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Application of high-flow nasal oxygenation as a rescue therapy in difficult videolaryngoscopic intubation

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Abstract

In difficult airway situations, the next step of the airway management method is selected according to the prior presence of difficulties in mask ventilation and endotracheal intubation. It is important for the practitioner to be calm, quick in judgment, and take action in cases of difficult intubation. Recently, high-flow nasal oxygenation has been rapidly introduced into the anesthesiology field. This technique could extend the safe apnea time to desaturation. Especially, it maintains adequate oxygenation even in apnea and allows time for intubation or alternative airway management. We report two cases in which high-flow nasal oxygenation was implemented in the middle of the induction process after quick judgment by clinicians. High-flow nasal oxygenation was successfully used to assist in prolonging the safe apnea time during delicate airway securing attempts.

Keywords

Difficult intubation, fiberoptic bronchoscope, high-flow nasal oxygenation, mask ventilation, safe apnea time, videolaryngoscope

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Introduction

High-flow oxygen inhalation by nasal cannula could improve oxygenation during self-respiration and apnea.[1,2] High-flow nasal oxygenation has the following advantages: positive pressure, keeping the airway open, maintaining peak end-expiratory pressure, and washout of end-tidal carbon dioxide and nitrogen; thus, it could prolong the safe apnea time.[3] In addition, the apparatus is comfortable and does not interfere with the intubation process in the mouth.[4] Clinicians try to predict difficult airway conditions before anesthesia induction, such as performing bedside tests; however, difficult airway conditions are sometimes unpredictable.[5] Unfortunately, anesthesia induction can begin without adequate anticipation because of human factors.[6] In difficult situations while attempting tracheal intubation, it is important to prolong the apnea period and create an environment for further intubation attempts while maintaining the oxygen supply.[7,8] In this situation, a high-flow nasal oxygenation method can aid in oxygen supply.[9] We report two cases that used high-flow nasal oxygenation in difficult airway conditions encountered after anesthesia induction.

Cases

A 20-year-old female (weight = 44 kg; height = 160 cm) was admitted to the Department of Plastic Surgery and scheduled for mandible distraction osteogenesis because of hemifacial macrosomia, as shown in Figure 1. The past medical history revealed that the patient had the Goldenhar syndrome.

Upon entering the operating room, the patient was monitored with electrocardiography electrodes, pulse oximetry, and noninvasive blood pressure. After pre-oxygenation with 100% oxygen, general anesthesia was induced with propofol (80 mg). After confirming loss of consciousness and adequate mask ventilation, 40 mg of rocuronium was injected. The surgeon requested that a nasotracheal tube should be used for intubation to secure surgical access. The anesthesiologists prepared a Portex® nasotracheal tube (ID 6.0, Ivory PVC; Smiths Medical, Kent, UK) and used a videolaryngoscope (UE scope; UE Medical Devices, Inc., Newton, MA, USA) per routine clinical practice, as a first-attempt device.

The videolaryngoscope was inserted through the mouth with some difficulty because of the limited mouth opening;

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Figure 1. Facial three-dimensional CT anterior and inferior views showing mandibular asymmetry.

the epiglottis tip with the posterior portion of the glottis was observed with external laryngeal manipulation. The nasotracheal tube could not be advanced through the nasal cavity because of severe resistance. Facemask ventilation was resumed, which was adequate. A smaller-sized nasotracheal tube (ID 5.5, Shiley™; Medtronic, Dublin, Ireland) was successfully advanced through the nasal passage; however, nasal bleeding started after insertion and obscured the videolaryngoscopic view, while the glottis could not be found. The blood was suctioned, and intubation was attempted again, but nasal bleeding continued, and the swollen larynx was difficult to expose. The additional intubation attempt was stopped as mask ventilation became difficult because of blood and secretions. Rapid desaturation occurred after cessation of mask ventilation. The responsible anesthesiologist called for help while the oropharyngeal airway was inserted, and mask ventilation was continued with a two-handed technique.

