Cricopharyngeal Dysfunction in Chronic Obstructive Pulmonary Disease*

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Dysphagia due to cricopharyngeal dysfunction is well known; however, there have been no previous data indicating an association between cricopharyngeal dysfunction and COPD. After observing marked cricopharyngeal dysfunction with aspiration in three patients who had frequent and severe exacerbations of COPD, we performed pharyngoesophageal examinations with videotaping in another 22 nonrandomized patients. Cineradiography or videofluoroscopic recording with capabilities of slow-motion and freeze-frame playback is mandatory, since the transit time of the bolus through the pharynx is rapid. Severe cricopharyngeal dysfunction was observed in 17 elderly patients with COPD. Deglutition disorders were elicited by careful questioning in 15 of these. In eight subjects, cricopharyngeal myotomy resulted in improvement of swallowing and complete or partial relief of acute exacerbations of respiratory distress. In one subject, myotomy relieved only the swallowing problem. The mechanism of cricopharyngeal dysfunction in elderly patients with COPD is unknown at this time, but may be related to gastroesophageal reflux, therapeutic agents, and/or alterations in pharyngoesophageal anatomic structures. We conclude that investigations for swallowing disorders should be considered in patients with COPD who have frequent acute exacerbations of respiratory distress.

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The intimate developmental and anatomic relationships of the tracheobronchial tree and gastrointestinal tract have demanded a complex system for separating their functions. The process of swallowing is one aspect. Failure of all or part of this process may lead to aspiration of oropharyngeal contents, a recognized pathophysiologic entity which produces, for example, anaerobic pulmonary infections, cough, wheezing, and respiratory distress. In the setting of obvious oropharyngeal dysphagia (with disorders such as brain-stem lesions, muscular disease, eg, polymyositis or myasthenia, and Parkinson's disease), this association may be easily recognized; however, subtle difficulties in passage of solids or liquids from the oropharynx into the upper esophagus are currently little appreciated. In this report, we wish to highlight important aspects of this phenomenon in a group of patients with COPD. We have studied 25 patients with severe obstructive airways disease, 21 of whom had various degrees of cricopharyngeal achalasia. Due to favorable responses to cricopharyngeal myotomy in eight of these patients, we propose that there may be a causal relationship between the two conditions in some patients. While considerable literature on cricopharyngeal function and dysfunction has been produced, we are not aware of any report raising the possibility that cricopharyngeal dysfunction may be related to or contribute to exacerbations of COPD.

**Materials and Methods**

**Protocol**

Based on our experience with three patients with severe COPD and clinically overt swallowing difficulties in whom cricopharyngeal dysfunction was verified, we studied an additional 22 patients with severe COPD who were subject to frequent exacerbations. All studies were performed in a community hospital. These studies were neither consecutive nor randomized, but were based upon historical data and the patient's willingness to have pharyngoesophageal studies with videotaping. Clinical historical data included "a feeling of something stuck in my throat," necessity of cutting food into very small pieces prior to ingestion, coughing up particles of food, and histories of aspiration or aspiration pneumonia. Decisions regarding recommendations for cricopharyngeal myotomy were made by a head-and-neck surgeon (L.Z.) according to standard clinical criteria and were based on historical data, frequent exacerbations of COPD with coughing and respiratory distress at times requiring hospitalization, and radiographic observations of severe upper esophageal obstruction due to cricopharyngeal spasm.

In addition, videofluoroscopic studies of swallowing were performed in 128 unmatched adult patients aged 27 to 85 years, without known pulmonary disease. They were referred for upper gastrointestinal examinations for various medical problems other than dysphagia.

