Journal of Clinical Anesthesia 37 (2017) 99–102

Contents lists available at ScienceDirect

Journal of Clinical Anesthesia

Original contribution

Determination of the diagnostic value of the Modified Mallampati Score, Upper Lip Bite Test and Facial Angle in predicting difficult intubation: A prospective descriptive study

Ata Mahmoodpoor [a], Hassan Soleimanpour [b,*], Samad EJ Golzari [c], Arezoo Nejabatian [d], Tannaz Pourlak [e], Masoumeh Amani [e], Saeed Hajmohammadi [e], Hamzeh Hosseinzadeh [b], Robab Mehdizadeh Esfanjani [f]

[a] Anesthesiology Research Team, Department of Anesthesiology, Tabriz University of Medical Sciences, Tabriz, Iran
[b] Cardiovascular Research Center, Tabriz University of Medical Sciences, Tabriz, Iran.
[c] Medical Philosophy and History Research Center, Tabriz University of Medical Sciences, Tabriz, Iran
[d] Students' Research Committee, Tabriz University of Medical Sciences, Tabriz, Iran
[e] Department of Oral & Maxillofacial Surgery, Faculty of Dentistry, Tabriz University of Medical Sciences, Tabriz, Iran
[f] Neurosciences Research Center, Tabriz University of Medical Sciences, Tabriz 51664, Iran.

ARTICLE INFO

Article history:
Received 14 March 2016
Received in revised form 5 November 2016
Accepted 12 December 2016
Available online xxxx

Keywords:
Difficult intubation
Modified Mallampati Score
Upper Lip Bite Test
Facial Angle

ABSTRACT

Background: Difficult intubation is a significant cause of mortality and morbidity related to anesthesia. We decided to evaluate the value of Modified Mallampati Score, Upper Lip Bite Test and Facial Angle in the prediction of difficult intubation.
Methods: In a prospective descriptive study, data from 132 patients who were candidates for elective maxillofacial surgeries under general anesthesia were gathered. Facial Angles were measured by a maxillofacial surgeon according to cephalometry. The Modified Mallampati Score and Upper Lip Bite Test were first measured by an anesthesiologist and then another anesthesiologist was assigned to record the Cormack and Lehane score during the intubation. Grades 3 and 4 were considered as difficult intubation. Sensitivity, specificity, positive predictive value, negative predictive value and Youden index were calculated for all tests.
Results: Difficult intubation was reported in 12% of the patients. Facial Angle ≤ 82.5° can predict difficult intubation with 87.5% sensitivity and 88.8% specificity. Among the three tests, a high Modified Mallampati Score had the highest specificity (94.5%) and a high Modified Mallampati Score and Facial Angle (FA ≤ 82.5°) had the highest sensitivity (87.5%). The highest NPV, sensitivity and Youden index were observed when using Facial Angle with the Modified Mallampati Score or with Upper Lip Bite Test.
Conclusions: Facial Angle has a high sensitivity, NPV and Youden index for the prediction of difficult intubation, but the best result is achieved when Facial Angle is used in combination with either the Modified Mallampati Score or Upper Lip Bit Test.

1. Introduction

A no ventilate-no intubate scenario is one of the most dreadful situations that could be encountered by an anesthesiologist. Difficult intubation (DI) still remains as one of the anesthesia-related mortality and morbidity contributors. Although most intubations are easy, DI might be faced in 1.5–13% of the general anesthesia cases which could be associated with serious morbidities and mortality [1–5]. Numerous methods have been introduced to overcome DI; yet, no standard test has been proposed to evaluate and predict DI [3–5]. Nevertheless, some methods are routinely used by anesthesiologists as follows: Upper Lip Bite Test (ULBT), Modified Mallampati Score (MMS), Hyomental distance, Thyromental distance, Neck movement, Body mass index (BMI), Palm print, Head extension, Jaw protrusion, Wilson Score, and Lemon method [3,6,7].

Most researchers believe that no single test is able to predict DI and a combination of these tests rather than a single test should be used [8,9]. Anatomical evaluation of the airway includes the visible (e.g. mouth, teeth, tongue and neck) and invisible (e.g. tongue base, larynx and epiglottis) parts. One of the contributing factors to DI is the Facial Angle (FA); its being less or more than the usual degrees would lead to backward or inward displacement of the jaw which in turn would cause DI. Consequently, to improve the quality of the airway evaluation, all above-mentioned factors ought to be considered simultaneously. In

Abbreviation: DI, difficult intubation; ULBT, Upper Lip Bite Test; MMS, Modified Mallampati Score; FA, Facial Angle.

