

A rare case of food-dependent exercise-induced anaphylaxis caused by potato snacks



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A rare case of food-dependent exercise-induced anaphylaxis caused by potato snacks is reported. Specific food triggers for anaphylaxis were identified by using the skin prick test, antigen analysis, and serum IgE assays. Four potato proteins were considered candidate antigens for food-dependent exercise-induced anaphylaxis. (J Allergy Clin Immunol Global 2024;3:100279.)

Key words: Anaphylaxis, food hypersensitivity, exercise-induced allergies, skin test, antigens, *Solanum tuberosum*

Food-dependent exercise-induced anaphylaxis (FDEIA) is a distinct type of allergy provoked by the ingestion of specific foods and secondary factors such as physical exercise and nonsteroidal anti-inflammatory drugs. Although wheat and crustaceans are the most common causative agents, there has been a recent increase in the number of reports identifying fruits and vegetables as causative agents. However, reports of FDEIA resulting from potato consumption are limited.¹⁻³ We report the case of a patient who experienced FDEIA resulting from the ingestion of potato snacks.

This study was conducted with adherence to the principles of the Declaration of Helsinki and approved by the institutional review board of Fujita Health University (approval no. HM22-269). Written informed consent was obtained from the patient's parents.

CASE DESCRIPTION

The patient was an 8-year-old boy with a history of bronchial asthma, allergic rhinitis, and atopic dermatitis but no known history of food allergies. He was prescribed medication to

Abbreviation used

FDEIA: Food-dependent exercise-induced anaphylaxis

control his asthma but was noncompliant with the prescription. Consequently, he experienced several minor cold-associated asthma attacks over the course of a year. The day before he was referred to our hospital, he had ingested natto, rice, potato snacks (consommé flavor), and honey bread in the evening. One hour after the meal, he engaged in 1 hour of baseball practice. Soon after returning home and taking a bath, he developed abdominal pain, nausea, and cyanosis of the lips. He also had urticaria on his trunk and lower limbs. He was immediately taken to a hospital. His vital signs at the time of arrival were normal, but wheezing was audible, leading to a diagnosis of anaphylaxis. The patient's symptoms improved after he received intramuscular adrenaline and antihistamine treatment, and he was discharged after 1 night of observation. Subsequently, he was referred to our hospital for further diagnosis and management.

First, we prescribed self-injectable adrenaline and instructed the patient to comply with his treatment regimen for bronchial asthma. In view of the absence of crustacean intake before symptom onset and the common association of wheat with anaphylaxis, we suspected FDEIA resulting from wheat ingestion. For confirmation, we measured the patient's specific IgE titers by using ImmunoCAP (Thermo Fisher Diagnostics, Inc, Tokyo, Japan). However, the assay yielded negative results for wheat (0.27 UA/mL). Moreover, the results of ω -5 gliadin testing (<0.10 UA/mL) and prick-by-prick testing using strong wheat flour and gluten were also negative (Table 1); therefore, we advised the patient to allow a 2-hour interval between meals and to engage in exercise only when feeling well. Five months after the initial episode, the patient played baseball and tag for 4 hours, during which time he ingested rice crackers, peanuts, and potato snacks (consommé-flavored potato chips and chili-flavored potato chips). Additionally, he consumed candy suckers and drank carbonated drinks immediately after returning home. One hour later, he experienced abdominal pain and vomiting, prompting his transfer to a hospital. In the ambulance, he developed urticaria and received an intramuscular adrenaline injection. After arrival at the hospital, periorbital edema and wheezing were observed. It was later revealed that the patient was noncompliant with his asthma controller medication (a beclomethasone propionate inhaler and pranlukast) owing to a lack of understanding of asthma. He had been eating natto and rice and potato chips and also regularly consuming unprocessed potatoes and engaging in

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TABLE I. Skin prick test (prick-by-prick test) results

Allergen	Concentration	Wheal size
Histamine dihydrochloride	10 mg/dL	6.0 mm × 6.0 mm
Normal saline	0.9% NaCl	1.5 mm × 1.5 mm
Strong wheat flour	10 mg/dL	1.0 mm × 1.0 mm
Gluten	10 mg/dL	1.0 mm × 1.0 mm
Potato (raw)	As is	6.0 mm × 4.0 mm
Potato (boiled)	As is	1.0 mm × 1.0 mm
Consommé	As is	1.0 mm × 1.0 mm
Potato snack 1 (Calbee potato chips, consommé flavor)	As is	1.0 mm × 1.0 mm
Potato snack 2 (Karamucho chili-flavored potato chips)	As is	1.0 mm × 1.0 mm
Potato snack 3 (Calbee potato chips, salt flavor)	As is	1.0 mm × 1.0 mm

