

Inspiratory Stridor after Tracheal Intubation with a MicroCuff® Tracheal Tube in Three Young Infants

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UNCUFFED tracheal tubes (TTs) have been the standard for tracheal intubation in infants and children for decades until the recent introduction of the MicroCuff (Kimberley-Clark, Roswell, GA) cuffed TT. Evidence suggests that the incidence of perioperative airway events after use of these new TTs is small,^{1,2} although the evidence for their safe use in neonates and young infants is scant. We identified three infants, two of whom were born premature and one who was syndromic, who developed postextubation stridor after the use of Microcuff TTs. Because postextubation stridor after surgery has been infrequent in infants in our neonatal intensive care unit (NICU), we believe that this cluster of three infants with postextubation stridor may signify an under-recognized risk when these TTs are used in young infants. Accordingly, we prepared this communication, summarizing the perioperative course of the three affected infants.

Case 1

A 28-week gestational age, premature infant presented for an exploratory laparotomy and takedown ileostomy. The trachea was intubated at birth with an uncuffed 3.0 mm internal diameter (ID) TT (Mallinckrodt, St. Louis, MO) (4.3 mm outer diameter [OD]) for 1 day. At 3 weeks' chronological age, the trachea was reintubated with an uncuffed 3.0 mm ID TT for an exploratory laparotomy for necrotizing

enterocolitis in the NICU. The trachea was extubated uneventfully on the eighth postoperative day (POD). At 8 weeks' chronological age (36 weeks' postmenstrual age) and 2.6 kg in weight, anesthesia was induced intravenously for takedown of the ileostomy. The trachea was intubated without resistance on the first attempt using a Miller #1 blade and a styletted Microcuff TT size 3.0 mm ID (4.3 mm OD), whose cuff was fully deflated before intubation. An air leak was not assessed, no air was injected into the cuff, and the cuff pressure was not checked. Anesthesia was maintained with an air/oxygen mixture and sevoflurane and pressure controlled ventilation. On POD #1 in the NICU, the infant self-extubated and inspiratory stridor immediately developed for which three treatments of racemic epinephrine by inhalation, heliox 80/20 and two doses of intravenous dexamethasone (0.2 mg/kg) 12 h apart were administered. On POD #2, the infant demonstrated an increased work of breathing associated with stridor. When the infant became bradycardic, chest compressions were commenced (for 1 min), and the trachea was reintubated with an uncuffed 3.0 mm ID TT. Intravenous dexamethasone (0.2 mg/kg) was administered every 12 h for 4 days before the trachea was extubated uneventfully on POD #4. After extubation in the NICU, a pediatric otolaryngologist performed a flexible fiberoptic laryngoscopy and determined that the vocal cords moved appropriately and bilaterally. The infant was subsequently weaned to room air and remained stable with neither stridor nor an increased work of breathing and was discharged home on POD #12.

Case 2

A 30-week, 6-day gestational age infant required tracheal intubation at birth, which was achieved with an uncuffed 2.5 mm ID TT (Mallinckrodt, 3.6 mm OD). The trachea was extubated 24 h later. The airway was supported with nasal continuous positive airway pressure. On day 2, the trachea was reintubated due to abdominal distention with an uncuffed 2.5 mm ID tube. A laparotomy and ileostomy were performed for spontaneous intestinal perforation in the NICU. The trachea was extubated on POD #5. At 6 weeks' chronological age (36 weeks, 6 days' postmenstrual age), and 2.8 kg in weight, a repeat laparotomy and ileostomy takedown were scheduled in the operating room. After an intravenous induction of anesthesia, the trachea was intubated on the first attempt without resistance with a

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Miller #1 blade and a 3.0 mm ID stylet Microcuff tube, whose cuff was fully deflated before intubation. The cuff was subsequently inflated with 0.5 ml of air. The cuff pressure was neither measured nor monitored during the procedure. Anesthesia was maintained with an air/oxygen mixture and sevoflurane and pressure controlled ventilation. On POD #3 in the NICU, the trachea was electively extubated after deflating the cuff, and inspiratory stridor immediately developed. The infant was treated with racemic epinephrine by inhalation, heliox 80/20 for 1 day and dexamethasone (0.25 mg/kg) every 12 h for 3 days. The stridor subsequently resolved and he remained stable breathing room air.

Case 3

A full-term neonate (41 weeks' gestational age) with Apert syndrome presented at 3 weeks' chronological age and 4 kg in weight for laparoscopic G-tube placement, Nissen fundoplication, and an open Ladd procedure. After anesthesia was induced intravenously, the airway was secured on the second attempt (due to an anterior and short epiglottis deviating to the left side) using Miller #1 blade and a 3.5 mm ID stylet Microcuff tube (5.0 mm OD), whose cuff was fully deflated before intubation. The tube passed the glottis without resistance. The cuff was inflated with 0.5 ml of air after placement, although the cuff pressure was neither measured nor monitored. Anesthesia was maintained with an air/oxygen mixture and sevoflurane and pressure controlled ventilation. On arrival of the infant in the NICU, the cuff was deflated. On POD #3, the trachea was electively extubated and inspiratory stridor immediately developed. The infant was treated with two doses of racemic epinephrine, heliox 80/20 for 1 day and dexamethasone (0.2 mg/kg) every 12 h for 2 days. Subsequently, the stridor improved and he remained stable, breathing room air. On POD #7, a craniostomy was performed. The same size TT was used, a 3.5 mm ID Microcuff tube, and it passed the subglottis easily. The cuff was not inflated for this surgery. Dexamethasone 1 mg was administered intravenously. The infant was transported to NICU postoperatively and the trachea was extubated 1 h after arrival. Stridor did not develop and the postoperative course was uneventful.

