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Case Report

Bronchoscopic intervention for cervical tracheal laceration: a case report and review of the literature

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Abstract: Tracheal and bronchial injuries are serious types of thoracic trauma, and a cervical-tracheal laceration is a rare sub-type. Because the integrity of the tracheal wall of most patients has not been damaged in a cervical-tracheal laceration, the patients' clinical manifestations lack any visible symptoms, easily causing a misdiagnosis or a missed diagnosis. In this study, the clinical data of one case of cervical tracheal laceration were collected, and the diagnosis, treatment, and prognosis of the patient were analyzed. The patient was admitted to the hospital and was confirmed to have a laceration of the neck trachea using an electronic bronchoscope. After the bronchoscopic intervention, the cartilage ring of the free trachea was removed, and the respiratory condition of the patient was improved. Electronic bronchoscopy is an important tool for the diagnosis of cervical tracheal lacerations. If the diagnosis is considered in clinical work, electronic bronchoscopy should be the first choice.

Keywords: Cervical tracheal laceration, tracheal and bronchial injuries, electronic bronchoscope, neck and chest trauma

Introduction

Severe compression, impact, and acceleration to the neck and chest as well as various sharp injuries are significant causes of tracheal and bronchial injury. Different degrees of tracheal or major bronchial damage may lead to airway obstruction or bleeding and can be life-threatening. Tracheal and bronchial injuries mainly include lacerations and ruptures of the trachea and bronchus. Currently, surgery is still the main treatment for both types of trauma. In tracheobronchial laceration (TBL), one type of mild injury to the trachea and bronchus, the main structure of the tracheal wall may remain intact without severe damage. If a non-surgical procedure is performed, the mortality and prognosis rates can be improved [1, 2]. This article reports a case of a TBL patient with tracheal cartilage avulsion and airway obstruction caused by trauma. The complete removal of the tracheal cartilage ring was achieved through bronchoscopic intervention therapy. This case will help accumulate future evidence for the treatment of TBL by bronchoscopy.

Case presentation

The patient was a 46 year-old man. He had a car accident that led to a combined neck and chest trauma (2 hours). He was transferred to the intensive care unit from the emergency department of our hospital on June 16, 2019. On physical examination, multiple scattered scratches were observed on his left chest and on the front of his neck. His breathing movements were poor on the left chest but normal on the right. The bilateral lower chest was dull on percussion, and his breath sounds in both lungs were thick with an extensive wet and dry voice. The abdomen was distended without tenderness or rebound tenderness and the bowel sounds (3-5 times/min) were weak.

The blood examination showed: white blood cells, 19.3×10^9/L; neutrophils, 89%; red blood cells, 2.37×10^9/L; hemoglobin 82 g/L; platelets, 108×10^9/L. The coagulation test showed: prothrombin time (PT), 11 sec.; activated partial thromboplastin time (APTT), 26 sec. The arterial blood gas revealed: pH, 7.32; oxygen

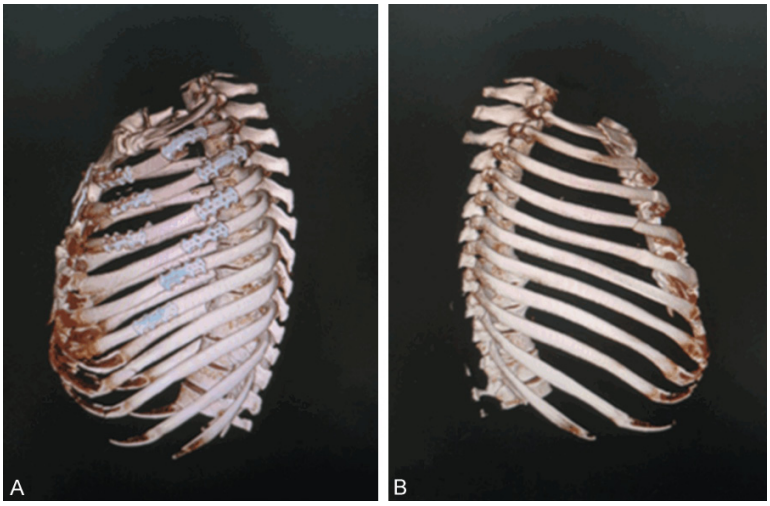

Figure 1. CT-3D reconstruction of chest rib fracture in the patient. A. 3D reconstruction of the left rib fracture after the internal fixation. B. 3D reconstruction of the right rib fracture after the internal fixation.

