Journal Homepage: -www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI:10.21474/IJAR01/15000
DOI URL: http://dx.doi.org/10.21474/IJAR01/15000

RESEARCH ARTICLE

ULTRA-SONOGRAPHIC ESTIMATION OF ENDOTRACHEAL TUBE SIZE IN PAEDIATRIC PATIENTS UNDERGOING SURGERY IN PRONE POSITION: A PROSPECTIVE OBSERVATIONAL CLINICAL STUDY

Dr. Neha Panse, Dr. Bansari Shah and Dr. Hrishikesh Yalgudkar

Manuscript Info

Manuscript History
Received: 05 May 2022
Final Accepted: 08 June 2022
Published: July 2022

Abstract

Background: ETT is important in securing paediatric airway and its right size plays crucial role in paediatric patients. The airway anatomy in paediatric patients is different from adults hence requires precise ETT size. The subglottic diameter being the narrowest portion of upper airway, determines the ETT size. USG is safe, reliable, non-invasive tool used to estimate the narrowest subglottic diameter to estimate the correct ETT size. Conventional formulae included age and height. Concerns in prone position include accidental extubation,secretions, difficult airway access, increased abdominal pressure, increased FRC.
Methods: Sixty patients in the age group 1-4 years posted for PSARP under GA were included in the study. USG guided ETT size was estimated and compared with conventionally estimated size.
Results:The size of ETT predicted by USG was more appropriate than that estimated by physical indices($p<0.005$). ETT size estimated by age-based formula was 2nd nearest to best fit tube. 65% patients were intubated in 1st attempt while 31.6% required 2nd attempt and 3.33% needed 3 attempts to get intubated with the best fit ETT.
Conclusion:USG is useful and reliable screening modality in estimating appropriate ETT size especially in paediatric patients undergoing surgery even in prone position such as PSARP.

Introduction:-

Choosing the correct Endotracheal tube (ETT) size is important in paediatric anaesthesia. The narrowest diameter of upper airway in paediatric patients is the subglottic diameter is important for appropriate ETT size selection.[1]

Size of the ETT is significant in paediatric patients because an inappropriately large sized tube may cause damage to the airway, post extubation stridor and subglottic stenosis. [2]On the other hand, a smaller tube will increase the resistance to gas flow, risk of aspiration, insufficient ventilation, poor monitoring of end tidal gases and the need to re-intubate with a different size of tracheal tube.

The ETT size is an important factor in surgeries which need prone positioning of the patients like Posterior Sagittal Anorectoplasty(PSARP).

In prone position the important change that occurs is a relative increase in functional residual capacity (FRC) when a patient is moved from a supine to a prone position while forced vital capacity and forced expiratory volume in 1 s

Corresponding Author:- Dr. Bansari Shah

(FEV1) change very little.[3] There is also risk of accidental extubation or change in position of ETT while changing position. Hence the need of well fitted ETT cannot be overemphasised.

Various methods based on age, weight, height and finger size have been traditionally used as prediction parameters for the selection of ETT size.[4] However, these methods are not always suitable because the size of the airway varies considerably between patients and the smallest diameter cannot be reliably predicted by height or weight.Using a bedside non-invasive tool, to measure the airway diameter could be helpful in anaesthesia and intensive care.[1]

USG has turned out to be a reliable, safe, non-invasive, pain free and real-time modality for evaluation of the upper airway's narrowest transverse diameter at the subglottic region and may be helpful to estimate the proper size of ETT.[2]

The primary aim of this prospective observational study was to assess the narrowest transverse diameter of the trachea at the subglottic region by USG and to estimate the appropriate size of ETT while the secondary aim was to compare the size with that estimated by conventional formulae.

Materials And Methods:-

After obtaining institutional ethical committee clearance and written informed consent from parents of all children we conducted this prospective clinical observational study for a period of 12 months in complete accordance with guidelines of Helsinki.

Study population included 60 children (power of study being 80% and confidence interval being 95%) in the age group of 1-5 years of American Society of Anaesthesiologists Physical Status (ASA) I and II undergoing elective Posterior saggitalanorectoplasty (PSARP) in prone position under general anaesthesia with orotracheal intubation.

The study did not include patients with active upper respiratory tract infection, tracheal or laryngeal pathology, ASA III and ASA IV patients.

