DO PHYSICAL MODALITIES HAVE A ROLE IN THE MANAGEMENT OF PATIENTS WITH CHRONIC ASTHMA?

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Key Words: asthma, electroacupuncture, transcranial electrical stimulation, speleotherapy, blood cells radiation with laser, pharmacotherapy

Abstract:
This paper reports the findings of a prospective study involving patients with chronic asthma. The goal was to investigate if physical modalities make a significant contribution to the management of asthma beyond pharmacotherapy. Subjects were 106 male and female patients (ages 18-62 years) with chronic asthma. The controls received pharmacotherapy alone whereas the experimental group received pharmacotherapy plus four physical modalities over five weeks. Clinical outcomes were determined based on data from blood chemistry, pulmonary tests, and patients' symptoms before and after each session. Results suggested significantly greater improvement of respiratory functions and a moderate reduction in the needs for medications in the experimental group. These correlated with greater improvements in patients' symptoms. The results suggest that the physical modalities might have induced a moderate enhancement in the clinical outcomes.

INTRODUCTION

Approximately 18 million people suffer from asthma in the United States, and during the last decade, incidence of asthma in American children and adult increased by 5.4% per year (Miller, 2001). According to a National Health Interview Survey (Miller, 2001), the prevalence of asthma among African Americans was higher than in white Americans. A recent study (Parronchi, 2000) reported that synthetic materials and fossil fuels were among the leading factors that aggravated allergic diseases such as asthma. Despite modern drug developments, approximately 5500 people die from asthma every year and the death rate among African-Americans is the highest from this disease (Miller, 2001). A report published by the World Health Organization (Kemp, 1997) suggested that children vaccinated against diphtheria, pertussis and tetanus were at increased risk of developing asthma. Although drugs are the primary means of the management of patients with asthma, they are associated with adverse effects (Kline, 1994; Selgrade, 1997; Arzumanyan, 2000).

Over the past decades, clinical researchers have examined a number of physical modalities for their potential use in the management of chronic respiratory diseases (Spannagel, 1961; Yu, 1976; Torokhtin, 1990; Astashev, 1990; Rakita, 1997; Klyachkin, 1997; Alexandrova, 1999). Specifically, several studies (Gorbenko, 1990; Goncharuk, 1994; Vinogradov, 1995; Miller, 2001) have reported qualitative and quantitative results to suggest that improved clinical outcomes in the treatment of asthma is possible if pharmacotherapy is combined with a physical modality, such as electrical stimulation or acupuncture. In patients who develop resistance to medications, the combined approach may contribute to better clinical outcomes (Astasidis, 1986b & 1991). Table 1 represents five treatment protocols, in which the effects of combined approach versus pharmacotherapy alone in the management of patients with asthma have been investigated previously on small patient populations.
Table 1: Combined Treatment Protocols Used for Patients with Asthma.

<table>
<thead>
<tr>
<th>Period</th>
<th># of Patients</th>
<th>Combined Treatment Method</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1982-84</td>
<td>34</td>
<td>Pharmacotherapy + Acupuncture</td>
<td>Astasidis, 1986b</td>
</tr>
<tr>
<td>1986-89</td>
<td>30</td>
<td>Pharmacotherapy + Acupuncture + TCES</td>
<td>Iliinsky, 1991</td>
</tr>
</tbody>
</table>

TCES = transcutaneous electrical stimulation. For definitions of the above treatments please refer to the text under Methodology section.

This study reports the clinical outcomes of using four distinct physical modalities, i.e., electroacupuncture, transcranial electrical stimulation, speleotherapy and intravenous laser radiation when used simultaneously with pharmacotherapy in the management of 106 patients, with a 3-8 year history of chronic asthma. Previous studies have established the clinical effect of the above modalities when used singly with pharmacotherapy (Spannagel, 1961; Yu, 1976; Reist, 1984; Jungi, 1990; Konovalov, 1990; Torokhtin, 1990; Shesterina, 1994; Zunchui, 1995; Vinogradov, 1995; Jobst, 1996; Gosin, 1998; Jinsheng, 1998).

