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Scientific Research

Comparison of Mallampatti Test, Thyromental Distance and Distance from Tragus to Nares for Predicting Difficult Intubation in Pediatric Patients

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Abstract

Clinical criteria for prediction of difficult airway in adults may not be applicable in children and available literature on the topic is limited. The objective of this prospective observational study was to assess the usefulness of Mallampati classification, thyromental distance (Tm) and distance from tragus to nares (Tn) in two groups of pediatric patients, those who are less than five and above five years of age, and to correlate these assessments with different grades of Cormack and Lehane (C&L) classification. One hundred and ninety six pediatric patients from one month to eight years of age, ASA grade I and II and planned for elective surgery under general anesthesia with tracheal intubation were recruited. Age, gender, weight (kg), BMI, distance between tragus and nares (cm), Mallampati grades and thyromental distance (cm) were noted preoperatively. Relationship of these variables with C&L grading at the time of laryngoscopy was recorded. C&L grades 2 & 3 was observed in 28 patients in younger age group (n = 120) as compared to two children above 5 years (n = 76) (p < 0.001). C&L grade 3 was seen with decreasing tragus to nares distance (p < 0.002) and with decreasing Tm distance (p = 0.025) in younger age group. In conclusion, this study showed that distance between tragus to nares, Mallampati classification (if applicable) and thyromental distance can be useful for assessment of difficult airway in children less than five years of age.

Keywords

Mallampatti Classification, Thyromental Distance, Cormack and Leehan Classification, Tragus to Nares Distance

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1. Introduction

This identification of patients with a difficult airway is vital in planning anaesthetic management so that tracheal intubation and positive pressure ventilation can be achieved safely. Several preoperative screening tools are being used in clinical anesthesia to identify adult patients who are difficult to intubate. A significant association is seen between noninvasive clinical predictors of airway assessment and the incidence of difficult intubation (DI), yet no single method is expected to predict DI accurately. Anesthetic literature is deficient regarding airway assessment tools for paediatric patients. Wide range of pediatric anatomical and developmental differences makes application of the adult clinical predictors to children a challenge. There is little data to support their use in pediatric population. The aim of our study was to prospectively assess the usefulness of Mallampatti classification, thyromental distance and distance from tragus to nares as a predictor of difficulty in performing laryngoscopy, insertion of tracheal tube and ability to visualize the larynx in children up to eight years of age.

2. Material and Methods

2.1. Patients and Settings

This was a prospective observational study conducted in pediatric or daycare ward and operating theatre from June 2006 till June 2008 at the Aga Khan University Hospital (AKUH) Karachi, Pakistan. Each patient coming for any elective surgical procedures requiring tracheal intubation for general anesthesia were enrolled after informed written consent from the parents; excluding the children with congenital maxillofacial defects, unconscious or with GCS less than 15, BMI less than standard for their age, upper airway pathology (*i.e.*, maxillofacial fractures and tumors, oral malformation like clefts etc.) or cervical spine fractures. Sample size was calculated taking product of equal proportion of patients in inclusion and exclusion criteria and 95% confidence interval, dividing them with margin of error. All enrolled patients went under routine pre-operative assessment, Mallampatti classification done by asking co-operative children to open their mouths, distance from tragus of ear to nares (Tn) was measured in cms as a straight line from front of tragus to base of alae nasi. Thyromental (Tm) distance was measured in cms as straight line from thyroid notch to lower border of mentum with head extended in all patients with standard measuring tape. In non-co-operative patients failure to perform pre-operative tests were recorded. Difficult Intubation (DI) was defined as "difficulty in performing laryngoscopy" or "insertion of endotracheal tube or C&L grade above 2". Easy intubation was defined as "no difficulty experienced during insertion of laryngoscope, visualization of the cords or intubation". This study was approved by Ethical Review Committee of AKUH.

