

Immune Mechanism and Nutritional Intervention of Food Allergy

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Abstract. With the increasing number of people with food allergy, the public's awareness of their own health is constantly improving. The key to reduce the prevalence and incidence of food allergy is to understand the immune sensitization mechanism of food allergy and conduct nutritional intervention in daily life. The main immune sensitization of food allergy is related to immunoglobulin E and specific helper T cells in the human body. Meanwhile, the occurrence and development of food allergy are also closely related to the intestinal flora. After understanding the mechanism of sensitization, nutritional intervention can be carried out from the aspects of avoiding sensitization factor intake, food replacement, and not blind diet. Due to the particularity and complexity of food allergy diseases, the public's understanding of them is still limited, and the measures should be adjusted and improved from all aspects of the society. This paper reviews the mechanisms of immune sensitization and the nutritional intervention of food allergy, and puts forward suggestions and ideas for the nutritional intervention of food allergy.

Keywords: Food allergy, immune mechanism, dietary and nutrition intervention.

1. Introduction

Despite improved health care, and modern facilities, the global prevalence of allergic diseases is still rising day by day worldwide, including food allergy, drug allergy, allergy and asthma. Globally, about 250 million people have food allergies, 300 million people have asthma, 400 million people have rhinitis, and one-tenth of the population have drug allergic reactions [1]. The appearance of these symptoms is accompanied by a weakening of immune function and the increase of allergic reactions. Therefore, it is essential to understand the sensitization mechanism behind allergic diseases and to intervene.

Among these diseases, food allergies have been of great public concern. Food allergy is one kind of pathological and potentially fatal abnormal immune response caused by food protein. It affects the physical health of 1% to 4% of adults and about 8% of children worldwide, and the incidence is also increasing [2]. In developed countries, its incidence is as high as 10%. The prevalence rate of food allergy among infants aged from 0 to 36 months in China is as high as 9.82% [3]. The age span of food allergy patients is large, with the rising global prevalence, this disease causes public concern [1].

With the development of the times and the popularity of health awareness, most people not only focus on the symptoms caused by food allergies, but also understand how to prevent them. At the same time, it is also very important to understand the sensitization factors of food allergies. By the combined action of genetic and environment, can occur in multiple organs. The immune sensitization mechanism of food allergy is mainly caused by two factors, immunoglobulin E (IgE) mediated and antigen-specific T helper 2 cell (Th 2) immune response tendency. In addition, intestinal microbes are also an important factor affecting the body's immune function to cause food allergy. Different types of food allergies have different rates of onset and different conditions.

In fact, food allergies are mainly caused by the excessive reaction of the immune system, and food allergy is mostly repeated and cannot get rid of, but the intervention of dietary nutrition can avoid allergy. Therefore, it is particularly important to conduct dietary intervention and nutritional hygiene education for food allergy. This article reviews the immune mechanisms of food allergy, and the nutritional interventions in daily life.

2. Immune-sensitization Mechanism of Food Allergy

2.1. Immune Sensitization

Symptoms of food allergy mainly occur in the skin, respiratory tract, digestive tract, such as urticaria, eczema, nasal congestion, runny nose, dyspnea, nausea and vomiting, abdominal pain and diarrhea, and even anaphylactic shock in severe cases. Food allergy may also cause nervous system disorders, leading to energy, impulse, insomnia in the spirit and personality, and even accompanied by other complications such as thyroid diseases.

IgE is an immunoglobulin in the human body that it can bind to mast cells, basophils and sensitize them. When IgE and these two cells combine and then combine with the antigen entering the body to release bioactive substances, it causes a type I hypersensitivity reaction. This type of allergic reaction is characterized by that it can cause local or systemic reactions, occur, disappear quickly, accompanied by physiological function disorders and a small number of cell damage. The mechanism of IgE to food allergy is that when food antigen enters the human body, it comes into contact with specific IgE (sIgE) that binds to mast cells and other cells, so that mast cells release bioactive substances such as histamine, thus mediating the occurrence of food allergy symptoms [4].