METHODOLOGY

Subjects:
A total of 106 patients (64 males, 42 females) with chronic asthma participated in this study. Sixty two patients were in the experimental group and 44 in control group. All patients were of white European origin, at ages of 18 to 62 years. All of these patients were treated at all sessions by the same investigator (B. Astasidis, M.D.), and all were examined before and after each treatment session. This study was approved by the Institutional Review Board at the Clinical Research Center for Respiratory Diseases, Saint Petersburg, Russia, and by the Department of Health, Kalamata, Greece. All patients reviewed and signed a consent letter before being included in the study.

Inclusion, Exclusion and Termination Criteria:
The inclusion criteria were: a) having suffered from asthma at least for two consecutive years prior to participation in this study, b) having taken steroid medications for the past six months or longer, c) being at ages of 16 to 65, and d) being able to complete the course of this study for 5 weeks. The exclusion criteria were: a) having a history of stroke or myocardial infarction, b) having mental retardation or any psychiatric disorder, and c) developing asthma attacks or severe reaction to any of the treatment modalities at any time during the study. The treatment was also terminated if the subject declined to continue with the study.

Screening:
All subjects were interviewed, screened and examined by the same physician (B. Astasidis), using a detailed medical questionnaire. The screening included taking a 10-second electrocardiogram, performing a complete blood cell counts and blood chemistry, and a pulmonary function test.

Patient Preparation and Treatment Protocol:
Each patient was placed on a recliner in semi-supine position and was prepared with appropriate electrode attachments (see below). Each patient was checked for a second time for safety precautions and correct placement of electrodes. The treatment protocol was performed as follows:
1. **Pharmacotherapy:** All patients were receiving five prescribed medications at appropriate dosages as determined by the referring physician. Each of these patients had been under the care of the physician for at least 3 to 8 years. The five drugs consisted of a beta-agonist, theophylline, sodium chromoglicate, a corticosteroid and an immune modulator.

2. **Physical modalities** consisted of electroacupuncture, transcranial electrical stimulation, speleotherapy and intravenous laser radiation of the blood cells. These modalities were used in the following sequence:

a. **Electroacupuncture** is thought to increase the levels of endorphins and enkephalins in the cerebrospinal fluid and blood (Zunchui, 1995; Jobst, 1995). A total of eight needles were used for each patient. These were placed in the points of common action, lung meridian, and points of allergy according to published procedures (Jungi, 1990; Zunchui, 1995; Yu, 1976; Jobst, 1996; Jobst, 1995). Each needle was connected to an electrical stimulator (Reflex - 301, Moscow, Russia). Electrical current was delivered through the needles by an electrical stimulator and the intensity was gradually increased to 20 microamper (Zunchui, 1995). The current had a cycle of 5 sec. negative and 15 sec. positive at 8-200 Hertz (Hz). The treatment was for 25 min.

b. **Transcranial Electrical Stimulation (TCES)** is also thought to increase the levels of endorphins and enkephalins in the brain and blood (Badalian, 1982). TCES was delivered by an electrical stimulator (Electroson- 4T; Moscow, Russia) through two electrodes pasted to the forehead and occipital areas. Two identical electrodes (2 x 5 cm) were pasted to each patient, one to the forehead and another between the mastoid processes over a shaved area. The current had a ratio of 2:1 for impulse (3 sec.) and rest (1.5 sec.). The current intensity for each patient was determined individually. It started at zero milliamper and was slowly progressed up until the patient reported a gentle tingling sensation felt under the electrodes. This was the maximum intensity used for each patient throughout the study. The threshold at which patients began to feel the sensation ranged from 1.2 to 2 milliamper. The current frequency was 8-10 Hz during the first 20 minutes, 73-78 Hz for the next 30 minutes, and was set to 8-10 Hz during the last 10 minutes of the treatment. This treatment lasted 60 minutes.

