Exercise-induced respiratory symptoms are not always asthma

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Eighty-eight patients with a history of exercise-induced respiratory symptoms performed a maximal exercise test in order to study the reasons for stopping the test. There was a wide range of percentage maximal fall in peak expiratory flow (PEF), from minus 3% to 63%, mean 11%, recorded 0-30 min, mean 12 min after the break. In the controls the maximal decrease was 0-16%, mean 6%. Diagnostic criteria for asthma were fulfilled by 48 patients (55%). Of these patients 42% had a fall in PEF ≥ 15% (exercise-induced asthma). Of the non-asthma patients 10% had a fall ≥ 15%. The most common reason for stopping the exercise in the asthma group was breathing troubles (46%), the most common reason in the non-asthma group was chest pain/discomfort (35%). In about 20% of the patients dizziness and/or pricking sensations in arms or legs indicated hyperventilation as an additional reason for stopping the exercise. It is concluded that other kinds of reaction, than bronchial obstruction such as breathing troubles not directly related to bronchial obstruction and chest pain, may be important factors that can restrict physical capacity in patients with exercise-induced respiratory symptoms.

Introduction

Physical exercise provokes bronchoconstriction in the majority of patients with clinically recognized asthma. Most exercise tests have been carried out as submaximal tests over 6-8 min on a bicycle ergometer or a motor-driven treadmill (1-3). After this period of time there may be a progressive bronchoconstriction which reaches its maximum within 10 min. A fall in forced expiratory volume in 1 s (FEV1) or peak expiratory flow (PEF) of more than 15% is usually considered as abnormal and is used as the definition of exercise-induced asthma. As greater ventilation and cold and dry air increases the tendency for bronchoconstriction, these factors have to be considered and standardized (2).

Most studies of exercise-induced asthma have focused on bronchial obstruction as the main clinical variable (3,4). Prevention and treatment of bronchospasm with inhaled β2-agonists and other drugs have also been successful in reducing patients complaints. However, many patients with airway or breathing problems do not report any significant effect of inhaled of the β2-agonist, and some exhibit symptoms not typical of asthma. Little attention has been paid to signs and symptoms other than bronchial obstruction and few researchers have discussed bronchoconstriction in relation to airway symptoms and physical capacity. In an earlier study using a standardized bicycle test, it was shown that a group of patients with asthma-like symptoms could be distinguished from patients with carefully defined asthma, especially regarding bronchoconstriction, oxygen saturation and rating of dyspnoea (5). The aim of this study was to observe different symptoms in relation to airway function tests, after a maximal exercise test in patients with a history of exercise-induced respiratory problems. The study was approved by the local scientific ethical committee.

Patients and method

Eighty-eight consecutively selected patients, (62 women and 26 men, mean age 37, range 16-70 years) with a history (identified by a questionnaire) of exercise-induced asthma-like symptoms, were included. All patients were referred to our outpatient asthma and allergy clinic for investigation of suspected asthma. The exercise test was part of this investigation. For the purpose of this study the criteria for the diagnosis of asthma were: 1. a history of wheezing, 2. β2-reversibility ≥ 15% in FEV1, or ≥ 20% in diurnal variation of PEF or a positive methacholine test (provocational concentration causing a 20% fall in FEV1, PC20 < 4 mg ml⁻¹). The exercise test was performed by running up a staircase in a building with six indoor floors (temperature 18-20°C, humidity 40-50 %). Ten healthy controls, eight women and two men, mean age 39, range 18-49, served as controls. The participants were instructed to run up and down the staircase without warming up and at a moderate tempo (not rushing and not walking), one floor higher each time for as long as possible, and to report the reason for stopping the exercise. If the patient was able to run up to
the sixth floor he/she was instructed to repeat this for as long as possible.

In 66 patients (75%) one or more drugs had earlier been prescribed for treatment of asthma and prevention of exercise-induced asthma; inhaled steroids (budesonide or beclomethasone 400–1600 μg day⁻¹) in 39 patients, an additional long-acting β₂-agonist (salmeterol) in eight patients and short-acting β₂-agonist (terbutaline or salbutamol) in 66 patients. Before the exercise test the patients were instructed not to take any bronchodilators for 12 h. Medication with inhaled steroids was not changed before the exercise. As an indication of atopy, 43 patients had a positive skin prick test to one or several common allergens (mite, pollen and animal dander). None of the patients had recently been exposed to allergens and none had a history of cardiac disease or other diseases relevant to the test.

Before and 0, 5, 10, 15, 20 and 30 min after finishing the exercise test, PEF (peak expiratory flow in 1 min⁻¹), peripheral oxygen saturation, pulse and heart rate and end-tidal CO₂ (Oscorox multigasmonitor and pulsoximeter, Datex instrument. corp.) were measured. The main reason for stopping the exercise was exerted. The first recording after the test was performed immediately after returning to the ground floor which took less than 1 min.

