SEVEN publicações acadêmicas
EM PARCERIA COM: IEMS UNIASSELVI

Respiratory muscle training in an asthmatic patient: A case study

Renata Silva de Toledo[1], Luís Henrique Sales Oliveira[2], Pâmela Camila Pereira[3].

ABSTRACT

Asthma is a chronic inflammatory condition of the airways, characterized by hyperresponsiveness and variable obstruction to airflow. It often begins in childhood and can be triggered by various external factors such as allergens and pollutants. Inflammation involves mediators such as eosinophils, mast cells and cytokines, resulting in airway damage and tissue remodeling. During asthma attacks, bronchial obstruction occurs with pulmonary hyperinflation and changes in ventilatory mechanics. Treatment includes approaches such as Respiratory Muscle Training (RMT), which improves lung function and quality of life by focusing on muscle strengthening and reducing dyspnea.

Keywords: Asthma, Inflammation, Physiotherapy treatment.

INTRODUCTION

The term asthma encompasses the symptoms and the numerous changes that occur with the airways, however, according to the III Brazilian Consensus on the Management of Asthma (2002), it is defined as a chronic inflammatory disease caused by hyperresponsiveness of the lower airways and variable airflow limitation, and may be reversible spontaneously or with treatment. Although the onset of the disease can occur at any age, it is more frequent early in life, being considered the most common chronic disease in childhood (PEREIRA et al., 2021).

Asthma is mainly triggered by inflammation of the bronchi, a complex process involving several changes between inflammatory cells, mediators, and structural cells of the airways. Such inflammation is observed in patients with different degrees of the disease, from those with newly diagnosed asthma to those with milder or even asymptomatic forms. Characteristics of the inflammatory response include the presence of eosinophils, mast cell degranulation, some interstitial damage to the airway walls, and the activation of Th2 lymphocytes, which produce several cytokines, such as the interleukins IL-4, IL-5, and IL-13. Especially IL-4 plays an important role by increasing the production of Immunoglobulin E (igE) and the expression of high and low affinity receptors for IgE in various inflammatory cells (LAMBRECHT; HAMMAD; FAHY, 2019).

The causes that trigger asthma in general are external agents such as: flaking of domestic animals, infections, exercise or exertion, occupational stress, contact with allergens present in the air (dust mites,

---

[1] Student of the Physiotherapy Course at Centro Universitário de Itajubá – FEPI
[2] Professor of the Physical Therapy Course at Centro Universitário de Itajubá – FEPI
[3] Professor of the Physical Therapy course at Centro Universitário de Itajubá – FEPI

pollen, fungi), some food products, emotional and pharmacological factors and air pollution. Studies have found that obesity can increase the propensity and development of asthma, due to its impact on airway inflammation and respiratory mechanics (PEREIRA et al., 2021).

Bronchial mast cells release several inflammatory mediators, such as histamine, leukotrienes, tryptase, and prostaglandins. Similarly, macrophages release Tumor Necrosis Factor (TNFα), IL-6, nitric oxide, among others. T lymphocytes contribute to the release of IL-2, IL-3, IL-4, IL-5, granulocyte colony growth factor alpha (GM-CSF), while eosinophils release Major Basic Protein (MBP), Eosinophilic Cationic Protein (ECP), Eosinophilic Peroxidase (EPO), as well as lipid mediators and cytokines. Neutrophils contribute to the release of elastase, while epithelial cells release endothelin-1, lipid mediators, and nitric oxide. These mediators cause lesions and changes in the integrity of epithelial tissue, affect autonomic neural control (such as substance P and neurokinin A), influence airway tone, modify vascular permeability, induce mucus hypersecretion, affect mucociliary function, and increase airway smooth muscle reactivity. (LAMBRECHT; HAMMAD; FAHY, 2019).

Such mediators have the ability to affect the ciliated epithelium, resulting in damage and rupture. This triggers a process in which epithelial cells and myofibroblasts, located below the epithelium, begin to proliferate and deposit collagen in the interstitial space of the reticular lamina of the basement membrane. This phenomenon contributes to the apparent increase in basement membrane thickness and to the irreversible lesions that can occur in certain patients with asthma. In addition, other changes, such as smooth muscle hypertrophy and hyperplasia, an increase in the number of goblet cells, an increase in submucosal glands, and changes in the deposition and degradation of extracellular matrix components, are part of the remodeling process that affects the physiology of the airway. These changes may contribute to the irreversible obstruction observed in some patients (LAMBRECHT; HAMMAD; FAHY, 2019).