2.2. Data Collection

Gender, height (cm) and weight (Kg) were recorded and BMI was calculated, Malampatti, Tn (cm) and Tm (cm) were measured. All patients received pre-medication with syrup midazolam 0.4 $mg \cdot kg^{-1}$ approximately 30 - 60 minutes before surgery. After placing routine monitoring, all patients were positioned supine without support under occiput. Every child went under inhalational induction with Sevoflurane or intravenously with thiopentone sodium (4 $mg \cdot kg^{-1}$) if an IV was *in situ*. Laryngoscopy performed two minutes after administration of atracurium 0.5 $mg \cdot kg^{-1}$ IV. Macintosh blade was used in size according to the physique of child and cricoid pressure was applied where required also recorded. In case of difficulty in visualizing, the larynx Miller blade was used instead or head position changed and recorded. C&L grade was noted. Pre-operative assessment and intubations (PVC tubes) were done by primary investigator.

2.3. Statistical Analysis

Measurements were expressed as median with interquantile (IQ) ranges as normal cutoff ranges for Tn and Tm distances for children are not available. Chi-Square test was applied for comparison of Mallampati classification with C&L grades (**Table 2**). Kruskal Wallis Test was used to compare Tn and Tm distances in two stratum of age, *i.e.* children less than five years and above five years of age (**Table 3**). All data analysis was conducted using Statistical Package for Social Sciences (SPSS version 15.0). Statistical significance was considered when *p*-value was less than 0.05.

3. Results

A total of 196 patients were enrolled from daily operating room lists convenient to primary investigator. **Table 1** summarizes the demographic data of the study population. Data was organized in two sets, *i.e.*, children less than five years (pre-school) and above five years of age (school going).

3.1. Mallampatti Classification

Mallampatti classification was possible in 116 (59.2%) co-operative non-irritable children. In the preschool group Mallampati test could not be performed in 76 children, whereas in those above five years of age only four children were non-compliant. The relationship of Mallampatti classification with Cormack and Lehane grade is shown in **Table 2**.

3.2. Cormack and Lehane Grading

Cormack and Lehane Grade 1 were observed in 166 (84.7%) patients, Grade 2 in 28 (14.3%) and Grade 3 in two (1%) patients. Of the two cases where Grade 3 was observed, one was a six months old child who had Tm of 4 cm and Tn distance of 7.8 cm (Miller blade used with cricoid pressure). In the second child aged two months, Tn distance was 9.8 cm and Tm 3 cm (Macintosh laryngoscopic blade used). It was not possible to assess Mallampatti grade in either of these children in the preoperative assessment. The relationship of age with Cormack and Lehane grades is shown in **Table 3**.

Out of 28 patients with laryngoscopic Grade 2, children less than five years of age (pre-school group) were 26 (92.9%). Two patients with Cormack and Lehane Grade 3 were both (100%) younger than five years. The number of children with laryngoscopic Grades 2 and 3 was significantly higher in children less than five years of age compared to older children ($p < 0.001$).

No relationship was seen between gender and body mass index with Cormack and Lehane laryngoscopic grades (p-values 0.859 and 0.858 respectively).

3.3. Distance between Tragus to Nares (Tn-Distance) and Its Relationship with Cormack and Lehane Grading

As cut off reference ranges of Tn and Tm distance for prediction of difficult intubations among children are not available, therefore most favorable median according to age distribution was proposed as control in age wise stratification. The variation in Tn and Tm distance according to age distribution is given in **Table 4**. The relationship Tn and Tm distance and Cormack and Lehane grades is shown in **Table 5**.

Table 1. Demographic data.

Age Groups	Gender (M:F) 118:78	Weight (kg)	Length (m)	BMI (kg/m^2)
Less than 5 years (n = 120)	M:F 73:47	10.72 ± 3.8 (10 - 11.4)	0.80 ± 0.14 (0.78 - 0.83)	16.01 ± 3.57 (15.3 - 16.4)
5 years and above (n = 76)	M:F 45:31	20.37 ± 5.58 (19 - 21.6)	1.15 ± 0.12 (1.12 - 1.17)	15.7 ± 4.4 (14.6 - 16.8)

Table 2. Relationship of mallampatti classification with Cormack Lehane laryngoscopic grades (n = 116).

Mallampati Classification	Cormack and Lehane Laryngoscopic grades		
	Grade-1 ***n* (%)**	Grade-2 ***n* (%)**	Total
Grade I	60 (55.0)	2 (28.6)	62
Grade II	49 (45.0)	4 (57.1)*	53
Grade III	0 (0)	1 (14.3)*	1

*Shows significantly higher Cormack and Lehane grade (Grade 2) for Mallampatti grade II, III (p = 0.001). Values given in parentheses are percentages.