STATISTICS

Standard statistical methods were used for analysis of correlation (r). Fishers exact test was used for analysis of symptoms (reasons for stopping) in the asthma and non-asthma group. P < 0.05 was considered significant.

Results

All 88 patients and the 10 controls completed the test. All patients were able to run at least up to the second floor, 25 patients were able to run up and down six floors 2–6 times. All controls were able to run six floors up and down 1–5 times. The main reasons for stopping the exercise fell into four main categories: symptoms related to breathing (34%), symptoms related to chest pain/discomfort (26%), tiredness of the legs (27%) and other symptoms such as problems with the knees (13%). No injury or other unexpected event occurred. Mean pulse rate at the ground floor 0–1 min after exercise was 135, range 72–203, in the patients and 125, range 95–147, in the controls. Three patients ending with a pulse rate below 100 per min complained of dizziness, chest pain and breathing problems, respectively. One of the controls ending with a pulse rate below 100 complained of dizziness.

PEF and other data before and after the test are summarized in Table 1. As illustrated in Fig. 1 there was a wide range in the percentage maximal fall in PEF in the patients, from −3% to +63% (mean 11%) recorded 0–30 min (mean 12 min) after stopping exercise. Only eight patients (9%) had a maximal fall ≥15% within 5 min. In the controls the maximal decrease was 0–16% (mean 6%) recorded 5–45 min (mean 18 min) after stopping exercise.

Analyses of the relationships between maximum percentage fall in PEF and other variables showed a significant relationship with fall in O₂ saturation (r = 0.62, P = 0.0001), respiratory rate at 0 min (r = 0.25, P = 0.02) and sensitivity to methacholine (r = 0.47, P = 0.0001).

A fall in PEF ≥15% (exercise-induced asthma) was observed in 20/48 asthmatics (42%) and in 4/40 non-asthmatics (10%). In the controls, 1/10 individuals (10%) had a maximum fall ≥15% (Table 2). The most common reasons for stopping the exercise in the asthma group were breathing trouble (42%), tired legs (25%) and chest pain/discomfort (19%). The most common reasons for stopping the exercise in the non-asthma group were chest pain/discomfort (35%), tired legs (30%) and breathing trouble (20%). Significantly more patients in the asthma group compared with the non-asthma group reported breathing trouble (P < 0.05). When the patients were further separated into those treated with and without inhaled steroids (Table 2), a PEF fall ≥15% was seen in 13/27 (48%) asthmatics treated with steroids and in 7/21 asthmatics treated without steroids (33%). The most common reason for stopping the exercise in the steroid treated patients of the asthma group (n = 27) was breathing trouble (52%) (Table 2).

Mean end-tidal CO₂ in the patients before the test was 3.2–5.8% (mean 4.8%). The lowest value after the test was 1.6–5.1% (mean 3.7%), recorded 0–55 min (mean 18 min) after stopping. Dizziness and/or pricking sensations in the arms or legs as possible signs of hyperventilation were reported in 18/88 patients (20%). In these patients the lowest post-exercise CO₂-value was 1.6–4.7% (mean 3.3%) recorded 5–35 min (mean 19 min) after stopping. The lowest CO₂-value in all patients was 1.6–5.1 (mean 3.7%).

Discussion

The study has shown that not only bronchial obstruction, but also other types of reaction, may be of considerable
importance in patients with a history of exercise-induced
airway/chest symptoms. By including patients with a
history of exercise-induced asthma-like symptoms it was
shown that the degrees of bronchoconstriction, ranging
from none to very strong. The fact that bronchial
obstruction is not an ‘all or nothing’ reaction is well
illustrated in Fig. 1 where the maximal decreases in PEF are
shown in ranking order. The patients were instructed to
make a maximal effort and to give the reason why they
could not run any longer. If the reason for stopping the
exercise had been bronchoconstriction one would have
expected a greater fall in PEF immediately after stopping.
However, the mean time for the maximal decrease in PEF
was 12 min and in only eight patients (9%) the maximal fall
was ≥15% within 5 min of stopping, strongly indicating
that bronchoconstriction may not explain the reason for
stopping the exercise in the majority of patients. The PEF
values were continuously checked during the exercise (every
time on the ground floor) and none of the patients had a fall
in PEF that was later restored during the running. This
control may rule out the possibility of ‘running out of
bronchoconstriction’ in any of the patients.

Tiredness of the legs, seen in the controls may be
considered as a natural reason for stopping strenuous work
but breathing troubles and chest pain, found in 60% of the
patients, are abnormal reactions. These factors hampered
further exercise and may, therefore, be seen as factors that
restrict physical capacity. From a clinical point of view it is
of fundamental importance to consider all factors that may
restrict physical activity, not only bronchoconstriction.

