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Seasonal change in maximal expiratory flow-volume pattern in patients with Japanese cedar pollenosis.

Keiko Nishioka* Tadamichi Meguro† Mitsuhiro Okano‡
Yu Masuda** Chisato Saito†† Eiji Yasumitsu‡‡

*Hiroshima City Hospital,
†Okayama University,
‡Okayama Univerisity,
**Okayama University,
††Okayama City Hospital,
‡‡Yasumitsu Otorhinolaryugeal Clinic,

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Keiko Nishioka, Tadamichi Meguro, Mitsuhiro Okano, Yu Masuda, Chisato Saito, and Eiji Yasumitsu

Abstract

Fifteen patients with Japanese cedar pollenosis were examined for lower airway function. Flow-volume patterns obtained from flow-volume and volume-time curves during the pollen season (March) and outside of the pollen season (June) were evaluated. In a previous report we classified maximal expiratory flow-volume (MEFV) curves in five patterns from A to E. In the present study, the patterns did not vary between the two periods except in one patient. Eleven patients out of 15 showed type E patterns, in which the flow-volume curve was concave along its entire course. In most of the patients with severe or moderate symptoms of allergic rhinitis only during the pollen season, the curve shifted to the right, but the parameters of the curves did not increase significantly outside of season. These findings suggest that patients with Japanese cedar pollenosis suffer from continuous latent peripheral airway obstruction. Extremely slight changes in the flow rate were detected by comparing the curves obtained during the two periods.

KEYWORDS: pulmonary function test, pollenosis, pollinosis, maximal expiratory flow-volume curve, flowvolume pattern

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Seasonal Change in Maximal Expiratory Flow-Volume Pattern in Patients with Japanese Cedar Pollenosis†

Keiko Nishioka*, Tadamichi Meguro[a], Mitsuhiro Okano[b], Yu Masuda[b], Chisato Saito[c] and Eiji Yasumitsu[d]

Department of Otolaryngology, Hiroshima City Hospital, Hiroshima 730, [a]Department of Public Health, [b]Department of Otolaryngology, Okayama University Medical School, [c]Department of Otolaryngology, Okayama City Hospital and [d]Yasumitsu Otorhinolaryngeal Clinic, Okayama 700, Japan

Fifteen patients with Japanese cedar pollenosis were examined for lower airway function. Flow-volume patterns obtained from flow-volume and volume-time curves during the pollen season (March) and outside of the pollen season (June) were evaluated. In a previous report we classified maximal expiratory flow-volume (MEFV) curves in five patterns from A to E. In the present study, the patterns did not vary between the two periods except in one patient. Eleven patients out of 15 showed type E patterns, in which the flow-volume curve was concave along its entire course. In most of the patients with severe or moderate symptoms of allergic rhinitis only during the pollen season, the curve shifted to the right, but the parameters of the curves did not increase significantly outside of season. These findings suggest that patients with Japanese cedar pollenosis suffer from continuous latent peripheral airway obstruction. Extremely slight changes in the flow rate were detected by comparing the curves obtained during the two periods.

Key words : **pulmonary function test, pollenosis, pollinosis, maximal expiratory flow-volume curve, flow-volume pattern**

In a previous study, we attempted to determine if interrelationship exists between the upper and lower airway functions of patients with hypersensitivity to pollens such as Japanese cedar. We obtained reproducible and characteristic flow-volume curves from effort-dependent expiratory high lung volumes to effort-independent expiratory low lung volumes in patients with allergic rhinitis and bronchial asthma. Characteristic maximal expiratory flow-volume (MEFV) curves were classified into 5 types from A to E according to our systematic criteria, described in previous reports (1, 2). In the past, patterns of flow-volume loops were analyzed, because there were limitations to presenting all changes in airways from those of large airways to those of medium sized or small airways by the various indices of flow-volume curves. We have further noticed that flow-volume curve changed in MEFV curves from peak flow rate to low lung volumes. In our previous study, the incidence of type A was significantly lower in patients with nasal allergy than in the control group. The incidence of type E was significantly higher (46 %), and that of type B was high (32.4 %) in the group with perennial nasal allergy (2). The objective of this study was to determine whether maximal expiratory flow-volume curves or pattern in flow rate differed between in and outside of pollen season.

Subjects and Methods

The present study includes data from 15 patients with Japanese cedar pollenosis, 6 men and 9 women, aged 15 to 55 years (Table 1). All had seasonal allergic rhinitis (nasal obstruction accompanied

* To whom correspondence should be addressed.

