

The i-gel supraglottic airway device improves airway management during endobronchial ablative therapy under general anesthesia: a case report

Journal of International Medical Research
50(8) 1–7

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DOI: 10.1177/03000605221115163

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Abstract

Endobronchial ablative therapy (EAT) in patients with preexisting obstructive airway disease can cause hypoxemia because bronchoscope insertion interferes with ventilation and a low fraction of inspired oxygen (FiO_2) is essential to avoid airway fire. A man in his early 50s with moderately severe obstructive airway disease was scheduled for EAT for treatment of tracheal papillomatosis. Ventilation and oxygenation would have been difficult because of narrowing of the endotracheal tube by bronchoscopic insertion and a low FiO_2 ; therefore, an i-gel supraglottic airway device with a larger inner diameter was inserted. All visible intratracheal papillomas were ablated by a potassium titanyl phosphate laser through the bronchoscopic port that passed through the lumen of the i-gel at an FiO_2 of 0.3. During anesthesia for EAT, the i-gel supraglottic airway device provided a wider lumen for ventilation. We were thus able to provide stable ventilation at an FiO_2 of 0.3 during EAT in this patient with obstructive airway disease, avoiding airway fire and hypoxemia.

Keywords

Endobronchial ablative therapy, i-gel, laser, supraglottic airway, obstructive airway disease, tracheal papillomatosis, case report

Date received: 22 April 2022; accepted: 4 July 2022

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Introduction

In addition to appropriate airway management, endobronchial ablative therapy (EAT) for advanced diagnostic and therapeutic bronchoscopy often requires complex anesthetic techniques with deep sedation or general anesthesia.^{1,2} Typical EAT for multiple intraluminal masses involves lengthy ablation procedures. Ventilation can be difficult if the patient has coexisting pulmonary disease, and the insertion of a bronchoscope can worsen the ventilation. Furthermore, anesthesiologists must limit the fraction of inspired oxygen (FiO₂) in the air to <0.3 to avoid airway fire.^{3,4} The combination of obstructive airway disease, insertion of the bronchoscope, and a low FiO₂ can cause hypoxemia. We herein present the case of successful anesthetic management using the i-gel supraglottic airway device (Intersurgical, Wokingham, Berkshire, UK) during laser-assisted EAT for tracheal papillomatosis in a patient with obstructive airway disease.

Case report

A man in his early 50s was scheduled by his pulmonologist for EAT as treatment for tracheal papillomatosis. The patient was 157.4cm tall and weighed 82.7kg, and he had a body mass index of 33.4kg/m². He was a heavy smoker (30 pack-years), and pulmonary function testing revealed moderately severe obstructive airway disease without response to a bronchodilator (Figure 1). His surgical history included six operations under general anesthesia within the last 2 years, including laser cordectomy, tracheostomy, recurrent oral mass excision, and microlaryngeal surgeries with a potassium titanyl phosphate laser for oropharyngeal and laryngeal papillomas. During the most recent surgery, multiple masses protruding into the tracheal lumen

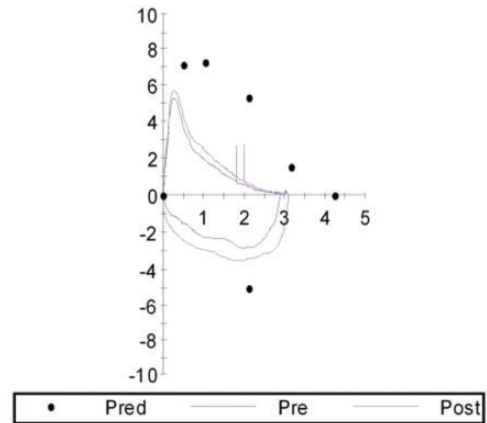


Figure 1. Flow-volume loop in preoperative pulmonary function test showing moderately severe airway obstruction.

from the mid-trachea to the carina were identified by flexible bronchoscopy under anesthesia. To remove these papillomas, the patient was transferred from the otolaryngology department to the pulmonology department. The pulmonologist tried to ablate the masses under sedation and topical anesthesia, but the procedure was unsuccessful because of the patient's severe dyspnea. Thus, a decision was made to operate under general anesthesia the next day, and the patient provided written informed consent to treatment by EAT under general anesthesia.

