CLINICAL REVIEW

The effect of the pulsatile electromagnetic field in patients suffering from chronic obstructive pulmonary disease and bronchial asthma

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Abstract

Pulsatile electromagnetotherapy (PETh) stimulates biological tissues and processes; it modulates ion exchange across cell membranes and thus regulates the tone of smooth muscles. On the basis of these effects we hypothetized that PETh might treat COPD and bronchial asthma.
We examined 117 (61 females, 56 males) adult patients who were decided in 4 groups. The 1st consisted of 16 patients with COPD who were treated by PETh and pharmacologically. The 2nd group (control) consisted of 24 patients with COPD who were treated only with medicaments. The 3rd group consisted of 37 asthmatics, treated by PETh and medicaments. The 4th group (control) consisted of 40 asthmatics treated only with medicaments. The effectiveness of PETh was assessed by lung function tests, which were performed using a Spirometer 100 Handi (Germany). We measured FVCex, FEV1, percentage of FEV1/FVCex, MEF25, 50, 75, PEF and registered the flow-volume loops.
PETh was applied by apparatus MTU 500H (Therapy System, Czech Republic). It was administered 10 doses; once daily for 20 min, with a frequency of 4.5 Hz and a magnetic induction 3 T. The initial 3 doses were about 25 % lower then the later doses. PETh was very effective in patients with COPD. The measured indexes imrpoved about 200–660 ml or ml.s^{-1}, except FVC. PETh was less effective in asthmatics. Most indices improved without statistical significance, about 50–620 ml or ml.s^{-1}. The indices of FEV1/FVC and MEF25 deteriorated. The changes in controls without PETh were very small. ***(Tab. 2, Fig. 1, Ref. 19.)***
Key words: pulsatile electromagnetic field, effect of magnetic field, chronic, obstructive pulmonary disease, bronchial asthma.

The Ministry of Health assigned to us a pulsatile electromagnetic therapeutic (PETh) apparatus to test its effectiveness. Study of the literature shows that the PETh can be effective mainly in diseases of the musculoskeletal system. This fact we verified in our previous study (1). The beneficial effect attracted our interest in this old therapeutic method which could have a renaissance in medicine. In present study we have focused on lung diseases because the information about the usefulness of PETh in these conditions is rare.

We were curiously first of all about its use in the treatment of patients suffering from chronic obstructive pulmonary disease (COPD) and bronchial asthma. We assessed the effectiveness of PETh on the basis of lung function tests.

Material and methods

Subjects

One hundred and seventeen patients, 61 females and 56 males participated in this study; that were devided in 4 groups.

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Acknowledgement: The authors are indebted to Prof. J.G. Widdicombe for the continuous and stimulating discussions.
This work was supported by grants from the Jessenius Faculty of Medicine, Comenius University, Martin, Slovakia.

Tab. 1. Differences between predicted values of indices and actual values found either before PETh (groups 1 and 3) or in controls without PETh (groups 2 and 4).

	FVC l	FEV1 L	FEV1/FVC %	MEF25 $l.s^{-1}$	MEF50 $l.s^{-1}$	MEF75 $l.s^{-1}$	PEF $l.s^{-1}$
Group 1 COPD with PETh (n=16)							
Mean	+0.07	+1.15	+24.56	+1.32	+3.29	+4.11	+3.05
S.E.M.	2.212	0.141	3.516	0.157	0.189	0.351	0.414
p	NS	***	***	***	***	***	***
Group 2 COPD without PETh (n=24)							
Mean	+1.01	+0.93	+6.05	+0.49	+1.82	+3.01	+3.06
S.E.M.	1.135	0.110	2.305	0.098	0.215	0.279	0.311
p	***	***	*	***	***	***	***
Group 3 Asthma with PETh (n=37)							
Mean	+0.76	+0.93	+9.84	+0.72	+1.77	+2.55	+2.50
S.E.M.	0.129	0.123	2.121	+0.123	0.242	0.325	0.332
p	***	***	***	***	***	***	***
Group 4 Asthma without PETh (n=40)							
Mean	+0.56	+0.83	+11.24	+0.72	+1.92	+2.58	+0.278
S.E.M.	0.077	0.070	2.183	0.101	0.163	0.234	0.278
p	NS	***	***	***	***	***	***

- = decrease in value, + = increase in value, * $p<0.05$, ** $p<0.01$, *** $p<0.001$, NS = not significant.