†: A part of this study was presented at the World Conference on Lung Health, 1990.

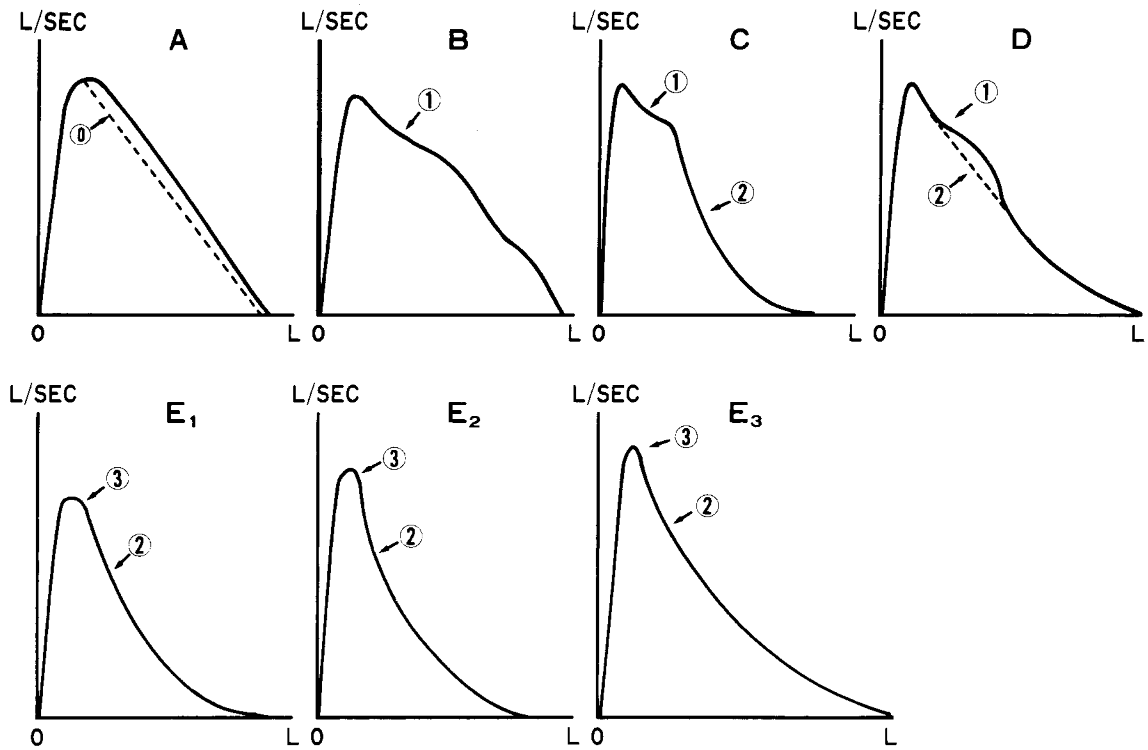

Fig. 1 Schemata of maximal expiratory flow-volume patterns in airway allergy.

by hypersecretion, sneezing and itching of various degrees) for at least 3 years. They had no asthmatic attacks with bronchial hypersensitivity or complaints of lower airway symptoms during the past several years, but some of these patients had a history of bronchial asthma in childhood. The following diagnostic procedures for Japanese cedar pollenosis were performed in all patients: intracutaneous skin tests and nasal challenges with inhalant allergens, Japanese cedar pollen extract, serological examination for specific IgE antibody titer of the pollen (RAST score more than 2), serum IgE antibody titer, and examination of the mucous membranes of the nasal cavity.

The flow-volume and volume-time in all subjects were measured with the patient in a sitting position using a Model AS-4500 flow-volume and volume-time curve recorder (Minato Medical Science). The following indices were calculated simultaneously from the curve using a computer; %FVC, $FEV_{1.0\%-G}$, FVC, $FEV_{1.0}$, PEFR, $\dot{V}_{75}$, $\dot{V}_{50}$, $\dot{V}_{25}$, $\dot{V}_{10}$ and $\dot{V}_{50}/\dot{V}_{25}$. After confirming the reproducibility of the MEFV charts for each subject, the pattern was classified as type A through E. In the type A curve, the flow volume shows a continuous and linear change after the peak flow rate. The type B curve has a concavity in the upward direction immediately after the peak flow rate. The type C curve has a similar concavity in the upward direction at the high lung volume position as well as the low lung volume position. The type D curve is transitional between types C and E. The type E curve is concave along its entire course, and can be further

Table 1 Age distribution of 15 patients

Patients	
Age (Year)	Number
10—19	3
20—29	1
30—39	8
40—49	2
50—59	1
Total	15

divided into three subtypes, E_1–E_3 (Fig. 1).

