Original Research Paper

Volume-9 | Issue-1 | January-2019 | PRINT ISSN - 2249-555X

ANAESTHESIOLOGY

COMPARATIVE STUDY OF MICROCUFF ENDOTRACHEAL TUBE AND UNCUFFED ENDOTRACHEAL TUBE IN PEDIATRIC ABDOMINAL SURGERIES.

Dr. Pravin Rameshrao Kutemate — Senior Resident Doctor, Department of Anaesthesia, B.J. Medical College, Sassoon Hospital, Pune

Dr. Maya Jamkar* — Professor, Department of Anaesthesia, B.J. Medical College, Sassoon Hospital, Pune *Corresponding Author

Dr. Pradnya Bhalerao — Associate Professor, Department of Anaesthesia, B.J. Medical College, Sassoon Hospital, Pune

ABSTRACT

INTRODUCTION AND AIMS: Since last 60 years pediatric anesthetists have used uncuffed tubes in infants and have lived with the handicaps of uncuffed tubes. The tradition to use uncuffed tubes in pediatrics patients and the condemnation of the cuff are not very logical and should be reconsidered in view of new scientific evidence and developments. In the last few years it has been shown that microcuff tubes can safely be used in pediatric age group and that there is no need to forego the benefits of a sealed airway.

METHOD'S- 60 children of ASA physical status I or II scheduled for elective surgery were randomly allocated into 2 groups. Group A were intubated with microcuff endotracheal tube. Group B were intubated with uncuff endotracheal tube. In our present study we compare tube exchange rate, capnography, post-extubation stridor in both microcuff and uncuffed endotracheal tubes. Also we monitored intracuff pressure in microcuff tubes.

RESULTS- Tube exchanges were significantly lower in Microcuff endotracheal tube than uncuffed endotracheal tube. Plateau-type capnography was noted in patients with Microcuff endotracheal tubes and post extubation stridor was significantly lower in Microcuff endotracheal tube than uncuffed endotracheal tube.

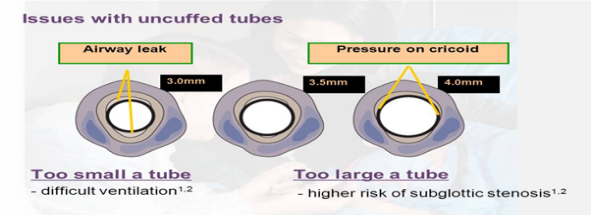
CONCLUSION- Microcuff endotracheal tubes are desirable and safe to use in the pediatric patients population, provided they are used appropriately, with care and attention given to proper sizing and assessment of cuff pressures.

KEYWORDS : microcuff endotracheal tube, pediatric patients.

INTRODUCTION

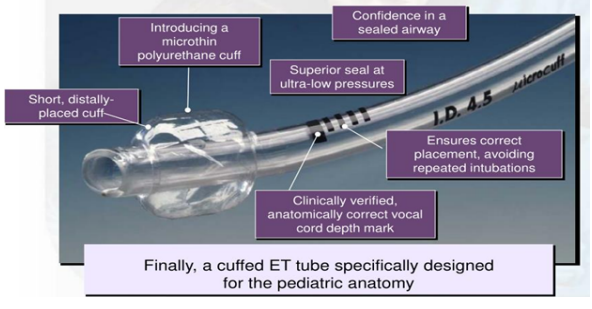
Traditional teaching suggests that in children under 8 years of age requiring intubation, uncuffed tracheal tubes should be used.(1) Practically, it is often difficult to find an appropriately sized tube which produces adequate seal for ventilation and an acceptable leak minimizing undue pressure on the laryngeal mucosa and surrounding structures. The search for this perfect balance can result in a dilemma: whether to accept large air leak or to insert an oversized tracheal tube.

Previously the infant airway was thought to be funnel shaped with the narrowest portion at cricoid cartilage being round[(2)] However, Litman et al report that the cricoid cartilage is in fact ellipsoidal and that the uncuffed tube rests on the posterolateral aspects of this area. This can cause excessive pressure on the adjacent mucosa yet a leak can still occur through the anterior aspect of the cricoid area. (3) Uncuffed tubes are sealed by the encircling cricoid ring which is called "cricoid sealing", whereas the cuffed tubes provides tracheal sealing by cuff inflation below the cricoid ring. Tracheal sealing with a high- volume low-pressure (HVLP) cuff allows to estimate and adjust precisely the pressure exerted by the cuff on the tracheal mucosa.