c. **Speleotherapy** (inhalation of aerosol ions of sodium chloride, calcium, magnesium and potassium) has been shown to improve the respiratory tract drainage and to have bactericidal and bacteriostatic effects (Wurtemberg, 1987; Torokhtin, 1990; Konovalov, 1992). This treatment was performed in a computerized, glass-walled chamber at a constant level of aerosol mass concentration, with the temperature at 18-22 degrees centigrade (70-75 F) humidity at 45-55%. This treatment was administered for 75 minutes.

d. **Intravenous Laser Radiation of the Blood Cells:** This intervention is associated with the cell-mediated immunity by enhancing the functions of T-helper and T-suppressor cells (Konovalov, 1992; Rakita, 1997). A fine catheter was inserted into the patient’s right or left antecubital vein and the probe of a laser transducer (Frazino Laser Laboratories, Frazino, Russia) was inserted into this catheter until the tip had been advanced inside the vein by 14 centimeter from the catheter tip in the vein. At the onset of this treatment, the transducer was turned on and red laser beam was emitted from the transducer tip into the vein for 30 minutes. The laser wavelength was 0.63
micron at 2.5 milliwatt. This session lasted 30 minutes, and was administered twice a week for a total of 10 treatments.

Patients in the control group received sham physical modalities in the speleotherapy chamber with the aerosol-generating control turned off but the fixtures such as fan and lights remained turned on.

Patients Survey:
Patients’ condition and responses to the treatment protocol were collected and analyzed by: a) feedback received from the patients during and after each session, b) routine clinical observations and examinations and, c) data collected from a survey that the patients completed after each treatment. This survey was conducted to accurately evaluate and quantify the clinical outcomes. The major questions asked in the survey included: frequency of coughs and asthmatic attacks, use and frequency of prescribed corticosteroids, productive coughs, quality of sleep, breathing difficulty and the level of daily physical activity.

Diagnostic Methods:
To assess the inflammatory process associated with asthma, blood biochemical analysis was performed. Also, changes in the inflammatory process were assessed by the ratio between the levels of serum albumins to serum globulins. The humoral immunity was evaluated by determining the level of serum immunoglobulins IgA, IgG and IgM, using established methods (Kline, 1994; Selgrade, 1997; Kon, 1999). Cellular immunity was assessed by measuring the levels of T-lymphocytes, active T-cells (Ta) and the phagocytic activity of monocytes and neutrophils. For the examination of T-lymphocytes, we used the method of spontaneously producing rosettes with sheep erythrocytes (Selgrade 1997). T-helper and T-suppressor cells were evaluated by the production of rosettes with theophylline (Kemp, 1997). The flow-volume loop of respiration was examined on a Pneumoscreen unit (Jaeger, Germany). The respiratory parameters were evaluated on the basis of predicted values, the normal limits and the range of deviations from the norm developed by Klement, et al. (1986). The bronchial resistance to airflow and the vital capacity were assessed by plethysmography, using a Bodyscreen unit (Jaeger, Germany).

Data Analysis and Controls:
The data collected throughout the study were analyzed to determine the statistical significance (P value of lat least <0.05) and standard deviations. The collected data were analyzed for each patient for “before” and “after” each treatment session. Therefore, this study utilized controls in two different contexts, a) each patient was his or her own control, and b) data from the control group were compared collectively versus those the experimental group. The absolute difference or delta (δ) was defined as a value for the experimental group minus that for the control group.

