Journal of Clinical Anesthesia (2016) **33**, 422–427

ELSEVIER

Journal of Clinical Anesthesia

Original Contribution

Cuffed endotracheal tubes in neonates and infants undergoing cardiac surgery are not associated with airway complications☆

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Received 6 December 2015; revised 11 March 2016; accepted 23 April 2016

Keywords:
Postextubation stridor;
Congenital heart disease;
Endotracheal intubation;
Pediatric anesthesia

Abstract

Study Objective: To determine the incidence of postoperative airway complications in infants <5 kg in weight undergoing cardiac surgery intubated with Microcuff (Kimberley-Clark, Roswell, GA) endotracheal tubes (ETTs).

Design: Retrospective review of infants weighing <5.0 kg with congenital heart disease (CHD) presenting for cardiac surgery.

Setting: Single-center, tertiary pediatric cardiac critical care unit at a university hospital.

Patients: A total of 208 infants weighing <5 kg underwent cardiac surgery for CHD from 2008 to 2013.

Intervention: Intubation with Microcuff (Kimberley-Clark) ETTs.

Study Design: Retrospective review of infants weighing <5.0 kg with CHD presenting for cardiac surgery to a single-center tertiary care university hospital. Measurements: Perioperative data were collected. Primary outcome was development of tracheal stenosis and/or reintubation for stridor. Stridor was defined as mild (≤2 doses of racemic epinephrine), moderate (>2 doses of racemic epinephrine), or severe (requiring reintubation). Secondary outcomes were variables possibly contributing to postextubation stridor. Infants with a tracheostomy, airway anomalies, and death prior to initial extubation were excluded. Logistic regression analysis was performed to evaluate the association between clinical risk factors and the incidence of postextubation stridor.

Results: A total of 208 infants weighing <5 kg underwent cardiac surgery for CHD from 2008 to 2013; 12 subjects were excluded for death prior to initial extubation. No infant developed tracheal stenosis. The incidence of any stridor was 20.9% (95% confidence interval, 15.8%-27.1%) with severe stridor in 2 cases (1%). Age at surgery, weight, duration of intubation, dexamethasone use, and ETT size were not significantly associated with postextubation stridor. Presence of a comorbidity was significantly associated with stridor ($P = .01$).

☆ The authors have no potential conflicts of interests or sources of financial assistance for this study.

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http://dx.doi.org/10.1016/j.jclinane.2016.04.038

Conclusions: Microcuff ETTs in infants <5.0 kg in weight undergoing cardiac surgery are associated with a low incidence of severe postextubation stridor. Because cuffed ETTs allow for improved control of ventilation/oxygenation and decreased risk of aspiration, they should be considered for use in this high-risk population. Larger studies are needed to confirm these results.

1. Introduction

Traditionally, cuffed endotracheal tubes (ETTs) are avoided in neonates and small infants for concern of development of airway complications including postextubation stridor, laryngeal edema, and/or subglottic tracheal stenosis/injury [1–5]. Historically, cuffed ETT tubes have been reserved for children older than 8 years, when the laryngeal structure changes from cone to cylindrical shape, better accommodating the bulk of an ETT cuff [6]. Uncuffed ETTs have been deemed safer because lack of a cuff enables a larger internal diameter tube size, allowing for lower airway resistance and more efficient suctioning of tracheobronchial secretions [3,7]. In addition, it has been theorized that uncuffed ETTs exert less pressure on subglottic tracheal mucosa which decreases risk of airway swelling and postextubation stridor [5,7]. Accordingly, the risk for airway mucosal injury, glottic injury, and chance of bronchial intubation/injury often deters clinicians from using cuffed ETTs, particularly in neonates and small infants [1–3,5–8].

However, cuffed ETTs have multiple benefits including (1) more accurate capnographic tracing and spirometric tidal volume measurement, (2) improved control of ventilation and maintenance of airway pressures improving oxygenation, (3) fewer airway manipulations to upsize the ETT tube, and (4) reduced microaspiration [9–12]. Furthermore, airway injury/complications are often unrelated to the presence of a cuffed ETT and are secondary to other factors including multiple intubation attempts, prolonged duration of intubation, concurrent upper respiratory infection, reflux/aspiration, and improper ETT size [4,13].

MicroCuff (Kimberley-Clark, Roswell, GA) ETTs and other high-compliance, low-pressure cuffed ETTs are made of a polyurethane material that provides an effective seal at lower pressures, resulting in decreased compression and ischemia to the tracheal mucosa with reduced likelihood of airway swelling [3,10,11]. Recently, a small case series strongly advised against the use of Microcuff ETTs in infants <6 months of age and/or <3 kg in weight due to the development of postextubation stridor. [4].

We present our experience with the use of Microcuff ETT in neonates and infants <5 kg in weight with congenital heart disease (CHD) undergoing cardiac surgical palliations or reparative procedures. Few data exist describing the airway complication rate of Microcuff ETT in this high-risk patient population. We hypothesize that cuffed ETTs allow for consistent positive airway pressure during postoperative mechanical ventilation, improving control of oxygenation and ventilation in infants undergoing cardiac surgery, without inciting airway complications.

2. Methods

We performed a retrospective chart review of sequential infants weighing <5 kg with CHD presenting to the University of Rochester Medical Center (URMC) in Rochester, NY, for surgical repair or palliation from January 1, 2008, to June 30, 2013. Infants with a preexisting tracheostomy or known airway anomalies, and/or who died prior to initial extubation were excluded.

Data collected included weight, length, gestational age at time of birth, days old on day of surgery, gender, cardiac diagnosis, and type of cardiac procedure performed. The presence of a "significant" comorbidity, defined as (1) a documented chromosomal or suspected genetic abnormality due to significant dysmorphic features on examination (ie, DiGeorge and velocardiofacial syndrome), (2) extracardiac abnormality/malformation (ie, trachea-esophageal fistula), or (3) previously diagnosed significant medical comorbidity (ie, necrotizing enterocolitis). The Risk Adjustment for Congenital Heart Surgery Score and Society of Thoracic Surgeons and European Association for Cardio-thoracic Surgery score were compiled for each procedure. The number of lifetime intubations, ETT manipulations (at initial, intraoperative, and postoperative periods), which included ETT exchanges for uncuffed to cuffed, plugged ETT tubes, and/or size changes, multiple ETT attempts, and duration of intubation were also recorded. Primary outcome was the incidence of airway complications including tracheal stenosis, reintubation for upper airway edema, and presence of postextubation stridor. Postextubation stridor was defined as follows: mild (requiring ≤2 doses of racemic epinephrine), moderate (requiring >2 doses of racemic epinephrine), or severe (requiring reintubation and/or eventual tracheostomy for upper airway obstruction/abnormality). Administration of dexathamethasone (before and after extubation), ETT size, number of intubation attempts, and cuff pressure (when available) were recorded. ENT consultation and findings on assessment, hospital length of stay, and hospital-acquired infections were recorded.

During the study period, 3 attending anesthesiologists performed the pediatric cardiac cases. ETT size was selected by the anesthesiologist on the day of surgery. If an uncuffed ETT was already in place, it was changed to a cuffed tube at