.1	91.8	12.22	22.8-76.9	< 0.0001

IIG = interincisor gap; TMD = thyromental distance; NM = neck movement; MPC = Mallampati class
RHTMD = ratio of height to thyromental distance; RHSMD= ratio of height to sternomental distance TP = true positive;
TN = true negative; FP = false positive; FN = false negative; Sens = sensitivity; Spec = specificity; PPV = positive predictive value;
NPV = negative predictive value; CI = confidence interval

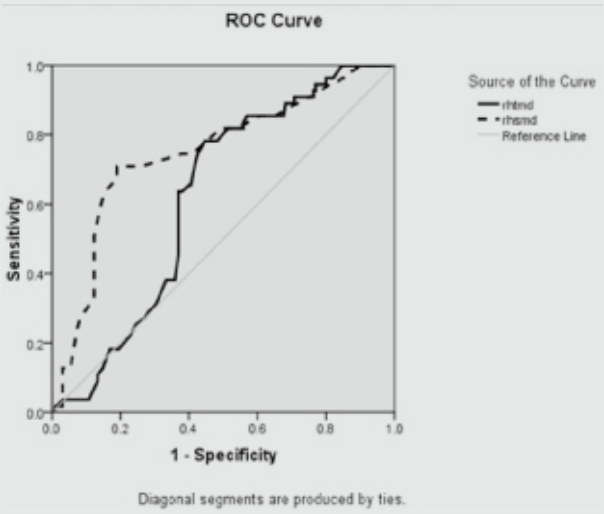

Figure-3. Receiver operating characteristic (ROC) curve for the ratio of height to thyromental distance (RHTMD) and ratio of height to sternomental distance (RHSMD) in predicting difficult tracheal intubation in men.

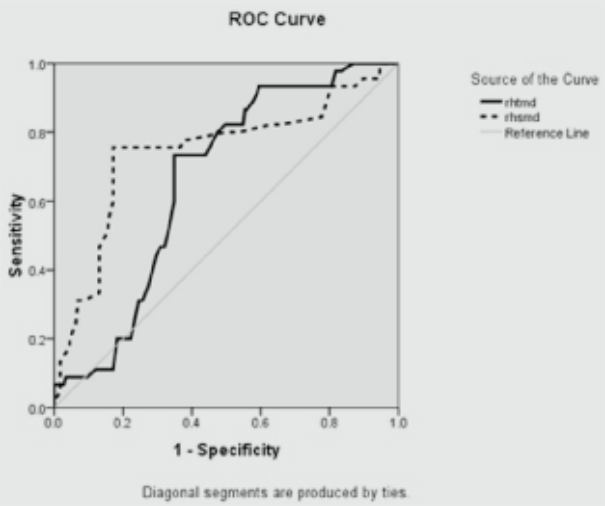

Figure-2. Receiver operating characteristic (ROC) curve for the ratio of height to thyromental distance (rhtmd) and ratio of height to sternomental distance (rhsmd) in predicting difficult tracheal intubation in women.

The ratio of height to thyromental distance (RHTMD) was calculated. After calculating sensitivity and specificity, cut off point for RHTMD was 23.5 which had the highest sensitivity and specificity.

The ratio of height to sternomental distance (RHSMD) was calculated. After calculating sensitivity and specificity, cut off point for RHSMD was 12.5 which had the highest sensitivity and specificity.

The ratio of height to thyromental distance (RHTMD) was calculated. After calculating sensitivity and specificity, cut off point for RHTMD was 23.5 which had the highest sensitivity and specificity.

The ratio of height to sternomental distance (RHSMD) was calculated. After calculating sensitivity and specificity, cut off point for RHSMD was 12.5 which had the highest sensitivity and specificity.

DISCUSSION AND CONCLUSION

Difficult airway management and failure in that is an important factor in morbidity and mortality of general anesthesia. According to research by American Society of Anesthesiologists, difficult intubation is still the third important cause of respiratory events resulting death and brain injuries[18].

Predicting the airway status before committing laryngoscopy and tracheal intubation and being prepared for that is of critical importance. According to that, finding more trustable and easier methods for predicting the airway status is one of the goals of all anesthesiologists. In this study the new approach of the ratio of height to sternomental distance(RHSMD)was used to predict difficult airway and it was compared with other common approaches like interincisor gap, thyromental distance, sternomental distance, neck movement range, Mallampati class and the ratio of height to thyromental distance (RHTMD).

