Original Article

Prediction of difficult airway by thyromental height test- a comparison with modified mallampati test.

Nurullah M[1], Alam MS[2], Hossen M[3], Shahnawaz M[4]

Abstract

Background: Management of airway is central to the Practice of anaesthesia. One of the anaesthesiologist fundamental roles is to maintain a patent airway at a all times.Maintaining a patent airway is essential for adequate oxygenation and ventilation and failure to do so, even for a brief period of time, can be life threatening. Recently, thyromental height test (TMHT) has been proposed as one of the highly sensitive and specific bedside tests to predict difficult airway**.** ***Objective****:* To assess the predictivity of thyromental height test in comparison to modified Mallampati test. ***Methods***: This cross sectional study was carried out in Anesthesiology department of ISMCH during the period of January, 2015 to December, 2016. A total number of 139 consecutive patients scheduled for elective surgical procedure under general anaesthesia requiring intubation having American Society of Anesthesiologists grading I-II. Statistical analyses of the results were obtained by SPSS-20. Sensitivity, specificity, accuracy, positive predictive value and negative predictive value of Thyromental height test and Modified mallampati scoring in diagnosis of difficult airway were calculated. ***Results*****:** Most (74.4) of the patients belonged to age ≤50 years. Male to female ratio was 1.01:1. Majority 91(65.5%) patients had thyromental height of ≥50 mm. In the diagnosis of difficult airway, Thyromental height test was 92.7% sensitivity, 93.5% specificity, 93.5% accuracy and 85.4% positive predictive values, 97.8% negative predictive value, 13.1% positive likelihood ratio, 0.05 negative likelihood ratio. On the other hand Modified mallampati scoring was 48.8% sensitivity, 92.7% specificity, 79.1% accuracy, 75.0% positive predictive values, 80.2% negative predictive value, 6.7% positive likelihood ratio, 0.55 negative likelihood ratio for prediction of difficult airway. ***Conclusions***: It can be concluded that the thyromental height is useful diagnostic modality for predicting difficult airway.

Keywords: Thyromental height test; Modified Mallampati test; Airway; Cormack–Lehane grading.

Bangladesh Journal of Medical Science Vol. 17 No. 03 July'18. Page : 455-461
DOI: http://dx.doi.org/10.3329/bjms.v17i3.37014

Introduction

Respiratory events are the most common anaesthetic related injuries, following dental damage. The three main causes of respiratory related injuries are inadequate ventilation, oesophageal intubation and difficult tracheal intubation. Of all anaesthetic deaths, 1.5% to 20% is attributed to inability to manage a difficult airway[1,2] and suboptimal management of these difficult airways also causes anaesthesia related mortality[3]. Thus, accurate prediction of difficult laryngoscopy (Cormack and Lehane grades III and IV) is very important in anaesthesia practice[4]. In the light of this, the anaesthesiologists have established preanaesthetic assessment of patient and airway as

1. Dr. Md. Nurullah, Assistant Professor, Department of Anaesthesiology, IBN Sina Medical College & Hospital, Dhaka.
2. Dr. Md. Shah Alam, Professor (CC), HOD, Department of Anaesthesiology, IBN Sina Medical College & Hospital, Dhaka.
3. Dr. Mahmud Hossen, Ex. Medical Officer, Department of Anaesthesiology, IBN Sina Medical College & Hospital, Dhaka.
4. Dr. Marufa Shahnawaz, Consultant, Department of Anaesthesiology, IBN Sina Medical College & Hospital, Dhaka.

Correspondence to: Dr. Md. Nurullah, Assistant Professor, Department of Anaesthesiology, IBN Sina Medical College & Hospital, Dhaka. Email: md.nurullah10@yahoo.com

first standard of practice. Prediction of potentially difficult airway management during preoperative period can be determined by using a single anatomical landmark like anatomy of the oropharyneal structure, architecture, range of movement of oropharynx (mobility of temporomandibular joint) and neck or by using multifactorial indexes[5-7]. Multifactorial indexes are more accurate than single measures, so identifying a single reliable predictor of difficult intubation would be valuable. Clinical evaluation of the anatomical structures can be done by noting the atlanto-axial joint extension, thyromental distance, and modified Mallampati classification[8]. Other new tests like upper lip bite test have also been used to assess the airway of the patients for difficult intubation[9].

