The efficiency of USG and age related formula to determine the endotracheal tube diameter in pediatric patient

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Introduction

Determination of the correct sized endotracheal tube (ETT) is frequently challenging. Although the age or height based formulas are used, repeated laryngoscopic procedures are often necessary to identify the appropriate tube for individual patients to obtain sufficient ventilation with the accurate size. In this study we aimed to compare efficiency of USG measurement and age based formula to determine the correct uncuffed endotracheal tube diameter according to established tube diameter in clinically.

Methods

After the obtaining ethics comitee and parenteral informed consent. The patients from 2 to 10 years of age who were planned various type of surgeries were prospectively included this study. Exclusion criteries were patients weighted less than 10 kg or more than 50 kg and suspected laryngeal and upper airway abnormalities. After the general anesthesia was induced by inhalation or intravenous way, the maintenance was provided with remifentanil and sevoflurane with mask ventilation.

During the mask ventilation and end of the inspiration, internal transverse diameter of cricoid level was measured with ultrasonography in B mode with a linear probe placed on the midline of the anterior neck. The cricoid cartilage apperance was established with the arched, rounded hypoechoic structure and the hyperechoic air column width was measured as cricoid diameter. The tube diameter was also calculated with Cole formula and noted for same patient. The neuromuscular blocker was administered and the tube diameter was also calculated with Cole formula and noted for same patient. The neuromuscular blocker was administered and patients were entubated with the best fit endotracheal tube in clinically. The endotracheal tube (ETT) which was providing less than 20 peak airway pressure and 6-8 ml/kg tidal volume during the ventilation was accepted the convienent diameter and size. All patient characteristics, results from measurements, and the predicted OD calculated according to the formulas ‘ID [mm] = 4 + age [years]/4’ for the specific tube models were noted.

Results

The one hundred patients were enrolled the study. Mean age was 4.24±1.85 years. The succesful intubation rate at the first attempt was 87 %, the second attempt rate was 12 %, and only 1 % patient need the third attempt. The mean diameter was obtained with Cole formula (4.95±0.53mm) were smaller than the clinically fitted endotracheal tube diameters (5.66±0.5 mm). The mean cricoid diameter obtained with USG measurements (8.32±0.98mm) were higher than the clinically fitted endotracheal tube diameters (7.82±0.72mm). Correlation with clinical established ETT size and both formula and USG were shown in figure 1 and 2.

Bland Altman analysis showed (figure 3 and 4) a mean bias of 0.71 mm with the limits of agreement (bias±0.36 SD) 0.0012 to 1.42 for formula and a mean bias of 0.5 mm with limits of agreement (bias±0.73 SD) -0.93 to 1.93 for ultrasound.

Discussion

Measuring cricoid diameter with ultrasonography may provide prediction of the best fit ETT size with 0.5 mm difference. The corrected R² value was 0.49 for USG and 0.57 for formula. The ratio of the appropriate endotracheal tube selection was reported between 47-77% in previous studies with Cole formula. We found the similar accuracy rate. We relaxed that the formula provides smaller size than the clinically usage and the bigger ETT tube sizes are being measured with ultrasonography evaluations.

Ultrasonography has some problems with the pediatric group such as difference of the anatomic structural alterations with age, being an operator dependent technique and discrepancy between transverse and anterior diameter of the larynx to determine the correct size. All these factors may affect that the ultrasound is not accurately reliable technique for exact ETT size.