Case Report

A novel method using a single lumen tube and extraluminal bronchial blocker for one-lung ventilation in severe tracheal stenosis: a case report

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Abstract: Double-lumen tubes (DLT) and bronchial blockers (BB) are usually used to functionally isolate the lungs during thoracic surgery. However, for patients with tracheal stenosis, management of one lung ventilation (OLV) in the anesthesia is still full of challenges due to mismatching between the trachea lumen and tracheal tube diameter. In the past, a small single-lumen tube (SLT) combined with an endobronchial pediatric BB or extraluminal detached BB of a uninvent obtained successful OLV in patients with tracheal stenosis. Additionally, nonintubated tracheal and surgical pneumothorax may work. We first report an interesting case of a 65-year-old man with a history of an upper left lobe nodule in the lung and tracheotomies. A chest computed tomographic (CT) scan showed the middle of the trachea was severely narrowed. We used a minor SLT and extraluminal BB and acquired optimal collapse of the left lung. He accepted video-assisted thoracoscopic lobectomy of an upper left lobe under general anesthesia. After both BB and SLT were removed, the patient did not present dyspnea or airway injury. The patient recovered well and was discharged from the hospital a week after surgery. This method, a minor SLT combined with extraluminal BB, is convenient for sputum suction and fiber optic bronchoscope examination, moreover, it is an option for OLV in severe tracheal stenosis cases.

Keywords: One lung ventilation; tracheal stenosis; extraluminal bronchial blocker; case report

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Introduction

The two principal devices used to establish lung isolation and one lung ventilation (OLV) include double-lumen tubes (DLT) (1) and bronchial blockers (BB), which were inserted through a conventional single-lumen tube (SLT) (2). However, when the airway is extremely narrowed, the appropriate DLT is difficult to insert. Meanwhile, it is difficult to simultaneously place BB and fiberoptic bronchoscopy in the narrow entrance of small SLT. In previous reports, a small SLT with pediatric wire-guided Arndt endobronchial blockers showed successful OLV in an adult patient with tracheal stenosis (3). The small SLT was inserted along with the detached blocker of a uninvent tube in a patient with tracheal stenosis for lung isolation (4). Nonintubated tracheal was used to maintain ventilation during stenosis tracheal resection surgery (5) and surgical pneumothorax may be an alternative method to achieve OLV in patients with more complicated airways (6). In this study, we describe an extraluminal technique for BB placement with minor SLT, which may be suitable for patients exhibiting airway stenosis during thoracic surgery. We present the following article in accordance with the CARE checklist (available at http://dx.doi.org/10.21037/apm-20-1676).

Case presentation

A 65-year-old man, 167 cm tall and weighing 80 kg, had a

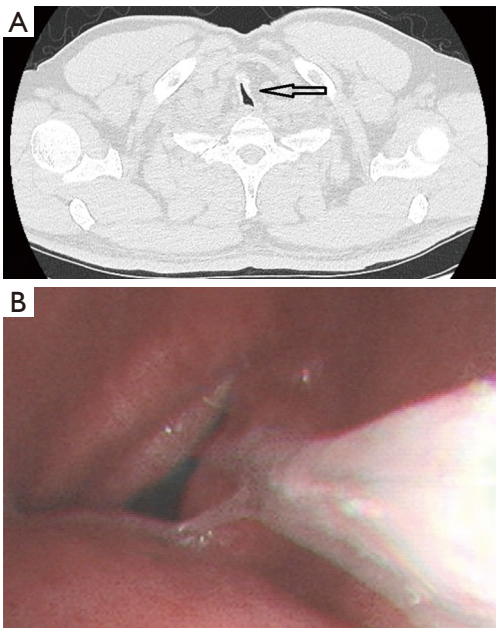

Figure 1 The assessment of tracheal stenosis. (A) A neck and chest CT scan revealed a case of serious tracheostenosis with the narrowest area measuring 2.9 mm × 6.7 mm (arrow). (B) Bronchoscopy revealed that the middle area of the trachea was severely narrowed. CT, computed tomography.

history of temporary tracheotomy due to traumatic brain hemorrhage eight years ago. He was found an upper left lobe nodule in the lung. However, a neck and chest computed tomography (CT) scan revealed serious tracheostenosis between cervical spine 7 and thoracic spine 1, the narrowest area measured 2.9 mm × 6.7 mm (*Figure 1A*). A bronchoscopy further confirmed that the middle of the trachea was narrowed (*Figure 1B*). The patient was diagnosed as tracheostenosis and an upper left lung lobe nodule. The patient was scheduled for video-assisted thoracoscopic lobectomy of an upper left lobe.