**Radiographic Methods**

Preliminary roentgenograms of the chest and soft tissue of the neck were obtained in all patients. The radiologic pharyngoesophageal examination included either cineradiography or videofluoroscopic recording with capability of playback analysis in slow-motion and freeze-frame modes. These studies are mandatory for an adequate evaluation, since the transit time of the bolus through the pharynx is quite rapid. Liquid barium swallows were supplemented by solid or semisolids such as barium-impregnated marshmallows or pieces of bagel coated with barium. Prior to administering contrast material, the motion of the soft palate was viewed fluoroscopically in the lateral projection, and the
function of the vocal cords was observed in the frontal projection. Upright lateral and anteroposterior views were obtained with contrast swallow. The first lateral swallow was viewed at the level of the larynx to check for laryngeal penetration. Examinations of the mouth, upper neck, and lower neck were then performed, followed by lateral decubitus and prone oblique views of the oropharynx and cervical and thoracic esophagus. Radiographic spot films of the esophagus were obtained. Additionally, examination was performed to search for gastroesophageal reflux. More sensitive techniques for diagnosis of gastroesophageal reflux (eg, nuclear scintiscan or esophageal motility studies) were not employed because of the additional inconvenience and cost to the patients.

The cineradiograms or videoradiograms were carefully examined for anatomic and functional abnormalities of deglutition. Normally, the cricopharyngeal segment is opened by relaxation of the cricopharyngeal muscle. At the completion of the swallow, contraction of the cricopharyngeal muscle occurs. Failure of the muscle to relax during swallowing is observed as a defect or posterior indentation into the barium column (Fig 1).

In those patients with cricopharyngeal achalasia, the dysfunction observed on radiologic studies was categorized according to the degree of upper esophageal obstruction and the presence or absence of airways penetration of barium. Less than 30 percent obstruction was termed 1 + ; from 30 to 50 percent was 2 + ; greater than 50 percent was 3 + ; and greater than 50 percent combined with Zenker's diverticulum or airways penetration or leakage was 4 + .

CASE REPORTS

A brief description of our index cases may be of help in describing this complication or abnormality.

CASE 1

An 80-year-old physician was admitted urgently to the Brotman Medical Center. One year previously, he had observed the onset of wheezing and severe dyspnea treated with bronchodilator drugs and large doses of corticosteroids (48 mg of methylprednisolone daily at the time of admission). On the evening of admission, the patient was awakened from sleep with severe coughing and wheezing that was unresponsive to therapy. While in the emergency room and later in a medical intensive care unit, he was given the customary large doses of intravenous steroids, aminophylline, antibiotics, and chest physiotherapy, with some improvement. After conversion to oral steroids, frequent exacerbations of dyspnea, coughing, and wheezing were recorded. Bedside observations suggested that symptoms became worse after eating or even swallowing saliva. Swallowing and upper gastrointestinal contrast studies, including videotaping of deglutition, revealed severe cricopharyngeal achalasia, as demonstrated in Figure 1. Retention of barium in the hypopharynx with tracheal aspiration was also seen on the videotape. Following cricopharyngeal myotomy, performed under local anesthesia, there was marked improvement in his clinical state. The underlying COPD was still present, but he was able to work full time and did not require corticosteroids.

CASE 2

An 80-year-old female patient with a long history of severe COPD had been making frequent visits to an emergency room with exacerbations typified by episodes of coughing, sputum production, wheezing, and severe shortness of breath. When questioned about swallowing, the patient and a family member described a long history of eating and drinking very small portions and of being an unusually slow eater. A videotape of her swallowing revealed severe cricopharyngeal achalasia (4 + ); she also had dramatic relief following cricopharyngeal myotomy. With minimal swallowing retraining, there was marked improvement in her eating habits, elimination of the frequent visits to the emergency room, and reduction in the frequency of exacerbations of respiratory distress.

CASE 3

A 75-year-old woman had severe COPD and complaints of swallowing difficulties. As shown in Figure 2, there was a prominent cricopharyngeal bar and a large Zenker's diverticulum. Following a myotomy, there was marked improvement in her swallowing ability, reduction in size of the Zenker's diverticulum, and relief from exacerbations of respiratory distress.

RESULTS

We studied 25 patients with cricopharyngeal dysfunction who had moderate to severe COPD and FEV₁ less than 70 percent of predicted (Table 1). All of these patients had been referred for frequent exacerbations.
of respiratory distress.

