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## January 2023 Medical Image of the Month: Abnormal Sleep Study and PFT with Supine Challenge Related to Idiopathic Hemidiaphragmatic Paralysis

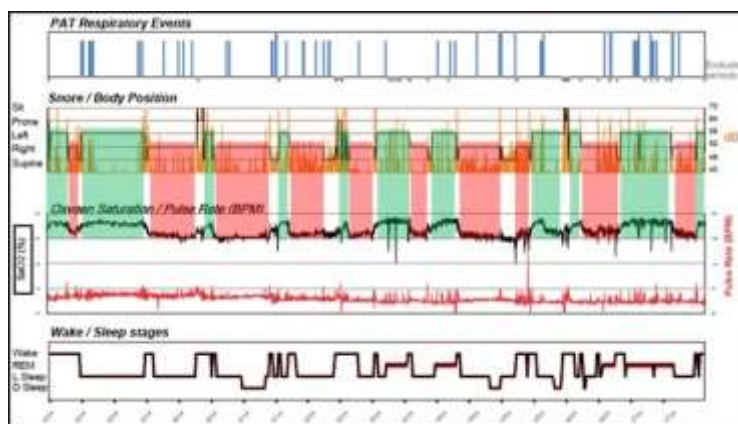


Figure 1. Results of a sleep study demonstrating a correlation between body position and oxygen saturation. When the patient moved into right lateral decubitus positioning, their SaO<sub>2</sub> dropped (red), when they moved into left lateral decubitus positioning, their SaO<sub>2</sub> recovered (Green). This position-dependent change in SaO<sub>2</sub> during sleep suggests right hemidiaphragmatic paralysis. (To view Figure 1 in a separate, enlarged window click [here](#)).

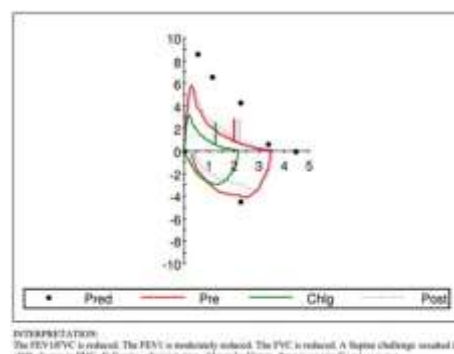


Figure 2. Flow-volume loop from pulmonary function testing demonstrates a significant reduction in forced vital capacity (FVC) and forced expiratory volume 1s (FEV1) with supine positioning (green line) compared to upright baseline (red line) suggestive of diaphragmatic dysfunction. (To view Figure 1 in a separate, enlarged window click [here](#)). (To view Figure 2 in a separate, enlarged window click [here](#)).