Several studies stated multiple disadvantages of uncuffed endotracheal tube like inappropriate size selection, increased tube exchange rate, chance of aspiration, gas leakage, operation theatre pollution, difficult low flow anesthesia, improper monitoring of end-tidal CO_2 ($EtCO_2$), tube tip dislodgement, and accidental extubation during manipulation of head. Throat pack given to prevent these complications again increases pack related postoperative sore throat. These problems can be solved by the use of microcuff tube. In last few years it has been shown that cuffed tubes can safely be used in infants and pediatric age group and that there is no need to forego the benefits of a sealed airway.

Microcuff tubes are specially designed cuffed tubes meant for the pediatric population. The cuff of the Microcuff tracheal tube differs from the conventional cuff in that it is made from ultra-thin (10 µm) polyurethane foil instead of the much thicker (50–70 µm) polyvinyl chloride or polyethylene foils. The Murphy eye has been eliminated, which has allowed the cuff to be moved more distally on the tracheal tube shaft. The cuff is short and when inflated, it expands below the sub-glottis, providing a seal with cuff pressure <15 cm H2O. The airway is sealed at upper trachea where the posterior membranous wall can stretch and produce a complete seal, rather than at the cricoid level. Thus, the problem that the cuff will cause airway mucosal injury, leading to sub-glottic stenosis is circumvented. Cuffed tracheal tubes in smaller children are increasingly used because of the high probability of inserting a correctly sized tracheal tube at the first intubation attempt and to create an effective airway seal without the use of an oversized tracheal tube.



In the past, concerns have been raised regarding cuffed tubes that the pressure in the balloon portion may be too high, that may cause pressure necrosis of the surrounding fragile epithelium potentially resulting in permanent upper airway damage such as subglottic stenosis. It was found that microcuff pediatric endotracheal tubes

required significantly lower sealing pressures of 11 cm H_2O when compared to other cuffed endotracheal tubes.(4) Microcuff endotracheal tubes are safe to use in the pediatric patients population, provided they are used appropriately, with care and attention given to proper sizing and assessment of cuff pressures.

This study was aimed to evaluate the use of microcuff endotracheal tube as compared to uncuffed endotracheal tube in pediatric patients. In our study we compare tube exchange rate, capnography, post-extubation stridor in both microcuff and uncuffed endotracheal tubes. Intracuff pressure was also monitored in the our study during surgery in microcuff tubes.

METHODS

After obtaining institutional Ethics Committee approval and written informed consent from all patient parents in their vernacular language. 60 neonates and children patients, of age group 3 month to 5 year of either sex, ASA (American Society of Anesthesiologists) grade I and II requiring abdominal surgery is enrolled in this study. Patients were randomly divided into 2 groups of 30 each by computerized randomization.

Group A (n=30) Patients intubated with microcuff endotracheal tube.
Group B (n=30) Patients intubated with uncuff endotracheal tube.
Patients with known airway anomalies, known or suspected difficult intubation, surgeries with planned post-operative ventilation, patients with respiratory tract infection were excluded from the study.

SIZING OF ENDOTRACHEAL TUBES:

Uncuffed endotracheal tube

size were calculated using Modified Cole's formula [size (mm internal diameter) = (age/4) + 4]

Microcuff endotracheal tube

Selection of an appropriately sized microcuff endotracheal tube to prevent airway mucosal injury is important. Cuffed endotracheal tube should be 0.5-1.0 mm smaller than the Uncuffed endotracheal tube.

Microcuff endotracheal tube

sized by a new Khine's formula(5)
[size (mm internal diameter) = (age/4) + 3]

Cuffed Size (mm ID)	Uncuffed Size (mm ID)	Patient's Age
3.0	4.0*	Full term newborn to 1st birthday
3.5	4.5	1 y to 3rd birthday
4.0	5.0	3 y to 5th birthday
4.5	5.5	5 y to 7th birthday
5.0	6.0	7 y to 9th birthday

* Smaller at discretion of attending anesthesiologist: 3.0 in 4 patients; 3.5 in 11 patients, 4.0 in 34 patients.

An intravenous line was established and Intravenous fluid started. Routine preparation of anesthesia machines and drugs were done. Premedication were administered slowly through iv route. Induction of general anesthesia with Inj. Thiopentone sodium 5-7 mg/kg iv and muscle relaxation with Inj. Succinylcholine 2mg/kg was done and followed by intubation with appropriate-sized uncuffed endotracheal tube in group A and Microcuff endotracheal tube in group B.

