

What is the Role of Inspiratory Muscle Training in the Treatment of Chronic Obstructive Pulmonary Disease?

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It may seem surprising that training inspiratory muscles—a well-known technique that has been in use for over 30 years—does not have a clearly defined place in the treatment of chronic obstructive pulmonary disease (COPD).¹⁻³ Yet it is not so surprising if we consider that this disease, which currently constitutes an important health problem throughout the world, has for decades had serious problems related to lack of definition and confusion regarding its diagnosis, coupled with a lack of consensus on how it should be managed.^{2,4} Furthermore, COPD has been viewed for many years by professionals with a sense of helplessness regarding its treatment, largely due to the almost exclusive use of forced expiratory volume in the first second for evaluating its progress and response to treatment. We now know that this parameter alone is insufficient and must be complemented with other measurements, such as health-related quality of life, dyspnea, exercise capacity, or degree of hyperinflation.⁵⁻⁷ This has made it difficult to define the role of the different therapeutic tools available for dealing with the disease. For example, until the recent consensus of the American Thoracic Society and the European Respiratory Society in 2004, no algorithm had been proposed for the use of bronchodilators in stable COPD that clearly established their fundamental role as symptom managers and that did not include inhaled corticosteroids, which have a different, though as yet incompletely defined function.⁸ Systemic corticosteroids have been commonly used in the treatment of severe exacerbations of COPD, even though sufficient scientific evidence to support their use has only become available in recent years. It has been possible to prescribe continuous home oxygen therapy

for patients with chronic respiratory insufficiency since the 1980s, following the studies by the Medical Research Council and the Nocturnal Oxygen Therapy Trial, which provided clear evidence-based indications; nevertheless, its usefulness in patients who desaturate during exercise and/or sleep is still unknown.⁹

Acknowledging a role for respiratory rehabilitation in the treatment of COPD has also brought the effects of the problems described into sharper focus. Gaps in the evidence base can also be attributed to the lack of a powerful industry to support necessary research. Nevertheless, the studies, meta-analyses and systematic reviews performed in the 1990s have clearly shown that general muscle training, essentially of the lower extremities but also of the arms, improves dyspnea, exercise tolerance and quality of life in patients with COPD.¹⁰⁻¹² The question of the influence of this muscle training on the course of disease (exacerbations, for example) and on survival also remains to be answered.⁹ Thus—respiratory rehabilitation—by extension of the benefits shown for general muscle training, which is a fundamental component of it—is recognized as an important therapeutic tool in all current clinical protocols and guidelines on the management of COPD.^{2,3,8,13} In contrast, the lack of resources for the practical application of respiratory rehabilitation in Spain is well known.

The difficulties mentioned so far, among others, may partly explain the lack of a defined role for inspiratory muscle training discussed at the beginning of this editorial. Nevertheless, in many respiratory rehabilitation centers in and, especially, outside Spain, training of the inspiratory muscles is included in programs aimed at patients suffering from COPD. To get a better idea of what is really known about this technique, we will attempt to answer 3 key questions: Are there theoretical reasons for expecting any benefit from improved function of the inspiratory muscles in COPD? Can training improve the function of the inspiratory muscles in patients with COPD? Does improved inspiratory muscle function produce a clinical benefit for these patients?

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Relevant to the first question is the well-known negative effect of the characteristic hyperinflation associated with COPD on the strength and stamina of the inspiratory muscles. The essential mechanisms are shortening of the muscle fibers, giving them a disadvantageous length-tension relationship and an increase in the radius of curvature with a reduction of the zone of apposition of diaphragm to rib cage—changes that reduce the ability of the diaphragm to generate force.¹⁴ COPD patients are also known to present skeletal muscle dysfunction along with airflow obstruction. This dysfunction is caused by the interaction of different local and systemic factors and affects different muscle groups in different ways.^{15,16} However, adaptive changes, such as myofibrillar shortening and increased aerobic capacity, have been described in the diaphragms of patients with COPD and such changes would explain the ability of these patients to generate equivalent or higher tension than healthy individuals with the same lung volume, although there is disagreement regarding this last point.^{17,18} These compensatory mechanisms are, however, insufficient, such that early fatigue of the inspiratory muscles plays a part in limiting the exercise capacity of patients with COPD and the reduction in maximal inspiratory pressure (PI_{max}) contributes to heightening the sensation of breathing discomfort.^{14,19} It is therefore logical to think that a therapy which can improve the strength and/or stamina of the inspiratory muscles would benefit patients suffering from COPD.

