Adjunct Devices for the Pediatric Difficult Airway: A Case Report

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This is a case report of a pediatric patient with a difficult airway, in which several airway adjuncts were used simultaneously to successfully provide adequate oxygenation and ventilation during cardiac arrest. Difficult airways are low-incidence, high-risk emergencies in children, and airway adjuncts may be used infrequently, let alone in combination. Included in the discussion of this case are a description of each airway adjunct and a discussion of the process needed to incorporate airway adjuncts safely and effectively into patient care. [Ann Emerg Med. 2021;■:1-4.]

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INTRODUCTION

Emergency and critical care physicians are often called upon to manage airways in hospitalized patients and participate in difficult airway teams.[1] Difficult airways are low-incidence, high-risk emergencies in pediatric patients, including hospitalized patients. The goal of emergency airway management is efficient first-attempt intubation while minimizing the risk of hypoxemia, hypoventilation, and hypotension.[2,3] First-attempt success in the pediatric emergency airway literature ranges from 50% to 80%.[2-6] With a lower first-attempt success rate, higher rates of adverse events, and low individual clinician exposure to difficult pediatric airways, emergency clinician familiarity with airway adjuncts is critical.[2,7] We present a case demonstrating the value of familiarity with 3 adjunct airway devices: an extraglottic airway, a Microcuff (Kimberly-Clark, Irving, TX) endotracheal tube, and a bougie.

CASE REPORT

A 9-month-old infant with trisomy 18 was hospitalized because of vomiting, dehydration, and a urinary tract infection. She unexpectedly suffered a respiratory arrest followed by a cardiac arrest on the day of planned discharge. The pediatric intensivist (TS) was called to the bedside, and the inhospital emergency response team was paged. In our institution, an academic Level I adult and pediatric trauma center, an emergency physician responds to inhospital emergencies and is responsible for airway management. When the emergency physician arrived, the child was apneic and pulseless. While confirming the family's resuscitative wishes, the pediatric intensivist was performing bag-valve-mask ventilation. Defibrillation pads were placed, and chest compressions started. An estimated weight of 3 kg was used for medication doses and equipment sizes.

Appropriate equipment, including an extraglottic airway, was readied. Epinephrine was administered through a distal femoral 25-mm intraosseous needle. The pediatric intensivist placed the extraglottic airway, Ambu King LTS-D, size 0 (Ambu Inc, Columbia, MD), and continued manually ventilating the patient; pulse oximetry and a portable capnometer confirmed adequate oxygenation and ventilation through the extraglottic airway. The team performed a resuscitative sonographic examination, noting the cardiac activity, a full inferior vena cava, adequate left ventricular ejection fraction, dilated right ventricle and right atrium, and bilateral thoracic sliding signs without B-lines. Chest compressions ceased following the return of spontaneous circulation, and a sedative and neuromuscular blocking agent were administered to the infant to facilitate tracheal intubation.

Using a 0-Miller direct laryngoscope (video laryngoscopy was not available), 3 intubations were performed. The infant was intubated twice with a 3.0 cuffed endotracheal tube (Sheridan, Teleflex, Morrisville, NC). After both these apparently successful attempts (TS, AS)—the 2 attending physicians believed that the tube was endotracheal based on examination and direct visualization of the tube through the cords—the endotracheal tube was removed due to the lack of positive waveform capnography. The extraglottic airway was replaced after both attempts, with effective oxygenation and ventilation. Gastric decompression was performed after the second endotracheal tube was removed.

On the third and final attempt, the patient was intubated with an uncuffed 2.5 endotracheal tube. The 2 attending physicians again believed that the third attempt was successful based on chest rise, auscultation, and direct visualization of the tube passing through the cords by the proceduralist. However, as with the first 2 attempts, neither qualitative carbon dioxide detection nor waveform capnography was detectable after 5 to 6 adequate breaths. In addition, the ventilator was alarming for inadequate pressure. Therefore, resuscitation team members questioned whether the tube was endotracheal.

