JMSCR Vol||05||Issue||02||Pages 17466-17473||February 2017

www.jmscr.igmpublication.org
Impact Factor 5.84
Index Copernicus Value: 83.27
ISSN (e)-2347-176x ISSN (p) 2455-0450
crossref DOI: https://dx.doi.org/10.18535/jmscr/v5i2.42

IGM Publication
Journal Of Medical Science And Clinical Research
An Official Publication Of IGM Publication

Original Research Article

Comparison of Methods for Prediction of Difficult Laryngoscopy and Intubation

Authors
Dr Madhuri Pramod Lonikar[1], Dr Ramesh G. Pathak[2], Dr Nazima Memon[3]
[1]Associate Professor, Dept of Anaesthesiology, Indian Institute of Medical Sciences and Research, Warudi, Badnapur, Dist. Jalna
[2]Professor & Head, [3]Assistant Professor, Department of Anaesthesiology, Dr Shankar Rao Chavan Government Medical College Nanded
Corresponding Author
Dr Madhuri Pramod Lonikar
Plot no.1, Niranjan Society, Tilaknagar, Gharkheda, Aurangabad- 431005

Abstract

Aims and Objectives

(1) To evaluate and compare various methods to predict difficult laryngoscopy and intubation and their combinations for sensitivity, specificity, Positive predictive value

(2) To observe if the combinations could attain 100% predictability.

Background: *Unexpected difficult laryngoscopy and intubation is a challenging condition for anesthesiologists, causing hazardous complications for patients including death. It is very important to anticipate such difficulty in patients with apparently normal airways. Difficult laryngoscopy is considered to be associated with difficult intubation. We conducted this study to evaluate and compare various tests to predict difficult laryngoscopy and intubation in terms of sensitivity, specificity and positive predictive value. We also compared the combinations of these tests to see if they could attain 100% predictability.*

Materials and Methods: *Patients' airways were assessed in this study using four tests. These tests included Modified Mallampati test, Wilson risk-sum, Thyro-mental distance and Mento-Hyoid distance. The study was conducted in 265 ASA Grade I and II cases. Sensitivity, specificity and positive predictive value of the individual tests and their different combinations were compared.*

Results: *80% sensitivity was seen with Modified Mallampatti test, Thyromental distance and Mento-hyoid distance when applied alone except Wilson risk-sum. Combination of Modified Mallampati test with either Thyro-mental distance or Mento-hyoid distance showed 100% Sensitivity. When Wilson risk-sum was applied with other three tests, sensitivity could not go beyond 90%. For positive predictive value, Mento-hyoid distance showed highest value but when combined with other tests, positive predictive value came down to 50%.*

Conclusion: *Modified Mallampati test is most simple bedside tests and can be easily performed even in bed ridden patients. Mento-hyoid distance is best predictor of difficult laryngoscopy in terms of sensitivity, specificity and positive predictive value. The predicting power of combination of these tests is more as compared to individual tests. Combination of Modified Mallampati with mento-hyoid distance is the best predictor among the combinations.*

Keywords: *Difficult Laryngoscopy, assessment of airway, sensitivity, specificity, positive predictive value.*

Introduction

One of the fundamental responsibilities of the anesthesiologist is to mitigate the adverse effects of anesthesia on the respiratory system by maintaining the airway patency and ensuring adequate ventilation and oxygenation.[1] During induction of anesthesia, the anesthesiologists come across the situation when the larynx is not visible at all or partially visible, and the endotracheal tube cannot be passed, one suddenly faces the challenge to give artificial ventilation and maintain the gaseous exchange. Complications like airway trauma, aspiration pneumonitis, cardiac arrhythmias, brain hypoxia and cardiac arrest can occur leading to unexpected death of the patient.[2]The incidence of difficult airway is found to be between 5% to 10%[3]. There is a continuous search to determine a highly sensitive as well as specific method to predict difficult laryngoscopy and intubation preoperatively, so that the anesthesiologists are better prepared in anticipation, subsequently reducing the incidence of complications. Unsuccessful intubation occurs when there is failure to intubate even after multiple attempts by experienced anesthesiologists. After multiple attempts at intubation the trauma to airway and laryngeal edema can occur this can cause the condition of the patient to be critical[4]. The preanesthetic assessment of the airway is important because it can predict the difficulty which can be encountered in a particular patient before the actual process of airway management has started[5]. There is a continuous search to determine effective methods for prediction of difficult laryngoscopy. The test like Malampatti test has been in use for predicting the difficult airway. But since this test takes into consideration only one aspect of airway ie intraoral disproportion hence its reliability is often questioned[5]. In fact no single test is reliable in anticipating the difficult airway. For this reason we tried to evaluate and compare four different tests in terms of indicators such as sensitivity, specificity and positive predictive value. We also compared combinations of two different tests, three tests and all the four tests to achieve 100% predictability.

