Diagnostic Accuracy of Modified Mallampati Test (MMP) and Thyromental Distance Test (TMD) in Predicting Difficult Laryngoscopy- A Comparative Study in a Tertiary Care Teaching Hospital in India

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ABSTRACT

BACKGROUND

Unanticipated difficult intubation is one of the most dreaded complications in anaesthesiology practice. The predictive reliability of the various tests currently available for predicting difficult airway is unclear. The purpose of this study was to assess the diagnostic accuracy of Modified Mallampati Test (MMP) and Thyromental Distance Test (TMD) individually and also in combination in predicting difficult laryngoscopy, by correlating these tests with Cormack-Lehane's grading.

METHODS

This observational study was conducted among 500 patients over a period of 2.5 years from April 2017 - September 2019, in MGM Medical College and LSK Hospital, Kishanganj, Bihar, India. 500 adult patients of either sex, having American Society of Anaesthesiology (ASA) status I, II and scheduled for elective surgery under general anaesthesia with endotracheal intubation were selected for this study.

RESULTS

While assessing the airway assessment data, MMP / TMD had the highest (92.31%) and TMD had the lowest (65.0%) sensitivity. For specificity TMD had the highest specificity (99.3%) among all the tests, and MMP had the lowest specificity (89.14%) as per our study. Diagnostic accuracy was highest in TMD (97.0%), closely followed by MMP / TMD (90.80%) and MMP (87.3%) respectively. PPV was highest in TMD (100%) and lowest in MMP (57.0%), and NPV was highest in MMP / TMD (97.81%) and lowest in TMD (72.81%).

CONCLUSIONS

We conclude that, MMP / TMD is the more preferred predicator than the individual tests MMP and TMD for assessing and predicting difficult airway.

KEYWORDS

Modified Mallampati Test, Thyromental Distance Test, Difficult Laryngoscopy, Cormack-Lehane Classification

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BACKGROUND

Successful management of the airway is an area of great importance in Anaesthesiology. Inability to maintain airway patency leads to life threatening consequences due to the resulting hypoxia which can lead to permanent brain damage and even death.[1] As stated in a report by the American Society of Anesthesiologists, difficult intubation results in 17% of the adverse respiratory events with 85% of these cases suffering permanent brain damage or death.[2] Intubation difficulty may lead to inadequate ventilation, oesophageal intubation, desaturation, hypertension and dental injury following intubation.[3]

Suboptimum preoperative assessment, lack of skill of the anaesthesiologist and the assistant and inability to identity failed intubation early have been cited as reasons for failed endotracheal intubation leading to morbidity and mortality.[4] The incidence of failed endotracheal intubation is 0.05 to 0.35% whereas that for failure to ventilate is 0.0001 - 0.02%.[5]

A variety of tests and indices are in place for preoperative airway assessment and predicting difficult airway, however, none of these have been shown to be full proof.[6,7] Endeavours to laryngoscopy along with stylet were made available in the operating room. Standard ASA monitors (pulse oximetry, ECG, NIBP, ETCO2 monitor) were attached. Intravenous midazolam (0.05 mg/Kg), glycopyrrolate (0.005 mg/Kg), ondansetron (0.1 mg/Kg), fentanyl (2 mcg/Kg) given before induction. After pre-oxygenation for 3 minutes, induction was done with intra-venous propofol (2 mg/Kg) and after mask ventilation was ensured, Injection Succinylcholine (2 mg/Kg) was given. Adequacy of the depth of anaesthesia and muscle relaxation was subjectively determined by the performing anaesthesiologist. Laryngoscopy and intubation were performed by an anaesthesiologist having experience in this speciality for more than 5 years. With the head in the sniffing position, a Number 3 or Number 4 Macintosh curved blade was used to obtain the laryngoscopic view, the grading of which was pursuant to the Cormack-Lehane classification which is generally considered the gold standard and includes Class I - Vocal cord fully visible; Class II - Only posterior commissure visible; Class III - Only epiglottis visible and Class IV - Epiglottis not visible.[8,9]

Cormack-Lehane grade I and II were rated as easy intubations. Cormack-Lehane grade III and IV were rated as difficult intubations. External laryngeal pressure was permitted after evaluation for the insertion of the endotracheal tube. After evaluation, endotracheal intubation was performed with PVC orotracheal cuffed tube. A tube of 7 mm internal diameter (ID) in females and 8 mm internal diameter (ID) in case of males was used. After inflation of the cuff, position of the tube was confirmed by auscultation and ETCO2. Ease of intubation and aid required for intubation were noted.

