

◎原 著

## Airflow, the volume and transfer factor of lungs in elderly asthmatics with long-term cigarette smoking

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**Abstract :** The influence of cigarette smoke on pulmonary function, airflow, lung volume, and transfer factor in patients with asthma was examined in 40 subjects over the age of 70 years (20 ever-smokers and 20 never-smokers), and 20 patients with pulmonary emphysema over age 70 (all ex-smokers). The ventilatory parameters showing airflow limitation (%FEV<sub>1</sub> and FEV<sub>1</sub>%) were not significantly different between ever-smokers and never-smokers of elderly asthmatics. In contrast, %FEV<sub>1</sub> and FEV<sub>1</sub>% values were significantly lower in patients with pulmonary emphysema than in those with asthma with or without a history of smoking. The %RV value was significantly larger and %DLco value was significantly more decreased in ever-smokers compared with never-smokers of the elderly asthmatics. However, there were no significant differences in %RV and %DLco values between asthmatics with a history of smoking and patients with pulmonary emphysema. The results show that cigarette smoke influences %RV and %DLco, but not %FEV<sub>1</sub> and FEV<sub>1</sub>%, suggesting airflow limitation of large and moderate size airways.

**Key words :** cigarette smoking, FEV<sub>1</sub>%, %RV, %DLco, elderly asthmatics

### Introduction

The adverse effects of environmental tobacco smoke (ETS) on the respiratory tract have been extensively characterized<sup>1, 2)</sup>. The association of ETS with pulmonary function may be clarified by addressing potentially susceptible subgroups.

In general, ETS is not significantly associated with FVC, FEV<sub>1</sub> or FEF<sub>25-75%</sub>. However, effects of ETS on FEV<sub>1</sub>, FEF<sub>25-75%</sub>, and FVC are observed among asthmatics, particularly in asthmatic women, whose duration of exposure to ETS at work is associated with lung function (life-time never-smokers). In non-asthmatic women and in men (both asthmatic and non-

asthmatic), no significant effect is observed<sup>3)</sup>.

In contrast, the possibility of the risk of active smoking for developing adulthood asthma also remains controversial. In a recent case-control study, adult onset asthma was not associated with ever-smoking. However, current smoking was found to increase asthma severity<sup>5)</sup> and several studies have supported higher incidence of asthma in current and former smokers, compared with never-smokers<sup>6-8)</sup>.

Our previous studies showed that the high-resolution CT (HRCT) lung densitometry, which correlated with parameters of airflow limitation and lung volume, but not with lung transfer factor, was influenced by aging, disease severity, and cigarette smoking<sup>9,10)</sup>. However, influence of long-term cigarette smoking on pulmonary function in elderly patients with asthma is still unclear. In the present study, we compared pulmonary function, %FVC, %FEV<sub>1</sub>, FEV<sub>1</sub>%, %RV (residual volume), and %DLco, between ex-smokers and never-smokers in elderly asthmatics, and between subjects with asthma (smokers) and pulmonary emphysema.

### Subjects and Methods

In this study, 40 asthmatics over the age of 70 years (14 women and 26 men), and 20 patients with pulmonary emphysema (mean age 75.3 years, all men and all smokers) were selected at random from Misasa Medical Center. The mean age of elderly subjects was 74.9 years and age at onset of the disease was 59.2 years. Twenty of them had a history of smoking more than 20 years (50.1 pack-year). All of them were ever-smokers. The remaining 20 elderly subjects were never-smokers. Asthma was diagnosed according to the definition proposed by the American Thoracic Society<sup>11)</sup>. The asthmatic subjects were stable with no changes

in asthma symptoms and medication for at least 1 month, except for the use of short acting  $\beta_2$  agonists.