Materials and Methods

After obtaining institutional ethical committee approval, the study was conduction at a tertiary care centre from June 2015 to June 2016.The study included 300 patients of either sex. The airway assessment of all patients was done by the same Anesthesiologist to avoid subjective variation in assessment of airway. Detailed clinical history and careful pre-anesthetic examination was done.

Inclusion Criteria

1) Adult patients of either sex.
2) Patients undergoing routine surgical procedures in surgery, orthopedics, Obstetrics and gynecology and ENT departments under general anesthesia.
3) Patients with ASA Grades I or II physical status.

Exclusion criteria

1) Age above 70 years.
2) Patients with severe systemic diseases.
3) Patients with pathological conditions which obviously make laryngoscopy difficult such as severe maxillary overbite, maxilla-facial airway trauma, neck tumors and abscesses etc.
4) Patients in whom surgery was planned under regional anesthesia.

Out of 300 patients, about 35 patients were excluded from the study due to the following reasons:

a) 5 patients with pathological conditions which obviously make laryngoscopy difficult such as severe maxillary overbite, maxilla-facial airway trauma, neck tumors and abscesses, requirement of cervical spine immobility, fibrosis of face and neck (burns and radiation), surgically induced deformities were excluded from the study.
b) 10 patients with cardio-vascular or respiratory systemic diseases were also excluded.

c) 20 cases were excluded from our study as they were planned under regional anesthesia. Finally, 265 patients of ASA grades I and II, 145 males and 120 females between the age group of 18 to70 years, undergoing routine surgical procedures in surgery (165), orthopedics (38), obstetrics and gynecology (27) and ENT (15) were included in our study.

Patients were explained about the purpose of our study. Informed written consent for anaesthesia and surgery was taken. The weight of each patient was recorded.

Following measurements were carried out-

A] Modified Mallampati test [MMT]- Modified Mallampati test, done by instructing the patient, to sit with head in neutral position and told to open their mouth as wide as possible and protrude their tongue, while the observer looking from the patient's eye level will inspect the pharyngeal structures with a pen torch, without the patient phonating and oropharyngeal view is graded. Class III & IV are classified as difficult intubation.

B] Thyromental distance (TMD) was recorded by using a measuring tape to measure the distance between the mentum of the mandible to thyroid notch in the mid-line with neck in full extension. It will be measured twice and average of the values taken for the sake of accuracy. A measurement of less than 6 cm is considered to be a predictor of difficult laryngoscopy and intubation.

C] Mentohyoid distance: (M-H distance)

It is the distance measured from mentum of chin to top of hyoid bone with head extended fully on the neck. If M –H is greater than 5cms, easy laryngoscopy was anticipated while difficult laryngoscopy with M –H less than 5cms.

D] Wilson's risk –sum evaluation [WRS]-

Five risk factors were evaluated according to grades of severity as 0, 1 and 2.

Total sum was counted.

Table 1: Risk factors evaluated in Wilson's risk – sum evaluation

	Risk Factor	Level	Criterion
1.	Weight	0	Less than 90 kgs
		1	90 to 110 kgs
		2	More than 110 kgs
2.	Head and Neck movements	0	Above 90º
		1	Above 90[10º]
		2	Less than 90º
3.	Jaw movement		
	(IG Inter-Incisor Gap)	0	IG ≥ 5cm. Slux ≥ 0
	(Sux- Subluxation of lower	1	IG < 5cm, Slux = 0
	jaw above Upper Jaw)	2	IG < 5cm, Slux < 0
4.	Receding Mandible	0	Normal
		1	Moderate
		2	Severe
5.	Buck teeth	0	Normal
		1	Moderate
		2	Severe

With score 0-2, easy laryngoscopy was anticipated while difficult laryngoscopy with score greater than 2.

Technique of Laryngoscopy and Endotracheal Intubation

After pre-medication and pre-oxygenation, induction of general anesthesia was done with inj.propofol 2mg/kg and Suxamethonium 2mg/kg. Laryngoscopy was performed in 'Sniffing' position by anesthesiologists with variable experience using appropriate sized McIntosh blade. Cormack and Lehane scale was used for grading of exposure of glottis.