An intubation if assisted was noted with respect to the following application of external laryngeal pressure; use of gum elastic bougie; use of Video Laryngoscopy (while using video laryngoscopy, the ETT was bent according to the angle of the blade with the help of a stylet.) and use of Fibre optic bronchoscopy.

Anaesthesia was maintained using oxygen (O_2): Nitrous oxide (N_2O) and isoflurane and non-depolarising muscle relaxant (vecuronium). All the vital parameters like NIBP, ECG, SpO2 and ETCO2 were monitored throughout the surgery. After completion of surgery neuromuscular block was reversed with Intravenous neostigmine and glycopyrrolate and extubation done after proper suctioning and 100% oxygenation.

METHODS

A total number of 500 patients were included in this prospective observational study. The following terms were used for understanding the utility of clinical tests-

1. True positive: A difficult endotracheal intubation that had been predicted to be difficult.
2. False positive: An easy intubation that had been predicted to be difficult.
3. True negative: An easy intubation that had been predicted to be easy.
4. False negative: A difficult endotracheal intubation that had been predicted to be easy.

Statistical Analysis

All collected data were compiled in Microsoft excel worksheet. Using the clinical data (the Mallampati Score, the Thyromental Distance, the Cormac-Lehane classification) recorded for each patient the Sensitivity, Specificity, Positive Predictive Value (PPV), and Negative Predictive Value (NPV) of each test were calculated. Secondly, combinations of predictors were also formulated. The usual definitions of sensitivity, specificity, Positive Predictive Value and Negative Predictive Value was used for the purpose of the study as follows:[10]

RESULTS

A total of 500 patients were included in the present study. The demographic data of all the patients is presented in Table 1. Mean age of the patients in this study was 40.81 ± 11.58 years. Mean height in our study population was 162.26 ± 9.06 cm. Mean weight was 62.12 ± 9.08 kg.

Among 500 patients, 258 (51.6%) were females and 242 (48.4%) were males.

As depicted in Table 2, in case of Modified Mallampati Score, in Class I 145 patients (29.0%), in Class II 255 patients (51.0%), in Class III 97 patients (19.4%) and in Class IV 3 patients (0.6%) were present. While in 23 patients (4.6%) out of 500, Thyromental distance (TMD) was found

to be < 6.5 cm and in another 477 patients (95.4%) it was >6.5 cm.

Descriptive Statistics				
	Minimum	Maximum	Mean	S.D.
Age (years)	18.00	57.00	40.81	11.58
Height (cm)	142.00	180.00	162.26	9.06
Weight (kg)	46.00	82.00	62.12	9.08

Table 1. Demographic Data of the Study Population

MMP Class	No. of Patients	% of Patients
I	145	29
II	255	51
III	97	19.4
IV	3	0.6
Total	500	100
TMD	**No. of Patients**	**% of Patients**
<6.5 cm	23	4.6
>6.5 cm	477	95.4
Total	500	100

Table 2. Results of Airway Assessment Test: Modified Mallampati Score and Thyromental Distance in the Study Population

Laryngoscopic View (CL Class)	No. of Patients	% of Patients
I	228	45.6
II	168	33.6
III	102	20.4
IV	2	0.4
Total	500	100.0

Table 3. Incidence of Difficult Laryngoscopy (Cormack & Lehane's Classification)

		MMP Class		Total	P	Significance
		Difficult	Easy			
Laryngoscopic view (CL class)	Difficult	57(57)	47(11.75)	104(20.8)	<0.001	Significant
	Easy	43(43)	353(88.25)	396(79.2)		
Total		100(100)	400(100)	500(100)		
		TMD		Total	P	Significance
		<6.5 cm	>6.5 cm			
Laryngoscopic view (CL class)	Difficult (III & IV)	22(95.65)	82(17.19)	104(20.8)	<0.001	Significant
	Easy (I & II)	1(4.35)	395(82.81)	396(79.2)		
Total		23(100)	477(100)	500(100)		

