

# Absorption of Egg Antigens by the Gut Observed by Oral Prausnitz-Küstner (Walzer) Reaction in Atopic Dermatitis

TOSHIYUKI AOKI, TATSUHIKO FUNAI, MASUKO KOJIMA and JUN ADACHI

*Department of Dermatology, Habikino Hospital of Osaka Prefecture, Japan*

Sera from 50 children (27 boys and 23 girls, under the age of 3 years) with atopic dermatitis allergic or not to hen's egg shown by skin test or radioallergosorbent test (RAST) were passively transferred to recipients which were then challenged with injection of egg antigen (Prausnitz-Küstner (P-K) test) or with ingestion of a raw egg (oral P-K test). Thirty-one patients showed positive P-K reaction with serum titers from 2 to 8 192. Fifteen of the P-K positive cases were also positive in the oral P-K test with titers from 2 to 256. The ratio of the oral P-K titer and the P-K titer in each positive case was from 1:2 to 1:32. The results indicate that a high percentage of atopic dermatitis patients with egg allergy have IgE antibody in the serum capable of reacting with an ingested egg. **Key words:** *Atopic dermatitis; Food allergy; Egg allergy; Prausnitz-Küstner reaction; Walzer reaction.*

T. Aoki, Department of Dermatology, Habikino Hospital of Osaka Prefecture, Habikino-3-7-1, Habikino City, Osaka 583, Japan.

Infantile atopic dermatitis is often associated with food allergy. However, whether or not and to which extent these children and their breast feeding mothers should avoid allergic foods is controversial (1). Elimination diet in the children with atopic dermatitis was reported to be beneficial (2, 3) or of limited value (4, 5). There are so many questions to be solved before this problem is completely understood: Are the food antigen inactivated by the antibody secreted into the digestive tracts? How much and which part of the food antigen can be absorbed by the gut? Which immunoglobulin classes (or subclasses) of the antibody can react with the food antigen circulating in the blood stream and the skin, and what is the result of the reaction? In this paper we will try to answer the question; what kind of and which strength of reaction can occur between IgE antibody in the serum of patients with atopic dermatitis and the ingested food.

In 1921 Prausnitz & Küstner reported that food

allergy could be passively transferred with the serum of one patient to another person (6). He induced the reaction by injecting food extract into the skin where the serum was inoculated a day before. In 1926 Walzer noticed that a similar reaction could occur in the serum-inoculated skin by ingestion of the food antigens (7). He injected the recipient with serum from two children, one allergic to egg and the other to herring. Several hours later the recipients ate a raw egg or 50 g of herring. Blush, erythema and wheal appeared 10-20 min later with the egg serum and 30-100 min later with the fish serum. He thought this was a direct demonstration of absorption of incompletely digested food. We adopted these tests to evaluate the nature and the intensity of IgE egg allergy in the atopic children.

## PATIENTS AND METHODS

### *Patients*

Fifty children (27 boys and 23 girls) with atopic dermatitis under the age of 3 years (6 months or under; 12, 7 to 12 months; 19, 1 year; 26, and 2 years; 7) were studied. Allergic states of these children to hen's egg as determined by skin test to the whole egg allergen and IgE-radioallergosorbent (RAST) to egg white are described later. Thirty-two of the 50 patients were positive in the skin tests and 33 were positive in the RAST.

### *Skin test*

A commercially available whole egg antigen (1:1 000, 0.025 ml, Torii Co.) was injected intracutaneously in the forearm of the patients and diameters of wheal and erythema were recorded at 15 min. A wheal greater than 9×9 mm or erythema greater than 20×20 mm were interpreted as a positive reaction.

### *RAST*

Phadebas IgE-RAST kit to egg white was used and the results were shown as scores. RAST scores of 2.0 or greater were interpreted as positive.