The thyromental distance, or area between chin and thyroid cartilage, is defined as the distance from the thyroid cartilage to the tip of chin or mentum[8]. However, thyromental distance was of little value in predicting a difficult intubation in adults[10], and is also difficult to be assessed in overweight patients and patients with neck abnormalities. Modified Mallampati test has been widely used to assess the presence of difficult airway. This assessment determines the size of the tongue in relation to the oropharynx, and the ability to open the mouth [11]. The literature indicates that the modified Mallampati classification has very high specificity but a low sensitivity and a high number of false positive results[12-14]. The MMT has shown poor reliability in assessing oropharyngeal views[15]. The upper lip bite test was developed by Khan et al [16], in order to evaluate the patient for difficult airway by a single, simple test. The test is classified according to the ability to bite the upper lip with the lower teeth. This test was found to be more accurate and specific than MMT for predicting easy intubation[16].

Recently, a new technique to evaluate difficult airway intubation was reported. The thyromental height test (TMHT) developed by Etezadi et al.[17] in an effort to produce a simple, single test that could be used preoperatively to evaluate for a difficult airway. The test uses the height between the anterior borders of the mentum and the thyroid cartilage, measured while the patient is lying supine with his/her mouth closed (which we termed "TMHT"). Since the height is measured with the help of a scale, the inter observer difference is negligible and the test is found to be more accurate. Although this technique shows much promise, limited data exist to support its widespread adoption as the method of choice for pre operative assessment of airway

Difficult airway is a major cause of anaesthetic deaths. Specific airway assessment techniques are required to positively predict these difficult airways and prevent these deaths and morbidities. Multifactorial indexes have been proved to be more effective in predicting difficult airway but single specific assessment technique provides quick and easy assessment. Therefore, this study is designed to demonstrate that the thyromental height test is a better and specific predictive assessment technique than modified Mallampati test.

Materials and methods

This cross sectional study was carried out on patients scheduled for elective surgical procedure under general anaesthesia requiring intubation who attended in ISMCH for indoor patients during the period from January' 2015 to December' 2016. A total number of 139 consecutive patients scheduled for elective surgical procedure under general anaesthesia requiring intubation having American Society of Anesthesiologists grading I-II. Rapid sequence induction of anaesthesia (different muscle relaxants used), Inability to open the mouth due to existing trauma or medical condition, existing neck or facial disease causing distortion of the airway, edentulous, and/or a history of difficult intubation, altered level of consciousness, confusion, or inability to follow commands and preexisting limitation or pain with cervical spine movement were excluded from the study. This study was conducted after obtaining ethical clearance certificate from Ethical Review Committee of ISMCH. The patients coming to Pre anaesthetic check up unit (PACU) for pre anaesthetic check up who were planned for elective surgery were examined and counseled about the study. In sitting position, under adequate light, the mouth and the oropharynx was viewed to check for the modified Malampatti classification. Classes I and II were considered predictive of easy laryngoscopy, and III and IV were considered predictive of difficult laryngoscopy. Then on the day of the operation, patient was asked to lie supine on the operating table with mouth closed and the height between the anterior border of the thyroid cartilage (on the thyroid notch just between the two thyroid laminae) and the anterior border of the mentum (on the mental protuberance of the mandible) was measured by two scales, used as a depth gauze. General anaesthesia was induced via a combination of fentanyl (1-2ug/

kg) and propofol (2mg/kg). Muscle relaxation was achieved with vecuronium (0.1mg/kg). After the patient was anaesthetized, expert anaesthesiologist who was unaware about the study intubated him. He/She was advised to note the Cormack-Lehane grading as well. All the patients were evaluated by detail history and by clinical examination. All these information were collected in a pre-designed structured data collection sheets.

Operational definitions:

MMT: Performed with the patient in a sitting position, head neutral , month open wide and tongue protruding to the maximum. The airway was examined with a flashlight and then graded.

The Class III or IV were considered difficult and class I or II were considered easy airway.

TMHT: The height was measured with the help of 2 scales one marking the mentum (horizontal) and the other marking the highest point of the thyroid cartilage (vertical).The cut off value taken was 50 mm. That is, any measurement of more than or equal to 50 mm was considered easy and the measurements less than 50 mm was considered difficult.

