Pollen allergy; Mechanism and Etiology

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Abstract

The term allergy refers to an exaggerated immune response to a foreign molecule. In a normal healthy individual, this foreign molecule will act as a harmless antigen, as it will be recognized & cleared by the immune system without causing any significant damage to host tissues. In certain individuals, such antigens stimulate immune system in such a way that a series of exaggerated immune responses are generated against it, leading to significant tissue injury and damage to the host. Such an exaggerated immune response may also cause death of the patient. Such antigen is termed as an allergen. Allergy is categorized under immunoglobulin E (IgE) mediated type I hypersensitivity reactions. These reactions occur when an antigen acting as an allergen attacks the immune system of the host and causes excessive stimulation of mast cells and basophils.

This is followed by the release of allergy mediators which are responsible for causing local or systemic anaphylaxis, allergic asthma, allergic rhinitis, conjunctivitis.Type1 allergens are of various types, the mechanism of action is same; however underlying factors may differ in each type. This article is about pollen allergens, in specific & will discuss the common sources of pollen allergens in Pakistan, the prevalence and the factors behind pollen allergy.

Key words: Allergy; allergen; aeroallergen; IgE antibody; Pollen grain; mast cell.

Mechanism of action and types of class 1 allergens

The actual mechanism consists of two different phases. The first phase is named as the sensitization phase and consists of events associated with the first time entry of allergen in the body. During this phase the allergen stimulates B lymphocytes (B cells) cells to produce antibody secreting plasma cells, which ultimately produce specific IgE antibodies. These antibodies get attached on the surface of mast cells and basophills. Upon subsequent exposure the allergen gets attached to the IgE molecules already bound on the surface of mast cells and results in cross linking. This is followed by a series of events which ultimately lead to the release of allergic mediators which may produce systemic anaphylaxis, localized anaphylaxis, allergic rhinitis, allergic asthma, atopic dermatitis, etc (Mauro et al. 2000; Mike 2006). Mechanism of action of Type 1 allergens is given in Figure 1.Type I allergens can be subdivided into different categories depending upon the route of entry (Figure. 2). This article will focus only on the pollen grains.

Pollen grain as potential source of allergy

Pollen grains are one of the most commonly encountered aeroallergens. As the name indicates, aeroallergens are airborne allergens, which enter the body through respiratory route. How far they travel in respiratory tract, is dependent on their size. The smaller the size of an aeroallergen, faster it will travel through the respiratory tract. The particles with size < 8 µm are considered to be able to penetrate in the respiratory tract, whereas those with size ≥ 20 µm are deposited on naso or oropharynx or on ocular mucous membrane, leading to allergic rhinitis, allergic asthma or conjunctivitis (Eric *et al*. 2004).

Pollens are one of the most abundantly found particles

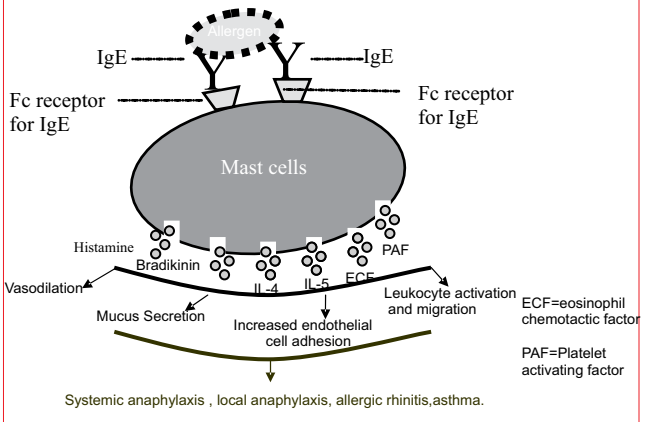

Fig.1. Mechanism of action of Type I allergens

in air. Being extremely light, they can travel up to large distances in air. Although pollen grains are potential allergens but all of the pollen grains are not causing allergy. Similarly allergy causing pollens will not affect all of the individuals. Allergic disorders develop only in case of heavy exposure to the allergens or in case if the individual has some genetic predisposition to allergy (Burge 2001).