RESULTS

General Status of Patients in Experimental Group:
Sixty five percent of the patients (N=40) tolerated the treatment protocol well throughout the study. By the 6th treatment session, these patients had already reported or began to report improvement in their symptoms. None of the patients in this group developed severe asthmatic or cough attacks during the study. Thirty five percent (N=22) of the patients, however, reported a short period of mild symptomatic aggravation such as increased expectoration of sputum or labored breathing. These were reported once and usually during the 3rd to 5th treatment sessions, which subsided within one to three days. During the transient flare-up, patients took rest and then returned to continue with the study voluntarily. None of these patients developed a second bout of symptom aggravation during
the rest of the study. At the completion of the 20th session, all of the patients reported a significant improvement in their symptoms (Table 2), which included improved sleep pattern, and a major reduction or complete relief of their fatigue, weakness and anxiety.

**General of Status of Patients in Control Group:**
These patients tolerated their medications well and approximately 70% of them reported either a significant improvement or complete relief of their symptoms by the completion of the study (Table 2). Approximately 40% of these patients reported to have had improved sleep, and none of them reported a symptom aggravation during the study.

**Improvement Rates:**
In the experimental group, the frequency and intensity of asthmatic attacks and the extent of breathing difficulty declined either totally or partially, by 87% compared with 70% in the control group (Table 2). In these patients, coughing became effortless, the amount of expectorated sputum declined and became more fluid. Approximately 12% and 30% of the patients in the experimental and control groups, respectively, did not report a significant improvement in their symptoms. The combined data for partial and complete improvement in the lungs, on the basis of auscultation, revealed that 90.4% of patients in the experimental group had improved significantly, compared with only 74.2% of those in the control group (Table 2).

**Table 2: Extent of Clinical Improvement in the Patients’ Sign and Symptoms.**

<table>
<thead>
<tr>
<th>Clinical Signs and Symptoms</th>
<th>Complete Improvement</th>
<th>Partial Improvement</th>
<th>No Improvement</th>
<th>Delta (δ)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Experim. Control (% of patients)</td>
<td>Experim. Control (% of patients)</td>
<td>Experim. Control (% of patients)</td>
<td></td>
</tr>
<tr>
<td>Asthma Attacks</td>
<td>22.6</td>
<td>13.6</td>
<td>66.8</td>
<td>57.3</td>
</tr>
<tr>
<td>Breathing Discomfort</td>
<td>17.3</td>
<td>10.4</td>
<td>70.4</td>
<td>60.5</td>
</tr>
<tr>
<td>Nasal Congestion</td>
<td>27.4</td>
<td>18.5</td>
<td>58.3</td>
<td>51.8</td>
</tr>
<tr>
<td>Auscultation Rales</td>
<td>30.1</td>
<td>22.3</td>
<td>60.3</td>
<td>51.9</td>
</tr>
</tbody>
</table>

δ = Denotes the value for the experimental group in each category minus that for the control group.

Similarly, a 50%-100% reduction in the combined use of beta-agonists and corticosteroids occurred for 80% and 62% of the patients, respectively, in the experimental and control groups (Table 3). Also, the percentage of patients who did not improve, in response to the drugs, were significantly lower in the experimental group (19.4%) than in the control group (38.6%).

**Table 3: Reduced Needs for beta-Agonist and Corticosteroid prescriptions.**

<table>
<thead>
<tr>
<th>Drug Use</th>
<th>Reduction by 100%</th>
<th>Reduction by 50%</th>
<th>No Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Experimental control</td>
<td>Experimental control</td>
<td>Experimental control</td>
</tr>
<tr>
<td>beta-Agonists</td>
<td>24.2</td>
<td>14.8</td>
<td>59.3</td>
</tr>
<tr>
<td>Corticosteroids</td>
<td>23.4</td>
<td>16.5</td>
<td>54.2</td>
</tr>
<tr>
<td>Average:</td>
<td>23.8</td>
<td>15.6</td>
<td>56.7</td>
</tr>
</tbody>
</table>

All numbers represent percentages of patients, in each category, whose needs for the medications had been reduced, as determined by their physicians, from 100% to 50% to none.
In addition, there was a significantly greater improvement in the symptoms of nasal congestion and resistance to inhalation in the experimental group, as compared with those in the control group (data not shown). These findings correlated closely with favorable changes in the pulmonary function tests (Table 4), including a moderate increase in vital capacity and a reduction in residual volume (RV), and airways resistance to airflow ($R_{aw}$). Table 4 reflects the values for VC and RV, as percentages of normally expected vital capacity, documented for the experimental group. There were insignificant changes in the plethysmography values for the control group (data not shown).