Airflow obstruction in asthma patients induces progressive air trapping in the alveolar units. The pulmonary hyperinflation generated compromises the respiratory muscles, resulting in increased work of breathing and greater energy expenditure to overcome the impedance imposed by the airways (CORDEIRO et al., 2020).

During asthma attacks, spasm, edema, and hypersecretion are the factors responsible for bronchial obstruction that impairs both phases of breathing. While inspiration becomes rapid and shallow, exhalation is long and ineffective, leading to pulmonary hyperinflation. There will be a change in ventilatory mechanics with lowering of the diaphragmatic domes, reduction of their path during respiratory movements, impairing basal ventilation (PEREIRA et al., 2021).

The rib cage adopts an attitude in inspiration, with decreased costal mobility with activation of the accessory muscles of respiration (trapezius, pectorals and sternocleidomastoids), characterizing upper thoracic breathing, generating a large energy consumption (PEREIRA et al., 2021). In addition to mechanical drawbacks, long-term corticosteroid use, even at low doses, may contribute to increased respiratory muscle weakness. Among its adverse effects, the reduction of protein synthesis and the increase in its degeneration contribute to the installation of muscle atrophy. This condition of respiratory muscle deficiency contributes to a higher risk of muscle fatigue, ineffective expectoration, and exercise intolerance due to the presence of dyspnea in the practice of various physical activities (CORDEIRO, et al., 2020).

Taking into account that asthma is a public health problem and has been affecting more and more people worldwide, it is important to emphasize the relevance of physical therapy treatment based on the assumption that respiratory strengthening is capable of strengthening the diaphragm, along with the dorsal and thoracic muscles (PEREIRA et al., 2021).

The quantification of muscle strength in asthmatic patients is of fundamental importance in order to allow an evaluation and direct the most appropriate treatment. Respiratory Muscle Training (RMT) represents a very effective alternative in the physical therapy treatment of asthmatic patients, promoting an increase in Forced Vital Capacity (FVC), increases in ventilatory muscle strength, increased tolerance to exertion, improvement in functional capacity, decreased perception of dyspnea and fatigue, as well as improved quality of life. (SOUZA, 2023).

OBJECTIVE

To verify the effects of RMT in an asthmatic patient.

METHODOLOGY

TYPE OF STUDY

This is an interventional and case study, carried out at the School of Physical Therapy Clinic of the University Center of Itajubá - FEPI, located at Avenida Cesário Alvim, 632, Centro.

SAMPLE

This is a 30-year-old female patient, single, 58 kg, 1.50 m tall, with a BMI of 23.8, with a medical diagnosis of asthma with ICD 10-J45. The volunteer was instructed on the study procedure and duly alerted to all the conditions.

METHODOLOGICAL PROCEDURE

A survey of scientific data was carried out with the keywords according to the DeCS: *Asthma*, *Lung*, *Inspiratory Muscle Training*, *Maximal Respiratory Pressure* and *Physical Therapy Modality* in Portuguese and English, in the following databases: *Lilacs*, *Scielo*, *Pubmed* and *Bireme*, 13 articles were included and 7 articles that did not correspond to the following theme were excluded for scientific basis and applicability of the research. The study was approved by the Research Ethics Committee of the Fundação de Ensino e Pesquisa de Itajubá – FEPI, under opinion 6.280.211/2023, located at Rua Doutor Antônio Braga Filho, 687 - Bairro Varginha, Itajubá – MG.

EVALUATION PROTOCOL

After acceptance, the volunteer signed the Free and Informed Consent Form (ICF). Subsequently, an Evaluation Form was carried out, consisting of data collection, evaluation of respiratory muscle strength, and the patient was sent to start the respiratory strengthening protocol.

Respiratory muscle strength was assessed using a Medical® Trademark manometer (Figure 1). For Maximal Inspiratory Pressure (PiMax) it is used to measure inspiratory force in order to possibly detect ventilatory weakness. The patient is seated, with the trunk erect at 90°, and a nose clip may or may not be used, but it is suggested to avoid air escape. Ask the patient to exhale maximally up to the Residual Volume (RV), then take a maximal inhalation and maintain this effort for 1 to 2 seconds.

To measure the Maximal Expiratory Pressure (PeMax), the manometer will also be used, the patient will be seated with the nose clip, a maximal inspiration is performed up to the Total Lung Capacity (TLC), followed by a maximal expiratory effort of 1 to 2 seconds. The maneuver must be performed at least 3 times, the value considered is the highest achieved. As shown in figure 1.

Figure 1 - Medical Commercial Brand Manometer ®

Source**:** Personal Archive.

