Brazilian Journal of Anesthesiology 2023;73(5):676–679

Sociedade Brasileira de Anestesiologia

Brazilian Journal of ANESTHESIOLOGY

CASE REPORTS

The use of a noninvasive positive pressure system to facilitate tracheal intubation in a difficult pediatric airway: a case report

José R. Soberón [a,b,*], Taran Sangari [c], Jessica Ching [d], Felipe Urdaneta [a]

[a] North Florida/Southern Georgia Veterans Health System and the University of Florida, Department of Anesthesiology, Gainesville, Florida
[b] University of Central Florida, Department of Anesthesiology, Orlando, Florida
[c] University of Florida, College of Medicine, Department of Anesthesiology, Gainesville, Florida
[d] University of Florida, College of Medicine, Department of Surgery, Division of Plastic Surgery, Gainesville, Florida

Received 15 December 2020; accepted 13 March 2021
Available online 19 April 2021

KEYWORDS
Noninvasive ventilation;
Continuous positive airway pressure;
Deep sedation;
Intubation, intratracheal;
Burns;
Pediatrics

Abstract Patients with burns to the head and neck may be difficult to intubate or ventilate via facemask. Furthermore, post-burn scarring and microstomia may reduce the success of rescue supraglottic airway placement. While awake tracheal intubation using a flexible intubation scope is considered the optimal technique for these patients, it may not always be feasible in the pediatric population. We report a case of successful management of a difficult airway in a child with extensive post-burn head and neck deformity using a noninvasive positive pressure system to aid with inhalational induction and deep sedation during intubation using a flexible scope.

Introduction

A difficult airway is a circumstance in which a clinician encounters difficulty with mask ventilation, laryngoscopy, or intubation in the process of securing an airway. Pediatric airway anatomy differs from adults which can complicate difficult airway management. Although techniques using novel airway devices with different technologies have improved the safety and management of pediatric difficult airway, pediatric patients with a history of head and neck burns present unique challenges to anesthesiologists. Characteristics of this patient population include oral scarring resulting in microstomia, limited neck extension due to scar tissue (or in some cases fixed neck flexion), dimin-

* Corresponding author.
E-mail: jsoberon@anest.ufl.edu (J.R. Soberón).

https://doi.org/10.1016/j.bjane.2021.03.012

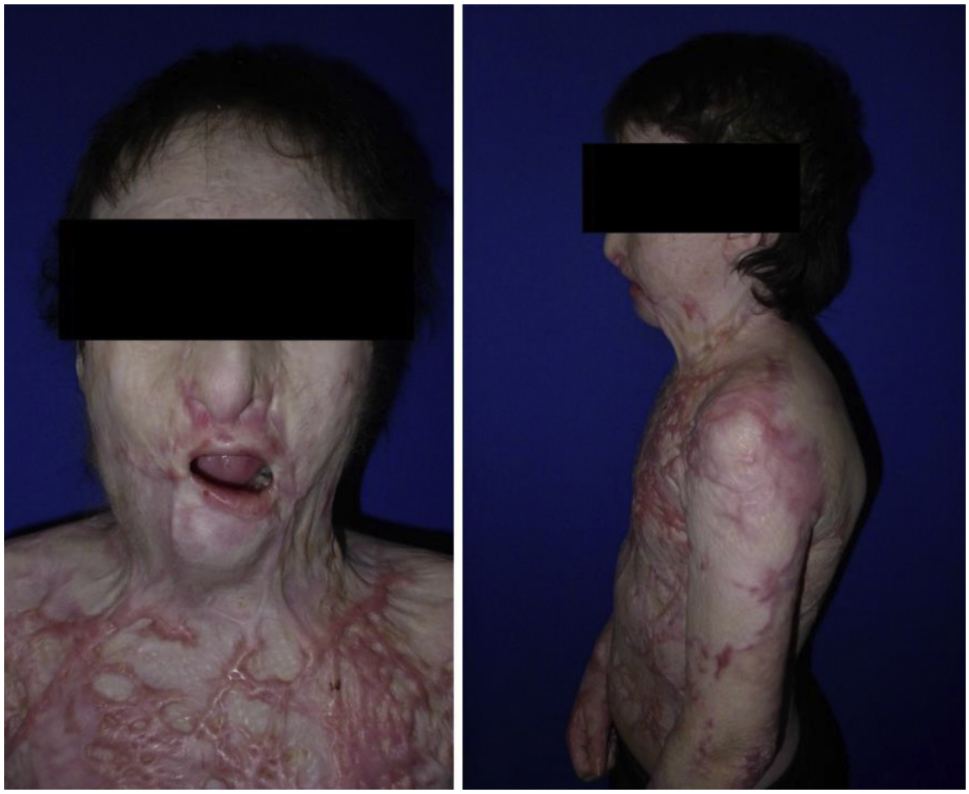

Figure 1 Front and side profiles of the patient. Note the extensive facial, neck, and chest scarring as well as microstomia.

