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# Dermatological Aspects of Contact Dermatitis from Eyeglass Frames and Optical Materials

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**A B S T R A C T**

*Although contact dermatitis (CD) from eyeglass frames is uncommon, occasionally it may be encountered. Various substances may cause allergic CD, including metals, cosmetics, plastics, rubber, solvents, antioxidants, dyes, and waxes, some of which can be found in the average eyeglass frame. Recently, it has been determined that plasticizers, UV stabilizers and nickel are the most common allergens. Thus CD from eyeglass frames should be suspected in patients with retroauricular dermatitis or with lesions on the point of contact with the skin. Sometimes, the question is raised whether skin lesions result from allergy or just irritation. It has also been found that the varnish applied to eyeglass frames could be a source of nickel. Sometimes, although the frame looks silver or gold, it may contain nickel. Additionally, palladium or titanium eyeglass frames have also been reported to result in allergic CD. Some titanium frames contain palladium, which may cause CD. Plastic frames occasionally present the problem as they contain a combination of materials, making it difficult to determine the exact composition. Most plastic glasses are made of zyl or propionate, and may contain other materials, such as nylon, carbon, polycarbonate, optyl and polyamid. Patch (epicutaneous) test on contact allergens with analysis of softened scrapings from frames is a valuable diagnostic method for these patients. Although topical corticosteroid therapy results in transient clinical resolution, they do not preclude recurrences and changing frame material is often the only solution for these patients. Additionally, hypoallergenic eyeglass frames are also available on the market.*

***Key words**: contact dermatitis, eyeglass frames; allergy, irritant, patch test*

## Introduction

As skin of the eyelid is very thin and delicate, it is common site of contact dermatitis (CD), a skin reaction which occurs when skin comes in contact with certain substances. Thereby, different substances may cause skin inflammation by two mechanisms – irritation or allergic reaction. Generally, the skin lesions in CD are mostly seen on the hands and areas that were exposed to the substances, including periocular region. There are three crucial types of CD: irritant CD, allergic CD, and photocontact dermatitis (divided into phototoxic and photoallergic dermatitis)[1–3].

Irritant CD may be caused by different chemical or physical irritants. Common chemical irritants include solvents (alcohol, xylene, turpentine, esters, acetone, ketones, and others); metalworking fluids (neat oils, water-based metalworking fluids with surfactants); latex; kerosene; ethylene oxide; surfactants in topical medications and cosmetics (sodium lauryl sulfate); alkalies, and many others.

On the other hand, allergic CD is less common than irritant CD, and the pathogenesis includes the interaction of cytokines and subpopulations of T lymphocytes. An allergic reaction does not occur the first time one is exposed to a particular substance, but on subsequent exposures, may cause allergic CD in 4 to 24 hours. Allergens caused this type dermatitis include metals, cosmetics, plastics, solvents, dyes, and others, some of which can be found in the average eyeglass frame.

Allergic CD is usually confined to the area where the trigger actually touched the skin, whereas irritant CD

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may be more widespread on the skin. Both forms have similar symptoms including erythema, oedema, bulae, weeping, followed by crusts, scales, often accompained by itching and burning sensation. Erythema is a usual reaction which appears immediately in irritant CD, while in allergic CD, it usually appears 24–72 hours after exposure. Irritant CD tends to be more painful than itchy, while allergic CD is often accompaind by itch.

Epidemiologically, CD (irritant or allergic) is a common problem. Thus, it has been determined that only approximately 20% of all CD cases are allergic[4]. Although CD from eyeglass frames is uncommon, occasionally it may be encountered.

## Pathogenesis of Allergic Contact Dermatitis

Delayed type hypersensitivity reactions (type IV allergic reactions) include allergic immune reactions manifesting primarily through T cells and Langerhans cells (cellular immunity)[5]. Contact hypersensitivity (allergy) is a type of delayed type hypersensitivity, which can develop after skin or mucosa were in contact with certain substances. Allergic CD is usually caused by low-molecular-weight substances (e.g. picric acid, dinitrochlorobenzene, different ingredients from herbs, cosmetic preparations, some medicaments, metals and others) which act as haptens.