RESPIRATORY MUSCLE TRAINING (TMR) PROTOCOL

To perform the Rehabilitation Protocol (Chart 1), vital signs were measured at rest and during exertion: Blood Pressure (BP), Heart Rate (HR), Peripheral O2 Saturation (SpO2). The consultations were carried out 2 times a week during 12 consultations, lasting approximately 40 minutes.

Table 1 – TMR Protocol

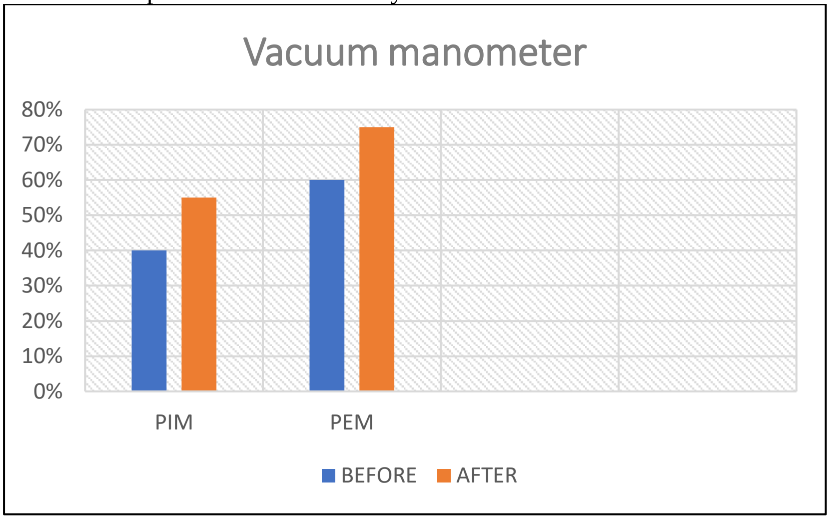
	INSPIRATORY MUSCLE STRENGTHENING	EXPIRATORY MUSCLE STRENGTHENING
Device	*PowerBreathe® Plus Medic* of the brand NCS®	*Theshold PEP* of the brand *Respironics®*
Load	40% of MIP	40% of Pemax
Series	3 series	3 series
Repetitions	20 reps / 1 minute interval between sets.	20 reps / 1 minute interval between sets.

Source: The author.

RESULTS AND DISCUSSION

After the training performed with the *PowerBreathe*® and *Threshold PEP*®, it was possible to observe a significant improvement in the manovacuometry values, with an improvement in MIP and MEP, as shown in Graph 1.

Graph 1 - Manovacuometry values before and after RMT.



The assessment of respiratory muscle strength is a non-invasive, simple, low-cost test that is useful in clinical practice. To measure respiratory muscle strength, the measurement of maximal respiratory pressures is used: MIP and MEP. Maximal inspiratory pressure (MIP) reflects the strength of the inspiratory muscles and diaphragm; while maximal expiratory pressure (MEP) reflects the strength of the abdominal and expiratory muscles. In the present study, an initial MIP of 40% and a MEP of 60% were observed. After IMT with *the PowerBreathe*® and *Threshold PEP*® devices, it was possible to verify a significant increase in MIP by 37.5% and MEP by 28.3%.

Lage et al (2021) analyzed the duration of the inspiratory muscle endurance test using an electronic flow resistive load device (*PowerBreathe KH2*®), obtaining significantly higher values in the Inspiratory Muscle Training (IMT) group compared to the Control Group (CG). In the present study, it was evidenced that asthma has negative effects on ventilatory mechanics in adult patients, causing a reduction in inspiratory muscle resistance, justifying the analysis of this measure.

In the study by David et al (2018), IMT was performed with the *Threshold* IMT® device (*Philips Respironics*) every 25 to 30 minutes, using a load of 30% to 40% of maximal inspiratory pressure, in asthmatic children. At the end of the physical therapy treatment, it was possible to observe an increase in the values of MIP and MEP in these patients. This corroborates the present study, showing the effectiveness of the *Threshold* IMT® device in patients of different ages.

Duruturk; Acar and Dogyrul (2018) conducted a study with 38 patients, aged between 18 and 65 years. Randomly divided into two groups, TMI (n=20) and CG (n=18), participants in the TMI group performed 30 breaths using the *PowerBreathe*® device 2 times a day for 6 weeks at 50% of MIP, in addition to respiratory kinesiotherapy during this period. In the CG, only respiratory kinesiotherapy was performed, without the use of IMT devices. Among the results obtained, it was possible to observe changes in the IMT group in variables, including MIP and distance walked in the 6-minute Walk Test (6MWT) in relation to the CG. In addition, in view of the present study, if respiratory kinesiotherapy was performed together with IMT, the effect would be enhanced.

