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Araştırma

The Ability of Children to Use Dry Powder Inhalers †

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The Ability of Children to Use Dry Powder Inhalers

Objective: *Dry powder inhalers (DPIs) are used in children with increased frequency, since no coordination between actuation and inhalation is required and the devices can easily be carried around.*

Material and Methods: *The aim of this study was to measure the peak inspiratory flow (PIF) in 20 asthmatic (5F, 15M) and 39 (15 F, 24 M) healthy school children aged 6 to 8 years, and to evaluate the applicability of DPI in this age group. Children with mild to moderate asthma were included in the study. PIF was performed by means of In-Check Dial (Clement Clarke International, UK). Pulmonary function tests including FEV1 and PEF were performed.*

Results: *For the asthmatic group median FEV1, PEF and PIF and related percentages were 91.6 (28.5%), 82.4 (21.1%) and 78.8 26.4 L/min, respectively. For the healthy controls, the respective measurements were 89.5 (14.7%), 81.7 (16.0%) and 81.2 20.2 L/min. Ranges for the asthmatics were 40 L/min to 120 L/min, and 45 to 120 for the healthy controls A positive correlation between PIF and FEV1 (p<0,001, r=0.492) was observed in both groups.*

Conclusion: *Since a PIF of at least 15 L/min is required for the use of most DPI devices, we concluded that children aged 6 years or more with mild to moderate asthma can use DPIs with efficacy and ease. Furthermore, because of the correlation between PIF and PEF, it may be useful to measure PIF during an asthma attack with relatively low PEF, before prescribing a DPI device.*

Keywords: *Asthma, child, dry powder inhaler*

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Çocukların Kuru Tozlu İnhalerleri Kullanma Yetileri

Amaç: İnhalerlerin çalıştırılmasıyla inhalasyon arasında koordinasyona gerek olmadığı ve cihazlar kolayca taşındığı için kuru tozlu inhalerler (KTİ'ler) giderek artan sıklıkta kullanılmaktadır

Gereç ve Yöntemler: *Bu çalışmanın amacı, 6-8 yaş arası 20 astım hastası (5 kız ve 15 erkek çocuk) ve ve 39 sağlıklı okul çocuğunda (15 kız ve 24 erkek çocuk) tepe inspiratuar akım hızının (TİAH) ölçümüyle bu yaş grubunda KTİ'lerin uygulanabilirliğini değerlendirmekti. Çalışmaya hafif-orta derecede astımı olanlar alınmıştır. TİA'ların ölçümleri In-Check Dial (Clement Clarke International, UK) cihazıyla değerlendirilmiştir. FEV1 ve PEF'yi de içeren akciğer fonksiyon testleri gerçekleştirilmiştir.*

Bulgular: *Astımlı grup için ortanca FEV1, PEF ve PIF ve yüzdeleri sırasıyla 91.6, %28,5; 82.4, %21.1 ve 78.8, 26.4 L/dk. idi. Sağlıklı kontroller için karşıt ölçümler sırasıyla 89,5, %14.7, 81.7 %16.0 ve 81.2 2, 0.2 L/dk. idi. PIF aralıkları astımlılar için 40 L/dk. 120 L/dk., sağlıklı kontroller için 45 120 L/dk. idi. Her iki grupta PIF ie FEV1 arasında pozitif bir korelasyon gözlenmiştir (p<0,001, r=0.492).*

Sonuç: *KTI cihazlarının çoğu için tepe inspiratuar akım hızının en azından 15 L/dk. olması gerektiğinden, 6 yaş ve üstü hafif-orta derecede astımı olan hastaların KTİ'leri etkinlik ve kolaylıkla kullanılabileceği sonucuna vardık. Ayrıca, PIF ile PEF arasında korelasyon mevcut olduğundan bir KTİ cihazı reçetelendirmeden önce göreceli olarak düşük PEF'de astım atağı sırasında PIF'in ölçümü yararlı olabilir.*

Anahtar kelimeler: *Astım, çocuk, kuru tozlu inhaler*

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INTRODUCTION

Asthma is a common, chronic respiratory disease affecting 1-18% of the population in different countries [(1)]. Inhalers are the cornerstone of therapy in asthma.

Therapeutic drug administration by inhalation covers a period of more than 4000 years and finds its origin in India and the Middle East [(2)].

Dry powder inhalers (DPIs) are increasingly used in children. After the 1987 Montreal protocol banning chlorofluorocarbons (CFCs), great improvement has been achieved in the field of asthma medications, and DPIs have become popular among inhaled drugs. They have several advantages. A coordinated breathing maneuver is not necessary. There is no need for an extra device like a spacer or holding chamber to improve drug delivery to the lung, and they can be

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easily carried around. It has also been reported that DPIs deliver greater percentage of the emitted dose to the lungs than pressurized metered-dose inhalers (pMDIs) [3].