Table 4. Comparison of Airway Assessment Data using Modified Mallampati Score and Thyromental Distance

Scoring System	TP	TN	FP	FN	Odds Ratio
MMP	57	353	43	47	9.96
TMD	22	395	1	82	105.98
MMP / TMD	96	358	38	8	113.05

Table 5. True Positive (TP), True Negative (TN), False Positive (FP), False Negative (FN) Rates in All the Scoring Systems

[N.B.: Diagnostic odds ratio ranges from 0 to infinity. Higher diagnostic odds ratio are indicative of better test performance]

Scoring System	Sensitivity	Specificity	PPV	NPV	Diagnostic Accuracy	95% CI Sensitivity	95% CI Specificity
MMP	54.81	89.14	57.00	88.25	87.3	(50.45, 59.17)	(86.41, 91.87)
TMD	65.0	99.3	100	72.81	97.0	(62.57, 67.73)	(99.31, 100.19)
MMP / TMD	92.31	90.40	90.57	97.81	90.80	(90.21, 94.41)	(88.32, 92.48)

Table 6. Values of Sensitivity, Specificity, Positive Predictive Value (PPV), Negative Predictive Value (NPV)

Aid Used	No. of Patients	% of Patients
ELM	93	18.6
FOB	2	0.4
GEB	26	5.2
NONE	379	75.8
Total	500	100
Ease of Intubation	**No. of Patients**	**% of Patients**
ASSISTED	121	24.2
EASY	379	75.8
Total	500	100

Table 7. Incidence of Assisted Intubation along with the Different Aids Used for Difficult Intubation

Grade III Cormack & Lehane was found in 102 (20.4%) patients and Grade IV was found in 2 (0.4%) patients. In remaining 396 patients, laryngoscopy was found easy (Grade I & II) as depicted in Table 3.

It has been shown in Table 4 that, in case of MMP classification 100 patients were predicted to have difficult laryngoscopy (MMP Class III & IV), among them 57 patients (57%) were found practically difficult (Cormack & Lehane Class III or IV) view but in 43 patients (43%) it was easy (Cormack & Lehane Class I or II). In remaining 400 patients, 47 patients (11.75%) were found to have difficult view while 353 patients (88.25%) were found to have easy view according to Cormack & Lehane classification. This co-relation between MMP classification and Cormack & Lehane grading was statistically significant ($p < 0.001$). Also, in 22 patients (95.65%) the TMD is <6.5 and laryngoscopy was also found difficult (III or IV). In 1 patient the TMD was <6.5 but laryngoscopy was found easy. Among the rest 477 patients who had a TMD >6.5, in 17.19% patients, laryngoscopy was found difficult and in 82.81% patients, laryngoscopy was easy. This correlation between TMD classification and Cormack & Lehane grading was statistically significant ($p<0.001$).

Table 5 shows the true positive, true negative, false positive, false negative rates in the scoring systems. In case of MMP classification the values were 57, 353, 43, 47 and in TMD the values were 22, 395, 1, m82 respectively. The odds ratio for MMP, TMD and MMP / TMD combined was 9.96, 105.98 and 113.05 respectively.

In Table 6, the values of sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), 95% confidence interval for sensitivity and specificity of each test alone and in combination has been shown. Among the individual tests Sensitivity was found to be MMP / TMD> MMP > TMD (92.31> 54.81 > 65.0); Specificity was TMD> MMP / TMD> MMP (99.3 > 90.40 >89.14); PPV was TMD > MMP / TMD> MMP (100.00 > 90.57 > 57.00); NPV was MMP / TMD > MMP > TMD (97.81 > 88.25> 72.81); Diagnostic accuracy was TMD> MMP / TMD > MMP (97.0> 90.80 > 87.3).

Table 7 shows intubation was assisted in 121 (24.2%) patients and in 379 (75.8%) patients it was easy while out of the total assisted intubations, External Laryngeal Manipulation (ELM) had to be done in 93 (18.6%) cases. Intubation was accomplished with gum elastic bougie alone in 26 (5.2%) patients. Fibre optic bronchoscope was used in 2 (0.4%) cases.

DISCUSSION

Unexpected difficult intubation is a major contributor to anaesthesia related morbidity and mortality. Pre-operative airway assessment is of utmost importance to safeguard against unexpected difficult intubation but which anatomical landmarks and tests are the best predictors still remain

debatable. This justifies the search for a predictive test which has both the ease of applicability and the accuracy of prediction.

