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ORIGINAL ARTICLE

Influence of Lung Compression Technique on Spirometric Values in Smokers : A Pilot Study

Baño-Alcaráz A [*] [a] (PT,DO), Peinado-Asensio M [a] (PT,DO)

a. Madrid Osteopathic School. Madrid. Spain.

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Key Words:

Lung;
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ABSTRACT

Introduction: The essential function of the respiratory system is to supply oxygen to the blood, which requires an adequate respiratory mechanics. The elastic forces increase lung retraction during inhalation and decrease proportionally to the exhalation. There is evidence that smokers experience a drop in Forced Expiratory Volume in 1 second (FEV1) of about 50 mL/year.

Objectives: To evaluate the influence of the Lung Compression Technique (LCT) on Spirometric Values (SV) in smokers.

Material and Methods: A randomized pilot study was conducted. We applied a LCT in forty-one (n=41) smokers, which were randomly distributed into two groups (experimental: n=24; control: n=17). All of them underwent spirometry before and after the intervention. They were previously surveyed about their smoking habits and the presence or absence of comorbidities. We analyzed the changes in the following spirometric values: Forced Vital Capacity (FVC), Forced Expiratory Volume (FEV1), Peak Expiratory Flow (PEF), and Forced Expiratory Flow 25–75% (FEF2575). Spirometry was performed according to the rules of the American Thoracic Society (ATS) and Spanish Society of Pneumology and Thoracic Surgery (SEPAR).

Results: The results indicate that there are significant variations in PEF (p=0.008) and FEF2575 (p=0.005) in the experimental group versus the control group after application of the LCT. We found an increase statistically significant in PEF and FEF2575 in the experimental group. No changes were found in FVC (p=0.634) and FEV1 (p=0.058) between study groups.

Conclusions: The LCT could be helpful for improving respiratory mechanics in smokers, increasing spirometric variables as PEF and FEF25-75%.

* *Corresponding author: email: aitor_ft@hotmail.com (Aitor Baño)* - *ISSN on line: 2173-9242*

INTRODUCTION

The essential function of the respiratory system is to supply oxygen (O_2) to the blood, which will be transported to the tissues, as well as to remove carbon dioxide (CO_2) from the blood to the atmosphere. This function needs proper respiratory mechanics [1].

The elasticity of the respiratory system is a decisive force in respiratory mechanics, which depends on the combined elasticity of the lung and the chest [1-5].

The elastic forces of retraction of the lung increase during inhalation due to increased surface tension and to stretching of the elastic fibers of the lung. These forces decrease proportionally during exhalation [1].

Smoking is associated with decreased lung function[6-9], particularly with an important annual decline in FEV1 (40 ml compared to 25 ml in nonsmokers) [10].

Reduced lung function, measured as Flow Expiratory Volume in one second (FEV1), is associated with increased mortality derived from respiratory problems [11].

Studies of lung function monitoring have shown that nonsmokers from 30 years old, exempt from any other respiratory disease, experience a significant decline in FEV1 of 30 to 35 mL/year[12], related to the natural aging process of the lung.

This drop is slightly higher in smokers, about 50 mL/year [13,14]. In fact, smoking is a major risk factor for developing Chronic Obstructive Pulmonary Disease (COPD)[12, 14-27].

From 40-50 years onwards, the prevalence of developing COPD increases every year and more in smokers [28]. In this sense, a fully effective respiratory cycle can be achieved by increasing the mobility of the ribcage and thoracic spine [29].

MATERIAL AND METHODS

Design

The study was a controlled, randomized, double-blind clinical trial (patients and assessors were blinded).

Study Population

We included in our research forty-one (n=41) patients, who were divided into two groups: experimental group (EG) and control group (CG). The EG was composed of twenty-four (n=24) patients (11 men and 13 women) with a mean age of 32.79 ± 8.4 years, whereas in the CG were seventeen (n=17) patients (8 men and 9 women) with a mean age of 32.76 ± 10.7 years.

Randomization

The randomization was performed by random number tables.

Study Protocol

Patients were surveyed about their smoking habits and recent presence of associated diseases.

They were informed about the study and were given the informed consent form that must be signed prior to treatment.

Afterwards, each patient was randomly distributed in one group (EG or CG). Both groups underwent spirometry before the intervention (pre-intervention).

