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Breathing training on lower esophageal sphincter as a complementary treatment of gastroesophageal reflux disease (GERD): a systematic review

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Abstract. – OBJECTIVE: Gastroesophageal reflux disease (GERD) represents one of the most common gastrointestinal disorders, but is still a challenge to cure. Proton pump inhibitors (PPIs) are currently the GERD's standard treatment, although not successful in all patients; some concerns have been raised regarding their long term consumption. Recently, some studies showed the benefits of inspiratory muscle training in increasing the lower esophageal sphincter pressure in patients affected by GERD, thereby reducing their symptoms.

MATERIALS AND METHODS: Relevant published studies were searched in Pubmed, Google Scholar, Ovid or Medical Subject Headings using the following keywords: "GERD" and physiotherapy", "GERD" and "exercise", "GERD" and "breathing", "GERD and "training".

RESULTS: At the end of our selection process, four publications have been included for systematic review. All of them were prospective controlled studies, mainly based on the training of the diaphragm muscle. GERD symptoms, pH-manometry values and PPIs usage were assessed.

CONCLUSIONS: Among the non-surgical, non-pharmacological treatment modalities, the breathing training on diaphragm could play an important role in selected patients to manage the symptoms of GERD.

Key Words
Gastroesophageal reflux disease, Breathing training, Systematic review.

Introduction

Gastroesophageal reflux disease (GERD) is "a condition which develops when the reflux of stomach contents causes troublesome symptoms (i.e., at least two heartburn episodes per week) and/or complications"[1].

It accounts for one of the most common gastrointestinal disorder, though still representing a challenge to treat. A variable percentage ranging from 14 to 20% of adults in the USA have been reported to be affected, although those prevalence data are based on self-reported chronic heartburn symptoms[2].

GERD occurs along with an inappropriate relaxation of the lower esophageal sphincter (LES), that causes the gastric acid to enter the distal esophagus, thereby stimulating the chemoreceptors, causing irritation and leading to the onset of symptoms. Both esophageal (heartburn) and extraesophageal symptoms (including oral, pharyngeal, laryngeal, and pulmonary disorders) of GERD are triggered by mucosal injury and are directly related to the frequency of reflux events, the duration of mucosal acidification, and the caustic potency of the refluxate[3,4].

Frequently, GERD patients present to otolaryngologists with symptoms such as dry or sore throat, globus sensation, hoarseness, chronic cough, dysphagia, or buccal burning. However, the clinical examination cannot always reveal striking and/or suggestive pathological findings, and, as a direct consequence of this, the underlying disease is not often primarily diagnosed. Frequently, the misdiagnosed patients are commonly treated for (non-allergic) rhinitis with post-nasal drip, non-specific rhinopharyngitis, or recurrent sinusitis[4].

Reflux is physiologically prevented by specific esophageal anti-reflux barriers, including the LES and the angle of His.

The LES is a bundle of tonically contracted circular smooth muscle fibers at the distal part of the esophagus. It is 2-4 cm in length and is

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surrounded by the diaphragm hiatus. In resting conditions, it generates a positive pressure higher than the intra-abdominal pressure, preventing the reflux of gastric contents into the esophagus and consequently symptomatic heartburn.

The thoracic diaphragm consists of a costal and a crural part, inserted to the ribs and the vertebral column respectively.

The right and left crura tie the esophagus up creating a canal where the esophagus enters the abdomen. The outer fibers of the canal are oriented in a cranial-to-caudal direction, whereas the inner fibers are oriented obliquely. The crural diaphragm exercises a pinchcock-like action on the lower esophageal sphincter during contractions, thus exerting an extrinsic sphincter effect. The phrenoesophageal ligament links anatomically the crural muscles and the LES supplying for an additional mechanism to prevent reflux of stomach contents into the esophagus.

Both the lower esophageal sphincter and the crural diaphragm contribute to the esophagogastric junction (GEJ) pressure[5].