A pre-operative assessment test should be able to predict maximum number of patients of difficult laryngoscopy correctly at the same time predict easy laryngoscopy correctly. Thus, good pre-operative assessment tests should be highly sensitive and also highly specific. Tests should have a high Positive Predictive Value with few negative predictions.[5,11]

The objective behind this study was to find out the effectiveness of some simple airway assessment tests that are easy to perform at the bedside and are less time consuming, so that it can be performed in situations when constrain of time is there and most importantly can predict difficult airway quite accurately. TMD is a measure of the mandibular space, the area bounded by the plane of the line of vision and the part of the mandibular arch in front of this plane. It is an important test for difficult laryngoscopy. It is simple and easy to perform. TMD still remains the simplest popular bedside test.[12,13] TMD has a wide range of cut off values from 5.5 to 7 cms. TMD less than < 6 cm predicts a difficult airway; 6-6.5 cm indicates less difficult airway and >6.5 cm signifies normal airway.[14] For the purpose of this study, we took TMD of 6 cm as the cut off mark.

Mallampati classification based on oropharyngeal structure and first introduced by Mallampati et al. in 1985 for difficult airway assessment in obstetrics patients and subsequently modified by Samsoon and Young is not widely used for difficult airway assessment for all categories of patients.[14,15] Although, Mallampati Classification is a standard, it has got many limitations as has been pointed out by many studies.[16, 17] MMP class I and II are easy for laryngoscopy but MMP class III and IV can pose difficulty in viewing the glottis. MMP is noted in all patients with mouth maximally opened with head extended and tongue maximally protruded without phonation. In this posture MMP correlates best with Cormack-Lehane's grading as has been mentioned in certain studies.[18, 19]

Cormack-Lehane class I and II signifies easy laryngoscopy whereas Cormack-Lehane class III and IV as difficult.[20] We correlated Cormack-Lehane's view during direct laryngoscopy with the finding of the other two tests.

In this study, we found no significant correlation between mean age, sex, height and weight of patients to that of the two assessment tests namely TMD and MMP and for incidence of difficult laryngoscopy. This is in contrary to several studies which have shown that male sex, increased age, height and weight were more prone to difficult intubation and where risk factors for difficult intubation.[21, 22] In our study, as per Table 3 Grade III Cormack & Lehane was found in 102 (20.4%) patients and Grade IV Cormack & Lehane was found in 2 (0.4%) patients. In remaining 396 patients, laryngoscopy was found easy (Grade I & II). This was in consonance with many studies.[21, 23, 24]

In this study, we found that, when the tests are assessed individually, Modified Mallampati Test has a low sensitivity 54.81%, a moderately high specificity of 89.14% with a low Positive predictive value of 57.0% and negative predictive value of 88.25% which corroborated with previous studies by Prakash et al., Srinivasan C et al.[25,26]

The study by Shah et al. and Srinivasan C et al. showed that MMP had a specificity of 77.5% and sensitivity of 76.4% with PPV of 23.6%.[5,27] Basunia et al. in their study had different result and found that MMP had a high specificity of 93.4%, moderate sensitivity of 62.5% and a PPV of 59.5%.[21]

Huge variations are seen in other studies also. Safavi et al. have shown a high sensitivity of 87.37% and low specificity of 14.63% with MMP test.[3] Tamire et al. and Yıldırım İ et al. in their study showed MMP had a high sensitivity of 82.4%, moderate specificity of 66% and a very low PPV of 13%.[11,27] A study by Khan et al. had slightly different result of moderate sensitivity (70.2%) and specificity (61.0) with very low PPV of 19.5%. This variation may be due to significant inter-observer variation with Mallampati test. Khan et al showed that one critical factor in doing a reliable Mallampati score was maximal extrusion of tongue and opening of the mouth. Failure to employ these manoeuvres is a chief drawback when performing the evaluation.[16] So, we can conclude that, MMP test which is an age old test for predicting difficult intubation, definitely has great value in preoperative assessment although some previous studies may contradict.