The 1st group consisted of 16 patients, 4 females and 12 males, aged 54±4 (mean±S.E.M.) yr, who were hospitalized at the Department of pneumophtisiolgy in Martin Teaching Hospital with diagnosis of chronic obstructive pulmonary disease (COPD) and were treated by PETh except the relevant medication.

The 2nd group was a control, and consisted of 24 patients, 8 females and 16 males, aged 69.3±1.8 yr; they had COPD and were treated in the Martin Teaching Hospital with relevant medication but without PETh.

The 3rd group consisted of 37 patients, 23 females and 14 males, aged 42.2±2 yr who were admitted to the Sanatorium Helios, High Tatra, with diagnosis bronchial asthma and were treated by PETh except the relevant medication.

The 4th group was again a control, and consisted of 40 asthmatic patients, 26 females and 14 males, aged 51.7±11 yr who were treated in the Sanatorium Helios with the relevant medication but without PETh.

All patients had been previously diagnosed as having COPD or bronchial asthma on the basis of criteria of British Thoracic Society (2, 3). The patients were clinically stable. They had a regular therapeutic regime for at least 4 weeks before entering the study as required by health dispensation centres. For the study were selected patients with approximately the same degree of severity and requirement for therapy.

The patients with COPD had coughing every day, all day which was provoked by changes of their postural position or by changes in the quality of the environment (cold, dust etc.). They had respiratory difficulties from early infancy and suffered very often from viral infections, angina, bronchitis and repeated pneumonia. These patients were treated by anticholinergic, ß-agonists, methylxanthine, antiphlogistic, expectorant and antitussive agents in response to individual requirements.

The patients suffering from bronchial asthma had previously shown allergic responses to dust, pollen, mitts etc., and bronchoconstriction to cold. Three patients had asthma after lung lobectomy. The asthmatics were treated mainly by ß-agonist, methylxanthine and inhaled corticoid agents. This basic therapy was continued in accordance with the requirements of health dispensaxaetion centres. All patients had been non-smokers for more than 20 years.

For all patients we recorded their medical histories. We made routine examinations of chest (physical, x-ray etc.) and blood. We cultivated sputum and assessed microbic flora. These results are not presented, since they were used only to confirm the clinical diagnosis and status.

The Ethics Committees of the Martin Teaching Hospital and the Sanatorium Helios approved the study. Basic therapy was not withdrawn because of the decision of these committees.

Pulmonary function tests

The effectiveness of PETh we assessed on the basis of lung function tests. The measurements were performed using a Spirometer 100 Handi (ZAN, Germany) in accordance with standardi-

Tab. 2. Differences between values of indices before and after either PETh (groups 1 and 3) or in controls without PETh (groups 2 and 4).

	FVC l	FEV1 L	FEV1/FVC %	MEF25 $l.s^{-1}$	MEF50 $l.s^{-1}$	MEF75 $l.s^{-1}$	PEF $l.s^{-1}$
Group 1 COPD with PETh (n=16)							
Mean	-0.03	+0.27	+7.50	+0.32	+0.20	+0.41	+0.66
S.E.M.	0.024	0.057	1.639	0.063	0.052	0.150	0.097
p	NS	***	***	***	**	*	***
Group 2 COPD without PETh (n=24)							
Mean	-0.03	-0.06	-1.83	-0.03	+0.02	-0.06	-0.06
S.E.M.	0.021	0.034	2.090	0.020	0.018	0.037	0.028
p	NS	NS	NS	NS	NS	NS	NS
Group 3 Asthma with PETh (n=37)							
Mean	+0.15	+0.05	-1.79	-0.03	+0.05	+0.28	+0.62
S.E.M.	0.077	0.071	1.575	0.104	0.142	0.245	0.249
p	NS	NS	NS	NS	NS	NS	NS
Group 4 Asthma without PETh (n=40)							
Mean	+0.13	+0.05	-1.70	+0.05	+0.06	+0.15	+0.26
S.E.M.	0.071	0.051	1.208	0.070	0.108	0.174	0.206
p	NS	NS	NS	NS	NS	NS	NS