Parental consent was obtained for study as well as for the use of data for research purpose. A thorough pre-anaesthetic evaluation was done preoperatively and any associated congenital anomalies were ruled out. Nil by mouth status was confirmed from the mother (attendant) and patient was premedicated with injKetamine 1mg/kg and inj Glycopyrrolate 0.01mg/kg in the preoperative room to avoid separation anxiety. Patients were premedicated with injMidazolam 0.02mg/kg and injOndemsetron 0.08mg/kg inside the OT. This helped in mild sedation of the patients and then Ultrasonography was performed by an experienced anaesthesiologist on every patient to measure the subglottic diameter.USG utilised high resolution B mode linear probe (5-12 MHz and 7-15 MHz) positioned in the midline of the neck with the patient in sniffing position. The true cords were seen as paired hyper-echoic linear structures and as the probe is moved caudally cricoid arch is visualised. The sizes of ETT estimated by age based and right little finger formulae were noted and kept ready at hand. After the standard general anaesthesia protocol and administration of muscle relaxant, patient was intubated with the ETT predicted by USG and a leak was estimated at 10-20 cm of water. [5] If any leak was noted, the tube was exchanged with the next sized tube. The number times tube needed to be changed and the adequacy of ventilation during prone position was also noted. Any incidence of desaturation, accidental extubation, laryngospasm or sore throat and discomfort after extubation were recorded. The USG depicted size was then compared with the age-based formulae used for uncuffed ETT: inner diameter (Modified Cole's formula) = Age (in years)/4+ 4 and for cuffed ETT: inner diameter (Khine's formula) = Age (in years)/4 + 3 [4] and the size calculated based on the right little finger diameter. These were then compared with the actual used tube size.

It was an observational-cross sectional study. The minimum required sample size at 5% level of significance is 52 patients. To cover up any drop outs we enrolled 60 patients in the study who fulfilled the inclusion criteria.

Sample size was calculated using:

$$n = \frac{Z^2_{\alpha} pq}{d^2}$$

Where p is the observed accuracy q = 1-p d is the margin of error Zα/2 is the ordinate of standard normal distribution at α% level of significance. Interpretation and analysis were carried out using software Microsoft office Excel 2010 and Statistical package for social science (SPSS) International business machines (IBM) version 22, IBM SPSS Statistics base (SPSS South Asia Pvt., Ltd., Bengaluru, India).

Qualitative data was denoted by using range, frequencies and percentages whereas mean and standard deviation corresponded quantitative data. The distribution of the predicted endotracheal tube size by different modalities was compared with best fit endotracheal tube using the Chi-square test. Comparison of efficacy of different modalities for prediction of endotracheal tube size was done by using Pearsons correlation coefficient. The distribution of size of endotracheal tube was compared between different age groups using the Chi-square test.

Results:-

Table 1:- Demographic and physical profile of the subjects.

Age mean ± SD	26.88± 16.23
Male : female	14 : 46
Weight mean ± SD (kg)	11.27 ± 3.34
Height mean ± SD (cm)	79.95 ± 15.74
ASA grade I:II	58 : 2

Table 2:- Attempts of intubation.

No of subjects	No of attempts
39 (65%)	1
19 (31.6%)	2
2 (3.3%)	3

Table 3:-

	Best fit< size predicted	Best fit= size predicted	Best fit > size predicted	Pearsons correlation with best fit
Predicted size by age based formula	4	95	1	0.743
Predicted size by right little finger formula	1	97	2	0.587
Predicted size by USG	0	100	0	0.973

Table 4:- Comparison of endotracheal tube size estimated by different modalities with the best fit endotracheal tube

Techniqueused for ETT size estimation	ETT size by USG(mm)	ETT size used on OT table	ETT size by right little finger based formula	ETT size used on OT table	ETT size by age based formula	ETT size used on OT table
Mean	5.70	5.70	6.08	5.48	5.53	5.70
SD	0.68	0.64	0.50	0.42	0.58	0.56
SE	0.06	0.06	0.06	0.09	0.05	0.07
T value	0.0000		3.8324		0.5520	
P value	1.0000		0.0001		0.5811	

Comparison between the Best fit and predicted size of Endotracheal tube by Prediction of endotracheal tube size in children by predicting subglottic diameter using ultrasonographic measurement versus various modalities was done by using chi square test. The predicted tube size was equal to best fit determined by ultrasonography (100%) followed by comparison to right little finger (97%) and Age based formula (95%)

On correlation using Pearson's correlation coefficient [Table 3]. It was observed that there was a moderate correlation of best fit Endotracheal tube with endotracheal tube size by agebased formula (r = 0.743), right little finger based formula (r = 0.587).

