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Evaluation of olfactory function in children with seasonal allergic rhinitis and its correlation with acoustic rhinometry

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ABSTRACT

Objectives: Seasonal allergic rhinitis (SAR) is common in children and hyposmia is a major symptom affecting the quality of life. The aim of the present study is to assess olfactory dysfunction in pediatric patients with SAR and correlate the results with acoustic rhinometry measurements.

Methods: Forty children, diagnosed as moderate and severe SAR based on clinical findings, ARIA (Allergic rhinitis and it's impact on asthma) classification and prick test results were enrolled in the study. Endoscopic nasal examination, acoustic rhinometry, total nasal symptom score (TNSS) and Connecticut Chemosensory Clinical Research Center (CCCRC) tests were performed 'in season' (May–August) and 'out season' (November–February). Three patients who did not show up in 'out season' examinations were excluded from the study.

Results: The ages of the children ranged between 8 and 18 years with a hyposmia increased and odor identification decreased ($p < 0.005$, $p = 0.003$, respectively), whereas no differences were found between odor thresholds and the discrimination values ($p > 0.05$). Mean CCCRC value was obstruction score ($r = -0.340$, $p = 0.04$), subjective hyposmia ($r = -0.44$, $p = 0.007$) and TNSS ($r = -0.494$, $p = 0.02$). Although some of the acustic rhinometry parameters were lower during allergy season, there were no correlations between acoustic rhinometry parameters and CCCRS values.

Conclusion: Nearly half of the children with AR reported a mild to moderate hyposmia during pollen season and there was a decrease in odor identification, which can be easily shown using a CCCRC test.

1. Introduction

Allergic rhinitis (AR) is an inflammation of the nasal membranes caused by an Ig-E mediated hypersensitivity reaction to sensitized antigens with a prevalence reaching up to 40% in children worldwide [1]. Common symptoms of AR include sneezing, nasal congestion, nasal itching, rhinorrhea, coughing, a sore throat and itchy eyes. Seasonal allergic rhinitis (SAR) usually occur during the spring and fall season and are typically in response to outdoor allergens like pollens from grass, trees and weeds, whereas perennial allergies occur year round, or at any time during the year in response to indoor substances, like dust mites, pet dander, cockroaches or mold. Although AR itself is not life-threatening, it might be associated with asthma, sinusitis and anaphylaxis, and thus has further important health implications. The quality of life might be compromised by frequent night awakenings, easy fatigue, defects of language and irritability, and limited outdoor activities.

Smell disorders can result from a physical blockage of the nose, such as a deviated septum, nasal allergies, and swelling of the mucosa caused by chronic rhinosinusitis, nasal polyps or from damage to the olfactory cleft or nerve or upper-airway inflammation by physically obstructing access to the smell nerves or damaging the special cells and nerves of the smell pathway [2]. Hyposmia is a fairly common complaint in patients with long-standing allergic or nonallergic rhinitis [3–8]. In a systematic review, smell disorders were shown to be present in 20–40% of the adult patients with AR [9]. However, they are often neglected by the patients and overlooked by the physicians. Both obstruction of airflow across the olfactory epithelium secondary to inflamed mucosa or enlarged polyps and nasal inflammation without obstruction were suggested to cause olfactory dysfunction in AR.

In the literature, there are limited number of studies about olfactory dysfunction in pediatric patients with SAR. In a recent study [10], using a subjective scale, odor dysfunction was reported in 44% of the AR

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children with ages between 6 and 12 years and loss of smell frequency and intensity was found to be related to disease duration and severity. However, in another study, olfactory function was found to be normal in children aged 6–18 years with AR and non-AR [11]. The aim of this study is to evaluate the changes in olfactory function in pediatric patients with SAR using both subjective and objective scales in allergy season, compare the findings with out season measurements and correlate the results with acoustic rhinometry parameters.

2. Materials and methods

2.1. Patient selection

The study was approved by the Ethics Committee of Selcuk University with the protocol no 2016/4. Written informed consent was obtained from parents of the children who participated in the study.

Forty children with ages between 8 and 18 years who were admitted to the Department of Otorhinolaryngology-Head and Neck Surgery or referred from the Department of Pediatric Allergy-Immunology with symptoms of SAR between May 2016 and August 2016 were enrolled in the study.

SAR was diagnosed based on clinical findings, ARIA classification [12] and prick test results. The children were tested with a panel of common inhalant allergens including house dust mites, a mixture of 12 grass pollens, a mixture of four grain pollens, tree pollens, molds, Cladosporium mixture, animal epithelium and cockroach (Stallergenes SA, 92160, Antony, France). A mean wheal diameter greater than 3 mm was considered positive. According to skin prick test, children who had only pollen allergy were included in the study.

Inclusion criteria were a history of seasonal nasal symptoms for at least 2 years, diagnosed as moderate and severe AR based on ARIA criteria and positive skin prick test to only pollens. Exclusion criteria were anatomical deformities causing airway obstruction, such as adenoid hypertrophy, tumor or choanal atresia, nasal polyps, upper respiratory tract infection or acute rhinosinusitis within 2-weeks, asthma, treatment with steroids, antihistamines, thyroid medications and/or antidepressants for a month or longer, immunotherapy, previous nasal surgery, history of head trauma and smoking.