Another important sensitization factor in food allergy is the tendency to respond Th 2. After passing through the intestinal mucosal barrier, food antigens will form a certain growth factor-inducing regulatory T cell (Treg) with macrophages [5]. Treg has the effects of lowering the immune response, maintaining the autoimmune tolerance, and suppressing the occurrence of autoimmune diseases. After his first exposure to a food allergen, Treg will less tolerance to food antigens, Such as exposure to certain pathogen-associated molecular patterns (PAMPs) or after epithelial injury, Production of interleukins IL-25, IL-33, and thymic stromal lymphopoietin (TSLP) [6]. At this time, Treg cells change into Th2. With the activation and value increase of Th 2 cells, the immune effects are also amplified. Th2 will secrete cytokines to activate mast cells, basophils and other cells to participate in the occurrence of hypersensitivity reaction.

2.2. Role of the Gut Microbes in the Sensitization Mechanisms

The development of gut microbes and immunity very early in life, the diversity and number of bacterial species in the gut greatly affect the immune system for life, but also affect the susceptibility to allergic diseases. The "hygiene hypothesis" for the first time points out the potential role of microorganisms in the occurrence of allergic diseases [7]. The intestinal barrier is the first barrier in human immunity, which can effectively prevent foreign harmful substances and pathogen microorganisms from entering the human body. There is growing research evidence that food allergy is also closely linked with gut flora.

Bunyavanich et al. conducted long-term follow-up of 226 infants with milk allergy, found that 3~6 months old baby intestinal flora composition and milk allergy before 8 (PERMANOVA $P=0.047$), the occurrence of milk allergy to infants, the intestinal flora is rich in *Clostridium bacillus* and Phylum Firmicutes, but in children with milk allergy did not ease, its early intestinal flora without this characteristic [8]. Therefore, it can be seen that the intestinal flora is also greatly related to the clinical occurrence and development of food allergy.

The germ-free mouse model demonstrated that the microbiota modulates Th2-type immune responses. germ-free mice were more sensitized to milk than wild-type mice, and sensitized germ-free mice showed stronger responses to challenge tests and stronger systemic Th 2 immune response [9]. Bacteria flora transplantation is protective in germ-free mice susceptible to food allergy, a process associated with the expansion of ROR γ t + Treg cells. Such Treg cells can inhibit the IgE response and enhance the IgA response to [10].

It can be seen that intestinal flora can promote IgA secretion through Treg cells. IgA is also a kind of immunoglobulin in the human body, which is involved in local mucosal immunity and prevents infection by combining with the corresponding pathogenic microorganisms. Insufficient synthesis of IgA may dispose the newborn to respiratory and gastrointestinal infections [5]. IgA can promote

tolerance through antigen rejection, subsequently reducing allergen intake and improving the function of the intestinal mucosal barrier, while IgA can be obtained in maternal colostrum. Thus, an emphasis on the cultivation of advocacy flora early in life can affect immune function for a lifetime.

3. Nutrition Intervention to Avoid Food Allergy

Studies have shown that the standardized dietary intervention for children with food allergy can improve the clinical symptoms and nutritional status of children with food allergy, and the curative effect is obvious [11]. Therefore, the prevention of food allergy through nutritional intervention can reduce the frequency of food allergy occurrence. Changes in nutrient intake to improve the symptoms of food allergy, and reasonable choice of alternative food, so that food variety diversification and quantity rationalization can prevent food allergy. For ordinary people, reasonable optimization of the daily diet structure to enhance intestinal immunity can greatly reduce the occurrence of food allergy symptoms. Even if the symptoms of food allergy appear, timely medical treatment can greatly reduce the development and outcome probability of allergic diseases.