The ingredients for consommé flavor were as follows: salt, lactose, sugar, edible processing fats and oils, vegetable and meat extracts (Chinese cabbage extract, chicken extract, yeast extract fermented seasoning, beef extract, and edible fats and oils), spices, vegetable extracts, soy sauce, fructose, yeast extract/seasonings (amino acids, etc), modified starch, and acidity regulators; wheat, milk components, beef, soy, and chicken were also included in some parts. The ingredients for potato snack 1 were as follows: potatoes, vegetable oil, chicken consommé powder (includes wheat, soy, and pork), sugar, salt, dextrin, starch, powdered soy sauce, powdered sauce (includes apple), onion extract powder, spices, beef consommé powder, vegetable powder (tomato and carrot), tomato extract powder, flavored chicken oil, plum powder/seasonings (amino acids, etc), flavorings (including sesame), caramel color, acidity regulators, paprika color, sweeteners (stevia), spice extracts, and red koji color. The ingredients for potato snack 2 were as follows: potatoes, vegetable oil, spices, sugar, hydrolyzed protein (including soy), glucose, salt, chicken bouillon powder, vegetable extract powder (including milk components, soy, pork, gelatin), flavored oil (contains wheat and soy), oligosaccharides/seasonings (amino acids, etc), paprika color, acidity regulators, spice extracts, sweeteners (stevia and glycyrrhiza), flavorings (soy-derived), and caramel color. The ingredients for potato snack 3 were as follows: potatoes, vegetable oil, salt, and dextrin/seasonings (amino acids, etc). The IgE levels for specific allergens were measured as follows: for rice, 0.11 UA/L; for soybean (natto), 0.15 UA/L; for peanuts, 0.51 UA/L; and for *Arabis hypogaea* 2, less than 0.10 UA/L. Honey was not tested.