The team ultimately decided that the lack of detected carbon dioxide was likely due to the combination of a significant air leak and small tidal volumes in an infant weighing less than 5 kg. The 2.5 uncuffed tube was replaced with a Microcuff endotracheal tube, and a neonatal capnometry adapter for the monitor was attached. Under direct laryngoscopy, the 2.5 uncuffed endotracheal tube was exchanged over a 5F Portex (Smiths Medical, Minneapolis, MN) tracheal tube exchanger for a 3.0 cuffed Microcuff endotracheal tube, and the cuff was inflated. Qualitative capnography and waveform capnography were both subsequently confirmed, and the ventilator no longer alarmed for low pressures. The Microcuff endotracheal tube remained in place until extubation.

The infant had a multiorgan system failure that ultimately resolved. She was discharged to home at her baseline with her family. The etiology of the arrest remains unclear.

DISCUSSION

In the case presented, the patient had many anatomic and physiologic features contributing to a difficult airway: she was small (2.87 kg), was young (aged <1 year), had a genetic condition (albeit without anatomic features associated with difficult airway), and had sudden, unanticipated apnea and cardiac arrest requiring cardiopulmonary resuscitation. We believe that 3 airway adjuncts were essential to successful airway management: an extraglottic airway, a neonatal bougie, and the Microcuff endotracheal tube (Figure).

Early Placement of an Extraglottic Airway

Early placement of an extraglottic airway, rather than only considering its use as the second- or third-line rescue device, may be advantageous in pediatric difficult airway management. In this scenario, an extraglottic airway was placed early in the resuscitation to optimize oxygenation and ventilation, while the team performed simultaneous critical tasks: establishing intraosseous access, connecting cardiorespiratory monitors, assembling appropriately sized airway equipment, and administering weight-based doses of epinephrine.[8,9] Out-of-hospital clinicians use extraglottic airways for a similar rationale—extraglottic airway placement during resuscitation has a high first-attempt placement success rate, even in novice hands.[9-12] Extraglottic airway placement is typically successful even with airway anomalies, including congenital disorders.[12,13]

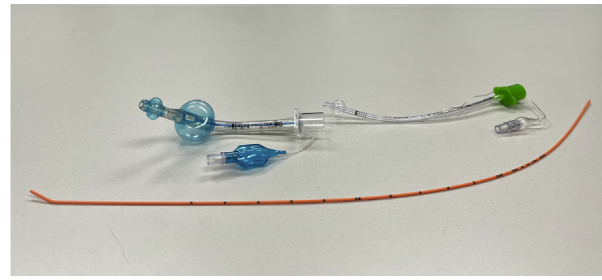

Figure. Adjunct devices that are used to manage a difficult airway in a critically ill pediatric patient. Top left, Ambu King LTS-D, size 0, extraglottic airway. Top right, Microcuff 3.0 cuffed endotracheal tube. Bottom, Portex 5F neonatal bougie tube exchanger.

Emergency and critical care physicians should understand the 3 benefits of newer generation extraglottic airways: gastric decompression ports, better seal pressures, and the ability to intubate through the extraglottic airway.[13,14] Using the gastric decompression port to decompress the stomach allows more functional residual capacity, which may improve ventilation and oxygenation and provide additional safe apneic time to maximize the chances of first-attempt intubation success. A full discussion of the nuances of extraglottic airway use is beyond the scope of this article. However, an important issue is the potential for epiglottis displacement and obstructed ventilation, especially with the longer, floppier epiglottis of infants. In addition, blind intubation through a pediatric extraglottic airway is difficult.

Neonatal Bougie for Small (<4.5 mm) Endotracheal Tube Exchange

The adult airway literature supports the use of a bougie to improve the first-attempt success rate.[15] Bougie use has been described in anesthesia literature for infants and children with difficult airway anatomy and studied in simulation-based airway research.[7,16-19] The neonatal bougie is able to fit through endotracheal tube sizes 2.5 to 4.5, whereas a slightly larger pediatric 10F bougie (SunMed LLC, Grand Rapids, MI) is able to fit through endotracheal tube sizes 4.5 to 6.0.

Although the bougie was not used during the initial laryngoscopy in the case presented, the team recognized the importance of reducing further airway manipulation.

