RESEARCH

23(97), May - June, 2019

ISSN 2321–7359
EISSN 2321–7367

Medical Science

Predictive value of maxillopharyngeal angle to other multivariate airway assessment tests for difficult intubation in patients undergoing general anesthesia in Iranian population

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***Background*: Differences in patient characteristics due to race or ethnicity may influence the incidence of difficult airway. Unexpected difficulties in endotracheal intubation can be a significant etiologic factor in morbidity and mortality in clinical practice. The aim of this study was to evaluate the ability of maxillopharyngeal angle (MPA) to predict difficult airway. *Methods*: In this prospective, single, observational and anthropometrical study, we collected data on 213 consecutive patients scheduled for elective surgery under general anesthesia requiring endotracheal intubation and then evaluated all for factors before surgery. *Results*: In this study, 213 patients (119 males and 94 females) with mean age of 44.319±13.52 (25 to 70) years were investigated. Based on Cormack and Lehane (C&L) grading, the highest sensitivity and specificity were 51.9% and 48.1% for 98.25, respectively. According to Mallampati test (MMT), the highest sensitivity and specificity were 49.6% and 50.4% for 98.25, respectively. The high positive predictive value was observed in MPA based on C&L and MMT grading (92.98 and 71.92, respectively). *Conclusion*: Based on the findings, of present study, the PPV was great for MPA test to predict the difficult airway and it was noticed to use this test to predict the airway difficulty along with established methods to in patient undergoing general anesthesia.**

INTRODUCTION

Endotracheal intubation difficulties as a major concern for an anesthesiologist may be a significant etiologic factor in mortality and morbidity in clinical practice due to sympathetic stimulation that can result in tachycardia and hypertension (1, 2). So, in patients with apparently normal airway, the airway management in order to predict a difficult airway is essential factor. The importance of identifying risk of difficult tracheal intubation (DTI) is obvious and it has been shown that 85% of all errors regarding airway management lead to permanent cerebral damage (3) and the management of difficult airway was the reason of more than 30% of all anesthetic (4, 5). The concomitant factors may be separated into factors linked with anesthesia and characteristics factors in patients associated with the general populations (6).

According to the literature, DTI has been described for 1/5 -13% of patients undergoing general anesthesia (7). To direct observation of mouth to the glottis opening, the aligning the oral, pharyngeal and laryngeal axis is beneficial. Difficult laryngoscopy, pain and some degree of extension at the upper cervical and flexion at the lower cervical spine, are synonymous with DTI in most cases. Therefore variances in patient features due to race or ethnicity may affect the incidence of difficult airway (8).

Some methods with accurate markers have been developed to predict potential DTI, even before laryngoscopy, but they showed limited success (2). Among the available methods, the Mallampati and related modified tests as a pre-operative bedside test are carried out to predict a difficult airway (6, 9, 10, 25). The original Mallampati test (MMT) with a high degree of accuracy to identify DTI was reported with specificity of 100% and sensitivity of 50% (6, 11). Moreover, difficult laryngoscopy has been diagnosed by Cormack and Lehane (C&L) grading (III and IV) in 80% of studies which was dependent on inability to see the glottis structure in the standard intubation position (12). Moreover, as an earnest attempt, numerous researches have combined the physical factors to predict DTI through multifactorial index (13, 14). The newer airway assessment tests such as maxillopharyngeal angle (MPA) has been introduced to better understanding the pathophysiology of difficult laryngoscopy (14). The more than 100° angle has been considered as normal value and less than 90° proposed as a difficult direct laryngoscopy (15). In a prospective and observational study, we tried to evaluate the accuracy of the MPA in