In this study the incidence of difficult laryngoscopy was 21 percent that is higher comparing with 3 – 18 percent in other studies[6]. This greater incidence might be due to racial differences or personal experience of anesthesiologist.

Ideal assessments and tests for predicting difficult

Table-V. The comparison of diagnostic features of the ratio of height to thyromental distance (RHTMD) in women

RHTMD	Sensitivity	Specificity	1 - Specificity
18	100	-	100
20	97.8	16.6	83.4
21.95	93.3	40.6	59.4
22.9	80	52.6	47.4
23.05	73.3	56	44
23.48	73.3	65.1	34.9
23.51	71.1	65.1	34.9
24	51.1	66.9	33.1
25	20	77.7	22.3
27.1	6.7	98.9	1.1
29	-	100	-

Table-VI. The comparison of diagnostic features of the ratio of height to sternomental distance (RHSMD) in women

RHSMD	Sensitivity	Specificity	1 - Specificity
9.9	100	-	100
11.45	100	5.1	94.9
11.85	93.3	14.9	85.1
11.95	93.3	19.4	80.6
12.11	82.2	34.3	65.7
12.17	82.2	37.1	62.9
12.20	80	46.3	53.7
12.28	80	50.3	49.7
12.30	77.8	61.1	38.9
12.33	77.8	81.6	37.7
12.48	75.6	82.9	17.1
12.59	60	86.9	17.1
13.05	31.1	91.4	8.6
29	-	100	-

Table-VII. The comparison of diagnostic features of the ratio of height to thyromental distance (RHTMD) in men

RHTMD	Sensitivity	Specificity	1 - Specificity
12	100	-	100
19.52	100	7.2	92.8
20.05	96.4	17.9	82.1
20.57	90.9	28.7	71.3
21.05	85.5	32.3	67.7
22.05	83.6	44.1	55.9
22.58	81.8	48.7	51.3
22.7	78.2	51.8	48.2
22.92	78.2	55.4	44.6
23.25	65.5	59.5	40.5
23.35	65.5	60	40
23.42	63.6	62.1	37.9
23.46	63.6	62.6	37.4
23.48	63.6	63.1	36.9
23.9	45.5	63.1	36.9
24.55	38.2	66.7	33.3
26.05	3.6	89.2	10.8

laryngoscopy should have high sensitivity and specificity and the least occurrence of false negative and false positive. False negative is dangerous as it will lead to not being prepared to deal with a potential difficult airway.

In the study by Sava and co[14] the IIG did not have any relationship to difficult laryngoscopy but SMD⩽ 12.5 cm and TMD⩽ 6.5 cm were considered as sensitive and specific tests for predicting difficult laryngoscopy. Specificity and sensitivity of SMD was more than TMD. In this study unlike Sava's study, IIG was one of the effective risk factors for difficult laryngoscopy. TMD⩽6.5 cm did not have any predictive value for difficult laryngoscopy; but SMD⩽ 12.5 cm had positive predictive value which agreed with Sava's study.

Table-VIII. The comparison of diagnostic features of the ratio of height to sternomental distance (RHSMD) in men

RHSMD	Sensitivity	Specificity	1 - Specificity
10	100	-	100
11.69	100	9.2	90.8
12	90.9	24.1	75.9
12.11	85.5	34.9	65.1
12.11	85.5	35.4	64.6
12.13	85.5	34.6	65.1
12.17	85.5	39.5	60.5
12.21	81.8	46.2	53.8
12.28	81.8	50.8	49.2
12.38	74.5	62.1	37.9
12.40	70.9	73.8	26.2
12.5	70.9	81	19
12.54	69.1	81	19
12.58	67.3	81	19
13.05	27.3	91.8	8.2
28.2	-	100	-

Iohom and co.[19] concluded that the Mallampati class along with measuring TMD and SMD were useful routine clinical tests in predicting difficult laryngoscopy. Mallampati score and SMD had predictive value in this study but TMD did not.

Ramadhani and co.[15] found that SMD was a proper test for predicting difficult airway and might be effective in association with other tests. This finding is matched with our study.

