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REVIEW ARTICLE

Airborne Contact Dermatitis

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Abstract:

Airborne dermatoses are complaints linked to external environmental, chemical, and biotic agents carried through the air. In general, airborne dermatoses that are most common in the work environment, tend to cause diagnostic problems that are challenging for both the patient and the doctor. It should also be borne in mind that since the external culprit agents are present in the environment, they do not only come in contact with the skin and mucosa, but can also be inhaled or ingested, thus also causing respiratory and systemic symptoms. Among the various clinical forms, airborne contact dermatitis interests the parts of the body exposed to the air: face, neck, upper aspect of the chest, hands, wrists. These cases must be differentiated from photocontact dermatitis; in the latter case, however, shadowed anatomic areas, such as the upper eyelids, behind the ears, the submandibular region, and under the hair, are not affected.

Keywords: Airborne contact urticaria, Airborne dermatoses, Allergic contact dermatitis, Environment, Gases, Vapours, Droplets, Plants, Airborne contact dermatitis.

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1. INTRODUCTION

Airborne contact dermatoses are skin complaints linked to external environmental, chemical, and biotic agents carried through the air [1 - 4]. Contact dermatitis is defined “airborne” on the basis of: [1] the existence of dust or of volatile causative agents, [2] the nature of the lesions, [3] the history of the patient, [the follow-up], and [4] the results of epicutaneous tests. In general, because they are so common in work environments, airborne dermatoses tend to cause diagnostic problems that are challenging for both the patient and the doctor. It should also be borne in mind that since the external culprit agents are present in the environment, they do not only come in contact with the skin and mucosa, but can also be inhaled or ingested, thus also causing respiratory [bronchitis, asthma, rhinitis] and systemic symptoms [1 - 4].

Nowadays, cases of airborne skin afflictions are reported all over the world, reflecting the complexity and diversity of the problems encountered as a result of new causal agents and/or particular technical procedures.

2. AIRBORNE CONTACT DERMATITIS

Airborne contact dermatitis is an inflammatory reaction linked to various contactants suspended in the air. The diagnosis of this complaint is based on the patient history and on follow-up, observation of the presence of dust or of volatile causative agents, on the distribution of the lesions, and on the results of patch tests [4]. Although the clinical-morphological diagnosis of airborne contact dermatitis is not generally difficult, identifying the causative contactant, and selecting appropriate treatment often poses a considerable challenge for the dermatologist.

2.1. Epidemiology and Pathogenic Mechanism

The prevalence of airborne contact dermatitis is difficult to estimate, for various reasons. The etiological diagnosis is usually challenging as it involves recomposing a puzzle; sometimes, the clinical diagnosis is difficult too, especially in cases where not only sites exposed to airborne contact are affected but also covered sites, as frequently occurs.

From the epidemiologic standpoint, airborne contact dermatitis can be classified as occupational and non-occupational. The common belief is that occupational forms are more frequent than non-occupational, in the same way as airborne irritant contact dermatitis is thought to be more common than the allergic form of airborne contact dermatitis.

2.2. Clinical Features

The skin symptoms of airborne contact dermatitis do not generally have any special or peculiar morphologic

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characteristics and can, thus, be confused with those of common contact dermatitis of the corresponding category. The clinician must base the diagnosis of the airborne origin of dermatitis on two factors: the case history and the site of the lesions. It must be remembered that airborne contact can affect both exposed and covered sites, whatever the chemical-physical nature of the contactants, because all such agents [droplets, gases, dust, powder] can cross or impregnate clothing (Table **1**).

Table 1. Clinical diagnosis of airborne contact dermatitis.

History of airborne origin of the dermatitis
Sites of lesions:
1. Sites exposed to the air
a. Face ("shaded" areas): upper eyelids, behind the ears, submandibular region, nasolabial folds
b. Neck, nape of neck, scalp, hands, wrists, forearms, lower legs (in women)
2. Non exposed areas
a. Major body folds

The most common sites for airborne contact dermatitis are the parts of the body that are exposed to the air: the face, neck, upper aspect of the chest ("V" region of the neck), hands, wrists, underarms, and sometimes, lower legs in women. Dermatitis affecting these sites must be differentiated first, often with some difficulty, from photocontact dermatitis. In photocontact dermatitis, however, "shadowed" anatomic areas, such as the upper eyelids, behind the ears ("Wilkinson's triangle"), the submandibular region and under the hair [scalp and nape of the neck] are not affected [1 - 4]. The nature of the causal agent and the results of photo patch tests can guide differential diagnosis with classical contact photodermatitis.