Pulmonary function tests were performed in March (the pollenation period for Japanese cedar) and in June (outside of season). We compared the differences in types of MEFV curves and the changes in flow rates during the two periods.

Results

The MEFV curves obtained in March (pollen season for Japanese cedar) and June (outside of season) showed similar patterns in all patients except 1 (Table 2). Eleven of the 15 patients showed type E (from E_1 to E_3) MEFV curves. In 9 patients, the curves shifted upward and to the right, with no change in the characteristic form of the curves, resulting from an increased vital capacity and peak expiratory flow rates (PEFR) outside of season. In 5 patients, the curves were located in almost the same position in both seasons. The curve moved to the left in only 1 case.

Two groups of patients were compared: those who had marked or mild symptoms of nasal allergy during the season and no symptom outside of season, and those who had only mild nasal allergy symptoms during both seasons. In the first group, the MEFV curves shifted upward and to the right in 9 of 12 patients outside of

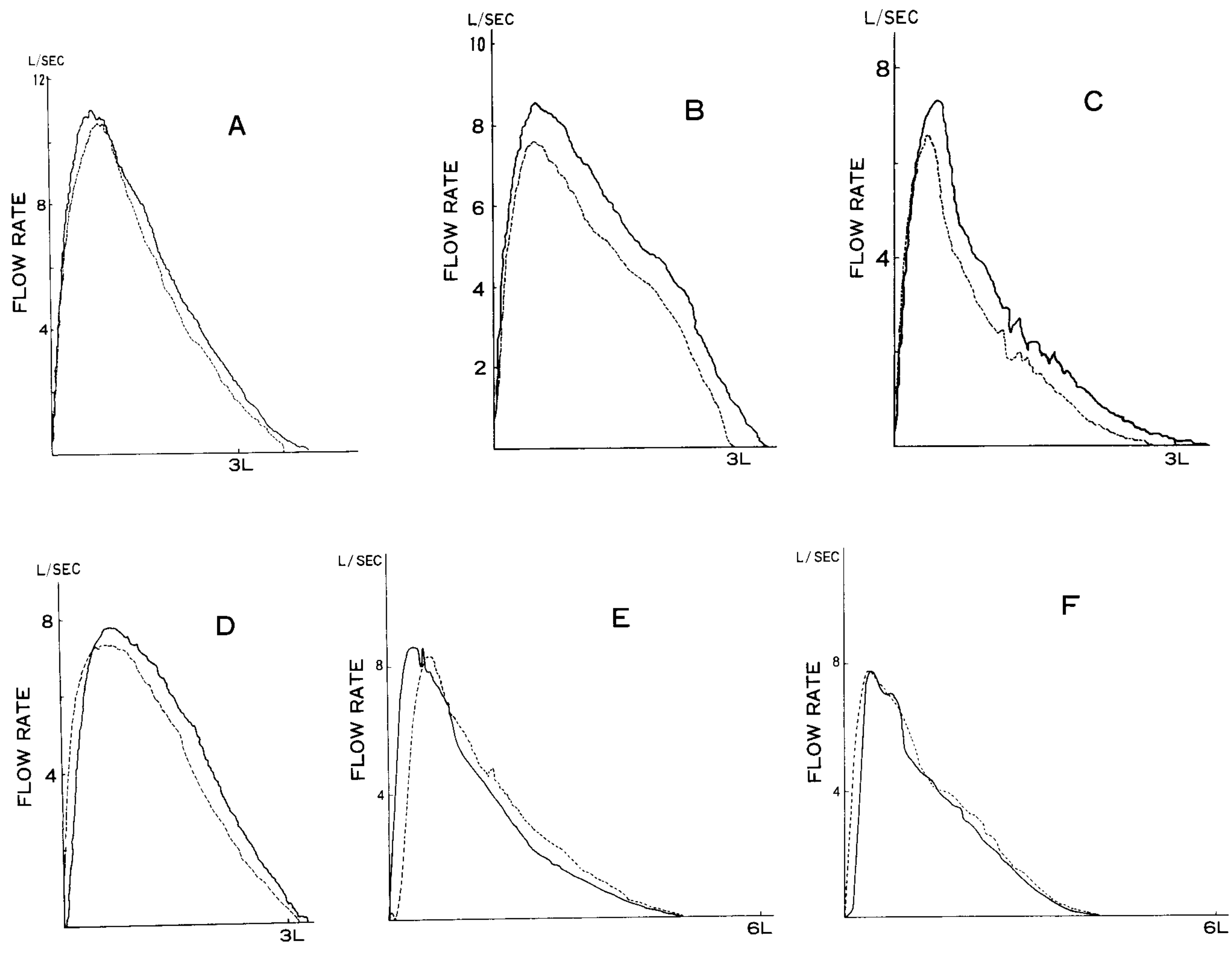

Fig. 2 Flow-volume patterns of six typical cases during two seasons. A: Case 1; B: Case 2; C: Case 3; D: Case 4; E: Case 5; F: Case 6. pollen season (dotted line); outside of season (solid line)

season. In the second group, the curve remained in the same position in 2 of the 3 patients, and shifted somewhat to the left in 1 case (Table 3). There was a statistically significant difference ($p < 0.05$) in the frequency of the shift to the right between both groups.

Typical cases are shown in Fig. 2.

Table 2 Types of flow-volume patterns changing from pollen season to outside of season

Types of flow-volume patterns[a] pollen season→outside of season	Number of patients
A→A	2
B→B	1
E→E	11
B→A	1
Total	15

a: maximal expiratory flow-volume patterns are classified into A–E according to our systematic criteria

