Asploro Journal of Biomedical and Clinical Case Reports
(ISSN: 2582-0370)
Review Article
DOI: https://doi.org/10.36502/2021/ASJBCCR.6228

Cuffed vs Uncuffed Endotracheal Tubes for Pediatric Patients: A Review

Yim A[1], Doctor J[1], Aribindi S[2], Ranasinghe L[3*]

[1]*Fourth-year Medical Student, California Northstate University College of Medicine, Elk Grove, CA, USA*

[2]*Pediatric Anesthesiologist, Kaiser Permanente, South Sacramento, CA, USA*

[3]*Professor of Medical Education and Emergency Medicine, California Northstate University College of Medicine, Elk Grove, CA, USA*

Corresponding Author: **Leonard Ranasinghe, MD**

Address: Professor of Emergency Medicine. College of Medicine, 9700 W. Taron Dr., Elk Grove, California 9757, USA.

Received date: 05 December 2020; **Accepted date**: 29 January 2021; **Published date**: 10 February 2021

Citation: Yim A, Doctor J, Aribindi S, Ranasinghe L. Cuffed vs Uncuffed Endotracheal Tubes for Pediatric Patients: A Review. Asp Biomed Clin Case Rep. 2021 Feb 10;4(1):50-53.

Abstract

The use of uncuffed endotracheal tubes (ETT) in patients younger than 8 years old has been in practice for the last 60 years. In the last decade, there has been a change in clinical practice with a transition to cuffed ETT use, and there continues to be debate between cuffed vs uncuffed ETT use. This narrative review article aims to review the current literature on the topic and highlight some key points in the argument of cuffed vs uncuffed ETT use in pediatric patients. Cuffed ETTs are increasingly being used with several studies over the last 20 years demonstrating its benefits. Studies have claimed cuffed ETT has a clinical, environmental, and economical benefit over uncuffed ETT. Despite shortcomings of various studies and no definitive conclusion of a superior type of endotracheal tube, cuffed ETTs are here to stay in the world of anesthesia.

Keywords

Cuffed Endotracheal Tube, Pediatric General Anesthesia, Uncuffed Endotracheal Tube, Pediatric Patients

Introduction

The use of uncuffed endotracheal tubes (ETT) in patients younger than 8 years old has been in practice for the last 60 years. This was based on studies of pediatric cadaveric specimens which concluded that the airway had a funnel shape with the narrowest part at the cricoid cartilage. Thus, it was recommended to use an uncuffed tube large enough to seal at the level of the cricoid ring but allow an air leak between 20 to 30 cm H_2O for adequate positive pressure ventilation without damaging the tracheal mucosa from excessive pressures [1]. In the last decade, there has been a change in clinical practice with a transition to cuffed ETT use. However, there continues to be a debate between cuffed vs uncuffed ETT use due in part to lack of research [2]. This narrative review article aims to review the current literature on the topic and highlight some key points in the argument of cuffed vs uncuffed ETT use in pediatric patients.

Method

In this narrative literature review, a search using the terms "cuffed endotracheal" OR "uncuffed endotracheal" AND "pediatric" in PUBMED was conducted. In addition, a manual search of cross-references was done. For this review, we included 16 articles, which include 3 editorials, 5 review articles, 2 prospective, 3 retrospective, and 3 randomized controlled trials.

Results

Traditional teaching was to use appropriately sized uncuffed ETT in children less than 8 years old in order to maximize the internal diameter of the tube and avoid mucosal damage by the cuff. With larger diameter endotracheal tubes, there is less airway resistance and less difficulty with suctioning. This traditional teaching was based on anatomical differences in the pediatric airway which suggested that the pediatric larynx was funnel-shaped with the narrowest part at the cricoid ring. The reasoning was that the funnel shape of the larynx allows uncuffed tubes to have a proper seal with minimal leak without the additional risk of cuff induced mucosal damage and resulting tracheal stenosis [3]. In fact, several mathematical analyses of tracheal lengths have suggested cuffed ETT are predisposed to cause glottic injury [4,5].

