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Aerial Pollen Diversity in India and Their Clinical Significance in Allergic Diseases

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Aeroallergens play a major role in the pathogenesis of respiratory allergic diseases, particularly asthma and rhinitis. Pollen, fungi, animal danders, house dust mites, domestic pets, and insects are of particular importance as triggering factors. Pollen are well studied as allergens among all other aeroallergens and are important source of pollinosis.

Respiratory allergy are prevalent among all populations all over the world. One can really think the gravity of the situation by looking at the epidemiological data available across the globe (1-6). Epidemiological studies carried out in different countries report the prevalance of respiratory allergy from 15% to 30%. A survey conducted in Finland shows a prevalance of around 14% allergic rhinitis and 2.5% asthma. In Australia 27% of children are reported to have wheeze. Asthma is prevalent in about 9% Greek population. Recent surveys carried out in India revealed 20 to 30% of the population suffer from allergic rhinitis and 15% develop asthma. An epidemological study carried out 30 years ago (1964) in Delhi had reported only 10% population having allergic rhinitis and 1% asthma. Thus it is well established that the incidence of allergy is increasing all around the world.

Knowledge about allergens has progressed rapidly during the last few decades with better understanding of molecular mechanism of allergy. Structure and function of allergens have been identified. The knowledge of qualitative and quantitative prevalance and their seasonal and annual variataions is of paramount importance in effective diagnosis and management of pollen related allergens. Several studies have provided explanations about the relationship between allergic sensitization, allergen exposure and clinical observations such as allergic cross-reactions. Pollen allergens cross react strongly with other pollen allergens among the same family and allergens among the pollen as well as foods. Reports regarding the pollen associated food allergy are also observed. We have tried to briefly review these aspects with particular reference to pollen allergy in India

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MONITORING AIR BORNE ALLERGENS

The role of the different pollen allergens varies with environment conditions, such as climatic factors, pollution and degree of exposure, The knowledge on diurnal, seasonal and annual fluctuations in airborne pollen in any geographical area is essential for effective diagnosis and treatment of pollen allergy. Because of change in the climatic conditions, observation on diurnal and seasonal prevalance becomes very important (7). Therefore a continuous monitoring of aerial pollen diversity is recommended.

SAMPLING DEVICES

Aerobiological sampling is carried out to monitor the qualitative and quantitative prevalance of aeroallergens through various sampling devices. Some of the sampling devices are mentioned briefly.

Gravimetric Sampler

Gravimetric sampler are based on the principle that bioparticulates settle down on a surface due to gravitational force. Durham's gravity sampling device is the commonly used sampler for the purpose (8). However this sampler has sevaral disadvantages and is no more preferred.

Impaction sampler

In impaction sampler particles are sampled passively from air on adhesive coated stationary or rotating rods. Rotorod sampler developed by Perkins (9) is used to qualitatively know the particles recovered / unit of air sampled. Rotorod aeroallergen model (Sampling Technologies. Inc. USA) is most popular.

Suction samplers

Suction sampler are based on the suction of a certain volume of air according to a known velocity and for a chosen duration on a trapping. There are several suction samplers available like (I) Hirst spore trap (10), (II) Burkard seven days sampler, (III) Burkard personnel slide sampler (IV) Burkard petriplate sampler and (V) Anderson sampler

Filtration samplers

Filters of a definite pore size offer volumetric potential especially appropriate for smaller aerosol classes and where ambient velocities are low. Filter can be used for the culture traps as well as after staining for analysis.

ANALYSIS OF AIR SAMPLES

The recognition of aeroallergens is divided into two phases: 1) Collection of material and 2) Sample analysis. Regardless of their method of collection, samples of mixed biologic aerosols are analyzed by one of the following techniques.

1. Direct microscopy

The microscopic identification of distinctive particles is an approach validated by years of practical applications of both gravimeteric and volumetric samplers. Pollen are identified on the basis of morphology, shape and size. A variety of other particles, like basidiospores, ascospores and spores of rust, smuts, downy mildew and primitive green plants are recognizable, which, fail to grow on most laboratory media. Therefore it is most dependable way to identify most of the pollen and fungal spores.

