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An Evaluation of the Efficacy of Predictive Tests and Anthropometric Measurements in Determining Difficult Intubation in Children

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ABSTRACT

Objective: Determining risk factors prior to intubation is crucial for patient safety. This study aimed to assess the usability of the predictive tests and anthropometric measurements in identifying potential difficult intubation in children.

Materials and Methods: This prospective study involved 200 pediatric patients aged 7 to 15 years who were scheduled to receive general anesthesia and were classified as American Society of Anesthesiologists (ASA) I-II with no pre-existing airway issues. Patients were categorized based on age into three groups: Group 1 (7–9 years, n=69), Group 2 (10–12 years, n=65), and Group 3 (13–15 years, n=66). Modified Mallampati Classification (MMC), mandibular protrusion (MP), tooth anomalies (missing tooth, decayed tooth, protruding upper incisor, and long upper incisor), thyromental distance (TMD), sternomental distance (SMD), and atlanto-occipital joint mobility (AOJM1 and AOJM2) were determined for each patient. These prediction tests were then compared with the Cormack–Lehane (CL) classification.

Results: Statistically significant differences were observed between the groups in terms of TMD, SMD, and missing tooth. The MMC exhibited the highest sensitivity and positive predictive value (PPV) (100% and 47%, respectively), while the MP had the highest specificity (94.5%). It was predicted that reference values of ≤6 cm for TMD and ≤12 cm for SMD would yield very low sensitivity and PPV for Group 1.

Conclusion: Reference values of ≤5 cm for TMD and ≤10 cm for SMD were found to provide useful predictive information for children aged 7–9 years.

Keywords: Pediatrics, Cormack–Lehane classification, anthropometry, difficult intubation, tracheal intubation, general anesthesia

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INTRODUCTION

In pediatric anesthesia management, maintaining an open airway during anesthesia and surgery is crucial. Difficult laryngoscopy often leads to difficult intubation under general anesthesia, resulting in intubation failure and potentially fatal outcomes (1).

Various tests and methods based on the measurement of anatomical structures are used in the preoperative assessment to predict intubation difficulty in pediatric patients. These include oropharyngeal view, mandibular position, distance from the jaw tip to certain anatomical points, measurement of cervical movements, and detection of dental anomalies (2). Although it is not practical to use all of these methods together, combining a few tests reduces the margin of error and strengthens the prediction of difficult airway (3).

Accurate airway assessment using a variety of clinical tests has been shown to detect a 98% difficult airway in adults and older children, reducing the number of unexpected difficult intubations and helping plan initial airway management (4). However, these parameters cannot be predicted for airways in different age groups in children. Therefore, the lack of studies and the possibility of straining the airway in children without apparent anatomical deformities suggest the need for research in this area.

This study aims to assess the effectiveness of the modified Mallampati classification (MMC) system in predicting difficult intubation in children. The secondary aim is to investigate the mandible protrusion (MP) in preoperative determination of potential difficult intubation in children. Furthermore, the study aims to evaluate the predictive accuracy of thyromental distance (TMD) and sternomental distance (SMD) as preoperative airway assessment tests in children. Finally, it aims to determine the predictive value of atlanto-occipital joint mobility (AOJM1, AOJM2) tests in predicting difficult intubation in children. The hypothesis is that MMC is a good predictor of difficult intubation in children.

MATERIALS and METHODS

This single-center prospective study was approved by the Gaziantep University Ethics Committee (No: 2014/387, Date: 12.15.2014), and written consent was obtained from the parents of all participating patients. The study was conducted over a 6-month period from December 2014 to June 2015. A total of 200 patients, aged 7 to 15 years, with American Society of Anesthesiologists (ASA) physical status classification I-II, scheduled for elective surgery, and requiring endotracheal intubation under general anesthesia at a tertiary university hospital were included in the study consecutively. Patients were grouped into Group 1 (7–9 years), Group 2 (10–12 years), and Group 3 (13–15 years). Patients with the following conditions were excluded from the study: requiring emergency rapid sequence intubation, body mass index (BMI) of 25 kg/m^2 or higher, severe pathologies that could cause head and neck motion restriction, prominent airway-related syndromes or malformations, history of difficult intubation, history of head and neck surgery, history of radiotherapy, intellectual disability, and cooperation difficulties. All endotracheal intubations in the study were performed by the same anesthesiologist with three years of experience.

