

Clinical Communications

Coca-Cola allergy identified as fructose-induced anaphylaxis

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Clinical Implication

- We first report a case of anaphylaxis to fructose, which might be mediated by direct basophil/mast cell activation.

TO THE EDITOR:

Fructose is a component of sucrose or “table sugar,” a disaccharide composed of 1 molecule of glucose and fructose each. It exists in fruits as natural sugar and is consumed by all age groups worldwide as a major energy source for humans. There have been many reports about fructose intolerance, which causes gastrointestinal symptoms, such as abdominal pain, flatulence, and diarrhea due to impairment of fructose absorption in the small intestine.¹ To our knowledge, however, there was no report about immediate hypersensitivity reactions to fructose until now.

A 20-year-old woman visited the allergy outpatient clinic of Ajou university hospital for generalized urticaria and loss of consciousness after drinking Coca-Cola. She had no allergic diseases in the past and had no history of allergic reactions to any food or drug other than urticaria and angioedema developing after eating bread and Coca-Cola 1 year earlier. After the first attack, she experienced 6 episodes of anaphylaxis approximately 30 minutes after consumption of sweet food, such as honey, strawberry jam, peach, apple, and ice cream. Her father had nonsteroidal anti-inflammatory drug-induced urticaria, and her elder brother had a food allergy to crustaceans.

All laboratory data, including complete blood cell count, eosinophil count, erythrocyte sedimentation rate, thyroid and liver function test, and antinuclear antibody, were within the normal range. Total IgE level was 41 kU/L and serum specific IgE levels to wheat, gliadin, gluten, and peach were all less than 0.35. Moreover, major inhalant allergen-specific IgE (such as house dust mite, birch, oak, ragweed, and mugwort), as well as allergic skin prick test, also demonstrated negative results.

An oral provocation test was performed with Coca-Cola after admission. Generalized urticaria and angioedema were observed 14 minutes after drinking 200 mL of Coca-Cola, which contains 22 g of sucrose (concentration, 110 mg/mL). On the next admission day, provocation with 18.56 g of sucrose also revealed a similar finding. Then, we planned oral provocation tests with glucose and fructose, the components of sucrose, as well as lactose, maltose, and wheat flour as a placebo in a double-blind, placebo-controlled manner, which was modified from a previously reported method.² The patient had systemic urticaria and angioedema with dyspnea 7 minutes after taking 18.56 g of

fructose, but there was no change in spirometry results, oxygen saturation, or serum tryptase level (Figure 1, A). Other monosaccharides and disaccharides, including glucose, lactose, and maltose, failed to induce allergic responses. Moreover, the patient had no allergic symptoms after a 30-minute exercise challenge test with 10 g of wheat flour.

Skin prick and intradermal tests were conducted with fructose and glucose (0.1, 1, and 10 mg/mL). All skin prick test results were negative, but intradermal tests with 1 mg/mL of fructose and 10 mg/mL of glucose showed positive reactions (Figure 1, B). Intradermal tests with 10 mg/mL of fructose were not attempted because of anaphylaxis risk. The same skin tests showed all negative responses in 12 healthy volunteers (6 atopic controls and 6 nonatopic controls) with the exception of 1 nonatopic control who, similar to our patient, exhibited a weak positive result at the highest concentration of glucose.

To elucidate the mechanism of fructose-induced anaphylaxis, serum specific IgE level to fructose was measured using ELISA as previously reported.³ However, serum specific IgE to a fructose-human serum albumin conjugate was not detected in the patient serum (Figure 2, A). Finally, the basophil activation test was conducted to evaluate a possible mechanism of direct fructose stimulation-mediated basophil cell activation. As in Figure 2, B, a high concentration of fructose, like the sucrose concentration in the Coca-Cola, markedly enhanced the expression of CD203c in the patient, but none of the healthy volunteers showed any positive result (Figure 2, B).

Fructose monosaccharide is 1 of the 3 main monosaccharides (fructose, glucose, and galactose) and the sweetest of all natural sugars.⁴ It is contained in almost all processed foods and fruits, even in vegetables, grains, and cereals, and can be safely taken by any person without fructose intolerance.¹ There have been some reports of allergic reactions to D-psicose^{5,6} and anaphylaxis caused by inulin^{7,8} or erythritol.⁹ However, these materials are processed sweeteners and have recently become commercially available. To our knowledge, this is the first case report of a natural sweetener, fructose. In this report, the positive oral provocation test result and the positive intradermal test result for fructose indicate that the patient had immediate hypersensitivity reaction to fructose. The positive intradermal test results at the highest concentration of glucose may be attributed to osmotic effects in the patient and 1 healthy volunteer. The positive skin test result and the increased expression level of CD203c on basophil surface suggested that the anaphylaxis was immediate response to fructose, but we could not detect the serum specific IgE to fructose-human serum albumin conjugate by our ELISA method, indicating that the patient's immediate hypersensitivity reactions might not be mediated by fructose-specific IgE or specific IgE level to fructose was below the detection level for our ELISA but by direct basophil/mast cell stimulation.

In conclusion, we reported the first case of fructose-induced anaphylaxis that was confirmed by double-blind, placebo-controlled oral provocation tests. On the basis of results of *in vivo* and *in vitro* tests, we conclude that this patient's anaphylaxis could be mediated by direct basophil/mast cell activation by fructose.

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Conflicts of interest: The authors declare that they have no relevant conflicts of interest.

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