Sources of allergy causing pollens

Allergy causing pollen can come from any plant, grasses, trees, weeds, flowering plants etc. The most common sources of allergy causing pollens in Pakistan are given in Table 1. (Shahid 2010).

Prevalence of allergy causing pollens

Pollination time of different plants varies largely. Some of the plants pollinate in the spring season whereas others pollinate in the fall. Therefore, pollen count of a particular plant keeps on changing throughout the year. The

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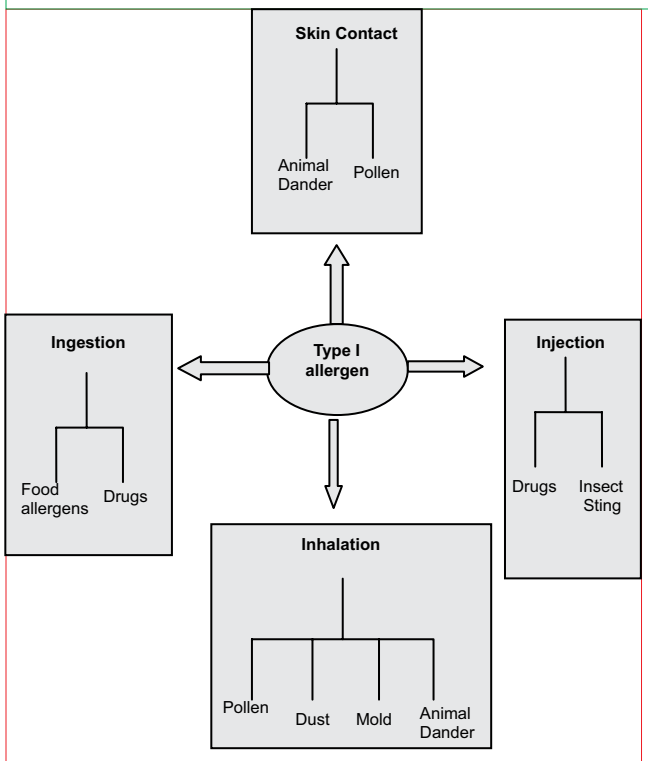

Fig .2. Different types of Type 1 allergens and their possible mode of entry in host.

pollination time of most common allergy causing plants in Pakistan is given in Table 2 (Shahid 2010).

During pollination, the pollen count in air is too high, indicating an alarming situation for the allergy patients. Different types of air samplers are used to collect the pollens present in air which are then counted and identified in microscope.

Consequences of pollen allergy

The chances of development allergy related disorders increase in season when pollen count is high. In case of allergic rhinitis, the symptoms may include sneezing, rhinorrhea, congestion etc (Bousquet *et al*. 2001). In case of asthma, patients experience episodic symptoms of wheezing, cough and dyspnea (CDC guidelines 2003). Sometimes patients experience acute inflammation of eyes and frequent itching, a condition termed as conjunctivitis (Rose 2007).

Since pollens travel through air, it is not possible to avoid 100% exposure. However some precautions may really help the patients in staying safe, or at least in lowering the severity of the symptoms, e.g., wearing a mask before going out, drinking a lot of water to prevent dehydration, using anti allergy medicines and inhalers, etc.

Factors influencing the development of allergy

In order to have a better understanding of pollen allergy it is important to mention that multiple factors are involved in its pathogenesis and susceptibility to individuals. These factors may include the following.

Genetic factors

Some people are genetically predisposed to several types of allergies including pollen allergy. They have higher levels of circulating IgE (up to12 µg/ml) than healthy individuals (0.3 µg/ml). The immune system of allergic individuals is tilted toward Th2 subtype. This results in the production of interleukin-4 (IL-4) & IL-13 which promote class switching in the B cells and thus synthesizing IgE antibodies.