Table 4: Plethysmographic Values for the Experimental Group.

<table>
<thead>
<tr>
<th>Pulmonary Function Test</th>
<th>Before Treatment (SD)</th>
<th>After Treatment (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{aw}$</td>
<td>0.43 (0.28)</td>
<td>0.31 (0.14)</td>
</tr>
<tr>
<td>VC</td>
<td>95% (14%)</td>
<td>108% (16%)</td>
</tr>
<tr>
<td>RV</td>
<td>16.2% (3.2%)</td>
<td>13% (3.4%)</td>
</tr>
</tbody>
</table>

$R_{aw}$ = airways resistance. $R_{aw}$ is defined as kilopascal pressure/liter/sec. VC = vital capacity, RV = residual volume. Numbers in brackets represent standard deviations (SD). Statistical $P$ values were equal or less than 5% ($p < 0.05$) for all numbers shown above.

Table 5 represents the data from the flow-volume loops in percentages of delta ($\delta$) values at the completion of the 20th treatment session. These values represent forced vital capacity (FVC), peak expiratory flow (PEF), and forced expiratory flow at 50% (FEF50). These values are shown as percentages of vital capacity. The magnitude of the delta values ($\delta$) for FVC was approximately twice as much for patients in the experimental group than for those in the control group. The delta values for PEF and FEF50 for patients in the experimental group were 53% and 147% greater, respectively, than those for patients in the control group.

Table 5: Improvement in Respiratory Function After Treatment.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Experimental Group (SD)</th>
<th>Control Group (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FVC</td>
<td>11% (3.2%)</td>
<td>5.7% (1.8%)</td>
</tr>
<tr>
<td>PEF</td>
<td>23% (4.7%)</td>
<td>15% (3.2%)</td>
</tr>
<tr>
<td>FEF50</td>
<td>22% (4.9%)</td>
<td>8.9% (2.1%)</td>
</tr>
</tbody>
</table>

FVC = forced vital capacity, PEF = peak expiratory flow, FEF50 = forced expiratory flow at 50%. The $P$ value for the above data was < 0.01. Numbers in brackets are standard deviations (SD).

IgA, IgG and IgM: At the completion of the study, the blood levels of IgA, IgG and IgM, which were abnormally low in both groups at the beginning of the study, improved by 50%, 33% and 71%, respectively, in 84-88% of patients in the experimental group. In the control group, these values increased slightly (12%-20%), however, they remained at subnormal levels in 74-77% of the patients (Table 6). The levels of these immune indices did not change significantly in 14-16% of patients in the experimental group, compared with 23-26% of the patients in the control group.

T-Cells: As shown in Table 6, these cells represent a subpopulation of T-lymphocytes that are predominantly of T-helper and T-suppressor types. At the completion of the study, the serum levels
of T-helper cells, declined by 8% in the experimental group, compared with a 5% decline in the control group. These changes occurred in 83% of the patients in the experimental group and in only 71% of those in the control group. The percentage of patients in whom the T-cell levels did not change stood at approximately 17% and 29%, for the experimental and control groups, respectively.

Table 6: Changes in the Serum Indices of Immune System.

