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Case Report

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Unexpected Bronchomalacia Combined with Excessive Dynamic Airway Collapse was Diagnosed by Intraoperative Bronchoscopy: A Case Report

Yuling Tang[1], Yu Li[1*]

[1]*Department of Anesthesiology, West China Hospital, Sichuan University and The Research Units of West China (2018RU012)-Chinese Academy of Medical Sciences, Chengdu, China*

Corresponding Author: **Yu Li**

Address: Department of Anesthesiology, West China Hospital, Sichuan University, No.37, Guoxue Lane, Wuhou District, Chengdu 610041, Sichuan Province, China; Tel: 18980601545; Email: 774896418@qq.com

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Abstract

Expiratory central airway collapse (ECAC) comprises tracheobronchomalacia (TBM) and excessive dynamic airway collapse (EDAC). ECAC is a progressive disease that can be congenital or acquired, and it can be confirmed by inspiratory-dynamic expiratory chest CT or dynamic bronchoscopy. We present the case of a 65-year-old man who underwent radiofrequency ablation for hepatocellular carcinoma under general anesthesia. After tracheal intubation in the operating room, the respiratory sound in the left lung disappeared, and the respiratory sound in the right lung was clear during chest auscultation. Bronchoscopy revealed complete collapse of the left main bronchus. Intraoperative bronchoscopy confirmed that the patient had ECAC (both TBM and EDAC).

Keywords

Expiratory Central Airway Collapse, Excessive Dynamic Airway Collapse, Bronchomalacia, Bronchoscopy, Inspiratory-Dynamic Expiratory Chest CT

Introduction

Expiratory central airway collapse is characterized by excessive constriction of the trachea and bronchus during exhalation, which can result in insufficient or absent ventilation, leading to hypoxia and even catastrophic hypoxemia in the perioperative period, especially during anesthesia induction. An analysis of CT scans from a cohort of current and former smokers revealed that the prevalence of ECAC in this high-risk group was 5%, and it was associated with worse respiratory quality of life [1]. The purpose of this case report is to provide a brief description of the epidemiology and treatment of ECAC, and to highlight the possibility of perioperative poor ventilation due to ECAC through a case report format.

Case Presentation

A 65-year-old man was admitted to the hospital for radiofrequency ablation of hepatocellular carcinoma. The patient had been diagnosed with hepatocellular carcinoma for two years and had a history of two radiofrequency ablation procedures for hepatocellular carcinoma under local anesthesia. He suffered from tuberculosis 40 years ago and was cured with regular treatment. He had no history of smoking and drinking, no history of blood transfusion or allergy, but two histories of local anesthetic surgery. Preoperative examinations, such as laboratory tests and

electrocardiograms, showed no obvious abnormalities. He completed chest computed tomography (CT) but had no results with only images. He was scheduled for open radiofrequency ablation under general anesthesia.

In the operating room, standard electrocardiogram, oxygen saturation (SpO_2), and noninvasive blood pressure (NIBP) monitoring were performed before general anesthesia. The preoperative heart rate was 71 beats/min; NIBP, 123/70 mmHg; SpO_2, 99%. Patients were induced with midazolam (2 mg), propofol (1 mg/kg), sufentanil (0.3 μg/kg), and cisatracurium (0.2 mg/kg). Mechanical ventilation was performed after endotracheal intubation. However, the left lung respiratory sound disappeared, and the right lung respiratory sound was clear during auscultation of the chest. We checked the patient's oxygenation, ventilation, and end-tidal partial pressure of carbon dioxide, which remained within the normal range. Tracheal tube depth and sputum blockage were examined one by one without abnormalities. Therefore, we further examined with bronchoscopy, which showed that the left main bronchus had completely collapsed and that bronchoscopy could not pass through the stenosis (**Fig-1**).

