

Respiratory Failure Due to Expiratory Central Airway Collapse

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We report a patient with respiratory failure due to expiratory central airway collapse successfully treated with airway stents. A 74-year-old male with obesity and obstructive sleep apnea had recurrent episodes of acute respiratory failure. Noninvasive positive-pressure ventilation failed because of patient intolerance and lack of improvement, and soon after he stopped using the noninvasive ventilator he developed severe respiratory failure that required a tracheostomy. He was transferred to our institution one month later. Fiberoptic bronchoscopy revealed diffuse expiratory central airway collapse of both main bronchi and the lower two thirds of the trachea, caused by bulging of the posterior airway membrane. During rigid bronchoscopy we inserted studded silicone stents in the right and left mainstem bronchi and in the distal trachea. The patient was weaned from mechanical ventilation 72 hours later and discharged to a long-term care facility. Expiratory central airway collapse should be considered in the differential diagnosis of patients with respiratory failure, especially when weaning from mechanical ventilation is difficult. Key words: respiratory failure, airway stent, sleep apnea, noninvasive ventilation. [Respir Care 2007;52(6):752–754. © 2007 Daedalus Enterprises]

Introduction

Expiratory central airway collapse can be caused by tracheobronchomalacia due to softening of the airway cartilages, or by excessive bulging of the airway's posterior membrane.¹ Both are dynamic forms of central airway obstruction, and are increasingly recognized as imitators of asthma and chronic obstructive pulmonary disease.^{1–4} Though both processes can cause respiratory symptoms, there are very few reports of these conditions causing respiratory failure and failure to wean from mechanical ventilation.^{5–11} We report a case of idiopathic excessive dynamic airway collapse that caused respiratory failure and inability to wean, and which was successfully treated with airway stents.

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The authors report no conflicts of interest related to the content of this paper.

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Case Summary

A 74-year-old male had been admitted to another facility for acute change in mental status, hallucinations, and shortness of breath. He was found to have hypercarbic respiratory insufficiency. His medical history included diabetes, hypertension, obesity, congestive heart failure, and chronic renal insufficiency. He was also diagnosed with severe obstructive sleep apnea and placed on bi-level positive-pressure ventilation, but he did not tolerate the therapy and stopped using it. One year prior to this hospitalization, he had a similar episode of respiratory failure, which resolved after several days of in-hospital noninvasive positive-pressure ventilation. He was not a smoker, denied alcohol or drug use, and had no personal or family history of lung disease.

During this hospital stay, noninvasive ventilation was attempted again but was not tolerated. Endotracheal intubation and mechanical ventilation were required. Inability to wean from the ventilator prompted tracheostomy and transfer to a long-term care facility. Because of persistent hypercapnia and continued need for mechanical ventilation, he was transferred to our institution, where flexible bronchoscopy via the tracheostomy tube showed excessive bulging of the posterior airway membrane during exhalation. The cartilaginous structures were intact. The lower

