

Oral allergy syndrome

Nuray Bayar Muluk, M.D.,¹ and Cemal Cingi, M.D.²

ABSTRACT

Objectives: To review oral allergy syndrome (OAS).

Methods: We searched several medical literature data bases with the following key words: "oral allergy syndrome," "OAS," "pollen-food allergy syndrome," "PFAS," "allergy," "diagnosis," "treatment."

Results: Oral allergy syndrome (OAS), also called "pollen-food allergy syndrome," is a type of food allergy brought about by flavors, nuts, raw fruit, and vegetables. The most well-known symptoms are mouth and throat itching, which starts rapidly after a food is placed in the mouth, and that, as a rule, continues for just a couple of minutes after the food has been swallowed. The frequency of OAS with pollen allergy has been reported as 5–8%; 1–2% of patients with OAS with pollen allergy show extreme responses, e.g., anaphylaxis. Birch tree pollen, ragweed pollen, and grass pollen hypersensitivity cause the symptoms. The diagnosis of OAS is confirmed by a positive history and positive skin-prick test result triggered by the food's fresh extract. Oral challenge result is normally positive with the raw food and negative with the similar cooked food.

Conclusion: Patients with grass allergy may have a response to peaches, oranges, celery, tomatoes, and melons. Patients with ragweed allergy may show OAS symptoms with melon, cucumber, banana, and zucchini. Physicians should be aware of OAS and know the appropriate treatment.

(Am J Rhinol Allergy 32, 27–30, 2018; doi: 10.2500/ajra.2018.32.4489)

Oral allergy syndrome (OAS), also called "pollen-food allergy syndrome," is a type of food allergy limited to the oral mucosa and caused by uncooked fruit, raw vegetables, flavors, and nuts.¹ The most well-known symptom is mouth and throat itching that begins immediately when food is placed in the oral cavity, and, as a rule, the symptoms continue for just a couple of minutes after the food has been swallowed. OAS is found in individuals who have pollen allergies and is brought about by allergens in nuts, vegetables, and fruits, which are fundamentally the same as allergens in pollen.²

OAS is a type of contact allergic response triggered by the contact of the mouth and throat with "raw fruits or vegetables." The most frequent symptoms are irritation or swelling of the mouth and throat. Adverse effects begin quickly after eating raw fruits or vegetables. In unusual cases, the response can happen more than an hour later. OAS can happen any time during the year.³

Symptoms may occur with a single food or with a wide range of fruits and vegetables. A single fruit, e.g., apple, may trigger symptoms. In OAS, patients respond to various foods. For example, for patients who are adversely affected by birch tree pollen (an airborne allergen that causes frequent reactions during the springtime), pitted fruits or carrot may provoke a response. Likewise, in subjects with birch-pollen allergy, peanut, almond, and hazelnut may also cause mouth itching. Individuals with grass allergy might have a response to orange, tomato, peach, celery, and melon. Those with responses to "ragweed" may have OAS when eating melon, cucumber, banana, or zucchini.³

EPIDEMIOLOGY OF OAS

In the pediatric population, OAS is predominantly found in adolescent populations⁴; it is more characteristic in patients with seasonal allergic rhinitis.^{5–8} Ma *et al.*⁹ revealed that the frequency of OAS in patients with pollen allergy was 5–8%; 20% of allergists reported that

a small number of patients show advanced systemic reactions; 30% of allergists never recommended epinephrine for OAS, and 3% routinely did recommend epinephrine when necessary.

SYMPTOMS OF OAS

Symptoms are produced after contact with an implicated food. Labial and oropharyngeal itching; paraesthesia; angioedema of the oral mucosa, tongue, palate, and oropharynx angioedema; and voice hoarseness can be seen. OAS occurs in 47–70% of patients with pollen allergy.^{2–4,10–13} OAS is an immunoglobulin E (IgE) mediated allergic response. Homologous proteins and cross-responding antigenic determinants in pollens and in different vegetables and fruits may initiate the symptoms.^{14,15} Patients with sensitivity to birch antigens frequently have a response to "crisp apple, celery, cherry, hazelnuts, and carrot," whereas patients sensitized to ragweed may respond to "melons, kiwi, and banana."^{16,17} Symptoms are generally localized to the oropharynx and oral mucosal manifestations; throat pruritus or angioedema may occur.¹⁸