There are several factors affecting the bioavailability of the drugs administered by DPIs. Those include: inspiratory flow rate (IFR) generated by the patient during inspiration, the physical properties of the drug powder formulation, and the design of the device [4,5]. IFR is important especially in children since they may not generate sufficient inspiratory flow for the optimal delivery of the drug into the lung. Studies critically assessing the ability of children to use DPIs are lacking. The aim of this study was to evaluate the applicability of DPIs by assessing IFRs in children aged 6-8 years old.

MATERIALS and METHODS

Twenty consecutive asthmatic patients from the Outpatient Clinic of the Department of Pediatric Allergy, and 39 healthy school children from a local elementary school were enrolled in the study. This study was performed between September-October 2002. Parents of all children signed an informed consent form. Parents of the school children filled a questionnaire about personal and family history of atopy. All children were physically examined. Pulmonary function tests including forced expiratory volume in 1 second (FEV1) and peak expiratory flow (PEF) were performed in asthmatic children using a spirometer (SensorMedics) and in school-children by a portable spirometer (Microlab, UK). PIF was measured by means of In-Check Dial (Clement Clarke International, UK). Each subject received a few minutes training with the investigator before measurement. The best attempt out of three deep inspirations was chosen.

Statistical methods

The SPSS statistical package (version 10.0) was used for the analysis. Student t test was used for the comparisons and Pearson test for correlation. Results were given as mean ± SD.

RESULTS

Twenty asthmatic children and 39 healthy children completed the study. There were 13 (65%) children with moderate and 7 (35%) with mild asthma. Children with moderate asthma used inhaled corticosteroids with a spacer regularly on a daily basis. Characteristics of the children are summarized in Table 1.

Table 1. Characteristics of asthmatic and healthy children.

	n	M/F	Age (years)	Height (cm)	Weight (kg)
Healthy children	39	25/14	6.4±0.5	115.6±6.2	20.7±2.9
Asthmatic children	20	15/5	7.3±0.9	123.3±7.3	25.5±5.7
Mild asthma	7	6/1	7.1±0.9	125.9±10.0	27.4±7.6
Moderate asthma	13	4/9	7.3±0.9	121.9±5.3	24.4±4.5

The mean values for FEV1 (1.2±0.4 l (;1.6±28.5%), PEF (242.9±89.5 l/min; 82.4±21.1%) and PIF (78.8±26.4 l/min) of asthmatics were calculated. The respective measurements of the healthy children were 1.0±0.2 l (89.5±14.7%), 153.4±30.0 l/min (81.7±16.0 %) and 81.2±20.2 l/min (Table 2). PIF ranged from 40 l/min to 120 l/min in asthmatics and 45 l/min to 120 l/min in healthy children. No significant difference in PIF was noted between asthmatics and healthy children (Figure 1). In the asthmatic group, there was no significant difference in PIF between mild and moderate asthmatic children.

PIF positively correlated with age (p:0.045, r:0.262), body weight (p:0.034, r:0.276), FEV1 (liter) (p<0.001, r:0.492), FEV (predicted %) (p:0.001, r:0.425) and PEF (predicted %) (p:0.036, r:0.281) in all children (Figure 2).

Table 2. PIF and spirometric values of asthmatic and healthy children.

	Age (years)	FEV1 (L)	FEV1 (pred) %	PEF (l/min)	PEF (pred) %
Healthy children (n=39)	6.4±0.5	1.0±0.2	89.5±14.7	153.4±30.0	81.7±16.0
Asthmatics (total) (n=20)	7.3±0.9	1.2±0.4	91.6±28.5	242.9±89.5	82.4±21.1
Mild asthmatics (n=7)	7.1±0.9	1.3±0.3	83.8±10.0	245.8±128.7	68.6±20.7
Moderate asthmatics (n=13)	7.3±0.9	1.2±0.4	94.8±33.3	241.7±75.0	88.1±19.2

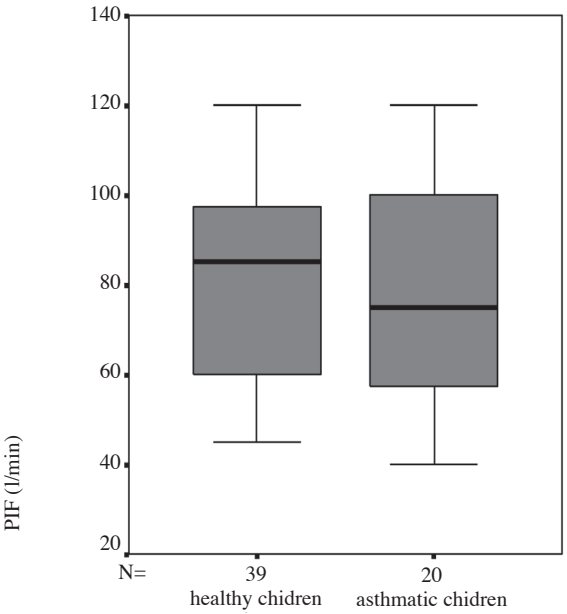

Figure 1. PIF values in healthy and asthmatic children shown in box plots.

