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Effects of a respiratory functional training program on pain and sleep quality in patients with fibromyalgia: A pilot study

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ABSTRACT

Objective: To evaluate the effect of 8-week respiratory functional training program on pain tolerance, sleep, and urinary antioxidant and cortisol levels in 18 patients with fibromyalgia.
Methods: Participants underwent a 12-week intervention: 4 weeks as control and 8 weeks of breathing exercises. Pain tolerance assay was done by using an algometer, whereas sleep quality was evaluated by actigraphy and by the Pittsburgh Sleep Quality Index. Cortisol and antioxidant levels were determined using commercial assay kits.
Results: Increases in the pain tolerance threshold were detected in the occiput point after one month of intervention as well as in the low cervical and second rib points after one and two months. Actigraphy revealed a decrease in sleep latency, whereas sleep questionnaire showed improvements in sleep quality, sleep duration and sleep efficiency. No changes in cortisol and antioxidant levels were detected.
Conclusion: The 8-week breathing exercise intervention reduced pain and improved sleep quality.

1. Introduction

Fibromyalgia (FM) is a multi-symptom syndrome characterized by widespread and diffused pain [1]. Fatigue, anxiety and/or depression disorders, sleep disturbances, lack of concentration and impaired cognitive and memory functions are clinical features recognized as non-specific pain-related symptoms in FM [2]. Numerous authors have also pointed out a crucial correlation between sleep function and pain in FM, where the poorer sleep the greater pain [3,4]. Moreover, abnormalities in the circadian rhythms of biological markers, such as melatonin, serotonin or cortisol, which are closely related with pain and sleep regulation, have been suggested to occur in FM [5]. Since around 90% of patients with FM suffer sleep disturbances, the management of these common complaints is a serious challenge.

It has been proposed that fatigue and pain could be involved in decreased grip strength in FM. Besides, it has been suggested that patients with FM have reduced maximum pulmonary pressures, which may indicate respiratory muscle vulnerability or dysfunction [6–8]. It is well known that aerobic and strength training-related therapies mitigate some FM symptoms and improve the quality of life [9]. However, literature related to other traditional mind-body integrative treatments is scarce. In this line, a yoga breathing technique (pranayama) in combination with range of motion and relaxation exercises has been proven to be effective for ameliorating some parameters related to quality of life and pain in FM [10].

Based on this background, the goal of this study was to evaluate the effect of a 12-week respiratory functional training program (RFTP) on pain tolerance, sleep quality, and cortisol and antioxidant urinary levels in patients with FM.

2. Patients and methods

A total of 18 patients who fulfilled the 1990 American College of Rheumatology [1] criteria for FM were enrolled. There were 4 dropouts during the study due to family-related reasons and/or

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disinterest in the adherence to the protocol of the study. Hence, 14 patients (51.07 ± 12.38 yrs) completed the study. Their height, weight, body mass index (BMI) as well as other demographic characteristics is represented in Table 1. All participants were of Caucasian ethnicity and were recruited with the help of National Association against Fibromyalgia and Chronic Fatigue Syndrome (MYOS). Informed consent was obtained from all individual participants included in the study. Exclusion criteria for participation in the study included patients suffering respiratory or sleep pathologies, on physical/psychological therapies, or with history of severe trauma, inflammatory rheumatic disease, or previous severe psychiatric episodes. The study was approved by the Ethical Committee of University of Evora (Portugal - (document 14003)) in accordance with the Declaration of Helsinki, the Council of Europe and the Universal Declaration of UNESCO on human rights, biomedicine and human genome.

2.1. Experimental design

The study had a longitudinal design. Participants underwent a 12-week intervention as follows: 4 weeks as control period and 8 weeks of breathing exercises based on Diaphragmatic Breathing (DB) technique. Nocturnal sleep quality evaluated by activimetry was measured during 2 weeks (from week 2 to week 4; control period), during week 8 (one-month exercise intervention period) and during week 12 (two-month exercise intervention period). Pain measurements and sleep quality parameters evaluated by Pittsburgh Sleep Quality Index (PSQI) were obtained the last day of weeks 0 and 4 (control period), and the last day of week 8 (one-month exercise intervention period) and week 12 (two months-exercise intervention period). Urine samples for cortisol and antioxidant analyses were collected the last day of week 0, week 8 and week 12 (Fig. 1).

