Fluctuating Olfactory Sensitivity and Distorted Odor Perception in Allergic Rhinitis

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Objective: To characterize the relationship between allergic rhinitis, the severity and duration of nasal disease, olfactory function, and self-reported olfactory symptoms, including fluctuations or distortions in odor perception.

Design: Assessment of olfactory function and symptoms of 90 patients with allergic rhinitis.

Setting: A clinic of a university teaching hospital and research facility.

Patients: Sixty patients who presented to the Taste and Smell Clinic who had positive allergy test results and 30 patients who presented to the Allergy-Immunology Clinic. The Taste and Smell Clinic patients were grouped by nasal-sinus disease status (30 without chronic rhinosinusitis or nasal polyps, 14 with chronic rhinosinusitis but without polyps, and 16 with nasal polyps).

Main Outcome Measures: Subjective olfactory symptom questionnaire and objective olfactory function tests.

Results: The Allergy-Immunology Clinic patients were diagnosed as being normosmic and the Taste and Smell Clinic patients as being hyposmic or anosmic with olfactory loss that increased significantly with nasal-sinus disease severity. Comparisons with normative data confirm that olfactory scores observed in all groups were significantly lower than expected because of the aging process alone. The self-reported duration of olfactory loss increased significantly with nasal-sinus disease severity. The Taste and Smell Clinic patients without chronic rhinosinusitis or nasal polyps reported the greatest incidence of olfactory distortions and olfactory loss associated with upper respiratory tract infections.

Conclusions: There appears to be a continuum of duration and severity of olfactory loss in allergic rhinitis that parallels increasing severity of nasal-sinus disease. As a result of the increased frequency of respiratory infection associated with allergic rhinitis, these patients are at risk for damage to the olfactory epithelium.

study compares patients with allergic rhinitis whose primary complaint is olfactory dysfunction with those whose primary complaints are of nasal and respiratory symptoms. This comparison is made to characterize the relationship between the severity and duration of nasal disease and the possible damage to the olfactory system.

MEASURES

Patient History

The questionnaire administered to all patients included subjective assessment of olfactory function, duration of olfactory problem, history of perceiving distorted odors, fluctuations in olfactory sensitivity, and presence of phantom odors (perceiving odors in the absence of any external odor stimulus). Subjects were questioned about problems associated with olfactory loss, including a history of nasal polyps, sinus surgery, head trauma, toxic exposures, or loss of olfactory function associated with upper respiratory tract infections. Subjects were asked to estimate the date of onset of their symptoms of allergic rhinitis. They were also questioned about their history relevant to allergic rhinitis, including exposure to perennial allergens (eg, dogs, cats, mites, and fungi) or irritants (eg, tobacco and volatile organic compounds) or a history of asthma.

Physical Examination

All TASC patients underwent examination of the nasal cavity with a speculum followed by endoscopic rhinoscopic examination. Visibility of the olfactory clefts was noted. Computed tomographic (CT) scans of the paranasal sinuses were obtained when chronic rhinosinusitis was suspected; it was confirmed if the patient had at least 2 of the clinical signs (rhinorrhea, postnasal drip, or cough for more than 3 months) and if the CT scan showed mucosal thickening or opacification of 1 or more sinuses. The results of the rhinoscopic examination and CT scan were used to classify the TASC patients into 3 groups by increasing severity of nasal-sinus disease (TASC-0 patients had no evidence of sinusitis or nasal polyps, TASC-S patients had...
evidence of sinusitis from either the CT scan or rhinoscopic examination but no polyps, and TASC-P patients had evidence of polyps on rhinoscopic examination).

Olfactory Tests

The test of olfactory function that was developed and used by the TASC consists of 2 parts: a test of detection threshold sensitivity to n-hexyl alcohol (up to 4% 1-hexanol by volume) and a test of odorant identification using common household items (eg, baby powder, coffee, chocolate, and peanut butter). 11 Nostrils are tested separately. The performance scores from the threshold and identification tests are reported on an 8-point scale (0-7); the diagnostic range is 0 to 1.75 for anosmia, 1.75 to 6.0 for hyposmia, and 6.0 to 7.0 for normosmia. Since previous studies have shown a significant correlation between nostrils on the TASC test, 11 results are reported as the mean of the 2 nostril scores.