Discussion

In the past, cuffed TTs were avoided in neonates and small infants for two key reasons.³ First, the bulk of the cuff limited the ID of the TT that would otherwise be inserted into the airway safely and this substantially increased the risk of plugging the tube with secretions, the difficulty in suctioning the tube and the airway resistance during spontaneous respiration after surgery. Second, an inflated TT cuff may exert sufficient pressure to cause ischemia of the very sensitive airway mucosa in the subglottis, which could lead to postextubation stridor.

The introduction of Microcuff TTs in pediatric anesthesia has resulted in a paradigm shift in clinical practice from uncuffed TTs and high compliance cuffed TTs to cuffed Microcuff TTs optimally designed for use in infants and children. Microcuff TTs differ from their predecessors in that the cuffs are cylindrical in shape, fixed closer to the tip of the TT, and of thinner material. The Microcuff cuffs seal the pediatric upper

airway at reduced pressures compared with traditional cuffs, thus reducing the risk of ischemic mucosal damage. We determined that the cuff-pilot balloons in the 3.0 and 3.5 mm ID Microcuff TTs contain approximately 0.5 ml of air, a finding not widely reported. We routinely actively deflate the cuff completely before tracheal intubation. Interestingly, when a cuffed tube is fully deflated, the cuff wrinkles. This has prompted the speculation that the edges could apply uneven pressure to the airway mucosa causing more mucosal injury than an uncuffed tube. Whether the full deflation of the Microcuff cuffs contributed to the stridor in these cases remains unclear.

Investigators have recommended age-appropriate sizes for Microcuff TTs in infants and children.¹ For full-term neonates (>3 kg) to 6 months of age, they recommend a 3.0 mm ID Microcuff TT, and for infants 6–18 months, a 3.5 mm ID TT.¹ Guidelines recommend 3.5 mm ID uncuffed TT for neonates and a 4.0 mm ID TT for 1 yr olds.⁴ In the current report, a 3.0 mm ID Microcuff TT was used in two infants of postmenstrual age 36 weeks and who weighed approximately 2.7 kg (within 10% of the recommended guidelines) and a 3.5 mm ID TT was used in a full-term infant, 1 month chronological age, 5 months younger than the age recommended for this size TT.

The incidence of perioperative adverse airway events and specifically stridor, after using Microcuff TTs in infants based on the investigators' size recommendations is small (for stridor is 2–3%).^{1,2} In a recent study, an acceptable Microcuff TT was one that passed the subglottis without resistance and for which an audible leak was present (with a fully deflated cuff) at 20 cm H₂O peak pressure, although the authors did not describe actively deflating the cuff before intubation.² If a 3.0 mm ID Microcuff TT did not satisfy the above conditions, an uncuffed 3.0 mm ID TT was used. With uncuffed TTs, we use the TT that passes the subglottis without resistance and for which the leak is not excessively large. On the basis of our large experience with uncuffed TTs, postextubation stridor has been a rare occurrence. It would seem that passing the subglottis without resistance does not reliably rule out stridor after the Microcuff TT in young infants. We posit that the additional bulk of a deflated cuff in a 3.0 and 3.5 mm ID Microcuff TT increases the OD enough in some vulnerable infants to cause mucosal ischemia and stridor. It is imperative that clinicians recognize that the 3.0 and 3.5 mm ID Microcuff TTs designed for neonates and infants are recommended for infants older and larger than those for the same diameter uncuffed tubes.^{1,4}

On the basis of these three cases, we urge clinicians to follow the manufacturer's recommendations for TT sizing and exercise caution when intubating the tracheas in preterm and full-term neonates, and small infants less than 6 months of age and/or less than 3 kg in weight, with Microcuff TTs until evidence confirms the safe use of these tubes in a large cohort.

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Nearly 50 years ago, in November of 1963, the president of the American Medical Association (*left*, Edward Annis, M.D.) and the president of the “WLM,” or Wood Library-Museum (*right*, Albert Betcher, M.D.), celebrated the Park Ridge, Illinois, opening of the WLM. As part of the festivities, the American Society of Anesthesiologists photographed AMA Pres. Annis handling the mask of an early carbon dioxide-absorbing apparatus designed by Dr. Dennis E. Jackson. Sadly, Dr. Betcher could not introduce Dr. Annis to Paul Wood, M.D.—the WLM’s founder had suffered a fatal heart attack in May of 1963 while preparing to open his namesake museum. (Copyright © the American Society of Anesthesiologists, Inc.)

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