Before arriving in the operating room, the patient was premedicated with 4% nebulized lidocaine (2.41 mg/kg) and intravenously administered atropine (0.006 mg/kg), hydrocortisone (1.2 mg/kg), and dexamethasone (0.12 mg/kg). In the operating room, the patient was preoxygenated for 5 minutes with 100% oxygen while undergoing electrocardiography and monitoring of his blood pressure, oxygen saturation by pulse oximetry (SpO₂), and bispectral index (BIS). Anesthesia was induced with propofol (target plasma concentration, 3.0–6.0 µg/mL) and remifentanyl (effect-site

concentration, 3.0–4.0 ng/mL) using a target-controlled infusion pump (Orchestra® Base Primea; Fresenius Kabi, Bad Homburg, Hessen, Germany), and rocuronium bromide (0.6 mg/kg) (Esmeron®; Merck Sharp & Dohme, Haarlem, the Netherlands) was administered as a neuromuscular blocking agent. After achieving a proper BIS for intubation, a size 5 i-gel device was successfully inserted. We maintained the patient under total intravenous anesthesia with propofol and remifentanyl infusion under BIS monitoring. Before laser ablation, the FiO_2 was lowered to 0.3 with an oxygen–air mixture until the expired oxygen concentration (FeO_2) approached 0.3 to avoid an airway fire. A flexible fiberoptic bronchoscope (5.9-mm BF-1T260 with capacious 2.8-mm-wide channel; Olympus, Tokyo, Japan) was inserted through a swivel between the i-gel and the corrugated tube. The bronchoscope initially showed a view of the larynx, displaying the proper positioning of the i-gel and the absence of papillomas within the larynx (Figure 2). After bronchoscopic examination, we ablated the intratracheal papillomas with a potassium titanyl phosphate laser (operated at 957 J) that was inserted through a side



Figure 2. Fiberoptic view of the larynx through the i-gel device shows that the device is securely positioned (green).

port of the bronchoscope (Figure 3). We used a fresh gas flow rate as high as 10 L/minute to compensate for peribronchoscopic air leakage and bronchoscopic suction. Successful ablation of the intratracheal papillomas without bleeding was confirmed (Figure 4).

During surgery, the patient's vital signs were stable and the SpO_2 was maintained at 95% to 98% with an FiO_2 of 0.3. Only one episode of transient desaturation to 85% occurred during bronchoscopic fume suction, but the desaturation resolved soon after the cessation of suction. The end-tidal carbon dioxide (EtCO_2) value and airway pressure were maintained at 35 to 37 mmHg and 18 to 20 cmH_2O ,

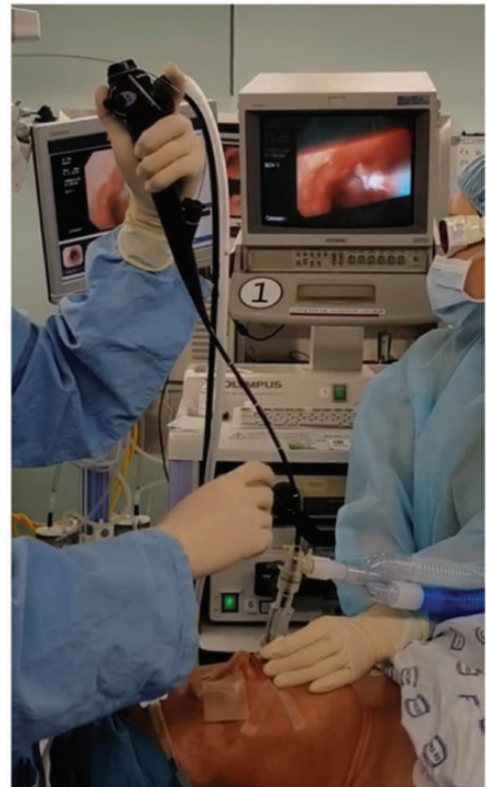


Figure 3. The bronchoscope passes through the i-gel device, and the potassium titanyl phosphate laser is introduced for ablation.