Allergy Tests

Skin testing included puncture tests and, if the results were negative, intradermal tests. For punctures, a bifurcated needle (ALO Laboratories, Columbus, Ohio) was used. Parterial allergens tested were Dermatophagoides farinae (10 000 allergic units [AU] per milliliter), Dermatophagoides pteronyssinus (10 000 AU/mL), Alternaria (1:20 wt/vol), Aspergil-

Figure 3 shows the frequency distribution of symptoms of olfactory dysfunction for the 30 AC patients, the 30 TASC-0 patients, and the 30 combined TASC-S and TASC-P patients. Compared with the other 2 patient groups, TASC-0 patients reported a greater incidence of olfactory distortions (14 [47%], compared with 3 [10%] of 30 patients in each of the other groups \( \chi^2 = 15.56, P < .001 \)) (Figure 4). Fluctuations were reported significantly more frequently by the combined TASC-S and TASC-P group (22 patients [73%], compared with 10 patients [33%] in the AC group and 13 patients [43%] in the TASC-0 group \( \chi^2 = 10.40, P = .006 \) (Figure 3). The incidence of reports of phantom odors was not significantly different among the patient groups.

For each of these symptoms of olfactory dysfunction, we explored the association of olfactory cleft visibility within nasal-sinus disease status and found that for TASC patients without nasal-sinus disease, odor distortions were reported significantly more often by patients with olfactory clefts visible than by those in whom neither cleft was visible \( \chi^2 = 4.04, P = .044 \). In fact, only 4 (13%) of the TASC-0 patients had neither olfactory cleft visible and none of these patients reported olfactory distortions.

Items from patient medical histories that were associated with olfactory loss are shown in Figure 5. Patients in the combined TASC-S and TASC-P group had

1). Further analysis of the composite olfactory function scores showed that neither visibility of the olfactory clefts nor its interaction with disease status significantly affected olfactory function (Table 2); ie, nasal-sinus disease status has a significant effect on olfactory function, and although cleft visibility is associated with nasal-sinus disease, it is not a significant factor in olfactory function.

The mean composite olfactory scores for each TASC patient group were significantly lower than scores predicted for people their age \( t = 2.36, P = .01 \) (Figure 1 and Figure 2).

The self-reported duration of olfactory loss for the TASC patients increased significantly with increasing signs of nasal-sinus disease \( F_{2,37} = 4.35, P = .02 \). Patients with allergic rhinitis but no other signs of nasal-sinus disease (TASC-0 patients) reported having olfactory problems for significantly less time than patients with allergic rhinitis and chronic rhinosinusitis (TASC-S) or polyps (TASC-P) \( P = .05 \) (Figure 3). The self-reported duration of nasal symptoms did not differ significantly among the 3 TASC patient groups. A typical TASC patient had been suffering with nasal symptoms for 20.6 ± 2.4 years (mean ± SE), which is significantly longer than for a typical AC patient (1.7 ± 0.5 years) \( F_{3,70} = 13.57, P < .001 \) (Figure 3).
As has been reported elsewhere, we also found that patients with chronic rhinosinusitis, but without nasal polyps; and TASC-P, TASC patients with nasal polyps.

We examined the olfactory function of patients with allergic rhinitis. Our study sample included patients from an AC, whose primary complaint did not include olfactory dysfunction, and patients from a TASC, whose primary complaint was olfactory loss. We found that the TASC patients were older, had nasal symptoms longer, and had lower olfactory function scores, and were more likely to have histories of nasal-sinus disease than the AC patients.

We also observed that men and women were not uniformly distributed among the TASC nasal-sinus disease patient groups. Allergy test results showed that there were no differences when allergens were grouped as perennial (on average, 87% of each patient group tested positive for mite, cat, dog, and/or fungi) or seasonal (on average, 84% of each patient group tested positive for grass, trees, and/or ragweed). There were significant differences for some individual tests. Fewer TASC patients tested positive for dog (16 [53%] TASC-0 patients and 8 [28%] TASC-S/TASC-P patients compared with 21 [70%] AC patients; \( \chi^2 = 10.75, P = .005 \)) and for ragweed (17 [57%] TASC-0 and 15 [50%] TASC-S/TASC-P patients compared with 26 [87%] AC patients; \( \chi^2 = 9.99, P = .007 \)).