Standard monitoring systems were used to detect vital signs, including the measurement of invasive arterial blood pressure, heart rate, electrocardiogram, spectral entropy, and peripheral oxygen saturation.

Anesthesia was administered using midazolam (0.025 mg/kg), lidocaine (1 mg/kg), etomidate (0.3 mg/kg) and sufentanil (0.3 μg/kg). After confirming mask ventilation, cistracurium (0.2 mg/kg) was administered for tracheal intubation. The glottis was exposed using video laryngoscopy. A BB (9 French, lubricated with silicone oil) was first inserted into the glottis and turned forward, to the left (*Figure 2A,B*). Next, a small SLT (5.5 mm inner diameter, lubricated by silicone oil) was inserted into the glottis and passed through the tracheal stenosis without resistance until the cuff passed the glottis (*Figure 2C*). Last, fiberoptic bronchoscopy was inserted into the SLT to adjust the BB to the left main stem bronchus (*Figure 2D*), ensuring that only right lung ventilation was occurring (*Videos 1,2*).

Collapse of the left lung using BB achieved optimal exposure for the operative field. Parameters for right-lung ventilation included a tidal volume of 6 mL/kg, respiratory frequency of 12 breaths/min, airway pressure of 17–20 cmH_2O, pulse oximetry oxygen saturation of over 95% and end-tidal carbon dioxide 35–45 mmHg.

The intraoperative pathological diagnosis was confirmed to be adenocarcinoma and the patient underwent video-assisted thoracoscopic lobectomy of an upper left lobe. Both BB and SLT were removed after the surgery, no dyspnea, airway injury or edema were found. The postoperative pathologic diagnosis was adenocarcinoma *in situ* (pTaisN0M0). The patient recovered well and was discharged from the hospital a week after surgery.

The patient reported a comfortable experience from the start of anesthesia to extubation and showed no awareness. In addition, no dyspnea, sore throat, or hoarseness presented during the surgery.

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Declaration of Helsinki (as revised in 2013). Written informed consent was obtained from the patient.

Discussion

The management of OLV in patients with tracheal stenosis requires both careful assessment and skilled manipulation. In this case, surgery of the left lobe of the lung was a good indication for BB. The pre-surgery evaluation suggested that the minor diameter of SLT could pass through the stenosed area. After confirming that mask ventilation was properly prepared, muscle relaxants were used for tracheal intubation. The standard approach for the placement of BB requires that the fiberoptic bronchoscopy is inserted into the lumen of the SLT. In small children, it is not feasible to place both the fiberoptic bronchoscopy and BB through the narrow lumen of SLT, therefore, extraluminal placement of BB is a viable alternative. The most significant advantage of extraluminal placement of BB is the absence of coupling

