drugs, physical exercise, and infection. In addition, a pure hyperoncotic state can cause experimental rhabdomyolysis in conjunction with disseminated intravascular coagulopathy. Our patient had a peak creatine kinase value of 2,182 U/L (a 12-fold rise) 24 h postoperatively and myoglobinuria consistent with rhabdomyolysis. Neither succinylcholine, a preoperative intramuscular injection, nor the insertion of the insufflation needle during laparoscopy should increase creatine kinase values to this level.

This case describes the complications arising from pulmonary embolization of 32 percent dextran 70 as a distending medium during hysteroscopy associated with arterial desaturation, disseminated intravascular coagulation, hemoptysis, and rhabdomyolysis. As pulmonary artery catheterization was not believed to be clinically necessary, recovery of dextran from the pulmonary circulation was not performed. The diagnosis of dextran embolization was made based on clinical findings (pleuritic chest pain with hemoptysis), the distribution of (dependent) pulmonary infiltrates, and documented perfusion defects by radionuclide scintigraphy. The likelihood of occurrence may be related to the volume used and instillation pressure. Pulmonary and critical care physicians as well as gynecologists and anesthesiologists should be aware of these potential complications of this hysteroscopy medium.

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Expiratory Collapse of the Trachea Presenting as Worsening Asthma*

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A 50-year-old woman with lifelong asthma had nearly total expiratory collapse of her distal trachea. The signs and symptoms were similar to those of asthma except for a pronounced upper airway component to her wheezing and the immediate onset of dyspnea on exertion. Surgical repair led to significant improvement in symptoms and resolution of tracheal collapse on expiration. Ultrafast computed tomography was a valuable adjunct to bronchoscopy in diagnosis and management. Expiratory collapse of the trachea should be considered in the differential diagnosis of wheezing and intractable reactive airway disease.

(Chest 1993; 104:633-35)

Reversible airflow obstruction in adults is usually caused by reactive airway disease (asthma), but "everything that wheezes is not asthma." One condition that masquerades as asthma is expiratory collapse of the trachea. As described by Herzog, these patients have "flabbiness" and prolapse of the dorsal membranous portion of the trachea into the lumen during expiration, causing marked airflow obstruction. Men over 40 with chronic bronchitis or emphysema are most often affected. Symptoms may occur suddenly and include cough, extreme expiratory difficulty, and stridor. Collapse of the airway during cough prevents adequate expectoration.

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of secretions and may result in bronchitis.

We describe a middle-aged patient with lifelong asthma who presented with severe expiratory collapse of the trachea and upper airways. Surgical repair dramatically reversed the tracheal collapse and allowed resumption of daily activity. Expiratory collapse of the trachea should be considered in patients with asthma so that proper treatment can be offered. Medical treatment is ineffective, but in carefully selected patients, surgical repair may lead to significant improvement in symptoms.

CASE REPORT

A 50-year-old white woman with a history of asthma since childhood was evaluated for exacerbation of reactive airway disease during the preceding 2 years, which was unresponsive to oral and inhaled corticosteroids. She was comfortable at rest but had marked dyspnea that appeared immediately on trivial exertion, such as walking a few steps. She also had wheezing; a loud, brassy cough productive of thick yellow sputum; and orthopnea. There was no rhinitis or seasonal variation in symptoms, and skin tests to common aeroallergens were negative. She had quit smoking 5 years previously. There were no symptoms or familial history suggestive of a connective tissue defect.

On physical examination, wheezing was exacerbated by minimal exertion (walking three or four steps from a chair to the examination table), was clearly of upper airways origin, was loud, and stopped suddenly before the end of expiration. Spirometry revealed an FEV₁ of 1,280 ml (predicted, 2,420 ml) and an FVC of 1,730 ml (predicted, 3,190 ml). The flow-volume loop showed an obstructive ventilatory defect with nocturnal after the initial rapid expiratory phase. The chest radiograph was unremarkable. Repeated bursts of prednisone (15 mg four times a day for 14 days) did not improve symptoms or spirometric values. Bronchoscopy exhibited changes consistent with acute and chronic bronchitis, including erythema, edema, and copious secretions. The trachea collapsed on expiration, causing nearly total obstruction of the lumen with the most severe collapse just above the carina. The prolapse was most prominent on forced expiration and coughing, and appeared to be the cause of the wheeze. The more distal airways partially collapsed on expiration as well.