Spirometry was performed by means of a CHESTAC 33 (Chest Co, Tokyo, Japan) linked to a computer when their symptoms were stable. The following measurements were performed on all subjects: forced vital capacity (FVC), FEV<sub>1</sub>, and FEV<sub>1</sub>/FVC. Residual volume (RV) was measured by body plethysmography (Autobox 2800, Chest Co, Tokyo, Japan). The diffusing capacity for carbon monoxide (DLco) was measured by the single breath technique using a CHESTAC 33. The actual DLco values were corrected for hemoglobin and carbon monoxide levels. The FVC, FEV<sub>1</sub>, RV (residual volume), and DLco measurements for each patient were expressed as a percent of the predicted values<sup>12)</sup>.

Serum IgE was measured by radioimmunosorbent test (RIST), and IgE antibodies specific to aeroallergens including house dust mite, pollens, moulds, and animal danders were measured using the Pharmacia CAP system (Pharmacia Diagnostics AB, Uppsala, Sweden).

Statistically significant differences of the mean were estimated using the unpaired Student's *t* test. A *p* value of <0.05 was regarded as significant.

### Results

#### 1. FVC and Airflow limitation

The FVC value was not significantly different between ever-smokers (79.2 ± 16.8%) and never-smokers of asthmatics (83.7 ± 16.1%), and between ever-smokers of asthmatics and patients with pulmonary emphysema (79.5 ± 17.9%). The value of %FEV<sub>1</sub> was significantly larger in both ever-smokers (69.2 ± 19.7%) (*p* < 0.05) and never-smokers of asthmatics (73.2 ± 20.3%) (*p* < 0.001) compared with patients with pulmonary emphysema (54.5 ± 12.2%). However,

no significant difference was found in %FEV<sub>1</sub> value between ever-smokers and never-smokers of asthmatics. The FEV<sub>1</sub>/FVC (FEV<sub>1</sub>%) was also significantly larger in ever-smokers (58.6 ± 11.9%) (p < 0.001) and never-smokers (63.5 ± 9.3%) (p < 0.001) of asthmatics than in patients with pulmonary emphysema (45.1 ± 7.6%). However, no significant difference was observed between ever-smokers and never-smokers of asthmatics (Fig. 1).

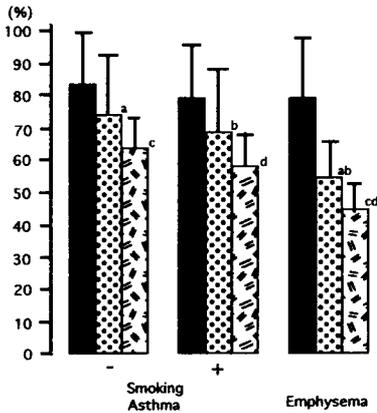


Fig.1. %FVC (■), %FEV<sub>1</sub> (▣) and FEV<sub>1</sub>/FVC (▤) values in patients with asthma and pulmonary emphysema. a, c, and d; p < 0.001, b; p < 0.01.

2. Lung volume

The %RV value was significantly lower in never-smokers of asthmatics (129.1 ± 25.4%) than in ever-smokers of asthmatics (174.0 ± 41.6%) (p < 0.001) and in patients with pulmonary emphysema (193.0 ± 33.1%) (p < 0.001). The %RV value was not significantly different between ever-smokers of asthmatics and patients with pulmonary emphysema (Fig. 2).

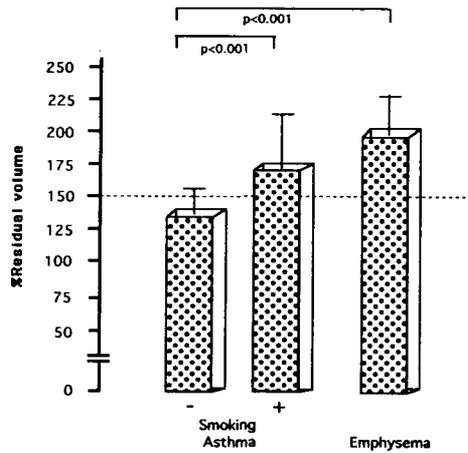


Fig.2. %Residual volume (RV) in patients with asthma and pulmonary emphysema.