Table 2: Lehane Scale for grading of exposure of glottis

Grade 1	**Most of the glottis is visible**
Grade 2	At best almost half of the glottis is seen, at worst only the posterior tip of the arytenoids is seen
Grade 3	Only the epiglottis is visible
Grade 4	No laryngeal structures are visible

Easy laryngoscopy: Grades I & II

Difficult laryngoscopy: Grades III & IV

The tests were compared using following criteria

A. Specificity - It is the ratio of no. of cases proved to be easy for laryngoscopy to no. of cases predicted to be easy.
B. Sensitivity - It is the ratio of no. of difficult cases detected by a test to the total no. of difficult cases.

C. Positive predictive value - It is the ratio of no. of cases proved to be difficult to the no. of predicted difficult cases by a test.

All the three indicators of the individual tests, combination of any two, three and all the four tests for their efficiency were studied.

Results

Total 265 patients of ASA grades I and II were studied. Out of these 145 (55%) were males and 120 (45%) were females with a male to female ratio of 1: 0.82.

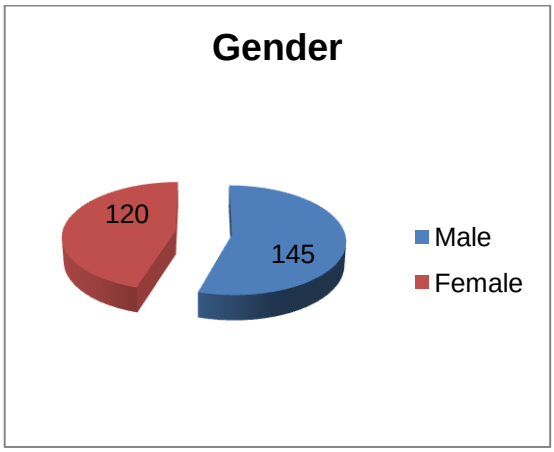

Fig 1 : Gender Distribution Of the studied cases.

The patients included those who were undergoing routine surgical procedures. Majority of the patients were from department of surgery (165) followed by orthopedics (38), obstetrics and gynecology (27) and ENT (15).

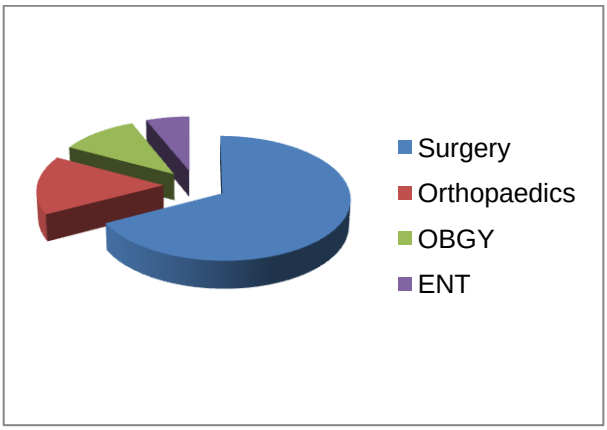

Figure 2: Department wise distribution of the studied cases.

The analysis of the studied cases and distribution of grades of laryngoscopy according to various tests revealed that according to modified malampatti test 250 patients fell into the category of easy (I and II) and 10 patients were in the category of difficult (III and IV). The number of patients in easy and difficult category were 257 and 3, 255 and 5 and finally 257 and 3 respectively for Wilson risk sum, T hyro-mental distance and Mento –hyoid distance. (Table 3).

Table 3: Distributions of grades of laryngoscopy according to different tests

Tests		Grades of Laryngoscopy		Total No.of Patients
		Easy I & II	Difficult III & IV	
A	Modified Mallampati test			
	Easy I & II	250	1	251
	Difficult III & IV	10	4	14
B	Wilson Risk Sum			
	Easy (score 0-2)	257	5	262
	Difficult (score >2)	3	0	3
C	Thyro-mental distance			
	Easy (> 6 cms)	255	1	256
	Difficult (4-6 cms)	5	4	9
D	Mento-Hyoid distance			
	Easy (>= 5 cm)	257	1	258
	Difficult (<5 cm)	3	4	7

The cases were also studied for inter-comparison of all four tests for prediction of difficult laryngoscopy. The comparison is given in table-4.