Table 3 Cases with shifting flow-volume curve

Degree of the nasal symptoms	Number of patients		
	Shift to right	Shift to left	Same position
Nasal symptoms in the pollen season			
Middle grade <	9	0	1
Low grade	0	0	2
Nasal symptoms outside of season			
Positive	0	1	2
Total	9	1	5

Table 4 Differences in parameters during pollen season and outside of season (data outside of season—data in pollen season)

	Mean of each parameters
%FVC	4.09 ± 2.04 (%)
$FEV_{1.0\%-G}$	−2.40 ± 0.74* (%)
FVC	0.043 ± 0.241 (L)
$FEV_{1.0}$	0.023 ± 0.040 (L)
PEFR	0.205 ± 0.120 (L/sec)
$\dot{V}_{75}$	0.209 ± 0.136 (L/sec)
$\dot{V}_{50}$	0.069 ± 0.106 (L/sec)
$\dot{V}_{25}$	−0.154 ± 0.046*(L/sec)
$\dot{V}_{10}$	−0.231 ± 0.078*(L/sec)

Mean ± USD (n = 15) * $p<0.05$

Case 1 (M. M.). The MEFV curve was classified as E_1, and shifted to the right without a change in pattern outside of season. The values of $FEV_{1.0}$, FVC, %FVC, and PEFR outside of season were higher than those in season, while the values of $\dot{V}_{75}$, $\dot{V}_{50}$, $\dot{V}_{25}$, and $\dot{V}_{10}$ were decreased outside of season (Fig. 2–A).

Case 2 (K. Y.). The MEFV curve was classified as type B, and shifted remarkably to the right outside of season (Fig. 2–B).

Case 3 (A. T.). MEFV curves were type E_2 with quite similar patterns during both seasons, even with the same characteristic changes, during expiration. Outside of season, FVC, %FVC and PEFR were improved markedly, and $\dot{V}_{75}$, $\dot{V}_{50}$, $\dot{V}_{25}$ and $\dot{V}_{10}$ were somewhat lower (Fig. 2–C).

Case 4 (M. O.), This type A curve shows a prominent shift to the right outside of season (Fig. 2–D).

Case 5 (S. S.). This patient was suffering from persistent symptoms of nasal allergy in June. The curve shows a left-hand shift out of season (Fig. 2–E).

Case 6 (N. S.). This patient had only mild symptoms of nasal allergy during the pollen season. The two MEFV curves during pollen season and outside season are in almost the same position (Fig. 2–F).

