


A Case of Tracheal Stenosis Following Brief Intubation for an Acute Exacerbation of COPD

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Abstract: Tracheal stenosis following brief intubation is a rare but serious complication and could be misdiagnosed in specific individuals, especially those with chronic obstructive pulmonary disease (COPD) and asthma. This case report describes a patient with COPD who developed tracheal stenosis following emergency intubation for an acute exacerbation. The patient was managed with invasive ventilation for 28 hours due to an acute exacerbation of COPD and pulmonary encephalopathy. After extubation, the patient presented with respiratory distress, which was successfully treated with bronchoscopic cryotherapy.

Keywords: chronic obstructive pulmonary disease, tracheal stenosis, bronchoscopy, cryotherapy

Post intubation tracheal stenosis (PITS) is an uncommon but life-threatening complication of endotracheal intubation. Sometimes such conditions could be misdiagnosed and treated as asthma.^{1,2} The duration of intubation is a key factor for PITS and the clinical randomized controlled trials has shown that intubation lasting more than 48 hours significantly increases the risk.³ Tracheal stenosis occurring with intubation durations less than 48 hours was most mentioned in only a few case reports. In these cases, PITS primarily resulted from long-term granulation and scar formation, but it could also be caused by short-term edema, ischemic necrosis, inflammation, and other complex acute mucosal lesions in the cuff area, leading to acute airway stenosis.⁴⁻⁶ Interventional bronchoscopy has been frequently as the first-line treatment approach and laser or dilatation is the preferred method.^{7,8} PITS which occurs with intubation durations less than 48 hours in patients with chronic obstructive pulmonary disease (COPD) has been rarely reported. Here we present a patient with COPD who developed tracheal stenosis following 28 hours of endotracheal intubation for an acute exacerbation. Moreover, the patient was successfully treated with bronchoscopic cryotherapy.

Case

A 65-year-old male with an acute exacerbation of chronic obstructive pulmonary disease (AECOPD) and unconsciousness accompanied by hypercapnia received emergency endotracheal intubation for invasive ventilation in the emergency room. He was transferred to the respiratory intensive care unit (RICU) later. Protocol for early extubation utilizing light sedation was conducted. After 28 hours of invasive ventilation, the patient's condition improved soon, following a successful spontaneous breathing trial (SBT). Then the endotracheal tube was removed and sequential support with high-flow nasal cannula (HFNC) was initiated. However, four days after extubation, the patient developed severe wheezing. Despite initial treatments with intravenous steroids and inhaled bronchodilators, the patient's symptoms continued to worsen and type II respiratory failure with decompensated acidosis occurred again. Further evaluation revealed tracheal stenosis below the vocal cords on CT scans where no significant edema or stenosis was found on admission (Figure 1A-C). Urgent bedside flexible bronchoscopy was performed, revealing a circumferential Myer-Cotton⁹ class III stenosis approximately 3 cm below the vocal cords, prone to bleeding upon touch (Figure 1D). The endotracheal tube was reinserted under bronchoscopic guidance, positioning the stenotic area above the cuff. Given the limited operating space, laser and other heat-based modalities carry a higher risk of airway burns and perforation, and

also pose a risk of scar formation. Cryotherapy has a low risk of airway perforation and damage to adjacent structures, as well as a low risk of bleeding and scar formation. Considering the high likelihood of acute mucosal edema and injury observed under bronchoscopy, with easy bleeding upon contact, cryotherapy, which is sensitive to hydrated tissues, easy to operate, and capable of better controlling the depth and range of freezing, was chosen as the treatment strategy for acute PITS. The cryoprobe is delivered to the lesion site via the flexible bronchoscope, and tissue removal is achieved by a pulling-out method in cryotherapy, extracting the frozen tissue that is attached to the cryoprobe (Figure 1E). To avoid significant hemorrhage, the bronchoscopic cryotherapy was performed with two sessions, achieving complete removal of the suspected granulation tissue and the alleviation of the stenosis (Figure 2A). Pathological examination of the biopsy specimens obtained during the procedure revealed necrosis and inflammatory cell infiltration (Figure 2B). The patient was successfully weaned off the ventilator again soon without any recurrence of dyspnea. A follow-up CT scan (Figure 3A) and bronchoscopy (Figure 3B and C) two weeks later revealed a patent tracheal lumen with no significant stenosis. The follow-up CT scan 3 months later (Figure 3D) still revealed no significant stenosis. Six months post-discharge, the patient maintained stable health during subsequent telephone follow-ups, exhibiting no significant respiratory symptoms such as wheezing.

