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A clinical comparative study of microcuff paediatric tracheal tube v/s uncuffed endotracheal tubes in paediatric airway management

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Abstract

Background: In paediatric airway management, uncuffed Endo tracheal tubes(UETT) were always thought to be safe for practice. Cuffed ETT(CETT) were found to cause airway edema and increased resistance to airflow in the post extubation period. With the advent of Microcuff paediatric tracheal tube (MPTT), the airway management protocol has led to tremendous change. The goal of our study was to compare TT exchange rates and post extubation stridor between MPTT and uncuffed TTs in paediatrics.

Methods: 140 paediatric patients aged 1 to 6 yrs., requiring general anesthesia were divided into group 'MPTT' (Microcuff Paediatric Tracheal Tube) and group 'U' (Uncuffed ETT) randomly. Patients were intubated orally following which incidence of number of tube exchange rates and post-extubation stridor for both MPTT and uncuffed tubes was noted. In addition, airway sealing pressure was noted for MPTT.

Results: We found that, there was less tracheal tube exchange rate with MPTT and post extubation stridor was comparable with uncuffed ETT.

Conclusion: This clinical study shows that the MPTT are safe for use as they have fewer incidence of airway morbidity namely tube exchange rates and post extubation stridor.

Keywords: Cuff pressure, Microcuff paediatric tracheal tubes, Stridor, Tracheal sealing pressure, Tube exchange rate, Uncuffed tube

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Introduction

Use of cuffed ETT in children for securing the airway is a topic of debate. This is because of expected side effects of CETTs like tracheal mucosal injury, its sequalae in post extubation period.[1,2] It has been said that airway mucosal perfusion could be hampered when pressure exceeds 48 cm of H_2O.[3] The goal of any cuff newly designed or yet to be designed should be such as to provide enough seal but not allow aspiration.

The disadvantages of oversized ETTs is subglottic mucosal ischemia and ulceration which may lead to post extubation stridor, especially when intubated for longer duration whereas uncuffed ETTs may result in aspiration, air leak and environmental pollution due to inadequate sealing. In addition, uncuffed tubes in daily practice have varying outer diameters in parallel with different manufacturing companies. Because of above disadvantage the anaesthetists experience difficulty in choosing an appropriate sized tube for that particular child at very first attempt. So, in our study, we have chosen MPTT and UETT from only one manufacturing company.

End points of this study were to compare sealing pressure, tracheal tube exchange rates and post extubation stridor between microcuff and uncuffed endotracheal tubes in paediatric patients.

Material and Method

After obtaining institutional ethical committee clearance and written informed parental consent, the study was conducted over a period of three years on 140 children at Bapuji hospital, Davangere. Children aged between 1 to 6 years belonging to ASA grade I and II undergoing elective surgery under general anaesthesia were randomly selected. ASA grade III, IV, emergency surgeries and those with airway anomalies were excluded. A thorough pre anesthetic evaluation was carried out in all the patients and the procedure was explained in detail to parents/guardians. Subjects were divided into group 'MPTT' and group 'U' randomly. After securing appropriate sized I.V. cannula, patients were premedicated with inj. Fentanyl 2µg/kg IV and inj.Glycopyrrolate .01mg/kg IV. Patients were preoxygenated and induced with inj. Propofol 2mg/kg, relaxed with inj.Atracurium 0.5mg/kg and then intubated orally with appropriate size ETT using direct laryngoscopy as mentioned below,

For MPTT (Kimberly Clark) tubes, Newborn>3 kg <1 yr = 3 mm, ID of 3.5 mm = 1 to 2 yr, ID in mm=Age/4+3.5(2yrs), Age/4+3 > 3 yrs according to manufacturer's user protocol.