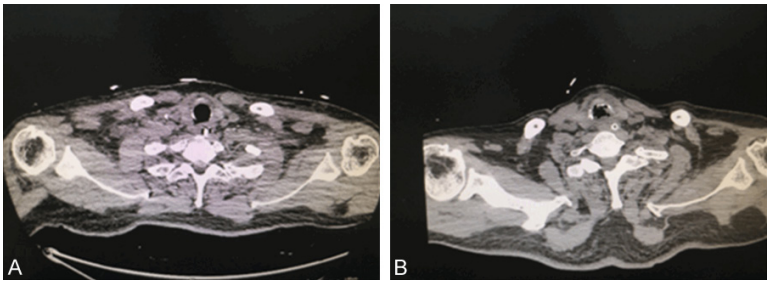

Figure 2. Chest CT findings before and after the bronchoscopy for the treatment of cervical tracheal tears. A. The tracheal high-density shadow on the right side of the trachea before the bronchoscopy is shown. B. The lumen is unobstructed after the bronchoscopy.

partial pressure, 64 mm Hg; carbon dioxide partial pressure, 48 mm Hg. The chest CT showed multiple bilateral rib fractures. After multiple internal rib fixations were performed on the left side, inflammation was found in both lungs. The patient was physically healthy in the past. On June 6, 2019, he was admitted to the First Hospital of Xinji City, where a double-thoracic wound debridement, an open selective rib fracture reduction, and an internal fixation were performed (**Figure 1**). After admission, he was diagnosed with (1) Multiple injuries of the neck and chest, with multiple fractures of the ribs after internal fixation. (2) Type II respiratory failure and double lung inflammation. The patient was treated with mechanical ventilation, anti-infectives, anti-shock, and other treatments. The endotracheal intubation sleeve was damaged several times during the treatment. The patient did not respond as expected after the intubation sleeve was replaced, and his blood oxygen saturation remained at 85-90%. A re-examination of the neck and chest CT showed a suspicious "cartilage-like" high-density shadow in the tracheal cavity under the glottis, connected to the tracheal wall with a narrow lumen. After consulting with the thoracic surgeon, it was concluded that a tracheal tear was present at the end of the cartilage ring which had been pierced by the endotracheal intubation sleeve (**Figure 2**). In order to improve ventilation, a bedside tracheotomy was performed under the tracheal tear on July 1, 2019. However, his oxygen saturation remained at 90-93%.

A bronchoscopy was performed under intravenous propofol anesthesia on July 3, 2019. Tracheal cartilage was found 2 cm below the glottis, which confirmed that the endotracheal intubation sleeve had punctured the tracheal cartilage. A single-stage electrocoagulation snare and foreign body forceps were performed to alternatively resect the tracheal cartilage ring. Complete hemostasis of the cut edge of the trachea was carried out by electrocoagulation after a complete resection. 3% norepinephrine solution was used to stop the bleeding after the operation and the whole process lasted for an hour (**Figure 3**). After the operation, the monitoring of the respiratory tract was strengthened to prevent an infection. An antitussive was administered to avoid increasing the airway pressure caused by the severe cough. Glucocorticoids were utilized to reduce anastomotic inflammation, inhibit granulation tissue proliferation, and prevent tracheal stenosis by reducing the formation of postoperative anastomotic scar tissue. After the operation, the patient's blood oxygen saturation was 97-