3.1. Avoid Sensitized Food Intake

For food allergies, the most important is to avoid the intake of Sens factors, China's current national standards the national standards for food safety prepackaged food labels (GB7718-2011) requirements, prepackaged food labels for eight kinds of sensitizing substances, including gluten grain and its products, crustacean animals and its products, fish and its products, eggs and its products, peanuts and its products, soybean and its products, milk and dairy products, nuts and nuts products. Foods containing these 8 sensitizing substances are the main causes of food allergy in China, so it is crucial to avoid these sensitization factors from entering the body, and it is also the first choice to prevent food allergy [2].

But while avoiding sensitized food, also cannot blindly prevent the intake of sensitized food. Noimark et al reported cases of severe nutritional problems following inappropriate food avoidance due to food allergy.1 case for milk allergy continuous breastfeeding and blindly limit weaning foods add 10 months term boys, tetany phenomenon, blood exclude hypoglycemic convulsions, and shows that blood calcium, phosphorus, alkaline phosphatase, elevated parathyroid hormone, vitamin D reduced rickets low calcium signs, iron deficiency anemia. This suggests that the blind delay of adjuvant food and adherence to exclusive breastfeeding leads to a serious insufficient of vitamin D, calcium and iron intake in children [12].

3.2. Choose Alternative Foods

However, as far as children and adults with food allergies are concerned, blindly avoiding sensitized food does not guarantee the diversity of food intake, so adopting alternative food is essential. Finding alternative food can adjust food intake according to the Dietary Guidelines for Chinese Residents. Take lactose intolerant people as an example, lactose intolerant people can drink soybean milk or eat milk products without lactose and low lactose, such as lactose free formula or soybean milk powder. When choosing milk or yogurt, you should choose the package marked with lactose words. Infant lactose intolerance diarrhea should stop milk, use no (low) lactose milk powder to relieve symptoms [13]. By analogy, people who are allergic to gluten-containing grains and their products should choose the same cereal, potato and gluten-free foods instead, replacing barley and wheat with rice, millet, potatoes and other foods [2]. Food replacement can not only avoid the intake of sensitized food, but also ensure food diversity.

3.3. Don't Blindly Avoid Food

Some patients with food allergy do not seek the doctor in the first time when symptoms appear, but diagnose by themselves, directly avoid the entry of sensitized food, and do not replace food. In

the long run, the balanced diet will be affected. It is recommended to diagnose the clinician before the diet, find out the sensitizing substance, in order to decide which food diet [2].

One case was a 10-year-old female child who had egg allergic reaction at the age of 2. Six months ago, due to intermittent asthma allergen testing, she was recommended to avoid eggs, gluten, beef, chicken, fish, citrus, tomato and strawberry, followed by significant weight loss. The final sIgE test found that egg sIgE was only 0.8 kUA / L, household dust mite sIgE was 10.6 kUA / L, while the rest food was all sIgE negative; open challenge test with eggs proved that the child had immune tolerance to eggs. Therefore, the asthma attack in this case was related to household dust mites, and the previous large range of unreasonable food avoidance led to insufficient nutritional intake [12].

Therefore, for patients with food allergies, we should not only pay attention to avoid eating food with sensitization factors in the diet, but also cannot blindly refuse to eat.

3.4. Specific Nutritional Intervention Methods

The nutritional requirement of people with food allergies is consistent with that of normal people, and the recommended dietary amount by gender, age and activity intensity in the Dietary Nutrient Reference Intake of Chinese Residents [12]. Early life is an important stage of growth and development in one's life. For example, children with food allergies as an example, nutritional evaluation is a comprehensive evaluation of children's physical development evaluation, and the nutrition and intake of children with food allergies. It can also detect the nutritional status and nutritional deficiency of children through the growth curve, and constantly adjust the dietary intake of children in the process of growth and development to ensure a balanced nutrition. Patients with food allergy, especially children, need to pay attention to the unexpected intake of trace elements and minerals, and need to pay more attention to the intake of energy, protein and fat. We can evaluate whether the dietary intake of allergic children is reasonable by referring to the recommended number of various kinds of food in the Dietary Guidelines for Chinese Residents [12].