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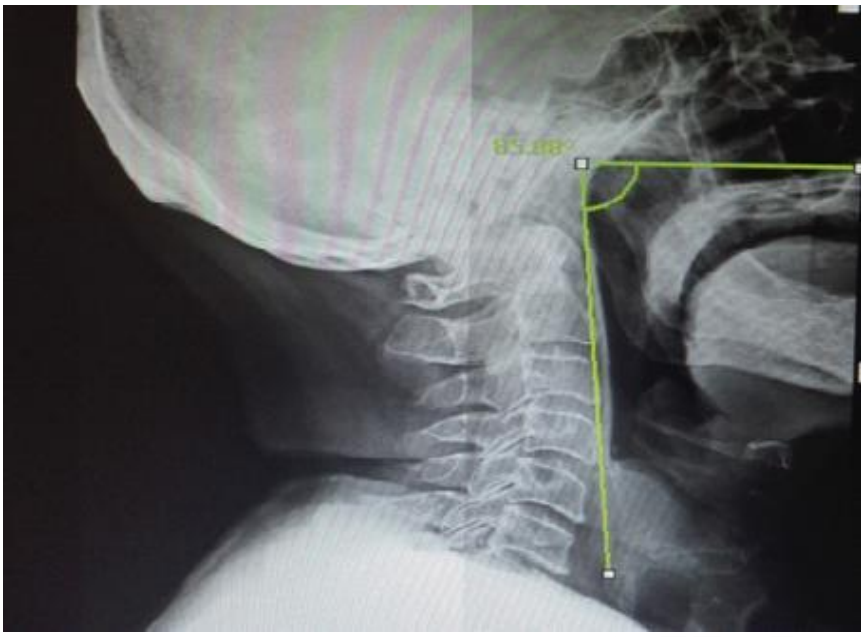

Figure 1 Maxilla pharyngeal angle assessment

predicting DTI in patients undergoing general anesthesia. According to previous studies, the sample size was 220. Due to disruptive factors, some patients were excluded from the study and the number of samples decreased to 213 people. On the other hand, such a study has not been reported in the Iranian population so far, and measuring this angle in the pre-anesthetic examination can be helpful in rescuing patients.

METHODS

After taking the informed consent of patients, this observational study was carried out on 213 consecutive ASA I-III adult patients with 25-70 years age scheduled for elective surgeries under general anesthesia requiring endotracheal intubation in Rasoul Akram Medical Complex, affiliated to Iran University of medical sciences in Iran. Anesthesia was induced with 4mg/kg of sodium thiopental intra venous (IV) by a single anesthesiologist and to facilitate endotracheal intubation. Atracurium 0/6 mg/kg IV was administered. A mask with 100% oxygen was used to lungs ventilation.

Exclusion criterion

Exclusion criteria included history of trauma or burn to the airway, craniofacial deformities, mass or tumors in facial, cervical and laryngeal regions, difficulty in mobility of the neck and mandible due to rheumatoid arthritis or cervical disk disorders, not ability to sit and restricted mouth opening function of the temporalmandibular joint, malocclusion class I& II& III, pregnancy, thick and muscular neck. A check list was designed to collect data including sex, age, weight, height, and body mass index (BMI) and clinical data (C&L, MMT and MPA).

Preoperative assessment of the airway

The following predictive tests were done in all patients:

Cormack and Lehane (C&L) grading: C&L grading was noted for each patients under general anesthesia during direct laryngoscopy (12). The view was classified as, *Grade I***:** Full view of vocal cord, *Grade II***:** Only posterior extremity of glottis or arytenoid cartilage observed, *Grade III:* Only epiglottis observed, *Grade IV***:** None of the structures (glottis or epiglottis) observed. Easy visualization was related to grade I and II and difficult one was related to grade III and IV on direct laryngoscopy. The case needed external laryngeal pressure during the intubation was excluded from the study

MMT: It was evaluated based on modified MMT described by Samson and Youngs (9) for all patients while patient seated and the head was in natural position. The visible oral cavity structures were observed upon maximal mouth opening without phonation. MMT was classified as: *Class I:* the soft palate, fauces, uvula and pillars visible, *Class II:* soft palate, fauces and uvula observed, *Class III:* Soft palate and base of the uvula seen and class *IV:* Soft palate not observed.

MPA: It was described as an angle between the maxillary axis (MA) and pharyngeal axis (PA) according to Adnet et al. (2001) definition (16). MA was defined as a line parallel to the hard palate and PA is a line of cervical vertebra (anterior portion of the atlas and axis [first and second cervical vertebrae]) on a lateral cervical radiograph taken in erect posture of patients with the neutral position of head. To this purpose, the radiographs was taken at the end of study for each patient and analyzed by an experienced radiologist. The angle between the MA and PA was named as the MPA. Usually, the MPA is greater than 100º (Figure 1).

