

Case Report



Anaphylaxis due to potato starch (possibly caused by percutaneous sensitization)

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OPEN ACCESS

Received: Dec 7, 2020

Accepted: Apr 19, 2021

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ABSTRACT

An 8-year-old boy with poor control of atopic dermatitis could eat potato products such as French fries without restrictions until 21 months of age. However, he developed generalized urticaria after eating potato products at the same age. Therefore, potatoes were excluded from his diet; nevertheless, he continued to consume a very small amount of potato starch but was without symptoms until the age of 8 years. At this age, he developed anaphylaxis after consuming potato starch and required administration of intramuscular epinephrine. He tested positive for potato-specific immunoglobulin E, skin prick test, and basophil activation test. He developed severe eczema with dry skin and erosion. We later discovered that potato starch had been used for play clay at his nursery school. Although he discontinued using potato starch play clay, it remained present in his surroundings for 6 years. His potato allergy may have developed and continued to worsen as a result of making indirect contact with surfaces that had previously been exposed to the allergen. Two-dimensional Western blot analysis on potato starch revealed the presence of proteins binding to the immunoglobulin E of the patient. Sodium dodecyl sulfate-polyacrylamide gel electrophoresis findings showed that 5 of the 6 protein bands had a similar molecular weight as that of potato proteins. Thus far, there are no reports of anaphylaxis due to potato starch. Children with atopic dermatitis or damaged skin may have sensitivity to potato starch and could develop anaphylaxis as noted in this case.

Keywords: Anaphylaxis; Mass spectrometry; Potato starch; Immunoblotting; Percutaneous sensitization; Potato

INTRODUCTION

Potato is a common food ingredient used worldwide, and potato allergy, although very rare, has been reported in some cases [1-4]. It is known that individuals with potato allergy tend to develop tolerance with age [1]. However, there have been no reports of allergy caused by eating potato starch. Here, we report the case of an 8-year-old boy who developed anaphylaxis caused by potato starch, although he could safely eat small amounts of potato previously.

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Conflict of Interest

KM is an endowed chair from Hoya Co., Ltd.
 The other authors have no conflicts of interest to declare.

Author Contributions

Conceptualization: Takae Kobayashi. Formal analysis: Takae Kobayashi, Masashi Nakamura, Nayu Sato, Yasuto Kondo. Investigation: Masashi Nakamura, Nayu Sato. Methodology: Masashi Nakamura, Kayoko Matsunaga. Project administration: Yasuto Kondo. Writing - original draft: Takae Kobayashi. Writing - review & editing: Takae Kobayashi, Masashi Nakamura, Kayoko Matsunaga, Joon Nakata, Kazunori Tagami, Nayu Sato, Takashi Kawabe, Yasuto Kondo.

In this case, we examine the clinical findings, present the possible factors affecting the development of his allergy, and illustrate that the allergy worsened between 2 and 6 years of age owing to indirect contact with surfaces that had previously been exposed to the allergen.

CASE REPORT

An 8-year-old boy with atopic dermatitis experienced severe eczema since infancy with no known food allergies, including to potato products such as French fries. At 18 months of age, he engaged in playing with potato starch-based clay at nursery school. Three months later, he developed generalized urticaria after eating boiled potatoes. Since the serum titer of potato-specific immunoglobulin E (IgE) was high (62 UA/mL) (Table 1), as determined by ImmunoCAP test (Thermo Fisher Diagnostics, Tokyo, Japan), potato was excluded from his diet except for potato starch (contains 0.11% of potato protein) [5]. He continued to use potato starch clay until 2 years of age without any symptoms and was able to eat potato starch daily until 8 years of age. However, the continued use of potato starch clay resulted in itchiness because he developed severe eczema with dry skin and erosion, which led to his teachers stopping him from using it. Notably, other children in the nursery continued to use potato starch clay, and sometimes he experienced pruritis while playing with them.

Although our patient excluded potato from his diet and avoided direct contact with potatoes, the continued use of potato starch clay by children around him and pre-existing eczema may have worsened this allergy until 6 years of age. During this time, the serum titer of potato-specific IgE was rising steadily.