A strong correlation was seen with ultrasonography (r = 0.973).

As shown in Table 2. 39 (65%) subjects were successfully intubated in first attempt. While 19 (31.6%) subjects required a second attempt owing to significant leak in 20 (20%), technical difficulty in 15 (15%) and tube too big in 5 (5%) subjects. Two (3%) subjects required a third attempt at intubation due to impropertechnique.

The mean and standard deviation for endotracheal tube size predicted by age based formula, comparison by right little finger, ultrasound is 5.53 ± 0.58, 5.48 ± 0.42, 5.70 ± 0.64 respectively

P value of the size predicted by USG compared to the other methods proved to be significantly more ($p>0.05$) .For age based formula p value was near significance. The p value for little finger based mesaurement method was <0.05 it was not of much significance.

Discussion:-

With the advent of USG, determining the appropriate size of ETT in paediatric population has been simpler. In the present study we conclude that the ETT size estimated by USG was more appropriate and the size matched the actual size used when compared to the ones predicted by conventional physical indices.

As the study was conducted in children undergoing PSARP, the prone position and the physiological changes associated with positioning were also major concerns to be addressed. Prone position has always been associated with difficult access to the airway after positioning, accidental extubation (use of un-cuffed tube in the study group), obstruction of ETT and sudden desaturation.[6]Marcano et al noted that prone positioning results in cephalad movement of ETT within the trachea [7]. These concerns mark the need for a well fitted ETT in paediatric patients with prone position.

Earlier an approximate size of ETT was determined by physical indices like, age-based formulae, size of the little finger and height based formulae. [8] Conventionally in our institute we use age based and little finger diameter formulae to estimate the size of ETT. Hence we compared the size of ETT estimated by these two formulae with that estimated by usg and the actual size used clinically.

Preoperative preparation and anaesthesia technique or postoperative care during the study period were kept constant in order to avoid bias. In all the subjects the minimal transverse diameter of the subglottic airway (MTDSA) was measured as previous studies have reported that ultrasound can accurately measure airway diameter in the transverse, which is not possible in the anteroposterior direction. As the anteroposterior diameter of the trachea is

larger than its transverse diameter, and this causes underestimation of the actual tracheal diameter and hence a smaller size of ETT than actual needed. Hence we decided to study the MTDSA as the study population was in prone position.

Earlier studies conducted by Schramm etal and Bae JY etal also conclude that the MTDSA is more accurate than age based formulae in predicting the exact size of ETT in paediatric patients.[9]

In a study by Altunetal they marked the cricoid cartilage as the reference point for measuring the subglottic diameter and it was suggested to be reliable and consistent [10] while Shihetal used the subglottic diameter as reference stating that it being the narrowest part of paediatric airway its diameter estimation will avoid any trauma to airway.[11]

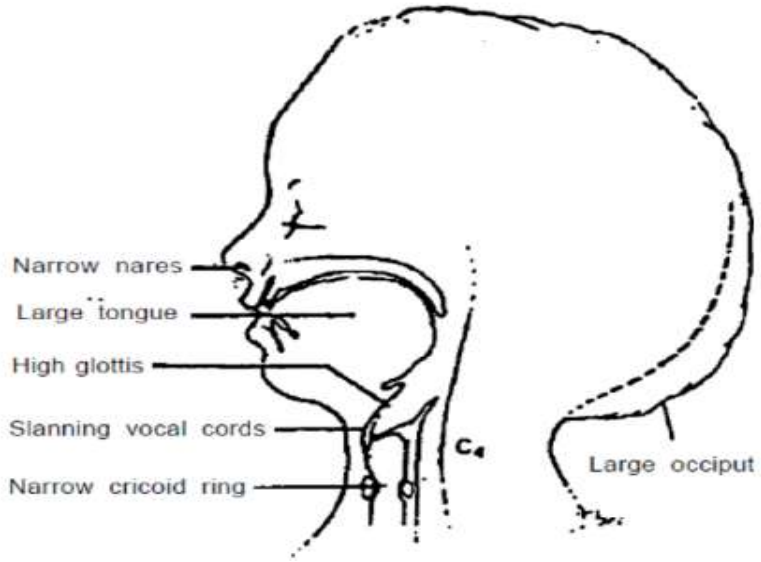
Different manufacturers have different ETT outer diameters. To avoid this bias we used only Portex uncuffed endotracheal tubes. Singh et al also standardized the brand of ETT to avoid differences in internal and external diameters.[12] In our study we found that estimation of MTDSA by USG was 100% accurate but the estimation of ETT size by age based formulae was 94% accurate and the estimation by left little finger diameter was about 99% accurate. These results are in accordance with those of Singh et al.