Despite the longstanding use and benefits of uncuffed ETT in young children, cuffed ETTs are increasingly being used with several studies over the last 20 years demonstrating its benefits. Based on plaster molds of the pediatric airway in cadaveric studies, the funnel-shaped larynx was understood to transition towards a more cylindrical adult airway around 8 years of age. Recent CT, MRI, and video laryngoscopy studies have shown that the narrowest part of the pediatric airway is actually at the infraglottic level with an elliptical form of anterior-posterior greater than transverse diameter; although, the rigid cricoid ring is still functionally the narrowest part of the larynx [6-9]. The newly appreciated elliptical shaped airway at the level of the cricoid cartilage is potentially vulnerable to damage even from a properly sealed uncuffed tube. With this, there is growing evidence that suggests uncuffed ETTs may not have better outcomes that truly offers an advantage over cuffed tubes, because the circular tube will occlude the elliptical airway only on the sides, leaving a gap in the anterior and posterior sides. The leak test done routinely to make sure that the tube is not too big, may actually show a leak, but there may be excessive pressure on the transverse walls of the trachea [1,10].

Now there is growing evidence that suggests cuffed ETT have additional clinical, environmental, and economic benefits compared to uncuffed ETT. Previously, there were concerns of tracheal mucosa damage from excessive pressures, but studies have shown they provide a reliably sealed airway at pressures <= 20 cm H_2O and reduce the need for tube exchanges [11]. Cuffed ETT has decreased incidences of sore throat and hoarse voice, likely from the decrease need for tube exchanges [12]. Studies have also shown no major difference in acute respiratory complications such as stridor after extubation between cuffed and uncuffed ETT [11,13] with some showing decreased postoperative complications [12].

In a study comparing leakage and tidal volumes in cuffed vs uncuffed ETT, cuffed ETT had significantly lower leaks and were measuring higher tidal volumes. It is assumed a majority of the leak is inspiratory due to increased intratracheal pressures. Expired tidal volume levels, which more accurately reflect true tidal volume, increased over time in the cuffed group suggesting better maintenance of lung volumes [12]. A retrospective study on neonates found that uncuffed ETT had a leak >5% in 75% of infants with a >40% leak occurring in 42.3% of infants around the third day of mechanical ventilation. Leaks were also associated with longer duration of mechanical ventilation [14].

Although cuffed ETT are more expensive than uncuffed ETT, they are environmentally and economically beneficial due to decreased tube changes and decreased medical gas consumption. In a study looking at sevoflurane consumption, they found the uncuffed group used 16.1 mL of sevoflurane compared to 6.2 mL in the cuffed group [15].

In a Cochrane review incorporating 3 randomized control trials in which cuffed vs uncuffed ETT were compared in children under 8 years old undergoing general anesthesia, they emphasized the very low quality of evidence in determining differences between cuffed and uncuffed ETT among the variety of studied parameters [2]. Additionally, many of these studies use stridor as a measure to screen airway injury, yet post-extubation stridor is not a validated measure and not always associated with airway injury. These studies

have been criticized for the lack of endoscopic evidence of damage [16].

The studied advantages of using a cuffed ETT in pediatrics are growing, yet there are still unique clinical circumstances for an uncuffed ETT. For instance, uncuffed ETT may be purposefully used for bronchial intubation to isolate a lung for neonatal thoracic surgery [10].

Discussion

The debate between cuffed vs uncuffed ETT use in pediatric patients younger than 8 years may still be ongoing, but there is a shift with growing evidence in support of cuffed ETT use in recent years. Studies have claimed cuffed ETT has a clinical, environmental, and economical benefit over uncuffed ETT. However, not enough large, randomized controlled studies have been performed providing high quality evidence in support of cuffed ETT use. Several observations such as possibility of bias in manufacturer supported studies, lack of application of solid statistical analyses to the data, have been pointed out. Regardless, there is a large body of evidence to support the safety of cuffed ETT in children that require surgical procedures and are intubated for a brief duration. Such evidence is lacking in neonatal and pediatric intensive care unit populations, however, and there is a definite need for more studies before practice changes are made in these high-risk populations. Despite shortcomings of various studies and no definitive conclusion of a superior type of endotracheal tube, cuffed ETTs are here to stay in the world of anesthesia.

Conflict of Interests

All authors have read and approved the final version of the manuscript. The authors have no conflicts of interest to declare.