When the airway specialist arrived, a brief summarization of prior intubation attempts was performed. Vigorous suction was performed to remove blood from the oral cavity, and mask ventilation was slightly improved; however, desaturation occurred rapidly after stopping mask ventilation. High-flow nasal oxygenation using Optiflow™ (Fisher & Paykel Healthcare, Auckland, New Zealand) was applied at 40 L/min with FiO_2 of 1.0 by connecting the oxygen tubing to the wall O_2 supply port to extend the safe apnea time. As the jaw was asymmetrical with limited mouth opening, supraglottic airway fitting was considered difficult and could worsen bleeding and airway edema. The anesthesiologist team and the surgeon decided to use an oral endotracheal tube; only one additional attempt was made to use a reinforced tube (ID 5.5) and an acute-angled videolaryngoscope (Glidescope®; GVL Verathon Inc., Bothell, WA, USA). If intubation with a Glidescope was unsuccessful, it was decided to wake the patient. The lower half of the glottis was observed with the Glidescope; however, the distal end of the tube could not be directed to the vocal cords. By adjusting the stylet angle to be more acute, the second attempt was made, and intubation was successful. A 6-min apnea time was needed for two attempts, and peripheral oxygen saturation was maintained at 100% with high-flow nasal oxygenation. The surgeon performed mandibular ramus corticotomy, external distraction device application, and sternocleidomastoideus myomectomy. The total anesthetic and operation times were 210 and 142 min, respectively. The patient was transferred to the post-anesthetic care unit and discharged after 4 days.

A 57-year-old male patient (weight = 62 kg; height = 170 cm) was admitted to the Department of Oral and Maxillofacial Surgery and scheduled for mandibulectomy and reconstruction with pectoralis major myocutaneous flap because of osteoradionecrosis. He underwent subtotal glossectomy, extended radical neck dissection, and reconstruction of a soft tissue defect with an anterolateral thigh flap because of tongue cancer 9 years ago. Otolaryngologists reported that left side vocal cord palsy existed with a 50% patency of the airway to the glottis level by pre-operative laryngoscopy. The patient was judged to be a difficult tracheal intubation because of limited neck extension due to post-operative wounds and contractures.

Upon entering the operating room, the patient was monitored with electrocardiography electrodes, pulse oximetry, and noninvasive blood pressure. After pre-oxygenation with 100% oxygen, anesthesia was induced with propofol (110 mg) and rocuronium (40 mg). Mask ventilation was adequate. A Portex® nasotracheal tube (ID 6.5) was inserted through the patient's nose. Glidescope was inserted through the patient's mouth, but unexpectedly, the epiglottis was not observed. The second attempt did not improve the visual field, and further attempts were stopped as bleeding began from the tongue flap.

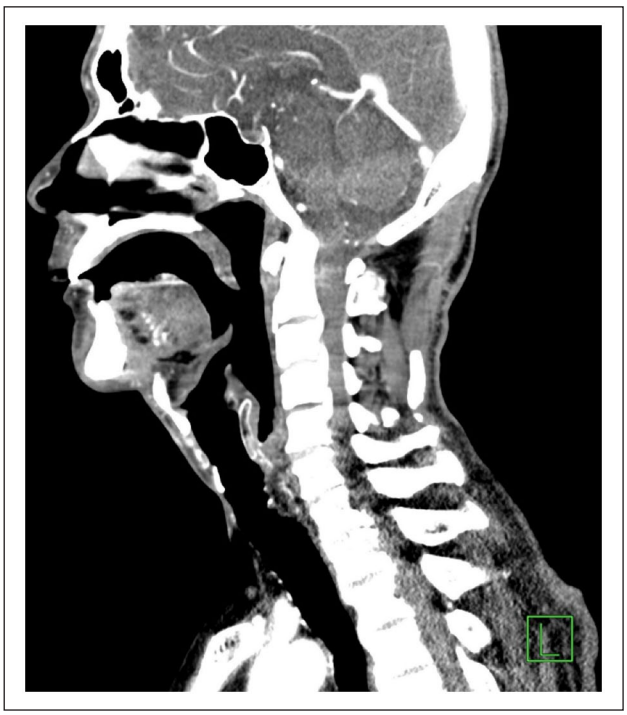

Figure 2. Neck CT showing anteriorly positioned larynx due to the neck contracture following previous surgeries.