In Krobbuaban and co.'s research[16], neck movement range less than 80 degrees, Mallampati class 3 and 4 and RHTMD $\geqslant$ 23.5 had predicting value for difficult airway and RHTMD had the highest sensitivity and Odds ratio and the least false negative cases. In that research, IIG $\leqslant$ 3.5 cm and TMD $\leqslant$ 6.5 cm did not have any predictive value.

In our study, NM $\leqslant$ 80 degrees, Mallampati class 3 and 4 and RHSMD $\geqslant$ 12.5 had the greatest sensitivity, specificity and Odds ratio and RHTMD followed them. Cut off point for RHTMD was equal to or more than 23.5 with corresponds with Krobbuaban's research, however RHTMD did not have the highest sensitivity and specificity and its false negative rate was not the least as well. In our study TMD $\leqslant$ 6.5 cm offered no prediction value that corresponds with Krobbuaban's research. Also in our study IIG $\leqslant$ 3.5 had statistical value in predicting difficult airway that is not match with Krobbuaban's study. Part of these differences might be due to ethnic and racial differences and the other part could be a result some variations in measuring methods and instruments.

Shmith and co.[17] found that RHTMD $\geqslant$ 25 was practical for predicting difficult airway in men and women although they mentioned that this measure might vary in different races. In our study RHTMD $\geqslant$ 23.5 was equal on both men and women and had predictive value for difficult airway but the achieved cut off point was equal to or more than 23.5 which was less than Shmith's research and corresponded with Krobbuaban's study that further confirms differences in racial and ethnic characteristics.

65 percent of the people in the United States are overweight or obese[20]. In this study about 60 percent were overweight or obese that is close to the results in the US.

Ezri and co.[21] found that difficult laryngoscopy did not have any relationship with increased BMI but in Toshiya Shiga's research difficult intubation was three times more common in the patients with BMI $\geqslant$ 30 compared with the patient with the patient with normal weight[12]. In our studyBMI $\geqslant$ 30 did not have any relationship with difficult laryngoscopy that agrees with Ezri's findings. The impact of obesity might vary in different ethnicities. The variations in fat mass accumulation in different parts of body and the limitation that it causes might be responsible for this difference in the results in different regions and ethnicities in the world. The remarkable point of our study is the measurement of a new index for predicting difficult laryngoscopy that is the ratio of height

to sternomental distance (RHSMD) for the first time in the world. We found that RHSMD ⩾ 12.5 has direct relationship with difficult laryngoscopy. This measure was the same in both men and women. RHSMD has the least rate of false negative in predicting difficult laryngoscopy. Considering sensitivity, specificity and Odds ratio, RHSMD is on the third position after neck movement range and Mallampati class. Since RHSMD has been measured for the first time in the world, it is not possible to compare it with other studies. However we hope that by the publication of our findings, other researches use this new approach and measure this index in other races and regions of the world so that it would be possible to compare the results together.

Our final word is that RHSMD along with neck movement range and Mallampati class, considering high sensitivity, specificity and Odds ratio could be used as valuable screening tests in predicting difficult airway.