2.2. Study design

Pollen season was determined according to Konya's pollen map for 2010 (www.aid.org.tr/aid.polen.konya). The period from May to July was considered 'in season' for tree pollens and from May to August for grass and grain pollens. A general medical history was taken for every child. The children were asked if they have hyposmia and a subjective scoring was performed on a scale from 0 to 3 (0 = no smell loss, 1 = mild, 2 = moderate and 3 = severe/no smell). Endoscopic nasal examination, nasal obstruction score, total nasal symptom score (TNSS), acoustic rhinometry, and Connecticut Chemosensory Clinical Research Center (CCCRC) tests were performed both during pollen season (May–August) and out season (November–February) and 3 patients who did not show up in 'out season' examination were excluded from the study.

2.2.1. Total nasal symptom score (TNSS)

Nasal symptoms were assessed using the total nasal symptoms score (TNSS) by calculating the sum of scores for nasal obstruction, rhinorrhea, nasal itching, and sneezing. Each nasal symptom was scored on a scale from 0 to 3 (0 = no symptoms; 1 = mild; 2 = moderate; 3 = severe) according to TNSS. Any symptom not causing significant discomfort was considered mild. Any symptom causing discomfort but not interfering with daily activity and/or disturbing sleep was considered moderate. Any symptom that interfered with daily activity and sleep pattern was considered severe. The scores for each symptom were summed and the total nasal symptom score was obtained. Loss of the sense of smell of the patients were also questioned.

2.2.2. Endoscopic nasal examination

Both sides of nasal cavities were evaluated endoscopically using the Storz 0° pediatric endoscope. Concha hypertrophy, nasal mucosal edema, paleness, rhinorrhea were recorded.

2.2.3. Acoustic rhinometry

Using acoustic rhinometry, the nasal volume from 0 to 2.2 cm (VOL1), the nasal volume from 2.2 cm to 5.4 cm (VOL2), total nasal volume from 0 to 5.4 cm (TVOL), the minimum cross-sectional area of the anterior (MCA1) and the minimum cross-sectional area of the posterior (MCA2) were measured from each nasal cavity within the distance of 5.4 cm from the nostrils. The test was repeated 3 times and the mean value was recorded.

2.2.4. Olfactory function

Olfactory function testing was performed by means of a modified Connecticut Chemosensory Clinical Research Center test [13] consisting of a threshold, identification, and discrimination test. The results of 3 tests were summed to calculate the CCCRC score. The validity of this test in the Turkish adult population was confirmed before [14].

Threshold testing was performed with solutions of 1-butanol in deionized water, decreasing in 8 steps. The strongest butanol concentration (bottle 0) was 4% butanol in deionized water. Each subsequent dilution (bottles 1–8) was a 1:3 dilution with deionized water. Possible scores ranged from 0 to 8. Starting with the lowest concentration, the patients received a bottle with odorant and a bottle filled with deionized water and had to decide which smelled stronger. In this test, 60 ml of the odorant was presented in a squeezable polyethylene bottle. The bottles were of identical appearance and presented simultaneously. Subjects were instructed to occlude one nostril and place the tip of the bottle immediately beneath the other nostril. If the choice was incorrect, the next stronger concentration of butanol was presented along with a bottle containing only water. A concentration was defined to be the threshold concentration if it was correctly identified four times for that nostril. The other nostril was then tested separately, and the scores for both nostrils were averaged to arrive at the final score. The test result was expressed as threshold score from 0 to 8.

In the identification testing 8 well-known odorants which contains Peanut butter, soap, mothballs, Vicks, chocolate, coffee, cinnamon and baby powder were presented within 180 ml opaque jars to the test person in the same manner. Subjects chose from a printed list containing the correct items as well as an equal number of distractor items. The forced choice items included the following: Vicks, burnt paper, wood shavings, coffee, baby powder, peanut butter, spearmint, cinnamon, soap, chocolate, mothballs, grape jam, ketchup, black pepper, and rubber. The ability to sense Vicks indicates intact trigeminal nerve function. Possible scores ranged from 0 to 7 items correctly identified. Scores for both nostrils were averaged to arrive at the final score.

In the discrimination testing the subject received three different odorants. Two were identical and the third was a different odor. The differing bottle had to be identified. A total of seven triplets were tested in this manner. The person received one point for each correct answer, with a possible maximum of seven points.

Scores for the butanol threshold test, identification tests and discrimination tests were subsequently averaged to arrive at a CCCRC score.

2.3. Statistical analyses

All analyses were performed using SPSS 21.0 (SPSS for Windows, USA). Values for categorical variables were provided in numerals and percentages of the total. Data are presented as the means ± standard deviation, IQR (interquartile range). Categorical variables were compared using chi-square test. The correlation between two continuous