Cormack and Lehane grading: Grade III or IV were considered difficult and grade I or II were considered easy airway/intubation.

Statistical analysis:

Statistical analyses was carried out by using the Statistical Package for Social Sciences version 20.0 for Windows (SPSS Inc., Chicago, Illinois, USA). Chi square test and odds ratio with 95% CI were used to analyze the categorical variables shown with cross tabulation and the continuous variable expressed as mean (±SD). Receiver-operator characteristic (ROC) analysis and test of validity were performed. A P-value was considered to be statistically significant if ≤ 0.05.

Results

Table I: Relationship between thyromental height test and Cormack-Lehane grading (n=139)

	Cormack-Lehane grade				OR	95% CI	P-Value
	Grade III+Grade IV (n=43)		Grade I + Grade II (n=96)				
	n	%	n	%			
<50 mm	41	95.3	7	7.3	260.64	45.94 -100	0.001[s]
≥50 mm	2	4.7	89	92.7			

s=significant

P value reached from chi square test

Table II: Relationship between modified Mallampati score and Cormack-Lehane grade (n=139)

Modified Mallampati score	Cormack-Lehane grade				OR	95% CI	P-Value
	Grade III+GradeIV (n=43)		Grade I + Grade II (n=96)				
	n	%	n	%			
Class III + Class IV	21	48.8	7	7.3	12.14	4.2 – 36.4	0.001[s]
Class I + Class II	22	51.2	89	92.7			

s=significant

P value reached from chi square test

The mean (±SD) age was 45.4±17.0 year with range from 16 to 79 years. Male patients were 70(50.4%) and female 69(49.6%). The mean thyromental height was 48.3±4.5 mm with range from 36 to 55 mm. Majority (79.9%) patients had class I + class II modified mallampati score and 96(69.1%) patients had Grade I + Grade II Cormack-Lehane grade.

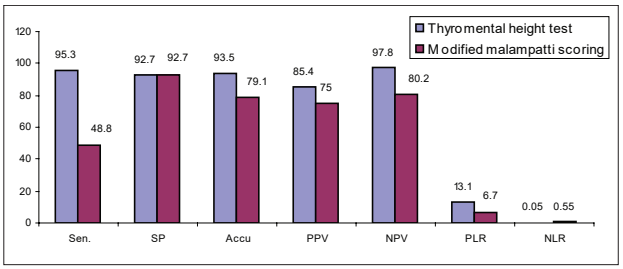
Table III: Relationship between Thyromental height test, modified Mallampati scoring and Cormack-Lehane grade (n=139)

	Cormack-Lehane grade	
	Grade III + Grade IV (n=43)	Grade I + Grade II (n=96)
	n	N
Thyromental height		
<50 mm	41 (TP)	7 (FP)
≥50 mm	2 (FN)	89 (TN)
Modified mallampati score		
Class III + Class IV	21 (TP)	7 (FP)
Class I + Class II	22 (FN)	89 (TN)

TP-True positive, TN-True negative, FP-False positive, FN-False negative

Table IV: Receiver-operator characteristic (ROC) curve of thyromental height

	Cut of value	Sensitivity	Specificity	Area under the ROC curve	95% Confidence interval (CI)	
					Lower bound	Upper bound
Thyromental height	43.50	92.7	93.5	0.946	0. 908	0. 985



Sen.-Sensitivity, SP-Specificity, Accu-Accuracy, PPV-Positive predictive value, NPV-Negative predictive value, PLR- Positive likelihood ratio, NLR-Negative likelihood ratio

Figure 1: Bar diagram showing sensitivity, Specificity, Accuracy, Positive predictive value, Negative predictive value, Positive likelihood ratio, Negative likelihood ratio of Thyromental height test & modified Mallampati scoring