Several studies have also reported role of single nucleotide polymorphisms of these cytokines in the pollen allergy, e.g., IL-13 polymorphism (C112T) in IL-13 has been found to be a protective factor in olive allergy whereas IL-13 (R130Q) is found to be a risk factor (Elena *et al*. 2009). Similarly IL-13 (Arg130Gln) single nucleotide polymorphism has also been linked to the increased risk of allergy (Min Wang *et al*. 2003). Apart from cytokines, several studies have also reported the role of mutations in Toll like receptors (TLR) in allergy, e.g., it has been reported that TLR-2 (R753Q) mutation modifies the cytokine production and increases the risk of atopic dermatitis (Salima 2008).

Hygiene hypothesis

It is strongly believed that lack of early childhood exposure to infectious agents or in other words individuals who are brought up in extremely hygienic environment are more prone to develop different types of allergies including pollen allergy (Maria *et al*. 2002). It is argued that lack of exposure to bacterial/viral pathogens down regulates the T-helper-1 (Th1) arm of immune system while T-helper-2 (Th2) arm is up regulated. Hence the individuals become more prone to allergies (Sergio *et al*. 2004).

Air polution

Diesel and other exhaust have been shown to enhance the ability to make the allergy antibody, IgE, in response to exposure to allergens (Syed Zafar *et al*.2009; Bartra *et al* 2007). It has also been reported that diesel exhaust particles influence the expression of huge amount of allergy causing proteins in pollen grains. Air pollutants also cause mucosal damage and impaired mucociliary clearance ultimately influencing increased risk of allergy (Riccardo 2007).

Conclusion

Pollen allergy is one of the most commonly encountered problems not only in Pakistan, but also in the rest of the World. Efforts are required to identify allergy causing plants (other then those which are already known) so that their plantation can be controlled. Full characterization of pollen allergens is desired so as to develop a better understanding of pathogenesis of pollen allergy. This may help in designing better treatment strategies and preventive measures.

Abbreviations

1. Arginine R
2. Arginine Arg
3. B lymphocytes (B-cell)

Table 1. Sources of Pollen Allergy in Pakistan

GRASSES	Tree	Weeds
Bermuda grass	Cyprus	Rose
Italian grass	Populus	Rumex
Flavus grass	Olia Ferogenia(Olive)	Urticacae(stinging nettle)
Wild oat	Jackarande	Ricinum (Castor)
Trimothy Grass	Silver Oak	Chenopod(Bathoo)
Meadow Grass	Accer	Artemesia
Italian Rye Grass	Paper Mulbery	Lantana
Bromus Grass	Accacia	Amaranthus viridus
SorgumGrass	Accacia Modeta	Brassica Compestoris(Sarson)
Swamp Meadow Grass	Pine	Dandilion
Smooth Finger Grass	Eucalyptus	Plantain
Common Reed Grass	Chinese Tallow	Canabis(bhang)
Wild Cane	-------	---------

Table 2. Pollination time of most common allergy causing plants in Pakistan.

Grasses	Bromus, Italian Grass, Flavus, Wild Oat, Trimothy Grass, Meadow Grass	Spring
	Sorgum, Swamp Meadow Grass, Common Reed, Wild Cane, Lemon Grass	Fall
	Bermuda	Throughout the year
Trees	Paper Mulberry, Pine, Acacia, Eucalyptus, Chinese Tallow, Olive, Jackarande	Spring
	Rubinia, Accacia Modesta, Silver Oak	Fall
Weeds	Rose, Brassica, Rumex, Dandilon, Urcticaceae, Plantain, Ricinum	Spring
	Chenopod, Cannabis, Amaranthus.	Fall

4. Glutamine (Q)
5. Glutamine (Gln)
6. Immunolglobulin E (IgE)
7. Interleukin-4 (IL-4)
8. Interleukin-13 (IL-13)
9. T-Helper-1 (Th-1)
10. Toll like receptor (TLR)

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