Mask ventilation was easily implemented when the airway specialist came. An extremely anteriorly positioned larynx was suspected (Figure 2), and an additional attempt was made with the support of an Optiflow and flexible fiberoptic bronchoscope (LF-GP, Olympus, Tokyo, Japan). High-flow nasal oxygenation was applied at 70 L/min with FiO_2 of 1.0 using Optiflow™ (Fisher & Paykel Healthcare) by connecting the oxygen tubing to the wall O_2 supply port. Portex® nasotracheal tube (ID 6.0) was inserted into the nose. After advancing the fiberoptic bronchoscope into the tube lumen, the glottis was detected after suctioning oral blood and an assisted jaw thrust. During this procedure, high-flow nasal oxygenation was provided through one nostril without the tube. The nasotracheal tube was successfully intubated, and peripheral oxygen saturation was maintained at 100%. The surgeon performed segmental mandibulectomy, reconstruction of a soft tissue defect with a pectoralis major myocutaneous flap, and reconstruction of a hard tissue defect with a reconstruction plate. The total anesthetic and operation times were 425 and 341 min, respectively. The patient was transferred to the intensive care unit and discharged on post-operative day 33.

Discussion

After induction of anesthesia, difficult airway situations can unexpectedly be encountered. As in our cases, a nosebleed can obscure the field of view, multiple attempts can cause the larynx to swell, or unexpectedly, a video laryngoscope cannot find glottis.

If mask ventilation is not possible, it may be necessary to immediately declare a cannot intubate–cannot oxygenate situation and implement front-of-neck access.[5] In our case, although tracheal intubation using a video laryngoscope was unsuccessful, mask ventilation was easily possible with one or two people, and SpO_2 was maintained at 100%. Therefore, tracheal intubation could be attempted using other equipment, such as a supraglottic airway or fiberoptic bronchoscope, in addition to a video laryngoscope.[5] In both cases, mandibular asymmetry and post-operative neck contracture could cause difficulty in fitting the supraglottic airway, which was not attempted because of bleeding and swelling of the tissues in the mouth.[8,10] Instead, devices such as an acute-angled video laryngoscope and a fiberoptic bronchoscope were considered, and only one attempt was made to avoid aggravating the difficult airway situation.

To maximize success of the final attempt, tracheal intubation attempts should not be interrupted due to the reduction of SpO_2.[7] Therefore, we applied high-flow-nasal oxygenation to extend the safe apnea time without reducing desaturation. In addition, the size of the tube used was changed, and the blood or secretion in the mouth was removed before starting intubation. High-flow nasal oxygenation is very easy to set, does not interfere with intubation attempts in the mouth, and can provide 70 L/min of FiO_2 1.0 oxygen.[1] When high-flow nasal oxygenation is applied, oxygen can passively reach from the pharynx to the alveoli even in the absence of spontaneous breathing using a neuromuscular blocker, while oxygen can be uptaken into the bloodstream without active lung expansion.[11,12] According to the existing studies, apnea time can be extended up to 30 min;[13,14] therefore, starting high-flow nasal oxygenation immediately after the first failed intubation attempt in an unanticipated difficult intubation case may be beneficial for allowing sufficient time for clinicians to focus on performing intubation techniques. Interestingly, Shallik and Karmakar[9] suggested that high-flow nasal oxygenation might be included in the difficult airway algorithm. In our case, as high-flow nasal oxygenation was applied, the SpO_2 rate was maintained at 100%, and the delicate intubation process lasting 6 min could be safely performed without interference. The flow rate can be increased and applied as needed from 30 to 70 L/min in adults, and as the flow rate increases, oxygen-depleted air in the oropharynx can be washed away. In addition, a gas containing high oxygen concentrations can be supplied into the trachea.[15] In this case, the first patient had severe nosebleeds; while blood and secretions were constantly accumulating in the oral cavity. Therefore, a 40-L/min flow rate was applied because oxygen at a high velocity would push blood or secretions down to the vocal cords and, thus, obstruct the view. This flow rate usually falls within the range of 30–40 L/min, which allows effective oxygen supply without discomfort in awake patients. Conversely, in the second patient, the maximum safety margin was secured by successfully applying the maximum flow rate of 70 L/min. When it is

difficult to administer oxygen because of the anatomical abnormality of the nasopharynx, an internal lumen that administers oxygen to the laryngoscope or oral airway can be made, and oxygen is administered to the deep oropharynx to provide apneic oxygenation.[16,17] In conclusion, high-flow nasal oxygenation can secure a safe apnea time to create an environment where medical staff can concentrate on tracheal intubation attempts, which is very important in cases of unpredictable and difficult tracheal intubation.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethical approval

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Informed consent

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