Twenty-one of the patients had dysfunction of the cricopharyngeous muscle shown by videotape recordings of the swallowing sequence. All patients studied except one were over the age of 50 years. There was an apparent association between age and severity of cricopharyngeal achalasia (Fig 3). All patients with severe cricopharyngeal achalasia (3+ to 4+) were 65 years old or older, and the majority were women.

The observed FEV<sub>1</sub> did not correlate significantly with the severity of cricopharyngeal achalasia, but two thirds of the patients with the most severe abnormalities also had severe cricopharyngeal achalasia. Of the 17 patients with severe cricopharyngeal achalasia, ten had an FEV<sub>1</sub> of 1.0 L or less, while four who were similarly affected had an FEV<sub>1</sub> of 1.6 to 1.8 L at the time of the studies. Further studies utilizing randomization techniques and evaluating reversibility of airways obstruction would be necessary to clarify the precise relationship between FEV<sub>1</sub> and cricopharyngeal achalasia in patients with COPD.

All but three subjects had received theophylline and inhaled β<sub>2</sub>-adrenergic medications; however, the three patients who had received no previous bronchodilator medications also had severe cricopharyngeal achalasia on radiologic examinations; two of these patients had severe reductions of FEV<sub>1</sub>. One subject (no. 16) had only mild symptoms of airways obstruction and a normal FEV<sub>1</sub> at the time of examination. Four of the subjects with cricopharyngeal achalasia had received prior corticosteroids, two by inhalation only. Two of the four patients without cricopharyngeal achalasia had been receiving oral corticosteroids. Sixteen of the subjects had a history of smoking, but we observed no correlation between this and cricopharyngeal achalasia.

Radiographic examinations for hiatal hernia were reported in 16 patients with cricopharyngeal dysphagia and were positive in 12. Although there was no definite association between hiatal hernia and cricopharyngeal dysfunction, ten of 13 patients with severe (3+ to 4+) radiologic swallowing disorders had radiographic evidence of hiatal hernia when so examined. Thirteen patients with severe cricopharyngeal dysfunction (3+ or 4+) were studied radiologically for gastroesophageal reflux; four of these were positive.

**Figure 2.** Severe cricopharyngeal dysfunction in a 75-year-old woman with severe COPD. There is esophageal compression due to dysfunction of a cricopharyngeal muscle and also the large Zenker's diverticulum (arrow), both of which may also be due to gastroesophageal reflux (case 3).

**Table 1—Characteristics of Patients with COPD Studied for Swallowing Disorders**

<table>
<thead>
<tr>
<th>Patient, Age, Sex</th>
<th>C-F Achalasia Severity (Radiographically)</th>
<th>FEV&lt;sub&gt;1&lt;/sub&gt;* (% Pred)</th>
<th>Clinical Dysphagia</th>
<th>Smoking Pack- yrs</th>
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*Best value obtained
†3 Cigars Per Day

**Figure 3.** Severity of cricopharyngeal achalasia compared with age (see text for discussion).
Among four patients with lesser transluminal narrowing (1 or 2+), one had reflux on examination. The incidence of gastroesophageal reflux in those studied for this was therefore 29 percent (5/17). Two patients had gastroesophageal reflux in the presence of severe COPD and studies negative for swallowing dysfunction. Definitive studies for reflux, including esophageal pH measurements by esophageal probe or acid perfusion studies, were not performed.

With informed consent, ten of the subjects had cricopharyngeal myotomies performed under local anesthesia. All of the subjects had severe cricopharyngeal dysfunction on video pharyngoesophageal study. The intent of the procedure was to improve deglutition and to relieve the frequent episodes of pulmonary distress believed to be secondary to aspiration. All subjects did observe marked improvement of deglutition, including two who were not aware of preoperative difficulties. Postoperative radiologic examinations revealed normal to minimally disturbed cricopharyngeal function. Eight of the subjects reported marked relief in episodes of cough, sputum production, wheezing, and dyspnea, as well as improved sleep. Objective data to support the subjective improvement in their symptoms exists only in the form of fewer admissions to the hospital and visits to the emergency room. One subject who had observed relief of her swallowing problem failed to notice any changes in respiratory status. Another subject died of unrelated causes shortly after cricopharyngeal myotomy. Pulmonary function studies after myotomy in six patients failed to show any consistent improvement in the subjects' chronic airways obstruction.