<table>
<thead>
<tr>
<th>Index</th>
<th>Before Treatment</th>
<th>After Treatment</th>
<th>Normal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Experimental</td>
<td>Control</td>
<td>Experimental</td>
</tr>
<tr>
<td>IgA, mg/mL</td>
<td>1.52 (0.1)</td>
<td>1.5 (0.1)</td>
<td>2.3 (0.2)</td>
</tr>
<tr>
<td>IgG, mg/mL</td>
<td>8.0 (0.3)</td>
<td>7.5 (0.5)</td>
<td>10.7 (0.3)</td>
</tr>
<tr>
<td>IgM, mg/mL</td>
<td>0.7 (0.15)</td>
<td>0.7 (0.09)</td>
<td>1.2 (0.1)</td>
</tr>
<tr>
<td>T-lympho /µL</td>
<td>1200.4 (54.3)</td>
<td>1227.6 (53.6)</td>
<td>1109.6 (62.3)</td>
</tr>
<tr>
<td>T-helpers /µL</td>
<td>1246.6 (51.3)</td>
<td>1240.5 (50.8)</td>
<td>980.7 (62.3)</td>
</tr>
<tr>
<td>T-suppressors /µL</td>
<td>240.5 (19.8)</td>
<td>240.4 (20.3)</td>
<td>335.9 (24.6)</td>
</tr>
</tbody>
</table>

Numbers in brackets represent the standard deviations.  P < 0.05 for all values.

DISCUSSION

The two most significant findings of this study were that the experimental protocol was as safe and more effective than the control protocol, and that the majority of the patients in both groups reported significant improvement for their symptoms. However, the magnitude and quality of symptom improvements were greater in the experimental group than in the control group. These findings were consistent with the findings reported by other studies (Astasidis, 1986a, 1986b, 1991; Iliinsky, 1991).

Safety:
Evidence in support of the safety of the experimental protocol comes from the fact that none of the patients developed a serious, life-threatening reaction to any treatment. The transient and mild flare-up that was reported in 22 of the patients early in their exposure to the experimental protocol, were relieved within 1-3 days, and all of these patients chose to return voluntarily to the study. It is likely that the symptoms were due to an exaggerated bronchial drainage, because of a transient hyperactivity of the mucus-secreting cells in small bronchi and bronchioles. Also, the fact that the mild flare-up did not recur in any of these patients during the rest of the study further supports the safety of the experimental protocol. In a previous study (Astasidis, 1991), similar mild reactions had been in about 30% of patients in exposure to the inhalation therapy.

Overall Clinical Outcomes:
The combined total and partial improvements in the frequency and intensity of asthmatic attacks and breathing difficulty of patients in the experimental group exceeded by 17% (87% Vs 70%) compared with the control group (Table 4). These results correlated well with improvement in lung rales (Table 4), the use of beta-agonists and corticosteroids (Table 5), and the improved sleep pattern, fatigue and anxiety reported by the patients in the experimental group. For the clinicians, who are challenged with the immunogenic, infective, environmental and emotional constraints in the management of asthmatic patients, the 17% improvement in the clinical outcomes is clearly important. The moderately higher clinical outcomes were likely to be associated with the physical modalities, although the placebo effect is not discounted. Also, whether the effects of the modalities were additive or synergistic beyond that of pharmacotherapy could not be deduced by the present results.
The authors do not claim that all patients with asthma should be treated by the experimental protocol presented in this study. Rather, we feel that the findings are noteworthy among the treatment options that may be considered, particularly for patients with chronic asthma. Undoubtedly, much future research is required to elucidate the specific role for each of the physical modalities in the enhancement of the clinical outcomes in asthma. If proven useful, these physical modalities may assume a distinct and limited role in the management of some patients with chronic asthma.

Effects on Respiratory Airways Drainage:
A pathological process in asthma is impaired drainage of the respiratory airways. Results from lung auscultations (Table 4) suggest that the addition of physical modalities to the treatment protocol might have positively influenced the drainage mechanisms. In this context, the aerosolized ions of sodium, calcium, magnesium and potassium inhaled during speleotherapy might have played a role in the relief of the airways inflammation or in the elimination of infective agents that caused the chronic inflammation.