With the diagnostic criteria used, exercise-induced
asthma was seen in 42% of asthmatic patients, which is a
figure lower than generally reported. This may partly be
due to the selection of patients, mild asthma in some cases
and the way of assessing bronchial obstruction. PEF is a
relatively insensitive measure, especially as regards changes

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**Fig. 1.** Maximal percentage change in peak expiratory flow (PEF) after physical exercise in 88 patients sorted in ranking
order. The dotted line shows the level of a 15% decrease in PEF. ●, asthma group; ◊, asthma like group.

**Table 2.** Number (percentage) of patients with a maximum fall in peak expiratory flow (PEF) ≥15% and the main reasons
for stopping the exercise. The patients are separated into those treated with and without inhaled steroids

<table>
<thead>
<tr>
<th></th>
<th>Asthma +steroid</th>
<th>Asthma no steroid</th>
<th>Asthma-like +steroid</th>
<th>Asthma-like no steroid</th>
<th>All patients</th>
<th>Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of pat.</td>
<td>27 (31%)</td>
<td>21 (24%)</td>
<td>12 (14%)</td>
<td>28 (32%)</td>
<td>88</td>
<td>10</td>
</tr>
<tr>
<td>PEF fall ≥ 15 %</td>
<td>13 (52%)</td>
<td>7 (28%)</td>
<td>3 (12%)</td>
<td>1 (4%)</td>
<td>25 (28%)</td>
<td>1 (10%)</td>
</tr>
<tr>
<td>Breathing trouble</td>
<td>17 (57%)</td>
<td>5 (17%)</td>
<td>3 (10%)</td>
<td>5 (17%)</td>
<td>30 (34%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Chest pain</td>
<td>3 (13%)</td>
<td>6 (26%)</td>
<td>7 (30%)</td>
<td>7 (30%)</td>
<td>23 (26%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Tired legs</td>
<td>5 (21%)</td>
<td>7 (29%)</td>
<td>2 (8%)</td>
<td>10 (42%)</td>
<td>24 (27%)</td>
<td>7 (70%)</td>
</tr>
<tr>
<td>Other</td>
<td>2 (18%)</td>
<td>3 (27%)</td>
<td>0 (0%)</td>
<td>6 (25%)</td>
<td>11 (13%)</td>
<td>3 (30%)</td>
</tr>
</tbody>
</table>
in small airways. However, changes in PEF were significantly related to changes in peripheral oxygen saturation, and it is unlikely that changes in small airways, in the absence of changes in PEF, may explain the reason for stopping the exercise. Another reason for using a measure other than PEF is the inability of many patients with an asthma-like disorder to perform a complete and reproducible forced expiration.

When patients were separated into those treated with and without inhaled steroids, exercise-induced asthma was found in about 50% of asthmatic patients treated with steroids and in about 30% of asthmatic patients treated without steroids. The study was not designed to analyse differences in effects of drugs, but the difference may indicate that inhaled steroids are not very effective in preventing exercise-induced asthma; is more likely however, that patients treated with steroids had a more severe asthma. Another explanation may be lack of compliance. It is possible that many patients do not like to take medicine for preventive purposes.

The test model was chosen to observe different airway and chest symptoms in relation to airflow function tests after a maximal exercise test. Although some interesting findings were obtained it should be pointed out that the test was not fully standardized. There was no perfect control of degree of ventilation and exercise load, these factors being better controlled in a test on a treadmill or a bicycle (2.5). Another factor that was not possible to control was the speed of running. To start at a higher tempo may lead to a different response than starting at a lower tempo, and it is often reported by patients that warming up before starting exercise has an inhibiting effect on the exercise-induced respiratory symptoms.

A lot of data were obtained in this study but only some are presented in this report. This is mainly a qualitative or observational study, where we focus on a few important observations that have not earlier been reported in the literature. The number of controls could have been higher in this study. However, the normal reaction to physical exercise in healthy people is well known (tired legs but no asthma). A lot of data were obtained in this study but only some are presented in this report. This is mainly a qualitative or observational study, where we focus on a few important observations that have not earlier been reported in the literature. The number of controls could have been higher in this study. However, the normal reaction to physical exercise in healthy people is well known (tired legs but no asthma). However, some of the symptoms seen after exercise, are similar to those found after provocation to strong scents (perfume) and capsaicin the sensory nerve system may also be involved in patients with exercise-induced respiratory symptoms. Earlier proposed mechanisms, behind the development of exercise-induced bronchoconstriction include transient hyperosmolarity of the airway surface liquid as a result of evaporative water loss (19) and a rapid airway rewarming after exercise, causing vascular congestion, increased permeability and oedema (20,21). However, our observations of an individually different degree of bronchial obstruction, not directly associated with time and type of exercise symptoms, strongly indicate that additional primary mechanisms in exercise-induced respiratory reactions have to be considered.

References


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