Table 3. Relationship of age with Cormack and Lehane laryngoscopic grades.

Age group (years)	Cormack and Lehane laryngoscopic grades			Total
	Grade-1 *n* (%)	Grade-2 *n* (%)	Grade-3 *n* (%)	
Less than 5 (Pre-school)	92 (55.4)	26 (92.9)	02 (100)*	120
5 and above (School going)	74 (44.6)	02 (7.1)	0 (0)	76

*Significant difference between age groups ($p < 0.001$), difficulty (Grade 3) in younger group. Values given in parentheses are percentages.

Table 4. Distance between nares to tragus (Tn) and thyro-mental distance (Tm) according to age distribution ($n = 196$).

Age group (years)	**No. of cases (n)**	**Median (Interquartile range) 25% - 75%**	
		Tn distance (cm)	Tm distance (cm)
less than 5	120	10 (9.5 - 10.5)	4.5 (4 - 5)
5 and above	76	11 (10.5 - 11.5)	5 (5 - 5.5)

Table 5. Effect of age on Tn and Tm distance with Cormack and Lehane Laryngoscopy grades (n = 196).

		Cormack & Lehane Grades			
Age groups		Grade-1 $n = 166$	Grade-2 $n = 28$	Grade-3 $n = 2$	*p*-value
Tn distance	Childrenless than 5 years ($n = 120$)	10 (9 - 10.6)*	9.5 (9.2 - 10)	8.8 (7.8 - 9.8)	0.002
	Children 5 years and above ($n = 76$)	10.7 (10.5 - 11.5)	10.8 (10.5 - 11)	---	0.961
Tm distance	Children less than 5 years ($n = 120$)	4.5 (4 - 5)*	4 (3.5 - 4.5)	3.5 (3 - 4)	0.025
	Children 5 years and above ($n = 76$)	5 (4.7 - 5.5)	6.2 (6 - 6.5)*	---	0.021

Median (interquartile range) of distance between nares and tragus (cm), *Shows significantly high proportion at $p \leq 0.05$ (Kruskal Wallis Test).

Median Tn in 166 patients, with Cormack and Lehane grade 1 was 10 cms (9 - 10.6 cms) in children less than five years. In children above five years the median Tn was 10.7 cms (10.5 - 11.5 cms).

Median Tn in 28 patients with Cormack and Lehane Grade 2 was 9.5 cms (9.2 - 10 cms) in children less than five years of age and 10.8 cms (10.5 - 11 cms) for children above five years. In only two patients (less than five years) with Cormack and Lehane Grade 3, median Tn distance was observed as 8.8 cms (7.8 - 9.8 cms). In two patients, younger than five years (n = 120) with Cormack & Lehane Grade 3, median Tn distance was significantly lower ($p = 0.002$) as compared to median Tn distance in children above 5 years with Cormack & Lehane Grade 1 and 2 ($p = 0.961$) (**Table 5**).

3.4. Thyromental Distance(Tm Distance) and Its Relationship with Cormack and Lehane Grading

The mean thyro-mental distance was 4.69 ± 0.82 cm (range 2.5 - 9). The IQ range and median for Tn and Tm distances according to both age limits are given in **Table 4**. **Table 5** shows the relationship between Tm distance and Cormack and Lehane grades. In patients with Cormack and Lehane Grade 1 the mean distance was 4.74 (SD ± 0.66) and median was 4.80 cm. For Cormack and Lehane Grade 2 mean distance was 4.25 cm (SD ± 0.92) and median was 4.15 cm. Median Tm distance (3.5 cm) was significantly low in Cormack and Lehane Grade 3 as compared to Grades 1 and 2, among children less than 5 years of age ($p < 0.05$).

3.5. Difficult Intubation

Difficult intubation was observed in four (2%) patients. Two were Cormack and Lehane Grade 2 and two were Grade 3. In patients with C&L Grade 2, one was a 12 months old baby with small mouth opening and difficulty

was experienced in inserting the laryngoscope blade. The second was a one month old child whose larynx was anterior and cricoid pressure was required for intubation. For only three patients Miller blade was used to visualize the larynx. Cricoid pressure was required in 30 (15.3%) patients, 23 (19.2%) from younger group and 7 (9.2%) from above five years group.