* *Corresponding author.
E-mail address: soleimanpourh@tbzmed.ac.ir (H. Soleimanpour).

http://dx.doi.org/10.1016/j.jclinane.2016.12.010
0952-8180/

this study, we aimed to answer the question of whether measuring the FA would be optimum for the prediction of DI. Mallampati Score and ULBT were measured in all subjects.

2. Methods

After the approval of the study by the Ethics Committee of Tabriz University of Medical Sciences (date: 2012/6/5, President of Ethics Committee, Dr. Ostadrahimi, Protocol Number: 91107), 132 patients scheduled to undergo elective maxillofacial surgeries under general anesthesia were included in this study from 2012 June till 2013 July. Sample size was calculated based on the following formula: $n = p(1-p)z^2/d^2$. ($z = 1.96$, $p = 9\%$ according to the previous studies with absolute error of 5%). Participants received information on the survey through a typed letter. Written informed consent was obtained by the corresponding author of this article (HS).

Inclusion criteria were all 18–50 year-old patients scheduled to undergo elective maxillofacial surgeries under general anesthesia with oral intubation. Exclusion criteria consisted of unwillingness of the patient to participate, subjects with limited mouth opening, edentulous patients, subjects with limited movement in their temporomandibular joints (TMJ), with dental abnormalities, with long mustache or beard and with large tongue. One day prior to the surgery, patients were visited by an anesthesiologist in the preoperative clinic. ULBT and Modified Mallampati Test were performed for all subjects by the anesthesiologist and the obtained data were registered in the allocated forms. In order to evaluate the range of motion for the TMJ and the dental structure of the patients, ULBT was used based on the following classifications: Class I: lower teeth can cover the mucosa of the upper lip; Class II: lower teeth can partially cover the mucosa of the upper lip; and Class III: lower teeth cannot cover the mucosa of the upper lip [10]. The Modified Mallampati Test was performed while the subject was sitting on a chair. Later, the patient was asked to open his/her mouth as much as possible without producing any noise. Based on the pharyngeal view, patients were classified in groups 0–4 [10].

FA was determined by a maxillofacial surgeon using cephalometry X ray and was registered in the forms. FA is the angle made by two anatomic lines (i.e. Frankfurt horizontal and facial planes). The Frankfurt horizontal plane is a line which crosses the inferior border of the bony orbit and the superior border of the external auditory meatus. The facial plane or nasion-pogonion line attaches the connection site of the upper section of the nasal bone and frontal border to the most anterior part of the mentum. The normal range for this angle is 90 ± 3 [11] (Fig. 1). All data related to the subjects including the type of the surgery, age, sex, weight, height, BMI, and facial trauma were recorded. Later, the subjects were visited by the second anesthesiologist who was blinded to the previously performed tests on the day of the surgery. The second anesthesiologist performed laryngoscopy and determined the Cormack and Lehane grade for each subject [12]. Premedication of the subjects was performed using midazolam 0.02 mg/kg and Fentanyl 1 μg/kg. Anesthesia induction was performed using propofol 1–1.5 mg/kg and atracurium 0.5 mg/kg. Intubation was performed after adequate hypnosis and muscle relaxation was achieved. Whenever there was uncertainty about the relaxation, train of four (TOF) ratio was measured using a peripheral nerve stimulator. Accordingly, at TOF ratio of zero, laryngoscopy and intubation were performed by the anesthesiologist assigned to the case using a Macintosh No. 3 blade while the patient's head was placed in the "sniffing" position. Patients with Cormack and Lehane grade of I or II were considered as easy intubation and those with Cormack and Lehane grade of III or IV were considered as DI. The anesthesiologist who performed the test was a single person to decrease the inter-observer variation. All collected data were analyzed using SPSS for windows version 15 (SPSS Inc., Chicago, IL, USA). To analyze the data diagnostic value, determination tests (sensitivity, specificity and positive and negative predictive values) and ROC curves to determine cutoff point for FA were used. P value ≤ 0.05 was considered statistically significant.

