



ULTRASOUND ASSESSMENT OF SUBGLOTTIC LARYNGEAL DIAMETER FOR ESTIMATION OF APPROPRIATE ENDOTRACHEAL TUBE SIZE IN PAEDIATRIC PATIENTS – A PROSPECTIVE RANDOMIZED STUDY

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ABSTRACT

Background and Aim: The appropriate size of endotracheal tube for children are traditionally selected based on their age, height and or weight by using formulas. The ultrasound guided measurement of subglottic laryngeal diameter can be used to appropriate selection of endotracheal tube. The endotracheal tube is selected based on the nearest external diameter corresponding to the measured subglottic region. The aim of the study is to compare the appropriateness of uncuffed endotracheal tube selection based on age based formula with that of ultrasound assessment of subglottic diameter in children. **Materials and Methods:** A prospective randomised parallel group study involving 60 children of age 2-6years undergoing elective surgeries under general anaesthesia were selected for study. They are divided into two groups as Group A – Endotracheal tube selection based on ultrasound assessment of diameter of subglottic region and Group B – Endotracheal tube selection based on age based formula which is $(Age / 3) + 3.5\text{mm ID}$. The noted parameters were internal diameter (ID) and external diameter (OD) of the predicted ETT by the two methods, ID and OD of the appropriate size ETT used and the ultrasound assessed subglottic diameter. **Results:** The incidence of ETT size predicted by ultrasound assessment of subglottic diameter was 83.33% while with age based formula it is 53.34%. The linear regression equation model in Group A showed $R^2 = 0.694$, $P = 0.001$ which was statistically significant. While in Group B it was $R^2 = 0.258$, $p = 0.001$. **Conclusion:** There was a strong correlation between the outer diameter of clinically used uncuffed ETT and the subglottic diameter assessed with ultrasound examination in paediatric patients. Hence USG assessment of the subglottic diameter is a better tool in predicting the appropriate uncuffed ETT in paediatric patients undergoing elective surgeries under general anaesthesia than the age-based formula.

KEYWORDS : Endotracheal tube, Subglottic area, Ultrasound

INTRODUCTION

The appropriate size of endotracheal tube for children are traditionally selected based on age, height and or weight by using the formulas.^[1] Most of time the selected endotracheal tube does not fit appropriately for the child. It may be too small for the child leading to air leak on ventilation or too large for the child where we may not able to insert the endotracheal tube.^[2] These lead to situation where we have to change the endotracheal tube leading to unnecessary prolonged time for intubation. This is to be avoided especially in children as they are more susceptible for hypoxia due to less respiratory reserve.^[3,4] The technique of subglottic laryngeal diameter measurement by ultrasound can be used to select appropriate endotracheal tube in children. The endotracheal tube is selected based on the nearest external diameter corresponding to the measured subglottic region.^[5] Hence we undertake this study to compare the ultrasound assessment of the subglottic area to predict the outer diameter of endotracheal tube with that of age based formula.^[6-10]

AIM

The aim of the study is to compare the appropriate selection of uncuffed endotracheal tube based on age based formula with that of ultrasound assessment of subglottic laryngeal diameter in children undergoing surgical procedures under general anaesthesia.

MATERIALS AND METHODS

A prospective randomised parallel group study was designed. After approval from institutional ethics committee 60 children were selected for study. The sample size was determined on basis of previous studies for the same. ASA I & II patients of age 2-6 years undergoing elective surgeries under general anaesthesia were included for study. The patients with URI, anticipated difficult airway, previous surgery involving upper airway and any obvious scars, mass or ulcer in the neck were excluded from the study. The consent for the study was obtained from the parents or legal guardians.

The patients undergoing the surgery were divided into two groups by computer based randomization.

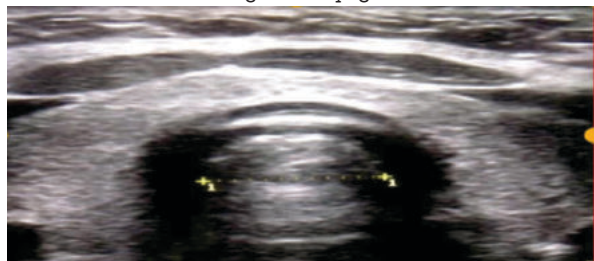
Group A – Endotracheal tube selection based on ultrasound assessment of diameter of subglottic region

Group B – Endotracheal tube selection based on age based formula which is $(Age / 3) + 3.5\text{mm ID}$ for the selected age group.

All patients were fasted for about 6 hours before surgery. Inside the operating room standard monitors like ECG, SpO₂, and NIBP were connected. After securing IV line, patients were premedicated with Inj. Atropine 20mcg/kg. After preoxygenation with 100% O₂ for 3 minutes, patients were sedated with Inj. Midazolam 0.03mg/kg and Inj. Fentanyl 2mcg/kg. After sedation, measurement of the subglottic diameter by ultrasound was done in group A, and the ETT with the nearest external diameter (OD) corresponding to the measured subglottic diameter was selected for intubation. While in Group B, the ETT with nearest ID as predicted by the age based formula was chosen for endotracheal intubation. Then patients were induced with Inj. Thiopentone 5mg/kg and paralysed with Inj. Atracurium 0.5mg/kg to facilitate endotracheal intubation. In each group intubation was done with the ETT chosen on the basis of either of the two methods and confirmed by bilateral air entry. A closed circuit was attached to the ETT, and the air leak test was performed. A stethoscope bell was placed over the mouth with positive pressure ventilation was applied to achieve sequential pressures of 10, 20 and 30 cm H₂O. An audible air leak was recorded as present or absent at each of these pressures. Et tube was considered appropriate if audible leak present at pressures between 10 and 20 cm of H₂O. It was considered large if audible leak present only at pressure > 20cm of H₂O and replaced by a 0.5mm smaller size tube.