In the preoperative assessment, the patient's demographic data including age, gender, body weight, height, and BMI were recorded. Mallampati classification (MMC), Cormack-Lehane (CL) classification, mandible protrusion (MP), thyromental distance (TMD), sternomental distance (SMD), and atlanto-occipital joint mobility (AOJM1, AOJM2) tests were performed on all patients to predict difficult airway. The number of protruding upper incisors (PUI), long upper incisors (LUI), missing teeth (MT) and decayed teeth (DT) were also recorded for each patient.

MMC, a guiding system in comparing airway assessment tests, was performed on all cases by examining the oropharyngeal structures in an upright and sitting position with the mouth fully open and the patient sticking their tongue out. Cases were then classified as follows: Grade I: soft palate, pillars, and the entire uvula visible; Grade II: soft palate and uvula visible; Grade III: soft palate and base of uvula visible, Grade IV: soft palate not visible. MMC Grade III-IV was considered as the predictive criterion for difficult intubation (5).

The MP test was performed with patients in a sitting position and grouped as follows: Group A - lower incisors in front of upper incisors when the patient pushes their lower jaw forward as far as they can; Group B - lower and upper incisors just in contact; Group C - lower incisors significantly behind upper incisors (6).

The patients were then placed in a supine position without a pillow, and the occipital angle-extension degree (AOJM2) of the head was measured using a protractor. Difficult intubation was predicted if the angle between the mouth corner-external auditory canal line and the horizontal plane was narrower than 90°. If the angle between the upper teeth occlusal face and the horizontal plane (AOJM1) was measured to be less than 35°, difficult intubation was predicted (7) (Fig.1). TMD was measured by placing a precision caliper between the thyroid notch and the anterior tip of the jaw with patients in the supine position, head fully extended, and mouth closed without swallowing. If this distance was 6 cm or less, it was considered a prediction criterion for difficult intubation. SMD was measured in the same position by extending the caliper from the tip of the jaw to the sternum. Values of 12 cm or less were considered a prediction criterion for difficult intubation.

After completing airway assessment, standard monitoring was applied to patients, and anesthesia induction was initiated. An appropriate Macintosh blade size 2–3 was used. The view of the larynx was graded using the Modified Cormack-Lehane classification system: Grade I - glottis can be easily seen, Grade II - only the posterior part of the glottis is visible, Grade III - only the epiglottis is visible, and Grade IV – the epiglottis or glottis is not visible. Cases graded as CL Grade III-IV were identified as susceptible to difficult laryngoscopy (5). All endotracheal intubations and anthropometric measurements in the study were performed by the same anesthesiologist with three years of experience.

In cases of failed intubation, it was planned to attempt intubation with a video laryngoscope. If this also failed, the difficult airway algorithm defined by the ASA would be followed (8). The sensitivity, specificity, and positive predictive value (PPV) ratios in predicting difficult airway were determined by applying the tests individually and in combination with each other.

Statistical Analysis

The sample size was calculated based on an expected significant sensitivity value of 75.8% for the Mallampati index compared to Cormack-Lehane index (9). The minimum sample size required for each group was calculated as 54 (α=0.05, 1-β=0.80). The G*Power version 3.1.9 program was used to calculate the sample size.

The Kolmogorov-Smirnov test was used to check for normal distribution of continuous variables. One-way analysis of variance (ANOVA) test and least significant difference (LSD) tests were used to compare parametric numerical data, while Kruskal-Wallis and Dunn tests were used to compare non-parametric numerical data, and chi-square analysis was used for categorical data. Statistical Package for the Social Sciences (SPSS) for Windows version 22.0 software package was used for statistical analysis, with $p<0.05$ considered statistically significant.

RESULTS

The patients' demographic data are shown in Table 1. Difficult intubation prediction values by group are given in Table 2.

There was a statistically significant difference between the groups in terms of TMD, SMD, and AOJM1. AOJM2 was determined to be 96.65±6.56° in Group 1, 97.46±6.42° in Group 2, and 98.72±5.93° in Group 3.