In 128 patients referred for upper GI radiologic evaluation for multiple conditions, videotaping of deglutition was performed. Among these patients, cricopharyngeal dysfunction was observed in 14 (11 percent). None of these had obstructions greater than 2.7 These data are similar to other reports. Eight of these patients were female. The frequency of cricopharyngeal dysfunction in the subjects 65 years old or older was 21 percent. Pulmonary function data are not available from these 128 individuals.

**DISCUSSION**

Patients with COPD are commonly subject to frequent exacerbations which are assumed to be related to infection or bronchial hyperreactivity. Herein we have identified an additional factor, cricopharyngeal achalasia, in 21 of 25 patients. In 17 of these patients, it was judged to be severe, and in retrospect, all were found to have some degree of symptomatic dysphagia. Surgical correction in ten of them was associated with definite clinical improvement of pulmonary symptoms in eight.

Aspiration of gastric secretions into the tracheobronchial tree is already considered a potential cause of chronic pulmonary disease. Hiatal hernia with gastroesophageal reflux has been associated with pulmonary fibrosis and with severe asthma. Symptoms suggestive of aspiration (specifically, recumbent cough) have been reported in 10 to 50 percent of the patients with reflux, and occult aspiration has been documented by radionuclide studies. The predominant reflux-permissive condition identified in these reports has been incompetence of the lower esophageal sphincter, with or without associated hiatal hernia; however, dysfunction of the upper esophageal sphincter, (in large part, the cricopharyngeal) has received much less attention.

The cricopharyngeal and adjacent muscles have been referred to as the "gatekeeper" of the esophagus. The cricopharyngeal muscle is normally contracted except during swallowing, vomiting, and belching. It is believed that the primary function of this muscle is to prevent esophageal respiration.

The act of swallowing involves a complex mechanism requiring precise coordination of the tongue, larynx, pharynx, and upper esophagus. Esophageal manometry has identified as part of this mechanism a pressure zone corresponding to the cricopharyngeal muscle and adjacent pharyngeal and esophageal muscles. This zone has the characteristics of a sphincter. It relaxes with swallowing, just before and including the period of pharyngeal contraction, and subsequently contracts to initiate the primary peristaltic wave of the esophagus.

Many conditions may disrupt the coordinated events that characterize normal pharyngoesophageal function. These include central nervous system lesions, conditions affecting muscle function directly, major oropharyngeal surgery, and idiopathic sphincteric incoordination. Achalasia is the most common disorder of the muscle. It can be defined for most patients as failure of the muscle to relax quickly enough during deglutition to permit the bolus to pass freely through the hypopharynx into the esophagus. In others the cricopharyngeal muscle relaxesproperly but then closes too quickly, before the whole bolus is able to move into the esophagus.

Although symptomatic cricopharyngeal achalasia is uncommon, a prominent cricopharyngeal bar can be seen in about 5 percent of barium studies of the pharyngoesophageal area. In addition, Paget and Pouillet, who made detailed upper gastrointestinal studies in 100 symptomless subjects more than 65 years old, found that 38 percent of the men and 15 percent of the women had neurologic dysfunction within the hypopharynx, with either pharyngeal hypotonicity, failure of the cricopharyngeal muscle to relax, or puddling in the valleculae and piriform sinuses.
The precise role or incidence of cricopharyngeal dysfunction in patients with COPD is not known at the present time. Cricopharyngeal dysfunction may precede the airways obstruction and contribute to subsequent progression and exacerbations of the airways abnormality. Alternatively, cricopharyngeal dysfunction may be secondary to COPD in some patients. Another possibility is that the two conditions may be related to common etiologic factors.