### *Passive transfer (P-T) of the patient's serum*

The conditions for performing this were; (1) the patient had been healthy and had no history of hepatitis, abnormal liver function tests or positive hepatitis B surface antigen, (2) a

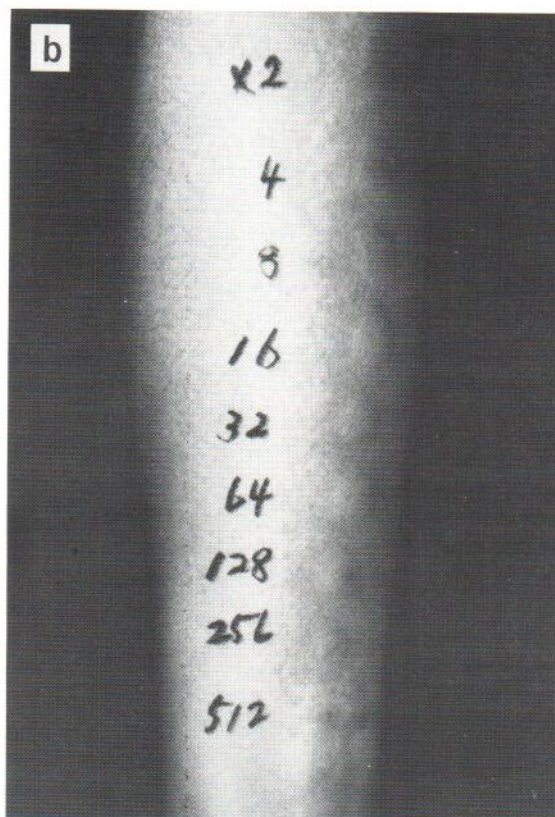
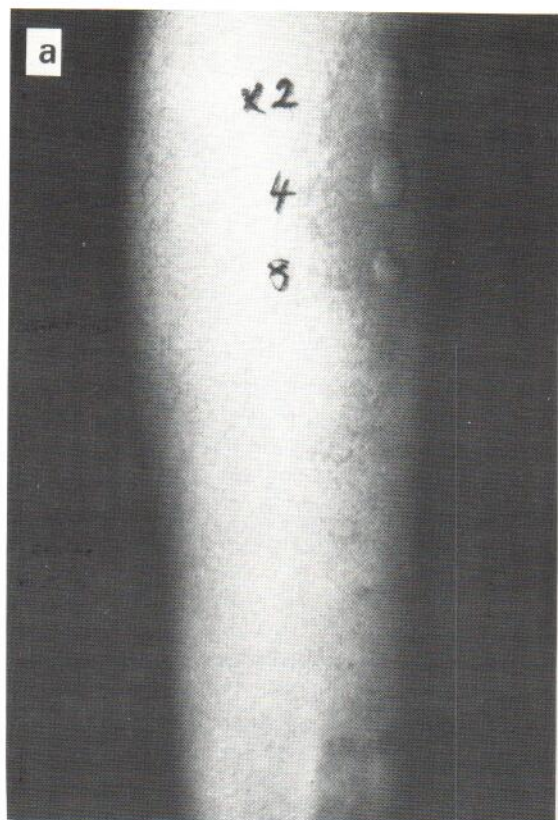


Fig. 1a-c. Positive oral P-K reactions at 1, 2 and 4 h after a raw egg ingestion.

nonallergic recipient could be obtained from the parents who was well aware of the medical history of the patient, and (3) the consent was obtained from the recipient. Two-fold serial dilutions (routinely titers 2 to 1024) of the patients serum were injected intracutaneously in both forearms of the recipient. One arm was prepared for the Prausnitz-Küstner test and the other for the oral Prausnitz-Küstner test. Eggs and all kinds of egg containing food were forbidden to the recipients from the day prior to the passive serum transfer to the day of the P-K test.