In a systematic review conducted by Silva et al. (2018) on IMT in adults with asthma, 5 randomized clinical trials with varied intervention protocols were included, since a load of 40% to 60% of MIP was used, which is a higher burden than that presented in our study, thus showing the benefit of using the *Threshold* IMT® device with different interventions.

In the study conducted by Chung et al. (2021) compared the effects of conventional breathing exercises and an IMT intervention in asthma patients. 60 patients with asthma (40-65 years of age) were randomly assigned to the conventional breathing exercise or IMT group for a 12-week intervention period. Outcome measurements were performed before and after the intervention, including spirometry, MIP and MEP data, asthma control test, asthma control questionnaire, 6MWT, and 3-day physical activity record. At the end of the study, it was possible to confirm an increase in MIP of 29.84%. This corroborates the present study, demonstrating that IMT can act as an alternative to conventional breathing exercises for middle-aged and elderly asthmatic patients.

The results indicate that RMT may be an effective intervention to improve lung function, quality of life, and asthma control in asthmatic patients. TMR targeting asthma can strengthen these muscles, contributing to more efficient breathing and reduced asthmatic symptoms. However, it was possible to observe that IMT is effective for children, adults and the elderly, and if associated with cardiopulmonary training, respiratory kinesiotherapy and even higher loads, the effect is potentiated, improving cardiopulmonary function, inspiratory and expiratory muscle strength and increasing tolerance to physical exercise. Further studies with longer intervention time are still needed for better quantification of results.

CONCLUSION

RMT can be an effective intervention to improve lung function and mechanics, as well as asthma control. The TMR, in addition to promoting the strengthening of the respiratory muscles, contributes to more efficient breathing, reducing symptoms and improving functional capacity as well as quality of life of these patients.

REFERENCES

III Consenso Brasileiro do Manejo da Asma. (2002). Definição, epidemiologia, patologia e patogenia. J Pneumol, 1(3), 1-46.

Cordeiro, J. A., Silva, C. P., Britto, M. C. A., et al. (2020). Avaliação estática e dinâmica da força muscular respiratória de crianças e adolescentes asmáticos. Rev. Bras. Saude Mater. Infant., 20(4), 1009-1016.

Chung, Y., Huang, T., Liao, Y., et al. (2021). O treinamento muscular inspiratório de 12 semanas na força muscular respiratória em pacientes adultos com asma estável: Estudo randomizado. Int J Environ Res Saúde Pública, 18(6), 3267.

David, M. M. C., Gomes, E. L. F. D., Mello, M. C., et al. (2018). Ventilação não invasiva e fisioterapia respiratória reduzem broncoespasmo induzido por exercício e inflamação pulmonar em crianças com asma: Ensaio clínico randomizado. Ther Adv Respir Dis, 10(6), 138-148.

Duruturk, N., Acar, M., Dogyurul, M. (2018). Effect of inspiratory muscle training in the management of patients with asthma: A randomized controlled trial. J Cardiopulm Rehabil Prev, 38(3), 198-203.

Lambrecht, B. N., Hammad, H., Fahy, J. V. (2019). The cytokines of asthma. Immunity Review, 50(4), 975-991.

Lage, S., Pereira, D., Nepomuceno, A., et al. (2021). Eficácia do treinamento muscular inspiratório na função muscular inspiratória, capacidade funcional e qualidade de vida em pacientes com asma: Um ensaio clínico randomizado. Clínica Reabilitação, 35(6), 8870-881.

Lodi, J. L. (2022). Efeitos do treinamento muscular inspiratório em pacientes portadores de asma: Uma revisão sistemática. Repositório Universitário de Ânima, 1(4), 114-129.

Pereira, A., Souza, A. C., Almeida, N. L. R., et al. (2021). Treinamento muscular respiratório no tratamento da asma brônquica. Revista Multidisciplinar do Nordeste Mineiro, 3(2), 1-20.

Santos, F. L., Senn, G., Castagnoli, L. M., et al. (2023). A intervenção do exercício no público infanto juvenil asmático. Revista Científica FAEMA, 14(1), 98-111.

Silva, I. S., Fregonezi, G. A. F., Dias, F. A. L. (2018). Treinamento muscular inspiratório para asma. Cochrane Database Syst Rev, 12(4), 130-138.

Souza, C., Almerinda, F., Santos, B., et al. (2019). Resistência muscular inspiratória em adultos com asma: Uma revisão sistemática. Ciências e Saúde, 12(2), 1-8.