

Original Research

Ultrasound for Assessing Diaphragm and Quadriceps Involvement in COPD Patients

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SUMMARY:

Chronic obstructive pulmonary disease (COPD) is often accompanied by various comorbidities, including structural and functional changes in both respiratory and peripheral muscles. Ultrasound offers a non-invasive method for evaluating muscle impairment, providing valuable insights into disease progression.

The quadriceps contractility index (Qci), assessed via ultrasound, is a quick, simple, and reliable measure of muscle function. Research indicates a strong correlation between Qci and COPD severity, clinical symptoms, and respiratory muscle performance. Additionally, ultrasound allows for the dynamic assessment of diaphragm function by measuring its movement amplitude, contraction speed, and the duration of each contraction phase.

Given its ability to evaluate muscle deterioration, ultrasound presents a promising tool for assessing disease severity in COPD patients.

Keywords: Chronic obstructive pulmonary disease, contractility index (Qci), Ultrasound, Respiratory distress, Smoking.

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INTRODUCTION:

GOLD 2023 defines broncho-pneumopathy obstructive chronic disease (COPD) as a “Heterogeneous lung disease characterized by chronic respiratory symptoms (dyspnea, cough, expectoration and/or exacerbations) due to of the airways (bronchitis, bronchiolitis) and/or alveoli (emphysema) that cause persistent obstruction, often progressive, of the airflow”¹

COPD is a major public health problem with the consequences it brings in terms of morbidity, mortality and disability. Globally, it is estimated that 480 million People had COPD in 2019. and this figure is underestimated. According to the Global Burden of Diseases, established by the World Health Organization, COPD is the third most deadly disease in the world. She was responsible for 3.23 million deaths in 2019 (5.7% of deaths) ^{2,3} According to the BOLD study, 10.1% of people over 40 would have COPD.⁴

The increase in tobacco consumption in developing countries as well as the Population ageing in the countries industrial companies will lead to an increase in the prevalence of COPD in the next 30 years. In 2030, 4.5 million deaths from COPD are expected annually.⁵

The cost of COPD is estimated in terms of health care and productivity loss a 48.4 billion euros per year for the EU countries. In France, direct cost is estimated at annual cost of the disease to 3.5 billion euro.⁶

In Algeria, according to the results of the Breath study, prevalence of COPD is estimated at 4% in the general population and 25% of smokers.⁷

Smoking increases this prevalence which 31.5% among smokers, 14.6% among Ex-smokers and 2.5% for non-smokers.⁸ COPD is associated with much comorbidity, including lung cancer, cardiovascular disease, osteoporosis, and the cachexia and muscle involvement.⁹ Muscular atrophy of skeletal muscles is an important general event of COPD.

This dysfunction has multiple causes, including physical inactivity and systemic inflammation.^{10,11}

Corticosteroid therapy systemic, hypoxemia, hypercapnia, hypersensitivity malnutrition, electrolyte disorders, Heart failure and hypogonadism are also involved.¹² Given the severity of the disease and population, it is estimated that 4 to 35% patients with COPD have a loss of muscle mass.^{13,14}

A recent study found that 32% of patients with COPD had strength of quadriceps below lower limits of

Normal and approximately 25% of patients in the GOLD I and II and 38% of patients at stage GOLD IV were affected by muscle weakness.¹⁵

This muscle weakness has several serious consequences, including intolerance to the decline in quality of the financial year life, and increased mortality.^{16,17,18}

In patients with a significant decrease of the air flow, the section decrease transverse to the middle of the thigh is associated with a 13 times higher relative mortality risk the one observed in patients whose mass muscular is good.¹⁹

The ultrasound evaluation of the quadriceps contractility (Qci) is feasible, fast, simple and reliable. The ICQ is related to severity of COPD, clinical symptoms and activity of the respiratory muscles. His measurement could be a promising new tool for Assess the severity of the disease.²⁰

The diaphragm is the main muscle of inspiration during resting breathing.²¹

It is a striated skeletal respiratory muscle, having a rhythmic activity, permanent, Involuntary, but adjustable by cortical activity. It is a resilient muscle, characterized by high oxidation capacity, a high proportion (60%) of fatigue resistant fibers and a lot of capillaries.²²

Dysfunction of the diaphragmatic muscles plays a significant role in the pathogenesis of respiratory distress in patients with COPD.²³

Traditionally, the weakness of the diaphragm to its shortening caused by hyperinflation, which places the diaphragm in a mechanical disadvantage.²⁴ Type I fibers produce a force is lower than that of Type II fibers, which improves fatigue resistance. However, several more recent studies show that Participation in other phenomena, such as Intrinsic alterations of the diaphragm.^{25,26}

In patients with COPD, it has been found that a transition to a higher proportion of Type I fibers compared to subjects healthy.²⁷

Exogenous oxidative stress caused by exposure Cigarette smoke, biomass and air pollution, oxidative stress endogenous resulting from cell activation inflammatory in the lung and reduction antioxidants leads to an increase in oxidative stress in the lungs. This is a significant factor in pathophysiology of COPD and its evolution, as well as in increased risk of exacerbations acute. Increased oxidative stress in the lungs of patients with COPD leads to a chronic inflammation, a decrease in anti-inflammatory effects of corticosteroids, a rapid aging of the lungs, fibrosis peripheral respiratory tract and a hyperproduction of mucus.²⁸

Oxidative stress plays an important role in the pathophysiology of COPD.^{29,30} Some studies have shown the association between stress oxidative and the

severity of COPD leading to medical comorbidities and dysfunction muscular.³¹

Several tools to evaluate directly or indirectly the diaphragm: Measurement of inspiratory pressure and transdiaphragmatic pressure by stimulation magnetic or electrical phreonic nerve, EMG or imaging. The evaluation does not diaphragm selective or invasive nature and very complex of these tools limit their use.

Two components of diaphragm function are commonly assessed by ultrasound:³²

- Subcostal diaphragm excursion anterior and lateral thoracic (EXdi).

- The thickening fraction of the diaphragm measured at the diaphragm apposition area on the thoracic cage (TFdi).

In pneumology, ultrasound is still little used in diaphragm exploration while it offers many advantages: Is a non-invasive, quick and easy to Can be used especially at the bedside patients with exacerbations COPD, especially with devices portable and ultra-portable.^{33,34} This provides possibility of structural analysis and functional of two hemi-diaphragms distinct.^{35,36}

Thus, thanks to ultrasound, it is possible to observe directly the dynamics of the diaphragm in measuring its amplitude, its contraction rate, the duration of each contraction phase. Being non-irradiant, this examination can be repeated as many times as you want to follow the time-lapse diaphragmatic kinetic.³⁷

Finally, ultrasound is a more cost-effective option compared to other methods used for diaphragm assessment.

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