2. Culture analysis

This technique of analysis is employed to identify the culturable fungal spores on the basis of their colony characteristics which otherwise, cannot be identified under the microscope. This include the tally of colonies produced in culture or semisolid media.

3. Immunoassay

Immunochemical analysis, following descending elution offers an analytic approach to dust without potential or defined form (eg. dander, seed pomace, arthropod effluvia etc.). If micronic aerosols do carry pollen allergens, these fractions are also accessible to immunoassay in bulk samples obtained by filteration. Procedure is based on inhibition by RAST and ELISA techniques.

AIRBORNE POLLEN IN DIFFERENT PARTS OF INDIA

In India, first systematic atmospheric survey was initiated at Calcutta by Cunningham in 1873 (11) more than a century ago. After a prolonged gap, Kasliwal and his colleagues undertook such studies in Jaipur (12). However, Shivpuri and his students did extensive studies in Delhi (13). Since then researchers, all over India, have conducted exhaustive studies on airborne pollen types and their concentration. Recently an "All India Coordinated Project on Aeroallergens and Human Health" sponsored by The Ministry of Environment and Forests, Govt. of India has been successfully completed by Singh and his collaborators (4). Important pollen and fungal allergens from 18 different places have been identified, quantified and characterized for their allergenic properties. This provides the most scientific and upto date information on aeroallergens of India.

In Delhi, surveys have been conducted from time to time by Singh & Shivpuri (14), Singh & Babu (15) and Malik *et al.* (16). The dominant pollen types recorded are grasses, cheno/amaranth, *Ailanthus, Ricinus, Morus, Xanthium, Cannabis, Artemisia* and *Holoptelea*. Lakhanpal and Nair reported 30 pollen types from the atmosphere of Lucknow (17), whereas, Mittre and Khandelwal reported 36 types (18). Recently under AICP on aeroallergens and human health, 43 types of pollen were recorded. The dominant types were *Holoptelea,* Poaceae, *Eucalyptus, Casuarina, Putranjiva* etc. *Holoptelea* contributed 22.2% pollen to the air from March to May. Poaceae pollen were recorded (11.8%) with maximum concentration in April to June, followed by Asteraceae. Under the same project at Solan (Himachal Pradesh), out of 22 types of pollen recorded, pollen of family Poaceae and Asteraceae were recorded in high concentration. Peak pollen season of Asteraceae was from March to October with maximum concentration in April. Poaceae pollen were recorded in high concentration in September. *Cassia, Quercus, Pinus, Cedrus* were also important contributors to pollen load (4).

From Central India, surveys carried out at Bombay, Gwalior, Nagpur, Bhopal, and Kolhapur, revealed that the dominant pollen types were from Poaceae, Asteraceae, Apocynaceae families, *Rosa, Cicer, Ricinus, Ailanthus, Holoptelea,* Cheno/Amaranth and *Cyperus* (19, 20, 21). Grass pollen in India has been reviewed by Chaturvedi *et al.* (22) who observed that highest percentage was reported from Aurangabad (80.64%), followed by Bhavnagar (70.26%) and Raipur (66.73%), all in Central India. Aerobiological surveys carried out at Mumbai, Pune and Kolhapur revealed *Cicer, Ricinus communis, Holoptelea*, Cheno/Amaranth, *Argemone, Cocos nucifera and Hibiscus as* the dominant pollen types (23, 24).

Recent survey at Pune revealed *Parthenium* to be the highest contributor to the pollen load with two peak seasons ie. from September to November and January to April. *Cocos* and *Cassia* were observed throughout the year. *Cocos* pollen were recorded in high concentration in April - May and November-December (4).

At Aurangabad, *Datura alba* was prevalent in air from August to October with 8.2% annual concentration. *Cleome* contributed 6.8% pollen in June to August. Other important contributors were *Altemanthera, Typha, Bougainvellia* etc. (4).