Table 4: Inter-comparison of tests for prediction of difficult Laryngoscopy

Sr. no.	Distribution of predicted difficult cases in-	According to the particular test	
1	Modified Mallampati test grades III & IV (n=14)	Wilson Risk Sum	
		Easy ≤ 2 (n=11)	Difficult >2 (n=3)
2	Modified Mallampati test grades III& IV (n=14)	Thyromental distance	
		Easy > 6cms (n=11)	Difficult ≤ 6 cms (n=3)
3	Modified Mallampati test Grades III &IV (n=14)	Mandibulo-Hyoid distance	
		Easy≥ 5 cms (n=10)	Difficult < 5 cms (n=4)
4	Thyro-mental distance≤ 6 cms (n=9)	Wilson Risk-Sum	
		Easy≤ 2 (n=7)	Difficult > 2 (n=2)
5	Thyro-mental distance ≤ 6 cm (n=9)	Mandibulo-Hyoid distance	
		Easy ≥ 5 cms (n=5)	Difficult < 5 cms (n=4)
6	Wilson –Risk Sum > 2 (n=9)	Mandibulo-Hyoid distance	
		Easy≥ 5 cms (n=6)	Difficult <5 cms (n=3)

1. Mallampati class anticipated 14 cases but falsely detected 11 cases according to WRS. Vice versa, Wilson risk sum falsely detected 7 cases out of 9, anticipated difficult according to Mallampati class.
   Impression- Therefore comparing between 2 tests, Wilson risk sum is superior to Mallampati class.
2. Comparing Mallampati class with TMD, Mallampati class falsely detected 11 out of 14 cases according to TMD. In contrast, TMD falsely detected 6 cases out of 9, according to Mallampati class.
   Impression - TMD is superior to Mallampati class.
3. Mallampati class falsely detected 10 out of 14 cases according to MHD. Conversely, MHD falsely detected 3 cases out of 7 according to Mallampati class.
   Impression - MHD is superior to Mallampati class.
4. For Wilson risk sum & Thyromental distance, both the tests detected 7 cases each according to other.
   Impression- WRS & TMD are equally powerful tests.
5. MHD falsely detected 4 cases out of 7 according to WRS. WRS falsely detected 6 out of 9 cases according to MHD.
   Impression - MHD is superior to WRS.
6. TMD falsely detected 5 out of 9 cases according to MHD. While MHD falsely detected 3 out of 7 cases according to TMD.
   Impression - MHD is superior to TMD.

Table 5: Sensitivity and Positive Predictive Value for individual tests and their combinations (MMT- Modified Mallampati test, TMD – Thyromental distance, MH – Mentohyoid distance, WRS – Wilson risk sum score, PPV- Positive predictive value)

Sr no.	Test	No. of cases predicted	No. of cases proved difficult	PPV %	No. of cases detected out of 5	Sensitivity %
1	MMT	14	4	28.6	4	80
2	WRS	9	2	22.2	2	40
3	TMD	9	4	44.4	4	80
4	MH	7	4	57.1	4	80
5	MMT+WRS	20	4	20	4	80
6	MMT+TMD	20	5	25	5	100
7	MMT+MH	16	5	31.3	5	100
8	MMT+WRS+TMD	26	5	19.2	5	100
9	MMT+WRS+MH	22	5	22.7	5	100
10	MMT+TMD+MH	22	5	22.7	5	100
11	All four tests	27	5	22.7	5	100

In our study, the incidence of difficult laryngoscopy was 1.9% and incidence of difficult intubation was 3.8%.

Sensitivity: It is the ratio if no. of difficult cases detected by a test to total no. of difficult cases. All the individual tests showed 80% sensitivity except Wilson Risk Sum (40%). Combination of any two tests was 100% sensitive except MMT + WRS (80%). All the triple combinations where 100% sensitive, also the four tests combined.

Specificity: It is the ratio of no. of cases proved to be easy for laryngoscopy to no. of cases predicted to be easy. For all the tests & their combinations, specificity ranged from 98.4% to 99.6%.

Positive predictive value: It is the ratio no. of proved difficult cases to total no. of difficult cases detected by a test.

MH Distance gave highest PPV (57%), followed by TMD (44.4%). Mallampati class (28.6%) & WRS (22.2%) were poor tests for prediction. In paired combinations, M-H Distance combined with Mallampati class or WRS had PPV of 50%. PPV declined with triple combination & combination of all the four tests.