The sensitivity, specificity, PPV, NPV and diagnostic accuracy of Thyromental Distance (TMD) in our study as depicted in Table 6 was good. These values also corroborate with some studies such as Sankal et al. In their study Sankal et al. showed that TMD had a sensitivity of 55%, specificity of 88% and PPV of 22%, although they used a very low cut off mark for TMD i.e. 4 cm.[18] Another study used a cut off of 6 cm, and yet showed that TMD had high specificity (96.1%), low sensitivity (23.3%), and also a low PPV (16.5%).[19] Other studies such as Basunia et al. showed a different result. Basunia et al. in their study showed that TMD has a moderate sensitivity of 65%, compared to it, specificity was low (56.1%) and PPV was very low (18.5).[21] Prakash et al. also showed a moderate sensitivity with low specificity and low PPV of TMD, although they used a very high cut off mark of 7 cms.[26]

Other variations are also seen such as Shah et al showed high specificity of TMD in their study but that at the cost of very low sensitivity. Such variations as seen may be due to variable cut off marks used for assessing TMD. A wide range of cut off values is quoted for TMD ranging from 5.5 to 7 cms. The cut-off values used in this study are mostly accepted and as recommended in the literature. TMD alone had been advocated as a screening test for predicting difficult laryngoscopy by Patil et al.[23] Thus from our study we can say TMD can also be used as a dependable predicator of difficult airway although variations among opinion are present.

When combination of the two tests was assessed sensitivity improved in comparison to any single test. Sensitivity was highest (92.31%), specificity was also high (90.40%). Diagnostic accuracy was also high (90.80%). Some studies also showed similar results, ie sensitivity was

higher in the combination of MMP / TMD than the two individual tests.[23, 24] So, our study agrees with the previous studies and we may conclude that MMP / TMD in combination is a better predicator of difficult airway than the individual tests.

Ideal test for prediction should have perfect sensitivity and specificity. We considered sensitivity the most important parameter as our target was to avoid the potentially serious outcome of unanticipated difficult tracheal intubation. Also, the False negative (FN) cases should be minimised which was the case with MMP / TMD combination as shown in Table 5. So we can conclude that although many other tests are also available, among the two tests chosen for our study, namely MMP and TMD, MMP and TMD does not have huge advantage over one another, both are more or less equally potent in predicting difficult airway, but the combination of these two tests are definitely a much better predicator of difficult airway.

Limitations

Our study was concerned only with elective surgical patients, and emergency patients were not considered. Extremes of age and obstetric patients were also excluded. Even though the internal validity in the present study seems to be adequate, it may not be applicable to all subgroups of population.

CONCLUSIONS

Combination of Modified Mallampati Test and Thyromental Distance Test is a better option because this has highest sensitivity with no false negative results. From the outcome analysis of our study, we also conclude that, both the tests individually are, also equally reliable. The main difference between Modified Mallampati Test and Thyromental Distance Test is that, Thyromental Distance Test can predict a difficult airway more accurately than Modified Mallampati Test, but the latter can rule out the possibility of a difficult airway more reliably than Thyromental Distance Test.

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REFERENCES

[1] Patel B, Khandekar R, Diwan R, et al. Validation of modified Mallampati test with addition of thyromental distance and sternomental distance to predict difficult endotracheal intubation in adults. Indian J Anaesth 2014;58(2):171-175.

[2] Rosenberg MB, Phero JC. Airway assessment for office sedation/anesthesia. Anesth Prog 2015;62(2):74-80.

[3] Safavi M, Honarmand A, 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 J Anaesthesia 2011;5(3):258-263.

[4] Domi R. The best prediction test of difficult intubation. J Anaesthesiol Clin Pharmacol 2010;26(2):193-196.

[5] Shah PJ, Dubey KP, Yadav JP. Predictive value of upper lip bite test and ratio of height to thyromental distance compared to other multivariate airway assessment tests for difficult laryngoscopy in apparently normal patients. J Anaesthesiol Clin Pharmacol 2013;29(2):191-195.

[6] Roth D, Pace NL, Lee A, et al. Airway physical examination tests for detection of difficult airway management in apparently normal adult patients. Cochrane Database Syst Rev 2018;5(5):CD008874.

[7] Ellard L, Wong DT. Preoperative airway evaluation. Curr Anesthesiol Rep 2020;10:19-27. https: //doi.org/10.1007/s40140-020-00366-w.

