Clinical Investigation

Use of Microcuff® endotracheal tubes in paediatric laparoscopic surgeries

Address for correspondence:
Dr. Nandini Dave,
C 303, Presidential Towers,
LBS Marg, Ghatkopar West,
Mumbai - 400 086,
Maharashtra, India.
E-mail: nandinidave@gmail.com

Rameshwar Mhamane, Nandini Dave[1], Madhu Garasia[1]
Department of Anaesthesiology, T. N. M. C. and B. Y. L. Nair Charitable Hospital, [1]Department of Anaesthesiology, Seth GS Medical College and KEM Hospital, Mumbai, Maharashtra, India

Access this article online
Website: www.ijaweb.org
DOI: 10.4103/0019-5049.151367
Quick response code

ABSTRACT

Background and Aims: Traditionally, uncuffed endotracheal tubes have been used in children. Cuffed tubes may be useful in special situations like laparoscopy. Microcuff® endotracheal tube is a specifically designed cuffed endotracheal tube for the paediatric airway. We studied the appropriateness of Microcuff® tube size selection, efficacy of ventilation, and complications, in children undergoing laparoscopy. **Methods:** In a prospective, observational study, 100 children undergoing elective laparoscopy were intubated with Microcuff® tube as per recommended size. We studied appropriateness of size selection, sealing pressure, ability to ventilate with low flow, quality of capnography and post-extubation laryngospasm or stridor. **Results:** Mean age of the patients was 5.44 years (range 8 months 5 days–9 years 11 months). There was no resistance for tube passage during intubation in any patient. Leak on intermittent positive pressure ventilation at airway pressure ≤20 cm H_2O was present in all patients. Mean sealing pressure was 11.72 (1.9 standard deviation [SD]) cm H_2O. With the creation of pnemoperitoneum, mean intracuff pressure increased to 12.48 (3.12 SD) cm H_2O. With head low positioning, mean cuff pressure recorded was 13.32 (2.92 SD). Ventilation at low flow (mean flow 1 L/min), plateau-type capnography was noted in all patients. Mean duration of intubation was 83.50 min. Coughing at extubation occurred in 6 patients. Partial laryngospasm occurred in 4 patients, which responded to continuous positive airway pressure via face mask. Severe laryngospasm or stridor was not seen in any patient. **Conclusion:** Microcuff® tubes can be safely used in children if size selection recommendations are followed and cuff pressure is strictly monitored. Advantages are better airway seal and effective ventilation, permitting use of low flows.

Key words: Microcuff® endotracheal tube, pediatric, laparoscopy

INTRODUCTION

The basic function of a tracheal tube is to provide a reliable connection between the patient's lung and the bag or ventilator. Ideally, this connection should be leak-proof without causing undue pressure to laryngeal or tracheal structures. Traditional teaching was that in children under 8–10 years of age, this sealing should be obtained with an uncuffed tracheal tube.[1] Disadvantages of uncuffed tubes include air leak, difficulties in effectively ventilating patients with lung disease, environmental contamination of anaesthetic gases, risk of aspiration, and difficulty in accurate measurement of end-tidal CO_2 concentration.[2,3]

Cuffed endotracheal tubes may be useful in special situations like laparoscopy and in surgical conditions at risk of aspiration.[4] Microcuff® endotracheal tube is specifically designed for the paediatric airway anatomy. Intubation depth marks and short, cylindrical cuff near tracheal tube tip allow adequate placement with a cuff-free subglottic zone, without the risk of endobronchial intubation.[5] We studied the appropriateness of microcuff® endotracheal tube size selection, efficacy of ventilation and monitoring and post-operative complications in children undergoing laparoscopic surgery.

How to cite this article: Mhamane R, Dave N, Garasia M. Use of Microcuff ® endotracheal tubes in paediatric laparoscopic surgeries. Indian J Anaesth 2015;59:85-8.

METHODS

After Institutional Ethical Committee approval and written informed consent from the parents, a prospective observational study was conducted. The study population included 100 patients of American Society of Anesthesiologists I and II physical status, aged between 8 months and 10 years, posted for elective laparoscopic surgery. Patients with known airway anomalies, known or suspected difficult intubation and planned post-operative ventilation in the intensive care unit were excluded from the study.

