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Abstract

Twenty-five patients with intractable asthma had swimming training in a hot spring pool for 3 months. The subjects were divided into three groups according to their clinical symptoms and ages. Changes of ventilatory function during swimming training were observed in each group. The ventilatory function test revealed that free swimming training in a hot spring pool for 30 min did not induce bronchoconstriction in any of the groups. The values of ventilatory parameters such as FEV 1.0%, %PEFR, %V50 and %V25 were improved after the 3-month swimming training. The improvement of ventilatory parameters, especially %MMF, %V50 and %V25, by the training was most remarkable in the type II asthma group. The percent increase in %MMF, %V50 and %V25 was highest in patients more than 61 years of age, and higher in patients aged 40 to 60 years than in younger patients.

KEYWORDS: ventilatory function, spa therapy, swimming training, intractable asthma.

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Improvement of Ventilatory Function by Spa Therapy in Patients with Intractable Asthma

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Twenty-five patients with intractable asthma had swimming training in a hot spring pool for 3 months. The subjects were divided into three groups according to their clinical symptoms and ages. Changes of ventilatory function during swimming training were observed in each group. The ventilatory function test revealed that free swimming training in a hot spring pool for 30 min did not induce bronchoconstriction in any of the groups. The values of ventilatory parameters such as FEV_{1.0%}, %PEFR, % $\dot{V}_{50}$ and % $\dot{V}_{25}$ were improved after the 3-month swimming training. The improvement of ventilatory parameters, especially %MMF, % $\dot{V}_{50}$ and % $\dot{V}_{25}$, by the training was most remarkable in the type II asthma group. The percent increase in %MMF, % $\dot{V}_{50}$ and % $\dot{V}_{25}$ was highest in patients more than 61 years of age, and higher in patients aged 40 to 60 years than in younger patients.

Key words : ventilatory function, spa therapy, swimming training, intractable asthma.

Bronchial asthma is characterized by an increased responsiveness of the airways to various stimuli. The majority of asthma attacks which are manifested by recurrent episodes of generalized airway obstruction are usually reversible and controllable by usual anti-asthmatic drugs. In some patients, however, the attacks are severe and chronic, and very difficult for physicians to control without corticosteroids. There are several problems in the treatment of these patients: firstly, their attacks require long-term therapy with corticosteroids, and secondly, exercise easily induces bronchoconstriction (exercise-induced asthma (1-5)).

Our previous studies on therapies for bronchial asthma have shown that spa therapy, especially swimming training in a hot spring pool, is a very effective therapy for steroid-dependent intractable asthma (6-8).

In the present study, changes in ventilatory function after spa therapy (swimming training) were examined in intractable asthma patients classified by clinical findings (9, 10) and age.

Subjects and Methods

Subjects. Twenty-five patients (6 females and 19 males) with bronchial asthma admitted to Okayama University Medical School, Misasa Medical Branch for spa therapy, *i.e.* swimming training in a hot spring pool. Their mean age was 50.0 years (16-69). All patients had been on oral prednisolone at a steady maintenance dose of 5 to 20 mg/day for at least one year.

Clinical classification of asthma. The subjects were classified into three types: 1-a, bronchospasm type; 1-b, bronchospasm+hypersecretion type, and II, bronchiolar obstruction type, according to their clinical findings (9, 10). The charac-

teristics of each type are as follows : The attacks of the 1-a (bronchospasm) type are mainly manifested by bronchospasm. The attacks of the 1-b (bronchospasm + hypersecretion) type are manifested by bronchospasm and hypersecretion (with sputum of 100 ml/day or more). The attacks of the II (bronchiolar obstruction) type are related to obstruction of bronchioles as well as to bronchospasm.

Improvement of clinical symptoms (cough, expectoration, wheezing and dyspnea) was observed in 4 out of 7 cases in type 1-a, in 9 out of 11 cases in type 1-b and in all cases in type II after the 3-month spa therapy.

Swimming training in a hot spring pool. All asthmatic patients underwent swimming training in a hot spring pool at Okayama University Medical School, Misasa Medical Branch. As their attacks were easily affected by environmental changes, the temperature of the room (27°C) and hot spring water (30°C) were kept constant. Under suitable conditions, free swimming training was carefully performed for 30 min a day, four times a week in the hot spring pool. All of the patients received the swimming training for 3 months. Changes in ventilatory function after the 3-month swimming training were compared to the values before the training.

Ventilatory function test. The ventilatory function test was performed using SPIROR-81 (Chest

Co.). The following parameters were used to observe changes in ventilatory function before and after the 3-month swimming training : % forced vital capacity (%FVC), forced expiratory volume in the first second/forced vital capacity (FEV_{1.0}%), % maximal mid-expiratory flow (%MMF), and % flow rate of 50% and 25% of the forced expiratory capacity (% $\dot{V}_{50}$, % $\dot{V}_{25}$).