The sensitization in allergic CD usually occurs from 5 to 7 days and occasionally as long as 20 days after the initial or sensitizing contact, at the site of contact. This condition is usually lifelong. Generally, the most common sensitizers are metals (nickel, cobalt, chromium), plants, paraphyenylenediamine, rubber components and others. Allergic CD is a common problem and a distribution of skin lesions in a patient presents the key in identifying the offending agent[4]. Studies have shown that persons who are more prone to such contact allergic reactions are those who suffer from atopy, what should be taken into consideration while testing such persons[5,6].

From pathogenetic perspective, after absorption into epidermis, the substance is associated to proteins (carriers) and it becomes immunogenic, leading to dermatitis (erythema, oedema, vesicles). Thereby, it has been proven that complexes of antigens and carriers enter Langerhans cells, which are the prevailing antigen-presenting cells in epidermis. Afterwards, the Langerhans cells come to regional lymph nodes where antigen together with MHC II molecule is then recognized by $CD4^+$ T cells, thus stimulating memory $CD4^+$ T cells. After repeated contact with the same antigen, Langerhans cells then present it to memory $CD4^+$ T cells in dermis which are then activated. Activated T cells secrete several proinflammatory cytokines. Thus IFNã causes ICAM-1 and MHC II expression on epidermal keratinocytes and endothelium cells, and what stimulate keratinocytes to secretion of cytokines causing inflammatory reaction (IL-1, IL-6, GM-CSF)[5]. Non-specific $CD4^+$ T cells are also being attracted, and they are connecting to keratinocytes over ICAM-1 and MHC-II molecules. Afterwards, in this area, macrophages are also being gathered through the action of lymphocyte cytokines (IFNγ, IL-3, TNFβ). The reaction is most expressed after 48–72 hours, and after that, it gradually diminishes, which is also due to contribution of PGE secreted by macrophages and keratinocytes and IL-10[5].

## Eyeglass Contact Dermatitis

It has generally been difficult to define the substances causing eyeglass CD. Spectacle frames are broadly classified into two groups – metallic and plastic. Although CD from eyeglass frames is uncommon, it should be suspected in patients with retroauricular, maxillar and nasal skin lesions. Thereby, this dermatitis sometimes may mimic seborrhoic dermatitis, actinic keratosis or squamous cell carcinoma in situ[4,7]. Characteristic eruption patterns present clues in the finding the etiological factor and possible allergens. It is important to ask the patients if they wear glasses, what can suggest that the problem may be associated with them.

It is considered that the reactions to eyeglass frameless may be caused by metals, plasticizers, UV stabilizers, plastics, antioxidants, solvents, dyes, waxes, rubber, and others. While allergic CD represents an immunological interaction between a chemical allergen and the skin, diagnosis is made by patch test. Patch test to standard series and softened scrapings from frames is a valuable diagnostic aid. Although patch testing with softened (with an organic solvent) scrapings from frames is useful in diagnosis, several portions of frames should be sampled since all parts are not be composed of the same material.

Although nickel is considered as the most common allergen, according to several investigations, plasticizers and UV stabilizers are the most common allergens, except in Taiwan and China, where nickel is the most common cause of eyeglass allergica CD[8–12]. A review of literature shows that among the metals, nickel is the most common agent causing allergic CD. In response to the frequency of nickel allergy in the general population, some eyeglass companies have begun producing »nickel-free« frames[13]. Glas and Egelrud found that the varnish applied to frames could also be a source of nickel, and they reported a case of allergic CD caused by nickel in a patient wearing »nickel-free« eyeglasses[13]. Palladium and titanium eyeglass frames have also been reported as causes of allergic CD[4,13,14].

On the other hand, irritant CD doesn't involve an immunological reaction, but may be a cause in the case of injuring the skin after persistent contact. The diagnosis of irritant CD is made clinically based on history and negative patch test[15].

## Common Offending Contact Supstances

Eyelids and eyes are usually sites where skin conditions are prone to be chronic and, for that reason, many topical medicaments are applied over the course of time. Besides that, particular anatomical and pathological con-

ditions, or special application methods, can increase skin penetration, which also increases the sensitizing capacity of pharmaceutical products. According results of Ayala et al., 50% patients with eyelid dermatitis had allergic CD (most commonly caused by nickel and cobalt); followed by irritant CD (21%); atopic dermatitis (14%) and seborrheic dermatitis (6%)[16]. The very loosely bound subcutis of the eyelid makes marked oedema a characteristic feature of eyelid dermatitis.