4. Discussion

Several non-invasive clinical preoperative airway measures have been described to help anesthetists in identifying patients who are unexpectedly difficult to intubate. A significant association of non-invasive clinical predictors of airway assessment with difficult intubation is seen [1]. Majority of these studies have been done in adults and minimal data is available for the use of predictive tools in infants and small children. Certain age related to anatomical characteristics may make laryngoscopy and oral endotracheal intubation difficult in pediatrics as compared to adults. This is particularly the same in the patient with a poorly-developed mandible and receding chin, and especially in those subjects where this is associated with a short distance between the angle of the jaw and the thyroid cartilage [1].

We could only find one abstract on literature search, in which frequency of difficult intubation in children has been reported as 3.4% [2]. Among adults, the reported frequency is 1% - 18% in different studies [3]-[6]. One of the problems with reported rate of difficult intubation is the variation in definition and the same applies to paediatric population. In our study, the frequency of difficult intubation (difficulty in laryngoscopy and Cormack and Lehane Grade 3 and 4) among paediatric cases was found to be 2%.

Mallampati classification has a sensitivity of 56% and specificity of 81% with 21% positive predictive value in adultsand has significant false-negative and false-positive rates [7] [8]. Kopp *et al*. [2] mentioned in an abstract at the predictive sensitivity of Mallampati test in paediatric patients which was 0.162%; the corresponding predictive specificity was 0.935%. More Mallampati class I airway were seen in children above three years and class II in children less than three years but they did not see any significant relationship between age groups and laryngoscopic grades. They concluded that Mallampati test taken alone was a weak predictor of difficult intubation among children. Contrary to this the usefulness of Mallampati test in a study of children old enough to follow instructions (age group 4 - 8 years), Mallampati classification of the airway showed strong correlation with the ease of laryngoscopy [9]. In our study Mallampatti classification could only be performed in 59% patients, 50% of them belonged to less than five years of age and 50% above. This test did not reveal any significant relationship with difficulty of intubation.

As regards thyromental distance (Tm) no cut off values were available for children as no studies of norms at different age groups were available. We were also unable to find any reference related to a cut off value differentiating between ease and difficulty of intubation in paediatric patients. We arbitrarily divided our patient population into age groups less than five years or more than five years. All four DI cases in our population were younger than five years of age; this probably indicates a relationship between increasing Tm distance and ease of intubation.

The correlation between the horizontal length of the mandible (*i.e*., the distance from the angle of mandible to the symphysis mentai) with ease of intubation has previously been proven in a study in adults [10]. As the angle of mandible is not developed in children (the angle of mandible lies exactly in straight line to tragus in adults), measuring the distance from tragus to nares (Tn) can be used as a surrogate for mandibular length. Tn distance can be taken as a surrogate reference for anterior larynx, *i.e*., shorter the distance from tragus to nares more anterior would be the larynx hence, higher grade of laryngoscopy or more difficulty in intubation should be expected. The mandible and ear are derived from the first and second branchial arch and cleft respectively. Various external measurements like nares tragus distance and nares till angle of mandible have been used to predict nares vocal length for nasal fiberoptic intubations, in adults [11]. Again there are no defined norms for these measurements in literature for paediatric patients. In our study decreasing distance between tragus of ear to nares was significantly correlated with increasing grades of Cormack and Leehan classification among children less than 5 years of age.

Our study has limitations. We did not measure the neuromuscular blockade with a nerve stimulator but relied on clinical criteria of muscle relaxation before tracheal intubation. We also did not have reference values to compare with. Further research with larger sample sizes is required to further explore the role of Tm and Tn distances in pediatric anesthesia.

5. Conclusion

Preoperative airway assessment in children is tricky and requires more than one parameter at the same time. In children less than five years of age, increasing grade of Cormack and Lehan laryngoscopy and increasing difficulty in intubation are seen with decreasing Tn and Tm distances. While in older children no significant trend was seen. We conclude that Mallampati classification (if appllicable), thyromental distance, distance between tragus and nares can be helpful in assessment of difficult intubation in pediatric patients younger than 5 years of age.

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