Discussion

General anaesthesia often requires endotracheal intubation, most commonly performed via direct laryngoscopy. Difficult laryngoscopy and intubation may increase morbidity in patients and may also lead to mortality. Prediction of difficult laryngoscopy and intubation can warn the anaesthetist to be prepared for techniques and equipment to secure airway in such patients, thus reducing the incidence of complications.

The incidence of difficult laryngoscopy in our study is 1.9%, which co-relates well with 1.8% (Oates et el 1991)[6], 1.8% (Rock and Murray 1991)[7], 3.4% (Nikihu A et el 2005)[8]. From the pooled data, (Lundstrom LH et el 2011)[9] states that incidence of difficult laryngoscopy varies from 0.7% to 31.3%. Factors like experience of laryngoscopist, type and size of Laryngoscope blade, application of laryngeal pressure, variation in incidence of obesity in different populations are factors affecting the incidence. We compared the four tests, each test with reference to other test (table 5); to know that how many cases are detected or missed according to each other. In our study the following observations were inferred:

1. It was found that Modified Mallampati Test proved to be more sensitive than Wilson Risk Sum. (Thyro-mental distance.)
2. The sensitivity of Modified Mallampati Test was increased by combining with Mentohyoid distance.
3. Mento- Hyoid Distance is the best test for prediction of difficult laryngoscopy and intubation in terms of sensitivity, specificity and Positive predictive value.
4. Combination of any 3 tests did not improve specificity and positive predictive value over 2 tests, but improved sensitivity only.
5. Even on combining the four tests, there was a possibility of unpredicted difficult intubation.

Sensitivity: It is the proportion of difficult cases picked up by a test out of total difficult cases.

A) Modified Mallampati test- we found it 80% sensitive. The values are variable in other studies as 75% (Mallampati SR 1985)[10], 50% (Oates et el 1991)[6], 61.5% (Nikihu et el 2005)[8], 49% (Shiga T et el 2005)[11], and 35% (Lundstrom LH 2011).[9]

We have taken precautions to minimize factors like inter-observer variation, lack of patient co-operation, ambiguous definition of class, extreme mobility of tongue & soft palate in an ill defined wavering boundary of Oro-pharynx, although they might be responsible for uneven observations.

B) Wilson Risk Sum – Our study showed sensitivity as 40%, which correlates well with 75% (Wilson et el) [12], 40% Oates et al [6] & 46% Shiga T et el[11]. According to Shiga T et el, Wilson Risk Sum yielded a low true positive rate and a low false positive rate meaning that the test correctly indentifies patients with easy laryngoscopy. Subjective assessment of factors like receding mandible & buck teeth can give variable results.

C) Thyro Mental Distance – In our study, sensitivity was 80%, which goes well with 90.9% by Frerk et al[13]. Shiga T et el found it 20% sensitive[11], Nikihu et el found it as only 15% sensitive[8]. This difference may be due to the fact that TMD doesn't take cognizance of factors like size of tongue relative to Oro-pharynx & neck mobility.

D) Mento Hyoid Distance - Sensitivity in our study was 80% similar to Thyro Mental Distance.

E) Combination of Modified Mallampati Test with Thyro Mental Distance – Showed sensitivity 75% (Frerk et el)[13] and 76.9% (Nikihu et el[8], 100% in present study. It proved as the best combination for prediction amongst all.

F) Combination of MMT + TMD + Extension at Atlanto Occipital Joint was 100%. Sensitive according to Deller et el (1990)[14] & Bellhouse C P (1988)[15]. Our study showed 100% sensitivity with any triple combinations.

Positive Predictive Value (PPV):

The PPV of Mallampati class is given as 5.7% [Mallampati et el 1985][10], 10% [Oates et el[6]], 17.3% [Frerk et el 1991][13]. The variation in the

observations might be due to the same factors as affecting sensitivity.

The PPV of Wilson risk-sum is given as 8% [Wilson et el][12], 13% [Oates et el][6], and 22.2% in present study. Lack of overweight patients according to western standards might be the cause of high PPV in our study. The PPV of Thyro-mental distance is given as 18.9% by Frerk et el[13]. We have found it as44.4%. Anterior larynx was the commonest cause of difficult laryngoscopy in our study. Paired and triple combinations of the tests showed lower values of PPV.As the causes detected by any two tests were not overlapping, their combination added to number of false positive cases.