We did not notice any incidence of desaturation, hypotension, bradycardia, sudden extubation or kinking and post extubation stridor in our results.Thus confirming its accuracy even when the patients are in prone position.

USG has been utilized earlier by various researchers to estimate paediatricETT size but none of them report its efficacy in patients positioned prone for surgeries.

We authors accept certain limitations of our study. Estimating the best fit tube size by observing the air leak test is a subjective finding and can be variable. Also the estimation of MTDSA by USG needs acquaintance of USG which may be variable. Though all measures were taken to avoid bias and the most experienced anesthesiologists were asked to do the estimation.

Figure 1 – Paediatric airway anatomy



Conclusion:-

USG proves to be useful predictor of ETT size estimation in paediatric patients and the accuracy is so much as to which can be relied upon even in patients positioned prone for surgery.

Refrences:-

1. Lakhal K, Delplace X, Cottier JP, Tranquart F, Sauvagnac X, Mercier C, et al. The feasibility of ultrasound to assess subglottic diameter. AnesthAnalg. 2007;104:611-14.
2.Gupta K, Gupta PK, Rastogi B, Krishan A, Jain M, Garg G. Assessment of the subglottic region by ultrasonography for estimation of appropriate size endotracheal tube: A clinical prospective study. Anesth Essays Res. 2012;6:157-60.
3. Lumb AB, Nunn JF. Respiratory function and ribcage contribution to ventilation in body positions commonly used during anesthesia. AnesthAnalg 1991; 73: 422–6
4.Khine H, Corddry D, Kettrick R, Martin T, McCloskey J, Rose J, et al. Comparison of cuffed and uncuffed endotracheal tubes in young children during general anesthesia. Anesthesiology. 1997;86:627-31
5.Shibasaki M, Nakajima Y, Ishii S, Shimizu F, Shime N, Sessler DI, et al. Prediction of paediatric endotracheal tube size by ultrasonography. Anesthesiology2010;113:819-24.
6.Anderton JM. The prone position for the surgical patient: a historical review of the principles and hazards. Br J Anaesth 1991; 67: 452–63
7. Marcano BV, Silver P, Sagy M. Cephalad movement of endotracheal tubes caused by prone positioning paediatric patients with acute respiratory distress syndrome. Pediatr Crit Care Med 2003;4 (2):186–189. [PubMed: 12749650]
8. King BR, Baker MD, Braitman LE, Seidl-Friedman J, Schreiner MS. Endotracheal tube selection in children: A comparison of four methods. Ann Emerg Med 1993;22:530-4.
9.Bae JY, Byon HJ, Han SS, Kim S, Kim JT. Usefulness of ultrasound for selecting a correctly sized uncuffed tracheal tube for paediatric patients. Anaesthesia. 2011;66:994–98.
10.Altun D, Sungur MO, Ali A, Bingül ES, Seyhan TÖ, Çamcı E, et al. Ultrasonographic measurement of subglottic diameter for paediatric cuffed endotracheal tube size selection: Feasibility report. Turk J AnaesthesiolReanim2016;44:301-5.
11. Shih MH, Chung CY, Su BC, Hung CT, Wong SY, Wong TK. Accuracy of a new body length based formula for predicting tracheal tube size in Chinese children. Chang Gung Med Journal. 2008;31(3):276-79
12. Singh S, Jindal P, Ramakrishnan P, Raghuvanshi S. Prediction of endotracheal tube size in children by predicting subglottic diameter using ultrasonographic measurement versus endotracheal tube size in children versus traditional formulas. Saudi J Anaesth2019;13:93-9.