Results

Effect of 30-min swimming training on ventilatory function. As bronchoconstriction is easily triggered in intractable asthma patients by a certain exertion load, the effect of each 30-min swimming training session on ventilatory function was examined. As shown in Table 1, a fall in FEV_{1.0}%, %PEFR, %MMF, % $\dot{V}_{50}$ and % $\dot{V}_{25}$, which represent obstruction of the airways, was not observed after the 30-min swimming training session. On the other hand, an increase in %MMF, % $\dot{V}_{50}$ and % $\dot{V}_{25}$ was observed in the patients of the type II asthma group after the swimming training. The type 1-a patients also showed an increase in % $\dot{V}_{25}$ after the training, although the increase in this parameter

Table 1 Changes in ventilatory function in patients with intractable asthma after a 30-min swimming training session in a hot spring pool.

Asthma type	No. of cases	30-min swimming training session	Ventilatory function					
			%FVC	FEV _{1.0} %	%PEFR	%MMF	% $\dot{V}_{50}$	% $\dot{V}_{25}$
1-a	7	Before	104*	67	78	45	39	29
			±15	±11	±20	±24	±24	±11
		After	102	67	82	45	37	30
			±15	±13	±21	±24	±22	±16
1-b	11	Before	108	63	87	42	32	28
			±23	±12	±31	±21	±20	±16
		After	108	63	87	42	31	33
			±25	±12	±33	±24	±19	±22
II	7	Before	78	66	66	23	22	15
			±28	±8	±8	±17	±17	±6
		After	77	69	71	34	24	20
			±27	±9	±21	±17	±14	±12

* Mean ± SD.

was not significant. The ventilatory function test suggests that free swimming training for 30 min does not generally induce bronchoconstriction and brings beneficial effects on bronchial asthma (Table 1).

Improvement of ventilatory function in all cases. The values of all parameters such as $FEV_{1.0\%}$, %PEFR, %MMF, % $\dot{V}_{50}$ and % $\dot{V}_{25}$, which represent obstruction of the airways, increased after 3 months of swimming training. The percent increase in $FEV_{1.0\%}$ was less than 10%, but the percent increase in the other parameters was more than 10%. The results show that the values of %MMF, % $\dot{V}_{50}$ and % $\dot{V}_{25}$, which are considered to show obstruction of small airways, are more improved by 3-month swimming training than the value of $FEV_{1.0\%}$ (Table 2).

Improvement of ventilatory function and asthma type. Improvement of ventilatory function after the 3-month swimming training was compared among the three asthma groups. The mean percent increase in %FVC was highest in the type II asthma group ($16.0 \pm 22.7\%$) (mean $\pm$ SD) compared to that in types 1-a ($4.3 \pm 5.0\%$) and 1-b ($2.0 \pm 2.7\%$), although the differences among them were not significant. The increase in $FEV_{1.0\%}$ was less than 10% in all asthma types. The percent increases in %MMF, % $\dot{V}_{50}$ and % $\dot{V}_{25}$ were the most remarkable in the type II asthma group. The increases were $25.4 \pm 24.1\%$, $28.9 \pm 22.0\%$ and $34.4 \pm 20.6\%$,

respectively. A significant difference was found in the percent increase in % $\dot{V}_{50}$ between type II and type 1-b ($p < 0.05$), and in % $\dot{V}_{25}$ between type II and type 1-b ($p < 0.02$) and between type II and 1-a ($p < 0.05$). These results show that ventilatory function of patients with intractable asthma was improved by 3 months of swimming training in a hot spring pool, and that the improvement of ventilatory function was most remarkable in %MMF, % $\dot{V}_{50}$ and % $\dot{V}_{25}$ of the type II asthma group (Fig. 1).

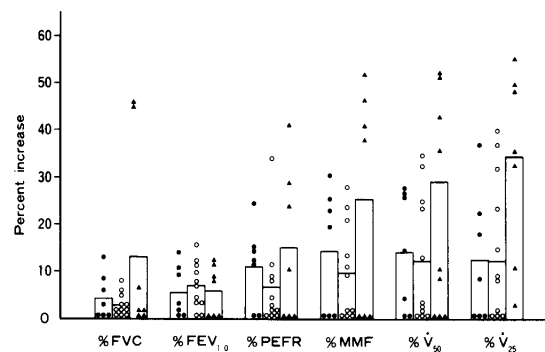


Fig. 1 Percent increase in each ventilatory parameter in three asthma types, 1-a (●), 1-b (○) and II (▲), after 3-month swimming training in a hot spring pool.