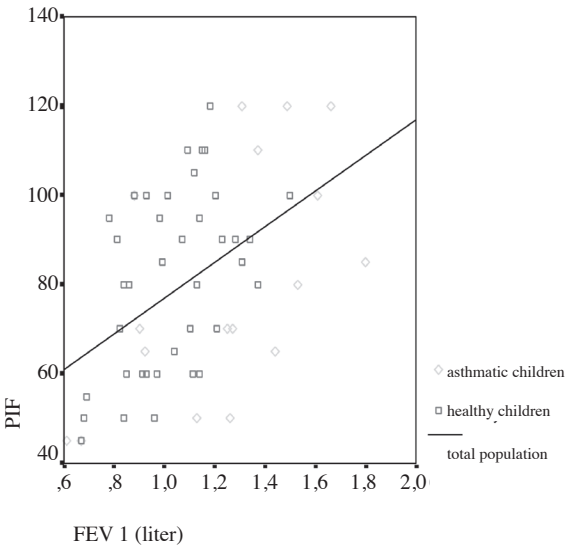

Figure 2. Correlation between PIF and FEV1 (liter) in the whole group (p<0.001, r:0.425).

DISCUSSION

The success of therapy using aerolised medications depends on the ability to deliver sufficient drug into the lungs with minimal side effects (6). Optimal inspiratory flow rate required for a sufficient drug delivery to the lungs ranges from 15 to 60 l/min for DPIs dependent on the type of the device [5-8].

There are three types of DPIs (5). The first type includes a single unit dose system, which usually contains an individual unit mainly a capsule (spinhaler, rotahaler). The second type is a multi-dose delivery system (discus, accuhaler) with multiple blister; each containing one-unit dose, and the third type is the form dispensing multiple doses (turbuhaler, easyhaler). The first type of DPI is not frequently used in the treatment of children since the required optimal inspiratory flow can be as high as 120 l/min [9]. The second and the third types of DPI are effective at IFR of 30 l/min and 60 l/min, respectively [7,8]. In our study, all children had PIF values above 40 l/min. Thirty-four (87%) school children and 15 (75%) asthmatic children produced inspiratory rates above 60 l/min. There are several studies evaluating PIF in asthmatic children with ages ranging between 5-17 years [10-13]. In these studies mean PIF values were found above 60 l/min, which were compatible with our results. Parry-Billings et al. [4] evaluated PIF generated through the Clickhaler DPI in asthmatic children aged 6 to 8 years, and found lower PIF values (46.5±14.6 l/min, range 26.8-71.1) than ours. The difference in IFRs might be due to the use of different measuring devices. There was no significant difference between healthy and asthmatic children for PIF. Our data were similar to those found by Aguilar et al. [11] as they did not find any significant difference in the PIF of 22 asymptomatic asthmatics and 21 healthy children aged 4-8 years. Four children with moderate asthma had PIFR under 60 l/min. Being previously trained how to use a pMDI with a spacer and its usage on a daily regular basis did not enhance PIF in asthmatic children. In our study children were not trained for the use of DPIs. Agertoft and Pederson evaluated turbuhaler usage in children aged 3-5 years, and showed that training and repeated education can increase IFRs. So it is expected that trained children would have even higher IFRs.

PIF showed positive correlation with age, weight, FEV1 (liter and % predicted) and PEF (% predicted). The positive correlation between IFR and age has been reported by other investigators [4,11]. Engel et al. [14] found significant positive correlations between inspiratory and expiratory volumes in asthmatic adults. Positive correlation between inspiratory and expiratory volumes must be taken into consideration

especially in children, since optimal inspiratory flow might not be generated when the child is severely obstructed. However, O' Callaghan et al. [8] evaluated the suitability of salbutamol clickhaler (Asmasal Clickhaler®) in stable mild to moderate asthmatic children over 6 years of age and found it to be effective. Drblik S et al. [15] compared terbutaline sulphate delivered by turbuhaler with pMDI + nebuhaler spacer in children during an acute asthmatic episode, and found both of them effective.

In conclusion, the present study demonstrates that children aged 6-8 years with mild to moderate asthma can generate sufficient inspiratory flow rates for optimal use of DPIs. In-Check Dial can serve as a guide to select appropriate device for inhalant therapy in asthmatic children Since there is a correlation between inspiratory and expiratory flow rates. It would also be beneficial to measure PIFR in children with severe asthma or during an acute attack before prescribing DPIs.

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