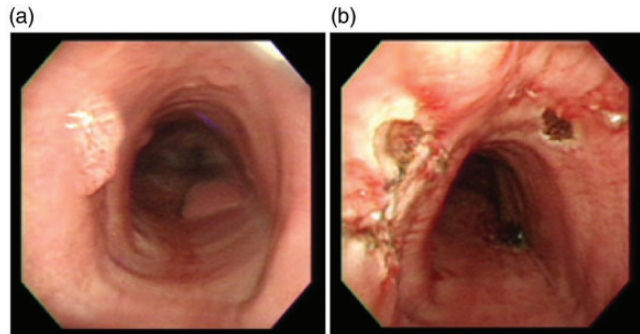


Figure 4. Intratracheal bronchoscopic findings (a) before and (b) after the ablation of multiple intraluminal papillomas.

respectively. After the completion of ablation, the patient's neuromuscular function was recovered by sugammadex (2 mg/kg) (Bridion®; Merck Sharp & Dohme) and the i-gel device was removed. The patient was transferred to the post-anesthesia care unit, and his recovery was uneventful. He received four more ablations under general anesthesia for newly developed intratracheal papillomas during the following year.

The reporting of this study conforms to the CARE guidelines.⁵ This case report was approved by the Institutional Review Board of St. Mary's Hospital, The Catholic University of Korea (approval number SC19ZESE0072). The patient provided written informed consent for publication of the report, and all patient details have been de-identified.

Discussion

Recurrent respiratory papillomatosis is a rare benign neoplasm of the larynx and presents with wart-like growths in the airway that affect the patient's voice and airway patency.⁶ Although this disease is benign, it is potentially deadly, with a risk of airway obstruction and a 3% to 7% risk of malignant conversion. It has a predilection for the upper airway and larynx, and lower airway involvement as seen in the

present case occurs in conjunction with upper airway and laryngeal involvement in 3% to 15% of affected patients.^{7,8} The current standard of care is surgical excision via a microdebrider, carbon dioxide laser, cryotherapy, electrocoagulation, Nd:YAG laser, or pulse-dye laser.⁹ EAT through a rigid or fiberoptic bronchoscope is the main treatment modality for malignant or benign airway lesions.¹⁰ Besides complications related to the EAT procedure, such as perforation, hemorrhage, fire, and embolism of the airway, general complications such as respiratory failure, myocardial infarction, arrhythmia, and death may occur more commonly in EAT than in routine bronchoscopy because EAT requires prolonged sedation and a decreased FiO_2 , which may increase the risk of hypoxia.¹⁰ For these reasons, general anesthesia was performed in the present case; this supported ventilation and oxygenation during the use of low FiO_2 in a patient with a limited ventilatory route during EAT.

The main approach to avoid airway fire during EAT is to reduce the use of the three essential elements of fire: an ignition source (a heat-based surgical device such as a laser or electrocautery device), an oxidizer (oxygen or nitrous oxide), and fuel (tissue, mesh, or plastic devices).¹¹ Thus, an FiO_2 and end-tidal oxygen of <0.3 are

recommended prior to activation of the laser or electrocautery device. Patients who cannot tolerate an FiO_2 of 0.3 should not undergo these procedures; instead, a therapeutic alternative such as the use of extracorporeal membrane oxygenation should be considered.¹² Because the gas in the trachea is a mixture of inspired and expired gas, it was important for us to confirm that the FeO_2 had decreased to the level we set in the present case. Once the FiO_2 had decreased to 0.3, time was required for the FeO_2 to decrease to 0.3. To maintain a low FeO_2 during EAT, sufficient undisrupted tidal ventilation should be guaranteed. Therefore, a larger lumen for ventilation was required during EAT to achieve a sufficient tidal volume in our patient.