[8] Raimann FJ, Tepperis DM, Meininger D, et al. Comparing four video laryngoscopes and one optical laryngoscope with a standard macintosh blade in a simulated trapped car accident victim. Article ID 9690839, Emergency Medicine International 2019;2019:9. https: //doi.org/10.1155/2019/9690839.

[9] Krage R, van Rijn C, van Groeningen D, et al. Cormack–Lehane classification revisited. British Journal of Anaesthesia 2010;105(2):220-227. https://doi.org/10.1093/bja/aeq136.

[10] Alan Agresti and Barbara Finley. Statistical methods for the social sciences. 4th edn. Pearson Prentice Hall 2009.

[11] Tamire T, Demelash H, Admasu W. Predictive values of preoperative tests for difficult laryngoscopy and intubation in adult patients at Tikur Anbessa Specialized Hospital. Article ID 1790413, Anesthesiology Research and Practice 2019;2019:13.

[12] Rao KVN, Dhatchinamoorthi D, Nandhakumar A, et al. Validity of thyromental height test as a predictor of difficult laryngoscopy: a prospective evaluation comparing modified Mallampati score, interincisor gap, thyromental distance, neck circumference and neck extension. Indian J Anaesth 2018;62(8):603-608.

[13] Kaniyil S, Anandan K, Thomas S. Ratio of height to thyromental distance as a predictor of difficult laryngoscopy: a prospective observational study. J Anaesthesiol Clin Pharmacol 2018;34(4):485-489.

[14] Mallampati SR, Gatt SP, Gugino LD, et al. A clinical sign to predict difficult tracheal intubation: a prospective study. Canadian Anaesthesia Soc Journal 1985;32(4):429-434.

[15] Samsoon GL, Young JR. Difficult tracheal intubation: a retrospective study. Anaesthesia 1987;42(5):487-490.

[16] Khan ZH, Eskandari S, Yekaninejad MS. A comparison of the Mallampati test in supine and upright positions with and without phonation in predicting difficult laryngoscopy and intubation: a prospective study. J Anaesthesiol Clin Pharmacol 2015;31(2):207-211.
[17] Lundstrøm LH, Vester-Andersen M, Møller AM, et al. The Danish Anaesthesia Database, poor prognostic value of the modified Mallampati score: a meta-analysis involving 177088 patients. British Journal of Anaesthesia 2011;107(5):659-667. https://doi.org/10.1093/bja/aer292.
[18] Sankal A, Halemani KR, Bhadrinath N. Assessment of the effect of supine posture and phonation on modified Mallampati grading and its applicability in prediction of difficult airway. J Mahatma Gandhi Inst Med Sci 2018;23(1):19-24.
[19] Vannucci A. Cavallone LF. Bedside predictors of difficult intubation: a systematic review. Minerva Anestesiol 2016;82(1):69-83.
[20] Cormack RS, Lehane J. Difficult tracheal intubation in obstetrics. J Anaesthesia 1984;39(11):1105-1111.
[21] Basunia SR, Ghosh S, Bhattacharya S, et al. Comparison between different tests and their combination for prediction of difficult intubation: an analytical study. Anesth Essays Res 2013;7(1):105-109.
[22] Shah PN, Sundaram V. Incidence and predictors of difficult mask ventilation and intubation. J Anaesthesiol Clin Pharmacol 2012;28(4):451-455.
[23] Patil VU, Stehling LC, Zauder HL. Predicting the difficulty of intubation utilizing an intubation guide. Anaesthesiol Rev 1983;10:32-33.
[24] Kulkarni AP, Tirmanwar AS. Comparison of glottic visualisation and ease of intubation with different laryngoscope blades. Indian J Anaesth 2013;57(2):170-174.
[25] Prakash S, Kumar A, Bhandari S, et al. Difficult laryngoscopy and intubation in the Indian population: An assessment of anatomical and clinical risk factors. Indian J Anaesth 2013;57(6):569-575.
[26] Srinivasan C, Kuppuswamy B. Comparison of validity of airway assessment tests for predicting difficult intubation. Indian Anaesth Forum 2017;18(2):63-68.
[27] Yıldırım I, Inal MT, Memiş D, et al. Determining the efficiency of different preoperative difficult intubation tests on patients undergoing caesarean section. Balkan Med J 2017;34(5):436-443.