PUI were detected in two cases in Group 1 and in one case in both Group 2 and Group 3. The presence of LUI was found to be statistically similar in all three groups.

The incidence of MT was determined to be 1.71±1.90 in Group 1 and 1.90±1.54 in Group 2. On the other hand, in Group 3, where the number of MT was determined to be 0.65±1.03, a statistically significant difference was observed compared to Group 1 and Group 2. The difference between the groups in terms of the number of DT was not found to be significant.

A correlation analysis of the prediction tests used in evaluating a difficult airway and their relationship with CL classification was

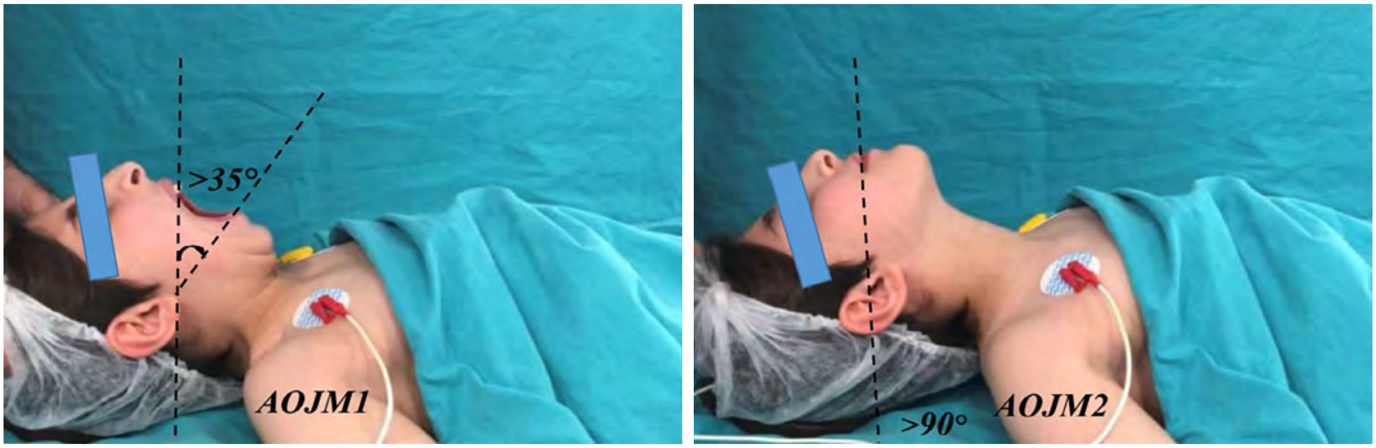

Figure 1. **Atlanto-occipital joint mobility 1 and 2**

conducted (Table 3). The sensitivity, specificity, and PPV ratios resulting from the correlation analysis are shown in Table 4.

A statistically significant relationship was found between CL and MMC in the correlation analysis. For MMC, sensitivity was found to be 100%, specificity 93%, and PPV 47%. A statistically significant correlation was found between CL grade and the MP test after the correlation analysis. For MP, sensitivity was found to be 75%, specificity 94.5%, and PPV 42%.

When CL and TMD were correlated, the difference between CL Grade I and CL Grade III cases was found to be statistically significant. No statistically significant difference was found between the measurements for CL Grade I and CL Grade II cases and between CL Grade II and CL Grade III cases. For TMD ≤6 cm, sensitivity was found to be 74%, specificity 84%, and PPV 32%. When CL and SMD were correlated, the difference was found to be statistically significant between CL Grade I and CL Grade III cases, and between CL Grade II and CL Grade III cases. No statistically significant difference was found between the measurements for CL Grade I and CL Grade II cases. For SMD ≤12 cm, sensitivity was found to be 75%, specificity 90%, and PPV 22%.

When the CL test and AOJM1 were correlated, the difference between CL Grade I and CL Grade III cases was found to be statistically significant. No statistically significant difference was found between the measurements for CL Grade I and CL Grade II cases and between CL Grade II and CL Grade III cases. For AOJM1 <35, sensitivity was found to be 52%, specificity 79%, and PPV 22%.