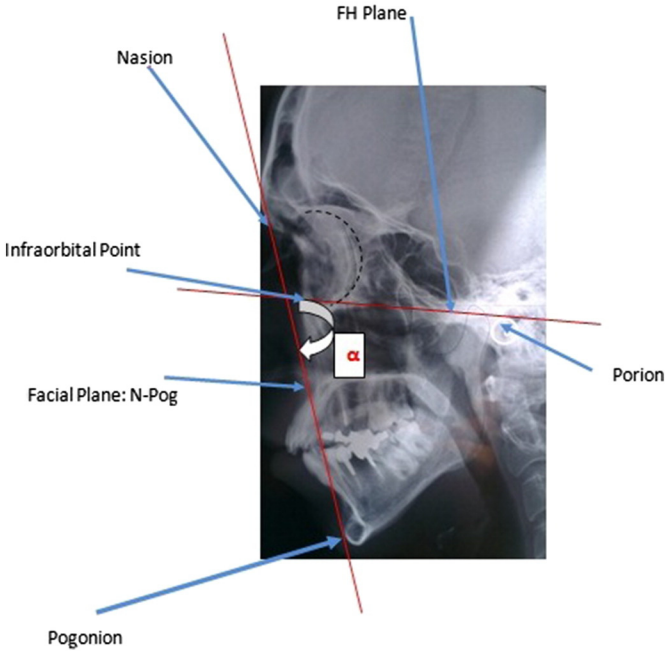

Fig. 1. Skeletal reference plans regarding Facial Angle: α: facial angle, FH plane: Frankfurt horizontal plane (as portion to infraorbital points), facial plane: N-Pog (nasion-pogonion).

3. Results

Of the studied subjects, 16 people (12%) were considered as DI based on the Cormack and Lehane grading system. We managed this problem with inserting LMA or using fiberoptic bronchoscope or the method which was explained by Parish et al. [5] in their study. There is no significant statistical relationship between the demographic findings (age and BMI) and DI but the intubation time and Facial Angle were relevant to DI (Table 1). Sensitivity and specificity of a high Modified Mallampati Score (Classes III and IV) in predicting DI were 87.5% and 94.5%, respectively (PPV = 70, NPV = 98.5). Sensitivity and specificity of high ULBT (Classes II and III) were 81.3% and 89.7%, respectively (PPV = 52, NPV = 97.2) and the FA had the sensitivity and specificity of 87.5% and 88.8% (PPV = 52, NPV = 98.5) (Table 2). The area for ROC was 0.963 and $p \leq 0.0001$. The most appropriate cutoff angle was ≤82.5° which could predict DI with a sensitivity and specificity of 87.5% and 88.8%, respectively (Fig. 2).

4. Discussion

The ability to evaluate and manage the airway has always been a major concern for physicians [2]. Based on the data obtained from our study, patients with an FA of <82.5° will probably face DI with a sensitivity of 87.5% and patients with an FA of higher than 82.5° will probably face easy intubation with a specificity of 88.8%. ULBT with a sensitivity

Table 1
Patient's demographic data and their risk factors for difficult intubation based on Cormack and Lehane views (EI = easy intubation, DI = difficult intubation).

Parameters	EI	DI	*P* value
Age (year)	26.8(±7.06)	26.3(±8.07)	0.78
BMI	24.0(±3.91)	24.7(±3.53)	0.48
Facial Angle	86.6(±3.72)	78.5(±2.89)	0.000
Intubation time (seconds)	11.2(±4.52)	21.8(±12.6)	0.011

Table 2
Sensitivity, specificity, positive and negative predictive value and Youden index of the tests in the determination of difficult intubation (ULBT: Upper Lip Bite Test, MMS: Modified Mallampati Score, FA: Facial Angle).

Airway assessment tests	Sensitivity %	Specificity %	PPV %	NPV %	Positive likelihood ratio	Youden index
MMS	87.5	94.5	70	98.5	16.83	63.3
ULBT	81.3	89.7	52	97.2	7.89	71
FA	87.5	88.8	52	98.5	7.81	76.3
FA + MMS	93.8	88.8	53.6	99	7.27	80.9
FA + ULBT	93.8	88.8	53.6	99	7.27	80.9
MMS Score + ULBT	87.5	88.8	52	98.1	7.81	76.3
FA + MMS + ULBT	93.8	84.5	45.5	99	6.05	78.3

and specificity of 81.3% and 89.7%, respectively (PPV = 52, NPV = 97.2) and Mallampati with a sensitivity and specificity of 87.5% and 94.5%, respectively (PPV = 70, NPV = 98.5) could predict DI; this finding was in line with the findings of previous studies. In 2008, Allahyari et al. compared ULBT, Horizontal Length of the Mandible (HLM), Interincisor Gap (IIG), Sternomental Distance (SMD), Thyreomental Distance (TMD), and Modified Mallampati Test (MMT) in the evaluation of females scheduled to undergo cesarean section. Accordingly, ULBT is a valuable test in predicting DI and also the combination of ULBT and MMT is a superior approach for the evaluation of the airway [6].

