Pitfalls in the interpretation of pulmonary function tests in neuromuscular disease

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

BACKGROUND

Dyspnea is a common complaint of patients with neuromuscular disease (NMD). Accordingly, these patients are frequently referred for lung function assessment. Some of the abnormalities brought by NMD, however, are prone to misinterpretation causing potential negative clinical consequences.

OVERVIEW

The director of a pulmonary function test (PFT) laboratory was questioned by a family physician about the interpretation of a PFT indicating that, despite the absence of airflow limitation, an 81-year-old, never-smoker woman with normal chest CT had "severe air trapping and a trend toward lung hyperinflation and low carbon monoxide transfer coefficient (K_{CO})." Under the assumption that the results indicated airway disease, she was empirically treated with a combination of bronchodilators which had no impact on her exertional dyspnea and fatigability. The patient repeated the test with the addition of a simplified protocol for NMD assessment. Results indicated a borderline decrease in static and dynamic MIPs but severe expiratory muscle weakness (including a low PEF), which was associated with a marked increase in RV and RV/TLC ratio (Figure 1). She was referred to the neurology department, being eventually diagnosed with a motor neuron disease (amyotrophic lateral sclerosis).

Depending on the relative contribution of inspiratory vs. expiratory muscle weakness, abnormalities on lung and/or chest wall compliance, underlying comorbidities (e.g., atelectasis and lung scarring predisposing to restriction vs. airway disease causing obstruction), and body habitus (obesity vs. underweight), the final pattern of dysfunction may vary substantially in NMD.[1] For instance, whereas RV in healthy elderly subjects is mainly determined by the volume at which the small airways close at low lung volumes,[2] RV becomes strongly dependent on the ability of those with expiratory muscle weakness to "squeeze" the airways near the end of expiration.[1,3] If RV—and, to a lesser extent, functional residual capacity (FRC)—increases in a patient with severe expiratory muscle weakness, but only with mildly impaired inspiratory muscle strength (i.e., preserved inspiratory capacity), TLC might be normal or, as seen in our lean patient, slightly increased (Figure 1).[4] In this context, a preserved TLC associated with a high RV/TLC ratio might be easily misinterpreted as indicative of air trapping due to airway disease. Because her diaphragm was only mildly impaired, FVC did not significantly decrease from a seated position to a supine position. Patients with clinically relevant expiratory muscle weakness

Measurement	Values
Spirometry	
FVC seated (%pred)	82
FVC supine (Δ from seated, %)	-6
FEV_1(%pred)	76
FEV_1/FVC	0.77
PEF (%pred)	57
Lung volumes	
TLC (%pred)	115
IC (%pred)	94
FRC (%pred)	118
RV (%pred)	152
RV/TLC	0.55
Gas exchange	
K_{co} (%pred)	83
DLCO (%pred)	74
Respiratory pressures	
MIP (%pred)	77
SNIP (%pred)	82
MEP (%pred)	41

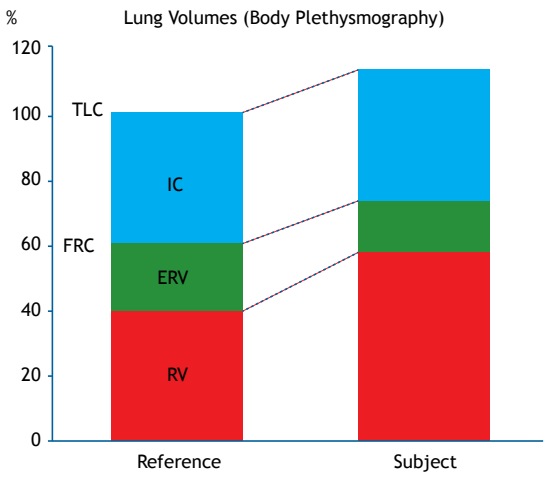

Figure 1. Standard respiratory function tests with measurements of maximal respiratory pressures (plus forced expiration with the patient in seated and supine positions) in an 81-year-old woman (body mass index = 19.6 kg/m²) under investigation for exertional dyspnea. Abnormal test results are marked in red. See text for discussion. %pred: % of the predicted value; IC: inspiratory capacity, FRC: functional residual capacity, K_{CO}: carbon monoxide transfer coefficient, SNIP: sniff nasal inspiratory pressure, ERV: expiratory reserve volume.

1. Pulmonary Function Laboratory and Respiratory Investigation Unit, Division of Respirology, 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.

may present with unequal distribution of ventilation and perfusion[3] which, in addition to microatelectasis, may decrease lung diffusing capacity at a given (low) alveolar volume, reducing K_{CO} (Figure 1).[5]

CLINICAL MESSAGE

The pattern of "extraparenchymal restriction" (low TLC and increased K_{CO}), coupled with low FRC and preserved RV, is commonly seen in patients with isolated inspiratory muscle weakness.[1] Such a pattern, however, might change in the presence of associated/dominant expiratory muscle weakness, leading to increased RV, normal-to-high TLC and FRC, and a trend toward low K_{CO}.[3] The interpretation of lung volumes and K_{CO} should therefore take into consideration the inspiratory and expiratory muscle strength in subjects with unclear "out-of-proportion" dyspnea in whom an NMD is suspected.

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