In patients who had distinct nasal allergy symptoms during the pollen season, the mean values of FVC, % FVC and $\dot{V}_{75}$ measured outside of season were exceeded those during pollen season, while the mean values of

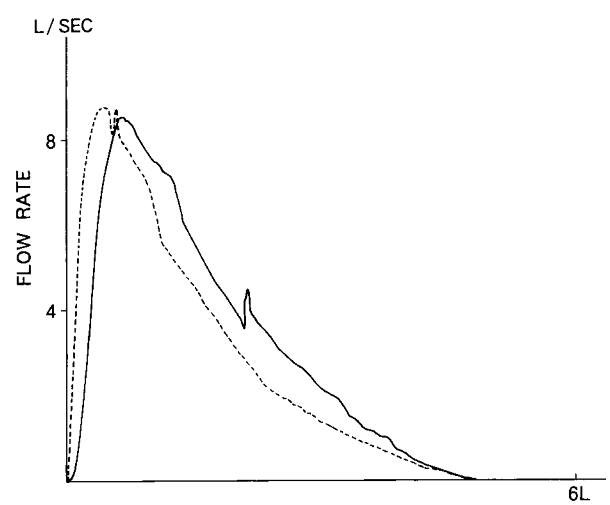

Fig. 3 Flow-volume curves of a case before and after using a bronchodilator. before using (dotted line); after using (solid line)

$FEV_{1.0\%-G}$, $\dot{V}_{25}$ and $\dot{V}_{10}$ decreased significantly (Table 4). Several patients performed pulmonary function tests after the inhalation of a bronchodilator outside of season. The curve, enhanced by the administration of a bronchodilator, shifted to the right and showed a type A-like curve, indicating improved pulmonary function (Fig. 3).

Discussion

It has been reported that some patients with allergic rhinitis have subclinical abnormalities, or latent obstructive changes in the lower airways (2-7). Doggett *et al.* have shown that patients with nasal allergy may have obstruction of the small and large airways (6). They also reported that airway resistance increased in 9 of 20 patients with allergic rhinitis, and that specific airway resistance was elevated in 13 patients. Fairshter *et al.* (5) reported that there was large airway constriction which did not vary with seasonal factors or symptoms in patients with nasal allergy. They also reported that the airway resistance (R_{AW}) was significantly higher, and the specific airway conductance (SG_{AW}) was significantly lower in patients with allergic rhinitis (4). According to Yajima *et al.* (3), a decrease of $\dot{V}_{50}$ and $\dot{V}_{25}$ in patients with allergic rhinitis suggests an obstruction in the peripheral lower airways. In our previous study, the presence of the flow-volume curve was categorized as type B, C, D or E in 33 of the 37 patients with perennial allergic rhinitis. The number of patients with type E curves significantly larger than any other type. The type E curve, which shows a concavity in the upward direction immediately after expiration, has been suggested to indicate the presence of peripheral lower airway obstruction (2). In 1976, Howard *et al.* (8) reported that the intrathoracic airways of the majority of patients with allergic rhinitis show abnormality during the pollen season. Ten of the 17 had elevated specific airway resistance (SR_{aw}) during pollen season, as compared with 3 of 17 with increased SR_{aw} outside of season. This abnormality returned to normal outside of the season. Morgan *et al.* suggested that this indicates the presence of reversible small airway abnormalities in patients with symptoms of hay fever, and that such abnormalities were best detected by measurement of dynamic compliance at varying respiratory frequencies (9). In the present study, FVC and PEFR showed higher values in 10 of the 15 patients, $PEV_{1.0}$ was also higher in 7 of the 15 patients outside of season. However, $\dot{V}_{25}$ and $\dot{V}_{10}$ were significantly lower than during the pollen season. Nevertheless, we found that flow-volume curves had shifted to the right in 9 of the 10 patients during the pollen season. From these results, we could detect even slight variations in the types of curves, and could investigate the change in the curve in each patient. This rightward shift could be derived from an increase in the vital capacity and expiratory flow rates through total expiration lung volumes.

It has been reported that patients with allergic rhinitis, especially pollenosis, have subclinical hypersensitivity of the lower respiratory tract (9). Particularly in those with hay fever, hypersensitivity of larger central airways has been suspected (10). Methacholine challenge induced hyperreactive response in 13 of the 17 patients with pollenosis. Most of them had a disorder of the lower respiratory tract during the season, which was reversible outside of the season (9). In our examination, the majority of patients showed a type E curve, this type of curve was not affected by the season. This finding suggests the presence of constant, not varying obstruction of the peripheral and lower respiratory tract, particularly of the bronchioles in such patients.

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