As to whether the inspiratory muscles of patients with COPD can respond to training, Smith et al²⁰ concluded in their 1992 meta-analysis that inspiratory training did not show a significant effect on any of the variables analyzed—not even on the strength or stamina of the inspiratory muscles. They attributed this to inadequate control of the loads used in 12 of the 17 trials included in the meta-analysis. The use of a valve to create a resistive load with no control of the breathing pattern and/or pressure did allow the patients to develop a more comfortable, slow, deep breathing pattern and so the desired pressure was not attained. It is currently clear that a specific inspiratory training protocol of sufficient duration and with adequate work loads ($>20\%$ of PI_{max}) leads to improvements in the strength and stamina of these muscles.²¹ Ramírez-Sarmiento et al²² have shown in a randomized controlled trial enrolling patients with severe COPD that a specific inspiratory training program increases inspiratory strength and stamina and produces structural changes to the external intercostal muscles (a 38% increase in the percentage of type I fibers and a 21% increase in the size of type II fibers). The inspiratory muscles therefore present functional changes with a structural basis when they are trained appropriately.

Recently, Lötters et al²³ performed a meta-analysis to evaluate the clinical repercussions of improved inspiratory muscle function in patients with COPD. The authors included 15 studies (a total of 200 treated

subjects and 183 controls with a forced expiratory volume in the first second that was 43% (SD, 15%) of reference) where the training load was at least 30% of PI_{max} . The overall analysis showed a positive effect of inspiratory muscle training on PI_{max} , inspiratory muscle stamina, and dyspnea during exercise and activities of daily living. The authors also performed a subanalysis in which they compared general training, either in isolation or associated with training of the inspiratory muscles. In this subanalysis, they observed that the combined training was significantly better at improving the strength and stamina of the inspiratory muscles and that in individuals whose PI_{max} was less than 60 cm H₂O there was a tendency for the distance covered in the walk test to increase. That the increase was not statistically significant the authors attributed to the variability and scarcity of data and to patient selection as, in some cases, ventilation was not the limiting factor of the patient's exercise capacity. Thus inspiratory muscle training can reduce dyspnea in patients with COPD and it seems that it may provide additional benefits when added to general training in patients with greater functional deterioration of the inspiratory muscles. As yet, there have been no studies carried out which are methodologically sound and which ensure that a sufficient load is used to compare general muscle training to training of the inspiratory muscles. In this issue of ARCHIVOS DE BRONCONEUMOLOGÍA, Serón et al²⁴ describe results in agreement with those mentioned above following a specific inspiratory training program in a sample of patients with COPD. They observe a statistically significant and clinically relevant improvement in health-related quality of life, measured using the Chronic Respiratory Questionnaire, and showed that it is the domain of dyspnea that improves the most. Of note, however, is the fact that the control group, which trained with the minimal load allowed by the threshold loading device used, showed a comparable improvement in all of the variables studied, including PI_{max} . It would seem that this low pressure, applied at intervals, was a sufficiently intense stimulus to induce training-related changes. This is partly explained by the fact that, for some patients, the load was in excess of 20% of PI_{max} .

We can therefore answer all 3 questions about inspiratory muscle training in COPD affirmatively: There is a theoretical base that justifies the use of such training. The inspiratory muscles retain the ability to respond structurally and functionally to training. The response to training is associated with reduction in dyspnea—one of the main goals in the management of COPD. The next question that should be asked is whether, and in which cases, specific inspiratory training can be considered a valid alternative or useful complement to general training in respiratory rehabilitation programs. Meanwhile, until studies addressing this question are performed, inspiratory muscle training could be of benefit to patients with COPD who present dyspnea despite receiving optimal treatment and who show significant deterioration in the strength and/or stamina of their inspiratory muscles.

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