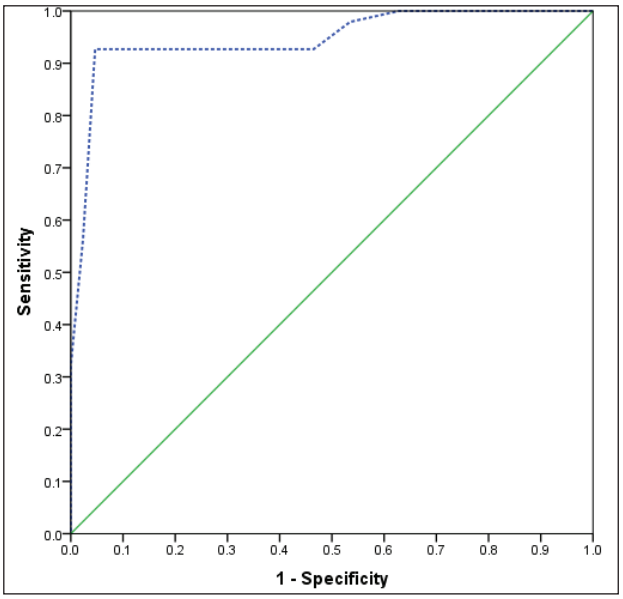


Figure 2: Receiver-operator characteristic (ROC) curve of Thyromental height test.

Table V: Relationship between the Thyromental height test and modified Mallampati scoring for difficult intubation.

	Difficult	Easy	OR	95% CI	P-Value
TMH <50 mm	41	7			
MMT III/IV	21	7	1.95	0.52 -7.32	0.250[ns]

RR= 1.14 (0.89-1.45), ns= not significant, P value reached from chi square test

Table VII: Relationship between the thyromental height and modified Mallampati scoring for easy intubation.

	Difficult	Easy	OR	95% CI	P-Value
TMH ≥50 mm	2	89	0.09	0.01-0.42	0.001[s]
MMT I/II	22	89			

RR= 0.11 (0.03-0.46), s= significant, P value reached from chi square test

Discussion

The TMHT was found to be a more accurate predictor of difficult airway than other single anatomical measures. MMT is one of the most widely reported methods used for prediction of difficult airway. Although when used alone this method has a poor predictive value, it may be valuable as part of a multivariate model for prediction of a difficult airway. This study was carried out with to assess the efficacy of thyromental height test and modified Mallampati test for predicting difficult airway and measurement along with its validity tests by calculating sensitivity, specificity, accuracy, positive predictive value (PPV) and negative predictive value (NPV) respectively.

Etezadi et al.[17] showed the mean age was 44.5 ± 15 years in their study patients. Similarly, Hester et al.[9] obtained that the mean age was found 44.3±13.15 years with range from 18 to 85 years, which are closely resembled with the present study. On the other hand, Seo et al.[18] and Hermite et al.[19] has observed higher mean age in their study patients, which were 53.2 ± 10.6 years and 50±18 years respectively. The higher age ranged maybe due to geographical variations, racial, ethnic differences and genetic causes had significant influence on their higher mean age. Seo et al. [18] found male 61.1% and female were 38.9%, which is comparable with the current study. On the other hand Etezadi et al. [17] and Hermite et al.[19] observed female predominant in their study, where they found 52.5% and 55.5% patients respectively.

Etezadi et al.[17] showed the means of thyromental height measurements were 59.17 ± 10.71 mm, which is higher with the current study. There were 22.0% participants with an MMT grade of III and none with a grade of IV observed by Hester et al.[9], which is comparable with the current study. In another study Seo et al.[18] found Mallampati classification (≥ Class III) in 58.3% of the patients.

Hester et al.[9] observed a total of 17 participants predicted to have a Cormack and Lehane graded

scale of III and IV. A grade III or IV on the Cormack and Lehane scale was exhibited by 18.0%; all were successfully intubated. Etezadi et al.[17] showed 7.3% patients had a C–L grade III or IV laryngeal view. Staikou et al.[20] obtained in their study that 71/81 had Cormack –Lehane grade I or II, 10 patients (10/81) had a Cormack-Lehane grade III and no patient had grade IV. The rate in successful blind intubation for patients with Cormack-Lehane grade III was 70% (7/10), with a 60% success (6/10) at first attempt.