The upper eyelids are particularly susceptible to airborne irritants or allergens, which can easily become trapped and, therefore, accumulate in this area. Moreover, the skin of the eyelids is particularly thin and so easily penetrated by chemicals.

Apart from photoinduced contact dermatitis, the differential diagnosis of facial and neck airborne contact dermatitis must include contact dermatitis due to directly applied agents, connubial (consort) dermatitis, an id-like spread of dermatitis elsewhere on the body, systemic contact dermatitis limited to the face, and ectopic dermatitis usually an asymmetric dermatitis, displaced from its usual site due to the transfer of allergenic particles from other sites of the body. Other eczematous diseases that must be taken into consideration in the differential diagnosis are atopic dermatitis and seborrhoeic dermatitis limited to the face (Table **2**).

Table 2. Differential diagnosis of airborne contact dermatitis of the face and neck.

Contact and photocontact dermatitis
Systemic contact dermatitis
Atopic dermatitis
Seborrhoeic dermatitis
Polymorphic light eruptions

The skin lesions can also occur on parts of the body not exposed to the air. Volatile substances (dust, gases, solid particles of animal and vegetal origin) and droplets can, in fact, penetrate the clothes. Dust particles accumulate in occluded sites, such as the genital area, and particularly in the major body folds (axillae, popliteal, and antecubital fossa). Of course, these cases need to be differentiated from atopic dermatitis, clothing dermatitis, or an id-like spread of contact dermatitis from other areas, all events that can also affect the major body folds.

Apart from the above-described skin symptoms, there can often be involvement of the mucosa (conjunctivitis, for example) and airways (in cases of inhalation of the same substances). Systemic symptoms are also possible (fever and the involvement of various internal organs) in cases of ingestion of the airborne agents.

For clinical observation, it is important to remember that it is fairly common to see patients who are affected contemporarily by direct contact dermatitis and by airborne contact dermatitis. This event is more commonly observed in occupational settings, when workers come in contact with the same substance both directly (while manipulating it) and in an aeromediated manner (because it is present in the environment). In this context, the most common culprit substances are epoxy resin dust, metal dust, cement powder, fiberglass, and medicaments in powder form. The same substance may also be present in the environment in different forms (powder and vapor, solid form and smoke, liquid form and gas), passing from one form to the other for natural reasons (temperature) or due to particular processing: various such examples are described below.

Apart from classic eczematous lesions (acute, subacute, or chronic), airborne contact dermatitis can manifest with peculiar papular-follicular pictures (fiberglass dermatitis) or as multiforme-like erythema (wood dust and the fumes of plants in combustion). Finally, again from the clinical standpoint, it should be borne in mind that the same agent can induce different clinical pictures.

3. AIRBORNE IRRITANT CONTACT DERMATITIS

Great numbers of airborne irritant contact agents have been identified up till now, nearly all in occupational environments [1 - 7]. In many cases, they are highly alkaline substances [pH>10] whose irritant effect is both chemical and mechanical. Some examples of airborne contact irritation are reported below.

3.1. Fiberglass Dermatitis

This is a classic and common example of irritant airborne contact dermatitis. Today, fiberglass is used in many different fields [8] principally for thermal and acoustic isolation purposes in the building industry, for fireproofing, as chemical filters, as an "armature" for plastic items, as "reinforcement" for rubber materials, in air conditioning filters, supports of electric circuits, and in the textiles industry (in draperies and curtains, for instance).

The entity of dermatitis differs according to various

factors: individual susceptibility (in comparable working conditions, atopics are more prone to develop dermatitis; there is a good correlation between the symptoms of fiberglass friction and the intensity of the dermographism; phototype I subjects are more susceptible); environmental conditions (high temperatures, low humidity, poorly aired environments and the concentration of fibers in the air foster the onset of dermatitis); the duration of the exposure; the mode of contact of the fibers with the skin (direct, localized contact or indirect airborne contact, so more extended); the pathogenic mechanism of dermatitis (mechanical-traumatic irritation through contact or intracutaneous penetration of the fibers, or else contact allergy to the resins employed in the fiberglass work process).

