



## Respiratory muscles in COPD: be aware of the diaphragm

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COPD is a limiting respiratory disease associated with high morbidity and mortality.<sup>(1)</sup> COPD is characterized by chronic airflow limitation due to small airway disease and parenchymal destruction.<sup>(1)</sup> Dyspnea and exercise intolerance (EI) are common in patients with COPD and are associated with reduced quality of life and increased mortality.<sup>(2,3)</sup> Dyspnea and EI might result from an imbalance in the load/capacity ratio of the respiratory muscles in COPD patients. Chronic airflow limitation imposes a load on respiratory muscles (as does lung hyperinflation), flattening the diaphragm and reducing its ability to generate tension. In patients with COPD, various other factors can impair respiratory muscle function, including activation of proteases, oxidative stress, malnutrition, ageing, and comorbidity-related systemic factors; however, changes in chest wall geometry and diaphragm position are the most commonly recognized and studied mechanisms contributing to respiratory muscle dysfunction.<sup>(4)</sup>

Diaphragm function has been largely evaluated in COPD patients. It has been demonstrated that inspiratory muscle weakness is related to dyspnea.<sup>(5-7)</sup> In addition to being related to EI and increased dyspnea, respiratory strength has been reported to be related to survival in COPD patients.<sup>(3)</sup> Therefore, it is relevant that respiratory muscles and diaphragm function in particular be assessed in COPD patients.

In an article published in the current issue of the JBP, Gonçalves et al.<sup>(8)</sup> showed that COPD patients with thoracic hyperkyphosis (TH) had lower diaphragmatic mobility when compared with a group of patients with COPD and no TH. Furthermore, the authors showed a negative correlation between diaphragmatic mobility and TH: a greater thoracic kyphosis translates to a lower diaphragmatic mobility. The authors hypothesized that a decrease in diaphragmatic mobility results in changes in the body posture in patients with COPD. However, TH might be a consequence of ageing alone and, in fact, impair diaphragmatic mobility.

Regardless of the real cause of TH (COPD or ageing), few studies have explored the impact of postural changes in patients with COPD, although thoracic alterations are commonly observed in clinical practice. Thus, elderly individuals, in whom COPD is more prevalent, can present with severe TH that can compromise diaphragmatic mobility and ventilatory function, of these patients, as well as contributing to further respiratory impairment in COPD patients.

Taking into account the clinical implications of diaphragmatic mobility, Dos Santos Yamaguti et al.<sup>(9)</sup> noted

that diaphragmatic mobility was lower in COPD patients than in healthy elderly individuals, and that air trapping was related to reduced diaphragmatic mobility. By means of ultrasound study, Paulin et al.<sup>(10)</sup> showed that patients with COPD and low diaphragmatic mobility presented with increased limitation in exercise capacity and increased post-exertional dyspnea during the six-minute walk test. More recently, using chest X-rays, Rocha et al.<sup>(11)</sup> noted that, in patients with COPD, diaphragmatic mobility was related to airway obstruction, lung hyperinflation, ventilatory capacity, and perception of dyspnea, but not to physical activity in daily life.

As demonstrated by Gonçalves et al.,<sup>(8)</sup> diaphragmatic dysfunction might be present in COPD patients with TH; however, as demonstrated in the study by Gonçalves et al.,<sup>(8)</sup> this topic has yet to be fully elucidated. First, there is question of the clinical relevance of the findings, given that no association was found between reduced diaphragmatic mobility and reduced maximal inspiratory pressure. Perhaps there is a decrease in diaphragmatic strength (transdiaphragmatic pressure) rather than in total inspiratory strength (when accessory inspiratory muscles are acting). Second, the fact that lung volumes, symptoms, and exercise capacity were not evaluated limits the clinical implications of lower mobility. Third, diaphragmatic mobility was assessed by chest X-rays. Although this method is noninvasive and easily performed, it involves the use of ionizing radiation, the transportation of the patient to the radiology sector, and patient cooperation in order to perform diaphragmatic breathing measurements. Diaphragm ultrasound (DUS) has been widely used in order to evaluate diaphragm dysfunction because of its advantages (safety, feasibility, repeatability, and reproducibility).<sup>(12,13)</sup> In addition, DUS allows the measurement of thickness and thickening of the diaphragm, a surrogate for contractility.<sup>(14)</sup> Moreover, a recent study has demonstrated that diaphragmatic dysfunction defined by reduced thickening fraction on DUS (< 20%) is related to prognostic implications in acutely exacerbated COPD patients.<sup>(15)</sup> Lastly, the study by Gonçalves et al.<sup>(8)</sup> is a descriptive study, and, therefore, it is impossible to evaluate the cause-and-effect relationship between TH and reduction of diaphragmatic mobility. Table 1 shows the most common variables studied by means of imaging methods for evaluating the diaphragm, as well as their clinical implications in healthy individuals and in patients with respiratory disorders.

Considering the importance and clinical relevance of this topic, although symptoms were not measured in that study,<sup>(8)</sup> it is clear that TH resulted in lower diaphragmatic mobility in COPD patients and, therefore, has a potential to

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**Table 1.** The most common variables studied by means of imaging methods for evaluating the diaphragm and their clinical implications in healthy individuals and in patients with respiratory disorders.

Variable	Clinical implication	Method
Mobility	Lung function	Chest X-rays Diaphragm ultrasound
	Inspiratory muscle strength	
	Dyspnea	
	Exercise capacity	
Thickness	Prediction of weaning from MV	Diaphragm ultrasound CT
	Diagnosis of diaphragmatic dysfunction	
	Assessment of progression of atrophy during MV	
	Inspiratory muscle strength	
Thickening fraction (%)	Diagnosis of diaphragmatic dysfunction	Diaphragm ultrasound
	Assessment of progression of atrophy during MV	
	Assessment of respiratory effort during MV	
	Prediction of weaning from MV	

MV: mechanical ventilation.

impair diaphragmatic strength. Future studies exploring the impact of chest wall alterations on diaphragm

performance and their clinical implications in COPD patients are of high interest.

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