REFERENCES

1. Henderson J. **Airway Management in Adults.** In: Miller RD, Erikson LI, Fleisher LA, Wiener – Kronish JP, Young WL. Miller's Anesthesia. 7thEdition. Philadelphia: Churchill Livingstone Elsevier Inc; 2010: 1573 – 1610.
2. Feldman M, Patel A. **Anesthesia for Eye, Ear, Nose, and Throat Surgery.** In: Miller RD, Erikson LI, Fleisher LA, Wiener – Kronish JP, Young WL. Miller's Anesthesia. 7th Edition. Philadelphia: Churchill Livingstone Elsevier Inc; 2010: 2333-50.
3. Naguib M, Ffarcsi, Franklin L et al. **Predictive Performance of Three Multivariate Difficult Tracheal Intubation Models: A Double – Blind, Case – Controlled study.** Anesth Analg 2006; 102:818-24.
4. Crosby ET, Cooper RM, Douglas MJ, et al. **The unanticipated difficult airway with recommendations for management.** Can J Anaesth 1998; 45:757–76.
5. Sadqa Aftab, Dillo Raja, Shamsunnisa Rashdi et al. **Preoperative Assessment of Risk Factors For Difficult Intubation**; Pakistan Journal of Surgery 2008;24: 60-64.
6. Rudin Domi. **A Comparison of Wilson Sum Score and Combination Mallampati ,Tiromental and Sternomental Distances for Predicting Difficult Intubation.** Macedonian journal of Medical Sciences 2009; Jun 15; 2: 1110-1115.
7. TurkanS,Ates Y, Cuhruk H, et al. **Should We Reevaluate the variables for predicting the Difficult Airway in Anesthesiology?** Anesth Analg 2002; 94:1340-44.
8. Arne J , Descoins P , Fusciardi J et al ; **Preoperative assessment for difficult intubation in general and ENT surgery: predicitive value of a clinical multivariate risk index ,** Br J Anaesth ,1998;80:140-6 .
9. Merah NA, Wong DT, Ffoulkes – Crabbe DJ et al. Modified Mallampati Test, **Thyromental distance and interincisor gap are the best predictors of difficult laryngoscopy in West Africans,** CAN J ANESTH 2005;52:3:291 – 296 .
10. Hester CE, Shelli C, Dietrich A. A **Comparison of Preoperative Airway Assessment Techniques: The Modified Mallampati and The upper Lip Bite Test,** ANNA Journal, 2007;75:177-183 .
11. Karkouti K, Rose DK, Wigglesworth D et al. **Predicting difficult intubation: a multivariable analysis,** CAN J ANESTH 2000; 74: 8: 730 – 739.
12. Shiga T, Wajima Z, Inoue T, et al. **Predicting difficult intubation in apparently normal patients: A Meta – analysis of Bedside Screening test performance.** Anesthesiology 2005; 103:429–37.
13. Kye-Min Kim. **First step to safe anesthesia: Pre-operative prediction of difficult airway ;** Korean J Anesthesiol 2009; 57: 3: 275-6.
14. Savva D. **Prediction of difficult tracheal intubation.** Br J Anaesth 1994; 73:149–53.
15. RAMADHANI S A L, MOHAMED L A, Rocke DA et al. **Sternomental distance as the sole predictor of difficult laryngoscopyinobstetric anaesthesia.** Br.J.Anaesth 1996; 77: 312 – 316.
16. Krobbuaban B,Diregpoke S, Kumkeaw S et al. **The Predictive value of the Height Ratio and thyromental Distance: Four Predictive Tests for difficult laryngoscopy.** Anesth Analg 2005; 101: 1542-5.
17. Shmitt HJ, Kirmse M, Radespiel – Troger M. **Ratio of patient's height to Thyromental distance improves prediction of difficult laryngoscopy,** Anaesth Intensive Care2002;30: 763-5.
18. Langerson O, Amour J, Vivien B et al. **Clinical Review: Management of difficult airway.** Critical Care 2006;10:243.

19. Iohom G, Ronayne M, Cunningham AJ. **Prediction of difficult tracheal intubation.** Europian J of Anaesth 2003;20:31–36.

20. Sinha AC and Eckmann DM. In: Miller RD, Erikson LI, Fleisher LA, Wiener – Kronish JP, Young WL. Miller's Anesthesia. 7th Edition. Philadelphia: Churchill Livingstone Elsevier Inc; 2010: 2089.

21. Ezri T, Warters RD et al. **The Incidence of class "Zero" Airway and the impact of Mallampati Score, Age , Sex and Body Mass Index on prediction of Laryngoscopy Grade,** Anesh Analg, 2001;93:1073-5.

Article received on: 23/02/2012 Accepted for Publication: 02/10/2012 Received after proof reading: 05/11/2012

Correspondence Address:
Dr. Ali Mirmansouri, MD
Assistant Professor of Anesthesiology
Department of Anesthesiology
Guilan University of Medical Sciences
Rash-Iran
a_mirmansoori@gums.ac.ir

Article Citation:
Farzi F, Mirmansouri A, Forghanparast K, Abdolahzade M, Shafai A. Ratio of height to sternomental distance; a comparison of common upper airway tests for predicting difficult laryngoscopy in elective surgical patients. Professional Med J Dec 2012;19(6):863-871.

"Some cause happiness
wherever they go;
others, whenever they go."

Oscar Wilde (1854-1900)