An ultrafast computed tomographic (CT) study (Imatron, South San Francisco, Calif) demonstrated a 79 percent decrease in the cross-sectional area of the trachea during expiration (Fig 1). The collapse was accentuated by exercise (89 percent obstructed) and improved with nasal continuous positive airway pressure (39 percent obstructed). A sleep study did not reveal any evidence of obstructive sleep apnea.

Medical management failed, and the patient remained almost totally disabled. Consequently, an external Gore-Tex stent was placed over the lower two thirds of the trachea and bilateral mainstem bronchi. After surgery, symptoms of expiratory collapse were markedly reduced, as demonstrated by repeat endoscopy and ultrafast CT (Fig 2). Spirometric values remained unchanged. Three years postoperatively, she has improved exercise tolerance with no recurrence of the expiratory collapse of the trachea.

DISCUSSION

Expiratory collapse of the trachea can be missed. Our patient was comfortable at rest but immediately on trivial exertion developed wheezing and dyspnea, characteristics that differentiate this disorder from exercise-induced asthma, in which wheezing occurs after a few moments of exercise. Furthermore, the brassy cough with loud upper airway wheezing, in the setting of longstanding obstructive lung disease, was classic for expiratory collapse of the

Figure 1. Selective preoperative ultrafast CT images of the trachea show 79 percent obstruction.

Figure 2. Selective postoperative ultrafast CT images show that collapse has been reduced to 31 percent.

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trachea. Her lack of response to repeated administration of prednisone indicated that further evaluation was necessary. Bronchoscopy showed tracheal collapse accompanied by acquired distal tracheomalacia, differentiating her disorder from asthma or other COPD.

Expiratory collapse of the trachea, also called acquired tracheomalacia, should be differentiated from other causes of airway obstruction. Expiratory collapse of the trachea is distinguishable from congenital tracheomalacia and bronchomalacia by age of onset. Collapse of the trachea in adults also occurs with idiopathic megatrachea (Mounier-Kuhn syndrome), but enlarged trachea distinguishes that condition. Acquired bronchomalacia alone has been described but is without tracheal involvement. Connective tissue disease of the airway such as relapsing polychondritis, Wegener's granulomatosis, Ehlers-Danlos syndrome, and cutis laxa, or prior trauma or surgery to the trachea should also be excluded.

Many reports of expiratory collapse of the trachea have been in surgical or non-English-language publications, and this syndrome may be more common than has been appreciated. Jokinen et al. reported expiratory collapse of the trachea in almost 5 percent of bronchitic patients, and Herzog found collapse in 1 percent of patients undergoing bronchoscopy. However, this condition has not been well described in internal medicine, allergy, and pulmonology journals.

Expiratory collapse of the trachea should be considered in asthma patients whose condition is refractory to medical therapy. Expiratory rhonchi or wheezes over the trachea, paroxysmal coughing, orthopnea, or a notch in the expiratory phase of the flow-volume loop should heighten suspicion. Fiberoptic bronchoscopy is the most direct method to confirm the diagnosis. Bronchoscopy in the awake patient allows use of dynamic maneuvers, such as cough and forced expiration. Cinebronchoscopy has also been used for diagnosis.

A more recent imaging modality, ultrafast CT, allows near real-time visualization of the trachea. To our knowledge, this is the first published use of ultrafast CT to assess expiratory collapse of the trachea. We were able to see and quantitate obstruction at rest, with dynamic maneuvers, with change in position, and in response to continuous positive airway pressure and surgery. This technology promises to play an important adjunctive role in diagnosis and management of expiratory collapse of the trachea.

The cause of expiratory collapse of the trachea is unknown. There may be a connective tissue defect. However, during bronchoscopy we and others have observed less severe asymptomatic prolapsole of the posterior membranous trachea in patients with significant COPD, and collapse may represent the far end of the spectrum of tracheal and bronchial changes in emphysema.

Surgical repair is the most effective therapy for expiratory collapse of the trachea. Patient selection is very important. Prior to considering surgery, bronchoscopy should provide unequivocal evidence of tracheal membrane prolapse with nearly total obstruction of the trachea. The more distal airways should also be examined for collapse. Patients with severe prolapse may benefit from surgery, even if the distal airways also collapse, as in this case. Stabilization of the trachea may lead to improvement in bronchitis and airway inflammation with less expectoration of secretions. Various surgical approaches to this problem have been developed but are beyond the scope of this discussion. In patients who are not amenable to surgical repair or who have less severe collapse, there may be some role for continuous positive airway pressure or expiratory resistance devices. Accurate diagnosis of anatomic causes of obstructive lung disease, such as expiratory collapse of the trachea, is important to identify patients who may benefit from surgery.

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