In considering the first possibility, it has long been appreciated that chronic obstructive pulmonary diseases have varied causes. Smoking has been considered to be responsible in the large majority of patients; however, careful longitudinal studies have shown that only a minority of smokers developed airways obstruction (although all develop mucous hypersecretion and, consequently, chronic bronchitis). Among other predisposing factors considered to play a part in the development of airways obstruction are hyperreactivity of the airways and abnormalities of pulmonary defense mechanisms such as abnormal cilia or anti-protease deficiencies. In the present study, we have identified a potentially far more common association in 21 of 25 patients with frequent exacerbations of COPD. We assume that the cricopharyngeal dysfunction leads to occult aspiration of small quantities of oropharyngeal contents. It is not unlikely that such repeated aspirations of oral secretions would be unrecognized and yet over a prolonged period could damage airway epithelium and promote parenchymal destruction. Presumed acute exacerbations of COPD common in this group of patients may have been related to larger aspirates.

It is possible, also, that cricopharyngeal dysfunction is secondary to COPD. Belsey has suggested that gastroesophageal reflux leads to cricopharyngeal achalasia, a mechanism protecting the larynx from aspiration of gastric acid. Since it can be speculated that COPD may favor increased gastroesophageal reflux by flattening of the diaphragm, the presence of COPD may lead to progressive cricopharyngeal achalasia. In addition, β-adrenergic drugs, theophylline, alcohol, cigarette smoking, and severe coughing paroxysms may lower or overcome lower esophageal sphincter tone and promote reflux; however, in a recent editorial, Winship stated that the role of gastroesophageal reflux in producing increased upper esophageal sphincter tone has not been clarified. While our radiologic observations are not supportive of its role, more definitive gastroesophageal reflux examinations should be performed, by ambulatory pH monitoring, for example, or acid perfusion studies (or both). There are no data suggesting an effect of drugs, tobacco, or alcohol on the upper esophageal sphincter.

Common etiologic factors that might be considered include aging. As noted previously, mild radiographic abnormalities of the upper esophageal sphincter are relatively common in the aged population, and "senile" emphysema with increasing airflow limitation is an accepted phenomenon. Nevertheless, our observations suggest that aging alone is not the cause of the swallowing disorder in these patients. While there may have been a bias in the selection of our patients, the observed incidence of 84 percent of cricopharyngeal achalasia is considerably higher than reported in the literature and, although surprising, indicates an important need for further studies. Furthermore, 17 of the 21 patients with COPD whom we studied had severe radiologic abnormalities of swallowing.

Although cricopharyngeal myotomy resulted in clinical improvement in eight patients with severe COPD dysfunction, the usefulness of this surgery has not been clarified. Swallowing rehabilitation programs may be equally beneficial. Prior to performance of this surgery, concern was raised that the myotomy could enhance aspiration secondary to gastroesophageal reflux; however, in eight patients followed up to two years after surgery, swallowing was greatly improved, and exacerbations of pulmonary distress were relieved. Furthermore, myotomy may not result in removal of the barrier to gastroesophageal reflux, as the remaining muscle may undergo axial lengthening and thereby prevent aspiration. Treatment of gastroesophageal reflux as a potential etiologic factor would also be rational and important.

The failure of the larynx to protect itself and the airway from aspiration has not been elaborated. Presumably, material that has not been cleared from the oropharynx by the preceding swallow is aspirated by the following obligatory inspiration. Other possibilities include malposition of the larynx during swallowing resulting in leakage into the airway and also possibly contributing to cricopharyngeal malfunction.

In conclusion, we reemphasize the nonrandomized aspects of this study and that the controls were unmatched. Our subjects consented to have the radiographic studies of swallowing performed after careful and intensive questioning regarding deglutition. We believe that swallowing disorders should be sought in patients with severe COPD who have frequent exacerbation of respiratory distress.

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