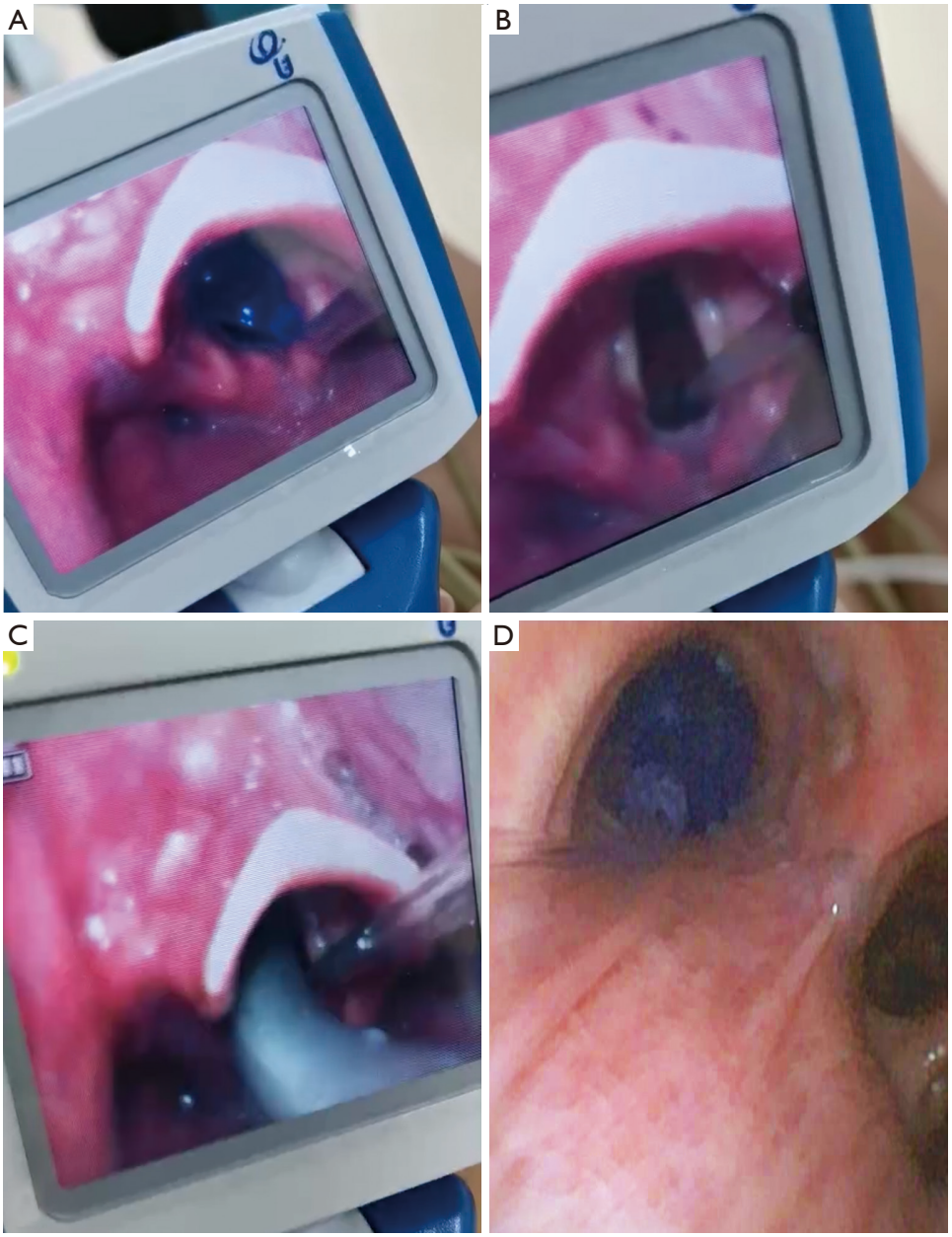

Figure 2 The operations of tracheal intubation using extraluminal placement of BB and SLT. (A) A BB was inserted into the glottis using a video laryngoscope. (B) The BB passed through the area of tracheal stenosis. (C) A minor SLT was inserted into the glottis and passed through the area of tracheal stenosis until the cuff passed the glottis. (D) The cuff of the BB was located at the left main stem bronchus using fiberoptic bronchoscopy. BB, bronchial blocker; SLT, single-lumen tube.

between fiberoptic bronchoscopy and BB within SLT. Meanwhile, larger diameter of fiberoptic bronchoscopy provides optimal optics and visualization (7).

Thus, we were inspired to choose minor diameter tracheal tube ventilation combined with extraluminal placement of the BB to achieve left lung isolation. This also reduces intraluminal resistance and is easier to perform suctioning during ventilation. Studies showed that the extraluminal placement of BB was quicker than the well-accepted intraluminal approach (8).

However, extraluminal placement of BB remains some limitations. For example, it is unable to insert BB into the glottis in some cases with more difficult airways (9). In addition, it is difficult to assess damage of the trachea that might be caused by BB movement. If the patient has abnormal opening of right main bronchus, the right positioning of BB may be not feasible. The balloon dilatation or nitinol stent implantation prior to surgery may be an optional method. However, postoperative dyspnea after extubation was reported in a patient with balloon dilatation (10) and sputum retention is a significant complication related to stent implantation (11). A laryngeal mask combined with BB is another technique (12) but anesthesia management is complex. In this case, early extubation is helpful to reduce airway edema and the tracheotomy is prepared for possible postoperative dyspnea. Anyhow, extraluminal or intraluminal placement of BB should be the necessary techniques mastered by every thoracic anesthesiologist (13).

In summary, in cases of severe tracheal stenosis, minor SLT combined with extraluminal BB is a feasible method to obtain OLV during thoracic surgery, which is convenient for sputum suction and fiber optic bronchoscope examination. However, it is difficult to insert BB in patients with more complicated airways such as invisible glottis, and it is difficult to assess narrow airway edema and injury caused by BB and tracheal tubes while supraglottic airway devices and nonintubated methods may avoid these issues.

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Footnote

Reporting Checklist: The authors have completed the CARE reporting checklist. Available at http://dx.doi.org/10.21037/apm-20-1676

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at http://dx.doi.org/10.21037/apm-20-1676). The authors have no conflicts of interest to declare.

Ethical Statement: Authors are accountable for all aspects of the work ensuring that questions related to the accuracy or integrity are appropriately investigated and resolved. Consent for publication and any accompanying images were obtained from the patient. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Declaration of Helsinki (as revised in 2013). Written informed consent was obtained from the patient.

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