Statistical analysis

Data were analyzed using statistics package for social sciences (SPSS) software, (17.0 version; SPSS Inc., Chicago, IL, USA). Data were described as mean± standard deviation (SD) or and number (percentage). The sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) were calculated for MPA based on C&L and MTT scores. P-value <0.05 was considered as significant level.

RESULTS

In this study, 213 patients (119 males and 94 females) with mean age of 44.319±13.52 (25 to 70) years were investigated. The demographic

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Table 1 The demographic characteristics of the patients

	Mean ±SD	Min	Max	Sex		P-value
				Male Mean ±SD	Female Mean ±SD	
Age (year)	44.319±13.52	25	70	46.008±13.71	44.18±13.04	0.123
Height (cm)	171.01±9.3	150	190	175.33±8.6	165.54±7.02	0.0001
Weight (Kg)	75.82±11.16	53	108	80.65±9.97	69.7±9.5	0.0001
BMI	25.87±2.85	18.5	38.28	26.23±2.76	25.41±2.92	0.0004
MPA (angle)	97.1±3.2	65	108	96.83±3.84	97.43±2.11	0.177

SD: Standard Deviation/ **Min:** Minimum/ **Max:** Maximum/ **BMI**: Body Mass Index/ **MPA**: Maxillopharyngeal Angle

Table 2 Distribution of various predictive tests based on C&L grading

Variables	Intubation assessment		P-value
	Easy Mean ±SD	Difficult Mean ±SD	
Age (year)	44.2±13.5	44.7±13.7	7.85
Height (cm)	170.65±8.98	171.97±10.13	3.57
Weight (Kg)	73.78±10.65	81.15±10.81	0.0001
BMI	25.27±2.56	27.44±3.02	0.0001
MPA (angle)	97.81±3.33	95.25±1.87	0.0001

SD: Standard Deviation/ Min: Minimum/ Max: Maximum/ BMI: Body Mass Index/ MPA: Maxillopharyngeal Angle

Table 3 Distribution of various predictive tests based on MMT

Variables	Intubation assessment		P-value
	Easy Mean ±SD	Difficult Mean ±SD	
Age (year)	44.1±13.3	44.6±13.9	0.791
Height (cm)	170.89±8.45	171.19±10.44	0.814
Weight (Kg)	73.59±9.94	78.99±12.07	0.0001
BMI	25.15±2.45	26.91±3.08	0.0001
MPA (angle)	97.72±3.64	96.21±2.19	0.0001

SD: Standard Deviation/ Min: Minimum/ Max: Maximum/ BMI: Body Mass Index/ MPA: Maxillopharyngeal Angle

characteristics and anthropometric measurements of the patients were summarized in Table 1. Moreover, these measurements were compared in sex groups. According to Table 1, there were significant differences in the mean height (P=0.0001), weight (P=0.0001) and BMI (P=0.0004) of sex groups. The distribution of various predictive tests based on C&L, MMT and MPA was evaluated and shown in Tables 2 and 3. Based on obtained findings, there were significant differences in the mean weight (P=0.0001), BMI (P=0.0001) and MPA (P=0.0001) according to the C&L grading (Table 2). There were significant differences in the mean weight (P=0.0001), BMI (P=0.0001) and MPA (P=0.0001) according to the MMT (Table 3).

According to the Table 4 and 5, the sensitivity and specificity of MPA were evaluated based on C&L and MMT. Based on C&L grading, the highest sensitivity and specificity were 51.9% and 48.1% for 98.25, respectively. Additionally, according to MMT, the highest sensitivity and specificity were 49.6% and 50.4% for 98.25, respectively. After finding the cut–off-point, the easy and DTI were assessed by MPA measuring and the difference of mean predictive variables was evaluated. It should be noticed that there were significant differences in the mean weight (P=0.011), BMI (P=0.0001) and MPA (P=0.0001) according to the intubation difficulty assessment (Table 6). The distribution of various predictive tests based on MPA intubation difficulty assessment was evaluated in Table 7. Then, PPV and NPV of determined cut off point were evaluated for each values in Table 8.