The main symptoms of OAS are itching and mild swelling of the lips, mouth, and throat.² More unusual symptoms are the ones that do not affect the mouth and throat, such as itching, slight swelling or redness of the hands, nausea or stomach irritation (10%), vomiting, diarrhea, chest tightness, or loss of consciousness.^{2,10} Manifestations of OAS may vary according to the pollen season. Symptoms are typically most evident during the associated pollen season and for a few months afterward. Likewise, OAS symptoms might be particular to one fruit.²

All individuals with OAS have a pollen allergy. Pollen allergy causes nasal symptoms (watery nasal discharge, nasal obstruction, sneezing, itching), eye symptoms (itching and swelling around the eyes), throat and ear symptoms (sore throat, voice changes, tingling in the ears), and sleep problems (frequent arousing, daytime fatigue) that happen at the same period every year.²

Allergic manifestations are usually limited to the oropharyngeal region, such as swelling of the lips, tongue, and throat. Approximately 9% of individuals have symptoms at the oropharynx, and 1–2% of individuals with OAS present with severe responses, e.g., angioedema and anaphylaxis.¹⁹ The response is created *via* "heat-labile food proteins," which cause cross-reactivity *via* the pollen proteins that cause allergy.⁵ Those reactions usually occur in individuals exposed to "birch-tree dust" after ingestion of "crude apples, fruits, potatoes, hazelnuts, carrots, and kiwis." In addition, individuals allergic to "ragweed" respond to "banana and crisp melons."^{6,7}

From the ¹Department of Otorhinolaryngology, Medical Faculty, Kirikkale University, Kirikkale, Turkey, and ²Department of Otorhinolaryngology, Medical Faculty, Eskisehir Osmangazi University, Eskisehir, Turkey

With the exception of data collection, preparation of this manuscript, including design and planning, was supported by the Continuous Education and Scientific Research Association

The authors have no conflicts of interest to declare pertaining to this article

Address correspondence to Nuray Bayar Muluk, M.D., Department of Otorhinolaryngology, Medical Faculty, Kirikkale University, Birlik Mahallesi, Zirvekent 2. Etap Sitesi, C-3 blok, No: 6–3/43, 06610 Çankaya, Ankara, Turkey

E-mail address: nbayarmuluk@yahoo.com; nurayb@hotmail.com

Copyright © 2018, OceanSide Publications, Inc., U.S.A.

BASIC MECHANISMS OF FOOD ALLERGY AND FOOD INTOLERANCE

In OAS, typical signs are associated with contact to food antigens and IgE-induced release of mediators. With regard to food intolerance that does not produce a positive radioallergosorbent test or skin test result, it seems appropriate to think about non-IgE-mediated causes.⁵ OAS is sometimes accompanied by a systemic reaction and is considered to be an IgE-mediated allergy.²⁰ Experimental reports emphasized particular elements that prevent improvement in oral tolerance that may similarly be involved in humans. Such elements include the apoptosis of T cells that are antigen specific, paralysis of the T cells, and deficiency in generation of T cells that are regulatory.^{21–24}

The interferon γ cytokine is also encoded in humans.²⁵ In fetal life, the T-helper (Th) type 2 cell cytokine pattern prevails. This predominance may prevent harm to the placenta by Th1 cells. If the Th2 profile persists after delivery, then this would contribute to the absence of development of oral tolerance.^{26,27} Microbial life is established in the gut quickly after delivery, which creates a strong provocation to shifting toward a Th1 cell-mediated response.^{28,29} The so-called hygiene theory proposes avoiding antibacterial treatment that might itself be responsible for the expansion in allergy.³⁰ Another essential component is the specific variation in IgE-mediated reaction. For example, a polymorphism in the CD14 gene is related to food allergy and elevated amounts of IgE.³¹ Furthermore, T-cell immunoglobulin mucin-1 (TIM-1) encoded by atopy susceptibility gene (Havcr1) is related to the control of Th1 and Th2 immune reactions. The evidence of a relationship between atopy and TIM-1 seems to show another application of the hygiene hypothesis.³²

The OAS is a remarkably common sign of food allergy, mainly in adults who are allergic to tree pollen.³³ The disorder includes oral itching, lip swelling, and laryngeal angioedema after contact with allergenic foods.³⁴ Infrequently, OAS may trigger severe swelling of the throat that causes difficulty swallowing and/or breathing. Anaphylaxis may be initiated by a pollen cross-reactive raw vegetable or fruit; nevertheless, this occurrence is extremely infrequent.³ Patients who have oral signs seem to show that the capacity exists for advancement to a further systemic reaction, and restriction of the diet would be correctly advised. Heating food does not change the allergic capability of those specific food allergens.³⁵