When CL and AOJM2 were correlated, the difference was found to be statistically significant between CL Grade I and CL Grade II cases, and between CL Grade I and CL Grade III cases. No statistically significant difference was found between the measurements for CL Grade II and CL Grade III cases. For AOJM2 <90°, sensitivity was found to be 51%, specificity 80%, and PPV 18%.

There was one case of PUI among the CL Grade I cases, two cases among the CL Grade II cases, and one case among the CL Grade III cases. A statistically similar correlation was found between CL

Table 1. Distribution of demographic data by group

	Group 1 (n=69)	Group 2 (n=65)	Group 3 (n=66)	p
Age (years) median (25%–75%)	8.0 (7.0–9.0)	11.0 (10.0–11.0)	14.0 (13.0–15.0)	<0.01
Height (cm)* (mean±SD)	121.7±8.6	137.6±6.7	153.4±8.5	<0.01
Weight (kg)* (mean±SD)	27.2±4.6	35.7±5.4	48±7.5	<0.01
BMI* (mean±SD)	18.25±1.0	18.76±1.4	20.25±1.3	<0.01
ASA				
I	56	59	55	0.219
II	13	6	11	
Gender				
Female	31	28	24	0.243
Male	38	37	42	

Oneway ANOVA test and LSD tests were used for comparisons of parametric numerical data, Kruskal Wallis and Dunn tests were used for comparisons of nonparametric numerical data, and Chi-square analysis was used for categorical data. *r: Spearman's correlation coefficient [0.4–0.6 medium, 0.6–0.8 strong, 0.8> very strong] relationship. The relationship of age with height, weight, and BMI is 0.546, 0.507 and 0.302, respectively. ANOVA: One-way analysis of variance; LSD: Least significant difference; Median (25%–75%): Median (25% Percentile–75% Percentile); SD: Standard deviation; BMI: Body mass index; ASA: American Society of Anesthesiologists

Table 2. Distribution of the parameters by group

	Group 1 (n=69)		Group 2 (n=65)		Group 3 (n=66)		Total (n=200)		p
	n	%	n	%	n	%	n	%	
Modified mallampati classification									
Class 1	30	43.5	41	63.1	40	60.6	111	55.5	0.134
Class 2	30	43.5	20	30.8	22	33.3	72	36	
Class 3	9	13	4	6.2	4	6.1	17	8.5	
Mandible protrusion									
Group A	61	88.5	61	93.8	61	92	183	91.5	0.164
Group B	8	11.5	4	6.2	5	8	17	8.5	
Cormack-lehane									
Grade 1	51	73.9	52	80	50	75.8	153	76.5	0.940
Grade 2	15	21.7	11	16.9	13	19.7	39	19.5	
Grade 3	3	4.3	2	3.1	3	4.5	8	4	
Protruding upper incisor									
PUI (+)	2	1.3	1	2.7	1	12.5	4	2	0.805
PUI (-)	67	98.7	64	97.3	65	87.5	196	98	
Long upper incisor									
LUI (+)	21	30.4	15	23.1	11	16.6	47	23.5	0.168
LUI (-)	48	69.6	50	76.9	55	83.4	153	76.5	
TMD, SMD, AOJM1, AOJM2, (mean±SD)									
TMD (cm)	6.75±0.91		7.58±0.76		8.03±0.99		7.44±1.04		0.001
SMD (cm)	11.82±1.64		13.01±1.03		14.12±1.30		12.97±1.65		0.001
AOJM1 (°)	40.66±4.82		41.76±4.51		44.46±5.75		42.28±5.28		0.001
AOJM2 (°)	96.65±6.56		97.46±6.42		98.72±5.93		97.60±6.34		0.161
Missing teeth, decayed teeth, median (25%–75%)									
MT (n)	2 (0–3)		2 (0–3)		0 (0–1)		1 (0–2)		0.001
DT (n)	4 (2–6)		3 (2–5)		3 (2–4)		3 (2–5)		0.085

Chi-square test was used for categorical analysis. Oneway ANOVA and Kruskal Wallis tests were applied normal and non-normal data analysis, respectively. PUI: Protruding upper incisor; LUI: Long upper incisor; TMD: Thyromental distance; SMD: Sternomental distance; AOJM1: Atlanto-occipital joint mobility 1; AOJM2: Atlanto-occipital joint mobility 2; MT: Missing teeth; DT: Decayed teeth

grade and the incidence of PUI after correlation analysis. When CL and LUI were correlated the difference between CL Grade I and CL Grade III cases was found to be statistically significant. No statistically significant difference was found between the measurements for CL Grade I and CL Grade II cases, and between CL Grade II and CL Grade III cases. In terms of difficult intubation prediction in relation to the incidence of LUI, sensitivity was found to be 62%, specificity 78%, and PPV 10%. When the CL test was correlated with the incidence of MT and DT, they were detected to be statistically similar.