#### Prausnitz-Küstner (P-K) tests

Two days after P-T of the serum, the same egg antigen as used for the skin testing was injected in the P-T sites and the reaction was read at 15 min. The maximum serum dilution that gave a positive reaction was recorded as the antibody titer of the serum. When a wheal and flare was observed, but did not satisfy the criteria, the reaction was recorded as trace and evaluated as negative.

#### Oral Prausnitz-Küstner tests (Walzer test)

Immediately after finishing the P-K test, a raw egg was given to the recipient orally and the P-T sites were observed for 4 hours. The evaluation of the result was as described. In some cases the test was repeated with a boiled egg.

## RESULTS

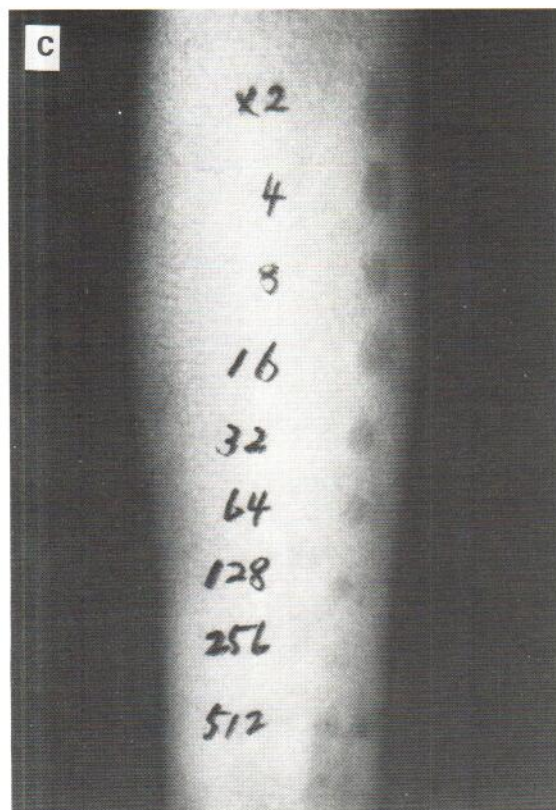
### P-K reaction

The positive reaction usually started with blush and itching 1 to 7 min after antigen injection, reached maximum at about 15 min, and thereafter faded away slowly leaving a slight red edematous induration for several hours. Of the 50 patients, 19 showed no wheal and flare reactions at all or only trace reactions. Thirty-one showed positive reactions at one or more P-T sites depending on the intensity of the allergy. The titers of the positive reactions (P-K titer) were from 2 to 8192.

### Oral P-K reaction

A typical positive reaction started first at the site of the lowest serum dilution with blush and itching, soon followed by a wheal and flare (Fig. 1a) at about 1 hour (30 min to 2 h) depending on the intensity of the allergy. Then the positive reaction spread to the higher serum dilutions, reaching a maximum reaction





at about 2 h (1–3 h), while the wheals and flares at the first positive tests were fading (Fig. 1b). Thereafter, all wheals and flares waned slowly and left a slightly red edematous induration (Fig. 1c) for several hours. Of the 50 cases studied, positive reactions were observed in 15 and their titers varied from 2 to 256.

*The relation of the P-K test and the oral P-K test to the skin test and the RAST*

The results of the P-K and oral P-K tests in relation to the results of the skin test and the RAST are summarized in Table I. In Fig. 2 the relation of the wheal

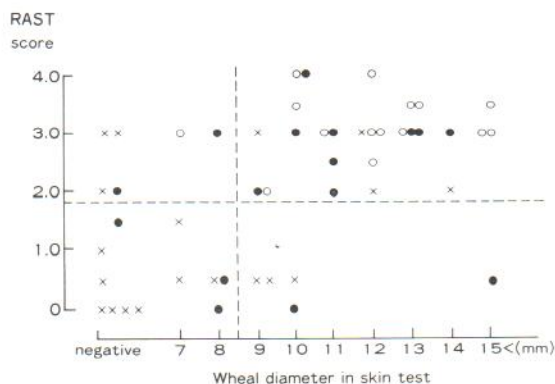


Fig. 2. The relation of the P-K test and the oral P-K test (Walzer test) to the wheal diameter in skin test and the RAST score. Open circle indicates positive both in the P-K test and the oral P-K test. Closed circle indicates positive in the P-K test but negative in the oral P-K test. Cross mark indicates negative in both tests.