ETIOLOGY OF OAS

OAS is brought about by food allergens; for the most part, these are “uncooked fruits and raw vegetables” that contact the patient’s oropharynx.² The allergic foods that trigger OAS are effectively inactivated by the corrosive action of the stomach, so the response typically ends when the food is swallowed. Thus, as a result, OAS seldom causes serious or life-endangering responses. Cooking or warming additionally attenuates the allergens, so cooked or canned foods seldom trigger OAS symptoms.²

Certain customary samples of foods that trigger OAS are recorded, alongside the kind of pollen that is identified with these foods²:

- Birch tree pollen hypersensitivity. The patients may experience oral symptoms after the ingestion of apricot, peach, apple, carrot, almond, plum, hazelnut, pear, celery, fennel, parsley, aniseed, coriander, soybean, caraway, or peanut.² Birch allergy can often be related to OAS. Bet v 1 is the chief birch allergen.³⁶
- Ragweed-pollen hypersensitivity. The patients may experience oral symptoms after eating banana, melon, cucumber, or kiwi.²
- Grass-pollen hypersensitivity. The patients may be used to perioral and oral symptoms and signs after the ingestion of orange, tomato, melon, or peanut. Also, irritated and red hands may be observed after peeling raw potato.² OAS develops in individuals with pollen allergy. Allergens in raw vegetables, fruits, and nuts resemble the pollen allergens.³⁷

Even though numerous foods are recorded for each of the pollens mentioned above, many patients with OAS respond to only one or few of these foods.²

DIAGNOSTIC TESTS

The determination of OAS is undertaken by clinical history and by skin-prick test (SPT) positivity with fresh food extracts. The oral challenge result is positive with the raw food and negative with the cooked food.^{8,38} Assessment of an individual with pollen-food allergy syndrome should incorporate a careful medical history to decide which foods trigger the symptoms and are responsible for the responses, tests that may incorporate SPT with fresh or raw fruits, and possibly oral food challenges. If there is a systemic response and diagnostic laboratory data, the food ought to be prevented, and epinephrine should be prescribed. Assessment for other associated foods ought to be undertaken.^{39–42}

The diagnostic exactness of SPT with artificial extracts is highly variable. Now and again, SPTs that use the food in its common form are more trustworthy, particularly for plant food allergy.⁴³ The indicative value of the specific IgE depends on the concentrate used.^{38,44} SPTs give prompt outcomes that permit a straightforward clinical assessment and are less expensive than *in vitro* techniques. Because of cross-reactivity, both strategies may give false positivity. For example, patients oversensitive to grass pollen ordinarily have IgE-specific reactions to oat, however, with no symptoms.⁴⁵ There have been some efforts to relate IgE-antibody levels to double-blind, placebo controlled food challenge (DBPCFC) results. DBPCFC is currently the criterion standard for a definite diagnosis of IgE-mediated allergy.^{46,47}

Elimination Diets

Elimination diets may be valuable in individuals with continuing symptoms. Positive food testing results to SPT and/or radioallergosorbent test and cases suspected from the medical history are confirmable. Twenty-one days are typically adequate to cast reliable doubt on food allergy. The outcome is viewed as positive if a steady improvement of the symptoms occur. If the symptoms return once foods are reestablished, a DBPCFC should be accomplished.¹³

DBPCFC

The DBPCFC is the principal approved test for food allergy diagnosis.⁴⁸ Because the technique is complicated and has a long duration, the test is restricted to individuals being evaluated for perpetual avoidance of foods fundamental to a healthy diet, *e.g.*, milk, eggs. In patients with past serious food responses, the test is contraindicated. The tested food is prepared in opaque capsules, or in its normal shape veiled by an inactive component. The dummy treatment consists of a case of using an item of similar appearance that contains dextrose or other inactive food components that are certain to be tolerated by the individual and permit satisfactory concealment of the administered food.⁴⁹

