Sauna to Transiently Improve Pulmonary Function in Patients with Obstructive Lung Disease

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ABSTRACT. Cox NJM, Oostendorp GM, Folgering HThM, van Herwaarden CLA: Sauna to transiently improve pulmonary function in patients with obstructive lung disease. Arch Phys Med Rehabil 70:911–913, 1989.

• The influence of sauna on pulmonary functioning in patients with an obstructive pulmonary disease was studied in 12 male patients by measuring forced vital capacity (FVC) and forced expiratory volume in one second on seven measure points the day of the sauna program. Despite the fact that body cooling and changes in osmolality of bronchial liquid can induce bronchoconstriction, we measured a significant improvement of the lung function parameters: FVC values were 3.22±0.89 and 3.6±0.99 before and after the sauna program, respectively. It is concluded that patients with an obstructive pulmonary disease can take part in sauna programs without eliciting bronchoconstriction; sauna even causes transient improvement of the lung function.

KEY WORDS: Obstructive pulmonary disease; Sauna

For many years the sauna has been part of our rehabilitation program for patients with obstructive pulmonary disease. Most participants report improvement of their airway conductivity. Many patients continue to visit the sauna on their own initiative after the end of the rehabilitation program.

Currently there is not much known about the effect of the sauna on the lung function parameters in these patients. The relation between pulmonary function and changes in temperature and humidity has been well established;[1-3] these studies have shown that the above-mentioned parameters can induce a bronchoconstriction. The temperature in the sauna cabin is high (90 to 110C), whereas the temperature of the water in the basin is low (5 to 10C). Hence, changes in temperature of the body take place in the sauna program and provocation of asthmatic complaints is possible. Furthermore, at the end of each sauna course, water is thrown on the heater; this causes a sudden increase in the relative humidity of the air and an increase in the water content of the inspired air. It is known that inhalation of hypotonic or hypertonic nebulized solutions can cause changes in osmolality of the bronchial liquid. The latter can induce bronchoconstriction.[5]

All this was not in agreement with our clinical experience; therefore, we decided to examine the influence of the sauna on the pulmonary function of patients.

METHODS

For the ambulant lung function test in the sauna we used the Calculair.[a] This is a portable electronic spirometer which measures the values of forced vital capacity (FVC), the forced expiratory volume in one second (FEV_1), and the peak expiratory flow rate (PEFR) in body temperature and pressure, saturated with water vapor (BTPS).

Abbreviations

BTPS	Body temperature and pressure, saturated with water vapor.
FVC	Forced vital capacity.
FEV_1	Forced expiratory volume in one second.
PEFR	Peak expiratory flow rate.
TLC	Total lung capacity.

First we examined the validity of this device. The correlation coefficients between the Calculair and the wet-spirometer[b] were 0.96 for FVC and 0.99 for FEV_1 and between Calculair and the Wright peak-flow meter[c] 0.97 for PEFR. Regression lines:

$y = 0.98x_1 + 0.80 \quad r = 0.96$ (for FVC)
$y = 1.09x_1 + 0.12 \quad r = 0.99$ (for FEV_1)
$y = 1.13x_2 + 0.53 \quad r = 0.97$ (for PEFR)
y = values measured with the Calculair device.
x_1 = values measured with the Pulmotest device.
x_2 = values measured with the Wright peak-flow meter.

Sequence and time of the different stages of the sauna were standardized. A warm shower was followed by ten minutes in the hot cabin (temperature 90C; relative humidity 15%). Subsequently, a cold shower and three immersions in a cold water bath (15C) were taken. Then a resting period of 10 to 15 minutes followed, after which the same procedure was repeated.

Heart rate, FVC, FEV_1, and PEFR were measured seven times: (1) At 8:45am, before the sauna. (2) Just before the sauna at about 3:30pm. (3) Immediately after leaving the sauna cabin. (4) After the cooling. (5) Immediately after leaving the cabin the second time. (6) After the cooling. (7) At 8:45am on the following day.

The highest values of two readings were recorded. This sauna program was repeated twice a week between 3:30 and 5:30pm. Twelve male patients from the rehabilitation group

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Table 1: Anthropometric Data of the Group Examined

Patient number	Age (yrs)	Height (cm)	Weight (kg)	TLC (l)	FVC (l)	FVC After inhalation of salbutamol	FEV_1 (l)	FEV_1 After inhalation of salbutamol	Treatment **
1	48	168	68	5.8(91)*	2.7(64)	2.8	1.4(42)*	1.7	1,5
2	58	178	83	6.3(88)	3.5(76)	3.7	2.0(57)	2.2	1,3
3	44	168	60	6.8(107)	2.0(46)	2.7	0.8(23)	1.0	1,3,4,5
4	33	171	70	7.7(117)	5.3(109)	5.3	3.2(81)	3.5	—
5	37	177	85	6.7(95)	5.1(100)	5.1	2.9(70)	3.4	1
6	49	170	63	5.7(88)	2.6(60)	3.2	1.4(41)	1.6	1,4,5
7	43	181	76	7.9(107)	3.6(70)	3.6	1.7(41)	2.0	1,2,4,5
8	51	174	56	7.0(103)	2.4(53)	2.5	1.1(31)	1.2	1,2,5
9	32	172	67	6.2(95)	2.5(51)	2.7	0.9(22)	1.0	1,4
10	38	183	90	6.8(90)	4.3(79)	4.3	2.1(48)	2.7	1
11	45	186	84	8.1(103)	5.0(92)	5.2	2.7(62)	3.3	1,4
12	39	168	59	7.3(116)	3.6(80)	3.9	1.4(39)	1.4	4

*Percentage of predicted value according to Quanjer.[8] **1 = B_2 sympathomimetics; 2 = Sodium cromoglycate; 3 = Anticholinergics; 4 = Theophylline; 5 = Corticosteroids.

participated. The characteristics of these patients are summarized in table 1.

