The Workup of Stridor: Virtual Bronchoscopy as a Complementary Technique in the Diagnosis of Subglottic Stenosis

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Introduction

Stridor is predominantly an inspiratory sound that is associated with upper-airway obstruction. Stridor can be caused by a variety of benign and malignant conditions. In an adult with stridor and a history of endotracheal intubation, laryngotracheal stenosis must be considered in the differential diagnosis. Laryngotracheal stenosis is most commonly the consequence of instrumentation, primarily prolonged intubation or tracheostomy.[1]

Virtual bronchoscopy is a noninvasive imaging technique that reformats images acquired via high-resolution multi-row-detector computed tomography into a 3-dimensional image of the tracheobronchial tree.[2] We describe virtual bronchoscopy as part of the workup of a subglottic stenosis.

Case Report

We saw a 53-year-old female with a history of systemic lupus erythematosus and autoimmune hepatitis, who 6 months previously had required intubation and 2 days of mechanical ventilation for a drug overdose. She presented to us with a 6-month history of progressive dyspnea on exertion, which had worsened over the last 3 months, such that she was unable to walk half a block without shortness of breath. She denied cough, fevers, or night sweats, but did report a 10-pound weight loss over the last year. She denied tobacco use. She had normal vital signs, clear lung fields, and a normal cardiovascular examination, but had stridor on deep inspiration and exhalation. Notable laboratory findings included hemoglobin 8.5 g/dL, hematocrit 26.3%, antinuclear antibody titer 1:256, and a positive double-stranded deoxyribonucleic acid. The levels of complement components 3 and 4 were within normal limits. Her chest radiograph was normal, and her pulmonary function test (PFT) values were notable only for flow limitation and flattening of both the inspiratory and expiratory limbs (Fig. 1), which suggested fixed airway obstruction. Fiberoptic bronchoscopy revealed a normal trachea and normal vocal cord motion, down to a subglottic stenosis 2 cm below the vocal cords (Fig. 2). The degree of stenosis prevented further passage of the bronchoscope, so the airway was not examined distal to the stenosis. Virtual bronchoscopy was performed to determine the length of the stenosis, and it confirmed the stenosis just distal to the vocal cords (Fig. 3). No other distal endobronchial abnormalities were seen on virtual bronchoscopy.

The differential diagnosis for this patient's dyspnea included subglottic stenosis, anemia, and systemic-lupus-erythematosus-associated lung disease. We did not think that anemia was the cause of the dyspnea, because her hemoglobin at presentation was unchanged from her hemoglobin at the time of her hospitalization for drug overdose. Systemic-lupus-erythematosus-associated lung disease was also considered less likely, given the clinical stability of her systemic lupus erythematosus, normal chest radiograph, and normal diffusion capacity for carbon monoxide. Her dyspnea was therefore presumed to be due to subglottic stenosis secondary to endotracheal intubation. Biopsy of the stenotic area was negative for malignancy or inflammation. The stenosis was ablated with neodymium-yttrium-aluminum-garnet laser (Fig. 4). After surgery, the patient reported resolution of her dyspnea, and there was partial normalization of the flow-volume loop (Fig. 5).

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

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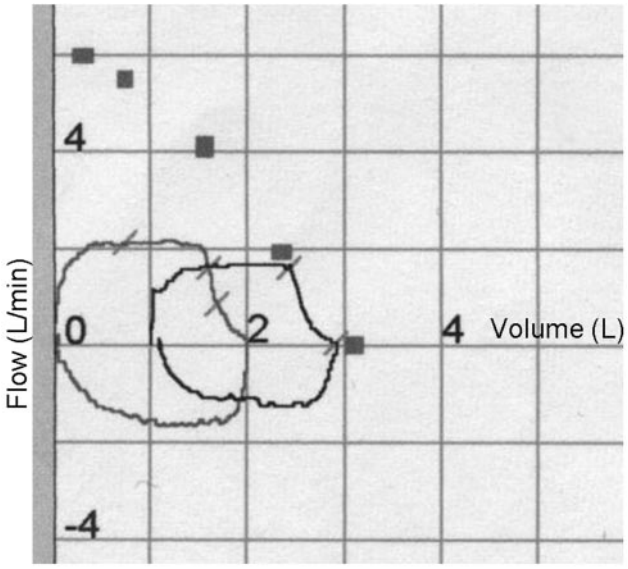

Fig. 1. Flow-volume loops from the initial pulmonary function test show flow limitation and flattening of both the inspiratory and expiratory limbs.