Non-IgE-Mediated Food Allergy

Food patch tests were, until recently, in use for the analysis of food allergy, including delayed signs. For pediatric patients who experience atopic dermatitis, including delayed responses, a food patch test improves diagnostic accuracy, yet not at the expense of sensitivity or speed.^{50,51} This technique was not approved for routine diagnosis. Despite the fact that numerous reports support the usefulness of “lymphocytes proliferation and cytokine increment” after exposure to food allergens, there is no affirmation of benefit over the customary analytic method.¹³

Lactose Breath Test

Diagnosis of lactose intolerance depends on the peak in breath hydrogen (H₂) after lactose intake that is used for the breath-test analysis.¹³

Cross-Reactivity

Allergic cross-reactivity is the situation in which IgE antibodies initially recognized as the epitopes of one allergic reaction are found to cause comparable problems in a further allergy.¹³ More than 65% of food allergens consist of just four basic species: (1) the Bet v1 homologs, (2) the profilins, (3) the cereal prolamin superfamily, and (4) the cupins.⁵² This might indicate broad IgE cross-reactivity, even among allergens that occur in systematically distinct plants. Moreover, IgE binding may happen if up to 35–40% of the amino acid sequence is conserved.¹³

CLINICAL FEATURES

OAS is typically diagnosed from responses to vegetables and fruits. OAS is sometimes inappropriately used when mild oral symptoms are actually pointing to seriously allergic responses to foods (*i.e.*, shellfish or nuts).⁹ In the study by Ma *et al.*⁹ about the prescribing habits of allergists for a child with nut sensitivity, 13% gave a conclusion of OAS and 25% did not count epinephrine. Similarly, 20% reported that they used the term OAS for systemic manifestations brought on by fruit.⁹

OAS used to be thought to be a self-limiting phenomenon related to ingestion of raw protein.¹² Silviu-Dan and Melanson¹¹ evaluated 26 patients with OAS to decide the risk of anaphylaxis separately from the oropharyngeal difficulties that occur after eating the specific protein. Six of the patients had extreme anaphylactic responses that required acute treatment.¹¹ Patients with OAS who had anaphylaxis had the same likelihood of allergic rhinitis or asthma as patients with OAS without anaphylaxis.¹¹

Risk factors for anaphylactic responses are

- having a systemic response to the food,
- responding to the cooked form of the food,
- SPT positivity to the food extract,
- lack of sensitization to the associated pollen,
- allergy to peach.^{10,34,53,54}

When fruit allergy develops without pollen allergy, responses will probably be extreme.^{34,53} In one review, 82% of the patients with food allergy and without allergic rhinitis showed systemic responses, (*i.e.*, 36% experienced anaphylaxis); conversely, 45% of patients with allergic rhinitis had systemic responses and 9% experienced anaphylactic reactions.⁵⁴

TREATMENT

Food allergy treatment depends on antihistamines, corticosteroids, and epinephrine (intramuscular). No clear evidence exists for using sodium cromoglycate.¹³ “Specific immune therapy” for food allergy is not feasible. Specific immune therapy that used peanuts was discontinued because of excessively high levels adverse effects.⁵⁵ Novel encouraging immunologic investigations of mice include the utilization of recombinant allergens and the use of the allergen mixed with heat killed listeria as an adjuvant.^{56,57}

Monoclonal humanized antibodies of anti-IgE may be used to counter severe food allergy. IgE receptor antibodies of the mast cells that lack cell degranulation might obstruct the allergic response. Initial studies demonstrate that anti-IgE treatment can, in essence, enlarge the threshold amount of peanut protein necessary to incite allergic symptoms in individuals with peanut allergy.⁵⁸ The utilization of anti-IgE treatment in combination with specific immune therapy might be a valuable therapy in the future.^{13,59,60}

Although serious responses are rarely encountered, intramuscular use of an epinephrine autoinjector (*e.g.*, EpiPen, Epinephrine Autoinjector, Mylan Specialty, Pfizer Company, WV) may be advised.³⁵ Food allergy-induced asthma encompassed 9.5% of individuals and asthma that occurred singly was recognized in just 2.8% of patients.

Food allergy-induced asthma is potentially life threatening, which leads to prescribing epinephrine autoinjectors and bronchodilators.⁶¹

CONCLUSION

Patients with grass allergy are capable of reacting to tomato, orange, peach, celery, and melon. Patients with ragweed allergy may show OAS symptoms after the ingestion of melon, banana, zucchini, and cucumber. Physicians should be aware of OAS and know the appropriate treatment.