The LES tone can be affected by drugs[6] and different kind of food, through an effect on its resting pressure eventually inducing reflux. Other contributing factors that increase intra-abdominal pressure and overcome the antireflux barrier include the Valsalva maneuver, weight lifting, the Trendelenburg position, pregnancy or obesity[7].

When lifestyle modification fails to improve GERD symptoms, the next step for the treatment of GERD is mainly medical and surgical in very selected cases[8].

Proton pump inhibitors (PPIs) currently represent the pharmacological standard treatment of GERD; however, some concerns have been raised regarding the long-term intake of PPI. Specifically, chronic consumption of PPI have been linked to an increased risk of hip fractures, community acquired pneumonia, gastrinoma, diarrhea and drug interactions, especially in patients treated with clopidogrel[9].

Moreover, the withdrawal of PPIs is known to be difficult as showed by Jensen et al[10]. The surgical outcomes may be affected by considerable side effects and endoscopic methods have largely failed to treat GERD[11]. Furthermore, PPI treatment fails to normalize esophageal acid exposure in a considerable percentage of adults who experiences reflux, particularly those with severe or complicated GERD, who tend to continue experiencing symptoms despite PPI treatment[12].

Nonetheless, there is an increasing interest on how complementary therapy can increase GERD patients' quality of life[13], and reduce the PPIs intake. Among the non-surgical and non-pharmacological therapies[7], physiotherapy of antireflux-complex has been recently proposed as a potential therapy for GERD. Similarly to any other striated muscle of the body, the crura of the diaphragm are prone to improve performance by physical exercise.

The aim of our work is to systematically review the published literature regarding all the potential therapeutic effects of breathing exercises on GERD symptoms.

Materials and Methods

Search and study selection

We performed a throughout search for appropriate published studies in Pubmed, Google Scholar, Ovid, using either the following keywords or, in case of Pubmed database, Medical Subject Headings: ("Gastroesophageal reflux disease" AND physiotherapy"), ("Gastroesophageal reflux disease" AND "exercise"), ("Gastroesophageal reflux disease" AND "breathing"), ("Gastroesophageal reflux disease AND "training") with no limit for the year of publication (Figure 1).

Only studies in English, published in peer-reviewed journals, reporting data about the use of breathing exercises were included. No studies related to bariatric therapy, cystic fibrosis, COPD, exercise and physiotherapy considered as general physical activity have been considered.

Literature reviews, technical notes, case reports, letters to editors, and instructional courses were excluded.

Two authors (CM and SL) independently assessed the full-text version of each publication, by selecting that on the basis of its content and excluding papers without the specific content. Reference lists of each selected article were analyzed to find more relevant studies.

Results

Four studies investigating the role of breathing exercises for the treatment of GERD has been reported in this review. The features of the studies are shown in Table I.

Nobre e Souza et al[14] concentrated on motor function, autonomic function and GERD symp-