DISCUSSION

The morbidity and mortality after anesthesia are main factors that have been suggested to be related to unexpected DTI (6). According to the results of previous studies, the incidence of DTI has been reported to be 1.3-13% based on the criteria employed for its description (7, 17-19). In this way, investigation of a simple and accurate predictive test is so essential to prevent the related deaths. However, no single test can accurately predict DTI (19). Although numerous studies have attempted to combine physical factors to predict DTI, none have been recorded to be successful in the clinical evaluation and these existing predictors of DTI are not suitable enough to use in clinic (15). Moreover, direct laryngoscopy for intubation can be carried out with aligning the oral, pharyngeal, and laryngeal axis to visualize the vocal cords through the curved oral airway space. For successful laryngoscopy, enhance in the vertical arrangement of the larynx, tongue and mandible to the facial line and submandibular space are main mechanisms (20). Mallampati et al. highlighted the importance of the tongue base in determining the DTI which has been introduced as a simple and reliable method for preanesthetic assessments (6).

According to the results of this study, the sensitivity of MPA test was 51.9% and the specificity of that was 48.1% and PPV (positive predictive value) was about 92.98% although the NPV was about 51.51% based on C&L. Moreover, the sensitivity of MPA test was 49.6% and its specificity was reported 50.4% and PPV was about 71.92% and the NPV was about 56.56% according to MMT. Different

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Table 4 The sensitivity and specificity of MPA based on C&L

MPA (degree)	Sensitivity	Specificity
94.2500	9.48	0.052
94.6500	9.35	0.065
94.9000	9.29	0.071
95.2500	9.09	0.091
95.7500	8.96	0.104
96.2500	7.60	0.240
96.7500	7.21	0.279
97.2500	6.95	0.305
97.7500	6.88	0.312
98.2500	**5.19**	**0.481**
98.7500	3.64	0.636
99.2500	2.40	0.760
99.7500	1.88	0.812
102.5000	0.13	0.987
106.5000	0.06	0.994

MPA: Maxillopharyngeal Angle

Table 5 The sensitivity and specificity of MPA based on MMT

MPA (degree)	Sensitivity	Specificity
93.2500	9.84	0.016
93.7500	9.76	0.024
94.2500	9.36	0.064
94.6500	9.12	0.088
94.9000	9.12	0.088
95.2500	8.96	0.104
95.7500	8.80	0.120
96.2500	7.44	0.256
96.7500	6.80	0.320
97.2500	6.64	0.336
97.7500	6.56	0.344
98.2500	**4.96**	**0.504**
98.7500	3.84	0.616
99.2500	2.56	0.744
99.7500	2.24	0.776
102.5000	0.16	0.984
106.5000	.008	0.992
109.0000	0.000	1.000

MPA: Maxillopharyngeal Angle

Table 6 Mean of various predictive tests based on MPA

Variables	Intubation assessment		P-value
	Easy Mean ±SD	Difficult Mean ±SD	
Age (year)	43.5±13.9	45.3±13.1	0.349
Height (cm)	171.32±8.90	170.67±9.78	0.613

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Weight (Kg)	74.03±10.13	77.89±11.97	0.0001
BMI	25.19±2.60	26.67±2.95	0.0001
MPA (angle)	99.05±1.27	94.86±3.30	0.0001

SD: Standard Deviation/ Min: Minimum/ Max: Maximum/ BMI: Body Mass Index/ MPA: Maxillopharyngeal Angle

Table 7 Distribution of various predictive tests based on MPA intubation difficulty assessment

Factor	Grade	MPA	
		Easy	Difficult
MMT	CL I	86	13
	CL II	20	35
	CL III	7	39
	CL IV	1	12
C&L	CL I	82	43
	CL II	28	31
	CL III	4	25

Table 8 Evolution of PPV and NPV for determined point of MPA according to C&L grading and MMT

Variable	**PPV (%)**	**NPV (%)**
MPA based on C&L	92.98	51.51
MPA based on MMT	71.92	56.56