References

[1] Taylor C, Subaiya L, Corsino D. Pediatric cuffed endotracheal tubes: an evolution of care. Ochsner J. 2011 Spring;11(1):52-56. [**PMID**: 21603336]

[2] De Orange FA, Andrade RG, Lemos A, Borges PS, Figueiroa JN, Kovatsis PG. Cuffed versus uncuffed endotracheal tubes for general anaesthesia in children aged eight years and under. Cochrane Database Syst Rev. 2017 Nov 17;11(11):CD011954. [**PMID**: 29149469]

[3] Deakers TW, Reynolds G, Stretton M, Newth CJ. Cuffed endotracheal tubes in pediatric intensive care. J Pediatr. 1994 Jul;125(1):57-62. [**PMID**: 8021785]

[4] Weiss M, Dullenkopf A, Gysin C, Dillier CM, Gerber AC. Shortcomings of cuffed paediatric tracheal tubes. Br J Anaesth. 2004 Jan 1;92(1):78-88.

[5] Ho AM, Aun CS, Karmakar MK. The margin of safety associated with the use of cuffed paediatric tracheal tubes. Anaesthesia. 2002 Feb;57(2):173-5. [**PMID**: 11871955]

[6] Litman RS, Weissend EE, Shibata D, Westesson PL. Developmental changes of laryngeal dimensions in unparalyzed, sedated children. Anesthesiology. 2003 Jan;98(1):41-45. [**PMID**: 12502977]

[7] Wani TM, Bissonnette B, Rafiq Malik M, Hayes D Jr, Ramesh AS, Al Sohaibani M, Tobias JD. Age-based analysis of pediatric upper airway dimensions using computed tomography imaging. Pediatr Pulmonol. 2016 Mar;51(3):267-71. [**PMID**: 26083203]

[8] Jugpal TS, Garg A, Sethi GR, Daga MK, Kumar J. Multi-detector computed tomography imaging of large airway pathology: A pictorial review. World J Radiol. 2015 Dec 28;7(12):459-74. [**PMID**: 26753061]

[9] Mizuguchi S, Motomura Y, Maki J, Baba R, Ichimiya Y, Tokuda K, Kaku N, Takada H, Maehara Y, Ohga S. Tracheal Size and Morphology on the Reconstructed CT Imaging. Pediatr Crit Care Med. 2019 Aug;20(8):e366-71. [**PMID**: 31162371]

[10] Thomas R, Rao S, Minutillo C. Cuffed endotracheal tubes for neonates and young infants: a comprehensive review. Arch Dis Child Fetal Neonatal Ed. 2016 Mar;101(2):F168-74. [**PMID**: 26458915]

[11] 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 Dec;103(6):867-73. [**PMID**: 19887533]

[12] Chambers NA, Ramgolam A, Sommerfield D, Zhang G, Ledowski T, Thurm M, Lethbridge M, Hegarty M, von Ungern-Sternberg BS. Cuffed vs. uncuffed tracheal tubes in children: a randomised controlled trial comparing leak, tidal volume and complications. Anaesthesia. 2018 Feb;73(2):160-68. [**PMID**: 29168575]

[13] de Wit M, Peelen LM, van Wolfswinkel L, de

Graaff JC. The incidence of postoperative respiratory complications: A retrospective analysis of cuffed vs uncuffed tracheal tubes in children 0-7 years of age. Paediatr Anaesth. 2018 Mar;28(3):210-17. [**PMID**: 29436138]

[14] Mahmoud RA, Proquitté H, Fawzy N, Bührer C, Schmalisch G. Tracheal tube airleak in clinical practice and impact on tidal volume measurement in ventilated neonates. Pediatr Crit Care Med. 2011 Mar;12(2):197-202. [**PMID**: 20581731]

[15] Salgo B, Schmitz A, Henze G, Stutz K, Dullenkopf A, Neff S, Gerber AC, Weiss M. Evaluation of a new recommendation for improved cuffed tracheal tube size selection in infants and small children. Acta Anaesthesiol Scand. 2006 May;50(5):557-61. [**PMID**: 16643224]

[16] Holzki J, Laschat M, Puder C. Stridor is not a scientifically valid outcome measure for assessing airway injury. Paediatr Anaesth. 2009 Jul;19 Suppl 1:180-97. [**PMID**: 19572855]