For uncuffed (Rusch) ETT - Age < 6 yrs =age in yrs / 3 + 3.5 according to modified Cole's formula.[4]

After intubation with either of the tubes, we confirmed an audible air leak at an airway pressure less than or equal to 20 cm of H_2O with positive pressure

ventilation.[5,6,7] With MPTT, cuff was inflated using pressure manometer(Fig. 1) to sealing pressure of 20 cm of H_2O or till the leak stopped whichever was attained earlier. At 20cm of H_2O of cuff sealing pressure, if still air leak was present tube was judged to be small and exchanged for next larger size(+0.5 mm). Minimal cuff pressure required to seal the airway and quality of sealing was recorded. Immediately after intubation, with either of the tubes if there was no audible air leak, the tube was judged to be bigger and exchanged for one smaller size(-0.5 mm). If there was excessive air leak with uncuffed tracheal tube not allowing adequate ventilation, it was exchanged for next larger size. Further, number of TT exchanges to find the appropriate-sized tube was recorded. Patients were maintained on O_2, N_2O, Inj. Atracurium 0.1mg/kg and volatile anesthetics. At the end of surgery patients were extubated after reversal with inj.Neostigmine and inj.Glycopyrrolate. Patients were observed for post-extubation stridor immediately, 2nd hr and 6th hr.

Fig. 1: Microcuff paediatric endotracheal tube and pressure transducer

Descriptive statistics were summarised in the form of mean±SD. Qualitative data were analysed using Chi square test and quantitative data were analysed using Student t test. P value less than 0.05 was considered as statistically significant. Statistical analysis was done using SPSS software (19th version).

Results

Demographic profile is as depicted in Table 1. There is no significant difference between two groups in terms of age, weight, gender and ASA category at p value of 0.05.

Table 1: Demographic data

	MPTT	U	p value
Age of patients (yr) (mean±SD)	3.30±1.72	3.10±1.38	0.43
Wt. of patients (kg) (mean±SD)	12.38±2.91	12.03±2.63	0.33
Gender (M:F)	32:38	35:35	0.61
ASA (I:II)	61:9	64:6	0.41

In our study, tube exchange rate was found to be statistically significant between the groups ($p<0.0003$)(Table 2). Excessive air leak was the commonest reason for tube exchange in both the groups, followed by no air leak in UETT group. In one of the patient UETT was exchanged twice for excessive air leak(Table 3).

With mean cuff pressure of 9.26 cm of H_2O(Table 2), we were able to seal the trachea with audible air leak in MPTT group. Post extubation stridor was noted 4%(Table 2) in either group. Exchange rate did not influence much of post extubation stridor in both the groups.

Table 2: Primary outcomes

	MPTT	U	p value
Duration of Tracheal intubation(mins) (Mean±SD)	77.67±15.25	78.80±17.45	0.69
No. of tube exchanges	3(4%)	18(26%)	0.0003
Minimal cuff pressure for sealing trachea(cm of H_2O)(mean)	9.26	NA	NA
Post-extubation stridor	3(4%)	3(4%)	1

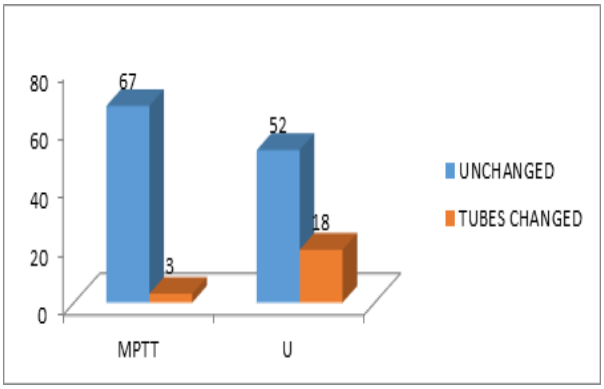

Fig. 2: No of children requiring Tube exchange

Table 3: Reasons for tube exchange

	MPTT	U
Excessive air leak	3	11
No air leak	0	7
Patients with more than one tube exchange	0	1

Discussion

Results obtained in this study for tube exchange rate and post extubation stridor proves that MPTT is a better and safer alternative when used as per manufacturer's user protocol for ET tube size selection.

In our study, we found out that, the tube exchange in UETT group was 26%, which was comparable to previous studies done by M. Weiss et. al., and A. Dullenkopf et. al.[8,14]

The main reason for the tube exchange in 'U' group is due to quandary in selecting an appropriate sized uncuffed tube from multiple companies with different outer diameters for same internal diameter resulting in post extubation complications in paediatric patients. To overcome this, we selected uncuffed tube from a single company.

The low rate of MPTT exchange in our study (4%), is comparable to that reported by M. Weiss et.al. (2%) and A. Dullenkopf et.al. (1.6%) which is statistically significant compared to uncuffed ETT ($p<0.0003$). Therefore MPTT proved a better alternative when compared to uncuffed ETT, thereby reducing the tube exchange rate, attempts of repeated laryngoscopy, intubation and trauma associated with it.