The noted parameters were internal diameter (ID) and external diameter (OD) of the predicted ETT by the two

methods, ID and OD of the appropriate size ETT used and the ultrasound assessed subglottic laryngeal diameter.



USG image of subglottic area measurement

Statistical Analysis

The distribution of demographic data in terms of age, sex, weight, and height were analysed using independent t-test. Sex distribution among the two groups was analysed using Chi-square test. Incidence of appropriate tube selection between the two methods calculated by chi square test.

Pearson correlation analysis of appropriate ET tube selected and appropriate ET tube used was done in both groups. P values less than 0.05 were considered significant. SPSS version 11.5 statistical software was used for all analyses

RESULTS

There were no significant difference with regard to age, sex, height and weight of the patients across both groups as shown in table below

parameters	Group A	Group B	P
Age(yrs)	3.9±1.1	3.6±1.1	0.29
Weight (kg)	11.6±1.02	12.3±0.8	0.16
Height(cm)	94.9±3.6	94.6±4.8	0.78
sex(M:F)	18:12	17:13	0.79

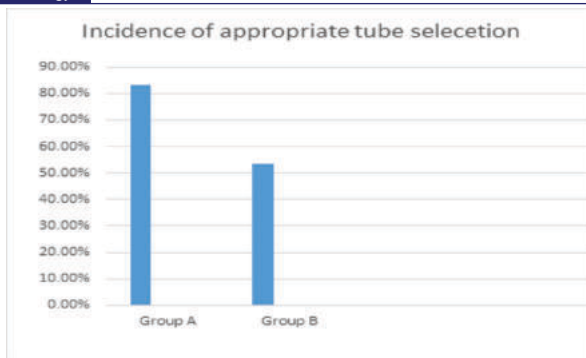
The incidence of ETT size predicted by ultrasound assessment of subglottic diameter was 83.33% while with age based formula it was 53.34%. There was a statistically significant difference in the incidence of appropriate tube selection between the two methods.

The selection of appropriate ET tube by ultrasound measured subglottic laryngeal diameter is better than the traditional age based formulas. The linear regression equation model in Group A showed $R^2 = 0.694$, $P = 0.001$ which was statistically significant.

While in Group B it was $R^2 = 0.258$, $p = 0.001$. In group B age based formula overestimated ID of ET tube size than used in 8 patients, who were less than their estimated ideal bodyweight. It also underestimated ID of ET tube size for 4 patients who were more than their ideal body weight.

Comparison Of Incidence Of Appropriate Et Tube Selection By Two Methods

Parameter	Group A %	Group B %	chi square	p
Incidence of appropriate tube selection	83.34	53.33	6.23	0.01



Comparison Of Prediction Methods With Appropriate Tube Used

Group	Pearson correlation coefficient	P
Group A	0.857	0.001
Group B	0.513	0.001

DISCUSSION

Age based formulas were used in paediatric patients to select the appropriate endotracheal tube for intubation. In our study only 53% of the patients had appropriate endotracheal tube selected based on the formulas. The use of ultrasound to estimate the subglottic area and choosing the nearest tube corresponding to the outer diameter of the endotracheal tube improved the chances of appropriate endotracheal tube selection to 83% in our study. This is similar to the findings of study done by Shibasaki M et al, Kim EJ et al, Gupta K et al where the use of ultrasound lead to improvement in selection of appropriate endotracheal tube for the children.^[7-9] Similarly various other formulas based on the length or weight of the children were also used as in studies by Hofer CK et al and Eck JB et al.^[11,12] The selection of appropriate endotracheal tube based on these varied around 50 -60%. The use of ultrasound to measure the subglottic area and choosing the ET tube has better chance in all studies. The use of appropriate tube in children avoids various complications like leakage during ventilation, post op laryngeal edema and laryngeal injury. As children develop laryngeal edema easily and for easy ventilation it is wise to select the appropriate tube for endotracheal intubation.

CONCLUSION

We found that ETT selection based on ultrasound assessment of subglottic diameter was more predictive in selecting the appropriate size uncuffed ETT than compared to age based formula. The commonly used formulas based on weight, height, and age have shown variable degree of appropriateness in the prediction of the optimal size ETT in paediatric population. There was a strong correlation between the outer diameter of clinically used uncuffed ETT and the subglottic diameter assessed with ultrasound examination in paediatric patients. Hence USG assessment of the subglottic diameter is a better tool in predicting the appropriate uncuffed ETT in paediatric patients undergoing elective surgeries under general anaesthesia than the age-based formula.

Conflict Of Interest: There was no conflict of interest in this study

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