Improvement of ventilatory function and patient age. The improvement of ventilatory function by the 3-month swimming training was compared among three age groups: 16-40, 41-60 and more than 61 years. The mean percent increase in %FVC was highest ($16.9 \pm 22.1\%$) in patients more than 61 years of age, but no significant difference was present between type II and type 1-a asthma groups. The percent increase in $FEV_{1.0\%}$ was similar and less than 10% in all groups. The percent increase in %PEFR was most remarkable in patients aged 41 to 60 years, but no significant difference was found among the three groups. The percent increase in %MMF, % $\dot{V}_{50}$ and % $\dot{V}_{25}$ was most in patients more than 61 years of age,

Table 2 Improvement of ventilatory function in patients with intractable asthma after 3-month swimming training in a hot spring pool.

Ventilatory parameters	Values before the training	Percent increase after the training
%FVC	$98.6 \pm 25.5\%$ *	$6.6 \pm 13.2\%$
$FEV_{1.0\%}$	$65.0 \pm 10.3\%$	$5.6 \pm 5.1\%$
%PEFR	$79.4 \pm 26.2\%$	$10.1 \pm 11.9\%$
%MMF	$39.0 \pm 20.8\%$	$15.3 \pm 16.8\%$
% $\dot{V}_{50}$	$30.7 \pm 19.9\%$	$17.4 \pm 17.3\%$
% $\dot{V}_{25}$	$24.6 \pm 13.8\%$	$18.0 \pm 19.6\%$

* Mean $\pm$ SD.

and more in patients aged 41 to 60 years than in patients aged 16 to 40 years. A significant difference was found in $\% \dot{V}_{25}$ between patients aged 0-40 and those older than 61 years ($p < 0.05$) (Fig. 2).

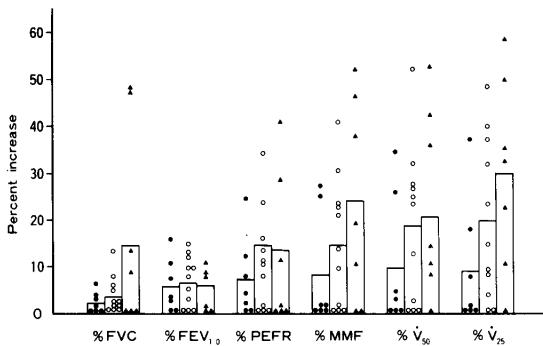


Fig. 2 Percent increase in each ventilatory parameter in three age groups, 0-40 years (●), 41-60 years (○), and over 61 years (▲), after 3-month swimming training in hot spring pool.

Discussion

There are several problems in the management of steroid-dependent intractable asthma. In the majority of patients with intractable asthma, bronchoconstriction is easily induced by a certain physical load (1-3, 9, 10). It has been reported that swimming training induces bronchoconstriction less frequently than other methods of exercise (11, 12). Another problem in the treatment of intractable asthma is that improvement of symptoms can not be attained by usual anti-asthmatic drugs. The attacks require a daily regimen of corticosteroids with adverse side effects. For these reasons, swimming training in a hot spring pool has been performed to improve symptoms and reduce the daily dose of corticosteroids used for the management of attacks. Our previous reports have shown that swimming training is one of the most beneficial ways for treatment of intractable asthma (6, 7). Moreover, a recent

report showed that swimming training in a hot spring pool was most effective in type II (bronchiolar obstruction type), rather effective in type 1-b (bronchospasm + hypersecretion type) and least effective in type 1-a (bronchospasm type) asthma patients (8). The results suggest that the clinical efficacy of swimming training is related to the asthma type defined by clinical symptoms.

In this study, improvement of ventilatory function after swimming training in a hot spring pool was examined in patients with intractable asthma. The results obtained here showed that the values of ventilatory parameters such as $\% FVC$, $FEV_{1.0\%}$, $\% PEFR$, $\% MMF$, $\% \dot{V}_{50}$ and $\% \dot{V}_{25}$ increased after the 3-month swimming training, and that out of these parameters, the percent increase in $\% MMF$, $\% \dot{V}_{50}$ and $\% \dot{V}_{25}$ was more remarkable than the increase in $FEV_{1.0\%}$. Moreover, regarding asthma types classified by clinical symptoms, the percent increase in $\% MMF$, $\% \dot{V}_{50}$ and $\% \dot{V}_{25}$ was highest in the type II asthma group. These results suggest that swimming training mainly improves obstruction of small airways. The clinical effects of swimming training are also related to patient age. Swimming training was most effective in patients more than 41 years of age (8). In this study, the percent increase in ventilatory parameters such as $\% MMF$, $\% \dot{V}_{50}$ and $\% \dot{V}_{25}$ after 3 months of training was considerably higher in patients more than 41 years of age. These results show that clinical effects of swimming training and the improvement of ventilatory function by the training are more remarkable in patients over 41 years of age.

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