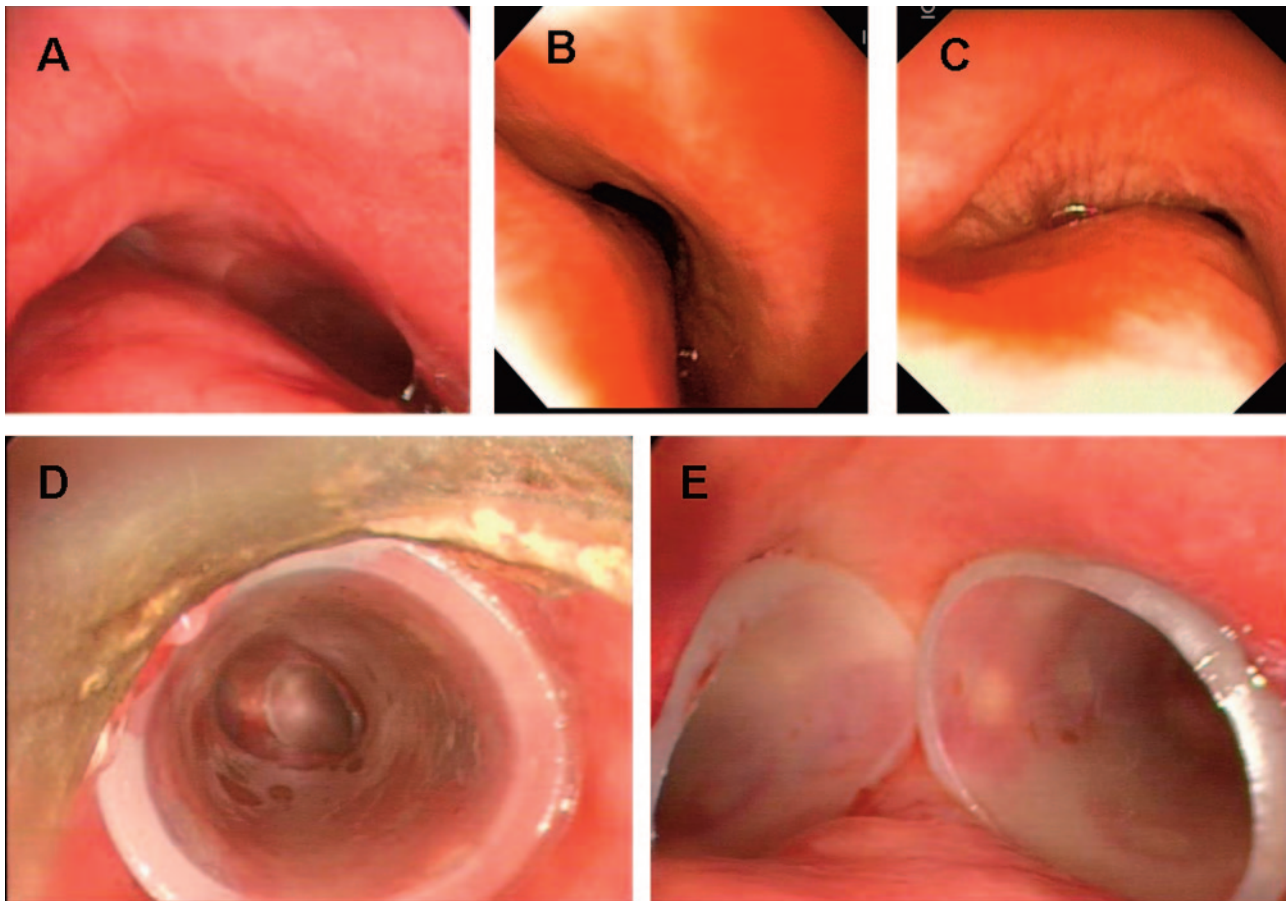


Fig. 1. Distal trachea (A), left main bronchus (B), and right main bronchus (C) before stent insertion. In this patient, excessive dynamic airway collapse was caused by bulging of the posterior airway membrane. Lower trachea (D) and mainstem bronchi (E) lumens completely restored after stent insertion.

two thirds of the trachea and both mainstem bronchi were severely narrowed (100% collapse) (Fig. 1). The findings were consistent with diffuse severe idiopathic excessive dynamic airway collapse.¹²

The next day the patient underwent rigid bronchoscopy under general anesthesia. Redundant tissue was seen in the oropharynx, consistent with the diagnosis of obstructive sleep apnea. The tracheostomy tube was bypassed by deflating the cuff. There was severe diffuse excessive dynamic airway collapse. There was also minimal granulation tissue at the tracheostomy stoma, and the granulation tissue was ablated with laser (no complications). Then a 16-mm × 50-mm studded silicone stent was inserted in the left main bronchus, a 16-mm × 40-mm studded silicone stent was placed in the right main bronchus (with an angular cut-out to assure ventilation of the right upper lobe), and an 18-mm × 50-mm studded silicone stent was placed in the trachea so that its distal tip was 1.5 cm above the carina (see Fig. 1).

The tracheostomy tube was changed to a Shiley # 6 fenestrated cuffed tube. The distal tip of the Shiley tube

was placed within the tracheal stent. Airway patency was thus restored. During the next 48 hours the patient underwent 2 surveillance bronchoscopies for secretion removal. Three days later he was successfully weaned off the ventilator. After a total hospital stay of 8 days the patient was discharged to a long-term care facility. Flexible bronchoscopy one month later showed substantial secretions and minimal granulation tissue above the tracheal stent, but the 3 stents were in correct position. Two months after the stent placement, rigid bronchoscopy was performed to remove the granulation tissue, and the stents were still in correct position. The patient died at an outside facility from causes unrelated to his airway disease.

Discussion

Expiratory central airway collapse can be an unrecognized cause of elevated peak airway pressure, inability to clear secretions, and failed weaning or extubation.^{1,13} In our patient, who had multiple failed weaning trials and required tracheostomy, bronchoscopy was performed to

evaluate the central airways for fixed or dynamic obstruction. In intubated patients, the endotracheal tube partially supports the trachea and prevents expiratory airway collapse. In addition, positive-pressure ventilation keeps the airway lumen open by acting as a pneumatic stent. Once the positive pressure or the endotracheal tube is removed, the patient may experience respiratory distress that requires reintubation. An unexplained extubation failure should prompt evaluation for expiratory central airway collapse.^{1,4} This is possible with cine-fluoroscopy, dynamic multi-slice computed tomography, or magnetic resonance imaging, especially in awake, cooperative, nonintubated patients. However, though those imaging techniques have greatly enhanced noninvasive visual and quantitative analysis of the central airways, some consider flexible bronchoscopy the definitive diagnostic technique for expiratory central airway collapse, and it is easily performed at the bedside.⁴

In our patient, tracheostomy alone was unsuccessful. Tracheostomy secures the airway, maintains the ability to suction secretions, and allows ventilatory support and airway access in case of acute airway obstruction. It may also improve symptoms if the tracheostomy tube bypasses or satisfactorily stents the affected airway segment, as might occur in patients with focal expiratory central airway collapse.¹ Tracheostomy, however, can be complicated by secondary tracheomalacia and stenosis at the stoma site.¹ Furthermore, it may exacerbate expiratory central airway collapse because it bypasses the glottis, such that a relative positive transmural pressure that keeps the airway lumen patent during exhalation is no longer maintained. This may explain why our patient did not improve after tracheostomy and failed to wean until the airway stents were inserted.