PPV: positive predictive value/ NPV: negative predictive value

studies have been conducted to evaluate the predictors of DTI. Lewis et al. (1994) determined different methods to predict DTI (21). Wilson et al. proposed even calculating airway indices that incorporate many assessment criteria (22). Wilson scoring test has a sensitivity of 75%, specificity of 88%, and positive predictive value of 9% and negative predictive value of 99%. Arne et al. (1998) did not consistently ensure accurate evaluation of difficult laryngoscopy (7). Mallampati grading was combined with factors such as obesity, short neck, abnormal teeth, receding mandible, facial edema, and swollen tongue in the obstetric population and showed a significant correlation between classification of airway and laryngoscopy grade. White and Kander (1975) showed that the posterior depth of the mandible (the distance between the bony alveolus immediately behind the third molar tooth and the lower border of the mandible) was an important measure to determine the DTI (23).

Based on the previous studies, cervical radiographic evaluation is a non-invasive, simple, and economical to predict the DTI (15). When some radiologic criteria are used to predict the DTI, interesting results are observed. Naguib et al. (1999) used a clinical, radiologic and three-dimensional computer imaging as a predictive model for DTI identification. They demonstrated that the PPV of this combined test was better than that of the clinical test alone (95.8%vs. 87.5%) (24). In a similar study, Gupta et al. (2010) established a prospective study to assess of difficult DTI by measured MPA on lateral cervical radiograph. They emphasized that this test could be used as pre-anesthetic airway assessment criteria routinely along with other indices to predict the DTI (15).

CONCLUSION

In summary, the results of present study showed that the PPV was great for MPA test to predict the difficult airway. As radiologic evaluation is simple and non-invasive model, we suggest that this test is carried out along with established methods to manage the airway difficulty in patient undergoing general anesthesia.

REFERENCES

1. Philip S, Nizar FF. Prediction of difficult laryngoscopy in patients undergoing endotracheal intubation: A comparative study of various airway assessment tests. Astrocyte. 2016;3(2):90.
2. Jain N, Das S, Kanchi M. Thyromental height test for prediction of difficult laryngoscopy in patients undergoing coronary artery bypass graft surgical procedure. Annals of cardiac anaesthesia. 2017;20(2):207.
3. Caplan RA, Posner KL, Ward RJ, Cheney FW. Adverse respiratory events in anesthesia: a closed claims analysis. Anesthesiology. 1990;72(5):828-33.
4. Benumof JL, Scheller MS. The importance of transtracheal jet ventilation in the management of the difficult airway. The Journal of the American Society of Anesthesiologists. 1989;71(5):769-78.
5. Bellhouse CP, Dore C. Criteria for Estimating Likelihood of Difficulty of Endotracheal Intubation with the Macintosh Laryngoscope. Anaesth Intens Care. 1988;16(3):329-37.
6. Mallampati SR, Gatt SP, Gugino LD, Desai SP, Waraksa B, Freiberger D, et al. A clinical sign to predict difficult tracheal intubation; a prospective study. Canadian Journal of Anesthesia/Journal canadien d'anesthésie. 1985;32(4):429-34.
7. Arne J, Descoins P, Fusciardi J, Ingrand P, Ferrier B, Boudigues D, et al. Preoperative assessment for difficult intubation in general and ENT surgery: predictive value of a clinical multivariate risk index. Brit J Anaesth. 1998;80(2):140-6.
8. Benumof JL. Difficult Laryngoscopy - Obtaining the Best View. Can J Anaesth. 1994;41(5):361-5.
9. Samsoon G, Young J. Difficult tracheal intubation: a retrospective study. Anaesthesia. 1987;42(5):487-90.
10. Mellado P, Thunedborg L, Swiatek F, Kristensen M. Anaesthesiological airway management in Denmark: assessment, equipment and documentation. Acta anaesthesiologica scandinavica. 2004;48(3):350-4.
11. Ezri T, Warters RD, Szmuk P, Saad-Eddin H, Geva D, Katz J, 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. Anesthesia & Analgesia. 2001;93(4):1073-5.
12. Cormack R, Lehane J. Difficult tracheal intubation in obstetrics.