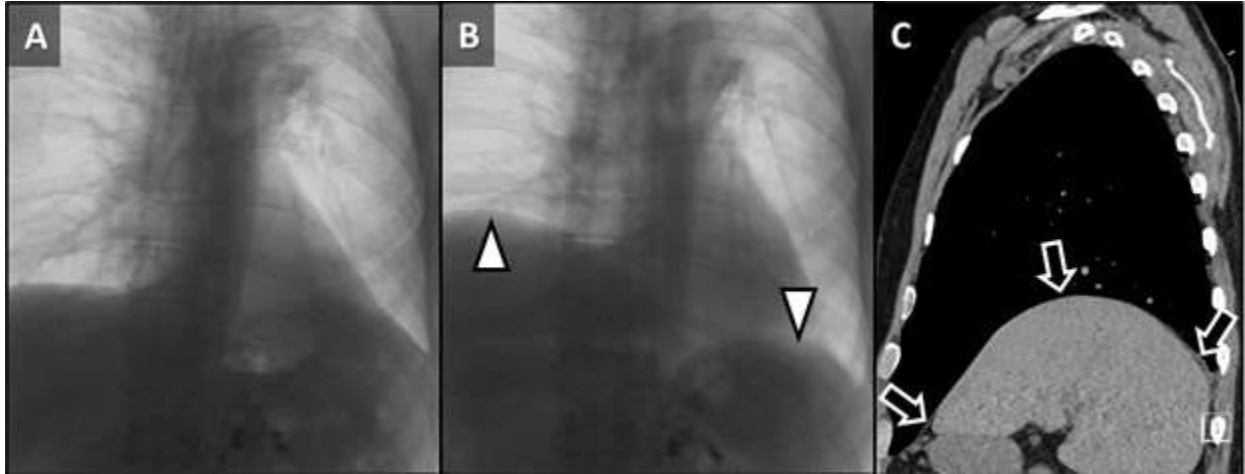


Figure 3. Fluoroscopic images from a sniff test at end tidal (A) and “sniffing” (B) portions of exam demonstrating normal depression of the left hemidiaphragm (down arrowhead) and paradoxical elevation of the right hemidiaphragm (up arrowhead) consistent with right hemidiaphragmatic paralysis. Sagittal reconstruction from a noncontrast chest CT (C) demonstrating an elevated but otherwise normal appearing right hemidiaphragm (arrows). (To view Figure 3 in a separate, enlarged window click [here](#)).

A 71-year-old man presented to our pulmonary clinic with a complaint of worsening dyspnea, which seems to be positional in nature. Symptoms were exacerbated by bending over or laying down too quickly. The patient was known to our practice, having had a kidney transplant 17 years ago, a left upper lobectomy for squamous cell carcinoma 6 years ago (no recurrence), and has been on fluconazole for 4 years due to disseminated coccidioidomycosis (cocci) with cavitary pulmonary involvement. The patient had recurrent DVTs 2 years ago and is on Eliquis. On top of that, the patient had COVID 1 year ago, but had recovered. An outside sleep study was remarkable for overnight hypoxia. Outside pulmonary function testing (PFTs) demonstrated a combined restrictive and obstructive picture. An outside chest CT failed to demonstrate any findings that would suggest COVID-related changes or progression of cocci as a

potential cause. A V/Q scan was low probability for pulmonary embolism.

The positional nature of the patient’s symptoms and suspicious physical exam findings suggested abnormal diaphragmatic motion as a potential etiology. The astute pulmonologist ordered a home sleep study to evaluate for any positional nature to the overnight hypoxia (Fig. 1), PFTs with supine challenge (Fig. 2) and a fluoroscopic sniff test to evaluate diaphragmatic motion (Figure 3). The sleep study did indeed demonstrate a strong correlation between patient position and SaO<sub>2</sub> (dropped when right side down or supine). The PFTs demonstrated a significant drop in pulmonary function with supine challenge. The sniff test demonstrated an elevated right hemidiaphragm with paradoxical motion during sniffing maneuvers (Fig. 3A,3B). Results were consistent with right hemidiaphragmatic paralysis. Of note, several months later repeat PFTs and sniff

test demonstrated some interval improvement in right hemidiaphragmatic paralysis suggesting a reversible process, probably inflammatory and perhaps related to a viral neuritis.

Diaphragmatic paralysis can be further categorized into unilateral or bilateral with these entities each having a somewhat different set of potential etiologies.

Distinguishing between unilateral vs. bilateral paralysis is important. Potential causes of unilateral hemidiaphragmatic paralysis can be separated into trauma/iatrogenic causes (such as following CABG), compression (such as cervical spondylosis or tumor along phrenic nerve), neuropathic (such as in multiple sclerosis) or inflammation (such as in the setting of a viral neuritis) (1). Viral neuritis affecting the phrenic nerve has been reported with COVID-19 (2). Up to 20% of cases of unilateral hemidiaphragmatic paralysis may be considered idiopathic (3).

The diagnostic approach to suspected hemidiaphragmatic paralysis is actually pretty well demonstrated by this case report. CXR, in combination with physical exam, is often good as an initial screening exam.

Diaphragmatic motion can be assessed with sniff testing using fluoroscopy (or ultrasound if there is a desire to limit exposure to ionizing radiation). Evaluation for causes of compression can be done with cross-sectional imaging, particularly CT or MRI. Pulmonary function testing with supine challenge and a sleep study can also provide useful information, as demonstrated by this case.

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### *References*

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