DISCUSSION

The main finding of this study is the positive correlation between difficult laryngoscopy and MMC in children. Some studies suggest that MMC, if detectable, is reliable in the evaluation of difficult laryngoscopy in pediatric patients (10, 11). In contrast, a study carried out by Mansano et al. (12), in the pediatric patients for whom the Mallampati test was used, the sensitivity was low. In their study, relatively few patients under the age of four were able to follow simple commands. Anticipation of difficult intubation is very important for anesthetists. Direct laryngoscopic examination can be helpful in this regard, but it is extremely difficult to perform and evaluate direct laryngoscopy before anesthesia. Therefore, a study to determine which test is the most reliable method for the preanesthetic prediction of difficult intubation in pediatric patients would be useful.

In this study, when examining the probability of all tests in predicting difficult intubation, the test with the highest sensitivity and PPV was found to be MMC (100%, 47%). Santos et al. (9) investigated the reliability of MMC in 180 pediatric patients aged 4–8 years in their MMC-CL correlation analysis study. They found the sensitivity to be 75.8%, specificity to be 96.2%, and PPV to be 42.9%. In Inal et al.'s (13) study on 250 pediatric cases aged 5–11 years, they correlated MMC with CL classification and determined that the test with the highest sensitivity in predicting difficult intubation was MMC (76.9%). In a similar study conducted on 760 adult patients,

Table 3. Distribution of the parameters in relation to Cormack–Lehane classification

	Grade 1 (n=153)		Grade 2 (n=39)		Grade 3 (n=8)		Total (n=200)		p
	n	%	n	%	n	%	n	%	
Modified mallampati classification									
Class 1	111	72.5	0	0.0	0	0.0	111	100	0.001
Class 2	42	27.5	27	67.5	0	0.0	69	100	
Class 3	0	0.0	12	32.5	8	100	20	100	
Mandible protrüzyonu									
Group A	151	98.7	30	71.8	2	25	183	91.5	0.001
Group B	2	1.3	9	28.2	6	75	17	8.5	
Protruding upper incisor									
PUI (+)	1	0.65	2	5.4	1	12.5	4	2	0.084
PUI (-)	152	99.35	37	94.6	7	87.5	196	98	
Long upper incisor									
LUI (+)	29	18.9	13	33.3	5	62.5	47	23.5	0.015
LUI (-)	124	81.1	26	67.7	3	37.5	153	76.5	
TMD, SMD, AOJM1, AOJM2 (mean±SD)									
TMD (cm)	7.58±0.94		7.15±1.18		6.12±0.99		7.44±1.04		0.001
SMD (cm)	13.07±1.58		12.89±1.78		11.25±1.28		12.97±1.65		0.003
AOJM1 (°)	42.90±4.68		41.05±6.67		36.25±4.02		42.28±5.28		0.001
AOJM2 (°)	98.46±6.20		95.38±5.92		97.60±6.34		97.60±6.34		0.002
Missing teeth, decayed teeth, median (25%–75%)									
MT (n)	1 (0–2)		1 (0–4)		2 (2–3.5)		1 (0–2)		0.130
DT (n)	3 (2–5)		4 (2–5)		4.5 (2–6)		3 (2–5)		0.330

Chi-square test was used for categorical analysis. Oneway ANOVA and Kruskal Wallis test were applied for normal and non-normal data analysis, respectively. PUI: Protruding upper incisor; LUI: Long upper incisor; TMD: Thyromental distance; SMD: Sternomental distance; AOJM1: Atlanto-occipital joint mobility 1; AOJM2: Atlanto-occipital joint mobility 2; MT: Missing teeth; DT: Decayed teeth

Ul Haq et al. (14) found that the test with the highest specificity for predicting difficult laryngoscopy was MMC (95.76%). Patel et al. (15) studied prediction tests in 135 adult patients and correlated them with the CL classification system. They found the sensitivity for MMC to be 28.6% and the specificity to be 93%.