In Eastern India, Chanda and his students took up the work in 1970s to assess the pollen types of Calcutta. Chanda & Sarkar (25) observed that grass pollen were the major contributors (39%) to the total pollen load in air. The other dominant pollen types being *Azadirachta, Caesalpaenia, Carica papaya, Mangifera indica, Amaranthus, Chenopodium, Xanthium and Argemone* (26). From the Eastern Himalayas (27, 28) dominant tree pollen types recorded are *Acer, Alnus nepalensis, Betula, Bucklandia populnea, Eucalyptus* and *Pinus*. Recent survey in West Bengal revealed, 59 types of pollen in air and their maximum concentration was recorded in May (4). *Trema orientalis* pollen were in high concentration from May to July. Pollen types of family Asteraceae and Chenopodiaceae were maximum in June and other important pollen types were from Asteraceae, *Pongamia, Areca catechue, Xanthium* and *Cocos*. At Gauhati, Poaceae, Cheno/ Amaranth, Asteraceae, *Putranjiva, Mangifera and Eucalyptus* were the dominant types of pollen (4).

From Southern India, studies carried out earlier at various places such as Visakhapatnam, Bangalore, Trivandrum, Kodaikanal and Chennai, revealed that *Casuarina, Parthenium, Spathodia*, Cheno/Amaranth, *Cocos* and *Eucalyptus* were dominant pollen types. However, at Visakhapatnam, 24 pollen types were recorded and Poaceae, *Peltophorum, Cocos, Casuarina*, Cyperaceae, *Eucalyptus* were the dominant types (29-33, 4). Recent aerobiological survey at Trivandrum revealed 15 pollen types and dominant were Poaceae, Cheno/Amaranth, *Aporosa* etc (4). At Chennai, 38 pollen belonging to 24 genera were identified. Pollen from Poaceae were the most abundant type and contributed 19.4% to the total pollen load from June to August. Pollen of *Acalypha* were recorded in highest concentration in the month of August which is followed by the pollen of *Casuarina* in the month of January and March (4).

Pollen calendars are very useful for clinicians as well as allergic patients to establish chronologic correlation between the concentration of pollen in air and seasonal allergic symptoms. Centre for Biochemical Technology now Institute of Genomics and Integrative Biology (Council for Scientific and Industrial Research) had published a book on pollen calendars of 12 different states of India (34). Important pollen season for grasses, weeds and trees prevalent in India are provided in the book.

CLINICALLY IMPORTANT POLLEN ALLERGENS

Based on clinico-immunological studies with pollen antigens , important allergenic pollen of India have been identified. The work on pollen allergy was initiated in 1950s by Shivpuri in Delhi. Subsequently, Kasliwal and his colleagues reported important pollen allergens of Jaipur (35). Shivpuri & Parkash (36) observed *Prosopis juliflora* as a major cause of pollinosis with 12% patients showing a positive skin reaction. Later, important pollen causing allergy were identified for Delhi by Shivpuri and his colleagues, some of them are *Ageratum, Ailanthus, Amaranthus, Anogeissus pendula, Artemisia, Cassia siamea, Cenchrus, Chenopodium, Cynodon. Ipomoea fistulosa, Paspalum distichum and Poa annua* (37, 38) recorded positive skin reactions in 16.9% patients to *Pinus roxburghii* from the foot hills of Himalayas.

Pollen causing allergy are quite variable in different ecozones which makes it very important to identify pollinosis causing species from every region and prepare extracts from them for diagnosis and immunotherapy for the benefit of allergy sufferers.

From Northern India, important allergens identified are *Prosopis juliflora, Ricinus communis, Morus, Mallotus, Alnus, Quercus, Cedrus, Argemone. Amaranthus, Chenopodium, Holoptelea* and grasses (4).

From Central India important pollen allergens are *Argemone, Brassica, Cannabis, Asphoedelus, Parthenium, Cassia, Azadirachta*, grasses, *Alnus, Betula, Malotus, Trewia nudiflora* (4).