Cerosby and colleagues suggested that the main reason hindering the proper evaluation of the airway is the different evaluation tools or techniques used by the evaluators [3]. Reed et al. proposed that large cutting teeth and limited mouth opening and backward displacement of the mandible increase the probability of DI [13]. Furthermore, upper abnormal teeth, Mallampati Score of 3 or 4 and problems in TMJ are of limited predictive value for DI [14]; limited tongue movement and decreased hyomental distance have also been introduced as predictive factors of DI. ULBT is a simple method for the evaluation of DI which was introduced in 2003. Accordingly, the more one is able to bite by cutting teeth on the upper lip, the less the probability there would be of DI [10,15]. Numerous methods with a combination of clinical findings, e.g. The Naguib Method and Wilson Method, have been proposed for the prediction of DI, each having their own sensitivity and specificity. The Naguib Method uses a combination of TMD, MMT, IIG (inter-incisor gap) and height; it has a sensitivity and specificity of 82.5% and 85.6%, respectively in the prediction of DI [16]. Norico Suzuki et al. evaluated the relation between different craniofacial types and DI. Accordingly, anteroposterior and lateral digital X rays in non-obese individuals were used. Consequently, the authors concluded that submandibular angle, among other craniofacial factors, is a major independent factor for the prediction of DI. The mandibular angle is directly and indirectly related to MMT and TMD, respectively. A mandibular angle of 83 and 81.5° were measured for males and females, respectively [17]; these findings are in line with our study. In a study by Naguib et al., radiologic bone (lateral X-ray) and soft tissue (CT scan) findings were added to the other clinical findings (TMD, neck circumference, and MMT). Radiologic findings including depth of C2 spine and angle A had a PPV of 95.8% compared to other clinical findings alone (PPV of 87.5%) [18]. Rose et al. used individual characteristics (sex, age and BMI) and four clinical airway findings (TMD, MTT, and decreased mouth opening and head extension) in order to predict DI [19]. In another study performed by Tremblay et al., a direct relation between DI and higher scores of Cormack & Lehane, higher scores of ULBT and also decreased Sternothyroid distance was discovered [20]. In one study by Khan et al., the predictive value of ULBT in difficult intubation was determined (sensitivity = 81%, specifity = 91%, PPV = 37%, NPV = 98%). They also had done multiple measurements on the lateral neck radiograph [thyromental, thyrosternal and sternomental distances and mandibular angle (the angle constructed from intersecting the lower border of the mandible line and a perpendicular line)] [21]. In another study by Khan et al., the combination of ULBT with sternomental distance had the highest sensitivity and the combination with thyromental distance the highest specificity in predicting DI [22]. The role of ULBT in predicting the difficult Bag Mask Ventilation was determined in another study by this group [23]. In a meta-analysis performed on 35 studies (50,760 subjects), it was demonstrated that no single bedside test can be of abundant sensitivity and specificity to predict DI and the most appropriate test to predict DI was a combination of TMD and MMT [9]. In an attempt to find a simple approach for the prediction of DI, Kamath et al. used lateral mandible graphs and TMD. The authors suggested that a TMD of <4.5 cm is a predictor of DI [21]. Mahmoodpoor et al. compared MMS, palm print score and 3-2-2 rule and suggested that palm print score is of high specificity for the prediction of DI; however, the most appropriate approach is to use the combination of the three methods [24]. Limited tongue movement and decreased hyomental distance have also been introduced as predictive factors of DI [25,26]. Considering the obtained results from previous studies and ours, it could be concluded that backward movement of the mandible and decrease in mandibular angle would lead to decreased TMD which in turn would contribute to DI.

