

Difficult Intubation in Children: Applicability of the Mallampati Index

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Summary: Santos APSV, Mathias LAST, Gozzani JL, Watanabe M – Difficult Intubation in Children: Applicability of the Mallampati Index.

Background and objectives: The concern of facing difficult airways brought the need of developing predictive testing for difficult intubation. Those tests were developed primarily for adult populations. In pediatric patients studies always focus on patients with congenital malformation, polytraumatized, and newborns. The objective of the present study was to determine the applicability of the predictive test used more often in adults, the Mallampati index, in patients 4 to 8 years old, correlating it with the Cormack-Lehane index.

Methods: One hundred and eight patients 4 to 8 years of age, ASA I, without any type of congenital malformation, genetic syndromes or cognitive deficits were evaluated. The Mallampati index was applied to patients during the pre-anesthetic evaluation. Evaluation of the Cormack-Lehane index was performed after anesthetic induction. A $p < 0.05$ was considered significant.

Results: The Mallampati index showed a significant correlation with the Cormack-Lehane index. The sensitivity and specificity of the Mallampati index were 75.8% and 96.2% respectively, but the sensitivity showed a wide confidence interval.

Conclusions: The Mallampati index was proven to be applicable in children 4 to 8 years old.

Keywords: Intubation, Intratracheal; Pediatrics; Predictive Value of Tests; Preoperative care.

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INTRODUCTION

In pediatric anesthesia 13% of reported respiratory problems are related with the difficulty to intubate ¹, and the literature demonstrates the importance of predicting the possibility of difficult intubation ²⁻⁴.

Regarding pediatric patients, studies on airways and difficult intubation are performed only on patients with congenital malformations or those with affections of the airways ⁵.

Important anatomic differences are observed according to the age. Prior knowledge of those anatomical differences is very important for anesthesiologists, since they will determine the intubation technique to be used influencing situations, such as position of the head, size and shape of the laryngoscope ⁶.

Predictive tests of difficult intubation were developed and evaluated in adults, and an extensive literature review revealed only the study of Koop et al. ⁷, in 1995, which evaluated the Mallampati index in children 0 to 16 years of age.

The lack of studies in children and the possibility of difficult intubation in pediatric patients, apparently without anatomic deformities indicate the need of studies in this field.

The objective of the present study was to determine the applicability of the Mallampati index in patients 4 to 8 years of age by evaluating its correlation with the Cormack-Lehane index.

METHODS

After approval by the Ethics on Research Committee of *Irmandade da Santa Casa de Misericórdia de São Paulo* (ISCMSp), patients 4 to 8 years of age of both genders undergoing surgical procedures under general anesthesia, from December 2007 to April 2009, were selected for this open prospective study.

Exclusion criteria were: patients younger than 4 years and older than 8 years; those with any anatomic malformation, genetic syndromes, and cognitive deficit, as well as patients whose superior and/or inferior incisors were absent.

All children were admitted in the morning of the day of the surgical procedure. Their weight and height were recorded and they underwent pre-anesthetic evaluation. During the evaluation, after their parents or guardians answered the health questionnaire, they were informed by the investigators of the study and after approval of their parents the investigator asked the child whether he/she would like to participate in a game in which he/she would have to make some movements, such as mouth opening, show the tongue, and look upwards with the mouth closed. After the patient agreed to participate in the study, the parents read and signed the informed consent.

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Upper airways were examined and the Mallampati index was evaluated.

After the exam, the patient was taken to the operating room without premedication. An anesthesiologist who did not participate in the pre-anesthetic evaluation performed the anesthesia with the usual technique. It consists in inhalational induction with oxygen and nitrous oxide at 1:1, and 8% sevoflurano. After anesthetic induction, venipuncture was performed with a 22G Teflon catheter, the concentration of the halogenated agent was reduced to 2.5%, and propofol (2 mg.kg⁻¹), fentanyl (5 µg.kg⁻¹), and atracurium (0.5 mg.kg⁻¹) were injected. The patient was ventilated for 5 minutes, placed in the olfactory position, and direct laryngoscopy with a Macintosh blade was performed. The Cormack-Lehane index was recorded.

Tracheal intubation was performed and mechanical ventilation was instituted with volume and respiratory rate adequate to maintain P_{ET}-CO₂ around 35 mmHg. Upon awakening, the neuromuscular blockade was reversed in all patients with atropine, 0.01 mg.kg⁻¹, and neostigmine, 0.04 mg.kg⁻¹.

Variables analyzed were: age, gender, weight, height, physical status according to the classification of the American Society of Anesthesiologists (ASA) and surgical procedure; Mallampati index (MI); and Cormack-Lehane index (CL).

Descriptive analysis was used for the results and Spearman's correlation coefficient between independent variables (MI, age, weight, and height) and the dependent variable (CL). For independent variables with a significant Spearman's correlation coefficient (between the independent and dependent variables), the specificity, sensitivity, positive predictive value (PPV), and negative predictive value (NPV) were analyzed in relation to the variable CL and respective confidence intervals (CI). The statistic difference was considered significant when $p < 0.05$. The tests performed were submitted to the software Statistical Package for the Social Sciences (SPSS) for Windows 10.

RESULTS

One-hundred and eight patients, 37% females and 63% males all classified as physical status ASA I participated in this study.