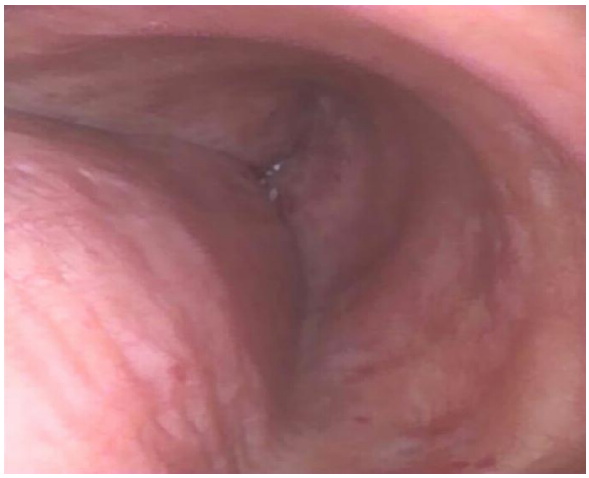
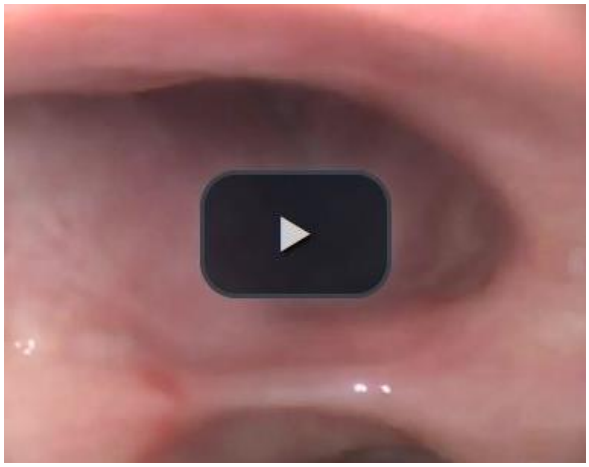


Fig-1:

Bronchoscopy revealed complete collapse of the left main bronchus

When the airway pressure reached 40 mmHg, a faint breath sound was heard in the left lung. When the patient's airway pressure was maintained at 17 mmHg, the tidal volume was approximately 435 ml, and the SpO_2 was 99%, we believed that passive single-lung ventilation could also ensure systemic oxygen. Then, the surgeon began the operation with passive single-lung ventilation. Unfortunately, we did not perform arterial blood gas analysis at that time. Sevoflurane was administered through inhalation, and refentanil was administered as needed for analgesia during surgery. The patient resumed spontaneous ventilation after surgery, bronchoscopy showed there was a fissure in the left main bronchus in the inspiratory phase, and the left main bronchus was completely collapsed during the expiratory phase (**Video-1**). Preoperative chest CT also demonstrated significant stenosis and exaggerated bowing of the posterior membrane of the left main bronchus in this patient. However, there was only imaging and no paper report, so imaging was mistakenly ignored by anesthesiologists. The patient was diagnosed with ECAC (both BM and EDAC) by intraoperative bronchoscopy and chest CT (**Fig-2**).



To watch the complete Video-1 online, click on the image

Video-1:

Bronchoscopy video footage collected intraoperatively showing there was a fissure in the left main bronchus in the inspiratory phase, fresh air could pass through it, and the left main bronchus was completely collapsed during the expiratory phase.

When the patient was fully conscious, we removed the tracheal tube and brought him safely back to the ward. The patient was discharged 2 days after surgery, and the length of hospital stay was 5 days. We informed the patient about the perioperative diagnosis of ECAC in the left main bronchus and advised the patient to complete a pulmonary function test. He refused on the grounds that he had no clinical symptoms, such as dyspnea and shortness of breath. Therefore, respiratory clinic follow-up was

recommended. Telephone follow-up was performed three months after the operation. The patient did not have any symptoms, such as pain or dyspnea, and no further treatment was intended unless symptoms developed.