Discussion

Tracheal stenosis following intubation in the ICU is a rare but serious problem. The incidence of post-intubation laryngotracheal stenosis in adults has been documented at a rate of 4.9 cases per million per year.¹⁰ Emergency intubation, undersedation, and cuff pressure have all been associated with PITS.^{11–14} In the present case, routine daily monitoring of cuff pressure and endotracheal tube position was conducted in the RICU. So, light sedation during mechanical ventilation, emergency intubation and inflammatory response around the cuff may be the primary risk factor for the short-term development of PITS in this patient. Nevertheless, the primary risk factor remains the extended

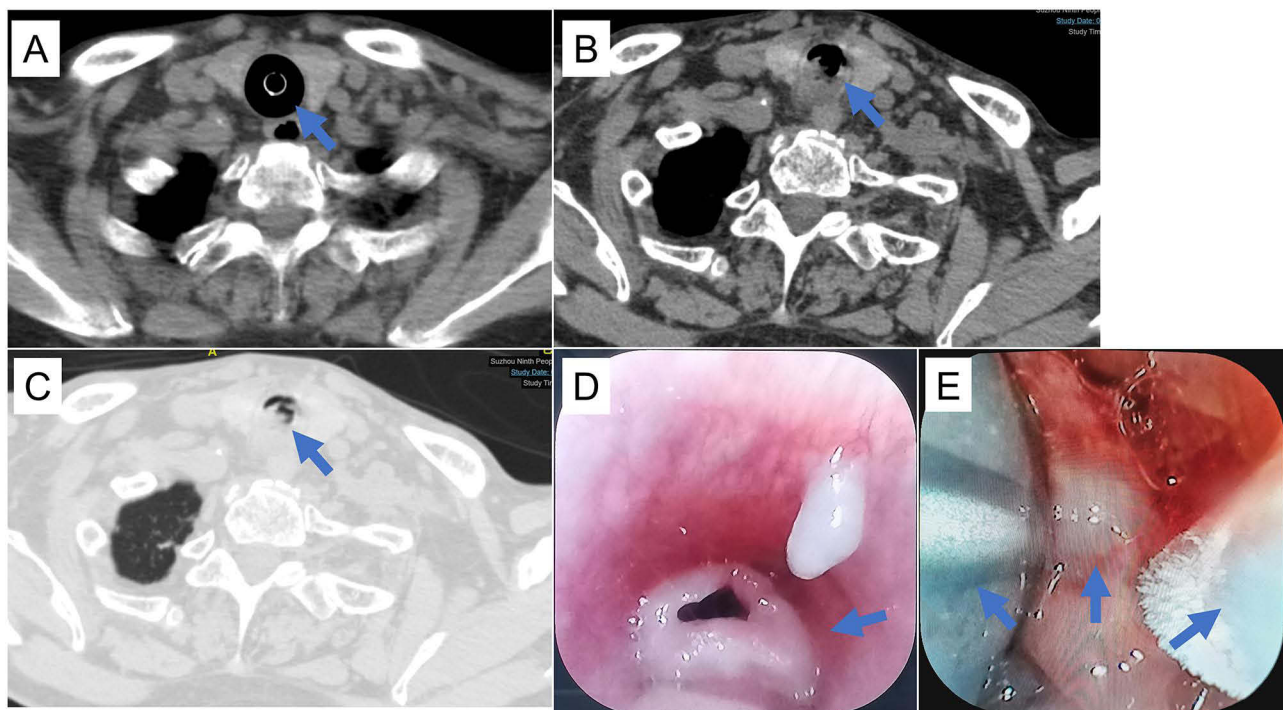


Figure 1 CT scan images in the clinical course of the patient and bronchoscopic image before cryotherapy. The CT scan on admission showed that the tracheal intubation was in good position and demonstrated no significant edema or stenosis within the tracheal lumen. The arrow indicates the trachea (A). CT scan images in mediastinal window revealed tracheal stenosis below the vocal cords. The arrow indicates abnormal structure on the tracheal wall (B). CT scan images in lung window revealed tracheal Myer-Cotton class III stenosis (C). Urgent bedside flexible bronchoscopy revealed a circumferential Myer-Cotton class III stenosis approximately 3 cm below the vocal cords. The arrow indicates narrow lumens with surface mucus adhesion (D). The bronchoscopic cryotherapy was performed to relieve stenosis. Arrows from left to right respectively indicate the endotracheal intubation tube, abnormal tissue within the trachea, and the cryoprobe (E).