Therefore, the team used a Portex 5F neonatal bougie as a tube exchanger. Unlike previous reports of neonatal bougie use in cases with multiple attempts at intubation, chest compressions, and extraglottic and bag-valve-mask ventilation, a pneumothorax did not develop in our patient after bougie use.[20,21] The 5F neonatal bougie is more flexible than a traditional adult bougie, and a coudé-shaped tip needs to be created before use. Neonatal and pediatric bougies deserve further study for pediatric emergency airway management.

Microcuff Endotracheal Tube

Since the advent of high-volume low-pressure cuffs, cuffed endotracheal tubes have been used in neonates.[22,23] To date, no study has found increased postextubation stridor when cuffed endotracheal tubes are used in infants and children.[24] We recently considered using cuffed endotracheal tubes for all pediatric intubations, including neonates, in our emergency department (ED). We reviewed the literature and noted fewer reintubations with cuffed endotracheal tubes, with similar rates of postextubation stridor.[22,23,25,26] We chose the Microcuff endotracheal tube (Kimberly-Clark), which is made of polyurethane with thin folds, rather than traditional polyvinylchloride cuffs, potentially providing a tighter subglottic seal.[27,28] We recognized 4 advantages of the Microcuff design: reduced reintubation rates, higher ventilation pressures in children with poor pulmonary compliance, ability to allow for precise, reliable monitoring of gas exchange, and decreased risk of vocal cord damage from the more distal cuff placement that allows cuff inflation in the trachea rather than near or on the vocal cords. In addition, the use of a Microcuff endotracheal tube has been shown to reduce viral vectors and air pollution in the ED, a timely consideration in the era of severe acute respiratory syndrome coronavirus 2.[22-29]

The Microcuff endotracheal tube has a black line to indicate where the tube should meet the vocal cords for appropriate depth placement to avoid the mainstem intubation, a common occurrence in pediatric intubation. The tube, similar to a 2.5 endotracheal tube, lacks a Murphy eye and can be more easily obstructed compared with those with a Murphy eye. When an uncuffed endotracheal tube has an air leak, the tube size is increased to the next larger size by 0.5 mm internal diameter. However, when a smaller endotracheal tube is too small and a larger endotracheal tube too large, a throat pack would be used to prevent an air leak or the patient would be switched to a cuffed endotracheal tube.[26] This precise scenario was encountered in the described case. We believe that the use of a Microcuff endotracheal tube in the abovementioned case had numerous benefits, including more efficient ventilation, maintenance of positive end-expiratory pressure, reliable respiratory capnography monitoring, reduced reintubation, and reduced risk of aspiration.[26]

Approach to Adoption of Adjunct Pediatric Difficult Airway Devices

The adoption of airway adjuncts into practice requires a thoughtful approach. Each device described in the abovementioned case has both potential benefits for basic and advanced airway management and unique nuances and challenges to effective use. Repeated clinical use of each device could provide experiential familiarity and clinician competency; however, individual clinician exposure to emergency pediatric airway management, let alone the difficult pediatric airway, is too low to expect most clinicians to gain competency in the use of airway adjuncts based on clinical experience alone. Therefore, a careful, systematic approach to the adoption of airway adjuncts into the management of the difficult pediatric airway is essential.

In our academic institution, the vetting process for a new airway device includes emergency physician airway experts suggesting airway devices for review to local pediatric emergency physicians, a literature review by stakeholders, trialing of the device in simulations, and a cost analysis. The core group of airway and pediatric experts subsequently decides whether to implement an airway device into clinical practice. Clinicians at institutions without both emergency airway and pediatric expertise may use a similar approach, with the addition of requesting advice from local or national airway experts and seeking consensus from local clinicians with relative airway expertise. Lastly, after implementation, clinical leaders must review each use of the airway adjunct, including any difficulties or challenges. Ideally, case review and data collection would be structured and systematic. Knowledge gained from case review should then be shared with all relevant care clinicians and used to inform improvements in the use of the device.

SUMMARY

Emergency and intensive care clinicians frequently manage difficult airways. For those caring for children, knowledge of anatomic and physiologic differences between adults and children is important. However, the approach to a difficult pediatric airway is similar to that of an adult—even in our smallest, most complex children. Knowledge of and competency with airway adjuncts is likely essential to effectively managing the most challenging airways. Clinical leaders must work diligently to incorporate airway adjuncts safely and effectively into clinical practice.

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