In this series it was observed that 91 patients had thyromental height of ≥50 mm among them 2(4.7%) had grade III+ grade IV Cormack-Lehane grade and 89(92.7%) had grade I + grade II Cormack-Lehane grade with odds ratio (OR) 260.64, 95% CI 45.64% to 100.0%. The difference was statistically significant ($p<0.05$) between two groups. Etezadi et al.[17]reported that Easy TMH was 99.3% in easy CL grade and 17.4% in difficult CL grade. Difficult TMH was found 0.7% in easy CL grade and 82.6% in difficult CL grade.

In this study it was observed that 111 patients had class I + class II modified mallampati score, among them 51.2% had grade III+ grade IV Cormack-Lehane grade and 92.7% had grade I + grade II Cormack-Lehane grade with odds ratio (OR) 12.14, 95% CI 4.2% to 36.4%. The difference was statistically significant ($p<0.05$) between two groups. Etezadi et al.[17] mentioned in their study that easy Mallampati was 86.3% in easy CL grade and 73.9% in difficult CL grade. Difficult Mallampati was found 13.7% in easy CL grade and 26.1% in difficult CL grade. Staikou et al.[20] mentioned in their study that there was no difference between Mallampati classification or Cormack-Lehane grade. Wanderley et al.[21] mentioned in their study that the modified Mallampati and Cormack-Lehane classifications were correlated, it was found that, of the 52 patients who were Mallampati class I/II, 96.2% were Cormack-Lehane grade I/II, while 3.8% were grade III/IV. Of the 29 patients classified as Mallampati III/IV, 93.1% were Cormack-Lehane grade I/II, while 6.9% were grade III/IV.

Etezadi et al.[17] had undertaken a total of 314 patients, MMT (class III, IV) among them 6 patients were true positive, 251 were true negative, 40 were false positive and 17 were false negative in grade 3 or 4 according to Cormack-Lehane grading. Hester et al.[9] showed 10 participants (20.0%) had false-positive finding for the MMT. In another study Khan et al.[16] found false-positive 33.3% for the MMT. The above findings are comparable with the current study.

Etezadi et al.[17] mentioned in their study that the typical advantage of the TMHT is high sensitivity and positive predictive values in comparison with the 3 other methods of airway assessment. Naguib et al.[7] reported the sensitivity of 3 multivariate clinical models[7] as 40.2%, 54.6 %, and 81.4%, respectively. The sensitivity of the TMHT, 82.6% (CI, 74.0% – 88.0%), is approximately equal to Naguib et al.[7] multivariate clinical model. Also, the specificity value of the TMHT test, 99.31% (CI, 96%–99.98%), is comparable with that of the above-mentioned multivariate clinical tests. Regarding MMT Hester et al.[9] found sensitivity 11.0%, specificity 75.0%, accuracy 79.0%, positive predictive value 9.0% and negative predictive value 79.0%. Mallampati test for detection of difficult intubation were 86.36%, 81.8%, 31.67% and 98.40% respectively. 3-3-2 rule was of sensitivity, specificity, PPV and negative predictive value of 26.67%, 94.46%, 92.96% and 42.86%, respectively[22]. In a meta-analysis, Shiga et al.[23] showed that specificity and sensitivity of each test in prediction of difficult intubation is not ideal but the authors used these tests together resulting in significant increase in specificity and sensitivity. In Mahmoodpoor et al.[22] study, when using three tests together, the sensitivity and specificity increased (Youden index: 0.89). An ideal predictive test should have both high sensitivity and specificity. The tests with high derived index values result in high PPVs and low sensitivity and an increased incidence of false negative predictions. In other words, tests with low score values are associated with high sensitivity and reduced false negative. Shiga et al.[23] published a meta-analysis in 2005 showing that specificity and sensitivity were not high with any of the tests used alone to predict a difficult airway and that they may result in poor positive and negative predictive values. Combining these tests leads to slightly better indexes. Lundstrom et al.[24] reported similar results in a meta-analysis published in 2011 involving 177,088 patients in whom only 35% of the patients in whom endotracheal intubation proved difficult had been identified as Mallampati III or IV. Adamus et al.[1] reported a sensitivity of 64.6% for the modified Mallampati classification in predicting cases of a difficult airway. In Wanderley et al.[21] study, 50%

of the patients (n = 2) in whom laryngoscopy was predicted to be difficult (Cormack-Lehane III/IV) were classified as Mallampati III/ IV, whereas those in whom intubation indeed proved difficult (1) or impossible (1) had been classified as Mallampati I/II. Although these results were not statistically significant in the present study (p = 0.54 and p = 0.56, respectively), they show a tendency towards agreement with the previously mentioned studies.