In case of microcuff endotracheal tubes, air leak pressure after intubation was tested with the patient in supine and head in a neutral position. In the absence of air leak at 20 cm H_2O inflation pressure, the tube had judged to be too large and replaced with the next smaller size (−0.5 mm ID). Tracheal tube with excessive air leak, not allowing adequate ventilation was exchanged to the next larger size (+0.5 mm ID). The cuff was inflated using the cuff pressure manometer. Cuff pressure was monitored continuously. Minimal sealing pressure was assessed under steady-state ventilation conditions and maintained during the procedure. This was performed by reducing the cuff pressure until an audible leak appeared at the patient's mouth and then pressure was increased until leak disappeared.

In case of uncuffed tube, after intubation with appropriate size tube, throat packing was done in case of air leakage.

Patients were maintained on O_2:N_2O (50%-50%), Isoflurane was used as inhalational agent – 0.4% to 0.6% and Inj. Atracurium was used as a skeletal muscle relaxant. Intracuff pressure was monitored every 30 minutes with the help of cuff pressure measuring device. Intra operatively we monitor Pulse rate, Blood pressure, Oxygenation saturation, Intracuff pressure and Capnography ($ETCO_2$). Post-operatively we monitored Pulse rate, Blood pressure, Oxygenation saturation and Post Extubation Stridor in both groups.

Statistical Analysis of data was managed in Microsoft excel spreadsheet. The data were expressed as mean ± SD. 2 independent sample t test, Chi square test and Wilcoxon signed rank test were used to investigate and model impact of various parameters like gender distribution, age, weight, ASA grading, tube exchange rate, intraoperative and postoperative pulse, B.P., SPO_2, intraoperative etco2, intracuff pressure monitoring and post extubation stridor. Demographics and General information like count, average and percentage for various parameters with all permutations and combinations were calculated in Microsoft excel. A p value <0.05 was considered statistically significant All graphs were drawn and all statistical analysis was done using GraphPad Prism 7.03 software.

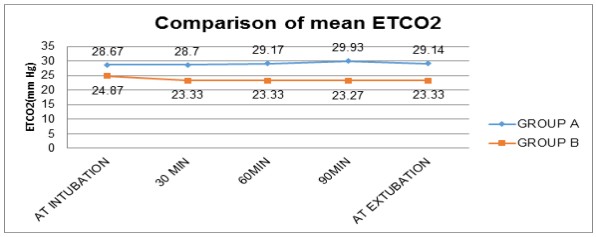
RESULTS

The study groups were comparable in terms of demographic profile such as age, sex, weight and ASA physical status. Intra operative vitals (Heart rate, blood pressure, oxygen saturation) also comparable in both the study groups. Intraoperative.

In present study we compare the use of microcuff versus uncuffed endotracheal tubes and the impact on tracheal tube exchange rate. We found that tube exchange rate was 6.6% in group A and 30% in group B. p-value is (0.045) which is <0.05 therefore number of tube exchanges significantly lower in GROUP A than GROUP B.

	GROUP A	GROUP B	Total	P-value
Tube exchanged	2(6.6%)	9(30%)	11(18%)	0.045
Tube not exchanged	28(93.3%)	21(35%)	49(70%)	
Total	30(100%)	30(100%)	60(100%)	

Mean End tidal CO_2 was measured and compared after induction, at 30 minute, 60 minutes, 90 minutes, and before extubation respectively in both Group A and Group B. In our study we found that in GROUP A, P value (>0.05) hence there was no significant difference between etCO2 at intubation to etCO2 at 30 min, 60 min and at extubation. In GROUP B, P value <0.05, hence there was significant difference between etCO2 at intubation to etCO2 at 30 min, 60 min and at extubation. Mean etCO2 varied significantly at various points of time in group B. In microcuff



endotracheal tube we found the better tracheal seal caused by the microcuff which result in significantly enhanced conditions regarding the ability to record an adequate capnography trace, which is difficult if uncuffed tubes are used. Plateau-type capnography was noted in patients with Microcuff endotracheal tubes.

Patient's trachea were extubated awake. Immediately before extubation, the cuff was fully deflated and then the tube was removed from the patient's trachea. Occurrence of post- extubation stridor, defined as any new high pitched inspiratory sound, within 1 h after extubation. In our study, post extubation stridor was seen in 3.3% patients in GROUP A and 20% patients in GROUP B with P value 0.04 ($p < 0.05$) which is statistically significant. Therefore number of patients with post extubation stridor are significantly lower in GROUP A than GROUP B.

Stridor	Group		Total	P-value
	GROUP A	GROUP B		
Seen	1 (3.3%)	6 (20%)	7 (11.6%)	0.04
Not seen	29 (96.6%)	24 (80%)	53 (88.3%)	
Total	30(100%)	30(100%)	60 (100%)	

In our study we monitor intracuff pressure using safety device called Cuff pressure manometer with pressure release valve so that the cuff pressure never exceeds the set limit. And we found that Mean intracuff pressure gradually increased in group A from intubation value then at 30 min , 60 min till 90min which is 11.3 at intubation 11.66 at 30 min , 11.7 at 60 min, 11.9 at 90 min.