In an occupational setting, the skin manifestations can follow direct manipulation of the fibers; in these cases, dermatitis will feature pruritus and punctiform excoriations on the backs of the hands. Most often, fibers suspended in the air reach the uncovered sites, and also some particular covered sites by insinuation under workers' clothing. The subjective signs of dermatitis will be pruritus and pricking sensations; objective signs are erythematous papules measuring 0.1-0.5 mm in diameter, excoriations, lesions due to scratching, and occasionally, pustules. The same micro papules, with a purpuric hue, can also interest the hair follicles. The preferential sites are the skin folds (axillae, groin, popliteal fossae, elbow folds), the extensor faces of the limbs and the belt zone

The diagnosis relies largely on medical history and clinical examination. A search for glass fibers is done by surface biopsy, consisting of stripping of the corneal layer by chemical (with one or two drops of 20% potassium hydroxide) or physical means (using adhesive tape), that is then directly observed under the microscope. Differential diagnosis needs to be made with various other pruriginous and extensive forms of dermatitis due to exogenous causes (Table **3**) and sometimes, especially in chronic and peculiar cases, with Hodgkin's disease and aspecific chronic leukemia pictures.

Table 3. Differential diagnosis of fiberglass dermatitis.

Eczema prurigo
Acariasis, pediculoses
Papular urticaria
Actinic prurigo
Phytodermatoses
Cutaneous lesions in neoplastic diseases

In general, workers fitting fiberglass products are those most exposed and hence, at risk of the disease, more so actually than those working at fiberglass factories, because the fiberglass concentrations in the environmental air can vary greatly depending on the application method and the air saturation in the work area. Rock wool dermatitis is comparable to fiberglass dermatitis [9].

3.2. Cement Dust Dermatitis

C*ement dust* dermatitis is fairly common in cement factories [10]. Being very pulverulent, cement insinuates under workers' clothing and overalls and also agglutinates on the face. Irritation is particularly severe in cases of excessive sweating, that dissolves some alkali cement components. Dry cement irritation is frequent in cement factories but less so at building sites, where damp cement diseases are prevalent (burns, irritant contact dermatitis, allergic contact dermatitis). In all cases, air-induced irritation is favored by a relatively low rate of environmental humidity.

The diagnosis of airborne dusts-induced dermatitis is based on the medical history, clinical examination, and laboratory tests, such as microscopic examination of the dust (polarized light), determination of dust on the skin (stripping with adhesive tape), and exposure test.

3.3. Airborne Dermatitis from Sprays, Vapours, and Gases

A less frequent observation is airborne irritation due to vapors and gases. In general, dermatitis affects the face; however, some vapors and gases impregnate clothing and are, therefore, responsible for lesions on covered body areas.

4. AIRBORNE ALLERGIC CONTACT DERMATITIS

Airborne contact allergy has a lower incidence than airborne irritation but is more often reported owing to the notable symptoms [11]. These are of common allergic contact dermatitis. The lesions are generally symmetrical, with an acute or chronic evolution, depending on the nature and concentration of the allergen and the frequency of airborne contact. The localization of the dermatitis is characteristic. The sites most often affected are those exposed to the air: the face, neck, décolleté, hands, forearms, and legs in women. On the face, the lesions affect the eyelids most severely, in the form of edema, the conjunctiva (pruritus, reddening, lachrymation, photofobia), retro auricular regions, and submandibular region. In some cases, only the eyelids and conjunctiva are involved, but covered areas can also be affected, such as the folds, where solid particles can insinuate under clothing and accumulate.

There are many culprit agents (Table **4**) [1 - 5, 12, 13]. Cement dust can cause allergic airborne contact dermatitis owing to its chromium or cobalt content. Such cases affect the face, generally inducing a dry, lichenified dermatitis associated with conjunctivitis.

Dermatitis from vapors, usually of occupational origin, can be induced by amines used as epoxy hardeners and resins [14, 15]. Additionally, rubber, glues, metals, pesticides and insecticides, and many other industrial and pharmaceutical substances have been reported as causes of airborne dermatitis. Forms due to pesticide droplets sprayed on plants are often observed in agriculture, showing clinical manifestations in both exposed and covered sites, since the drops impregnate clothing. The main culprits are thiurams, that can also be used in the production of medicaments.

Among the non-occupational forms, airborne contact dermatitis can develop due to fragrances in sprays.