From Eastern India, allergenically significant pollen types were found as *Lantana, Cucurbita* maxima, *Cassia fistula, Cocos nucifera* and *Calophyllum inophyllum*). Recent studies based on clinical and immunologic parameters reported *Phoenix, Ricinus communis and Aegle marmelos* as causative agents of allergy in this region (4).

From South India *Cassia, Ageratum, Salvadora, Ricinus, Albizia lebbeck and Artemisia scoparia have been reported* as important aeroallergens. (39, 40). Subbarao *et al.* (41) recorded allergenicity to *Parthenium hysterophorus* pollen extracts in 34% of allergic rhinitis and 12% bronchial asthma patients from Bangalore. Agashe & Soucenadin (42) recorded high skin reactivity to *Casuarina equisetifolia* in patients from Bangalore.

Clinical studies undertaken recently by various medical centres under AICP on Aeroallergens and Human Health (4) revealed important allergenic pollen for various regions in India. More than 35 pollen antigens were tested on atopic population to see the allergenicity. At Chandigarh, skin sensitivity was maximum against *Rumex acetosa* and *Ailanthus excelsa* (17.6%), followed by *Trewia nudiflora (9.7%), Argemone mexicana* (9.5%). 9.3% of the atopic persons showed sensitivity against *Cedrus deodara a* Himalayan Tree. At Delhi 12.6% of the atopic population were positive against *Amaranthus spinosus*, 8.46% to *Populus deltoides* and 7.46% against *Dodonea viscosa and Bauhinia vareigata*. At Calcutta 28.8% of the patients were sensitive against *Solanum sysimbrifolium,* while *Crotalaria juncea* (21.1%) and 18.18% each *against Ricinus communis* and *Ipomea fistulosa*. At Trivandrum, maximum skin reactivity was recorded against *Mallotus phillipensis* (12.1%) followed by *Prosopis juliflora* (6.3%).

Major allergens vary from, place to place. It is important for the clinicians to select only those pollen antigens for allergen sensitivity test, which are prevalent in a particular area in which patient is inhabiting. The above information has helped physicians all over the country in allergy diagnosis and management.

CROSS-REACTIVE ALLERGENS IN THE CLINICAL PRACTICE

Allergy is the result of binding between the epitopes on the proteins with the IgE antibodies. Because of evolution certain proteins has remained conserved from the different sources. It is known that allergic patients are frequently co-sensitized against different allergen sources. Progress made in the field of allergen characterization by molecular biological techniques has now revealed that sensitization against different allergen sources can be explained as cross-reactivity of IgE antibodies with structurally and immunologically related components present in these allergen sources. The similarities among allergens may facilitate allergy diagnosis by using a few representative cross-reactive allergens to determine the patient's IgE reactivity profile.

Cross reactive pollen allergens

Studies carried out across the globe suggest cross reactivity among different plants. *Lolium perenne* has been found to cross react *with Acacia,* Pineapple, *Olea europea, Dactylis glomerata, Ligstrum vulgare, Cynodon dactylon* and *Pinus radiata* (43-48). *Platanus acerifolia* has been found to cross react with *Corylus avellana, Prunus persica, Malus domestica, Arachis hypogaea, Zea mays,, Cicer arietinum, Lactuca virosa, Musa spp.* and *Apium spp.* (49, 50).

The pollen and seeds of *Ricinus communis* commonly grown in India for its oil and abundantly present in waste places cross reacts with *Hevea brasiliensis Mercurialis annua, Olea europea, Betula, Zygophyllum fabago and Putranjiva roxburghii* (51-54). *Areca catechu, Phoenix sylvestris, Cocos nucifera, Borassus flabelifer* and all members of

Table 1. Some of the cross-reacting tree pollen allergens with different foods reported by different workers