All patients received injection glycopyrrolate 0.004 mg/kg , injection ketamine 0.5 mg/kg, injection midazolam 0.05 mg/kg, all intravenous (IV) as premedication. Standard monitoring included electrocardiogram, pulse oximetry, non-invasive blood pressure, capnography and temperature.

Anaesthesia was induced with injection fentanyl 2 μg/kg, injection propofol 2.5 mg/kg. Injection atracurium 0.6 mg/kg was given to facilitate laryngoscopy and tracheal intubation. Size of microcuff® endotracheal tube was as per manufacturer's guidelines [Table 1]. Air leak pressure after intubation was tested with the patient supine and head in a neutral position. In the absence of air leak at 20 cm H_2O inflation pressure, the tube would be 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 would be exchanged to the next larger size (+0.5 mm ID). The cuff was inflated using the cuff pressure manometer. Cuff pressure was monitored continuously and limited to 20 cm H_2O with a pressure release valve. 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.

Anaesthesia was maintained with O_2: Air (50:50%) and isoflurane, using circle absorber with a mean flow of 1 L/min. Injection atracurium in bolus doses was administered for muscle relaxation. Patients were extubated after reversal with injection glycopyrrolate 0.008 mg/kg and injection neostigmine 0.05 mg/kg.

Parameters studied were size of microcuff® tube used, tube passage characteristics, sealing pressure, capnography characteristics, effectiveness of ventilation, changes in cuff pressure during surgery, complications if any. Coughing, laryngospasm or stridor at extubation was recorded. Any change in voice or cry pitch was also noted.

RESULTS

We studied 100 patients with a mean age of 5.44 years (range 8 months 5 days–9 years 11 months) [Table 1]. Our sample population included 72 males and 28 females. The type of surgeries performed were as shown [Table 2]. There was no resistance during intubation in any patient. Leak on intermittent positive pressure ventilation (IPPV) at airway pressure ≤20 cm H_2O was present in all patients. Mean sealing pressure was 11.72 (1.9 standard deviation [SD]) cm H_2O. With the creation of pneumoperitoneum, mean intracuff pressure increased to 12.48 (3.12 SD) cm H_2O [Table 3]. Further, with head low positioning, mean cuff pressure recorded was 13.32 (2.92 SD). Ventilation at low flow (mean flow1 L/min), plateau-type capnography was noted in all patients. Intraoperative endobronchial intubation or accidental extubation was not seen in any patient. Mean duration of intubation was 83.50 min. Coughing at extubation was seen in 6 patients, which

Table 1: Age of study population, size of Microcuff® tube used and number of patients in each group

Age	Size of Microcuff® tube used	Number of patients
8 months-2 years	3.5	12
2-4 years	4.0	15
4-6 years	4.5	18
6-8 years	5.0	30
8-10 years	5.5	25
Total number of patients	-	100

Table 2: Type of laparoscopic surgery

Surgery	Number of patients
Orchiopexy	20
Inguinal herniorrhaphy	45
Appendicectomy	17
Cholecystectomy	08
Congenital diaphragmatic hernia repair	03
Splenectomy	02
Diagnostic laparoscopy	05
Total	100

Table 3: Intracuff pressure variations

Intracuff pressure (cm H_2O)	Mean (SD)
Supine, with head in neutral position	11.72 (1.90)
With pneumoperitoneum	12.48 (3.12)
With head low position	13.32 (2.92)

SD: Standard deviation

responded to gentle nasopharyngeal suctioning. Partial laryngospasm occurred in 4 patients, which responded to continuous positive airway pressure (CPAP) via face mask. Severe laryngospasm or stridor at extubation was not seen in any patient.