The experience with stent insertion for expiratory central airway collapse is limited, especially in the setting of respiratory failure.¹ The dynamic process that continuously changes the shape of the airway alters the contact between the stent and the airway walls, which can cause stent migration and/or fracture, so airway stent selection can be difficult. Silicone stents are readily inserted and removed. In our patient we chose to insert 3 straight silicone stents instead of a Y-shaped stent. Though a Y-shaped stent with a long tracheal arm might have been a reasonable alternative, this would have amounted to a complete reconstruction of the central airways, which would have totally bypassed the normal mucociliary apparatus and thus increased the risk of mucus plugging in this bedridden and tracheostomized patient. Although placing a silicone stent re-

quires rigid bronchoscopy, and they are prone to migration, they offer sufficient strength^{14,15} to support the airways and are less likely than metal stents to cause life-threatening complications such as airway perforation or obstruction by granulation tissue.¹⁶

REFERENCES

1. Murgu SD, Colt HG. Treatment of adult tracheobronchomalacia and excessive dynamic airway collapse: an update. *Treat Respir Med* 2006;5(2):103–115.
2. Jokinen K, Palva T, Sutinen S, Nuutinen J. Acquired tracheobronchomalacia. *Ann Clin Res* 1977;9(2):52–57.
3. Johnson TH, Mikita JJ, Wilson RJ, Feist JH. Acquired tracheomalacia. *Radiology* 1973;109(3):576–580.
4. Carden KA, Boiselle PM, Waltz DA, Ernst A. Tracheomalacia and tracheobronchomalacia in children and adults: an in-depth review. *Chest* 2005;127(3):984–1005.
5. Komori M, Inoue H, Ikegami T, Hamada N, Koto H, Matsumoto K, et al. [A case of relapsing polychondritis successfully assessed for airway diameters under application of bi-level positive airway pressure (bilevel PAP).] *Nihon Kokyuki Gakkai Zasshi* 2004;42(2):185–190. (*Article in Japanese*)
6. Standertskjold-Nordenstam CG, Halttunen PA, Meurala HG. Cine-tracheobronchography and surgical correction of central airway collapse in an asthmatic patient. *Eur J Radiol* 1981;1(1):20–23.
7. Hautmann H, Huber RM. Stent flexibility: an essential feature in the treatment of dynamic airway collapse. *Eur Respir J* 1996;9(3):609–611.
8. Kanou A, Akimoto T, Kobayashi S, Tomita M, Tamura N, Kawano T, et al. [Relapsing polychondritis: a case with respiratory failure.] *Nihon Rinsho Meneki Gakkai Kaishi* 1997;20(1):52–59. (*Article in Japanese*)
9. Collard P, Freitag L, Reynaert MS, Rodenstein DO, Francis C. Respiratory failure due to tracheobronchomalacia. *Thorax* 1996;51(2):224–226.
10. Galan G, Faure F, Tinturier F, Ossart M. [Respiratory failure caused by megaesophagus and tracheomalacia.] *Ann Fr Anesth Reanim* 1999;18(9):987–990. (*Article in French*)
11. Chetty KG, Sassoos CS, Mahutte CK. Tracheobronchomalacia. Bronchoscopic diagnosis in a patient with chronic obstructive pulmonary disease. *J Bronchology* 1998;5:220–222.
12. Murgu SD, Colt HG. Tracheobronchomalacia and excessive dynamic airway collapse: novel diagnostic tools clarify the issues. *Pulmonary Perspectives* 2005;22:7–10.
13. Healy F, Wilson AF, Fairshier RD. Physiologic correlates of airway collapse in chronic airflow obstruction. *Chest* 1984;85(4):476–481.
14. Miyazawa T, Miyazu Y, Iwamoto Y, Ishida A, Kanoh K, Sumiyoshi H, et al. Stenting at the flow-limiting segment in tracheobronchial stenosis due to lung cancer. *Am J Respir Crit Care Med* 2004;169(10):1096–1102.
15. Ernst A, Feller-Kopman D, Becker HD, Mehta AC. Central airway obstruction. *Am J Respir Crit Care Med* 2004;169(12):1278–1297.
16. U.S. Food and Drug Administration. FDA Public Health Notification: Complications from metallic tracheal stents in patients with benign airway disorders. Issued July 29, 2005. [Internet.] Available at: <http://www.fda.gov/cdrh/safety/072905-tracheal.html>. (*Last accessed April 12, 2007*)