

Brief communications

Allergy to green algae (*Chlorella*) among children

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Microalgae of the divisions Chlorophyta, Xanthophyta, Bacillariophyta, and Cyanophyta are present in most outdoor and indoor habitats.¹ Since McElhenney et al.² reported positive skin reactions to four different airborne green algae among atopic patients in 1962, various figures have been obtained for the prevalence of sensitization to unicellular algae. We have studied the sensitization to the green alga *Chlorella* in children in Sweden with an immunochemically characterized extract.³

METHODS

Three groups of children were investigated: (1) 94 7-year-old children (55 boys and 39 girls), unselected with regard to allergy; (2) 129 consecutive patients (69 boys and 60 girls, aged 6 to 17 years with a mean age of 11 years), referred to the outpatient pediatric allergy clinic at the Department of Pediatrics in Linköping, Sweden, from September 1988 through October 1989; (3) 23 patients (14 boys and 9 girls, aged 10 to 17 years with a mean age of 13.4 years), from the allergy register of the allergy unit, who were sensitized to molds. A questionnaire concerning allergy symptoms and living environment (Table I) was completed by the patients in groups 2 and 3.

Serum samples from the patients in group 1 were kindly donated by Dr. Sven Andrae, Norrköping, Sweden.

A partially purified, lyophilized extract from the green alga *Chlorella homosphaera* was used.³ For skin prick tests (SPTs), the extract was reconstituted in 50% glycerol to a concentration of 5 mg dry weight/ml (2.2 mg protein/ml), sterile-filtered, and stored at -70°C until use. The extract used for conjunctival provocation tests

Abbreviations used

CPT: Conjunctival provocation test
PRU: Phadebas RAST units
SPT: Skin prick test

(CPTs) was prepared in 0.03 mol/L phosphate buffer with 0.9% NaCl, pH 7.4.

SPTs were performed as previously described⁴ with the limit for a positive SPT response set to an area of 3 mm², because no reactions of that size were found with the negative control solution (50% glycerol). The *Chlorella* extract for CPTs was diluted in albumin-saline solution to 0.05 and 5.0 mg dry weight/ml. The method for CPTs described by Dreborg⁵ was used.

The *Chlorella* extract (5 mg dry weight/ml) was coupled to CNBr-activated paper disks, and circulating *Chlorella*-specific IgE antibodies were determined with the Phadebas RAST (Pharmacia, Uppsala, Sweden) standard procedure. The limit for a positive RAST result was set to 0.20 Phadebas RAST units (PRU)/ml because the disks tested with a negative control serum, when spiked with 2 000 kU/L added myeloma IgE, resulted in less than 0.1 PRU/ml. Total circulating IgE was determined with Pharmacia IgE RIAC.

The study was approved by the Human Research Ethics Committee at the University of Linköping, Sweden. Patients or parents gave their informed consent.

RESULTS AND DISCUSSION

In sera from the 94 children from the general population comprising group 1, no *Chlorella*-specific IgE antibodies were found as determined by RAST. Nine of the 129 children in group 2 had positive wheal reactions with the *Chlorella* extract in SPT ($p < 0.0001$). Sera from seven of the patients with positive SPT results were available for analysis of IgE antibodies against *Chlorella*, and two of them were positive, whereas sera from four patients with SPT negative results showed negative RAST results ($p < 0.001$). Seven of the 23 mold-sensitive children had positive SPT responses to *Chlorella*. Six patients with SPT positive results and

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TABLE I. Allergic sensitivities, symptoms, and home environments of patients tested with *Chlorella* extract

	Group 2 (n = 129)		Group 3 (n = 23)	
	<i>Chlorella</i> SPT response		<i>Chlorella</i> SPT response	
	Positive (n = 9)	Negative (n = 120)	Positive (n = 7)	Negative (n = 16)
Sensitivity to				
Tree pollen (%)	55	31	71	62
Grass pollen (%)	67	34	71	56
Weed pollen (%)	0	8	57	56
Animal dander (%)	55	18	85	87
Molds (%)	0	2	85	87
Mites (%)	11	12	57	44
Foods (%)	44*	7*	85	50
Symptoms				
Seasonal rhinitis (%)	67	48	14	50
Asthma (%)	33	28	18	50
Perennial rhinitis (%)	0	8	28	31
Asthma (%)	0	11	42	31
No rhinitis/asthma (%)	33	28	0	0
Symptoms experienced†				
At snow melting (%)	ND	ND	57	37
In humid environments (%)	ND	ND	86	56
When playing in grass (%)	ND	ND	100	62
Factors in home environment				
Aquarium (%)	44	14	43	44
Cigarette smoke (%)	ND	ND	28	12
Moisture damage (%)	ND	ND	57	31

ND, Not determined.