The i-gel, a type of supraglottic airway device, was used during endobronchial tumor ablation delivered by an endobronchial Nd:YAG laser.¹³ The cross-sectional airway channel of a size 5 i-gel device is elliptical with a major axis of 13.4 mm and a minor axis of 12.9 mm.¹⁴ This results in a cross-sectional area of 135.8 mm², in contrast to the 56.7-mm² cross-sectional area of an endotracheal tube with an inner diameter of 8.5 mm. The cross-sectional areas

for ventilation after bronchoscope insertion are 108.5 mm² for a size 5 i-gel and 29.4 mm² for an endotracheal tube with an 8.5-mm inner diameter. If an endotracheal tube with an 8.5-mm inner diameter had been used, the remaining diameter would be only 2.6 mm when a 5.9-mm bronchoscope was inserted, making it almost impossible to ventilate an adult patient (Figure 5). During EAT with the i-gel in our patient, the peak airway pressure was maintained within the range of 18 to 22 cmH₂O, and the EtCO₂ ranged from 38 to 40 mmHg. The SpO₂ transiently dropped to 85% during excessive bronchoscopic suction but recovered soon after the temporary interruption of EAT. During the rest of the EAT procedure, the SpO₂ was maintained at 95% to 98%.

We performed total intravenous anesthesia with propofol and remifentanyl under BIS monitoring as previously recommended.¹ A potent inhalational agent such as sevoflurane is often used with remifentanyl infusion. However, nitrous oxide should not be administered while lasers are in use to reduce the chance of a fire. We used rocuronium bromide as a neuromuscular blocking agent for complete paralysis and positive-pressure ventilation instead of

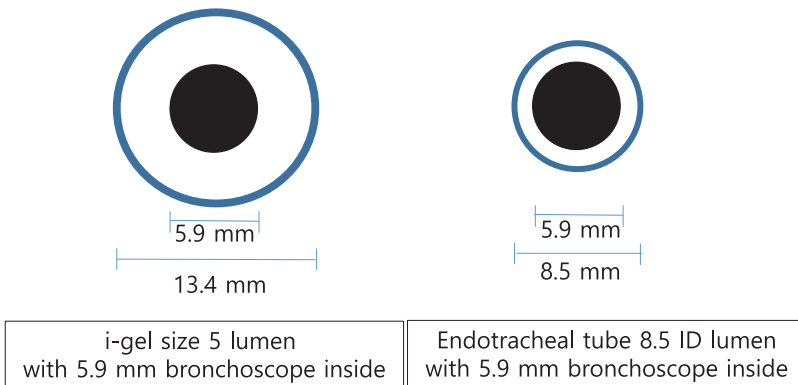


Figure 5. Schematic diagram of the airway lumen comparing a size 5 i-gel device and an endotracheal tube with an 8.5-mm ID with a bronchoscope inside. There is much less space for ventilation with the endotracheal tube than with the i-gel device. ID, inner diameter.

spontaneous ventilation because of concern that the laser beam would be deflected by the patient's movement and cause damage to other tissues. This strategy was successful during the lengthy operation, and sugammadex completely terminated the effect of the rocuronium bromide.

In this case report, we have described the performance of EAT for intratracheal papillomas under airway maintenance with an i-gel device. Because of the larger intraluminal space for ventilation than that provided by an endotracheal tube, it was possible to maintain constant ventilation and avoid airway fire at an FiO₂ of 0.3 in this patient with obstructive airway disease.

Acknowledgement

The authors would like to thank the patient for his permission to share his case information in this report.

Authors' contributions

All authors made substantial contributions to the following: Chung MY drafted the manuscript; Hong SJ, Shin MJ, and Cha SH obtained patient consent and acquired, analyzed, and interpreted the data; and Lee JY revised the article for important intellectual content and approved the final version for submission.

Declaration of conflicting interest

The authors declare that there is no conflict of interest.

Ethics statement


This case report was approved by the institutional review board of St. Mary's Hospital, The Catholic University of Korea (approval number SC19ZESE0072). The patient provided written informed consent for publication of the report.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

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