Practical challenges of diagnosing obstruction in the presence of restriction

José Alberto Neder[1,a], Denis E O'Donnell[1,b], Danilo Cortozi Berton[2,c]

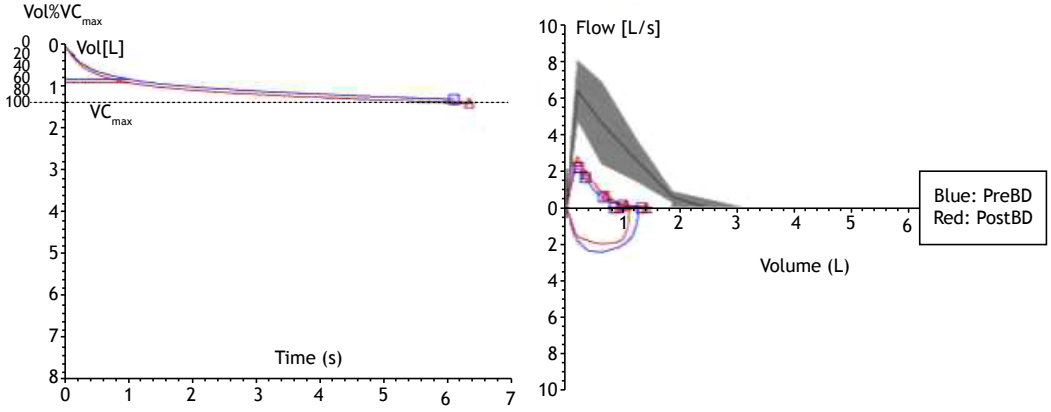
BACKGROUND

In a previous issue of this series,[1] we highlighted that fibrotic/restrictive and airway-centered/obstructive abnormalities may coexist in individual patients, leading to flows and volumes within the "normal" range. If the functional consequences of the former derangements dominate over the latter, recognizing obstruction might be even more challenging.

OVERVIEW

A 77-year-old, obese—body mass index (BMI) = 34.1 kg/m^2—woman with COPD (smoking history, 30 pack-years) was referred by her family physician to the respiratory clinic due to persistent dyspnea (modified Medical Research Council scale score = 3) despite therapy with inhaled long-acting β_2 agonist/inhaled corticosteroid (LABA/ICS). Her medical history included childhood asthma, pulmonary tuberculosis, poorly-controlled systemic hypertension, bioprosthetic aortic valve replacement due to severe stenosis, and atrial fibrillation. Spirometry showed an obstructive ventilatory defect pre- and post-bronchodilator (⇓FEV_1/FVC) with a moderate-to-severe reduction in FVC and FEV_1 (Figure 1A). Body plethysmography revealed associated restriction (⇓TLC) with a high RV/TLC ratio (Figure 1B). At the end of a six-minute walk test (100 m), she presented with severe dyspnea (Borg scale, 8/10) and high RR (32 breaths/min). Chest CT uncovered extensive fibrotic lesions and atelectasis, as well as severe cardiomegaly in association with emphysema (Figure 1C).

A



B

Spirometry		PreBD	LLN	ULN	Z-score	%pred	PostBD	%pred	ΔL	Δ%
FVC	L	1.32	1.85	3.13	-1.83	53	1.41	57	0.09	6.82
FEV_1	L	0.85	1.31	2.53	-1.76	44	0.93	48	0.08	9.40
FEV_1/FVC	%	64.13	69.27	86.27	-1.60	82	65.68	84	1.55	2.42
PEF	L/s	2.21	4.80	8.01	-2.62	34	2.54	40	0.34	15.23
MMEF25-75%	L/s	0.42	1.06	2.66	-1.80	23	0.47	25	0.005	11.07

Plethysmography										
TLC	L	2.96	3.47	5.63	-2.89	65	2.82	62	-0.14	-4.69
RV	L	1.67	1.39	2.94	-1.25	77	1.34	62	-0.32	-19.27
ITGV	L	1.76	1.54	3.66	-1.55	68	1.72	66	-0.04	-1.99
CI	L	1.20	1.09	2.00	-1.48	78	1.10	71	-0.10	-8.64
RV/TLC	%	56.20	35.38	57.38	1.75	121	47.60	103	-8.60	-15.30

Figure 1A and B. In A and B, pulmonary function test results showing a mixed ventilatory defect in a 77-year-old obese female with severe dyspnea despite pharmacological therapy for asthma/COPD. PreBD: pre-bronchodilator; PostBD: post-bronchodilator; LLN: lower limit of normality; ULN: upper limit of normality; pred: predicted; ΔL: difference between PostBD and PreBD in liters; Δ%: difference between PostBD and PreBD in %; MMEF: maximal mid-expiratory flow; ITGV: intrathoracic gas volume (functional residual capacity by plethysmography); and IC: inspiratory capacity.