During the whole test period all patients used an optimal pulmonary medication and were in a stable stage of their disease. Results are given as mean ± SD. Statistical analysis was carried out with the Student *t*-test for paired observations.

RESULTS

All results are presented in table 2. The results are compared with the values immediately before the sauna program (stage 2).

During the sauna program, there was a significant improvement in the FVC and FEV_1 (fig), but surprisingly, no decrease during the cooling stage was observed. Lung function tests on the day before and after the sauna showed the same values (1 and 7).

DISCUSSION

During the sauna program a slight improvement in lung function was observed, despite the fact that decrease in body temperature and changes in osmolality of bronchial liquid can induce a bronchoconstriction.[1,2,5]

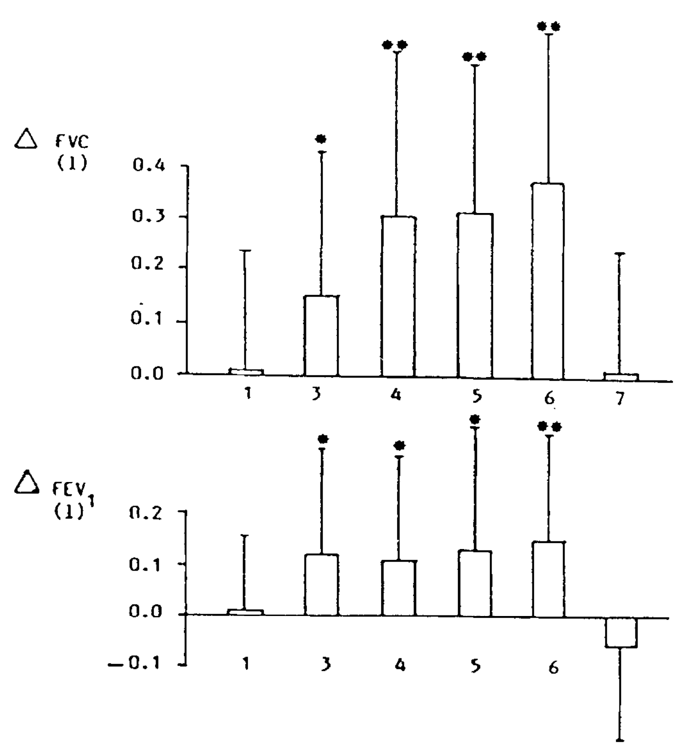
When the effect of sauna was compared to that of salbutamol, it appeared that the improvement in FEV_1 after sauna was 46% of the improvement after the use of salbutamol.

During the cabin stage, FVC and FEV_1 improved. This might be explained by a bronchodilating effect of the very warm, inspired air on the airways. It is a well-established fact that cooling of the bronchial mucosa causes bronchoconstriction.[3] It is conceivable that when breathing room air, the larger airways are already cooled (the esophageal temperature in a group of asthmatics breathing room air was found to be 30.6±1.5C),[6] and consequently somewhat restricted. When breathing ambient air of 90C, there is no more cooling and especially no heat loss.

Another possibility may be that there is an effect of the hot air in the cabin on the ventilatory muscles,[4] comparable to warming up before a sport performance. This leads to an increase in FEV_1 and FVC, as these parameters are partly effort dependent.[8] Furthermore, it is possible that the changes in temperature and condensation of water trigger the expectoration of mucus and thus improve the pulmonary function.

An explanation for the fact that there is no decrease in the above-mentioned parameters by body cooling (stages 4 and 5) could be that all patients had an optimal bronchodilatory treatment so that constriction of the bronchi could be prevented.

Changes in heart rate during the different stages are the well-known results of vasodilatation and constriction through variations in temperature.[7] Most of the patients enjoyed the sauna as part of our rehabilitation program because of its positive effect on their pulmonary functioning. The results of the pres-



Changes in FVC and FEV_1 in the different stages compared with stage 2, directly before the sauna course. (± SD; $n=12$) (Consequently all values for changes in FVC and FEV^1 at stage 2 are zero.) $*p<0.01$; $**p<0.001$.

Table 2: Influence of the Seven Stages of Sauna on FVC, FEV_1, and Heart Rate (Mean ± SD; $n = 12$)

Stage	1	2	3	4	5	6	7
FVC (l)	3.22 ± 0.89	3.22 ± 0.89	3.37 ± 0.96	3.53 ± 1.03	3.54 ± 0.99	3.60 ± 0.99	3.23 ± 0.90
FEV_1 (l/s)	1.65 ± 0.89	1.64 ± 0.89	1.76 ± 0.96	1.75 ± 0.79	1.77 ± 0.77	1.79 ± 0.79	1.58 ± 0.68
Heart rate (beats/min)	93 ± 14	93 ± 15	123 ± 20	86 ± 15	116 ± 19	88 ± 15	88 ± 15
***P* value vs stage 2**							
FVC	NS	–	<0.01	<0.001	<0.001	<0.001	NS
FEV_1	NS	–	<0.01	<0.01	<0.01	<0.001	NS
HR	NS	–	<0.001	<0.001	<0.001	<0.01	NS

ent study confirm these subjective feelings, and therefore we continue with the sauna as part of our rehabilitation program.

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Suppliers

a. Calculair model 413. Hospal. Uden, The Netherlands.
b. Pulmotest. Godart. Bilthoven, The Netherlands.
c. Wright Airmed Limited. Harlow, England.