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Positive Effect of *Chlorella vulgaris* Complementary Therapy on the Symptoms and Pulmonary Function in Patients With Silicosis

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Background: Silica is an element that accounts for 28 percent of the earth's crust. Silicosis is a relatively common cause of lung disease that is associated with high morbidity and mortality. Some types of work, such as mining, stone cutting, pottery, and road and building construction are associated with an increased risk of silica exposure, which can lead to silicosis. Silicosis is divided into acute, chronic, and accelerated forms. Due to the high prevalence and lack of proper treatment, use and detection of new trophy and particular prophylaxis methods against this disease is needed.
Objectives: In addition, due to the side effects of drugs and the lack of their complete efficacy, we studied the effects of the natural compound, *Chlorella vulgaris*, in addition to the other available treatments. This study provided insight into the effectiveness of *chlorella*.
Patients and Methods: *Chlorella vulgaris* was prescribed in addition to the other available chemical drugs for 8 weeks to a group of patients, and its effects on the clinical symptoms, general appearance, and spirometry indices were studied. Because increase confidence outcome of study the other group spot as control group. These two groups assimilate from all aspects.
Results: This study showed that Algomed improves cough, sputum, dyspnea and lung auscultation findings. Therefore, the evaluation of spirometry indices showed improvement in FEV_1 and FVC.
Conclusions: We conclude that *Chlorella vulgaris* is effective for treating silicosis. However, due to the limited number of patients and the short duration of the study, longer time periods and an increased number of patients are required for more definitive results.

Keywords: Pulmonary Function Test; Silicosis; *Chlorella vulgaris*

1. Background

The distribution of silicon in nature is almost the same as that of carbon in organic materials. Silicon accounts for approximately 28% of the earth's crust and has a high reactivity not only in its elemental form but also when combined with either oxygen alone, which forms free silica (SiO_2), or when combined with oxygen and other constituents, which forms silicates such as asbestos (1-4). In occupational settings in developing countries, the inhalation of crystalline silica causes silicosis. However, silicosis may also occur in developed countries, particularly in occupations such as mining, stone cutting, pottery, road, and building construction, which are all associated with an increased risk of silica exposure and silicosis (5, 6). Various factors such as exposure latency, exposure intensity, dust particle size, dust quality and quantity, percent of free silica, body resistance, and the presence of complicating factors such as infection are associated with the severity of silicosis (7). Because of the high prevalence and the lack of definitive treatment, there is a need for detection of useful trophy and particular prophylaxis methods to simply manage this disease.

2. Objectives

The current study was designed to investigate the potential effect of the natural compound, *Chlorella vulgaris*, compared to the other available treatments.

3. Patients and Methods

Patients with signs and symptoms of severe, chronic, and complicated forms of silicosis were referred to the Shahid Modarres Hospital, Isfahan, Iran, from 2011 to 2012. Patients with the following features were excluded from this study: severe silicosis, a history of heart disease, age up to 70, $FEV_1 < 40\%$, $TLC < 40\%$, non-cooperative during PFT, a history of hospitalization due to disease exacerbations during the previous three months, TB infection, and $BMI > 30$. A total of 47 steeped-up, chronic and complicated silicosis patients were divided into two groups. In group 1, 24 patients received nine tablets of Algomed daily for at least eight weeks. In group 2, 23 patients received treatment with the standard therapeutic protocol including a bronchodilator. To evaluate the treatment response, spirometric indices were assessed, and vari-

ous clinical manifestations before and after starting the study were analyzed.

3.1. Statistical Analysis

The statistical analysis included Chi-square tests, sign-tests, and Mann-Whitney U tests using SPSS statistical software, and data are expressed in frequencies.

4. Results

Our study sample included 47 patients: 23 patients in the control group and 24 patients in the case group. Two patients and one patient were excluded from the case and control groups because of the absence during the study.

The case group was also evaluated using the sign test regarding the health condition before and after two months of Algomed treatment. Of the 24 patients, 15 were improved and 9 exhibited no differences in two months. The P value was 0.0, which indicates that the treatment with Algomed was effective (Table 1).

The number of attacks were examined using the t-test, and significant results were obtained indicating fewer attacks after two months of treatment with Algomed (P value = 0.016). The spirometric indices were measured before and after two months of Algomed treatment, and they were analyzed using the t-test; the results showed significant changes in FEV_1, FVC and $FEF_{25\% - 75\%}$, and the P values were 0.008, 0.011 and 0.023, respectively. The FEV_1/FVC index also illustrated meaningful results indicating that the treatment with Algomed combined with other treatments can be beneficial to patients (P value = 0.004). The control group was examined using the sign test regarding their health condition after two months; of the 23 participants, only 2 were in the higher health condition group, 17 of them showed no changes, and 4 of them showed negative changes (P value = 0.687).

As shown in Table 2, the amount of sputum and cough in the control group revealed no specific positive changes during the two months of treatment.

