Dynamic hyperinflation on exertion: much remains unknown

Hiperinsuflação dinâmica no esforço: ainda muito a ser esclarecido

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Dyspnea on exertion is a very common complaint in patients with COPD. Results of pulmonary function testing at rest are often limited in explaining patient complaints and do not always reflect the pathophysiological mechanisms related to exertion. In this context, cardiopulmonary exercise testing can be performed with the prospect of not only confirming and measuring the reduced exercise tolerance but also of characterizing the multiple factors that can potentially contribute to exercise limitation. In COPD, although various mechanisms can act on exercise intolerance, mechanisms such as decreased peripheral strength and cardiovascular dysfunction, airflow limitation with dynamic air trapping has unique significance.[1-4]

The development of dynamic hyperinflation during exercise is highly prevalent in patients with moderate to severe COPD, reaching 80-85%,[1,2] but it also occurs in those with mild disease.[5] Dynamic hyperinflation on exertion is the result of expiratory flow limitation in response to reduced expiratory time, because of an increased ventilatory demand. In patients with expiratory flow limitation even at rest, dynamic hyperinflation, reflected by a change from functional residual capacity (FRC) to TLC, is the only strategy that allows a gain in flow during exhalation and, therefore, an increase in tidal volume (Figure 1A). In addition, the respiratory muscle strength that is generated determines a good response in the increase in volume (rectilinear portion of the pressure-volume curve, Figure 1A). Therefore, when there is a reduced ventilatory demand (i.e., during mild to moderate exertion), this strategy is well tolerated. However, when there is an increased ventilatory demand (i.e., during moderate to intense exertion), the change from FRC to TLC is greater, and inspiratory strength cannot generate a proportional gain in volume (neuromechanical dissociation), since it is in a less compliant portion of the respiratory system (Figure 1B). As a clinical consequence, dyspnea increases steeply, and the patient ceases exertion. In addition to the ventilatory overload, dynamic hyperinflation can cause adverse effects on the inspiratory muscles and cardiovascular system, including the possibility of decreased cardiac output.[1,3]

Most studies evaluating the occurrence of dynamic hyperinflation and its repercussions have involved exercise testing on a cycle ergometer. Functional assessment by this method has some advantages over functional assessment with the use of a treadmill, advantages such as direct determination of the imposed workload, possible occurrence of decreased locomotor variability, and the fact that it is easy to associate other measurements on exertion. However, assessment on a treadmill is more representative of patient activities of daily living, as well as generating greater maximal oxygen consumption, lesser peripheral muscle fatigue, and an increased ventilatory demand.[6]

In the article published in the current issue of the Brazilian Journal of Pulmonology, unlike in the vast majority of studies using a cycle ergometer, Cordoni et al. reported a high prevalence of dynamic hyperinflation in patients with moderate to severe COPD during treadmill walking (63%), a method that is closer to patient activities of daily living.[7] The authors used the dynamic measurement of inspiratory capacity (IC) for determining the operating lung volumes, a technique that is most widely used and is based on the premise that TLC does not change with exertion.[8,9] Although static lung volumes and diffusing capacity of the lung for carbon monoxide were not evaluated, the group of patients who developed dynamic hyperinflation on exertion tended to have a greater degree of obstruction (lower FEV_1).[7] Other studies have shown that the development of dynamic hyperinflation can be identified by simple submaximal exercise tests, such as the six-minute walk test.[10] Another important aspect of the study by Cordoni et al. was the identification of two patterns of dynamic hyperinflation (a stable and a progressive pattern), with repercussions on exercise tolerance, confirming that dynamic hyperinflation is prevalent but not uniform for all patients.[7] In their study, Vogiatzis et al. also defined two patterns of