3. Lung transfer factor

The %DLco was significantly lower in ever-smokers of asthmatics (66.2 ± 17.0%) (p < 0.001) and patients with pulmonary emphysema (64.1 ± 16.6%) (p < 0.001) compared with never-smokers of asthmatics (90.6 ± 16.7%). However, no significant difference was found in %DLco value between ever-smokers of asthmatics and patients with pulmonary emphysema (Fig. 3).

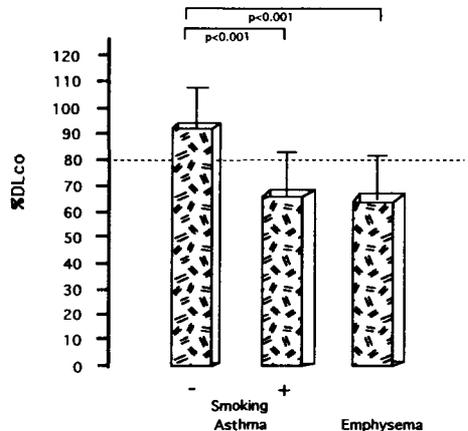


Fig.3. %DLco in patients with asthma and pulmonary emphysema.

## Discussion

It has been found that incidence of asthma and disease severity were associated with cigarette smoke when these were compared with never-smokers<sup>7, 8, 13</sup>. Another studies suggested that adult onset of asthma was not associated with ever-smoking, however, current smoking increased asthma severity<sup>5</sup>. Regarding the correlation between cigarette smoke and pulmonary function, it has been reported that environmental tobacco smoke (ETS) was not significantly associated with FVC, FEV<sub>1</sub>, or FEF<sub>25-75%</sub>. However, ETS effects on FEV<sub>1</sub>, FEF<sub>25-75%</sub>, FVC were observed among asthmatics, particularly in women, where duration of exposure to ETS at work was associated with lung function<sup>3</sup>. In this study, pulmonary function was examined in elderly patients with asthma from three different points: airflow limitation (%FEV<sub>1</sub>, FEV<sub>1</sub>/FVC, lung volume (%RV) and lung transfer factor (%DLco). The parameters showing airflow limitation (FEV<sub>1</sub> and FEV<sub>1</sub>/FVC) were not significantly different between ever-smokers and never-smokers of asthmatics. In contrast, the difference in these ventilatory parameters was significant between asthmatics (both ever-smokers and never-smokers) and patients with pulmonary emphysema (all ever-smokers). The results suggest that adverse effects of cigarette smoke on %FEV<sub>1</sub> and FEV<sub>1</sub>/FVC, which representing the airflow limitation in large and moderate sized airways, were not observed in elderly patients with asthma. In contrast, %RV and %DLco values were significantly lower in ever-smokers of asthmatics and in patients with pulmonary emphysema, suggesting cigarette smoke increases %RV and suppress DLco value. These results demonstrate that pathophysiology of asthma changes by cigarette smoking towards that of pulmonary emphysema,

however, long-term observations for asthmatics with a history of smoking show that asthma does not develop pulmonary emphysema even by cigarette smoking.

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**高齢者気管支喘息における長期間喫煙のairflow, lung volume およびlung transfer factorに及ぼす影響について**

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高齢者気管支喘息40例 (20年以上の喫煙者20例, 非喫煙者20例) および肺気腫 (全症例喫煙者) 20例を対象に, 長期間喫煙の肺機能, airflow, lung

volumeおよびlung transfer factor, に及ぼす影響について検討した。まずFVC値は, 喘息の喫煙例, 非喫煙例, および肺気腫症例の間に有意の差は見られなかった。%FEV<sub>1</sub>およびFEV<sub>1</sub>/FVC値は, 喫煙例, 非喫煙例いずれの喘息症例も肺気腫と比べ有意に高い値を示したが, 喘息の喫煙例と非喫煙例の間には有意差は見られなかった。一方, %RVおよびDLco値は, 喘息の非喫煙例に比べ, 喫煙例および肺気腫症例で有意に低い値を示した。

これらの結果は, 長期間の喫煙は%FEV<sub>1</sub>やFEV<sub>1</sub>/FVCにはあまり影響しないこと, しかし, %RVや%DLcoにはかなり影響することを示している。