- = decrease in value, + = increase in value, * $p<0.05$, ** $p<0.01$, *** $p<0.001$, NS = not significant.

zed guidelines. Expiratory forced vital capacity (FVCex) (1), forced expiratory volume in 1 s (FEV1) (1), percentage of FEV1/FVCex, maximal expiratory flow (MEF, $l.s^{-1}$!) at 75 %, 50 % and 25 %, peak expiratory flow (PEF, $l.s^{-1}$) were measured before and after PETh. Spirometric performance in patients of the control groups was recorded over the same time span as for the patients of the PETh groups. The changes in flow-volume loops were also recorded.

Magnetotherapy

The pulsatile electromagnetic field was applied by the apparatus MTU 500H (Therapy System, Brno, Czech Republic). We administered 10 doses; once dail for 20 minutes. The pulsatile electromagnetic field had a frequency 4.5 Hz and magnetic induction 3 mT. The initial 3 administrations were about 25 % lower in strenghts than the later full doses. These doses were recommended by the manufacturer (Biotrop parameters for MTU 500H).

Statistical analysis

Student's t test for paired samples was used to analyze the effect of the PETh on absolute differences of pulmonary parameters. The normal distribution of the tested samples was verified by the Kolmogorov—Smirnov's test. A p-value less than 0.05 was taken to indicate statistical significance. In tables we presented the mean, standard error of mean (S.E.M.) and p-value for the differences between predicted values of indices and actual values founbd either before PETh or in controls without PETh and the differences between values of indices before and after either PETh or in controls without PETh. The differences were used since these give better information about changes than do presentations of individual values.

Results

The Table 1 shows the differences between predicted and the actual values of indices of pulmonary function tests which was found either before PETh or without PETh.

In patients with COPD and bronchial asthma with PETh the predicted values of indices naturally exceeded the actual values and therefore the differences were statistically significant (groups 1 and 3) (Tab. 1).

Similarly, the described values were statistically significant in patients without PETh (groups 2 and 4) (Tab. 1).

Table 2 demonstrates the differences between values of indices before and after PETh and in controls. In patients with COPD and with applied PETh, all values of measureed indices showed statistical significance, except FVC (group 1) (Tab. 2). The bronchitis reported a subjective improvement of the ventilation and felt better. They had pink cheeks and elevated mood. At this time they did not want take medication what they explained that they are not dependent on medicaments thanks to PETh. Without PETh the differences at the beginning and the end of study period in bronchitics were not statistically significant (group 2) (Tab. 2).