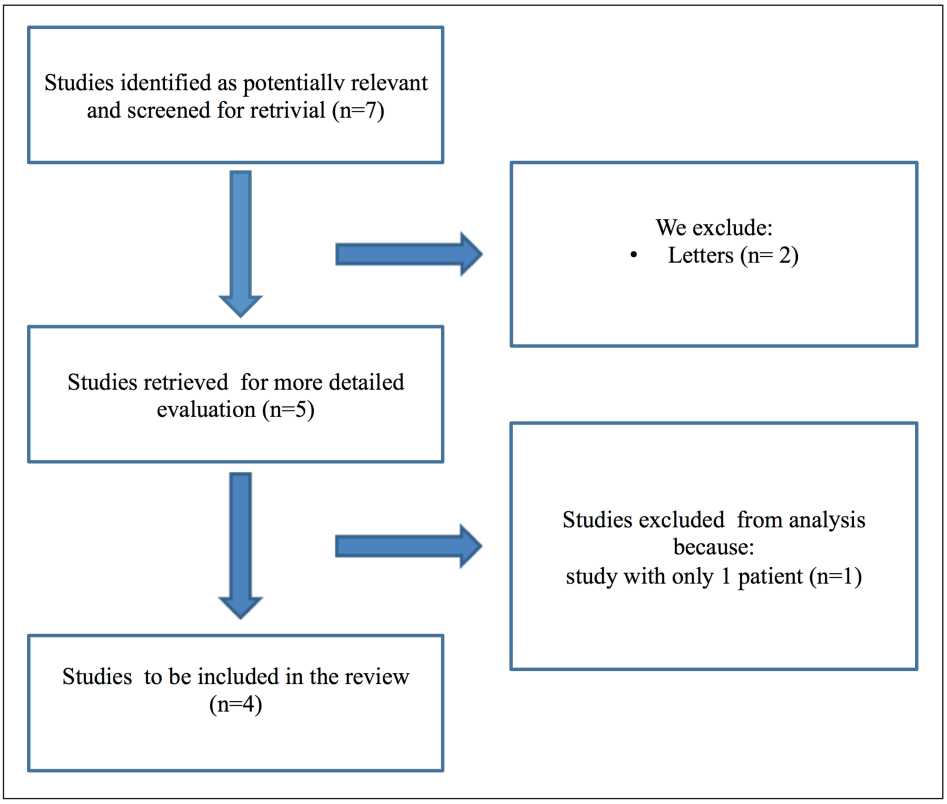

Figure 1. Flow chart of the articles research for a systematic review.

toms improvement in patients undergoing inspiratory muscle training (IMT). Patients underwent an IMT program under progressive inspiratory resistance, managed by a physical therapist, for 5 days a week for 2 months. Each IMT session consisted of 10 series of 15 inspirations (about 30 minutes). This training resulted in a significantly decrease of heartburn and regurgitation symptoms after IMT, with a concomitant improved average EGJ pressure and reduced progression of reflux in the upper part of the esophagus, evaluated by esophageal pH monitoring.

Carvalho de Miranda Chaves et al[15] used a training program consisted of 40 maximum inspirations form the residual volume, twice a day (morning and evening), 7 days a week over a period of eight weeks. They showed that constant or progressive inspiratory muscle training in GERD patients causes a statistically significant increasing of LES pressure in patients with hypotensive LES, although they did not evaluate GERD correlated symptoms, as underlined by Iovino and Ciacci[16].

Eherer et al[17] used a modified set of exercise typically used by professional singers, that aim to involve diaphragm in respiration, changing the respiration from thoracic to abdominal. It was divided into 5 exercises: first and second focused on supine abdominal breathing, moving the abdominal wall, eventually against resistance, while relaxing thorax and lower intercostal muscles, third, fourth and fifth focused on seated and standing inspiratory training with slow expirations, eventually following abdominal movements with arms elevations and vocalizing. After a month, there was a statistically significant decrease of acid exposure, an increase of Quality of life (QoL) (measured by GERD Health-Related Quality of Life Scale) in physiotherapy group, while the on-demand use of PPIs showed no statistical difference after 1 month. After an 8 months follow-up, there was a significant increase of QoL and a decrease of the need of on demand-PPI.

Da Silva et al[18] performed a randomized, blind study, dividing the patients in two groups: a group of 22 patients who really underwent osteopathic treatment, and a second group of 16 patient who undergo to a placebo technique. The treatment consisted of two steps: first step – four deep respirations, in which the inspiration and expiration movements are exacerbated by the investigator through manual contact on the lower rim of the last ribs; second step – four deep respi-

Table I. Features of the selected studies.