Exposure of the glottis is also due to anterior projection of the mandible, which requires the temporomandibular joint to function properly. Inal et al. (13) found in their study for predicting difficult intubation on pediatric cases that the MP test had the highest specificity (99.1%) and PPV (93.8%). They reported that it may be more advantageous to combine MMC and the upper lip bite test when predicting difficult airway in pediatric patients. Ul Haq et al. (14) found that the test with the highest sensitivity was MP (95.88%) for predicting difficult laryngoscopy. In our study, to predict difficult laryngoscopy, the test with the highest specificity was MP (94.5%). Similarly, Xu et al. (16), reported that forward protrusion of the mandible indicates the risk of difficult laryngoscopy in school-aged children with microtia.

There are differences in the definition of difficult intubation. Poor glottis imaging is considered a surrogate indicator of difficult intubation. However, adequate glottis visualization during laryngoscopy is not sufficient to guarantee tube advancement through the vocal cords into the trachea. Overall, MMC is a better indicator of difficult laryngoscopy compared to other routinely used tests. However, when used alone, it may not be sufficient to confidently predict difficult laryngoscopy or tracheal intubation and should therefore form part of the overall assessment of the airway. Difficult laryngoscopic images significantly predict difficult intubation (17, 18).

A limited number of pediatric reference values and several rates are reported in terms of TMD and SMD measurement values. In their study evaluating difficult intubation criteria in 166 patients (6–14 years old) with microtia, Xu et al. (16) found the sensitivity and specificity to be 82.35% and 89.39%, respectively, when they established the cut-off value for TMD as <4 cm. On the other hand, Inal et al. (13) determined the cut-off value for TMD as 5.5 cm. The limit value for TMD was reported to be 4.1–5.8 cm within the age range of 4–12 years in the Chinese population (19). Vannucci et al. (20) reported TMD values of 6–7.2 cm and SMD values of 13.5–15 cm.

In our study, we compared TMD ≤6 cm and SMD ≤12 cm between the groups to determine their usefulness as indicators of difficult intubation. We observed a significant difference between the groups. In Group 1, TMD ranged from 5–7 cm, whereas in Group 2 and Group 3 it ranged from 7–10 cm, increasing in direct proportion to

Table 4. Sensitivity, specificity and positive predictive value ratios

	Sensitivity %	Specificity %	PPV %
MMC	100	93	47
MP	74	94,5	42
TMD <6 cm	74	84	32
*TMD <5 cm	100	93,2	42
SMD <12 cm	75	90	22
*SMD <10 cm	100	94	33.5
AOJM1 <35°	52	75	22
AOJM2 <90°	51	80	18
LUI	62	78	10

*: Reference values set for Group 1. PPV: Positive predictive value; MMC: Modified mallampati classification; MP: Mandible protrusion; TMD: Thyromental distance; SMD: Sternomental distance; AOJM1: Atlanto-occipital joint mobility 1; AOJM2: Atlanto-occipital joint mobility 2; LUI: Long upper incisor

age. Similarly in Group 1, SMD ranged from 10–12 cm, whereas in Group 2 and Group 3 it ranged from 13–15 cm, increasing in direct proportion to age. Our study results suggest that TMD measurements of 6 cm and below may only be a criterion for predicting difficult intubation in children over 10 years old, and measurements of 5 cm and below may be a criterion for those between 7–9 years old. Furthermore, although SMD ≤12 is the value typically used as a difficult airway prediction criterion in adults, in our study, SMD measurements of ≤10 cm for 7–9 years old and ≤12 cm for those aged 10 and over were found to be more significant in terms of predicting difficult airway. Based on this information, taking TMD ≤5 cm and SMD ≤10 cm as a reference for Group 1 (7–9 years), statistical analysis showed that for TMD, sensitivity was 100%, specificity was 93.2%, and PPV was 42%, and for SMD, sensitivity was 100%, specificity was 94%, and PPV was 33.5%.