Postoperative vitals (Heart rate, blood pressure, oxygen saturation) were also found comparable in both the study groups.

DISCUSSION

There are many shortcomings of uncuffed endotracheal tubes. Such problems associated with uncuffed tracheal tubes can easily overcome by the use of a microcuff endotracheal tube. Though the cost of microcuff tube is higher than uncuffed tubes,but it can be outweighed by savings in exchanged tracheal tubes, anesthetic gases and oxygen(5).Cuff hyperinflation is not a pediatric problem but a problem of absent cuff pressure monitoring. To date,, cuff manometers are available for cuff pressure monitoring in clinical use(6)

Dullenkopf et al evaluate a new microcuff endotracheal tube And found that Microcuff pediatric tracheal tubes provided tracheal sealing with cuff pressures considerably lower than usually accepted. The rate of tube exchange was very low (1.6%), as was the rate of airway morbidity.(7)

Because of ease of intubation and high probability of inserting a correctly sized tracheal tube at the first intubation attempt with least post extubation morbidity and advantages of sealed airways, Microcuff endotracheal tubes was introduced in pediatric anesthesia.

In present study we compare the use of microcuff versus uncuffed endotracheal tubes and the impact on tracheal tube exchange rate. We found that number of tube exchanges were significantly lower in GROUP A (6.6%) than GROUP B (30%).

Weiss, M. Dullenkopf et al(1)
in 2009 found that Tube exchange rate was 2.1% in the cuffed and 30.8% in the uncuffed groups (P <0.0001). This results are similar to the findings in our study.

Crankshaw, D Mcviety et al(8)
in 2014 done study and concluded that cuffed tubes are shown to decrease the need for multiple intubations, reduce costs and are not shown to increase adverse effects in children of all ages. The results are in accordance with our study.

In microcuff endotracheal tube we found the better tracheal seal caused by the microcuff which result in significantly enhanced conditions regarding the ability to record an adequate capnography trace, which is difficult if uncuffed tubes are used. Plateau-type capnography was noted in patients with Microcuff endotracheal tubes.

Mhamane Rameshwar, Dave Nandini et al(9)
in 2015 studied the appropriateness of Microcuff tube size selection, efficacy of ventilation, and complications, in children undergoing laparoscopy. In their study plateau-type capnography was noted in all patients. The results are in accordance with our study.

Weiss, M. Dullenkopf, et al(1)
also noted intraoperatively that capnography was reliable in 98.6% (cuffed TTs) and in 95.6% (uncuffed TTs) (P < 0.0001, risk ratio 1.03).which is in accordance with our study.

In present study, we also compared post extubation stridor in both groups and found that post extubation stridor was significantly lower in Microcuff endotracheal tube (GROUP A) than uncuffed endotracheal tube (GROUP B).

Weiss, M. Dullenkopf, et al(1)
noted Post-extubation stridor in 4.4% of patients with cuffed and in 4.7% with uncuffed TTs (P=0.543). They concluded that the use of cuffed ETT in small children does not increase the risk for post-extubation stridor compared with uncuffed endotracheal tubes.

Shi, Fenmei Xiao, et al(10)
in 2016 also that the use of cuffed ETTs did not significantly increase the incidence of post-extubation stridor and the TT exchange rate was lower in patients receiving cuffed tubes intubation (p<0.00001)

In our study we monitor intracuff pressure using Cuff pressure manometer with pressure release valve so that the cuff pressure never exceeds the set limit. And we found that Mean intracuff pressure gradually increased in group A from intubation value then at 30 min , 60 min till 90min which is 11.3 at intubation 11.66 at 30 min, 11.7 at 60 min, 11.9 at 90 min.

Weiss, M. Dullenkopf et al.(1)
Noted that the minimal cuff pressure required to seal the trachea was 10.6 (4.3) cm H2O. This results are in accordance with our study.

Mhamane Rameshwar, Dave Nandini et al(9)
in their study noted Mean sealing pressure was 11.72 cm H2O. They concluded that Microcuff tubes can be safely used in children if size selection recommendations are followed and cuff pressure is strictly monitored.

CONCLUSION

From present study it can be concluded that, microcuff endotracheal tube is a better choice than uncuffed endotracheal tubes in pediatric patients. As this new microcuff endotracheal tube has low tube exchange rate, provide better sealing with reliable capnography and it has low incidence rate of post extubation stridor than uncuffed endotracheal tube when we meticulously monitor intracuff pressure.

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