### Table 1. Sex, Age, and Nasal-Sinus Disease Status of Patient Groups

<table>
<thead>
<tr>
<th>Patient Group</th>
<th>No. of Patients (Men/Women)</th>
<th>Age, y†</th>
<th>Allergic Rhinitis</th>
<th>Chronic Sinusitis</th>
<th>Nasal Polyps</th>
<th>Olfactory Cleft Visibility, No. (% of TASC group)</th>
<th>Neither</th>
<th>One</th>
<th>Both</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC</td>
<td>30 (10/20)</td>
<td>39.5 ± 10.0</td>
<td>+</td>
<td>−</td>
<td>−</td>
<td></td>
<td>. .</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>TASC-0</td>
<td>30 (12/18)</td>
<td>51.7 ± 13.1</td>
<td>+</td>
<td>−</td>
<td>−</td>
<td>4 (13)</td>
<td>10 (33)</td>
<td>16 (53)</td>
<td></td>
</tr>
<tr>
<td>TASC-S</td>
<td>14 (9/5)</td>
<td>49.7 ± 12.6</td>
<td>+</td>
<td>+</td>
<td>−</td>
<td>6 (43)</td>
<td>5 (36)</td>
<td>3 (21)</td>
<td></td>
</tr>
<tr>
<td>TASC-P</td>
<td>16 (14/2)</td>
<td>52.2 ± 11.5</td>
<td>+</td>
<td>+/−</td>
<td>+</td>
<td>5 (31)</td>
<td>5 (31)</td>
<td>6 (38)</td>
<td></td>
</tr>
</tbody>
</table>

*AC indicates Allergy-Immunology Clinic; TASC, Taste and Smell Clinic; TASC-0, TASC patients without chronic rhinosinusitis or nasal polyps; TASC-S, TASC patients with chronic rhinosinusitis, but without nasal polyps; and TASC-P, TASC patients with nasal polyps.
†Mean ± SD.
‡Plus sign indicates condition present in all cases; minus sign, condition absent; and plus or minus, condition present in some but not all cases.

### Table 2. Composite Olfactory Scores of Taste and Smell Clinic (TASC) Patients by Nasal-Sinus Disease Status and Olfactory Cleft Visibility

<table>
<thead>
<tr>
<th>Patient Group</th>
<th>Neither Olfactory Clefts Visible</th>
<th>One or Both Olfactory Clefts Visible</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>TASC-0</td>
<td>4.6 ± 1.6 (4)</td>
<td>2.9 ± 0.4 (26)</td>
<td>3.1 ± 0.4</td>
</tr>
<tr>
<td>TASC-S/TASC-P</td>
<td>0.8 ± 0.4 (11)</td>
<td>1.0 ± 0.4 (17)</td>
<td>0.9 ± 0.3</td>
</tr>
<tr>
<td>Mean</td>
<td>1.8 ± 0.7</td>
<td>2.1 ± 0.3</td>
<td>. .</td>
</tr>
</tbody>
</table>

*Values are mean ± SE. TASC-0 indicates TASC patients without chronic rhinosinusitis or nasal polyps; TASC-S, TASC patients with chronic rhinosinusitis; and TASC-P, TASC patients with polyps.
†Numbers in parentheses are numbers of patients.

**SKIN TESTS**

There was little difference in skin test results among the 3 patient groups. Allergy test results showed that there were no differences when allergens were grouped as perennial (on average, 87% of each patient group tested positive for mite, cat, dog, and/or fungi) or seasonal (on average, 84% of each patient group tested positive for grass, trees, and/or ragweed). However, there were significant differences for some individual tests. Fewer TASC patients tested positive for dog (16 [53%] TASC-0 patients and 8 [28%] TASC-S/TASC-P patients compared with 21 [70%] AC patients; \( \chi^2 = 10.75, P = .005 \)) and for ragweed (17 [57%] TASC-0 and 15 [50%] TASC-S/TASC-P patients compared with 26 [87%] AC patients; \( \chi^2 = 9.99, P = .007 \)).