1. Pulmonary Function Laboratory and Respiratory Investigation Unit, Division of Respirology and Sleep Medicine, Kingston Health Science Center & Queen's University, Kingston (ON) Canada
2. Unidade de Fisiologia Pulmonar, Hospital de Clínicas de Porto Alegre, Universidade Federal do Rio Grande do Sul, Porto Alegre (RS) Brasil.
a. http://orcid.org/0000-0002-8019-281X; b. http://orcid.org/0000-0001-7593-2433; c. http://orcid.org/0000-0002-8393-3126

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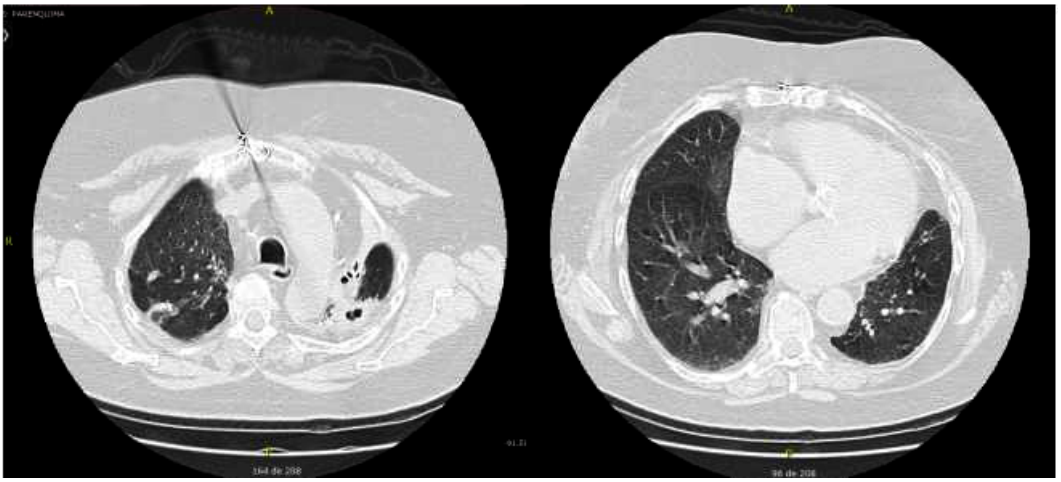

Figure 1C. In C, CT scans of the chest demonstrated centrilobular emphysema coexisting with fibrotic lesions and atelectasis, mainly in the left upper lobe (left scan), and cardiomegaly (right scan).

Low VC in a patient with airflow limitation more commonly reflects a larger increase in VC's "floor" (RV) than in VC's "ceiling" (TLC). In the appropriate clinical scenario, however, this can be ascribed to a coexistent restriction, i.e., a low "ceiling".[2] In the present case, a relatively small difference between FVC% (% of predicted) and FEV_1% (e.g., < 12%),[3] as well as an FVC% < 85% and an FEV_1/FVC ratio ≥ 55%,[4] might have raised the suspicion of associated restriction—which was confirmed by plethysmography. High BMI, chronic scarring, atelectasis, and cardiomegaly[5] might have all contributed to the restrictive defect. Care should be taken, however, that restriction *per se* may increase RV/TLC, because increased lung elastic recoil decreases TLC to a greater extent than it decreases RV. Thus, a high RV/TLC does not necessarily indicate air trapping.[2] A persistently low FEV_1/FVC ratio associated with a 320-mL decrease in post-bronchodilator RV in a heavy smoker provided further clues that, in this case, a high RV/TLC did represent air trapping.

Regardless of the etiology, patients showing a mixed defect are particularly prone to reporting exertional dyspnea: TLC minus functional residual capacity difference—i.e., inspiratory capacity (IC)—represents the limit for tidal volume (V_T) expansion on exertion. The IC of the patient was only 1.20 L (2.96-1.76 L): dyspnea ensues whenever V_T is a too large a fraction of IC (> 0.7).[6] It follows that reaching a V_T as low as ~0.8 L would be enough to elicit severe dyspnea: this explains her severe exercise intolerance and tachypnea despite the treatment with inhaled LABA/ICS..

CLINICAL MESSAGE

A decrease in VC in patients with airflow limitation might reflect air trapping or a mixed ventilatory defect. The latter is confirmed by FEV_1/(F)VC and TLC below the 5th percentile of predicted values.[2] A detailed clinical history and physical examination combined with chest imaging usually point to the underlying mechanism(s).

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