DISCUSSION

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.[6]

Microcuff® tubes are specially designed cuffed tubes meant for the paediatric 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 H_2O. 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.[7-10]

Creation of pneumoperitoneum and Trendelenberg positioning during laparoscopy reduces pulmonary compliance, which may lead to ineffective ventilation or excessive peritubal air leak with an uncuffed tracheal tube. Caudal displacement of the tracheal tube may be considerable during laparoscopy with pneumoperitoneum, especially with additional head-down tilt, increasing the risk of endobronchial migration of the tracheal tube.[11] Laparoscopy also presents a potential for aspiration. Advantages of the microcuff® endotracheal tube in this population, therefore, would be constant minute ventilation, precise respiratory monitoring and capnography, low fresh gas flow and lesser risk of pulmonary aspiration.

Selection of an appropriately-sized cuffed endotracheal tube is important to prevent airway mucosal injury. We were able to intubate the trachea without resistance in all patients, confirming the appropriateness of the size selection recommendations. Air leak was observed with IPPV at airway pressure ≤20 cm H_2O in all patients. Mean sealing pressure was 11.72 (1.9 SD) cm H_2O.

In a randomised controlled multicentre study of more than 2000 patients, Weiss *et al*. concluded that Microcuff® tracheal tubes can be safely used in children if cuff pressure is controlled and size selection criteria followed.[9] Mean sealing pressure in their study was 10.6 (±4.3) cm H_2O. The difference in sealing pressure in our study could be due to the difference in age range or simply due to a difference in population characteristics.

Though the upper limit of safety for cuff pressure in adults is 25–30 cm H_2O, there is no data in children regarding perfusion pressures of the tracheal mucous membrane, and it is believed that a lower cuff pressure would possibly be safe.

For the purpose of our study, effective ventilation meant a square wave capnogram, with $EtCO_2$ values in the clinically acceptable range of 35–45 mm Hg and ability to ventilate with low flow (<2 L/min). Pneumoperitoneum and head low positioning caused an increase in intracuff pressure (mean increase 12.48 [3.12 SD] cm H_2O and 13.32 [2.92 SD] respectively), but the pressure was always <20 mm Hg. In our study, creation of pneumoperitoneum and Trendelenburg position did not affect ventilation or the effectiveness of the seal. The intra-abdominal pressures were limited to 10 mm Hg in patients <4 years and 12 mm Hg in older patients.

Despite the head low positioning, we did not observe endobronchial intubation in any of the patients confirming the appropriateness of the depth marker. This has been corroborated in some other studies as well.[12,13] Confirmation of appropriate tube position in our study was determined clinically, by auscultation in all patients as we did not have a paediatric flexible bronchoscope at our disposal.

Several studies have confirmed the safety of the cuffed endotracheal tube with respect to airway complications, as long as an appropriate size is chosen, and the cuff pressure is monitored.[3,14]

In a study of 204 patients, Duracher *et al*. reported 6 cases of complications (dysphonia, hoarse cough, and laryngeal dyspnea), and attributed those to the use of an incorrectly predicted larger tube size.[15]

Incidence of stridor with Microcuff® tube in study by Weiss *et al*. was 4.4%.[9]

In our study, at extubation, coughing was seen in 6 patients who responded to gentle nasopharyngeal suctioning. Partial laryngospasm was seen in 4 patients who were treated with CPAP using a Jackson–Rees circuit, and humidified oxygen. History of recent upper respiratory tract infection (within 4 weeks) was present in 5 of these patients, which could have been a contributing factor for laryngospasm. No patient had a change of voice or cry pitch.

CONCLUSION

Our study confirms the appropriateness of size selection recommendations of Microcuff® tube in our patient population. Microcuff® tubes can be safely used in paediatric laparoscopy without increasing airway morbidity. Advantages include better airway seal, economy of fresh gas flows, and effective ventilation. Strict monitoring of cuff pressure is recommended whenever cuffed tubes are used in children.