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Anaesthesia. 1984;39(11):1105-11.
13. Oates J, Macleod A, Oates P, Pearsall F, Howie J, Murray G. Comparison of two methods for predicting difficult intubation. Brit J Anaesth. 1991;66(3):305-9.
14. Hatch DJ. Airway management in cleft lip and palate surgery. Brit J Anaesth. 1996;76(6):755-6.
15. Gupta K, Gupta PK. Assessment of difficult laryngoscopy by electronically measured maxillo-pharyngeal angle on lateral cervical radiograph: A prospective study. Saudi journal of anaesthesia. 2010;4(3):158.
16. Adnet F, Borron SW, Dumas JL, Lapostolle F, Cupa M, Lapandry C. Study of the “sniffing position” by magnetic resonance imaging. The Journal of the American Society of Anesthesiologists. 2001;94(1):83-6.
17. Arndt M, Benad G. The risks of anesthesia in obstetric interventions. Anaesthesiologie und Reanimation. 1993;19(4):88-94.
18. Braz LG, Modolo N, do Nascimento Jr P, Bruschi B, Castiglia Y, Ganem EM, et al. Perioperative cardiac arrest: a study of 53 718 anaesthetics over 9 yr from a Brazilian teaching hospital. BJA: British Journal of Anaesthesia. 2006;96(5):569-75.
19. Honarmand A, Safavi M, Ansari N. A comparison of between hyomental distance ratios, ratio of height to thyromental, modified Mallamapati classification test and upper lip bite test in predicting difficult laryngoscopy of patients undergoing general anesthesia. Advanced biomedical research. 2014;3(1):166.
20. Woods GM. Mandibular tori as a cause of inability to visualize the larynx. Anesthesia & Analgesia. 1995;81(4):870-1.
21. 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(1):69-75.
22. Wilson M, Spiegelhalter D, Robertson J, Lesser P. Predicting difficult intubation. Brit J Anaesth. 1988;61(2):211-6.
23. White A, Kander P. Anatomical factors in difficult direct laryngoscopy. Brit J Anaesth. 1975;47(4):468-74.
24. 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. Canadian Journal of Anesthesia. 1999;46(8):748.
25. Süheyla Abitağaoğlu, Ceren Köksal, Güldem Turan, Arzu Yıldırım Ar, Fatma Nur Akgün, Dilek Erdoğan Arı. Comparison of the clinical performances of i-gel and baska mask. Medical Science, 2019, 23(95), 100-107

Article Keywords
Maxillopharyngeal angle, difficult intubation, predictive factors

Declaration of interest
This study “Predictive value of maxillo pharyngeal angle to other multivariate airway assessment tests for difficult intubation in patients undergoing general anesthesia in Iranian population” Was supported by Tehran University of Medical Sciences Grant No. 32192.IR.TUMS.Medicine.REC.1395.1388. The authors (Maryam Milanifard[1], Mohammad Akbari[1], Tahmine Mokhtari[1], Valiollah Hassani[2], Gholamreza Hassanzadeh[1]) declare that there are no conflicts of interest that would prejudice the impartiality of this scientific work. There were also no conflicts of interest in designing and carrying out this current work. The authors alone are responsible for the content and writing of this article.

Acknowledgments
The author wish to sincerely thank support of all colleagues in Rasoul Akram Medical Complex, affiliated to Iran University of medical sciences in Iran. No conflict of interest existed.

Ethical Clearance
This study was approved by the ethics committee of Iran & Tehran University of medical sciences and all patients gave written informed consent (Ethical Code: IR_TUMS_Medicine_1395_1388).

Abbreviations
MPA: Maxillo pharyngeal angle
MMT: Mudified mallampati test
BMI: Body Mass Index
C&L: Cormack & Lehane
cm: Centimeter
F: Female
PA: Pharyngeal Angle
MA: Maxillary Angle
M: Male
LN: Lateral Neck
NPV: Negative predictive value
PPV: Positive predictive value
DTI: Difficult Tracheal Intubation

Article History
Received: 20 January 2019
Accepted: 7 March 2019
Published: May-June 2019

Citation
Maryam Milanifard, Mohammad Akbari, Tahmine Mokhtari, Valiollah Hassani, Gholamreza Hassanzadeh. Predictive value of maxillopharyngeal angle to other multivariate airway assessment tests for difficult intubation in patients undergoing general anesthesia in Iranian population. *Medical Science*, 2019, 23(97), 302-307

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