ished compliance of the submandibular space, and altered tracheal position.[1] Facial scarring, microstomia, and neck scarring are associated with difficulties with mask ventilation, supraglottic airway device rescue, and cricothyrotomy placement.[1] Because challenges in mask ventilation and intubation are often encountered in this patient population, airway management in these patients should be approached with caution. Although awake tracheal intubation may be considered ideal, an inhalational induction may be warranted in certain circumstances.[1]

The SuperNO$_2$VA Mask^{TM} (Vyaire Medical, Mettawa, IL, USA), a noninvasive nasal positive pressure device, can be used to provide Continuous Positive Airway Pressure (CPAP) during procedural sedation.[2] It is a flow-dependent portable disposable mask applied to the nose and maxillae that maintains airway patency and relieves upper airway obstruction[2,3] using positive pressure. The device has been used during moderate to deep sedation and during induction and intubation to prolong the safe apnea time.[3] It allows access to the mouth and has been used during endoscopic, transesophageal echocardiography, and bronchoscopic procedures. Although it can also be used to facilitate fiberoptic intubation,[4] there are no reports of its use during inhalational induction or pediatric difficult airway management. At the time of this writing, the existing SuperNO$_2$VA Mask^{TM} literature is derived exclusively from adults and a search of the published literature produced no citation regarding its use in the pediatric population. We report a case of successful inhalational induction and flexible intubation with the aid of the device on a child with a known difficult airway.

The patient's family provided written Health Insurance Portability and Accountability Act (HIPAA) authorization to publish this case report.

Case description

A 13-year-old, 32 kg, 1.4 m tall male with a history of extensive burns to the face, chest, and upper extremities presented for debridement of facial scalp wounds, lip commisuroplasty, burn contracture release, and laser therapy. Upon arrival to the preoperative holding area, the patient was apprehensive despite attempts at reassurance by his mother and members of the perioperative team. Physical examination revealed an anxious child with extensive burn scarring, minimal mouth opening and neck extension, and a Mallampati IV airway (Fig. 1). He was tearful and refused oral premedication, attempts at intravenous access, and lidocaine nebulization. He agreed to ''go to sleep with a mask''.

The patient was transported to the operating room where continuous pulse oximetry, electrocardiogram monitoring, and noninvasive blood pressure measurements were instituted while he was in the supine position with approximately 20 degrees of head elevation. Additional anesthesiology team members as well as a pediatric surgeon with expertise in tracheostomy placement were present in the operating room. The patient's anxiety, poor cooperation, and lack of intravenous access precluded an awake intubation with a flexible scope. Post-induction supraglottic airway placement or videolaryngoscopy were not considered feasible options due to his approximately one finger-breadth mouth opening.

Figure 2 Schematic illustrating the application of the SuperNO$_2$VA Mask™ for use in fiberoptic intubation. Images used with permission of Vyaire Medical.

Because of his extensive facial and neck scarring, difficult mask ventilation was anticipated. Given his unfavorable airway characteristics and likelihood of difficulty with mask ventilation and rescue techniques, sedation with preservation of spontaneous ventilation during intubation with a flexible scope was deemed the most prudent approach initial approach. If this was unsuccessful, a discussion with the family or surgical team would have been warranted to determine the appropriateness of an elective surgical airway versus awakening the patient. Equipment for emergency tracheostomy was immediately available in case a cannot intubate/cannot ventilate situation arose.

The SuperNO$_2$VA Mask™ was then placed over the patient's nose and firm downward pressure was applied while tightening the headstrap. The anesthesia machine breathing circuit was then attached to the SuperNO$_2$VA Mask™ and 10 L.min^{-1} of fresh gas flow (air) was administered (Fig. 2a). The Adjustable Pressure Limiting (APL) valve was set at 10 cm H_2O. Once an airtight seal was confirmed by observing the motion of the reservoir bag during inhalation and exhalation, a 50% mixture of nitrous oxide and oxygen was administered at 10 L.min^{-1}, and sevofluorane was gradually titrated until a state of deep sedation was achieved. Once peripheral intravenous access was successfully obtained, inhalational agents were discontinued, and 100% oxygen mixture was delivered. A propofol infusion was started at 50 mcg.kg^{-1}.min^{-1} and intravenous ketamine was administered in 5 mg increments (for a total of 20 mg over 10 minutes). Atomized lidocaine was sprayed onto the tongue as well as the posterior oropharynx and the trachea was orally intubated using a flexible intubation scope while the patient breathed spontaneously. After detection of end-tidal carbon dioxide, general anesthesia was induced using propofol and rocuronium.