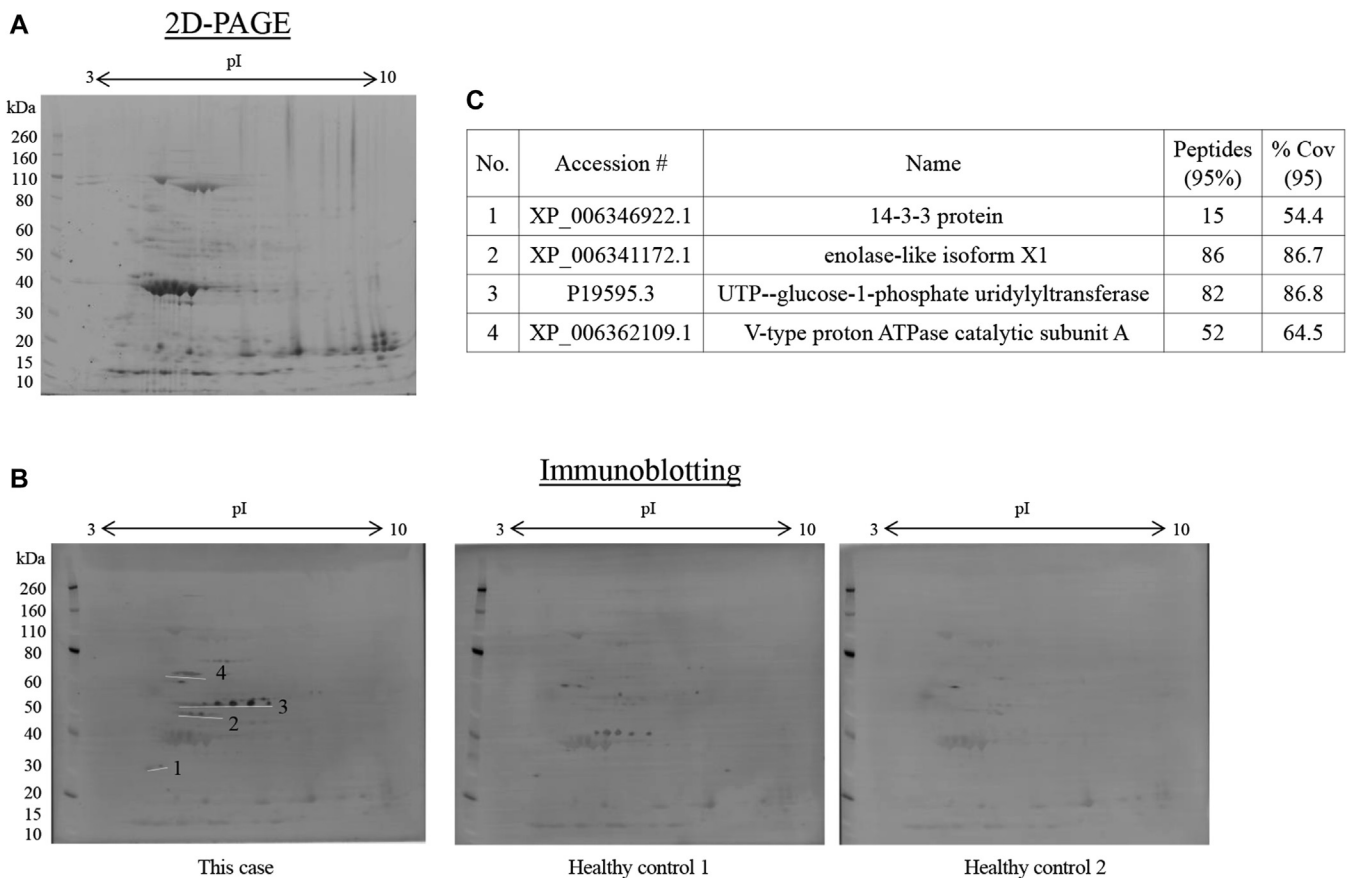


FIG 1. Two-dimensional (2D) immunoblotting and protein identification results. **A**, Potato protein analysis using 2D PAGE. **B**, Immunoblotting demonstrating proteins bound to IgE antibodies in the serum samples from the patient and controls. White lines indicate spots specific to this case. **C**, Protein (*Solanum tuberosum*) identification by mass spectrometry using the National Center for Biotechnology Information database (<https://www.ncbi.nlm.nih.gov/>). Cov, Percentage of coverage; pI, isoelectric point; UTP, uridine-5'-triphosphate.

exercise without experiencing any symptoms during the 5 months between the 2 reactions.

On the basis of these 2 episodes, we suspected that potato ingestion was the cause of anaphylaxis, but a specific IgE test for potatoes yielded a negative result (<0.1 UA/mL). However, a prick-by-prick test using raw potatoes showed a positive result (Table I). Therefore, potatoes were excluded from the patient's diet at school as well as for 2 hours before exercise. Following the second episode, the patient experienced postprandial abdominal pain and nausea daily despite the absence of potato ingestion. Skin and respiratory symptoms were absent. Physical examination, head computed tomography, abdominal radiography, and abdominal echography were performed, but no abnormalities were found. We suggested an exercise provocation test for diagnosis, but he and his mother were very anxious and refused. Because of the challenging diagnosis, we performed antigen analysis using a previously reported method (see the [Supplementary Methods](#) in the Online Repository at www.jaci-global.org).⁴ Immunoblotting using potato protein extract revealed the presence of spots at approximately 30 kDa, 50 kDa, 55 kDa, and 60 kDa that were reacted with the patient's serum IgE (Fig 1). On the basis of the antigen analysis and skin prick test results, we determined that the FDEIA in this case involved potato-induced IgE-mediated mechanisms. After the antigen analysis results were shared with the patient 11 months after the first episode, his abdominal pain disappeared. Therefore, we concluded that his abdominal pain could be a psychogenic reaction. To date, he has had no recurrence of anaphylaxis for 35 months.

DISCUSSION

In this case, the patient had consumed bread before the first episode of anaphylaxis, leading to initial suspicion that wheat, a well-known cause of FDEIA, might be the trigger. However, on the basis of the patient's subsequent dietary intake and symptoms and the results of skin prick testing and antigen analysis, it was considered highly likely that potatoes were the cause of his food allergy.

Currently, the World Health Organization/International Union of Immunological Societies database lists 4 potato allergens, and 2 others at approximately 50 kDa (1 of which is adenosyl homocysteinase) have been reported.^{5,6}

In our study, the IgE-bound proteins differed from those of known allergens. Among the 4 proteins detected, enolase is a recognized antigen in other foods and can induce allergic symptoms. Other proteins, including those from other species, are not registered in the World Health Organization/International Union of Immunological Societies database. Therefore, further investigations are required to determine the specific antigens responsible for inducing symptoms in this case.

This case had limitations, primarily the lack of a definitive diagnosis by an exercise provocation test. However, on the basis

of the patient's history, the binding of patient-specific IgE antibodies to potato protein, and the fact that the patient no longer had recurrent anaphylaxis after potato removal, it was hypothesized that potatoes were the cause of anaphylaxis. FDEIA involves reactions mediated by antigen-specific IgE, with a lowered symptom induction threshold owing to factors such as postingestion exercise, resulting in pronounced symptoms. The combination of multiple triggers further increases the possibility of symptom induction. However, the occurrence of symptoms is not guaranteed when specific food intake is combined with physical exertion or other factors; the reproducibility is low, making diagnosis challenging. There is no method to predict the initial onset of FDEIA, emphasizing the importance of preventing subsequent occurrences. In cases in which (as in this instance) a variety of foods were consumed at the time of the initial onset, identifying the causative food can be difficult, necessitating guidance to abstain from exercise for 2 hours after meals.

Several factors may have contributed to the development of anaphylaxis in this case. Besides bathing and exercise, the patient's poorly controlled asthma could have triggered his anaphylaxis. Even though the specific IgE test yielded negative results, potato-induced FDEIA cannot be definitively ruled out as the cause. Hence, skin prick testing, antigen analysis, and serum IgE assays are useful in identifying the specific food trigger for anaphylaxis.

DISCLOSURE STATEMENT

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