REFERENCES

1. Ta V, Scott DR, Chin WK, Wineinger NE, Kelso JM, White AA. Differential skin test reactivity to pollens in pollen food allergy syndrome versus allergic rhinitis. *Allergy Asthma Proc.* 2015; 36:379–85.
2. Nowak-Węgrzyn A. Patient education oral allergy syndrome (beyond the basics). In: Sicherer ST, Feldweg AM, editors. *UpToDate*. [cited 2017 Mar 20]. Available from: <https://www.uptodate.com/contents/oral-allergy-syndrome-beyond-the-basics>.
3. Pongdee T. Oral allergy syndrome (OAS). *The American Academy of Allergy, Asthma & Immunology (AAAAI)*. [cited 2017 Aug 6]. Available from: <https://www.aaaai.org/conditions-and-treatments/library/allergy-library/outdoor-allergies-and-food-allergies-can-be-related>.
4. Brown CE, Katelaris CH. The prevalence of the oral allergy syndrome and pollen-food syndrome in an atopic paediatric population in south-west Sydney. *J Paediatr Child Health.* 2014; 50:795–800.
5. Amlot PL, Kemeny DM, Zachary C, Parkes P, Lessof MH. Oral allergy syndrome (OAS): symptoms of Ig-E mediated hypersensitivity to food. *Clin Allergy.* 1987; 17:33–42.
6. Sicherer SH, Sampson HA. 9. Food allergy. *J Allergy Clin Immunol.* 2006; 117(suppl Mini-Primer):S470–S475.
7. Assa’ad AH. Gastrointestinal food allergy and intolerance. *Pediatr Ann.* 2006; 35:718–726.
8. Reda SM. Gastrointestinal manifestations of food allergy. *Pediatr Health.* 2009; 3:217–229.
9. Ma S, Sicherer SH, Nowak-Węgrzyn A. A survey on the management of pollen-food allergy syndrome in allergy practices. *J Allergy Clin Immunol.* 2003; 112:784–788.
10. Ortolani C, Pastorello EA, Farioli L, et al. IgE-mediated allergy from vegetable allergens. *Ann Allergy.* 1993; 71:470–476.
11. Silviu-Dan F, Melanson M. Oral allergy syndrome: A warning? Program and abstracts of the 56th annual meeting of the American Academy of Allergy, Asthma and Immunology; March 3–8, 2000; San Diego, Calif. Abstract 566.
12. Chippes BE. Food Allergy: New Insights and Management Strategies. *Medscape*. [cited 2017 Mar 20]. Available from: <http://www.medscape.org/viewarticle/420552>.
13. Ortolani C, Pastorello EA. Food allergies and food intolerances. *Best Pract Res Clin Gastroenterol.* 2006; 20:467–483.
14. Valenta R, Kraft D. Type I allergic reactions to plant-derived food: A consequence of primary sensitization to pollen allergens. *J Allergy Clin Immunol.* 1996; 97:893–895.
15. Kazemi-Shirazi L, Pauli G, Purohit A, et al. Quantitative IgE inhibition experiments with purified recombinant allergens indicate pollen-derived allergens as the sensitizing agents responsible for many forms of plant food allergy. *J Allergy Clin Immunol.* 2000; 105:116–125.
16. Anderson LB Jr, Dreyfuss EM, Logan J, Johnstone DE, Glaser J. Melon and banana sensitivity coincident with ragweed pollinosis. *J Allergy.* 1970; 45:310–319.
17. Eriksson NE, Wihl JA, Arrendal H. Birch-pollen related food hypersensitivity: influence of total and specific IgE levels. A multicenter study. *Allergy.* 1983; 38:353–357.
18. Ortolani C, Ispano M, Pastorello E, Bigi A, Ansaloni R. The oral allergy syndrome. *Ann Allergy.* 1988(pt 2); 61:47–52.
19. Sicherer SH. Food allergy. *Lancet.* 2002; 360:701–710.
20. Yamamoto T, Asakura K, Shirasaki H, Himi T. Clustering of food causing oral allergy syndrome in patients with birch pollen allergy. *Nihon Jibiinkoka Gakkai Kaiho.* 2008; 111:588–593.
21. Mowat AM. The role of antigen recognition and suppressor cells in mice with oral tolerance to ovalbumin. *Immunology.* 1985; 56:253–260.