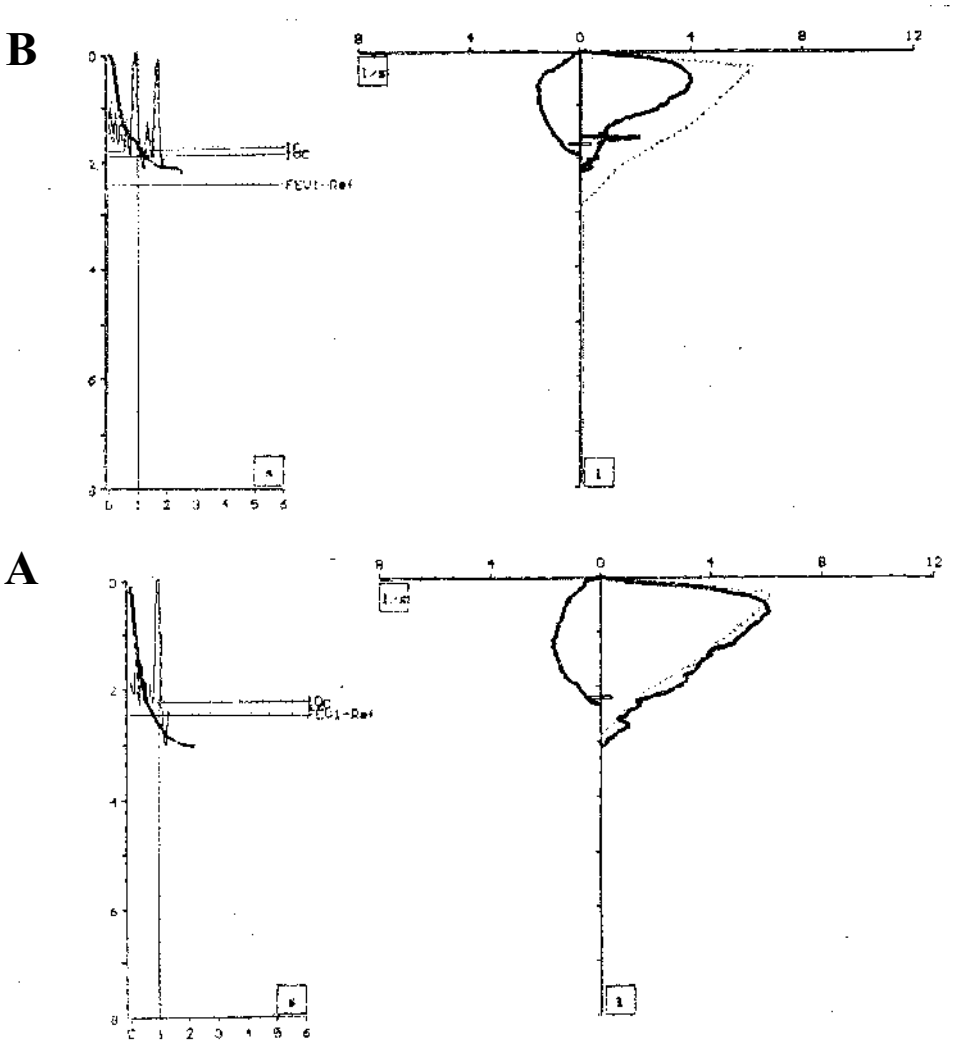

Fig. 1. The flow-volume loop from a patient suffering from bronchial asthma (55 yr old female). B – before therapy, A – after therapy.

Patients suffering from asthma despite of PETh did not show statisticaal differences of measured values (group 3) (Tab. 2). The improvements of FEV1 of 50 ml, MEF50 of 50 ml, and MEF75 of 280 ml and PEF of 620 ml were not statistically significant. The indices of FEV1/FVC and MEF25 were deteriorated. The asthmatics treated with relevant medication but without PETh after 10 days of observation showed no significant differences (group 4) (Tab. 2).

In majority of asthmatics with PETh the flow-volume loops tended to improve. The results for one patient are presented in Figure 1.

In tables we presented the most interesting indexes, only.

Discussion

The application of magnetic field for therapeutic purpose has along-term history. Theodor Priscanus studied the effect of the magnetic field on the headache already in the 4th century. Paracelsus was interested about the magnetotherapy in 16th century and the famous Mesmer in 18th one. At the end of 19th century Herman and Charcot studied the influence of the magnetism on body function and psychic. The first scientists who had interest about the pulsatile electromagnetic field in patients were D'Arsonval and Berlow (4). In 20th century the effect of magnetic field was well know in patients suffering from rheumatism, joint ache, melalgia, torture in tabes etc.

It was confirmed at present, that PETh is effective mainly in diseases of disorders of musculoskeletal system, rheumatism, chronic lesions of lower extremities etc. as shown in the literature (5). Very good effect have been obtained also in neurology (6), particularly in therapy of multiple sclerosis and of spasmodic states. The method has also been very successful in ophthalmology in therapy of degenerative conditions, e.g. retina (6, 7, 8).

In former Czecho-Slovakia a study was made of the effectiveness of PETh in selected clinics. Unfortunately the use of PETh in lung diseases has not been included in these projects. Cholodov

(9) made a list of clinical indications of PETh in which this possible particular therapy was mentioned.

The justification for this therapy resulted from the knowledge that a magnetic field has a stimulating effect on biological processes; it produces a favourable response in cellular and immunological actions and enhances the passage of ion exchange across cell membranes; the discharge or binding of Ca^{2+} ions inside cells; and the increased or decreased tone of smooth muscles (5, 9, 10, 11, 12, 13).