2.2. Exercise intervention

The practice of breathing exercises based on DB technique was introduced in week 4 until the end of week 12 (8 weeks of total exercise intervention). Patients received a single supervised formation session of breathing exercises with guidance from an expert the first day of week 0. These exercises were applied daily at home, in particular in bed, 30 min before going to sleep at night. Each session was focused on breathing exercises that strengthened and lengthened the thorax and abdomen skeletal muscles, including five breathing exercises (3 min for each one), which were performed in a circuit form (2 circuits/session): 1) awareness of breathing: in the supine position, inspire by the nose and exhale through the mouth with lips half-closed slowly; 2) costal expansion: in the supine position, with arms along the body with a stick held by the hands. Raise the arms and inspired and exhale and lower your arms; 3) diaphragmatic breathing–exercise 1: in the supine position, overlapping hands in the diaphragm located in the abdominal region, inspire by the nose and exhale through the mouth with lips half-closed slowly; 4) diaphragmatic breathing–exercise 2: in the prone position, with a folded towel under the diaphragm located in the abdominal region, inspire through your nose and exhale through the mouth with lips half-closed slowly; 5) diaphragmatic breathing–exercise 3: in the supine position, with a weight of 1 kg on the diaphragm located in the abdominal region, inspire by the nose and exhale through the mouth with lips half-closed slowly [11]. Patients were asked to fill in a diary indicating the date and the time at which they performed the breathing exercises. Patients who did not fulfill with 80% of the programmed sessions were excluded from the final analysis of this study.

Table 1
Socio-demographic characteristics of patients with fibromyalgia at baseline.

Age (years)	51.07 ± 12.08
Weight (kg)	62.35 ± 9.19
Height (m)	1.62 ± 0.07
Body mass index (BMI; kg/m^2)	23.65 ± 4.00
Duration of symptoms (years)	13.35 ± 7.93
Time of diagnosis (years)	7.42 ± 4.53
Number of tender points (0–18)	17.10 ± 0.05

Each value represents the mean ± SD of fourteen participants.

2.3. Threshold pain tolerance

The threshold pain tolerance was evaluated with a standard pressure algometer (Digital Pain Meter, Miacalcic®, PB by NIM brevettato, Siena). Since the intervention focused on the respiratory muscles located in thorax and abdomen only the five pairs of tender points located on the body trunk and neck were measured (low cervical, second rib, occiput, trapezious, and supraspinatus pairs) according to the American College Rheumatology Criteria for classification of FM [1]. Gradual compression pressure was administered with the algometer placed perpendicularly onto the target point with a controlled strength of 1 kg/s until the patient felt pain. The tender point is noted as positive when the patient perceives pain at pressure $\leq$4 kg/cm^2.

2.4. Sleep parameter measurements

2.4.1. Actigraphy monitoring

Actigraphy monitoring was used to record and display the temporal patterns of the individuals' activity and rest (Actiwatch, Cambridge Neurotechnology Ltd., Cambridge, UK). Each participant wore a wrist actimeter that logged activity for 14 days (2 weeks) in basal conditions (from week 2 to week 4), it means before starting with the exercise intervention; and during 2 non-consecutive weeks within the exercise intervention, it particular in week 8 and week 12. These actimetry data were then analyzed with the sleep analysis (Cambridge Neurotechnology Ltd.) software package to give the following parameters: sleep efficiency (sleep percentage while the participant was in bed); number of awakenings (number of high activity episodes during sleep); total nocturnal activity (total activity pulses during sleep); sleep latency (time period measured from going to bed until the onset of sleep); assumed sleep (difference between the onset and the final awakening); actual sleep time (assumed sleep minus awake time); immobility (minutes when mobility was zero).

2.4.2. Pittsburgh sleep quality index (PSQI) questionnaire

Subjective sleep quality over the prior month was assessed using the PSQI. This is a self-administered questionnaire that discriminates between 'good' and 'poor' sleepers. The PSQI comprises 7 components: subjective sleep quality (1 item), sleep latency (2 items), sleep duration (1 item), habitual sleep efficiency (3 items), sleep disturbances (9 items), use of sleeping medication (1 item), and daytime dysfunction (2 items). The components scores were summed to obtain a PSQI global score (range 0–21). A global score of 5 or greater was indicative of poor-quality sleeper.

2.5. Urinary cortisol and antioxidant levels

First-void morning urines were collected the last day of week 0 (basal value), week 8 and week 12 (exercise intervention period values). The samples were stored at −20 °C until biochemical assay. Cortisol was measured using a commercial enzyme-linked