At 6 years, the boy visited our hospital for a medical checkup. We performed a skin prick test (SPT) and an oral food challenge (OFC) [6] to confirm his threshold level of potato tolerance before his admission to elementary school. SPT using a bifurcated needle (Tokyo M. I CO. Inc., Tokyo, Japan) revealed a positive reaction to boiled potato (10×6 mm). We performed an OFC to confirm the threshold level of tolerance, with moderate amount of potato, keeping in mind his tendency of developing a delayed anaphylactic reaction as indicated by his medical history [7]. Within 3 hours of ingesting 8 g of boiled potato, an anaphylactic reaction that included generalized urticaria, abdominal pain, vomiting, and a mild drop in blood pressure.

Upon consuming potato starch at 8 years, he developed anaphylaxis, including generalized urticaria and abdominal pain, which subsided on administering intramuscular epinephrine.

Basophil activation test [8, 9] was performed using an allergenicity kit (Beckman Coulter Inc., Fullerton, CA, USA). Anti-CD63 antibody (Anti-Hu CD63-APC; EXBIO, Praha, Vestec, Czech Republic) was measured to analyze the upregulation of CD63 on CD203c+ basophils

Table 1. Serum IgE values of the patient from 2 years old to 7 years of age

Variable	Age (yr)				
	1	2	3	6	7
Total IgE (UA/mL)	-	355	861	2,226	2,807
Potato (UA/mL)	62.2	41.0	78.3	370.0	437
Alder (UA/mL)	-	0.1	0.1	50.5	26.5
Orchard grass (UA/mL)	-	0.1	0.1	54.3	-
Cedar (UA/mL)	-	5.08	9.45	245	-
TARC (UA/mL)	-	452	519	261	-

IgE, immunoglobulin E; TARC, thymus and activation-regulated chemokine.

adsorbed in flow cytometry using FACSCalibur (Becton, Dickinson and Company, Franklin Lakes, NJ, USA). The heparinized whole blood samples were stimulated with increasing concentration of potato extract and incubated for 15 minutes at 37°C. CD63 expression increased in a concentration-dependent manner: 5.7%, 33.5%, 53.0%, and 83.0% for potato extract concentrations of 8×10^{-4} , 8×10^{-2} , 8×10^{-1} , and 8×10^2 $\mu\text{g/mL}$, respectively.

Antigen analysis [10] was performed for proteins extracted from the commercial potato and potato starch. Sodium dodecyl sulfate-polyacrylamide gel electrophoresis (SDS-PAGE) revealed 6 dense bands of protein for potato that were not evident for potato starch (**Fig. 1A**). The results from immunoblotting analysis showed that the patient's IgE antibodies reacted with many proteins including those in the six bands from potatoes, while those from a healthy subject (control) did not react with any protein (**Fig. 1B**). Western blot analysis of potato starch revealed that 5 of the 6 protein bands had a similar molecular weight as that of potato proteins obtained using SDS-PAGE. The binding of IgE antibodies to proteins in potato starch was completely inhibited by potato protein in the inhibition test (**Fig. 1C**). These results suggest that although the potato protein was present in the starch at amounts insufficient for detection by SDS-PAGE, the potato starch still had antigenicity as shown by the Western blotting findings. Therefore, this resulted in an allergic reaction in our patient.

The IgE antibodies from the patient significantly reacted to 3 proteins registered as food allergens by the World Health Organization/International Union of Immunological Societies: patatin (Sola t 1, 40 kDa [**Fig. 1B**: 4, 5]), cysteine reaction protease inhibitor (Sola t 3, 21 kDa [**Fig. 1B**; 3]), and serine protease inhibitor (Sola t 4, 16 kDa [**Fig. 1B**; 1, 2]) [11].