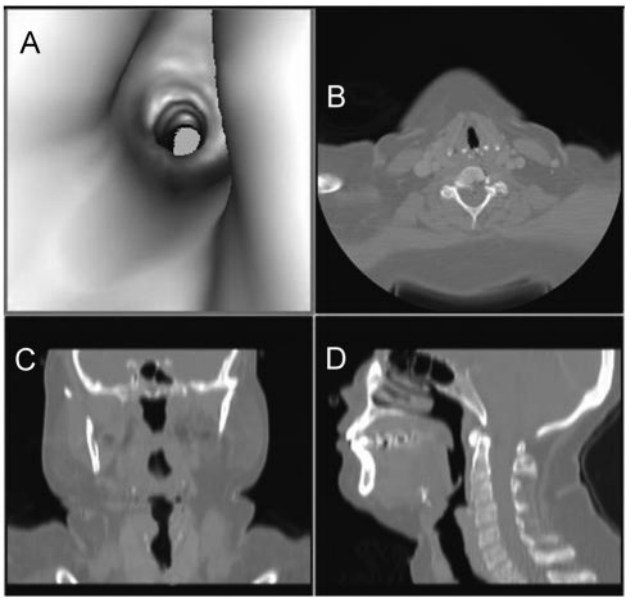

Fig. 3. A: Virtual bronchoscopy (reformatting of computed tomography images), showing the stenosis. B: Axial slice. C: Coronal view. D: Sagittal view.

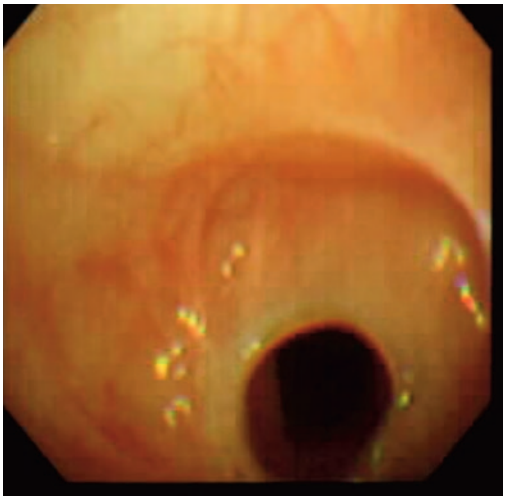

Fig. 2. The initial fiberoptic bronchoscopy showed tracheal narrowing.

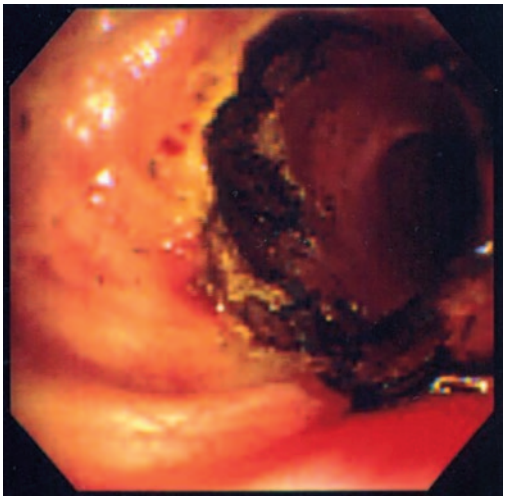

Fig. 4. Postoperative bronchoscopy shows improvement in subglottic stenosis.