Plants	Foods	Evaluation Method	References
Ambrosia sp. (Ragweed)	Melon, banana	RAST	Andersen *et al.*, 1970 (67)
Grass	Swiss chard, Tomato, peanut	RAST, Nasal provocation test, RAST inhibition RAST, skin test	de Martino *et al.*, 1988 (68) de la Hoz *et al.*, 1991 (69)
Birch	Tomato, melon, water melon Apple, carrot, potato Rosaceae, hazelnuts	Immunoblot Immunoassay (IgE)	Dreborg & Foucard, 1983 (70) Ortolani *et al.*, 1988 (71) Pauli *et al.*, 1996 (72) Wuthrich *et al.*, 1990 (73)
Birch/mugwort Grass & Birch *Artemisia*	Apple, cherry, peach, pear Celery, carrot Kiwi fruits Rosaceae (peach, apple, chestnut	SPT, RAST	Eriksson, 1978 (74) Pastorello *et al.* (75)

the familiy palmacae are reported to cross react among themselves from India (55). *Cynodon dactylon (*common grass) cross reacts with *Pennisetum clandestinum, Stenotaphrum secundatum, Eragrostis, Brassica napus, Olea europea, Ligustrum vulgare, Lolium perenne* (47, 56-59, 93) (Table 1)

POLLEN FRUIT SYNDROME

Existence of an association between sensitivity to different pollen and sensitivity to diverse edible vegetables has been describe by various authors (Table 2). Some studies describes a relationship between birch pollinosis and sensitization to hazelnut, apple, carrot, potato, kiwi and other vegetables (60, 62, 63). Heiss *et al.* reported association between mugwort pollinosis and sensitization to celery, carrot, spices, nuts, mustard and Leguminoseae vegetables (63). Enberg *et al.* have reported association between ragweed pollinosis and hypersensitivity to Cucurbitaceae vegetables (e.g., watermelon, melon, cucumber) and banana (61). Some studies showed association between grass pollinosis and sensitization to tomato, potato, green-pea, peanut, watermelon, melon, apple, orange and kiwi (64). The association between pollinosis and edible vegetable sensitization may be because of the presence of lectins in edible vegetables, presence of IgE to carbohydrates of the glycoproteins (cross-reactive carbohydrate determinants); existence of common allergens between pollen and edible vegetables. Three allergens have been identified as responsible for cross-reactivity in these associations: profilin, a

Table 2. Some of the cross-reacting tree pollen allergens with other plants reported by different workers

Pollen	Cross reactivity	Diagnostics	Reference
Lolium perenne	*Acacia* Pineapple *Olea europea* *Dactylis glomerata* *Ligustrum vulgare* *Bermuda grass* *Cynodon dactylon* *Pinus radiata* D. Don	RAST inhibition Blotting, Blotting, inhibition Competitive binding inhibition ELISA inhibition	Howlett *et al.*, 1982 (43) Mourad *et al.*, 1988 (44) Cornford *et al.*, 1990 (45) Roberts, 1992 (46) Baldo, *et al.*, 1992 (47) Pike, *et al.*, 1997 (48)
Platanus acerifolia	*Corylus avellana* *Prunus persica* *Malus domestica* *Arachis hypogea* *Zea mays* *Cicer arietinum* *Lactuca virosa* *Musa* spp. *Apium* spp.	Skin prick tests EAST inhibition RAST inhibition	Enrique *et al.*, 2002 (49) Miralles *et al.*, 2002 (50)
Ricinus communis	*Hevea brasiliensis* *Mercurialis annua* *Olea europea* *Betula* *Zygophyllum fabago* *Putranjiva roxburghii* *Ricinus* (seed)	Immuno-blotting inhibition RAST inhibition ELISA inhibition	Singh *et al.*, 1997 (51) Singh, 1997 Putranjiva (52) Belchi-Hernandez *et al.*, 1998 (53) Palosuo *et al.*, 2002 (54)
Fraxinus xcelsior	*Olea europea* *Ligustrum vulgare* *Syringa vulgaris*	Immunoblot inhibition Immuno-blotting inhibition and FEIA inhibition	Pajaron 1997 (76)

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Table 2 contd...