diameter of the skin test and the RAST score is shown. Of 31 P-K positive cases, 23 were positive both in the skin test and the RAST, but the remaining 8 were negative in either or both of the skin test and the RAST. Of 15 oral P-K positive cases, 14 were positive both in the skin test of the RAST and 1 was skin test negative and RAST positive. There was no oral P-K positive case with negative RAST or with negative P-K test.

*The relation of the P-K test and the oral P-K test*

The P-K titers of 31 positive cases and the oral P-K titers of 15 positive cases as well as their relations are summarized in Fig. 3. All 5 cases with the low P-K titers of 2 or 4 were negative in the oral P-K test. Of 21 cases with the moderate P-K titers from 8 to 256, 12 were positive in the oral P-K reactions, and 3 cases with the high P-K titers of 1 024 or higher all showed positive oral P-K reactions. The ratio of the oral P-K titer and the P-K titer in each case was from 1:2 to 1:32.

Table I. The relation of the P-K test and the oral P-K test to the results of the skin test and the RAST

RAST	(+)	(+)	(-)	(-)	Total
skin test	(+)	(-)	(+)	(-)	
P-K test	(+) 23	3	2	3	31
	(-) 4	3	3	9	19
Oral P-K test	(+) 14	1	0	0	15
	(-) 13	5	5	12	35
Total	27	6	5	12	50

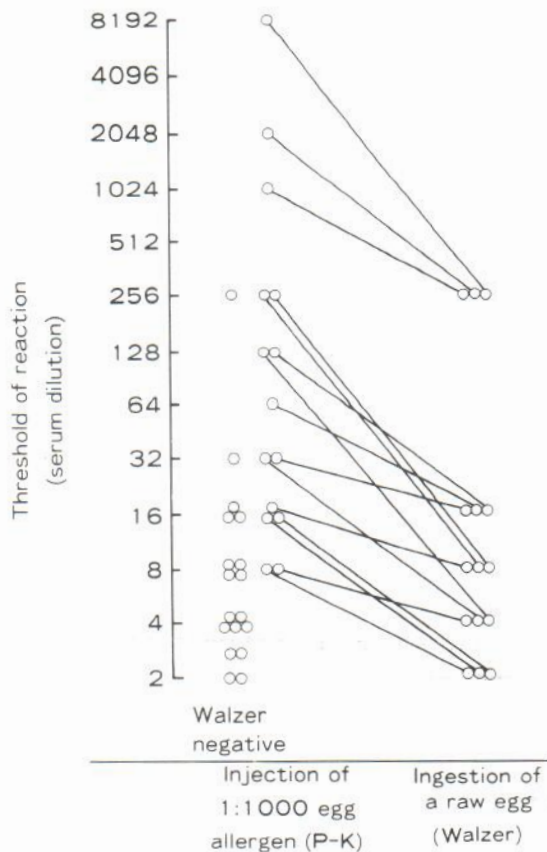


Fig. 3. Comparison of the titers (thresholds) of the positive reactions in the P-K test and the oral P-K test (Walzer test). The titers are shown by the maximum serum dilution with positive reaction. The two titers are lined in the cases positive in the both tests.

*Comparison of a raw egg and a boiled egg in the oral P-K test*

In seven cases, the oral P-K test was repeated with an egg boiled for 10 min. A positive reaction was observed only in two. As shown in Fig. 4, the oral P-K titers of these 2 cases were 256 to a raw egg and 32 and 2 to a boiled egg, respectively. The time of appearance of the reaction after a boiled egg was similar to that with a raw egg. The remaining one case with the titer of 256 and the four cases with the titers between 16 and 2 to a raw egg were all negative to a boiled egg.