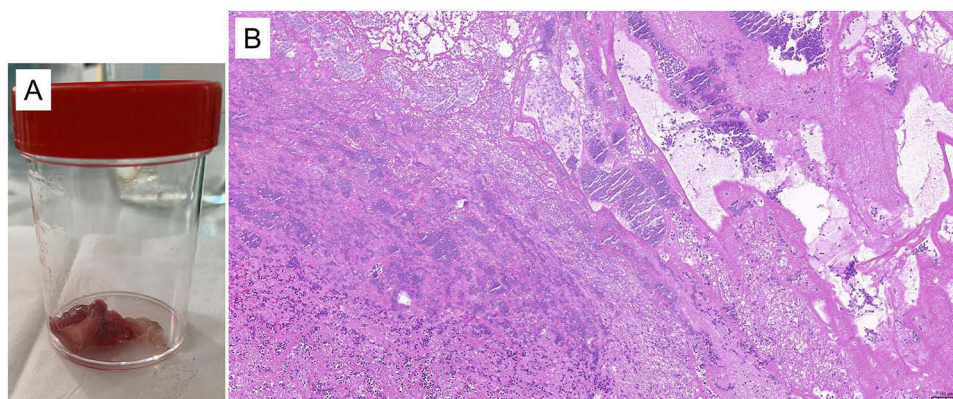


Figure 2 Tissue and pathology. Tissue samples of necrosis and inflammatory exudate from the stenotic area within the tracheal lumen were obtained using bronchoscopic cryotechnology (A). Histopathological examination at 100x magnification revealed inflammatory exudate and necrotic material. A certain amount of mucus and cellulose like structures can be observed (B).