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groups. While there were slightly more women than men in the TASC-0 (allergic rhinitis only) group, men outnumbered women 2 to 1 in the TASC-S (chronic rhinosinusitis) group and 7 to 1 in the TASC-P (nasal polyps) group. This finding is consistent with a previous study of 445 patients with nasal polyps in which men outnumbered women 2 to 1.12

Among all patients with allergic rhinitis, there appears to be a continuum of olfactory loss from patients without additional nasal-sinus disease to those who have chronic rhinosinusitis to those with nasal polyps (the majority of whom also have sinusitis). These findings are consistent with our previously published studies7,10; patients with allergic rhinitis alone tend to have milder olfactory problems. Although the AC patients were younger and olfactory function is known to decline with age,13 a comparison with age-corrected predicted scores illustrates that the aging process alone cannot account for the degree of olfactory loss suffered by TASC patients (Figures 1 and 2). It is clear from Figure 1 that the olfactory function scores of the TASC patients are substantially below the scores predicted for people their age. Interestingly, the olfactory function scores for the AC patients are also significantly lower than expected for their age group (Figure 2), although their diagnostic category remains normosmic.

Nasal obstruction, as measured by olfactory cleft visibility (Table 1), is significantly although weakly associated with nasal-sinus disease. However, we did not find an association between cleft visibility and olfactory function in the present study or in our earlier study.10 At best, cleft visibility is a crude measure of nasal obstruction; however, other studies using other measures (eg, rhinomanometry10) have also been unable to demonstrate an association between obstruction and olfactory dysfunction.

It is interesting that the duration and severity of olfactory loss is associated with the severity of nasal-sinus disease, whereas the duration of nasal symptoms alone is not. Since olfactory loss may be considered to be one of the signs of nasal-sinus disease,1 our results suggest that the 9 patients in the AC group who had already complained of olfactory problems may be among the first in...
this group to develop more serious signs of nasal-sinus disease in the future.

A significant number of TASC patients in this study reported a history of viral respiratory tract infections, which perhaps is to be expected, since allergic rhinitis has been shown to be associated with frequent respiratory tract infections. There is evidence from biopsy specimens of human olfactory mucosa that damage—perhaps irreversible damage—can occur as a result of these infections and that the degree of damage is correlated with olfactory dysfunction. Distortions in olfactory perception, which could be a consequence of epithelial damage, tend to be reported by patients whose olfactory loss is associated with viral respiratory tract infections. Among the patients in our study, the highest incidence of olfactory distortions and history of upper respiratory tract infection were reported by the patients with the lowest incidence of nasal obstruction, yet their olfactory function was significantly impaired. This suggests that the link between allergic rhinitis and olfactory loss may be caused in part by more frequent respiratory tract infections promoted by the pathophysiologic characteristics of allergic rhinitis, and not only by inflammatory diseases, such as nasal polyposis. This may also explain why, for a sizable number of patients in our earlier study, topical nasal steroid treatment for olfactory loss associated with nasal-sinus disease failed.

Among our patients, the frequency of self-reported fluctuations in olfactory sensitivity increased with the increasing severity of nasal-sinus disease. However, the frequency of self-reported distortions in odor perception was highest in those with less serious disease (Figure 4). It is possible that odor distortions only occur during a phase of recovery following an upper respiratory tract infection (ie, perhaps a degenerating [or possibly regenerating] olfactory epithelium temporarily produces faulty odor perceptions). This might explain why the highest incidence of self-reported distortions was among patients in the TASC-0 group (Figure 4), which also had the highest incidence of olfactory loss associated with upper respiratory tract infections. The TASC-S/TASC-P group also reported histories of upper respiratory tract infections but not distortions. The distortions may have occurred in an earlier stage in the development of this group’s nasal-sinus disease.

One of the limitations of our study is that the AC group in particular was a sample of convenience (ie, we offered olfactory function testing to everyone who came to the allergy clinic for treatment during the late summer). This could account for some of our results (eg, the younger age and the higher incidence of asthma in the AC group).

Our systematic examination of 90 patients with allergic rhinitis, including a series of 60 TASC patients, suggests that 2 details from a patient’s history may help determine the most likely cause of their olfactory loss: patient reports of fluctuations in olfactory sensitivity are significantly associated with obstructive nasal-sinus disease, and patient reports of distorted olfactory perceptions are significantly associated with viral respiratory tract infections. In patients with allergic rhinitis, the duration and severity of olfactory loss are associated with more severe nasal-sinus disease. These patients are at increased risk for olfactory loss because allergic rhinitis promotes the development of repeated respiratory tract infections, which lead to damage to the olfactory epithelium.

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REFERENCES