Effects on Drug-Resistant Patients:
It is well known that a percentage of patients with severe bronchial asthma, who are dependent on corticosteroids, will eventually become resistant to the drugs over time (Miller, 2001). Results from previous studies (Astashisdis, 1986a & 1991; Iliinsky, 1991; Alexandrova, 1999) and present report indicate that pharmacotherapy combined with certain physical modalities may facilitate patients’ recovery, and more importantly, reduced the number of chronic asthmatic cases that were resistant to pharmacotherapy alone.

Table 7 represents the percentages of patients with chronic asthma whose symptoms were relieved efficiently by combining one or more physical modalities to pharmacotherapy. These patients would have otherwise been partially or fully resistant to pharmacotherapy studies (Astashisdis, 1986a & 1991; Iliinsky, 1991; Alexandrova, 1999).

Table 7: Role of Physical Modalities in the Clinical Outcomes.

<table>
<thead>
<tr>
<th>Combined Treatment Method</th>
<th>% of Patients*</th>
<th>Reference(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pharmacotherapy + Acupuncture</td>
<td>7-9%</td>
<td>Astashisdis, 1986(b)</td>
</tr>
<tr>
<td>Pharmacotherapy + BCLB</td>
<td>6-7%</td>
<td>Astashisdis, 1986(a), 1991</td>
</tr>
<tr>
<td>Pharmacotherapy + Acupuncture + Speleotherapy</td>
<td>10-12%</td>
<td>Astashisdis, 1991</td>
</tr>
<tr>
<td>Pharmacotherapy + Acupuncture + TCES</td>
<td>7-10%</td>
<td>Iliinsky, 1991</td>
</tr>
<tr>
<td>Pharmacotherapy + Acupuncture + Speleotherapy + BCRL</td>
<td>11-13.5%</td>
<td>Astashisdis, 1991</td>
</tr>
<tr>
<td>Pharm. + Acupuncture + Speleotherapy + BCRL + TCES</td>
<td>16 -18.5%</td>
<td>Present study</td>
</tr>
</tbody>
</table>

* = Percentage of pharmacotherapy-resistant patients, treated effectively for asthmatic symptoms.

Effects on Respiratory Functions:
The data obtained from plethysmography and respiratory function tests (Tables 4 and 5) suggest a moderately better clinical outcomes for the experimental protocol over those achieved by pharmacotherapy alone. The results also suggest that the physical modalities might have had a positive influence on the immune system to control asthma. The decline in the resistance to bronchial airflow and residual volume, and the increase in vital capacity suggest that the experimental protocol
must have effectively relieved the airways inflammation. The inflammatory reaction in asthma is thought to be associated with inadequately regulated CD4 T-cells, hyperactivity of local mast cells, hypersecretion of histamine, leukotrienes and antigen-specific IgE, and eosinophilia in the bronchial airways (Selgrade, 1997; Kline, 1994; Chuchalin, 1989; Kon, 1999). Limited immunological data presented by our present study suggest that the experimental protocol might have influenced the activation of T-cells function. Also, results from previous studies (Taylor, 1976; Jungi, 1990; Konovalov, 1990 & 1992) are consistent with the data on respiratory functions presented in this study (Table 5).

Effects on Immune System:
The data in Table 6 may suggest an association between the physical modalities and improvements in the immune system by influencing a greater production of IgA, IgG and IgM synthesis. These effects are not likely to be associated with the drugs, as some of these drugs, e.g., corticosteroids, are known to inhibit the immune system and protein synthesis. However, the specific effects of the physical modalities on the immune system awaits much future research.

CONCLUSION

The clinical, laboratory and functional results and observations obtained in this study suggest that treatment of patients with chronic asthma might meet with more success if pharmacotherapy is combined with the physical modalities used in this study. The experimental protocol may find acceptance among the popular treatment options that are available to the health care providers in the management of chronic asthma. The experimental protocol appeared to enhance the patients’ respiratory and immune functions, significantly reduced the needs for prescribing beta-agonists and corticosteroids, and improved the overall clinical outcomes of patients with chronic asthma.

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