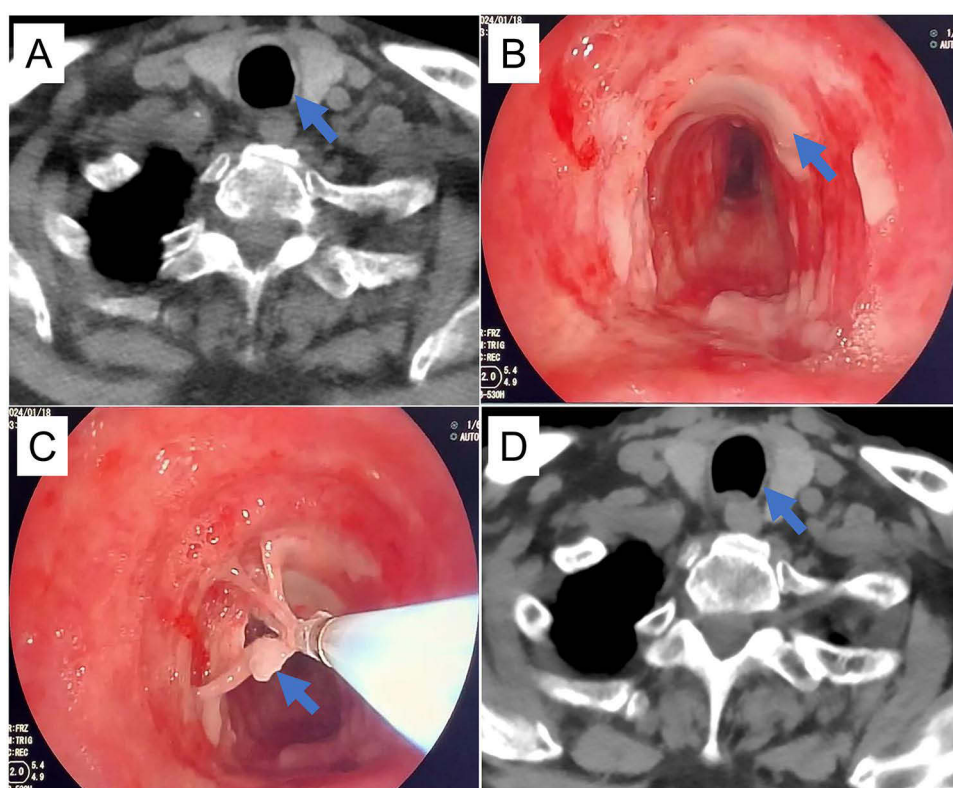


Figure 3 The follow-up CT and bronchoscopic images after successful cryotherapy. A follow-up CT scan and bronchoscopic image two weeks later revealed a patent tracheal lumen with no significant stenosis (A and B). Residual necrotic and inflammatory exudate tissues were further cleared using bronchoscopic cryotechnology (C). Arrows indicate residual necrotic and inflammatory exudate tissues on the tracheal wall (B and C). A follow-up CT 3 months later revealed a patent tracheal lumen with no significant stenosis (D).

duration of intubation, notably exceeding seven days.⁸ Another study shows that patients intubated for more than 48 hours were more likely to develop PITS than control patients.³ While Xue J et al and Yang KL have reported cases of tracheal stenosis following intubation durations of 24 hours and 18 hours, respectively, the occurrence of PITS with intubation durations less than 48 hours is still extremely rare and prone to misdiagnosis.^{4,5} In the present case, when the patient developed severe wheezing four days after extubation, he was still considered as the AECOPD. Due to misdiagnosis, CT scans and bronchoscopy were delayed by nearly seven hours, despite the patient's wheezing being refractory to both intravenous steroids and inhaled bronchodilators, ultimately leading to respiratory failure. Therefore,

the exacerbation of severe wheezing in COPD patients may not always indicate AECOPD, particularly in those with a recent history of emergency endotracheal intubation. PITS in COPD patients should be recognized as an emergency and need early identification. Early neck and chest CT screening is crucial. Portable bedside bronchoscopy is a safe and rapid method for further clarification of airway emergencies.

Currently, balloon dilation, laser therapy, and cryotherapy can all be chosen as bronchoscopic treatment modalities for PITS. They can be used alone or in combination to enhance the therapeutic effect. However, there is a concern that heat-based treatments may lead to the formation of additional scar tissue, which could potentially cause recurrence. In contrast, cryotherapy is linked to the preservation of the extracellular matrix and may facilitate healing with reduced scarring.^{15,16} Therefore, cryoablation after thermal therapy modalities may reduce the risk of scar formation caused by thermal therapy. However, the success rate and long-term recurrence rate of bronchoscopic treatment for PITS mainly depend on the type of PITS. The success rate is higher for simple PITS than which in complex PITS, while the recurrence rate after bronchoscopic procedure is higher for complex PITS than simple stenosis (complex stenosis 95.7% vs simple stenosis 17.2%).^{17,18} Complex stenosis tends to require multidisciplinary collaborative treatment.¹⁹ In this case, the acute PITS has a short stenosis segment of vertical extension and does not involve tracheal cartilage collapse. Therefore, it is more inclined to be simple PITS and cryotherapy alone can safely and effectively relieve the stenosis. At the same time, cryotherapy can maximize the reduction of scar repair after treatment. Thus, in theory, the recurrence rate is relatively low. However, according to previous literature reports, follow-up every six months is still necessary.²⁰

Conclusion

Typically, tracheal stenosis occurs in adults with intubation durations exceeding 48 hours, making the 28-hour presentation in our case unusual. COPD patients with PITS are more prone to misdiagnosis due to their respiratory distress, necessitating heightened vigilance. This case underscores the importance of considering tracheal stenosis in COPD patients with a recent history of endotracheal intubation who exhibit unexplained respiratory deterioration. Early neck and lung CT scans and bronchoscopy should be performed with a lower threshold. Moreover, COPD patients should undergo long-term active follow-up after mechanical ventilation and be alert to the possibility of PITS when experiencing poorly controlled respiratory distress. In most cases, CT scan is the preferred simple and easy-to-operate method for differentiation. Unlike the chronic PITS formation process involving granulation growth and scar formation, acute PITS occurring after short-term intubation has a more complex acute airway mucosal lesion mechanism. Therefore, in such situations, cryotherapy is an optional treatment method, which poses a lower risk of airway burns and long-term stenosis recurrence compared to thermal therapy.

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Disclosure

The authors declare that there are no conflicts of interest in this work.

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