BIOCHEMISTRY OF FOOD ALLERGY

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Abstract

The term 'allergy' implies a reaction of the immune system, involving among other events an immunoglobulin E (IgE) triggered discharge of histamine from the body's mast cells. Food allergy is a clinical symptom that results from an inappropriate immune response to a food protein or food additive. Food allergens are proteins, usually glycoprotein and they share the same physical and chemical characteristics. Predisposing factors of food allergies include: the introduction of food before an epithelial gastric mucosal barrier closure, an immature gastrointestinal associated lymphoid tissue (GALT), feeding poorly digestible proteins, incomplete digestion, increased mucosal permeability, decreased immunoglobulin A (IgA) secretion, adrenal insufficiency and liver dysfunction. The most common sources of food allergens are fish, shellfish, peanuts, wheat, eggs, soybeans and cow's milk. Allergy to food can be detected through food allergy tests. Nutritional recommendations for allergies and therapies to counteract allergies are available.

Introduction

Biochemistry of Food Allergy

Food allergy is a clinical symptom that result form an inappropriate immune response to a food protein or food additive. (Burks and Stanley, 1998).

The normal immune response to a dietary protein is an increased mucosal immunity associated with active suppression of system response. Food allergies are mediated either by immunoglobulin E (IgE) or by other immunologic mechanism such as those that involve formation of immune complex between antigens and immunoglobulin G (IgG) and cell mediated delayed type hypersensitivity (Levy, 2001).

Given the obligate exposure of the gastrointestinal tract to food proteins and to potential allergens, it is not surprising that this organ system has developed in order to provide defence mechanism that prevent foreign materials from gaining entry into the immune system. Development of food allergy entails an adverse reaction to exogenous food or food protein fragments which escape lumen hydrolysis and are thus available for exposure to the gastrointestinal associated lymphoid tissue (GALT).

Food or food constituents are normally degraded by digestive enzymes in the gastrointestinal tract beginning in the mouth and stomach and ultimately completed in the small intestine. Relative stability of protein in simulated gastric fluid and simulated intestinal fluid correlate with allergenic activity. (Astwood et al, 1996).

The defense against hypersensitivity to a dietary protein is a well-developed multitier system dependent on a well-effective mucosal barrier association with oral tolerance generated by cellular immune system of the gastrointestinal associated lymphoid tissue. (GALT).

The balance between tolerance (suppression) and sensitization (priming) depends on several factors such as genetic background, nature and dose of antigen, frequency of administration, age at first antigen exposure, immunologic status of the host and antigen transmission via breastmilk. (Strobel, 2002).

In determining food protein allergenicity, two essential factors are considered: sensitization and the allergic reaction. The characteristics and what determines a food protein to be recognized by the gastrointestinal immune system as foreign is unknown. However in assessment of food protein allergenicity, the characteristic of an allergen should include an accumulation of physiochemical, immune chemical and biochemical information based on known food allergen characteristic (Aalberse, 2000; Kimber et al, 1999).

What is in agreement is that an allergen has some or all of the following characteristics: solubility (in the case of food allergy, the ability to cross the gut mucosal barrier), stability, (heat and digestive enzymes resistance) and surface structure molecule exposure.

An approach to food allergy is that when the body chemistry is out of balance, many individual
become hypersensitive and thus they react to foods in an excessive manner. Food allergies or sensitivities are becoming more common along with other allergy symptoms. A single food may give rise to different symptoms. Likewise the same symptom may have a number of different causes. Allergy to a particular food or group of foods can be detected through food allergy tests and nutritional recommendations for allergy are available.

**Literature Review**

Food allergy has been a confirmed cause of human illness since the twentieth century. Prevalence of adverse reaction to foods varies widely depending on whether they are defined using "gold standard":- double blind placebo controlled food challenge (DBPCFC) or as reported by patients and their families.

In one prospective study of children, 6% of children had food allergy or intolerance as confirmed by DBPCFC, which is lower than 28% among children, whose parents reported adverse reactions to food. (Bock, 1987).

A number of prospective studies indicate that allergy to cow's milk is prevalent among 2.5% of children under the age of 2. (Bock, 1987; Hide and Guyer 1983; Host et al 1988; Schrander et al, 1993). With the overall prevalence rate at same time during childhood of 6%, some children are at a greater risk. Food allergy occurs in 30% of children who have atopic dermatitis (Burks and Stanley, 1998). Food allergy is less common in adults, affecting between 1.5 and 2% of adults in United State (Jansen et ai 1994; Young et al, 1994).

The development of food allergy most often occurs in early childhood, before the age of three years. It involves mechanisms related to the nature of food allergen, the gastrointestinal tract and immune system, (Sampson, 1993).

Food allergens are proteins, usually glycoproteins, only a few foods are known to cause a vast majority of allergic reactions in children. Examples include: eggs, peanuts, milk, soy, and wheat, in adults, shellfish, nuts and peanuts. The gastrointestinal tract has a number of non-specific barriers to the entry of foreign proteins and one specific barrier is the secretary IgA produced by the immune system. Nonetheless, food protein can be absorbed into the blood stream and carried to target organs. Mechanisms have evolved to ensure that the immune system does not attack ones' own proteins (self) and proteins in foods. The general process by which the immune system is programmed not to attack such proteins is called tolerance. Tolerance is therefore a barrier to the entry of a food allergy. When people become sensitized to food, it is a breakdown of tolerance.