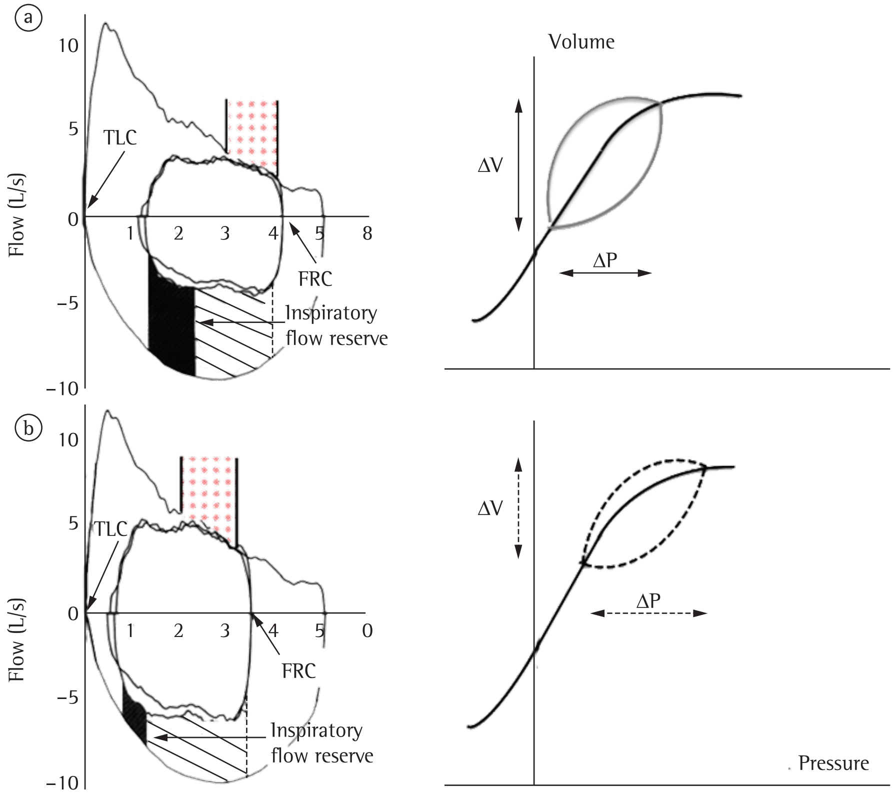

Figure 1 - In condition A, a COPD patient with expiratory flow limitation (area in red), with a reduced ventilatory demand on exertion, and being able to remain in the rectilinear portion of the pressure-volume curve. In condition B, the same patient, but now with an increased ventilatory demand and a greater change from functional residual capacity (FRC) to TLC (dynamic hyperinflation). Note that he no longer remains entirely in the rectilinear portion of the pressure-volume curve and that, despite producing an increased pressure gradient, he obtains a low gain in volume.

dynamic hyperinflation in patients with severe COPD during incremental cardiopulmonary exercise testing on a cycle ergometer: an early and a late pattern, according to the time point at which chest volume began to increase at the end of exhalation.[8] However, dynamic hyperinflation was measured by optoelectronic plethysmography, which shows important methodological differences when compared with the serial measurement of IC, and this does not allow us to conclude that the results are accurately comparable.

Regarding treatment options, the reduction in dynamic hyperinflation during exertion has been associated with a lesser degree of dyspnea, a finding that is confirmed by different interventions, such as the use of short- and long-acting bronchodilators, supplemental oxygen or helium-oxygen mixture, positive-pressure ventilation, and rehabilitation, all of which act to reduce airway resistance or ventilatory demand, or both.[4,11]

Despite the major medical and therapeutic advances resulting from studies on dynamic hyperinflation in COPD, especially in the last two decades, there are still some limitations. The amount of reduction in IC during exertion that defines the presence of dynamic hyperinflation has yet to be established. In addition, it has yet to be established whether the initial IC reference value for comparison should be the predicted value or the patient baseline value. This lack of standard criteria to characterize dynamic hyperinflation results in variability in the prevalence of this pathophysiological event. There are still few studies extensively investigating the behavior of dynamic hyperinflation during field or laboratory walk tests. Recently, even Denis O'Donnell—the author who has investigated dynamic hyperinflation in COPD most thoroughly—has suggested that the behavior of other ventilatory variables, such as inspiratory reserve volume and tidal volume, is more representative of a greater degree of dyspnea than is the occurrence of dynamic hyperinflation alone. In other words, the ventilatory demand to which individuals are subjected and their ability/inability to increase tidal volume have become more and more important. In this aspect, further studies, regardless of the exertion method adopted, will certainly have to consider and possibly correct many of the pathophysiological findings, such as dynamic hyperinflation, for the respective ventilatory demand.[1,12,13]

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