Qianhong Che et al. divided 158 children under 2 years old into intervention group and control group according to whether they had received nutritional intervention. Children in the intervention group were regularly guided by nutritionists and supplemented with nutrients (calcium, iron, zinc) and probiotics if necessary. The control group was only instructed orally when treatment by the pediatrician. After the intervention, the serum zinc level $[(68.2 \pm 8.5) \mu\text{mol/L}]$ was below the normal reference range, and the serum zinc and iron levels were significantly higher in the intervention group, with statistically significant differences $[(88.5 \pm 9.6) \mu\text{mol/L}$ vs. $(68.2 \pm 8.5) \mu\text{mol/L}$, $t=12.264$, $P < 0.01$; $(18.6 \pm 3.4) \text{ mmol/L}$ vs. $(12.8 \pm 2.7) \text{ mmol/L}$, $t=10.762$, $P < 0.05]$. There was no significant difference in serum calcium levels in two groups $[(2.42 \pm 0.14) \text{ mmol/L}$ vs. $(2.41 \pm 0.11) \text{ mmol/L}$, $t=1.254$, $P > 0.05]$. In the experiment, 31 children with mild malnutrition and 4 children with moderate malnutrition in the intervention group, a total of 35 children (40.0%); 26 children in control group, 3 children, a total of 29 children (39.7%); there was no significant difference between the 2 groups ($\chi^2=5.01$, $P > 0.05$). In the post-treatment intervention group, 13 children with mild malnutrition and only 2 children with moderate malnutrition, a total of 15 children (17.6%); in the control group, 22 children with mild malnutrition and 5 children with moderate malnutrition, a total of 27 cases (37.0%), and the incidence of malnutrition after treatment was statistically different ($\chi^2=22.03$, $P < 0.05$). The incidence of low body quality and wasting in the intervention group decreased significantly compared with that before treatment, and the differences were statistically significant ($\chi^2=17.06$ and 29.01 , both $P < 0.05$); the incidence of malnutrition in the control group did not decrease significantly, and the incidence of retardation and wasting in children > 12 to 24 months increased [14].

For adults, paying attention to food packaging labeling, avoiding sensitized food and making reasonable food replacement is the most effective intervention method. At the same time, it is also important to avoid hidden sensitized food into the body. Studies show that a few milligrams of peanut protein can cause allergies, and a peanut contains about 300 milligrams of protein, that means, a peanut is enough to cause allergic reaction [2]. Therefore, patients with food allergies should also always pay attention to trace amounts of sensitized substances in their daily life.

3.5. Limitation

With the development of the big health environment, many people begin to pay attention to their health, but they do not have a specific understanding of allergic diseases such as food allergy. Moreover, the incidence factors of diseases similar to food allergy are complex, and the speed and degree of onset vary from person to person. Studies have shown that with the increase of social attention to food allergy and popular science education channels, medical staff and parents' awareness of food allergy increased, and parents pay more attention to food allergy in children. However, due to the limited medical knowledge, parents' self-reported food allergy rate was 22.0% (131 / 596), with the difference from the prevalence of food allergy (9.9%, 59 / 596) ($P < 0.001$) [15]. Therefore, when children have similar food allergy symptoms, parents will also think that the child is suffering from food allergies.

A large proportion of people were tested for allergens after doctors gave symptoms, but there was no specific adjustment to the diet afterwards. Among people with food allergy, the so-called prevention strategy of food allergy is mostly divided into two types, one patient is "one size fits all" to avoid food containing allergens, the other patient is unscrupulous. Either way, the quality of life will be greatly reduced.

As the prevalence and incidence of food allergies are increasing every year, it affects a large number of people around the world. Therefore, letting the public understand the risk factors of food allergy and the impact on the quality of life, the clinical manifestations and signs of food allergy, and improving the awareness of food allergy is an important part of reducing the prevalence, morbidity and mortality of this kind of allergic diseases. When making the public understand the clinical symptoms of food allergy diseases, it is also important to allow the public to distinguish the different symptoms and development characteristics of various food allergies, and it is also very important to avoid blind medical treatment.