The t-test was used to assess the number of attacks, FEV_1, FVC, $FEF_{25\% - 75\%}$ and the FEV_1/FVC indices. Of these parameters, FVC and $FEF_{25\% - 75\%}$ were unchanged compared to the previous two months. However, the number of attacks and the FEV_1 and FEV_1/FVC indices showed significant changes with the regular treatments (the P values were 0.0, 0.04 and 0.001, respectively). CT scans were performed in all of the patients. In the case group, 5 (20.8%) patients had grade 0 perfusion, 8 (33.3%) had grade 1 perfusion, which represents small opacities without bronchovascular margin fading, 7 (29.2%) had grade 2 perfusion, which represents small opacities with partial bronchovascular margin fading and 4 (16.7%) had grade 3 perfusion, which represents small opacities with complete bronchovascular margin fading. In the control group, 13 (56.5%) patients had grade 1 perfusion, 7 (30.4%) had grade 2 perfusion and 3 (13%) had grade 3 perfusion. None of the study population had grade 0 perfusion. The most common pattern of perfusion in the patients was grade 1. The comparison between the two groups in terms of grade 1 perfusion (small opacities without bronchovascular margin fading) showed that there were no differences between the groups. In addition, there were no differences in the forms (nodular, reticular, and reticulonodular) and size of the opacities between the groups. There were no significant differences in conglomerated masses or parenchymal involvement between the groups. There were also no differences in the health condition at the beginning of treatment between the groups based on the Mann-Whitney U test findings. The comparison of the symptoms showed no significant differences between the two groups except cough, which was observed at a higher incidence in the case group (P value = 0.001). The number of healthy days at the beginning of the study also illustrated no meaningful differences between the groups. Based on the Chi-square test, the physical activities that led to dyspnea in both groups showed no significant differences. The level of exercise

Table 1. Frequency of Symptom Alleviation

Symptoms and Signs	Frequency of Positive Changes	P Value
Sputum	12 individuals	0.013
Dyspnea	16 individuals	0.000
Wheezing	12 individuals	0.003
Cough	11 individuals	0.003

Table 2. Frequency of Symptom Alleviation

Symptoms and Signs	Number of Positive Changes Using Algomed	P Value
Sputum	4	0.687
Dyspnea	7	0.016
Wheezing	9	0.004
Cough	5	0.63

that led to dyspnea in both groups were similar. However, the case group complained of dyspnea during exercise and most of the control group patients complained of dyspnea during walking at the beginning of study. At the end of the study, there was no difference in the severity of the dyspnea reported by patients in both groups. The spirometry indices at the beginning of the study showed no significant differences between the groups. The health condition after two months of treatment was assessed using the Mann-Whitney U test, and no differences between two groups were observed. Thus, Algomed did not affect the feeling of healthiness.

We compared the groups after two months of treatment; the symptoms were significantly alleviated in the case group. Algomed was effective at reducing symptoms such as cough, sputum, dyspnea and lung auscultation findings (Table 3).

The patients were examined in terms of the level of exercise that made them experience dyspnea. The case group experienced dyspnea while exercising, and the control group mostly experienced it while walking up stairs, and there was a meaningful correlation (P value = 0.007). Therefore, Algomed has positive effect on the level of exercise that leads to dyspnea. We compared the groups regarding their spirometric indices, which showed that Algomed was useful in improving FEV_1 and FVC and did not have any effect on $FEF_{25\% - 75\%}$ or FEV_1/FVC.

Table 3. Frequency of Symptoms

Signs and Symptoms	P Value
Cough	0.001
Sputum	0.003
Dyspnea	0.015
Wheezing	0.010

5. Discussion

Silicon accounts for 28 percent of the earth's crust. Individuals exposed to this material include miners, masons, potters, road and construction workers and are susceptible to silicosis (5). Silicosis is a fairly common respiratory disease and is associated with a high mortality rate (8). Various factors such as the duration and intensity of the exposure, the particle size, the number and type of inhaled particles, the particles of silica, the body's natural resistance and the presence or absence complicating factors such as infectious disease all affect the severity of silicosis (9). The disease is divided into acute and chronic forms. Because of the high prevalence and the absence of a cure for this disease, new treatments and effective prevention methods as well as detailed instructions for managing the disease are needed (10). Given the chemical side effects and the lack of effective drugs, we aimed to evaluate the effect of the natural compound, *Chlorella vulgaris*, alongside other available remedies, which if effective, can be used as a useful therapy in silicosis patients. Therefore, this drug along with other chemical drugs was administered for 8 weeks, and the effect of this treatment approach on the clinical symptoms of patients with spirometric indices was examined. Along with this group, to establish the reliability of the results, another group of patients was enrolled as the control group. In the case of cough, sputum, dyspnea, wheezing and spirometric indices during the two months, there was a significant reduction in the severity of symptoms and an improvement in the spirometric indices were observed. In the control group, at the end of two months, there was no significant change in cough and sputum, but audible breath findings were improved in the patients. The spirometry indices of the control group showed improvement in the FEV_1/FVC and FEV_1. Based on the comparison of the results, the group receiving Algomed exhibited improvements in the sputum, dyspnea and lung auscultation findings compared to the group that did not receive Algomed. However, no significant difference between the two groups was observed in the number of attacks of breathlessness. Comparison of the spirometric indices also revealed improvement in FVC and FEV_1 in the Algomed group compared to the control group. Therefore, we conclude that this component is effective at improving patients with silicosis, but due to the limited number of patients and the limited duration of the study, further studies with larger sample sizes and longer treatment periods are required for more definitive conclusions.

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