His surgery was uneventful, and the patient was extubated awake at the conclusion of the procedure. He was discharged home later that day.

Discussion

Between 2000 and 2018, 203,180 children less than 20-years old were treated for facial burns in US Emergency Departments.[5] Of these, 41.9% were less than 5-years old.[5] For patients with significant burn injuries, surgical treatment is staged and prioritizes the most bothersome or functionally limiting sequelae. In this instance, the operation was aimed at addressing mouth distortion, hypertrophic chest scarring, and hand contractures. Airway management of patients with extensive neck and facial scarring presents numerous challenges and a variety of techniques have been suggested in this patient population. These include awake tracheal intubation, pre-induction surgical neck scar release under local anesthesia, videolaryngoscopy, and the use of an intubating supraglottic device.[1] Although the successful use of these techniques has been reported in both the adult and pediatric burn populations, none of these techniques were feasible in our patient due to anxiety, poor cooperation, absence of intravenous access, and microstomia. Other factors such as poor submandibular space compliance and altered tracheal position can make intubation challenging and a surgeon capable of emergency tracheostomy should be immediately available.[1]

Numerous factors can result in a catastrophic outcome: (1) Previous known and poorly documented difficulty airway and failed invasive option, (2) Difficulty with patient cooperation or consent, (3) Difficult mask ventilation, (4) Difficult supraglottic airway placement, (5) Difficult laryngoscopy, (6) Difficult intubation, and (7) Difficult surgical airway access.

While the SuperNO$_2$VA Mask™ has been successfully used to facilitate fiberoptic intubation in adults,[5] to our knowledge this is the first reported instance of its use for inhalational induction or fiberoptic intubation in a child. Various devices are available for noninvasive ventilation in the pediatric population. These include such as nasal cannula, neonatal/infant prongs, nasal mask, face mask, full face mask, and a helmet. The benefits of the SuperNO$_2$VA Mask™ instead of these devices or high flow nasal oxygen include the ability to administer 10–15 L.min^{-1} of gas mixtures (air, oxygen, nitrous oxide, or volatile agents) while keeping the mouth free for topicalization and flexible bronchoscopic intubation as well as the ability to oxygenate and relieve upper airway obstruction (Fig. 2b). The ability to deliver rapidly titratable gas mixtures is especially beneficial in pediatrics, where an inhalational induction may be performed in the absence of intravenous access. Because the device requires patent nasal passages to allow gas flow, it should not be used in patients with scarred or obliterated nasal passages.

In summary, we found the SuperNO$_2$VA Mask™ to be a useful device for inhalational induction, oxygenation, and intubation in a pediatric patient with a known difficult airway. Further research is necessary to determine its safety and efficacy in pediatric difficult airway management

as well as inhalational induction in the general pediatric population.

Authors' contributions

José R. Soberón, Jr.: This author helped obtain consent for publication, conducted a literature review, prepared and edited the manuscript, and is the corresponding author.

Taran Sangari: This author helped conduct a literature review and assisted in the preparation and editing of the manuscript.

Jessica Ching: This author helped conduct a literature review and assisted in the preparation and editing of the manuscript.

Felipe Urdaneta: This author helped conduct a literature review and assisted in the preparation and editing of the manuscript.

All authors have reviewed and approved the submitted draft of the manuscript.

Conflicts of interest

Dr. Urdaneta is a member of the Advisory Board of Vyaire Medical and has received speaker honoraria from them.

The remaining authors declare no conflict of interest.

Acknowledgements

We thank Dr. Lauren V. Soberón, Ms. Christina L. Hendricks, and the University of Florida Department of Anesthesiology Editorial Office (Gainesville, Florida) for their input and assistance.

References

1. Prakash S, Mullick P. Airway management in patients with burn contractures of the neck. Burns. 2015;41:1627–35.
2. SuperNO$_2$VA^{TM} [package insert]. Mettawa, IL: Vyaire Medical; 2019. Available from: https://www.vyaire.com/sites/default/files/2019-04/SuperNova-Clinical-Protocol_BCCR-Approved.pdf. Accessed on July 24th, 2020.
3. Ghebremichael S, Gumbert SD, Vanga N, et al. Evaluation of SuperNO$_2$VA^{TM} mask technology in a clinical setting: A pilot study. Trends Anaesth Criti Care. 2017;16:54–61.
4. Cataldo Sh, Mondal S, Lester Lc, Hensley Nb. Using the SuperNO$_2$VA device on a patient with a known difficult airway: a case report facilitating fiberoptic intubation and postoperative nasal positive pressure. A A Pract. 2019;12:160–4.
5. Auh E, Kistamgari S, Yang J, Smith G. Children with facial burns treated in United States Emergency Departments, 2000 to 2018. Acad Pediatr. 2020;20:540–8.