Effects of Age on 1-Second Forced Expiratory Volume Response to Bronchodilation

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SUMMARY

Background: The bronchodilation test is used to detect reversible airways obstruction, considered important for diagnosing asthma. However, little is known about the effects of age on the bronchodilation response. The aim of this study was to evaluate the effects of age on the bronchodilation response by determining changes in the 1-second forced expiratory volume (FEV_1) in a Chinese population.

Methods: All patients underwent pulmonary function testing to evaluate forced vital capacity, peak expiratory flow, and FEV_1. We assessed bronchodilation by measuring the change in FEV_1 (ΔFEV_1) before and after inhalation of 0.4 mg of fenoterol (two puffs) delivered by a metered-dose inhaler with a spacer.

Results: Of the 1,616 patients tested in the clinic, the 333 (21%) who had a positive bronchodilator test, defined as $\Delta FEV_1 > 12\%$ and 200 mL, were enrolled in the study. For this population, the ΔFEV_1 was $+360.8 \pm 138.6$ mL (mean ± standard deviation) or $+21.0\% \pm 9.1\%$. In a multiple linear regression model, the absolute ΔFEV_1 (expressed in milliliters) was independently and negatively predicted by age ($p < 0.001$), and baseline peak expiratory flow ($p < 0.001$), but positively predicted by height ($p < 0.001$).

Conclusion: Age was an important determinant for response to bronchodilation as determined by the absolute change in FEV_1. [International Journal of Gerontology 2009; 3(3): 149–155]

Key Words: asthma, bronchodilators, lung function tests, spirometry

Introduction

Flow-volume spirometry is a reproducible and reliable method for assessing lung function. The bronchodilation test is used to detect reversible airways obstruction, considered to be important for diagnosing asthma[1,2]. In clinical practice, the criterion for a significant spirometric bronchodilation response in adults is recommended to be an increase in 1-second forced expiratory volume (FEV_1) of 12% and 200 mL from baseline[3,4].

The change in FEV_1 (ΔFEV_1) in response to bronchodilation can be influenced by many factors, including the bronchodilation medication, its mode of delivery, and the type of spirometer used[5,6]. FEV_1 has been shown to be the best variable for determining the response to bronchodilation in terms of statistical power and reproducibility, but it is dependent on the baseline FEV_1 at the population level[6]. Some previous reports have documented smaller bronchodilation responses in older people and an effect of sex on the response[7,8]. A low baseline ratio of FEV_1 to forced vital capacity (FVC), or FEV_1:FVC ratio, also reflects airflow limitations and is another determinant of the change in FEV_1 in response to bronchodilation[9].

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Numerous studies on bronchodilation responses have been published in patients with obstructive ventilatory defects in selected or non-selected populations[7–10]. Some studies involved asthmatic population samples with reversible obstructive airways, but the concurrent changes in baseline lung function have not been reported in aged populations[7,8]. Furthermore, South Asian populations have a smaller FEV_1 and ΔFEV_1 by volume and, therefore, are more likely to be classified as having an equivocal response. The aim of this study was to evaluate the effects of age on the distribution and range of the changes in FEV_1 in response to bronchodilation in a group of Chinese patients who had a positive bronchodilator test.

Materials and Methods

Subjects and study design

A total of 1,616 patients underwent pulmonary function measurements with bronchodilator testing in an outpatient setting at a local teaching hospital in Taitung, Taiwan, and a tertiary care medical center in Taipei from January 2006 to December 2008. Patients were excluded if they were < 18 years of age, had poor performance on pulmonary function testing, or had a peak expiratory flow (PEF) at < 40% of predicted.

All subjects who had a positive bronchodilator test were included and categorized by age (< 30, 30–39, 40–49, 50–59, 60–69, and > 70 years of age).

Pulmonary function tests and bronchodilator test

Pulmonary function measurements were performed according to the American Thoracic Society guidelines[11,12]. No bronchodilators, either β-adrenergic agonists or theophylline, were administered within 8 hours before the start of the study. All patients also underwent spirometry and lung volume measurements using either the nitrogen washout method (Vmax 22; SensorMedics, Yorba Linda, CA, USA) at the Taitung hospital, or a body plethysmograph (Vmax 22 and Autobox 6200; SensorMedics) at the Taipei hospital. Predicted and percent-predicted values were calculated for FEV_1, FVC, and the FEV_1:FVC ratio using the reference values recommended by Knudson et al.[13].

Bronchodilator reversibility tests were performed using the largest FEV_1 and FVC from the best of three spirograms recorded on a single-breath bellows spirometer[11]. All subjects then inhaled 0.4 mg (two puffs) of fenoterol (Berotec; Boehringer Ingelheim, Ingelheim, Germany) using a metered-dose inhaler (MDI) under the guidance of a well-trained technician. Spirometry was performed and repeated after a 15–20 minute delay. A positive bronchodilator response was defined as improvement of the FEV_1 of > 12% and 200 mL over baseline during a single testing session. Subjects with a positive bronchodilator response constituted our study population.

Statistical analysis

All data are expressed as mean ± standard deviation. Changes in FEV_1 are expressed as absolute and percent changes from baseline. Differences between groups were analyzed as appropriate using the Pearson's χ^2 test for categorical variables. Bronchodilator response variables (ΔFEV_1, expressed in milliliters and as percentage) were assessed using multiple logistic regression analysis. Analysis of variance, followed by Fisher's protected least significant difference *post hoc* test, was used to compare differences in continuous variables among the different age groups. A p value < 0.05 was considered statistically significant. Differences between groups were tabulated and analyzed using SPSS version 12.0 (SPSS Inc., Chicago, IL, USA).

Results

Population sample

A total of 1,616 patients underwent pulmonary function measurements with bronchodilator testing during the study period. Of these, the response to bronchodilators was positive in 333 individuals, who thus constituted the study population; of these, 114 (34%) were elderly (age, 60–86 years).

For the population, the mean change in FEV_1 was +360.8 ± 138.6 mL or 21.0% ± 9.1%; the mean change in FEV_1 for men was +385.8 ± 149.2 mL or 21.5% ± 9.9% and that for women was +326.8 ± 117.2 mL or 20.7% ± 8.3% (Table 1). Men had a significantly greater absolute ΔFEV_1 ($p < 0.001$), but the percentage of ΔFEV_1 (%ΔFEV_1; $p = 0.459$) did not differ by sex (Table 1).

In a multiple linear regression model, the absolute bronchodilator response (ΔFEV_1, expressed in milliliters) was independently and negatively predicted by age ($p < 0.001$), weight ($p = 0.030$) and baseline PEF ($p < 0.001$), but positively predicted by height ($p < 0.001$)