**DISCUSSION**

We demonstrate in this paper that serum from patients with atopic dermatitis passively transferred to the skin of healthy adults caused type I allergic reac-

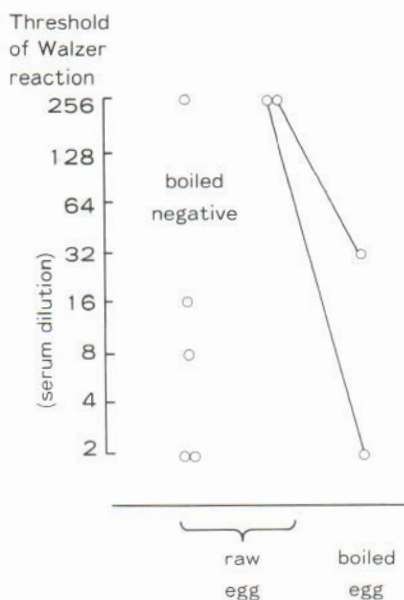


Fig. 4. Comparison of the oral P-K test (Walzer test) induced by a raw egg and by a boiled egg. The titers (thresholds) of the two cases positive in the both tests are lined.

tions at the P-T sites in reaction to the antigens arriving there after the ingestion of a raw egg by the recipients. The strength of the oral P-K reaction was mostly between 1/32 to 1/2 of that of the skin P-K reaction. The total amount of egg antigens arriving at the skin during the oral P-K test is therefore estimated to be in the same range of antigen amount as is contained in 0.025 ml of the 1:1000 egg allergen.

The percentage of the positive oral P-K reaction occurring with the serum of the patients who were shown to be allergic to hen's egg by the skin test or the RAST was surprisingly high (39.5%). This suggests that many egg allergic children with atopic dermatitis have IgE egg antibody levels in the serum sufficient to react with the ingested egg and cause type I allergic reactions. The patients studied in this paper were under the age of three years. In this age group raw eggs are rarely eaten, but they may get boiled or baked eggs. The antigenic activity of a boiled egg in comparison to a raw egg could be studied only in a few cases. From our data it may be suggested that the antigenic potency of a boiled egg is roughly 1/10 or 1/100 of a raw egg or less. If we assume that the ratio of the body weights of the children and the mothers is approximately 1/10, a boiled egg might be able to cause a typical type I allergic reaction in an egg allergic atopic child relatively often.



As compared to the ordinary P-K reaction which is caused by the antigen inoculated directly at the reaction site, the oral P-K reaction is induced by the antigen conveyed to the skin via blood vessels. This explains the time lag in the appearance of the urticarial reaction at different serum dilutions in the oral P-K test; the reaction first appeared at the site of the highest concentration and then at following concentrations. Walzer described the difference of the onset time of the oral P-K reaction by different foods (9). Reactions came earlier with herring and later with a raw egg. Our investigation confirm the late onset by a raw egg as well as a boiled egg.

Patients with atopic dermatitis have not only IgE antibody but also other classes of antibodies (IgG and IgA) to foods (8). What kind of functions these antibodies have are not known yet. But it is speculated that food antibodies of IgG or IgA classes might modify, perhaps inhibit, the symptoms delivered by IgE antibodies at various places of the body like in the digestive tract, the blood stream, in tissue fluid and on mast cells. In this study, the oral P-K test was performed two days after passive transfer of the patient's serum. Therefore, short-term skin sensitizing IgG antibodies (9) were thought to have disappeared from the P-T sites at the time, and the urticarial reaction we observed in the oral P-K tests were probably purely IgE-dependent.

The symptoms occurring in patients with atopic dermatitis after eating "allergic" foods are thought to

be much more complicated than the one we have observed in the oral P-K test. Our investigation is only the first step to analyze the detailed mechanisms of food allergy occurring in atopic dermatitis.

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