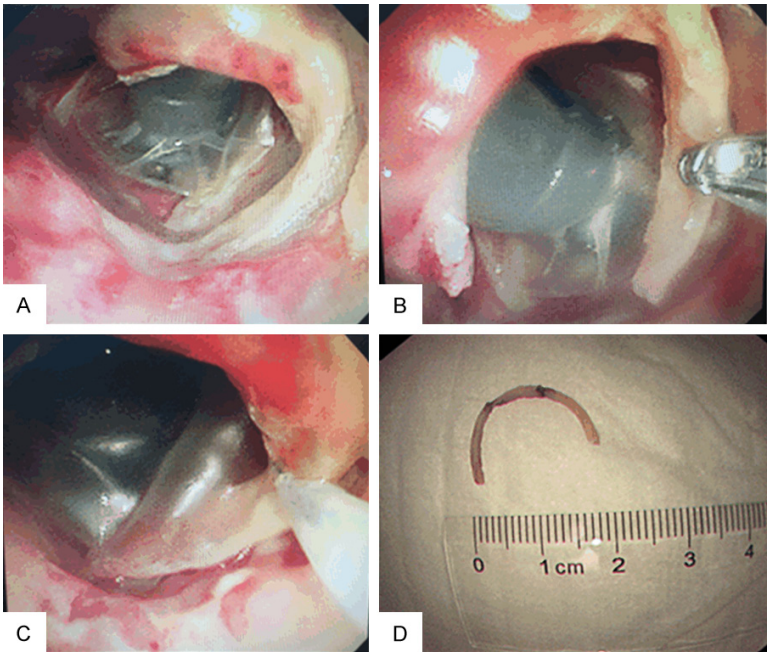

Figure 3. Bronchoscopic findings of the tracheal cartilage ring removed using bronchoscopy. A. Free tracheal cartilage was visible on the right tracheal wall of the tracheal incision on the cranial side. B. A foreign body clamp to disassociate the free cartilage. C. Cutting the tracheal cartilage with a monopolar electrocoagulation snare. D. Removal of the tracheal cartilage.

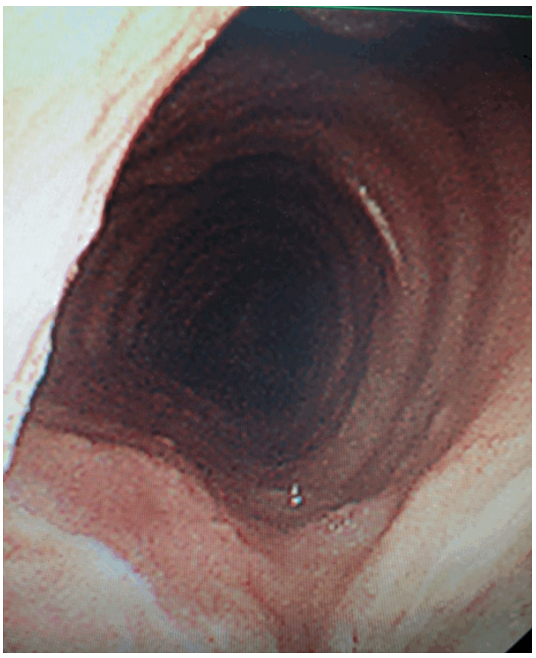

Figure 4. Bronchoscopic view after the intervention. The lumen is unobstructed.

100%, his heart rate was 88 beats/min and his blood pressure was 139/75 mm Hg. The mechanical ventilation and antibiotics were stopped on July 10, 2019, and the patient was transferred to the general ward the next day. He was discharged on July 20, 2019. On August 12, 2019, the patient was reviewed using bronchoscopy in our hospital and the lumen was found to be unobstructed without any significant softening or stenosis. The patient had no complaints of discomfort and could perform moderate physical activity (**Figure 4**).

Discussion

Tracheal or bronchial injury is divided into cervical tracheal injury, chest tracheal, and bronchial injury according to the injury site. The former is common in patients suffering from a direct and violent impact to a weakened area of the trachea. The latter is mainly due to rapid compression to the front and back of the thorax; the lungs then pull the trachea to opposite sides, leading to uneven stress on the trachea (carina) or bronchus and causing damage. According to the extent of injury to the tracheal or bronchial areas, it can be divided into TBL or tracheal and bronchial rupture injuries. The former has a mild degree of injury. The incidence of tracheal or bronchial injuries and TBL is 0.4-2.8% and <1%, respectively [3]. TBL is common in composite cervical and thoracic trauma. One study found that most cases of tracheal or bronchial traumas usually occur with injury to other organs and other parts of the body. These commonly include multiple rib fractures, flail chest, spinal injury, abdominal injury and so on [4]. In this case, the patient had multiple rib fractures which resulted in a floating chest wall, a paralyzed chest, blood pneumothorax, and severe abnormal breathing. The complexity of the combined injuries led to the missed and delayed diagnosis. Thus, patients with combined neck and chest injuries should be checked carefully to exclude the possibility of TBL. TBLs are usually located at the end of the

trachea and at the beginning of the bronchi, within 1.5-2.0 cm from the carina (this region in the thoracic cavity is the weakest of the upper respiratory tract). Since the anatomical position of the organs is relatively fixed, when there is a sudden deceleration, the shear force squeezes the thoracic trachea and bronchus; this suddenly increases pressure in the lumen which damages the organs. However, due to its deeper position, large longitudinal placement, and protection of the surrounding tissues and organs, the cervical trachea is less prone to damage. In this case, the tracheal injury was in the cervical region, 1 cm above the tracheotomy, and 2 cm below the glottis. This is inconsistent with sites commonly reported in the literature for similar injuries [5]. The trachea may have been directly damaged by the external blunt injury. Additionally, although the trachea was damaged, the integrity of the trachea was intact. When compared to common thoracic tracheal or bronchial injuries, this cervical tracheal tear is more insidious, so more attention should be paid to it clinically.