Pollen	Cross reactivity	Diagnostics	Reference
Cryptomeria japonica	*Lycopersicom esculentum* *Cupressus arizonica* *Juniperus ashei* *Chamaecyparis obtusa*	RAST inhibition and immunoblot inhibition ELISA	Midoro-Horiuti *et al.*, 1999 (77) Kondo et al., 2002 (78)
Artemisia vulgaris	*Matricaria chamomilla* *Betula* *Ambrosia trifida* *A. bienni* *A. tridentata* *Abellana nux* *Mercurialis annua* *Euonymus europaeus* *Phleum pratense*	IgE immunoblotting. Immunoblotting inhibition conjunctival and bronchial challenges CAP inhibition	Herold *et al.*, 1991 (79) Valenta *et al.*, 1992 (80) Katial *et al.*, 1997 (81) Caballero *et al.*, 1997 (82) de la Torre Morin *et al.*, 2001 (83) Garcia-Selles, 2002 (84)
Helianthus annuus	Mugwort *Argyranthemum frutescens* *Taraxacum officinalis* *Solidago virgaurea* *Ambrosia elatior*	RAST and immunoblotting inhibition	Fernandez *et al.*, 1993 (85)
Betula verrucosa	*Malus domestica* *Apium graveolens* *Daucus carota* *Apium graveolens* *Actinidia chinensis* *Prunus avium* *Artemisia vulgaris* *Corylus avellana* *Alnus glutinosa* *Pyrus communis* *Carpinus betulus* *Castanea sativa*	RAST inhibition immunoblotting inhibition enzyme allergosorbent test (EAST), Western blotting, competitive inhibition basophil histamine release T cell proliferation assay	Valenta, 1991(86) Hirschwehr, 1992 (87) Ebner, 1993 (88) Hirschwehr, 1993 (89) Holm *et al.*, 2001 (90) Karamloo *et al.*, 2001 (91) Kazemi-Shirazi, 2002 (92)
Areca catechu	*Phoenix sylvestris* *Cocos nucifera* *Borassus flabellifer*	ELISA inhibition dot blotting	Chowdhury, 1998 (55)
Cynodon dactylon	*Pennisetum clandestinum* *Stenotaphrum secundatum* *Eragrostis* *Brassica napus* *Olea europea* *Ligustrum vulgare* *Lolium perenne*	Immunoblot inhibition RAST, ELISA Mab immunoblot	Matthiesen *et al.*, 1991 (93) Baldo *et al.*, 1992 (47) Potter, 1993 (56) Chang, 1994 (57) Smith, 1997 (58) Prescott, 2001 (59)

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Table 2 contd...

Pollen	Cross reactivity	Diagnostics	Reference
Zygophyllum fabago	*Mercurialis* *Ricinus* *Olea* *Betula*	RAST inhibition	Belchi-Hernandez (53) (merculars ricinus, olea, betula)
Parietaria judaica	*Parietaria officinalis* *P. mauritanica* *M. annua* *Olea europaea* *Fraxinus elatior* *Ricinus communis* *Salsola kali* *Artemisia vulgaris*	ELISA. (RAST) inhibition immunoblotting anti-Part 1 monoclonal antibody-based ELISA MAb	Ayuso, 1995 (94) Vallverdu, 1997 (95)

14 kD protein that regulates actin; Bet v 1, the 18 kd birch pollen allergen; and a 60-69 kD allergen. (63, 65).

Thus It is important to study in depth associated sensitization's and the common allergens responsible for them in order to improve diagnostic methods and treatment of these syndromes.

POLLEN POLLUTION AND ALLERGY

Evidence suggests that urbanization with its high levels of vehicle emissions, and westernized lifestyle are linked to the rising incidence of pollen-induced respiratory allergy seen in most industrialized countries. Moreover, the increase in respiratory allergy parallels an increase in outdoor and indoor air pollution. Although the role played by outdoor pollutants in allergic sensitization of airways has yet to be elucidated, it is well established that outdoor pollution exacerbates respiratory symptoms in atopic subjects. Acute and chronic exposure to such components of air pollution as sulphur dioxide, nitrogen dioxide, ozone and respirable particulate matter (isolated or in various combinations) enhances airway responsiveness to aeroallergens in atopic subjects. Studies carried out by our group suggest that gases like SO_2 and NO_2 has their effects on the pollen grains, and these pollutants can modify the morphology of these antigen-carrying agents and alter their allergenic potential (Arnima, 2001). In addition, by inducing airway inflammation, which increases airway epithelial permeability, pollutants overcome the mucosal barrier and so "prime" allergen-induced responses. Lastly, air pollutants such as diesel exhaust particulates can also facilitate the immunoglobulin (Ig)E response that leads to pollinosis symptoms in atopic individuals.