22. Chen Y, Inobe J, Marks R, Gonnella P, Kuchroo VK, Weiner HL. Peripheral deletion of antigen-reactive T cells in oral tolerance. *Nature*. 1995; 376:177–180.
23. Hoyne GF, Le Roux I, Corsin-Jimenez M, et al. Serrate1-induced notch signalling regulates the decision between immunity and tolerance made by peripheral CD4 (+) T cells. *Int Immunol*. 2000; 12:177–185.
24. Sudo N, Sawamura S, Tanaka K, Aiba Y, Kubo C, Koga Y. The requirement of intestinal bacterial flora for the development of an IgE production system fully susceptible to oral tolerance induction. *J Immunol*. 1997; 159:1739–1745.
25. MacDonald TT, Monteleone G. IL-12 and Th1 immune responses in human Peyer's patches. *Trends Immunol*. 2001; 22:244–247.
26. Wegmann TG, Lin H, Guilbert L, Mosmann TR. Bidirectional cytokine interactions in the maternal-fetal relationship: is successful pregnancy a TH2 phenomenon? *Immunol Today*. 1993; 14:353–356.
27. Holt PG, Sly PD, Björkstén B. Atopic versus infectious diseases in childhood: A question of balance? *Pediatr Allergy Immunol*. 1997; 8:53–58.
28. Romagnani S. The role of lymphocytes in allergic disease. *J Allergy Clin Immunol*. 2000; 105:399–408.
29. Neurath MF, Finotto S, Glimcher LH. The role of Th1/Th2 polarization in mucosal immunity. *Nat Med*. 2002; 8:567–573.
30. Strachan DP. Hay fever, hygiene and household size. *BMJ*. 1989; 299:1259–1260.
31. Woo JG, Assa'ad A, Heizer AB, Bernstein JA, Hershey GK. The –159 C–T polymorphism of CD14 is associated with nonatopic asthma and food allergy. *J Allergy Clin Immunol*. 2003; 112:438–444.
32. Umetsu SE, Lee WL, McIntire JJ, et al. TIM-1 induces T cell activation and inhibits the development of peripheral tolerance. *Nat Immunol*. 2005; 6:447–454.
33. Pastorello EA, Ortolani C. Oral allergy syndrome. In: Metcalfe DD, Sampson HA, Simon RA, editors. *Food allergy: adverse reactions to foods and food additives*. 3rd ed. Malden, MA: Blackwell Science. 2003; 169–182.
34. Pastorello EA, Farioli L, Pravettoni V, et al. The major allergen of peach (*Prunus persica*) is a lipid transfer protein. *J Allergy Clin Immunol*. 1999; 103:520–526.
35. Twarog FJ, Moody CT. Oral Allergy Syndrome (Food Pollen Syndrome). [cited 2017 Aug 6]. Available from: http://concordallergyandasthma.com/oral_allergy_syndrome.pdf.
36. Ciprandi G, Comite P, Ferrero F, et al. Birch allergy and oral allergy syndrome: The practical relevance of serum immunoglobulin E to Bet v 1. *Allergy Asthma Proc*. 2016; 37:43–49.
37. Oral allergy syndrome. [cited 2017 Aug 6]. Available from: <https://www.allergypartners.com/oral-allergy/>.
38. Ortolani C, Ispano M, Pastorello EA, Ansaloni R, Magri GC. Comparison of results of skin prick tests (with fresh foods and commercial food extracts) and RAST in 100 patients with oral allergy syndrome. *J Allergy Clin Immunol*. 1989; 83:683–690.
39. Crespo JF, Rodriguez J, James JM, Daroca P, Reano M, Vives R. Reactivity to potential cross-reactive foods in fruit-allergic patients: implications for prescribing food avoidance. *Allergy*. 2002; 57:946–949.
40. Rodriguez J, Crespo JF, Burks W, et al. Randomized, double-blind, crossover challenge study in 53 subjects reporting adverse reactions to melon (*Cucumis melo*). *J Allergy Clin Immunol*. 2000; 106:968–972.
41. Rodriguez J, Crespo JF, Lopez-Rubio A, et al. Clinical cross-reactivity among foods of the Rosaceae family. *J Allergy Clin Immunol*. 2000; 106:183–189.
42. Rodriguez J, Crespo JF, Burks W, et al. Randomized, double-blind, crossover challenge study in 53 subjects reporting adverse reactions to melon (*Cucumis melo*). *J Allergy Clin Immunol*. 2000; 106:968–972.