The clinical manifestations of tracheal and bronchial injury depend on the location of the damage to the trachea, the degree of injury, and the integrity of the tracheal wall. Common clinical manifestations include severe dyspnea, hemoptysis, subcutaneous emphysema on the neck and face, and open wounds in the chest and neck. This article mainly discusses the closed injury of the trachea and bronchus, namely TBL. Currently, closed injury of the trachea and bronchus is classified into three types. In type I, the free end of the bronchi opens in the pleura of the cavity, and the main clinical manifestations are tension pneumothorax, dyspnea, cyanosis, hemoptysis, etc. In type II, the free end of the bronchi is located in the mediastinum without a connection to the pleural cavity, the clinical manifestations are extensive subcutaneous emphysema in the mediastinum, neck, and upper chest. In type III, the free end of bronchi depends on the surrounding sleeve tissue to maintain ventilation, temporarily without any clinical manifestations [6, 7]. The patient in this study can be classified as a type III trachea, bronchial injury. Since patients with type III injury have symptoms and signs of other severe injuries (which can mask the bronchial injury) early diagnosis is sometimes quite difficult. In this case, the tracheal laceration was due to air leakage from the endotracheal intubation sleeve. Therefore, chest CT with virtual endoscopy and electronic bronchoscopy is the preferred course of investigation in patients with clinically suspected TBI [8].

The treatment of TBL consists of surgical and non-surgical procedures. In this case, the subcutaneous emphysema on the mediastinum and neck suggested that the integrity of the trachea or bronchus wall was destroyed, so any non-surgical treatment was not expected to be successful. Surgical treatment should be decisively performed to prevent tracheal mediastinum or tracheoesophageal fistula caused by delayed treatment, which may cause an aggravated life-threatening systemic inflammatory response [9, 10]. Tracheal or bronchial tears should be carefully investigated during surgery. If the wound inflammation is not severe and the time since injury is <48 hours, a one-stage surgical suture should be selected as soon as possible. Non-surgical treatments for TBL, especially bronchoscopy, have the advantages of less trauma, low risk, and a good prognosis in comparison with surgery. However, there are certain indications for bronchoscopic TBL intervention [11, 12]. In this case, no subcutaneous emphysema was found in the neck or mediastinum since the trauma occurred, and no open wound was observed in the neck, and TBL was not confirmed on admission. However, alarms from the cuff pressure device and air leakage from the endotracheal intubation sleeve (detected by the device after 2 replacements of the sleeve), made us consider a diagnosis of neck and chest trauma combined with TBL. Finally, it was bronchoscopically confirmed that the tracheal cartilage ring was avulsed and that 1/2 of the total length of 1 injured tracheal cartilage was free. In this case, the symptoms of systemic infection and poisoning were apparent during the early stages of diagnosis and treatment. The patient had been in a critical condition for 1 month when the TBL was diagnosed. Granulation tissue around the damaged part of the tracheal wall was observed by bronchoscopy, and the cartilage ring was disassociated in the damaged area. The tracheal cartilage ring was disassociated and completely removed by alternate bronchos-

cope snare unipolar electrocoagulation (Martin) and foreign body clamp blunt dissociation. After surgery, the patient recovered smoothly and was transferred to the general ward, and the ventilator was removed on the 8th day. This bronchoscopic intervention could avoid opening surgery to repair the patient's trachea and decrease the possibility of postoperative open-surgical complications [13-15]. After the surgery, a bronchoscopy review showed that the tracheal lumen was unobstructed and that there was no obvious hyperplasia. No additional treatment was needed. In case there was granulation hyperplasia, bronchoscopy would have been required to resect the granulation tissue to ensure a smooth and complete tracheal tube wall. Our experience of bronchoscopy for TBL, as in this case, indicates that if an injured patient's vital signs are stable, a routine bronchoscopy should be carried out to assess the degree of wall tear. In addition, if the trauma is more than 2 weeks old, the granuloma around the injury and disassociated cartilage ring, including the tracheal cartilage ring, can be removed bronchoscopically.

In summary, TBL is a relatively mild type of tracheal and bronchial injury. For TBL cases that meet the indications for bronchoscopy, the treatment should ideally reduce the risks associated with the treatment and ensure a rapid recovery after surgery.

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Disclosure of conflict of interest

None.

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