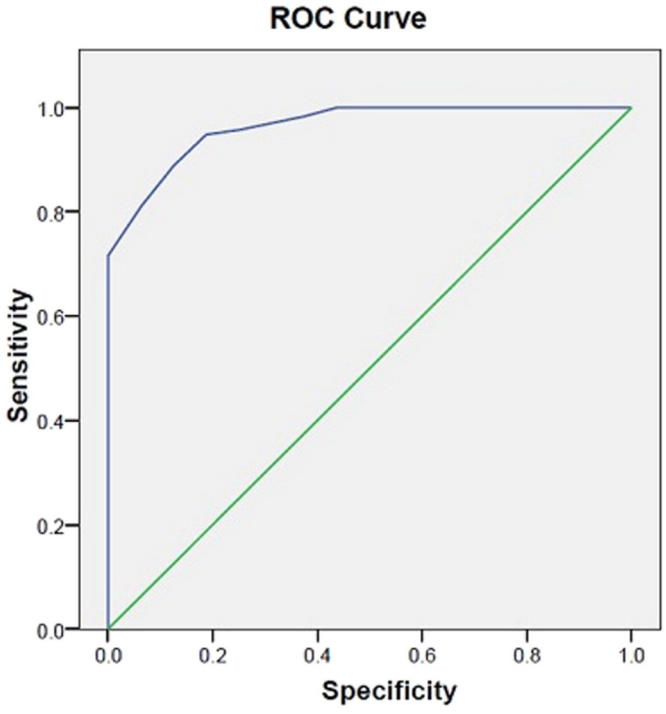

Fig. 2. ROC curve of Facial Angle for predicting difficult intubation.

Our study has some limitations. This was a single center study which evaluated the FA in elective patients with a strict protocol for exclusion criteria. In this study we didn't evaluate the combined effect of FA with other tests like MMS, TMD, and 3-3-2 rule as this method could increase the sensitivity of DI prediction.

5. Conclusion

Considering the fact that using tests with low sensitivity for the prediction of DI could lead to missing some cases, it seems that we could use FA for the prediction of DI, thanks to its high sensitivity. Since our study is the first to introduce this test, it could be considered a novelty in the field of maxillofacial surgery airway management. Nevertheless, further studies with a larger sample size on heterogenous patients focusing on the predictive value of FA in the prediction of DI are required before considering it as a routine screening test.

Competing interests

The author(s) declare that they have no competing interests.

Authors' contributions

Hassan Soleimanpour, Ata Mahmoodpoor and Samad EJ Golzar drafted the manuscript. Arezoo Nejabatian, Tannaz Pourlak, Masoumeh Amani, Saeed Hajmohammadi, Hamzeh Hosseinzadeh and Robab Mehdizadeh Esfanjani designed the study and performed statistical analysis. All of the authors were involved in patient management or the writing of the manuscript. All the authors read and approved the final manuscript.

Acknowledgments

The authors are grateful to all the health staff and patients who participated in the study, in addition to the staff of the *Imam* Reza Hospital. This article is based on a dataset forming part of Arezoo Nejabatian's specialty thesis, entitled “Determining of sensitivity of Facial angle, Modified Mallampati Score and Upper Lip Bite Test in prediction of difficult airway”. It is registered at Tabriz University of Medical Sciences (No: 92/3-3/2) and was presented in June 2015.