In this study it was observed that 48 patients had a thyromental height of <50 mm among them 41 had difficult and 7 had easy intubation. 28 patients had class III + class IV modified Mallampati score, among them 21 had difficult and 7 had easy intubation with odds ratio (OR) 1.95, 95% CI 0.52% to 7.32% and relative ratio 1.14. The difference was not statistically significant (p>0.05) between the two groups. Etezadi et al.[17] obtained that easy TMH was found 99.3% in easy CL grade and 17.4% in difficult CL grade. Easy Mallampati was found 86.3% in easy CL grade and 73.9% in difficult CL grade.

In this study it was observed that 91 patients had thyromental height of ≥50 mm among them 2 patients had difficult and 89 had easy intubation. 111 patients had class I + class II modified Mallampati score, among them 2 had difficult and 89 had easy intubation with odds ratio (OR) 0.09, 95% CI 0.01% to 0.42% and relative risk 0.11. The difference was statistically significant (p<0.05) between the two groups. In Etezadi et al.[17] study reported that Difficult TMH was found 0.7% in easy CL grade and 82.6% in difficult CL grade. Difficult Mallampati was found 13.7% in easy CL grade and 26.1% in difficult CL grade.

Limitation Of The Study

The study population was selected from the department of Anesthesiology of ISMCH Dhaka, so that the results of the study may not be reflect the exact picture of the country. The present study was conducted at a very short period of time. Therefore the sample lacks representation of the population. Thus, the study place was selected purposively and the respondents, those are interviewed, were attended a particular department of a specific hospital. Small sample size was also a limitation of the present study.

Conclusion

Thyromental height of ≥50 mm, class I + class II modified mallampati score and grade I + grade II Cormack-Lehane grade were more common. As the Cormack-Lehane grade of the present study significantly more effective with thyromental height than modified Mallampati test for predicting difficult airway and the validity tests are almost identical as observed by many investigators. Hence, it can be concluded that the thyromental height is useful diagnostic modality for predicting difficult airway.

Recommendations

Further studies can be undertaken by including large number of patients.