4. Conclusion

In conclusion, it is claimed that food allergy is caused by IgE and Th 2 factors in the human body, and the intestinal flora is closely related to food allergy. With the increasing prevalence of food allergy, the public is not known, so the hygiene education and education of food allergy still need to be improved. It is not only necessary to teach the public the basic knowledge, but also to allow the public to manage their dietary intake, so there is a long way to go to educate food allergy diseases.

This article summarizes that these aspects can improve the awareness of food allergy of different people: (1) informatization of personal files: data the information of food allergy history and other related information in personal files, It allows different doctors to quickly understand patient information; (2) Service optimization of hospitals at all levels: in the treatment of patients with food allergies, Should provide dietitians with good professional quality, Diet adjustment according to the different stages of the disease; (3) professionalization of relevant personnel training: training of nutrition and other professionals, Provide relevant talents for the society, Improve professional research; (4) Standardization of policy formulation: the policy designated personnel can be based on the reflection of the relevant grass-roots workers, On the basis of the existing policies, Form a unique preventive medical care system in China, To prevent allergic diseases, such as food allergies.

References

- [1] Xiaoying Zhou, et al. Environmental Factors and Allergic Diseases [J]. Journal of Changzhou University (Natural Science Edition), 2019, 31 (04): 76 - 85.
- [2] Huiyan Li, et al. Five tips for preventing food allergies [J]. *Public Health*, 2022 (07): 80 - 81.
- [3] Du Zhi-rong, et al. Mechanism of intestinal microbiota in the development of food allergy [J]. *Chin J Clin Immunol*, 2022, 16 (03): 304 - 308.
- [4] Xuetao Cao, et al. <Medical Immunology>. People's Medical Publishing House. 2021. 7.

- [5] Schulke S. Induction of interleukin-10 producing dendritic cells as a tool to suppress allergen-specific T helper 2 responses [J]. *Front Immunol*, 2018, 9: 455.
- [6] Xin Tong, et al. Mechanism of immune sensitization and immunotherapy of food allergy [J]. *Chin J Clin Immunol*, 2022, 16 (06): 636 - 641.
- [7] Strachan DP. Hay fever, hygiene, and household size [J]. *BMJ*, 1989, 299: 1259 - 1260.
- [8] Bunyavanich, et al. Early-life gut microbiome composition and milk allergy resolution [J]. *J Allergy Clin Immunol*, 2016, 138: 1122 - 1130.
- [9] Rodriguez B, Prioult G, Hacini-Rachinel F, et al. Infant gut microbiota is protective against cow's milk allergy in mice despite immature ileal T-cell response [J]. *FEMS Microbiol Ecol*, 2012, 79: 192 - 202.
- [10] Abdel-Gadir A, Stephen-Victor E, Gerber GK, et al. Microbiota therapy acts via a regulatory T cell MyD88/ROR γ t pathway to suppress food allergy [J]. *Nat Med*, 2019, 25: 1164 - 1174.
- [11] Shufei Wei, et al. Application of standardized diet intervention on improving children with food allergy [J]. *China Modern Medicine*, 2021, 28 (17): 129 - 132.
- [12] Haili Yao. Dietary management in children with food allergies [J]. *Chin J Pract Pediatr*, 2011, 26 (03): 173 - 175.
- [13] Being plagued by lactose intolerance? Four ways to teach you the relief [J]. *Renowned Doctor*, 2022 (13): 14.
- [14] Qianhong Che, et al. Monitoring growth and development and nutritional status after comprehensive nutritional intervention of infants with food allergy [J]. *Chin J Applied Clin pediatr*, 2017, 32 (19): 1463 - 1466.
- [15] Zhuoyin Ma, et al. Clinical characteristics and influencing factors of children with parent-reported food allergy [J]. *Chin J Pediatr*, 2022, 60 (07): 676 - 681.