4.1. Plants and Woods in Airborne Dermatitis

Woods and plants are often causal of airborne contact dermatitis: the allergens are dried botanical material and smoke from burning plants. The plant families most often responsible

for airborne allergic contact dermatitis are the Compositae family and the Anacardiaceae family [16 - 19]. Among the Compositae, well known causal plants are ragweed, sunflowers, goldenrod, and chrysanthemums. Their flowers, leaves, stems, and pollens contain sesquiterpene lactones, responsible for the allergic reactions.

Table 4. Most common airborne allergizing substances.

1. Metals
✓ Chromates, Cobalt, Nickel, Mercury
2. Solvents
✓ Formaldehyde
3. Pharmaceutical chemicals
✓ Albendazole
✓ Chloroquine sulfate
✓ Spiramycin
✓ Chlorpromazine
✓ Quinolone compounds
✓ 8-Methoxypsoralen
4. Plastics, rubbers, glues
✓ Acrylates
✓ Benzoyl peroxide
✓ Diaminodiphenymethane
✓ Dibutylthiourea
✓ Epoxy acrylates
✓ Epoxy resins
✓ Formaldehyde resins
✓ Phenolformaldehyde resins
5. Plants and wood allergens
✓ Sesquiterpene lactones
✓ Tropical woods
✓ Essential oils
✓ Garlic
✓ Primula obconica
✓ Tea tree oil
6. Miscellanea
✓ Cigarettes and matches
✓ Phosphorus sesquisulphide
✓ Isothiazolinones
✓ Halogenated compounds

Airborne allergic contact dermatitis is commonly caused in the USA by plants of the *Toxicodendron* genus of the Anacardiaceae family: poison ivy, poison oak, and poison sumac [17].

Florists are often exposed to various plant families, including the Compositae (Asteraceae), the plant most often causal of airborne contact dermatitis [20]. A study by Hausen and Oestmann showed that 50% of florists have dermatitis of the face [18].

Various airborne dermatitis forms, due to contact with woods, are occupational in carpenters, joiners, cabinet makers, and associated trades subjects [21]. The most sensitizing woods are of tropical and subtropical origin; dust from these woods can cause airborne contact dermatitis as well as an erythema multiforme-like eruption [22].

In hot and dry regions, pulverized parts of dead plant material become windborne and can induce dermatitis of the exposed skin, which may be mistaken for photo contact dermatitis [23, 24].

4.2. Airborne Skin Lesions due to Pesticides

Pesticides are the only toxic substances intentionally released into environments to kill living things [25]. They are used in agriculture for the control of pests (pesticides), weeds (herbicides), fungi (fungicides), and rodents (rodenticides), they are also used in horticulture, forestry, and livestock production, but their use is not limited to these sectors, and also comprises of use in homes, schools, buildings, roads, and parks: indeed, it is difficult to find any place where pesticides are not used. They can also be present in the air, in foods and in the water we drink. Pesticides, herbicides, and fungicides are the major groups [25 - 28].

The prevalence and incidence of skin reactions to pesticides are not known but are surely higher than reports in the literature would suggest [29 - 33]. Irritant contact dermatitis is believed to be more frequent than allergic contact dermatitis [linked particularly to insecticides and fungicides].

4.3. Airborne and Direct Allergic Contact Dermatitis

Very frequently, airborne and direct skin contact occur. This is since, especially in occupational sectors, workers can come in contact with the same substance *via* different routes, particularly in the case of substances in powder form. Practical examples are dermatitis due to cement and powdered resins: the workers have both direct and airborne contact with these, owing to the strong concentrations in the air. Pulverulent substances, present in both occupational and non-occupational settings, can come into direct or airborne contact with the skin while also being inhaled. In this event, owing to the multiple pathogenic mechanisms, dermatitis is usually accompanied by systemic symptoms that can also be severe. Various examples include that of mustard gas in liquid form and giving off vapors, as already described [33, 34].

5. AIRBORNE PHOTO CONTACT DERMATITIS

Airborne photo contact reactions affect sites exposed to light. In theory, there are no clinical signs enabling a clear differentiation between photodermatitis due to direct or airborne contact. In practice, however, in non-airborne forms, some parts of the face are relatively or completely spared [region under the chin, retro auricular regions, upper eyelids], whereas in airborne forms no part of the face is spared. Nevertheless, there are many exceptions to this rule, therefore, the diagnosis must be based on an accurate medical history, analysis of subjective symptoms and objective signs, and the results of patch and photo patch tests.

Among the occupational phototoxic agents that can induce airborne contact dermatitis, polycyclic hydrocarbons and psoralens or furocoumarins are particularly important.