Then we applied the Lung Compression Technique (LCT) to the EG, but the CG did not receive any intervention. Immediately after applying the LCT, we performed again other spirometry in both groups (post-intervention).

Selection Criteria

Patients included in the study met the inclusion criteria and did not meet any exclusion criteria (Table 1).

Inclusion criteria were the following:

1. - The patient must sign the informed consent form. The confidentiality of personal data was respected in accordance with the current spanish legislation (Law 15/1999 Protection of Personal Data [30]). All necessary data, both personal and health data were

essential data for the study. Likewise, we inform participants that their personal information not be disclosed to anyone outside the investigation.

2. - Patients smoking for more than 2 years.
3. - Patients who smoke more than 10 cigarettes/day[31].
4. - Age between 18 and 50 years [28, 32].

Intervention in Experimental Group

Patients of the EG were submitted to the LCT [33, 34]. This technique aims to provoke a therapeutic elastic rebound in the lung, because manual compression which is exerted on the patient in the expiratory phase of respiration, in addition to the sudden decompression is performed in the inspiratory phase of respiration.

The patient remains in the supine position with hip and knee flexion, so that the feet soles are flat on the table. The therapist is placed beside the table, placing a hand behind the patient's thorax and the other hand is resting on the anterior part of the hemithorax (figure 1).

The technique consisted of applying compression to the chest during the expiratory phase, while maintaining this compression at the beginning of the inspiratory phase and dropping abruptly at the end of the inspiratory phase. We performed a rhythmic pumping technique synchronized with the patient breathing in both hemithorax (bilaterally).

Intervention in Control Group

Patients of the CG were placed in the same position as patients of EG. The therapist performed the same contacts and held such position during 3 breaths, but exerting no compression at all.

Spirometric Variables

Patients of both groups (EG and CG) underwent three pre-intervention spirometry tests and three post-intervention spirometry tests, and we used the mean of these measurements.

1. - Lung Cancer
2. - Hemothorax
3. - Acute infections
4. - Acute respiratory failure
5. - Myocardial infarction within the last month
6. - Rib fractures
7. - Recent cardiac crisis
8. - Recent surgery (eye, ear, chest and abdomen)
9. - Pregnancy
10.-Poor health status, cardiovascular instability, fever, nausea, vomiting
11. - Pneumothorax
12. - Active tuberculosis
13.- Hemoptysis
14. - Aneurysms
15. - Tracheotomies

Table 1. Exclusion Criteria

Figure 1. Lung Compression Technique (LCT)

To perform spirometry we used a Datospir 120A spirometer (Sibelmed, Barcelona, Spain), previously calibrated following the manufacturer's recommendations and standards for spirometric testing, according to the American Thoracic Society (ATS) [35] and the Spanish Society of Pneumology and Thoracic Surgery (SEPAR).

Spirometric variables considered were:

- FVC (Forced Vital Capacity): The maximum volume of air exhaled after a maximal inspiration, expressed in liters (L).
- FEV1 (Forced Expiratory Volume in one second): Volume of air exhaled during the first second of FVC in liters (L).
- PEF (Peak Expiratory Flow): Peak flow reached a maximum effort from a position of maximal inspiration, expressed in liters/second (L/s).
- FEF25-75: (Forced Expiratory Flow 25-75 %) Forced Expiratory Flow average measured during the middle half of FVC, expressed in L/s.

Statistical Analysis

Statistical analysis was performed using the software "SPSS for Windows" version 15.0.

The normality of variables was established using the Kolmogorov-Smirnov test and graphical methods. When we observed a non-normal distribution we applied nonparametric tests (Mann-Whitney).

In the case of normal distribution we used parametric tests (Student t-test). We applied the chi-square tests χ^2 for analysis of dichotomous variables (table 2).

We established a significance level of $p < 0.05$, according to international standards for biomedical research [36, 37].

RESULTS

Our results indicated a clear statistical difference in PEF (p=0.008) and FEF2575 (p=0.005) between the CG and EG.

We found an increase statistically significant in PEF and FEF2575 in the experimental group. No changes were found in FVC (p=0.634) and FEV1 (p=0.058) between study groups.

Although the FEV1 was statistically not significant (p=0.058), we observed a trend to statistical significance. Likewise, no significant variations were observed in FVC (table 3).

DISCUSSION

Some authors observed that the use of different techniques in smokers produced changes in spirometric parameters.