Nikhar et al. (21) conducted a study to correlate TMD and SMD measurements with the CL classification system in 400 patients aged 3–15 years with a normal airway. They investigated the relationship between these measurements and height, age, and body weight, and found that these distances were directly proportional to growth and development. They observed that the most important factor was height, but body weight did not have a significant impact. Conversely, Ray et al. (22) compared TMD and SMD rates based on weight in children aged 1–12 years and found that TMD values were a better predictor according to weight. They reported that sensitivity, specificity, and PPV for TMD values by weight between 6–12 years were 100%, 70%, and 22%, respectively.

It has been reported that AOJM1 <35° and AOJM2 <80° pose a risk for difficult intubation, and values below these are predictors of difficult intubation (23). In Group 1 and Group 2, the majority of AOJM1 angle values were between 30–45°, and in Group 3, they were between 40–55°. A statistically significant difference was found in AOJM1 when comparing between the groups, associated with age and growth. Although this may be distinctive for CL Grade IV cases, no AOJM2 <86° or CL Grade IV cases were detected in our study. As the pediatric patient group has a relatively small head size and short neck, it should be considered that assessing these patients with adult occipital angle measurement techniques and degree values may not provide accurate results.

In a study by Başpınar et al. (24), examining AOJM in four groups, it was found that the possibility of difficult intubation increased with an increasing degree, and this relationship was significant. In our study, we found the lowest occipital angle value to be 86° and determined that an occipital angle of less than 90° would be the criterion for predicting difficult intubation and conducted our statistical analysis accordingly. Our study found a sensitivity of 51%, specificity of 80%, and PPV of 18% for an occipital angle less than 90°.

Among the predictive parameters for difficult intubation, the distribution of LUI was similar among the groups. However, the distribution was different between cases classified as Grade I, Grade II, and Grade III under the CL system. In our study, the sensitivity for the incidence of LUI was detected to be 62%, specificity was 78%, and PPV was 10%.

A significant difference was observed between the groups in the number of MT. The average number of MT in Group 1 and Group 2 was 1.8, which was significantly higher than Group 3 with an average of 0.6. This was due to the fact that Group 3 patients in the 13–15 age range had almost fully developed teeth. However, according our data, 22 out of the 66 patients in Group 3 had 1–4 MT and showed a similar distribution in CL Grades I, II, and III. This suggests that the number of MT is not a determinant criterion for predicting difficult intubation. The groups showed a similar distribution in terms of DT, and no difference was observed when compared with CL classification.

A statistically significant relationship was found between CL classification and MMC, MP, TMD, SMD, AOJM1, AOJM2, and the presence of LUI. Regarding the presence of PUI, DT and MT, no difference was found when compared to CL classification. Kılıc et al. (25) reported that the upper lip bite test (ULBT) was superior to other tests and that this test may be useful when combined with MMC in pediatric patients aged 5 to 11 to predict difficult intubation. Başpınar et al. (24), indicated that MMC, ULBT, and mouth opening are meaningful tests that can be used to predict both difficult laryngoscopy and difficult intubation. Similiar to our study, they mentioned that SMD, AOJM, and Cormack-Lehane classification are associated with difficult intubation. In our research, no complications such as oral trauma, lost teeth or hypoxia occurred.

There are a few limitations that deserve comment. First, due to technical difficulties, we did not include intubation sets, so caution should be exercised when applying our results to intubation practice. Another limitation of our study is that pediatric patients may not fully understand directions and may not follow them, but this can be mitigated by appropriately demonstrating the test to the patient by the anesthesiologist.

CONCLUSION

We observed that MMC and MP tests, when used alone or in combination, are the most effective in predicting difficult intubation in the pediatric patient group. While adult reference values are suitable for TMD and SMD measurements of children aged 10 and over, we believe that reference values of TMD ≤5 cm and SMD ≤10 cm are more appropriate for children aged 7–9 years.

Ethics Committee Approval: The Gaziantep University Clinical Research Ethics Committee granted approval for this study (date: 15.12.2014, number: 2014/387).

Informed Consent: Written informed consent was obtained from patients who participated in this study.

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