REFERENCES

1. Kaul TK, Bhat D. Editorial: ETT in children-cuffed or noncuffed. J Anaesthesiol Clin Pharmacol 2007;23:229-30.
2. Weber T, Salvi N, Orliaguet G, Wolf A. Cuffed vs non-cuffed endotracheal tubes for pediatric anesthesia. Paediatr Anaesth 2009;19 Suppl 1:46-54.
3. Khine HH, Corddry DH, Kettrick RG, Martin TM, McCloskey JJ, Rose JB, *et al.* Comparison of cuffed and uncuffed endotracheal tubes in young children during general anesthesia. Anesthesiology 1997;86:627-31.
4. Lo¨nnqvist PA. Cuffed or uncuffed tracheal tubes during anaesthesia in infants and small children: Time to put the eternal discussion to rest? Br J Anaesth 2009;103:783-5.
5. Bhardwaj N. Pediatric cuffed endotracheal tubes. J Anaesthesiol Clin Pharmacol 2013;29:13-8.
6. Weiss M, Gerber AC. Cuffed tracheal tubes in children – Things have changed. Paediatr Anaesth 2006;16:1005-7.
7. Dullenkopf A, Gerber AC, Weiss M. Fit and seal characteristics of a new paediatric tracheal tube with high volume-low pressure polyurethane cuff. Acta Anaesthesiol Scand 2005;49:232-7.
8. Weiss M, Dullenkopf A, Böttcher S, Schmitz A, Stutz K, Gysin C, *et al.* Clinical evaluation of cuff and tube tip position in a newly designed paediatric preformed oral cuffed tracheal tube. Br J Anaesth 2006;97:695-700.
9. Weiss M, Dullenkopf A, Fischer JE, Keller C, Gerber AC, European Paediatric Endotracheal Intubation Study Group. Prospective randomized controlled multi-centre trial of cuffed or uncuffed endotracheal tubes in small children. Br J Anaesth 2009;103:867-73.
10. Salgo B, Schmitz A, Henze G, Stutz K, Dullenkopf A, Neff S, *et al.* Evaluation of a new recommendation for improved cuffed tracheal tube size selection in infants and small children. Acta Anaesthesiol Scand 2006;50:557-61.
11. Böttcher-Haberzeth S, Dullenkopf A, Gitzelmann CA, Weiss M. Tracheal tube tip displacement during laparoscopy in children. Anaesthesia 2007;62:131-4.
12. Weiss M, Gerber AC, Dullenkopf A. Appropriate placement of intubation depth marks in a new cuffed paediatric tracheal tube. Br J Anaesth 2005;94:80-7.
13. Weiss M, Balmer C, Dullenkopf A, Knirsch W, Gerber AC, Bauersfeld U, *et al.* Intubation depth markings allow an improved positioning of endotracheal tubes in children. Can J Anaesth 2005;52:721-6.
14. Murat I. Cuffed tubes in children: A 3-year experience in a single institution. Paediatr Anaesth 2001;11:748-9.
15. Duracher C, Schmautz E, Martinon C, Faivre J, Carli P, Orliaguet G. Evaluation of cuffed tracheal tube size predicted using the Khine formula in children. Paediatr Anaesth 2008;18:113-8.

Source of Support: Nil, **Conflict of Interest:** None declared

Announcement

Conference Calender - 2015

Name of the conference: 63rd Annual National Conference of the Indian Society of Anaesthesiologists, ISACON 2015
Date: 25th to 29th December 2015
Venue: B. M. Birla Auditorium & Convention Centre, Jaipur, India
Organising Secretary: Dr. Suresh Bhargava
Contact: +91 98290 63830
E-mail: suresh3559@yahoo.com
Website: www.isacon2015jaipur.com

Name of the conference: TRISZAC 2015, 31st Annual Conference of Indian Society of Anaesthesiologists, South Zone and 39th Annual Conference of Kerala State Chapter
Date: 6th to 9th August 2015
Venue: Hotel KTDC Samudra & Uday Samudra Beach Hotel, Kovalam, Trivandrum
Organising Secretary: Dr. Gopakumar D
Contact: +91 98476 39616
E-mail: triszac2015@yahoo.in
Website: www.triszac2015.com

Name of the conference: KISACON2015, 31st Annual Conference of Indian Society of Anaesthesiologists, Karnataka State Chapter
Date: 9th to 11th October 2015
Venue: S N Medical College, Bagalkot
Organising Secretary: Dr. Ramesh Koppal
Contact: +91 98455 04515
E-mail: rameshkoppaldr@gmail.com
Website: www.kisacon2015.com