Modern eyeglasses are typically supported by pads on the bridge of the nose and by temple arms (sides) placed over the ears. The materials used in the production of modern eyeglass frames are plastic, metal, or a combination of the two (composites). Manufacturers select materials that are cost-effective, adjust easily, offer safety and workability, hold the lenses properly, and resist breakage, corrosion, and heat. Thus allergens in CD from eyeglass frames include metals, plastics, plasticizers, solvents, UV stabilizers, antioxidant, dyes, waxes, and others[7]. Thereby, the reactions may be caused by metals (cobalt, nickel), UV stabilizers (resorcinol monobenzoate, phenyl salicylate), plasticizers (abietic acid, diethyl phthalate, tricresyl phosphate, triphenyl phosphate, tritolyl phosphate), plastics (butyl acrylate, cellulose acetate, epoxy resin, phenol-formald ehyde, rubber), antioxidant (p--tert-butyl-phenol), solvents (ethylene glycol monomethyl ether acetate, methylethylketone), dyes (anthraquinone, brown-black dye, paraphenylenediamine, paraaminophenol, solvent yellow 3, red 26, red 481), waxes (aliphatic isocyanate, turpentine), and others[7].

The next substances are the most common groups of contact allergens: plastics, metals, and composites.

### *Plastics*

The most commonly used plastic in eyeglass frames, cellulose acetate (zylonite) is relatively inexpensive, easy to work with, and comes in a wide variety of colors, textures, and patterns. It is considered a common contact allergen from eyeglass frames[7].

Optyl is somewhat lighter in weight than cellulose acetate and is hypoallergenic, an advantage to skin-sensitive patients[7].

Many sports and safety glasses are made of nylon because it is virtually unbreakable and relatively lightweight. The material is, however, difficult to adjust and can be manufactured only in darker colors.

Polycarbonate plastic is 10 times more impact-resistant than conventional plastic or glass and is the material of choice for children's, sports, and safety glasses. Polycarbonate plastic is a very transparent, tough, and inert material, lenses are thinner and lighter than conventional plastic or glass lenses. Irritant and allergic CD from polycarbonates and nylon are rare[7].

### *Metals*

Although very lightweight, aluminum is difficult to solder or weld, limiting its adaptability to different designs. Few case reports of contact allergy to aluminium exist. It is considered a weak contact allergen[17].

Usually used as part of a metal alloy, cobalt appears in high-quality frames that can be made lightweight, durable, flexible, and thin. Contact allergy to cobalt chloride is common and is generally associated with concomitant contact allergy to nickel or chromate. Solitary cobalt allergy is rare. Allergy to cobalt chloride is equally common in both sexes[17].

Stainless steel contains 65% of nickel and is one of the most corrosion-resistant metals, but is difficult to work with in the manufacturing process. Nickel has since been established as an important ubiquitous contact allergen. Nickel is a common material used in hinges, end pieces, and heavy bridges, and for the inner core of temples.

Phosphor bronze, flexible alloy, is about 95 percent copper, making it a good choice for temples. Copper/tin alloys are called bronzes, and may also contain other metals. Copper has been considered a rare skin sensitizer[18–22].

### *Composites*

Carbon fiber graphite is a material made of nylon and carbon that provides the endurance of metal frames but is thin and lightweight. Although the material is black in its natural state, it is now available in a wide range of colors.

Copolyamide (MXP7) is a blend of nylon manufactured for frame-injection molding. The material is strong, lightweight, and durable, and it retains its shape unless heated. Copolyamide has been considered a rare skin sensitizer[23].

Titanium Ti-227 is nearly 50 percent lighter than most metal frame materials. It is noncorrosive, and one--third stronger than steel, making it an extremely desirable material for manufacturing frames. It's also difficult and expensive to extract and refine this abundant material. Titanium frames have been recommended for use in patients allergic to other metals. Some reports indicate that the metal can act as an allergen.

## Identifying the Cause of Contact Dermatitis

It is often difficult to trace the substance which has caused the skin to react to contact, particularly if the patient has chronic lesions. While reactions to substances that are not a part of everyday life (such as dinitrochlorobenzene or infrequently used topical drugs) usually present little diagnostic difficulty, the reactions to ubiquitous allergens (such as nickel and fragrances) may be much more difficult to trace. Certain patterns of skin disease can, however, point in the direction of particular groups of substances, or even toward one specific causative substance.