Discussion

This case reinforces some important points regarding subglottic stenosis. First, this serious complication can occur after a short and uncomplicated course of intubation and mechanical ventilation. Second, virtual bronchoscopy offers an expanded range of medical technology for diagnosing subglottic stenosis. The pulmonary function tests were diagnostic of a fixed extra-thoracic obstruction, with the classic flattening of the inspiratory and expiratory limbs of the flow-volume loop. Fiberoptic bronchoscopy has been the accepted standard for visualizing extra-thoracic airway obstructions, but it cannot visualize the airway distal to a high-grade obstruction and therefore does not assist in determining the length of the obstruction. The length of the obstruction influences the choice of therapy, because less invasive modalities are indicated for shorter obstructions.

For the last decade, virtual bronchoscopy has been studied for its role in diagnosing both benign and malignant airway obstructions. In one study of 20 patients with bronchial carcinoma, Fleiter and colleagues found that virtual bronchoscopy was able to view the airway distal to the site

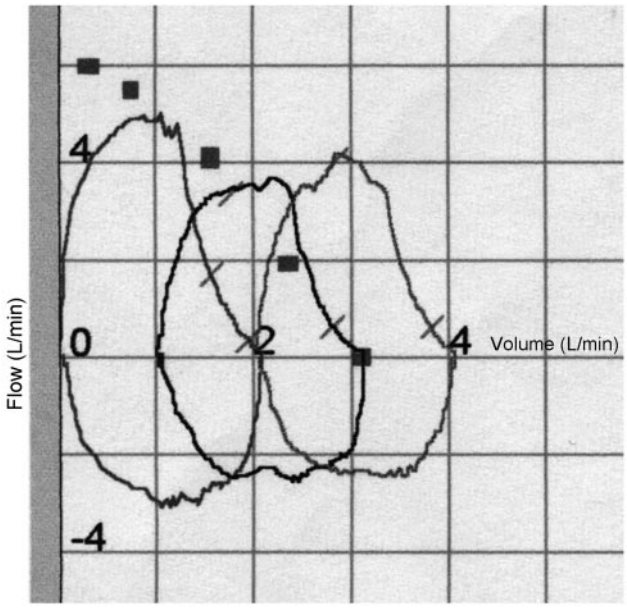

Fig. 5. Postoperative flow-volume loops show improved flow and resolution of flattening of the inspiratory and expiratory limbs.

of stenosis in 25% of patients in whom endoscopy was limited by the small airway diameter.[3] In another study of patients with thoracic malignancies, Finkelstein and colleagues prospectively evaluated consecutive patients for tracheobronchial lesions with fiberoptic bronchoscopy and virtual bronchoscopy. Fiberoptic bronchoscopy detected 35 lesions, but an additional 11 lesions not assessable via fiberoptic bronchoscopy were detected by virtual bronchoscopy.[4]

The initial studies of virtual bronchoscopy for benign airway stenosis were in animals. Eliashar et al induced laryngotracheal stenosis in 18 dogs and found virtual bronchoscopy better than endoscopy for measuring the length of the stenosis and the length of the tightest stenotic segment.[5] More recently, 23 patients with known benign major airway stenosis were prospectively studied to compare virtual bronchoscopy with fiberoptic bronchoscopy and PFT, by using pre-defined scores for each of the modalities and studying the correlations. The virtual bronchoscopy and fiberoptic bronchoscopy scores significantly correlated ($p < 0.001$), as did virtual bronchoscopy and PFT scores ($p = 0.03$), but there was no correlation between PFT and fiberoptic bronchoscopy, which suggests that virtual bronchoscopy should be used to evaluate tracheobronchial stenosis after treatment.[6]

This case illustrates the current range of diagnostic studies at our disposal, from the classic spirometric flow-volume loop to the emerging technology of virtual bronchoscopy, which allow diagnosis and guide therapy in patients with subglottic lesions and central airway stenosis.

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