According to Oscoz[31] (2005) the application of techniques on the diaphragm resulted in the modification of some spirometric values, such as FEV1 or PEF.

Ramos and Cataneo [38] (2007) reported that the application of exercise before surgery in smokers exerted a positive effect on PEF.

On the other hand, treatment with Global Postural Re-education in the anterior muscle chain, applied during 8 weeks to healthy subjects, has modified pulmonary pressures in thoracic expansion and abdominal mobility [39].

The tension and relaxation of viscoelastic elements of the lung depend on time, so the peak flow immediately after stretching the lungs is higher than after a pause with the lungs at total capacity [40,41].

Therefore, we may interpret that LCT can temporarily influence on the elastic properties of the lung, thereby improving some spirometric parameters immediately after the LCT.

Such parameters coincide with those most affected in smokers, indicating that the LCT would be considered as a useful procedure in the rehabilitation of lung pathology associated to smoking.

VARIABLES	GROUP EG n= 24	GROUP CG n= 17	p-value
SEX (man; woman)	m: 11(45,8%) w: 13(54,2%)	m: 8(47%) w: 9(53%)	0,938
AGE (years)	32,79(8,44)	32,76(10,72)	0,993
Pre_FVC (liters)	4,30(1,06)	4,05(0,92)	0,560
Pre_FEV1 (liters)	3,31(0,75)	3,31(0,85)	0,968
Pre_PEF (liters/second)	6,77(1,74)	6,86(2,34)	0,771
Pre_FEF 2575 (liters/second)	3,17(0,88)	3,40(1,32)	0,515

Table 2. Preintervention Values
Data are expressed as mean ± (SD) standard deviation; n: counting number; age in years; m: man; w:woman; FVC: Forced Vital Capacity (liters); FEV1: Forced Expiratory Volume in 1 second (liters); PEF: Peak Expiratory Flow (liters/second); FEF25-75%: Forced Expiratory Flow 25–75% (liters/second).

VARIABLES	GROUP EG	GROUP CG	p-value
Dif_FVC (liters)	0,15(0,56)	0,22(0,45)	0,634
Dif_FEV1 (liters)	0,13(0,37)	0,00(0,31)	0,058
Dif_PEF (liters/second)	0,08(0,87)	-0,71(0,95)	0,008 *
Dif_FEF2575 (liters/second)	0,03(0,36)	-0,36(0,34)	0,005 *

Table 3. Intergroup Comparative Pre/Post Intervention Values
Parametric Data are expressed as mean ± (SD) standard deviation; Non-Parametric Data are expressed as median ± (IR) interquartil range; Dif_FVC: Differences in Forced Vital Capacity (liters); Dif_FEV1: Differences in Forced Expiratory Volume in 1 second (liters); Dif_PEF: Differences in Peak Expiratory Flow (liters/second); Dif_FEF25-75%: Differences in Forced Expiratory Flow 25–75% (liters/second).The statistically significant differences were expressed as *p<0.05.

We believe that the obtained results are interesting, but we must be aware that some variables, such as PEF or FEF25-75%, are dependent on the effort [42, 43], so that their values (especially the PEF) does not indicate the quality of the spirometry.

On the other hand, we did not controll the patient's bronchial hyperreactivity. There is evidence of a direct relationship between PEF and bronchial hyperresponsiveness [44, 45] in patients with asthma and COPD [46-49].

According to other authors [31,38,39] we can state that the use of Osteopathy Manipulative Treatment (OMT) to treat respiratory problems is beneficial, for both chest mobility problems and chain retraction muscle. Additionally, this technique might also benefit patients with visceral problems.

Finally, it would be of interest in further studies of research to analyzed the results obtained by combining other treatment techniques that have shown effective results (Oscoz [31], Ramos and Cataneo[38], Moreno [39]).

Study Limitations

This study is limited by several aspects, including sample size, which should be increased in future studies.

In addition, a study should be conducted to determine the duration of the effect of the LCT, thereby assessing their practical applications.

CONCLUSIONS

The lung compression technique produces statistically significant increases in spirometric PEF and FEF25-75. By contrast, this technique does not modify FVC or FEV1 in lung.

ETHIC RULES

This study meets the ethical standards established in the Declaration of Helsinki [50], and subsequent revisions.

CONFLICT OF INTEREST

The authors of the manuscript declare no conflict of interest.

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