43. Sampson HA, Munoz-Furlong A, Bock SA, et al. Symposium on the definition and management of anaphylaxis: summary report. *J Allergy Clin Immunol*. 2005; 115:584–591.
44. Sampson HA, Albergo R. Comparison of results of skin tests, RAST, and double-blind, placebo controlled food challenges in children with atopic dermatitis. *J Allergy Clin Immunol*. 1984; 74:26–33.
45. Jones SM, Magnolfi CF, Cooke SK, Sampson HA. Immunologic cross-reactivity among cereals grains and grasses in children with food hypersensitivity. *J Allergy Clin Immunol*. 1995; 96:341–351.
46. Sampson HA. Utility of food-specific IgE concentrations in predicting symptomatic food allergy. *J Allergy Clin Immunol*. 2001; 107:891–896.
47. Garcia-Ara C, Boyano-Martinez T, Diaz-Pena JM, Martin-Munoz F, Reche-Frutos M, Martin-Esteban M. Specific IgE levels in the diagnosis of immediate hypersensitivity to cow's milk protein in the infant. *J Allergy Clin Immunol*. 2001; 107:185–190.
48. Bruijnzeel-Koomen C, Ortolani C, Aas K, et al. Adverse reactions to food. European Academy of Allergology and Clinical Immunology Subcommittee. *Allergy*. 1995; 50:623–635.
49. Bindslev-Jensen C, Ballmer-Weber BK, Bengtsson U, et al. Standardization of food challenges in patients with immediate reactions to foods—position paper from the European Academy of Allergology and Clinical Immunology. *Allergy*. 2004; 59:690–697.
50. Isolauri E, Turjanmaa K. Combined skin prick and patch testing enhances identification of food allergy in infants with atopic dermatitis. *J Allergy Clin Immunol*. 1996; 97:9–15.
51. Roehr CC, Reibel S, Ziegert M, Sommerfeld C, Wahn U, Niggemann B. Atopy patch test, together with determination of specific IgE levels, reduce the need for oral food challenges in children with atopic dermatitis. *J Allergy Clin Immunol*. 2001; 107:548–553.
52. Jenkins JA, Griffiths-Jones S, Shewry PR, Breiteneder H, Mills EN. Structural relatedness of plant food allergens with specific reference to cross reactive allergens: An in silico analysis. *J Allergy Clin Immunol*. 2005; 115:163–170.
53. Cuesta-Herranz J, Lazaro M, Martinez A, et al. Pollen allergy in peach allergic patients: sensitization and cross-reactivity to taxonomically unrelated pollens. *J Allergy Clin Immunol*. 1999; 104:688–694.
54. Fernandez-Rivas M, van Ree R, Cuevas M. Allergy to Rosaceae fruits without related pollinosis. *J Allergy Clin Immunol*. 1997; 100:728–733.
55. Nelson HS, Lahr J, Rule R, Bock A, Leung D. Treatment of anaphylactic sensitivity to peanuts by immunotherapy with injections of aqueous peanut extract. *J Allergy Clin Immunol*. 1997; 99:744–751.
56. Sampson HA. Immunological approaches to the treatment of food allergy. *Pediatr Allergy Immunol*. 2001; 12(suppl 14):91–96.
57. Yeung VP, Gieni RS, Umetsu DT, DeKruyff RH. Heat-killed *Listeria monocytogenes* as an adjuvant converts established murine TH2-dominated immune responses into TH1-dominated responses. *J Immunol*. 1998; 161:4146–4152.
58. Leung DY, Shanahan WR Jr, Li XM, Sampson HA. New approaches for the treatment of anaphylaxis. *Novartis Found Symp*. 2004; 257: 248–260; discussion 260–264, 276–285.
59. Asero R. Effects of birch pollen-specific immunotherapy on apple allergy in birch pollen-hypersensitive patients. *Clin Exp Allergy*. 1998; 28:1368–1373.
60. Kelso JM, Jones RT, Tellez R, Yunginger JW. Oral allergy syndrome successfully treated with pollen immunotherapy. *Ann Allergy Asthma Immunol*. 1995; 74:391–396.
61. Rancé F, Dutau G. Asthma and food allergy: report of 163 pediatric cases. *Arch Pediatr*. 2002; 9(suppl 3):402s–407s. □

Copyright of American Journal of Rhinology & Allergy is the property of OceanSide Publications Inc. and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.