On the basis of the favourable effect of magnetic fields on organism we explored the possibility of treating inflammatory processes of the airways and lungs. These processes are characterized by hypersecretion of mucus and spasm of the airway smooth muscle. The requirement of the successful PETh is the quality of the applied magnetic impulses. They must be tissue-specific. It is possible to apply single or bursts of impulses, to change their duration and the timing of their rise and fall. The frequency of impulses is also very important. We have used apparatus, which has programmable indices of the magnetic field, which ensured the most effective therapy. The apparatus and the choice of the quality of applied magnetic impulses was made based on the valuable experience of Chvojka (6, 7, 8), who is the expert of Czech Ministry of Health for PETh.

In our study, the routine medication of asthma was not interrupted in patients for ethical reasons.

The effectiveness of PETh was assessed on the basis of lung function tests, which obviously have an important role in routine clinical evaluation of pulmonary disorders. They give quantitative data about the progress of lung disease as well as its response to treatment (14, 15, 16).

The creation of a control group was a problem. The control patients and the PETh-treated are naturally only roughly identical. The clinical colleagues advised us to put the patients in a switch-off magnetic field applicator. We regarded this to be unsuitable since it would be misleading for the patients (non ethical).

PETh was very successful in patients suffering from COPD. Except for FVC the other indices increased: FEV1 about 270 ml, MEF25 about 320 $ml.l^{-1}$, MEF50 about 200 $ml.l^{-1}$, MEF75 about 410 $ml.l^{-1}$, PEF as much as 660 $ml.l^{-1}$ and FEV1/FVC 7.5 % (Tab. 2). This improvement was also subjective. The patients breathed more easily; and the amount and density of mucus seemed improved. The patients had no complaints and requested the continuation of PETh. Their quality of life was improved. In patients with COPD, who were treated only by drugs, therapy was ineffective. They were in stabilized condition without marked improvement of lung function indices.

In asthmatics PETh was less successful. We did not find statistical significances between measured values of indices before and after PETh. The values of PEF non-significantly increased in average of 620 $ml.s^{-1}$, what therapeutically is not negligible. The increasing of other values did not exceed 50 ml or 50 $ml.s^{-1}$. The indices of MEF25 and FEV1/FVC deteriorated. Despite of this moderate effect in asthmatics, the spasm of the airway smooth muscle may have been relaxed as judged by auscultation. Perception of the ventilation was eased. The ease of expectoration was improved. It was interesting that most of the treated asthmatics fell asleep after laying in PETh applicator because their ventilation was made easier. We suggest that the improvement of respiratory indexes might be more marked with repeated application of PETh for a period of 3 month as it is recommended by Chvojka (6, 7, 8).

In the control group 4 of asthmatics the measured indices on the whole did not reach the post-PETh values of the group 3.

We conclude that PETh can potentiate classical pharmacological treatment. The success of PETh is good in patients with COPD. In asthmatics an objective effect was less marked and the changes were statistically not significant. Despite of the effect subjectively was present and therefore PETh can be recommend in both conditions. The difference in effectiveness may by due to the different pathologies of asthma and COPD. COPD is a disorder characterized by reduced maximum expiratory flow and forced emptying of the lungs, features which do not change markedly over several month. Asthma is a chronic inflammatory disorder of the airway in which many cells play a role. In susceptible individuals this inflammation causes symptoms which are usually associated with widespread but variable and reversible airflow obstruction. It is associated with increased responsiveness to variety of stimuli (2, 3, 17, 18, 19).

Our clinical colleagues accepted our result and recommended PETh for mentioned conditions. It is well known from practice that even the mild increase of gas exchange in lungs (e.g. a few ml), although statistically not significant, might improve the oxygen supply to the body and by this way it makes better the clinical status.

The differences between predicted indices and the actual ones in all study groups were statistically highly significant, which testified to the gravity of the conditions and justified the selection of patients.

We did not see any negative effects of PETh.

Description of the use of PETh in lung disease has previously been absent from the literature, except for the allusion by Cholodov (1971) which has been mentioned.

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Received February 6, 2002.
Accepted June 20, 2002.