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ORIGINAL ARTICLE

Breathing pattern in asthmatic patients during exercise

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KEYWORDS

Cardiopulmonary exercise test (CPET);
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Abstract *Objectives:* To study the effect of exercise on asthmatic breathing pattern.

Background: Asthmatic patients have been reported to be breathless regardless of the degree of airway obstruction. Task performance may induce changes in breathing pattern and these in turn may mediate such a feeling. There is increasing interest in the use of breathing modification techniques in the treatment of asthma.

Methods: This study was conducted on 20 asthmatic patients in stable mild state, they were selected from the Chest Department of the Menoufia University Hospital from February 2014 to September 2014. All patients were subjected to clinical history and examination, plain chest-X-ray (postero-anterior and lateral views), ECG and echo if needed, pulmonary function tests and cardiopulmonary exercise testing.

Results: Breathing pattern parameters tidal volume (VT), respiratory rate (RR), minute ventilation (VE), mean inspiratory flow (VT/TI) increased during exercise then decreased during the recovery period while inspiratory time (TI) and total breath duration (Ttot) decreased during exercise then decreased during the recovery period.

There was an increase in forced vital capacity (FVC), forced expiratory volume in one second (FEV1), peak expiratory flow (PEF). Forced expiratory volume in one second/forced vital capacity (FEV1/FVC) during exercise and a decrease during the recovery period while forced expiratory time (FET100%) showed an opposite change.

Conclusion: Breathing pattern was altered significantly during exercise in asthmatic patients.

Introduction

Bronchial asthma is a common chronic inflammatory disease of the airways characterized by variable and recurring symptoms, reversible airflow obstruction, and bronchospasm and

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its common symptoms include wheezing, coughing, chest tightness, and shortness of breath [1].

Breathing pattern is an oscillatory event approximating a sinusoidal function, of which the amplitude is tidal volume (VT) and the period is the total breath duration (Ttot) [2].

Early studies of exercise performance in patients with respiratory disorders identified reductions in ventilatory capacity and gas-exchange as the main causes of reductions in exercise capacity. Whether or not the breathing pattern of asthmatic patients change with exercise and whether it influences exercise outcome remains to be elucidated [3].

Aim of the study

The aim of this study was to evaluate the effect of exercise on the breathing pattern of asthmatic patients.

Methods

A written consent was obtained from all patients prior to inclusion and the regional ethics committee of the Menoufia University Hospital approved the study. The study was conducted in the Chest Department of the Menoufia University Hospital from February 2014 to September 2014. All patients underwent history taking, clinical examination, routine laboratory investigations, chest X-ray (postero-anterior and lateral views). ECG and echocardiography if needed. They also underwent pulmonary function tests before and after bronchodilatation using salbutamol (200–400 μg) to assess reversibility. Forced vital capacity (FVC), forced expiratory volume in one second (FEV_1), forced expiratory volume in one second/forced vital capacity (FEV_1/FVC), peak expiratory flow (PEF), forced expiratory flow between 25% and 75% of FVC (FEF 25–75%) and forced expiratory time FET100% were measured before, during, immediately after exercise and 30 min after exercise (during the recovery period), cardiopulmonary exercise test was performed (using Quark CPET-Italy). Assessment of the breathing pattern of the patient [tidal volume (VT), respiratory rate (RR), Minute ventilation (VE), inspiratory time (TI), total breath duration (Ttot), fractional inspiratory time (TI/Ttot), mean inspiratory flow (VT/TI)] before, during, immediately after and 30 min after exercise were done. In this study incremental exercise testing protocol was used as a modification of Balk's Protocol [4].

The test duration was 7 min which is divided into: 2 min for warming up, 4 min exercise and 1 min recovery. The speed starts by 1 km/h till 4 km/h during warming up stage, with a grade 3%, then the speed increases gradually to reach 5 km/h during exercise and grade increases till 7%. Finally, during recovery, speed and grade decrease till rest again.

Results

There was a statistically significant change between patients regarding tidal volume (VT), respiratory rate (RR), inspiratory time (TI), mean inspiratory flow (VT/TI) and fractional inspiratory time (TI/Ttot) before, during, immediately after and 30 min after exercise as there was an increase in tidal volume (VT), respiratory rate (RR), minute ventilation (VE), mean inspiratory flow (VT/TI) and fractional inspiratory time (TI/Ttot) during exercise and they decreased significantly during the recovery period while inspiratory time (TI) and total breath duration (Ttot) decreased during exercise then decreased during the recovery period (Table 1).

There was statistically significant differences regarding forced expiratory volume in one second (FEV1), forced expiratory flow between 25% and 75% of FVC (FEF 25–75%) and peak expiratory flow (PEF) before, during, immediately after and 30 min after exercise, as there was an increase in FVC, FEV_1, PEF, FEV_1/FVC during exercise and a significant decrease during the recovery period while forced expiratory time (FET100%) decreased during exercise then increased during the recovery period (Table 2).

During exercise, there was a positive correlation between VT and FVC, between RR and FEV1/FVC and FET100%, between TI and FET100% and between VE and FEF 25–75% (Table 3).

Before exercise, there was a positive correlation between both maximal rate of oxygen consumption (VO_2 max) and carbon dioxide volume (VCO_2) on one hand and FET100% on the other hand while 30 min after exercise, there was a positive correlation between FEV1 with VCO_2 (Tables 4–6).

Discussion

This study highlights the changes in breathing pattern during quiet breathing and incremental exercise in asthmatic patients. Tidal volume (VT), respiratory rate (RR), minute ventilation (VE), mean inspiratory flow (VT/TI) increased during exercise then decreased during the recovery period while inspiratory time (TI) and total breath duration (Ttot) decreased during exercise then decreased during the recovery period (Table 1).

The results coincide with Kassabian et al., who reported an increase in VT, VE, VT/TI and RR [5].

Gallagher et al., reported that during progressive exercise ventilation increases initially through an increase in VT and RR but at high levels of exercise further increase in ventilation is almost completely a result of increase in RR and VT plateaus is seen [6].

They reported that an early elevation of VE is a normal respiratory response to exercise by increasing the depth of breathing (increased VT) as the workload further increases by increasing RR.

Margaret et al., reported an increase in RR with incremental exercise, modest change in VT, shortened expiratory time and doubling of flow rates [7].

Wilkens et al., reported a decrease in duty cycle (TI/Ttot) at rest and at maximal exercise in asthmatic patients with a high inspiratory flow rate and high minute ventilation [8].

Also, Martin et al., measured breathing pattern in 15 asthmatic patients and reported increase in VT and VE with increased exercise [9].

This study agrees with Romer et al., who reported a decrease in RR and VE after exercise in asthmatic patients but they found an increase in VT and TI [10]. As did McMahon et al. [11].

Eastwood et al., found that there is an initial increase in VT than RR in asthmatic patients as exercise increases then the continued increase in RR compromises VT such that VT plateau increases or even decreases slightly resulting in tachypneic shift [12].