Title	Authors	Study design	Patients	Therapy	Parameters	Result
Inspiratory muscle training improves antireflux barrier in GERD patients.	Nobre e Souza MÂ1, Lima MJ, Martins GB, Nobre RA, Souza MH, de Oliveira RB, dos Santos AA.	Prospective study	20 patients, 7 controls	Inspiratory muscle training	EGJ manometry, assessment if tLESR, esophageal pH monitoring, heart rate variability	tLESR reduced, GERD syntoms reduced
Respiratory physiotherapy can increase lower esophageal sphincter pressure in GERD patients.	de Miranda Chaves R, Suesada M, Polisel F, de Sá CC, Navarro-Rodriguez T.	Prospective study	20 patients, 9 controls	Inspiratory muscle training	Esophageal manometry, mid respiratory pressure, end expiratory pressure before and after therapy	Increase of LES pressure by MRP in 75% of patients, increase of EEP in 60% of patients.
Positive effect of abdominal breathing exercise on gastro-esophageal reflux disease: a randomized, controlled study.	Eherer AJ, Netolitzky F, Högenauer C, Puschnig G, Hinterleitner TA, Scheidl S, Kraxner W, Krejs GJ, Hoffmann KM.	Prospective randomized controlled study	20 patients with GERD, randomized in 10 training group and 9 control group	Diaphragmatic contraction respiration	GERD Health-Related Quality of Life Scale, GIQLI	Significant decrease in acid exposure in patients, QoL scores improved significantly after 1 month. After 9 months still on training PPI usage significantly decreased
Increase of lower esophageal sphincter pressure after osteopathic intervention on the diaphragm in patients with gastroesophageal reflux.	da Silva RC, de Sá CC, Pascual-Vaca ÁO, de Souza Fontes LH, Herbella Fernandes FA, Dib RA, Blanco CR, Queiroz RA, Navarro-Rodriguez T.	Prospective randomized study	38 patients with GERD randomly divided in 16 treated with sham tecnique and 22 treated with osteopatic thecnique	Modified osteopathic techniques for diaphragm stretching	Average respiratory pressure (ARP), maximum expiratory pressure (MEP) after the treatment	Statistically significant increase of ARP in osteopatic technique group, no statistically significant difference in MEP

rations, in which, during the expiratory phase, the investigator will sustain the ribs grid using the same contact to avoid the descent of the thoracic cage during the expiratory phase. The results were measured via manometry, choosing average respiratory pressure (ARP) and maximum expiratory pressure (MEP) and highest point (HP), and the mean between all these parameters, all measured immediately after treatment. The results showed a statistically significant increase of average respiratory pressure in osteopathic technique group, but no statistically significant difference in maximal expiratory pressure.

Discussion

GERD represents an increasing burden on our health-care system. Studies focused on GERD-related symptoms show a worldwide increase in prevalence, estimated approximately around 4% per year. The possible contributing factors of this trend include increased longevity and obesity rates, greater consumption of medications affecting the esophageal function, and potentially the changing prevalence rates of Helicobacter pylori infection. GERD has a negative impact on patients' quality of life as well as on the economy of the society[19].

PPIs currently represents the mainstay treatment of GERD, even though the long-term intake of PPIs is not free of side effects[10].

Although lifestyle modifications lack sufficient data to show objective improvement of reflux [8,20], patients usually experience a subjective advantage by changing their habits.

Among the non-surgical, non-pharmacological GERD treatments, the breathing exercises could represent a promising and rational treatment.

It is known that the contraction of the crural diaphragm has a pivotal role in the physiological anti-GERD barrier; it has been reported to induce a three-four fold increase of pressure within the GEJ region. Being a striated muscle, the crural diaphragm has a dedicated innervation and actively contracts during inspiration. The breathing training could train the crural diaphragm, therefore positively influencing the anti-reflux barrier.

Even though all the analyzed papers showed an overall positive effect of breathing training, the heterogeneity of methods and measured parameters makes almost impossible to perform a metanalysis over those data. There is a clear lack of consensus regarding which method could be the best to objectivize those results. The exercises themselves (physiotherapy, manipulative osteopathy, inspiratory muscle training) are not standardized and not directly comparable due to different muscle training protocols.

Conclusions

Given its safety, cost effectiveness and lack of collateral effects, the breathing training could play a crucial role in the management of mild GERD. Moreover, it may represent a promising option for the treatment of PPI-refractory GERD patients and could help in reducing the annual PPI needed intake in responder GERD patients, as Erher suggested[17].

A joint consensus regarding the breathing training on LES would be desirable for encouraging randomized, multicentric trials to confirm the effectiveness of this non-pharmacological GERD treatment.

Conflict of Interests:

All authors declare that they have no conflict of interest in connection with this paper.

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