Highest PPV was shown by Thyro-mental distance [44.4%] and Mento-hyoid distance [57.1%]. Combination of Mento-Hyoid distance with either Mallampati class or Wilson risk-sum showed PPV of 50%, hence it is recommended over individual tests as well as triple combinations to keep false positive cases to a minimum. Combination of Mallampati class with Thyro-mental distance yielded low sensitivity but had highest discriminative power amongst the currently available tests.

Conclusion

The incidence of difficult laryngoscopy in our study was 1.9% .We observed that Mento-hyoid distance showed highest sensitivity and Positive predictive value (PPV). Modified Mallampati test combined with Mento-hyoid distance showed maximum sensitivity and PPV. Triple combinations improved sensitivity but not the PPV.MMT + WRS + TMD combination was found 90% sensitive. All the four tests combined could not predict 100% cases.

Acknowledgements

We express our deep sense of gratitude to the Management, JIIU Trust and Dr. Amarnath B. Solepure, Dean, IIMSR Medical College, Badnapur, Jalna, Maharashtra. We also deeply acknowledge the help and support of Dr. Sudhir Bhople, Prof. & Head, Dept. of Anaesthesia and Dr. A. M. Khadri, Medical Superintendent, Noor Hospital, Badnapur and my patients.

References

1. Miller's Anesthesia 8th edition Saunders 2015 Volume I page -1647—48.
2. Akinyemi O.O. Midline neck landmarks and difficult laryngoscopy Indian journal of Anesthesia 1980;28:231-234
3. Crosby ET, Cooper RM, Douglas MJ, Doyle DJ, Hung OR, Labrecque P, Muir H, Murphy MF, Preston RP, Rose DK, Roy LCan The unanticipated difficult airway with recommendations for manage-ment The unanticipated difficult airway with recommendations for management.J Anaesth. 1998 Aug; 45(8):757-76.
4. Rich JM, Mason AM, Ramsay MA , AANA journal course: update for nurse anesthetists. The SLAM Emergency Airway Flowchart: a new guide for advanced airway practitioners. J. 2004 Dec; 72(6):431-9.
5. Karkouti K, Rose DK, Ferris LE, Wigglesworth DF, Meisami-Fard T, Lee H Can Inter-observer reliability of ten tests used for predicting difficult tracheal intub-ation. J Anaesth. 1996 Jun; 43(6):554-9.
6. Oates J.D.L. , McLeod A.D., Oates P.D., Pearshall F.J., Howie J.C., Murray G.D. Comparison of two methods of predicting difficult intubation. British Journal of Anesthesia,1991;66:305-09.
7. Rocke D.A., Murray W.B.,Rout C.C.,Gouws E. Relative risk analysis of factors associated with difficult intubation in obstretic Anesthesia. Anesthesiology 1992;77:67-73.
8. Nikihu A. Merah, David T. Wong, Dorothy J. Ffoukes-Crabbe, Olusula T.Kushimo, Christopher O.Bode Modified Mallampati test, Thyro-mental distance and Inter-incisor gap are the best predict-ors of difficult laryngoscopy in West-

Africans Canadian Journal of Anesthesia 2005/52:3/p 291-296.

9. Lundstrom L.H., M. Vester-anderson, A.M. Moller, S.Charuluxananan, J.L. Hermita and j. Wetterslev The Danish Anesthesia Database Poor prognostic value of the Modified Mallampati Score: A meta-analysis Involving 177088 patients British Journal of Anesthesia 2011;107 (5):659-67.
10. Mallampati S. Rao, Gatt S.P., Gugino L.D., Desai S.P., Waraska B., Freiberger D., Liu P.L. A clinical sign to predict difficult tracheal intubation,A prospective study. Canadian Anesthetist's Society Journal 1985;32:429-34.
11. Toshiya Shiga, Zen'ichiro Wajima,Tetsuo Inoue, Atsuhiro Sakamoto Predicting difficult intubation in apparently normal patients. Anesthesiolody 2005;103:429-437.
12. Wilson M.E., Spiegelhalter D., Robertson J.A., Lesser P. Predicting difficult intubation British Journal of Anesehesia 1988;61:211-16.
13. Frerk C.M. Predicting difficult intubation Anesthesia 1991;46:1005-08.
14. Deller A.,Schreiber M.V.,Cramer J., Annefeld F.W. Difficult intubation: Incidence and Predictability A prospective study of 8284 adult patients Anesthesiology 1986;73(3):1053
15. Bellhouse C.P., Dore C. Criteria for estimating the likelihood of difficult endotracheal intubation with the McIntosh laryngoscope. Anesthesia and Intensive care, 1988;16:329-337.