In the most obvious cases, CD is seen at the exact site of contact with the offending item. Allergic nickel CD occurs under eyeglasses that occlude the skin, such as the metal case of eyeglasses, and is frequently easy recog-

nized. Gawkrodger et al. examined 134 patients with positive patch tests to nickel and found the following prevalence of sites: palm 49%, dorsum of the hands 39%, wrist 22%, face 20%, arm 16%, neck 14%, and periorbital area 12%[20]. It is also important that the contact pattern of nickel dermatitis is also dependent on cultural tradition and on the groups of patients studied, as well as on climatic factors. Thus sweating caused by high temperatures increases the release of nickel from nickel-plated items[21]. Nickel is also released by plasma, a fact that may explain the high rate of nickel sensitization after era piercing[22].

Sometimes, there is a lack of control over spectacle frame quality, leading to a difficulty in determining the true source of many frames[23]. It has generally been difficult to define the chemicals causing eyeglass allergic CD, because of long chain between the retail shop and the manufacturer, and industry's reticence to share the chemistry involved[7]. Although persons have eczematous lesions on the place where frames are in contact with the skin, diagnosis is often delayed, particularly because of similarity to seborrheic dermatitis.

On the other hand, the reactions to lenses are also possible. However, CR-39 lenses are the most common plastic lenses due to their low weight, high scratch resistance, low dispersion, and low transparency to ultraviolet and infrared radiation. Polycarbonate and Trivex lenses are the lightest and most shatter-resistant, making them the best for impact protection. So, the contact lens users may also develop allergic reactions, such as giant papillary conjunctivitis, triggered by constant local irritation by contact lenses on the conjunctival surfaces. Topical ophtalmic products and preparations used in the care of contact lenses can also cause CD of the eyelids[24]. Irritant contact conjunctivitis has been seen after the use of acrylic monomers found in printing inks. However, the patients with optical accessories should be aware of these problems.

**TABLE 1**
SUBSTANCES REPORTED TO HAVE CAUSED CONTACT ALLERGY IN OPHTHALMICS

| Preservatives | Beta-blockers | Mydriatics |
|---|---|---|
| Benzalkonium chloride | Befunolol | Atropine |
| Benzethonium chloride | Betaxolol | Cyclopentolate |
| Chlorhexidine gluconate | Carteolol | Dipivalyl-epinephrine |
| Cetalkonium chloride | Levobunolol | Homatropine |
| Phenylmercuric nitrate | Metipranol | Phenylephrine |
| Sorbic acid | Metoprolol | Scopolamine |
| Thimerosal | Timolol | Tropicamide |
| **Antibiotics** | **Antiviral drugs** | **Antihistaminics** |
| Bacitracin | Idoxiuridine | Chlorpheniramine |
| Chloramphenicol | Trifluridine | Sodium cromoglycate |
| Gentamicin | β-interferon | Amlexanox |
| Kanamycin | | N-acyl-aspartyl glutamic acid |
| Neomicin | | Ketotifen |
| Polymyxin B | | |
| Oxytetracycline | | |
| Penicillin | | |
| Sulphathiazole | | |
| Cefradine | | |
| Tobramycin | | |
| **Anesthetics** | **Enzymatic cleaners** | **Others** |
| Benzocaine | Papain | Apraclonidine |
| Procaine | Tegobetaine L7 | Boric acid |
| Oxybuprocaine | | Brominidine |
| Proxymetacaine | | D-Penicillamine |
| Proparacaine | | Diclofenac |
| Tetracaine | | Dorzolamide |
| | | Echothiopate iodine |
| | | Pilocarpine |
| | | Prednisolone |
| | | Resorcinol |
| | | Rubidium iodide |

## Ophthalmic Preparations

Ophthalmic preparations sometimes cause the contact sensitization, too[25,26]. Patients with glaucoma who are chronically treated with several ophthalmic drugs are likely to become sensitized[27]. Symptoms may be limited to the eye (allergic contact conjunctivitis) or may involve the periocular skin and the eyelids. Allergic contact conjunctivitis often goes undiagnosed, since it usually occurs in patients who are already affected by ocular inflammation due to other causes, and its clinical features are not specific. Clinical examination reveals pronounced vasodilatation and chemosis of the conjunctiva. Watery discharge and papillary response can be present. Possible complications include punctate keratitis and corneal opacities.

