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An Uncommon Cause of Dyspnea: Unilateral Diaphragmatic Paralysis

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CASE

The patient is a 57-year-old Caucasian male presenting with exertional dyspnea. The symptoms started a few months ago and are aggravated by activity. Aggravating activities include walking upstairs, bending over, and exercise. Symptoms are relieved with rest. Other symptoms such as fever, chills, weight loss, chest pain, hemoptysis, nausea, vomiting, diarrhea, abdominal pain, dizziness, or syncope are absent. Past medical history includes hypertension, Hashimoto's thyroiditis, and obstructive sleep apnea. All these conditions are well managed with medication and CPAP therapy. Current prescribed medications include losartan 100 mg once daily, Amlodipine 10 mg once daily, and Levothyroxine 100 mcg once daily. Past surgeries include hiatal hernia repair, inguinal hernia repair, bilateral knee replacement, uvulectomy, tonsillectomy, and adenoidectomy. Social history revealed a 20 pack years smoking history and current alcohol consumption of approximately two alcoholic drinks per week. The patient has not smoked for over 15 years. At the visit, vitals were obtained: BP 128/84, HR 79, Respirations 18, Oxygen saturation 97%. Patient's height is 1.93 meters and weight is 137 kilograms with a calculated BMI of 37. Physical exam revealed a well-developed, well-nourished male in no acute distress. No masses or abnormal cervical nodes were palpable. Head was normocephalic/atraumatic with clear conjunctiva and sclera. Oral examination revealed an absent uvula, tonsils, and patent airway. Cardiovascular exam was regular rate and rhythm with a S3 heart sound and aortic ejection murmur present. Respiratory exam was clear to auscultation and did not show any obvious signs of respiratory distress, wheezing, crackles, or rhonchi. Abdominal exam did not reveal any tenderness to palpation, palpable masses, rigidity, or guarding. Musculoskeletal exam showed a normal gait and station. Psychiatric exam showed normal mood and affect.

The current symptoms resulted in a differential diagnosis list of chronic obstructive pulmonary disease, lung cancer, pneumonia, congestive heart failure, angina, and hiatal hernia. The absence of fever, weight loss, and night sweats reduces the likelihood of conditions such as pneumonia and lung cancer. The patient was referred for cardiology, pulmonology, and gastroenterology consultations for further evaluation. A complete blood count and complete

metabolic panel were within normal limits. Cardiology obtained an electrocardiogram, echocardiogram, and stress echocardiogram. The electrocardiogram showed normal sinus rhythm and nonspecific ST-T wave changes. Echocardiogram and stress echocardiogram revealed a dilated left and right atrium, mildly increased left ventricle cavity, normal wall thickness and systolic function, normal wall motion, no regional wall abnormalities, and an ejection fraction of 55-60%. The results of the cardiovascular diagnostic tests and lack of orthopnea, JVD, or edema reduces the likelihood of a cardiac cause.

Due to a prior history of hiatal hernia, gastroenterology performed esophagogastroduodenoscopy (EGD) and confirmed a stable surgically repaired hiatal hernia. The benign EGD reduces the possibility of a gastrointestinal etiology such as a recurring hiatal hernia.

Upon seeing pulmonology, pulmonary function tests (PFT) were obtained to assess expiratory volume (FEV), forced expiratory volume in one second (FEV1), total lung capacity (TLC), pre- and post- bronchodilator forced expiratory volume, and residual volume (RV). The FEV1/FVC ratio was 61, which is 80% predicted. Prebronchodilator FEV1 was 2.73, which was 60% predicted. Postbronchodilator FEV was 2.70, which was 59% predicted. TLC was 7.9, which was 93% predicted. RV was 3.44, which was 134% predicted.

FEV1/FVC Ratio	61 (80% predicted)
Prebronchodilator FEV1	2.73 (60% predicted)
Postbronchodilator FEV1	2.70 (59% predicted)
Total Lung Capacity	7.9 L
Residual Volume	3.44 L (134% predicted)

Table 1: Pulmonary Function Test Results

PFT results are consistent with a mixed pattern, a combination of obstructive and restrictive lung disease. A chest x-ray was also obtained which showed an elevated left hemidiaphragm. With the current symptoms and the prior history of smoking, a diagnosis of COPD as well as another lung condition are possible. After these diagnostic tests, a trial of bronchodilators was given which did not provide any relief. Due to the ineffectiveness of bronchodilator therapy and the findings on chest x-ray, further workup was warranted. A CT scan of the chest and fluoroscopic sniff test were ordered to further evaluate the elevated left hemidiaphragm found on imaging. CT scan and fluoroscopic sniff test confirmed the left elevated diaphragm previously seen on chest x-ray. Referral to cardiothoracic surgery was then ordered for surgical consultation. After 12 months of

observation without resolution of symptoms, left thoracotomy and plication of the left hemidiaphragm was performed.