*The difference in frequency between patients with positive SPT responses to *Chlorella* and those with negative responses is significant.

†Known to be common among patients with mold (algae) sensitivity.

two of the 16 patients with negative SPT results had positive RAST results ($p < 0.0001$). The total serum IgE levels were similar in the patients with positive results and those with negative SPT results in groups 2 and 3. All patients with positive SPT results showed some reaction in CPTs with *Chlorella* extract (5 mg dry weight/ml).

The prevalence of reactions to other allergens and the symptoms in different environments are listed in Table I. It was obvious that most patients who reacted to *Chlorella* were also sensitized to many other allergens. Therefore we were not able to find any symptoms specifically related to *Chlorella* sensitization. However, one patient experienced local urticaria after contact with water from his aquarium. The higher incidence of *Chlorella* positivity found among mold-sensitized patients ($p < 0.0001$) may be due to simultaneous sensitization, or it may be because predominantly highly atopic individuals are sensitized to algae. Immunologic cross-reactivity may be a contributing factor. Because molds and green

algae grow under similar conditions, individuals sensitized to green algae would probably show a similar pattern of symptoms as those sensitized to molds.

The low degree of clinical sensitization to *Chlorella* found among nonatopic and atopic children in Sweden, the higher sensitization among atopic children with multiple sensitivities, the low levels of IgE antibodies against *Chlorella* as measured by RAST, and the great amount of protein material used to obtain a positive CPT result all indicate that *Chlorella* is a "weak" allergen. The production of the *Chlorella* extract and amount of material used for testing was similar to the amounts that we used in previous studies, found to be clinically relevant.⁶ This means that *Chlorella* either does not have sensitizing properties comparable to other studied inhalant allergens or it is present in concentrations too low to sensitize susceptible patients. This study does, however, clearly confirm that *Chlorella* is an allergen and may be of clinical significance in certain groups of patients.

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Hereditary angioedema with recurrent abdominal pain and ascites

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Abbreviations used

C1 INH: C1 esterase inhibitor
HAE: Hereditary angioedema
nl: Normal value

Hereditary angioedema (HAE) is a disorder characterized by decreased levels or function of complement C1 esterase inhibitor (C1 INH) and recurrent episodes of soft tissue swelling.^{1,2} Gastrointestinal involvement may cause severe abdominal pain, suggesting acute abdomen.³⁻⁵ We report a patient with HAE who was seen on two occasions with severe abdominal pain. Determination of the cause of this pain was made more difficult by the presence of significant ascites as determined by abdominal ultrasonography. On both occasions the patient was treated medically, and the ascites and other abdominal symptoms resolved within 3 days. Ascites has not, to our knowledge, been previously described with intestinal involvement in HAE.

CASE REPORT

A 19-year-old woman presented with known HAE. At the time of her initial diagnosis, the values were C1 INH less than 6 mg/dl (normal value [nl], 5 to 30 mg/dl) and 9% of activity for the functional assay of inhibitor activity (0% to 40% is presumptive evidence of HAE). At the time of admission to the hospital, she had a 1-day history of abdominal pain, fever, and protracted vomiting. The patient did not have any evidence of angioedema elsewhere.

Medical history was significant for multiple episodes of angioedema associated with minor trauma. Her family history was significant for HAE in a sibling and a paternal uncle. The patient was taking stanozolol 2 mg/day and oral contraceptive pills.

On examination, the patient appeared to have severe abdominal pain. Her temperature was 100° F (oral), heart rate was 100 beats/min, respiratory rate was 16 breaths/min, and blood pressure was 90/50 mm Hg. Results of examination of head, eyes, ears, nose, and throat and of the heart and lungs were unremarkable. The abdomen was soft with diffuse tenderness, and bowel sounds were present. Results of rectal and pelvic examinations were unremarkable. Significant laboratory values were as follows: hemoglobin, 14 gm/dl; hematocrit, 43.9%; white blood cell count, 14,900 cells/m³. Differential was 60% neutrophils, 14% bands, 18% lymphocytes, and 1% monocytes; C4 was less than 4 mg/dl (nl, 5 to 30 mg/dl). Serum glutamate oxaloacetate transaminase value was 44 IU/L (nl, 1 to 30 IU/L), and serum glutamate pyruvate transaminase value was 63 IU/L (nl, 1 to 30 IU/L). Results of chest x-ray were negative, and abdominal