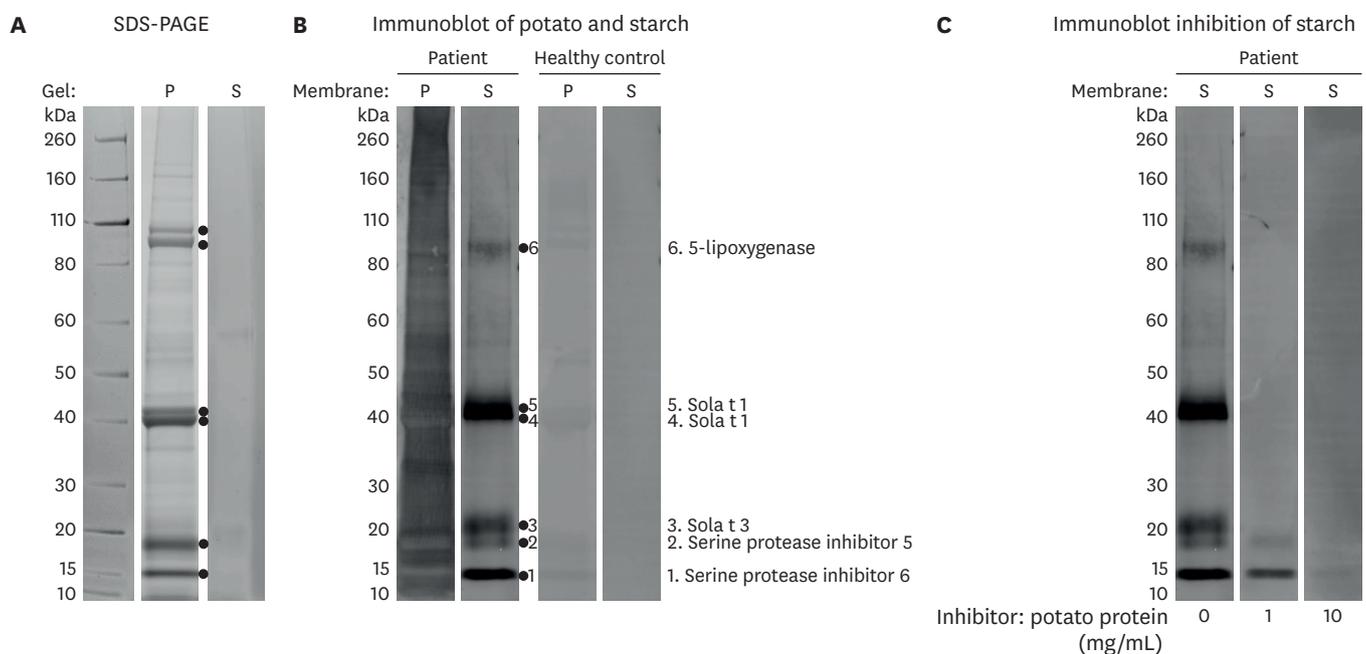


Fig. 1. Results of antigen analyses and immunoblot inhibition assays. (A) Sodium dodecyl sulfate-polyacrylamide gel electrophoresis (SDS-PAGE) and immunoblotting with potato (P) and potato starch (S) in patients and healthy control subjects. (B) Proteins that specifically bind to the immunoglobulin E of the patient were identified: 1 and 2, serine protease inhibitors 5 and 6; 3, a cysteine reaction protease inhibitor (Sola t 3); 4 and 5, patatin (Sola t 1); 6, 5-lipoxygenase. All proteins were previously registered as causative antigens in World Health Organization/International Union of Immunological Societies Allergen Nomenclature Sub-Committee (<http://www.allergen.org/>). (C) Immunoblot inhibition of the protein extracted from potato starch. The proteins in potato starch that specifically bound to the immunoglobulin E of the patient inhibited by the proteins in the potato.

DISCUSSION

Although potato consumption is common worldwide, potato-related anaphylaxis is extremely rare. Eke Gungor et al. [4] reported that potato may cause immediate and severe reactions in both raw and cooked potato.

Epidermal barrier dysfunction has been reported to be a risk factor for development of food allergies [12, 13]. A previous report on a case of contact urticaria reported that percutaneous sensitization was caused by failure of immune tolerance [14]. In recent years, transdermal antigen exposure has been reported to lead to food allergy [15]. Similarly, in our patient, poorly controlled atopic dermatitis may have resulted in the development of potato allergy, even though he did not have an allergic reaction to potato consumption. Therefore, we suspect that percutaneous sensitization from potato proteins present in the potato starch may have caused and aggravated his potato allergy.

Several factors may have contributed to the development of this allergy. Poorly controlled eczema may be triggered because of the presence of potato proteins in the environment. We report this case to emphasize that potato allergy, although rare, can exacerbate with age, and physicians must be careful about potato starch being an allergen.

ACKNOWLEDGMENTS

The authors would like to thank Ms. Miyuki Teshigawara for technical assistance. YK received funding from the Consumer Agency.

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