Patch test should be carried out with the eye preparations used by the patient and their individual ingredients. Ophthalmic preparations that may cause contact allergy are shown in Table 1. It is determined that both preservatives and active ingredients may produce contact sensitization. Patch testing to preparations sometimes may give false-negative results, especially when the responsible allergen is a preservative. Preservatives are certainly the most important sensitizers in eye drops, and are contained in many ophthalmic preparations. However, allergic conjunctivitis due to these compounds frequently go undetected, but it can actually be prolonged by the very eye drops that are prescribed to relieve the patient's ocular discomfort. Thimerosal sensitization is probably the main allergological problem in eye drop users, as it is also in contact lens wearers[28]. Preservative-free monodose eye drops are now available for the most important ophthalmic ingredients.

Active ingredients of the ophthalmic products that may cause sensitization include beta-adrenergic blocking agents, mydriatics, antibiotics, antiviral drugs, antihistamines, anti-inflammatory drugs, corticosteroids, anesthetics, and other[29]. The diagnosis of allergic contact conjunctivitis may be confirmed by a provocative test with the responsible eye preparation.

## Conclusion

*Prevention and treatment*

Treatment of CD includes removal or avoidance of the substance which causes the allergy or irritation and also cleansing the area with water and mild soap (to avoid infection).

Changing frame material is often the only solution in the case of CD to eyeglass frames. The skin leisons may be treated with topical corticosteroids (ointments or creams) or in severe cases even systemic corticosteroids4. Topical steroids must be used with caution because an overuse, misuse and/or prolonged use of steroids can worsen the problem or create an even more difficult condition. Special caution is needed for the application of steroids on the face. On the other hand, antihistamines are generally not very helpful for treatment of CD.

As preventive measure, it is possible to paint a thin coat of clear nail polish on any part of the frame that touches the skin, such as the temples or nose pads of the frame. This type of prevention is not longstanding, but the polish provides a protective barrier between the skin and the frame temporarily. The polish wears off in a few days but helps until the patient goes to ophthalmologist or optician for a permanent solution to frame allergy. The last possibility is to ask the optician to check the frame material and exchange the frame or nose pads for a hypoallergenic style.

There is also possibility of use of a manganese sulfate solution to reduce the itching in mild cases. Although topical corticosteroids produce clinical resolution, recurrences are generally not prevented. In the case of allergic CD where the patients cannot avoid repeated allergen exposure, there is possibility of topical immunomodulators (tacrolimus) which can reduce inflammation and inhibit recurrences[7].

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## DERMATOLOŠKI ASPEKTI KONTAKTNOG DERMATITISA UZROKOVANOG MATERIJALIMA NAOČALA I DRUGIM OPTIČKIM SREDSTVIMA

### S A Ž E T A K

Iako kontaktni dermatitis (CD) na okvire naočala nije čest u dermatološkoj praksi, ipak se ponekad susreće. Različite tvari mogu uzrokovati alergijski CD, uključujući različite metale, kozmetiku, plastiku, gumu, razrjeđivače, antioksidanse, boje i voskove, od kojih se neke od navedenih tvari mogu naći u okvirima naočala. Nedavno je utvrđeno da su plastifikatori, UV stabilizatori i nikal najčešći alergeni. Stoga je potrebno kod bolesnika s promjena kože retroaurikularno ili na mjestu kontakta kože i naočala posumnjati na CD uzrokovan okvirima naočala. Ponekad je nejasno da li su promjene kože nastale zbog alergije ili samo iritacije. Također je utvrđeno da bi lak nanesen na okvire naočala mogao biti izvor nikla. Ponekad, iako okvir izgleda srebrn ili zlatan, može sadržavati nikal. Osim nikla, okviri naočala od paladija i titana mogu također biti uzrok alergijskog CD-a. Plastični okviri ponekad predstavljaju problem s obzirom da sadrže kombinaciju materijala, što otežava utvrđivanje točnog sastava. Većina plastičnih naočala je sačinjena od propionata, najlona, ugljika, polikarbonata i poliamida. Patch (epikutani) test na kontaktne alergene primjenom strugotina iz naočala korisna je dijagnostička metoda za te bolesnike. Iako lokalna kortikosteroidna terapija dovodi do regresije uz privremeno kliničko poboljšanje, ne sprječava recidive pa je promjena materijala okvira često jedini izbor za te bolesnike. Uz to su na tržištu također dostupni hipoalergeni okviri naočala.