Furocoumarins are present in many plants. The presence of dry vegetable particles in the air during the summer favors the onset of dermatitis (airborne phytophoto contact dermatitis) on uncovered skin sites. Airborne photoallergic contact reactions are very rare. Possible culprits are fragrance ingredients (in the cosmetic industry), coaltar derivatives, olaquindox, and several drugs (in the pharmaceutical industry).

Combined airborne and photo aggravated contact allergies are also possible, as observed for Compositae and lichens [35]. Vegetable particles of plants containing furocoumarins could also be implicated. In fact, in cases of direct contact dermatitis from *Ficus carica,* photoallergic reactions due to 8-methoxypsoralen were also observed [36].

6. AIRBORNE CONTACT URTICARIA

Among the various substances that can induce contact urticaria (immunological or nonimmunological) [37], some are volatile or pulverulent, and these can undoubtedly cause airborne contact urticaria. Nevertheless, this mode of transmission has rarely been reported in the literature.

Allergy to natural rubber latex (usually derived from *Hevea brasiliensis*, of the Euphorbiaceae family) is an important health care issue today. Direct contact urticaria due to latex gloves involves the hands because natural rubber latex proteins are absorbed onto the cornstarch powder in the gloves. When the packets are opened or the gloves are pulled out of multipack boxes, the proteins are released into the air and can induce various clinical problems, such as airborne contact urticaria of the face, conjunctivitis, rhinitis, and even asthma [38, 39].

Other agents responsible for occupational airborne immunological contact urticaria are cosmetics, vegetables, fruit, ammonium persulphate, animal hair, and anhydrides [40]. Processionary caterpillars can provoke various airborne reactions, mainly of urticarial type, both non-immunological and immunological [41]. The disease is common among foresters and in non-occupational situations (trappers and campers).

7. DIAGNOSTIC PROCEDURES AND PREVENTION

Because there are huge numbers of irritant and allergizing agents carried through the air and scattered widely in both outdoor and indoor environments, the skin diseases they induce are presumably much more frequent than would appear from the literature. The problem is that the diagnosis of airborne contact dermatitis can be very difficult to make for various reasons. The approach to each individual case consists of various steps, that must consider the physical-chemical environment (outdoor or indoor) for each patient and the availability of specific tests at the laboratory.

The classical tools available for diagnosing an airborne contact dermatitis include medical history, clinical symptoms, any exacerbation of symptoms during work activities, determination of the presence of all possible causal agents at the workplace or in various outdoor environments, and a knowledge of the physical-chemical nature of these agents, as well as specific tests to be done in the patient or at the laboratory.

The diagnostic procedures performed in patients are as follows (Table **5**). Patch tests and/or photo patch tests, performed in the usual way [42, 43], must include all the suspected substances (that are not always easy to obtain in a pure state) at suitable concentrations. Epicutaneous tests must include additional procedures: open test, repeated open-application tests, and, adopting proper precautions, use tests. In cases of airborne contact urticaria, prick tests are warranted.

Table 5. Diagnostic procedures for suspected case of airborce contact dermatitis.

Patch and photopatch tests with the standard series, other relevant test batteries and with suspected products and chemicals from the work environment
Open tests, repeated open-application tests, use tests
Prick tests
Evaluation of irritant materials on the skin by means of noninvasive techniques
Determination of the presence of causal chemicals in the skin by skin surface biopsy

CONCLUSION

Airborne contact dermatitis is a morphological diagnosis that encompasses all acute or chronic dermatoses predominantly of exposed parts of the body, which are caused by substances which, when released into the air, settle on the exposed skin. Although the diagnosis of airborne contact dermatitis is not difficult for the trained eye, finding the causative contactant and the treatment of the resultant clinical condition may prove to be a challenge for the treating dermatologist. Contact dermatitis is designated as “airborne” based on the history of the patient and the follow-up, existence of dust or of volatile causative agents, the morphology and distribution of the lesions, and the results of epicutaneous tests. Over the years, there has been an increasing recognition on the part of dermatologists regarding the occupational as well as the non-occupational airborne allergens and irritants. Airborne contact dermatitis can result in a significant impact on patients’ quality of life, daily function, and personal relationship, therefore, that they may have to change their job because of this skin disease. However, it should be emphasized that complete recovery can often be achieved with avoidance of further exposure.

CONSENT FOR PUBLICATION

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CONFLICT OF INTEREST

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