DISCUSSION

The diaphragm is an organ that divides the thoracic and abdominal cavities and is the main muscle contributor to ventilation.^{2,6} With inspiration, an increase in intrathoracic volume and decrease in intrapleural pressure occurs. Reduced intrapleural pressure expands the lung, allowing air into the lungs through the airways.³ The diaphragm's arterial supply is from the right and left inferior phrenic arteries, intercostal arteries, and musculophrenic branches of the internal mammary arteries.⁶ The diaphragm is innervated bilaterally by the phrenic nerve, which originates from nerve roots C3-C5.^{2,5}

Damage to the phrenic nerve through various forms of trauma can result in unilateral diaphragmatic paralysis.^{2,3} Compressive etiologies, such as cervical spondylosis or malignancy, can also lead to this condition.^{2,3} There are also neuropathic etiologies including cerebrovascular accident, diabetic neuropathy, multiple sclerosis, Guillain-Barre syndrome, and myasthenia gravis.² Inflammatory and infectious etiologies such as COVID-19, Herpes Zoster virus, Lyme disease, and poliomyelitis can also be possible etiologies.^{2,3} It is possible for a specific etiology not to be found.³

Symptoms can vary by patient. It is possible for a patient to be asymptomatic with this condition.^{3,4,8} Other common clinical manifestations include dyspnea, orthopnea, fatigue, hypersomnia, and respiratory distress.^{4,8} Physical exam of patients with unilateral diaphragmatic paralysis is often benign.⁴ Diminished breath sounds may be present at the affected side.³ Many clinical manifestations of unilateral diaphragmatic paralysis are nonspecific for this condition and should be correlated with history and diagnostic tests.

An elevated hemidiaphragm will often be visualized on chest x-ray which will then be confirmed with a CT scan.⁵ CT scan also allows exclusion of other etiologies such as effusion, mass, or interstitial lung disease.³ After confirmation of this condition through chest x-ray and CT scan, a fluoroscopic sniff test can also be ordered to confirm the diagnosis. During a fluoroscopic sniff test, the diaphragm is observed fluoroscopically while sniffing forcefully in the standing position. Paradoxical elevation or absent movement of the paralyzed hemidiaphragm will be visualized.⁵ Pulmonary function tests are also often ordered as the presentation of unilateral diaphragmatic paralysis can mimic other lung conditions.⁵

Treatment of unilateral diaphragmatic paralysis initially starts with a period of observation.^{1,4,5} This condition can improve spontaneously but further treatment should be considered if resolution does not occur after 12 months.^{1,4,5} After twelve months of observation, the likelihood of this condition resolving spontaneously decreases significantly. Treatment options after twelve months can include respiratory therapy, ventilatory support, and surgery.^{1,4} Surgery consists of thoracotomy and diaphragm plication, a surgical procedure involving the paralyzed diaphragm being folded, sutured in place, and immobilized.^{1,4,5} Immobilization of the hemidiaphragm prevents upward movement into the hemithorax during inspiration, allowing for increased air into the lungs and increased gas exchange.^{1,5}

Prognosis of this condition is dependent on the other comorbidities that a patient may have. Having concurrent lung disease with this condition can result in decreased quality of life and worsening of symptoms.⁵ Patients can develop compensatory mechanisms to combat this condition, allowing for full recovery. Spontaneous recovery is possible for many patients, however, there are a subset of patients that do require surgical intervention.⁵

CONCLUSION

After undergoing left thoracotomy and hemi-diaphragm plication, the patient underwent a period of recovery and rehabilitation. At each subsequent clinic visit, improvement in dyspnea was reported. At the last visit, the dyspnea had completely resolved. This condition can mimic other cardiopulmonary diseases and the absence of obvious cardiac disease or lung disease should raise the suspicion of diaphragmatic paralysis, especially when symptoms are consistent with this disorder.⁸ Thorough history, physical exam, and diagnostic tests are required to diagnose this uncommon condition.

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