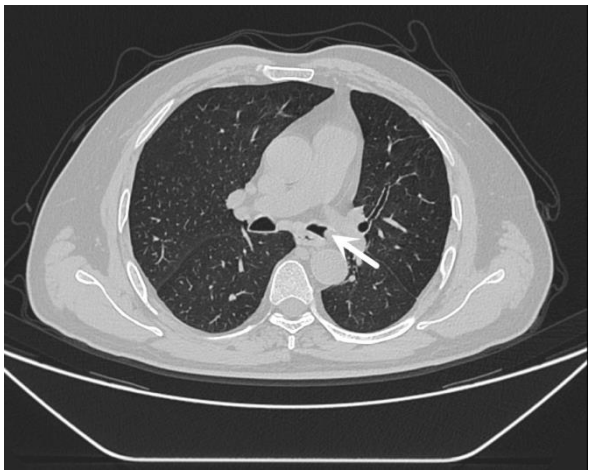


Fig-2:

Chest computed tomography (CT) on admission showed that the left main bronchus was significantly narrowed and exaggerated bowing of the posterior membrane (arrow in Fig-2). Left main bronchomalacia and excessive dynamic airway collapse were considered.

Discussion

ECAC can be a congenital or acquired progressive disease, defined as a > 50% reduction in cross-sectional area in the trachea and main bronchus. They can be confirmed by inspiratory-dynamic expiratory chest CT or dynamic bronchoscopy [2]. ECAC includes TBM and EDAC [2]. TBM is characterized by abnormalities of the tracheal and/or bronchial cartilage, including tracheomalacia (TM), bronchomalacia (BM), or TBM, depending on the location of the cartilage. EDAC is characterized by the normal structure of the tracheal cartilage, with the posterior membrane expanding inward, and it is distinctly different from TBM because of the absence of cartilaginous involvement [3].

Common causes of acquired ECAC include chronic obstructive pulmonary disease, asthma, obesity, inflammatory diseases, and infectious and mechanical extrinsic compression, leading to degeneration of normal cartilage or atrophy of smooth muscles in the membranous portion of the trachea [3]. In this case, the patient presented with abnormally flattened anterior tracheal cartilage and exaggerated bowing of the posterior membrane. Both EDAC and left main BM were diagnosed by intraoperative bronchoscopy and chest CT.

ECAC patients are usually asymptomatic or may have nonspecific symptoms until stenosis becomes severe (greater than 90%) [4]. If there are no clinical symptoms, acquired ECAC does not require treatment. As the disease progresses, obstruction greater than 90% can present with moderate to severe symptoms of ECAC in adults, including dyspnea, cough, expectoration, hemoptysis and shortness of breath [5]. Symptoms of ECAC can occur not only in patients with worsening underlying disease but also in exercise. Weinstein [6] et al. found that 6 individuals in the military had exertional dyspnea only during exercise and were diagnosed with EDAC. Therefore, defining ECAC solely on the basis of clinical symptoms may be problematic, as functional airway collapse has been demonstrated in healthy individuals and needs to be combined with underlying disease. Treatment of symptomatic ECAC includes treatment of the underlying disease and noninvasive positive pressure ventilation. Severe central airway collapse (> 90%) occurs in patients with ECAC, and corrective treatment is an option that includes airway stent placement [7] or tracheobronchial plasty (TBP) [7,8].

Currently, only a few cases of TBM, EDAC or ECAC have been reported perioperatively. Therefore, we believe that the perioperative diagnosis of ECAC is useful in identifying the reason for difficult ventilation. Undetected ECAC may result in difficult ventilation during the induction of anesthesia, as well as perioperative hypoxemia. Therefore, ECAC should also be considered when suffering from perioperative difficult ventilation and hypoxemia, excluding mechanical causes, sputum blockage, and reflux aspiration. Anesthesiologists should focus on preoperative symptoms and imaging.

Conclusion

ECAC can be confirmed by inspiratory-dynamic expiratory chest CT or dynamic bronchoscopy. ECAC should also be considered when suffering from perioperative difficult ventilation and hypoxemia.

Conflict of Interest

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

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