Finding an appropriate MPTT in first attempt in our study was 96%, whereas that for UETT was 74% which was comparable to previous studies done by M. Weiss et.al.[8] One of the reasons for decreased tube exchange rate in MPTT group was, these cuffed tubes were selected with a smaller diameter and cuff was inflated till it would provide adequate airway seal when ventilated to maximum of 20 cm of H_2O airway pressure. This resulted in significant reduction in tube exchange.

Finding an appropriate TT at the first attempt will be particularly helpful in emergency and intensive care settings and also for less experienced Anaesthesiologists.

Many Anesthesiologists using cuffed ETT in children still fear cuff induced airway lesion like post-extubation stridor. The acceptable limit for cuff pressure in paediatrics is said to be less than 25 to 30 cm of H_2O.[9,10]

The cuff of MPTT allowed to seal the trachea in all our patients was at cuff pressures less than or equal to 20 cm of H_2O, with a mean cuff pressure of 9.26 cm of H_2O which is, a value much lower than usually reported for uncuffed ETTs.[11,12,13]

The mean sealing pressure in our study was 9.26 cm of H_2O, comparable with M. Weiss et. al. (10.6 cm of H_2O) and A. Dullenkopf et.al. (9.7 cm of H_2O).[8,14]

The architecture of trachea is non uniform, non cylindrical, irregular and D- shaped. Also, narrowest portion of adult airway is glottis but it is subglottic area in children which plays an important role when it comes to use of cuffed ETTs.

Conventional ETTs are provided with cuff made of Poly vinyl chloride which are 50-80 microns thick, which when inflated form small channels in between cuff and tracheal wall encouraging microaspiration. In view of above disadvantage cuff needs to be inflated to pressure as high as 50 cm of H_2O.

MPTTs are designed with cuff made of ultrathin polyurethane material which is 10 microns thick. This feature allows sealing of tracheal lumen at cuff pressures less than 15 cm of H_2O or lower.[14] The ultrathin membrane allows trachea to be sealed without formation of channels between cuff and tracheal wall, henceforth avoiding microaspiration. Adequate seal provided reduces loss of exhaled gas into the surrounding area preventing air pollution, better expired gas analysis and helps in maintaining low flow anaesthesia and proves to be cost effective.

One problem of this ultrathin cuff is that it has to be handled very carefully.

One change with respect to murphy eye is its deletion in MPTT thereby giving space for distal placement of cuff on the shaft of MPTT. Also cuff is designed to be short enough to provide subglottic free zone when expanded, henceforth decreasing post extubation stridor. MPTT also has facilitated proper placement of cuff because of depth markings imprinted on it.

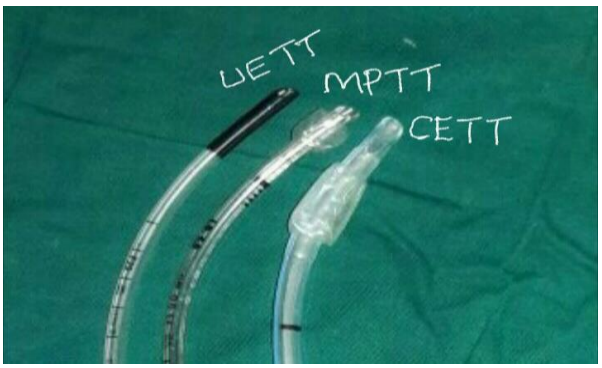

Fig. 3: Depth of cuff in different endotracheal tubes

Conclusion

MPTTs offer many benefits for routine use in paediatric airway management. Their usage requires selection of appropriate sized tracheal tube and cuff pressure monitoring. The extra expense due to use of MPTTs can be overcome by decrease in rate of tracheal reintubation with different sizes of UETTs. The use of MPTTs in small children provides a reliably sealed airway at pressures 0f </=20 cm of H_2O, reduces the tracheal tube exchange rate with comparable risk of post extubation stridor.

Limitations of our study

1. Study done only for operative period, not done for mechanically ventilated children.
2. Study not done comparing MPTT and CETT
3. UETTs from different manufacturers has not been compared with MPTT.

Conflict of interest: No conflict of interest.

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