Reference

1. Adamus M, Fritscherova, S, Hrabalek, L, Gabrhelik, T, Zapletalova, J & Janout, V, 'Mallampati test as a predictor of laryngoscopic view', *Biomed Pap Med Fac Univ Palacky Olomouc Czech Repub* 2010; 154: 4: 339-43.
2. Ittichaikulthol, W, Chanpradub, S, Amnoundetchakorn, S, Arayajarernwong, N, Pawaropart, N & Wongkum, W, 'Modified Mallampati test and thyromental distance as a predictor of difficult laryngoscopy in Thai patients', *Medical journal of the Medical Association of Thailand* 2010; 1:93:1:84.
3. Braz, LG, Braz, DG, Cruz, DS, Fernandes, LA, Modolo, NS & Braz, JR, 'Mortality in anesthesia: a systematic review', *Clinics* 2009; 64: 10: 999-1006.
4. Cormack, RS & Lehane, J, 'Difficult tracheal intubation in obstetrics', *Anaesthesia* 1984; 39: 11:1105-11.
5. Rucker, JC, Cole, D, Guerina, LR, Zoran, N, Chung, F & Friedman, Z, 'A prospective observational evaluation of an anatomically guided, logically formulated airway measure to predict difficult laryngoscopy', *European Journal of Anaesthesiology (EJA)* 2012; 29:5:213-7.
6. Safavi, M, Honarmand, A and Zare, N, 'A comparison of the ratio of patient's height to thyromental distance with the modified Mallampati and the upper lip bite test in predicting difficult laryngoscopy', *Saudi journal of anaesthesia* 2011; 5: 3: 258.
7. Naguib, M, Scamman, FL, O'sullivan, C, Aker, J, Ross, AF, Kosmach, S & Ensor, JE, 'Predictive performance of three multivariate difficult tracheal intubation models: a double-blind, case-controlled study', *Anesthesia & Analgesia* 2006; 102:3:818-24.
8. Stoelting, RK & Miller, R, 'Basics of Anaesthesia', *4th edition. Philadelphia, Pa: Churchill Livingstone* 2000.
9. 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 journal* 2007; 75:3:177.
10. Jimson, CT, Rimm, EB & Hussain, A, Predicting difficult endotracheal intubation in surgical patients scheduled for general anesthesia: a prospective blind study. Anesthesia & analgesia 1995; 81: 2: 254-8.
11. Mallampati, SR, Gatt, SP, Gugino, LD, Desai, SP, Waraksa, B, Freiberger, D & Liu, PL, 'A clinical sign to predict difficult tracheal intubation; a prospective study', *Canadian Anaesthetists' Society Journal* 1985; 32:4: 429-34.
12. Frerk, CM, 'Predicting difficult intubation', *Anaesthesia* 1991; 46:12:1005-8.
13. Oates, JD, Macleod, AD, Oates, PD, Pearsall, FJ, Howie, JC & Murray, GD, 'Comparison of two methods for predicting difficult intubation' *BJA: British Journal of Anaesthesia* 1991; 66:3:305-9.
14. Savva, D, 'Prediction of difficult tracheal intubation', *British journal of Anaesthesia* 1994; 73:2:149-53.
15. Karkouti, K, Rose, DK, Ferris, LE, Wigglesworth, DF, Meisami-Fard, T & Lee H, 'Inter-observer reliability of ten tests used for predicting difficult tracheal intubation', *Canadian journal of anaesthesia* 1996; 43:6:554.
16. Khan, ZH, Kashfi, A & Ebrahimkhani, E, 'A comparison of the upper lip bite test (a simple new technique) with modified Mallampati classification in predicting difficulty in endotracheal intubation: a prospective blinded study', *Anesthesia & Analgesia* 2003; 96:2:595-9.
17. Etezadi, F, Ahangari, A, Shokri, H, Najafi, A, Khajavi, MR, Daghigh, M & Moharari, RS, 'Thyromental height: a new clinical test for prediction of difficult laryngoscopy', *Anesthesia & Analgesia* 2013; 117:6:1347-51.
18. Seo, SH, Lee, JG, Yu, SB, Kim, DS, Ryu, SJ & Kim, KH, 'Predictors of difficult intubation defined by the intubation difficulty scale (IDS): predictive value of 7 airway assessment factors', *Korean journal of anesthesiology* 2012; 63:6:491-7.
19. hermite, J, Nouvellon, E, Cuvillon, P, Fabbro-Peray, P, Langeron, O & Ripart, J, 'The Simplified Predictive Intubation Difficulty Score: a new weighted score for difficult airway assessment', *European Journal of Anaesthesiology (EJA)*. 2009; 26:12:1003-9.
20. Staikou, C, Tsaroucha, A, Paraskeva, A & Fassoulaki, A, 'Association between factors predicting and assessing the airway and use of intubating laryngeal mask airway', *Middle East journal of anaesthesiology* 2010; 20:4:553-8.
21. Wanderley, GH, Lima, LC, de Menezes Couceiro, TC, Silva, WV, Coelho, RQ & Lucena, AC, Soares, AD, 'Clinical criteria for airway assessment: correlations with laryngoscopy and endotracheal intubation conditions', *Open Journal of Anesthesiology* 2013; 3:7:320.
22. Mahmoodpoor, A, Soleimanpour, H, Nia, KS, Panahi, JR, Afhami, M, Golzari, SE & Majani, K, 'Sensitivity of palm print, modified mallampati score and 3-3-2 rule in prediction of difficult intubation', *International journal of preventive medicine* 2013; 4:9:1063.
23. Shiga, T, Wajima, ZI, Inoue, T and Sakamoto, A, 'Predicting Difficult Intubation in Apparently Normal PatientsA Meta-analysis of Bedside Screening Test Performance. Anesthesiology', *The Journal of the American Society of Anesthesiologists* 2005; 103:2:429-37.
24. Lundstrøm, L.H., Vester-Andersen, M., Møller, A.M., Charuluxananan, S., L'hermite, J. and Wetterslev, J., 2011. Poor prognostic value of the modified Mallampati score: a meta-analysis involving 177 088 patients. *British journal of anaesthesia*, *107*(5), pp.659-667.