References

[1] Barak M, Philipchuck P, Abecassis P, Katz Y. A comparison of the Truview blade with the Macintosh blade in adult patients. Anesthesia 2007;62:827–83.
[2] Soleimanpour H, Gholipouri C, Panahi JR, Afhami MR, Ghafouri RR, Golzari SE, et al. Role of anesthesiology curriculum in improving bag-mask ventilation and intubation success rates of emergency medicine residents: a prospective descriptive study. BMC Emerg Med 2011;11:8.
[3] Cerosby ET, Cooper RM, Douglas MJ. The unanticipated difficult airway with recommendation for management. Can J Anaesth 1998;45:757–76.
[4] Soleimanpour H, Panahi JR, Mahmoodpoor A, Ghafouri RR. Digital intubation training in residency program as an alternative method in airway management. Pak J Med Sci 2011;27:401–4.
[5] Parish M, Panahi JR, Afhami MR, Mahmoodpoor A. Role for the second anesthesiologist in failed intubations. Anesth Analg 2006 Mar;102(3):971.
[6] Allahyari E, Ghaemei SR, Azemati S. Comparison of six methods for predicting difficult intubation in obstetric patients. Iran Red Crescent Med J 2008;10(3):197–204.
[7] Hussain Khan Z, Mohammadi M, Rasouli MR, Farrokhnia F, Hussain KR. The diagnostic value of the upper lip bite test combined with sternomental distance, thyromental distance, and interincisor distance for prediction of easy laryngoscopy and intubation: a prospective study. Anesth Analg 2009;109:822–4.
[8] Gupta S, Sharma KR, Jain D. Airway assessment: predictors of difficult airway. Indian J Anaesth 2005;49(4):257–62.
[9] Shiga T, Wajima Z, Inoue T, Sakamoto A. Predicting difficult intubation in apparently normal patients: a meta-analysis of bedside screening test performance. Anesthesiology 2005 Aug;103(2):429–37.
[10] Hester CE, Dietrich SA, White SW, Secrest JA, Lindgren KR, Smith T. A comparison of preoperative airway assessment techniques: the modified Mallampati and the upper lip bite test. AANA J 2007;75:177–82.
[11] FONSECA. Oral & maxillofacial trauma. Walker Powers. Forth ed. Barber Frost; 2013.
[12] Cormack RS, Lehane J. Difficult tracheal intubation in obstetrics. Anaesthesia 1984; 39:1105–11.
[13] Reed MJ, Dunn MJ, McKeown DW. Can an airway assessment score predict difficulty at intubation in the emergency department? Emerg Med J 2005;22:99–102.
[14] Lee A, Fan TYL, Gin T, Karmakar MK, Ngan Kee WD. A systematic review of the accuracy of Mallampati test to predict the difficult airway. Anesth Analg 2006;102: 1867–78.
[15] Mishra S, Bhat R, S K, Nagappa M, Badhe A. Comparison of upper lip bite test with modified Mallampati classification for prediction of difficult obstetric intubation. Internet J Anesthesiol 2008;19:1.
[16] Naquib M, Scamman FL, O'Sullivan C, Aker J, Ross AF, Kosmach S, et al. Predictive performance of three multivariate difficult tracheal intubation models. Anesth Analg 2006 Mar;102(3):818–24.
[17] Noriko Suzuki MD. Sub mandible angle in nonobese patients with difficult tracheal intubation. Anesthesiology 2007;106:916–23.
[18] Naguib M, Malabarey T, AlSatli RA, Al Damegh S, Samarkandi AH. Predictive models for difficult laryngoscopy and intubation. A clinical, radiologic and three-dimensional computer imaging study. Can J Anaesth 1999 Aug;46(8) (748–59).
[19] Rose DK, Cohen MM. The airway: problems and predictions in 18,500 patients. Can J Anaesth 1994 May;41(5 Pt 1):372–83.
[20] Tremblay MH, Williams S, Robitaille A, Drolet P. Poor visualization during direct laryngoscopy and high upper lip bite test score are predictors of difficult intubation with the GlideScope videolaryngoscope. Anesth Analg 2008 May;106(5):1495–500.
[21] Kamath SK, Randive SB, Bhatt MM. Difficult intubation—when can we predict it? J Postgrad Med 1991;37(1) (40–38).
[22] Khan ZH, Maleki A, Makarem J, Mohammadi M, Khan RH, Zandieh A. A comparison of the upper lip bite test with hyomental/thyrosternal distances and mandible length in predicting difficulty in intubation: a prospective study. Indian J Anaesth 2011 Jan;55(1):43–6.
[23] Khan ZH, Mofrad MK, Arbabi S, Javid MJ, Makarem J. Upper lip bite test as a predictor of difficult mask ventilation: a prospective study. Middle East J Anaesthesiol 2009 Oct;20(3):377–82.
[24] Mahmoodpoor A, Soleimanpour H, Nia KS, Panahi JR, Afhami M, Golzari SE, et al. Sensitivity of Palm Print, Modified Mallampati Score and 3-3-2 rule in prediction of difficult intubation. Int J Prev Med 2013;4:1063–9.
[25] Huh J, Shin HY, Kim SH, Yoon TK, Kim KD. Diagnostic predictor of the difficult laryngoscope: the hyomental distance ratio. Anesth Analg 2009;108:544.
[26] Khan ZH, Mohammadi M, Rasouli MR, Farrokhnia F, Khan RH. The diagnostic value of the upper lip bite test combined with sternomental distance, thyromental distance, and interincisor distance for prediction of easy laryngoscopy and intubation: a prospective study. Anesth Analg 2009 Sep;109(3):822–4.