Food allergies are mediated either by immunoglobulin E (IgE) or by other immunologic mechanisms. IgE mediated reactions are the most common in general population. Non-IgE mediated immunologic mechanism include cell mediated type hypersensitivities and immune complexes between IgG and antigens. Non-IgE mediated food allergies account for significant proportion of food allergies in infants and young children.

**Immediate on-Set IgE Reactions**

IgE mediated food allergies (Typel Reaction).

Food allergy involves the reaction of a food protein with antibodies produced against it by the immune system. The accompanying symptoms are the result of this in appropriate immune response.

Antibodies are specific proteins produced by the body's immune system, which fit into the foreign molecule in a lock and key fashion. Antibodies bind to foreign proteins thus neutralizing their effect. The antigens may be part of the coat of a free molecule for example, protein from cow’s milk.

The antigens in food which provoke an IgE response are mostly proteins or glycoproteins. (proteins with sugar groups attached). IgE is produced by white cells known as B-lymphocyte or B-cell, Helper T-cells are also involved in the process. It is a secretion of substance interleukin - 4 (IL -4) which influences B-cell to produce a IgE rather than another class of antibody (figure la). The IgE secreted by B-cell circulates throughout the body.
One part of IgE has a particular affinity for the receptors on the surface of mast cells found in the body tissues. Mast cells bind the tail of IgE molecules, which thereby sensitize those cells to specific antigens (figure la). If in subsequent encounter with the sensitized mast cell, an antigen forms a bridge between two adjacent IgE molecules, this acts as a signal for the release of a variety of substances which either have been stored in granules in mast cells (for example histamine) or are newly synthesized at cell surfaces (such as prostaglandin D2 and leukotriene C4 (Figure Ib).

Release of these substances causes inflammatory reactions capable of damaging or otherwise facilitating the removal of foreign materials.

Mast cells are scattered between the skin and below mucus surfaces in the eyes, nose, mouth, respiratory tract and intestine. A food allergic individual can therefore have a wide spread reaction, when mast cells with appropriate IgE are triggered into activity after encountering an appropriate antigen from good.

The inflammatory reaction which follows injury to the body, increases blood supply to the area, brings protective white cells and components of the immune system to the site of injury. The scale of reaction can be boosted by series' of enzymes and other blood constituents, known as compliments. These also can increase permeability of blood vessels. Prolonged reactions, involve T-lymphocytes which can infiltrate virtually all tissues. By releasing compounds called lymphokines, T-cells can attract yet more cells, leading to a further crescendo of inflammatory activity (Lessof, 1994).

Delayed on-set IgG reaction IgG mediated food allergies (Type III reaction)

Delayed on set IgG reactions (type III reactions) involves the formation and deposition of antigen - antibody (Ag-Ab) complexes, mostly involving IgG.

In contrast to the immediate IgE mediated reactions, these reaction are delayed, since they involve the gradual formation of immune complexes, IgG mediated reactions typically result from exposure to excess antigens; over an extended period of time. In the case of food allergy increased intestinal permeability coupled with repeated ingestion of particular food causes excessive antigens to be present in the immune system. Formation of insoluble antigen-antibody complexes result in the activation of complement and subsequent respiratory burst in neutrophils, the release of proteolytic enzymes, mast cell mediators and vasoactive particles and the aggregation of platelets. Although complement stimulates inflammation, it also functions to prevent the progression from small complexes to large ones, a factor that helps minimize the severity of symptoms.

Macrophage activity triggers the release of inflammatory mediators such as: intereukine - 1, tumour necrosis factor, reactive oxygen species and nitric oxide.

Symptoms of Food Allergy
There is a wide range of symptoms caused by food allergy and as shown in Table 1.

Table 1. Symptoms of food allergy.

<table>
<thead>
<tr>
<th>S/N</th>
<th>Gastrointestinal</th>
<th>Respiratory</th>
<th>Dermatological</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Nausea</td>
<td>Rhinitis</td>
<td>Angioedema</td>
<td>Anaphylaxis</td>
</tr>
<tr>
<td>2</td>
<td>Vomiting</td>
<td>Sneezing</td>
<td>Urticaria</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Colic</td>
<td>Asthma</td>
<td>Eczema</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Diarrhea</td>
<td>Wheezing</td>
<td>Pruritis</td>
<td></td>
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<tr>
<td>5</td>
<td>Abdominal cramps</td>
<td>Laryngeal cough</td>
<td>Erythema</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Bloating</td>
<td>Oedema</td>
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General nutritional recommendation for allergies
For a healthy immune system, the use of the following should be limited.

- High protein and high-fat products such as egg, milk, chicken, meat, soybean, chocolates, etc.
- Colorings
- Aromatic substances, such as carrots, tangerine, food supplements, etc.
- Limited use of food conservatives and antibiotics.

**Treatment and Prevention of Allergies**
In general, the methods of treating and preventing type 1 allergy are:

- Avoiding the allergen,
- Taking drugs that block the action of lymphocytes, mast cell or mediators, and
- Undergoing desensitization therapy.

**Conclusion**
Food allergy is either mediated by immunoglobulin E (IgE) or by other immunologic mechanism. IgE mediated reactions are the most common in the general population. Non-IgE mediated food allergy accounts for a significant proportion of food allergy in infants and young children. Food allergy may be due to an imbalanced body chemistry. The body may therefore become hypersensitive to foods which cause many types of allergic reactions. Finally, food allergy serves to keep us away from foods which tend to unbalance our body chemistry.

**References**