ALLERGEN AVOIDANCE

As primary mode of therapy, it is recommended to avoid exposure to sensitizing allergens as follows.

1. Avoid going outdoors on days when pollen are present in high concentration in air.
2. Close all windows in evening, when pollen generally settle down, to minimize their concentration.
3. Air conditioning decreases indoor pollen counts.
4. Do not plant lot of trees and shrubs around your house.
5. Take bath after coming from outdoors and use fresh cloths.
6. Eliminate weeds and grasses in your house compound.
7. Electronic/ electrostatic precipitator can be installed.

PHARMACOTHERAPY

The main goal of any therapy is to control symptoms and make life of the patient as normal as possible. As respiratory allergy is a life long disease so the management of the asthma includes continuous medication according to symptoms. Corticosteroids are the most commonly used for the management of respiratory allergy. Furthermore, relatively low doses of inhaled corticosteroids can be used to maintain good control if used in conjunction with other therapies. The most important management decision is to determine whether the patient needs inhaled corticosteroids; subsequently, decisions about dose, duration and method of delivery of treatment can be tailored to the individual depending on the preferences and social conditions of the patient. The role of newly developed antagonists to leukotrienes is not yet known but it may well be useful in mild asthma and in special forms of the disease.

IMMUNOTHERPY

Besides pharmacotherapy and allergen avoidance (preventive) therapy, Immunotherapy is considered as therapy, which can change the immune profile and can lead to reversal of immunomodulation. In case of immunotherapy extracts of the antigen, to which patient is sensitive, is injected in graded doses and at definite intervals so as to increase the level of blocking antibodies (IgG1, IgG4). Immunotherapy is very successful where patient is sensitized with single or few of the allergens and can dramatically reduce the symptoms and dependence on the drugs. In some cases patients are co-sensitized with several unrelated pollen allergens. Based on frequent co-sensitization patterns some of the hybrid proteins have been devolved with the polymerase chain reaction. These hybrids contain all the epitopes from the different allergen in a single protein. And these have been used for the for vaccination against pollen allergy. These molecules have shown stronger lymphoproliferative responses in cultured mononuclear cells of pollen-allergic patients than did equimolar mixtures of the individual allergens. Immunization of mice with the hybrids yielded higher antibody titers than did immunization with the individual allergen components or pollen extract, which suggests that the individual components of the hybrids can serve as molecular scaffolds for each other to enhance their immunogenicity. Antibodies induced with the hybrids in mice inhibited the binding of grass pollen-allergic patients immunoglobulin E to each of the individual allergens and grass pollen extract and may thus represent protective antibodies. The principle of increasing the immunogenicity of antigens by engineering hybrids thereof may be applied not only for the treatment of polysensitized allergic patients but also for general vaccine development (66).

FUTURE PRIORITIES

So with the above information quite obvious question is what next? Still all the possible allergens have not been characterized .As allergen avoidance is the measure of choice for the treatment of allergies and asthma in particular, all the possible allergens are required to be characterized bio-chemically as well as at molecular level. And relationship of the allergens with pathogenesis of the respiratory allergies and the increase in the prevalence are important questions which are required to be studied in detail. Molecular studies with reference with the cross reactive allergens are important for the proper diagnosis and treatment of the allergy. Allergen are required to be studied up to epitope level details.

For patients suffering from latex-fruit syndrome patient's are sensitive to many of the commonly used food and is not possible to avoid all the items and where chemotherapy immuno-therapy does not work or otherwise genetically modified foods which are devoid of specific allergens can be tailored for the problem free life for such persons.

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