Table I shows the levels of Spearman's correlation coefficient between independent (MI, age, weight, and height) and dependent (CL) variables and their level of significance. It was observed that MI was the only variable that showed a significant correlation with the Cormack-Lehane index ($p = 0.0001$).

Table II shows the results of the specificity, sensitivity, positive predictive value, and negative predictive value of MI in relation to CL and their respective confidence intervals. Note that the CI of sensitivity and positive predictive value has a wide variation.

DISCUSSION

Among the predictive tests for difficult intubation more commonly used at the bedside during anesthetic evaluation we can mention

Table I – Spearman's Correlation Coefficient Between Independent Variables and the Cormack-Lehane Index and the Degree of Significance

	Spearman's correlation coefficient	p
MI	0.404**	0.0001
Age	-0.091	0.346
Weight	-0.063	0.519
Height	0.004	0.965

MI: Mallampati index.

Table II – Sensitivity, Specificity, PPV, and NPV of the Mallampati Index Compared to the Cormack-Lehane Index

	MI x CL	Confidence Interval
Sensitivity	75.8%	21.9-98.7
Specificity	96.2%	89.9-98.8
PPV	42.9%	11.8-79.8
NPV	99.0%	93.8-99.9

MI: Mallampati index; CL: Cormack-Lehane index; PPV: positive predictive value; NPV: negative predictive value.

the Mallampati index modified by Samson and Young⁸, sternal-mental, thyromental, and hyoid-mental distance, mouth opening, neck mobility, and mandibular mobility. A meta-analysis performed by Shiga et al.⁹ in 2005 with studies that included only adult patients showed that none of those tests by themselves has a high specificity and sensitivity and they can present poor positive and negative predictive values. It also showed that discretely better indices are obtained with the association of those tests.

Especially in children, studies on difficult intubation are related to syndromes that cause musculoskeletal deformities and to newborns¹⁰. The lack of cognitive development might be the reason for the lack of studies on predictive techniques for difficult airways, since there is a need of patient understanding and cooperation.

The present study dealt with a specific group of children – called anatomically correct – who has been poorly investigated. According to a study by Tay et al.¹, in which critical incidents in 10,000 pediatric anesthetics were evaluated, this group of anatomically normal children was among the 13% of difficult intubations that led to severe respiratory incidents with important repercussions in morbidity and mortality.

We chose to investigate children 4 to 8 years of age because in this age group, the degree of cognitive development is good enough to perform predictive tests for difficult intubation and they have different anatomic patterns than those of adults¹⁰. From the age group of 8 to 10 years old on, anatomic structures become very similar to those of adults¹¹.

The variable chosen was used since it presents favorable previsibility results of difficult airways in adults, being easy to perform during pre-anesthetic evaluation⁸, and it was tested in this age group only in the study of Koop et al.⁷.

The Mallampati index showed a significant correlation with the Cormack-Lehane index ($p < 0.005$), contradicting the work of Koop et al.⁷ However, one should consider the age group

investigated by those authors, 0 to 16 years, since they were unable to perform the Mallampati index in all children due to the impossibility of its application in children younger than 4 years old. In those cases, Koop et al.⁷ used tongue depressors for visualization and grading the classes of the modified Mallampati index. Besides this study, which was published as a free topic in the Annals of the Congress of the American Society of Anesthesiologists (ASA) in 1995, we did not find any other studies on children in the literature⁷.

Sixteen of the children investigated by Koop et al.⁷ presented difficult intubation. However, 43% (206) were younger than 3 years of age and the authors did not report the age of the children with difficult intubation. They only mentioned that out of those 16 patients, 12 (75% of the cases) had a Mallampati index of 1 and 2. In the universe of 108 children, the present study observed four cases of difficult intubation and they bore all had Mallampati indices of 3 and 4.

Sensitivity – the capacity of the test to correctly identify a difficult airway – observed in this study was 75.8%; however, the confidence interval ranged from 21.9 to 98.7 suggesting that for this study, although the Mallampati index can find many cases of difficult intubation, it can also find many false positive cases. The same was observed in the works of Shiga et al.⁹ and Lee et al.¹², in adults, and Koop et al.⁷, showing that it might be a characteristic of the test regardless of the size of the study population.

As for specificity, which measures the capacity of the test to correctly exclude cases of difficult airways, it was observed to be 96.2% with a confidence interval of 89.9 to 98.9. Comparing with the literature, Koop et al.⁷ did not report this data in their study, which prevented it from being correlated with other data in children; in adults, the study of Bilgin and Ozyurt¹³ showed similar results: specificity of 93%.

The positive predictive value (PPV), which shows the fraction of patients who really have a difficult intubation among positive tests – in this case, patients with a Mallampati index of 3 or 4 – was 42.9%. The confidence interval varied from 11.8% to 79.8%, suggesting a lack of reliability of the test to correctly predict difficult intubation.

The negative predictive value (NPV) was 99% with a confidence interval of 93.8% to 99.9%, showing that, when facing Mallampati classes 1 and 2, the anesthesiologist can be confident he is not dealing with difficult airways.

Those results, both for PPV and NPV, are in agreement with those reported in the literature for adults¹². The lack of consideration in children prevents any type of correlation to be made.

In the present study, we observed that the Mallampati index, a predictive test of difficult intubation usually applied to adults, has proven to be applicable to a population of children 4 to 8 years of age without anatomical malformations and/or genetic syndromes.