Allergies to dental materials

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Abstract | Allergies related to dentistry generally constitute delayed hypersensitive reactions to specific dental materials. Although true allergic hypersensitivity to dental materials is rare, certain products have definite allergenic properties. Extensive reports in the literature substantiate that certain materials cause allergies in patients, who exhibit mucosal and skin symptoms. Currently, however, neither substantial data nor clinical experience unequivocally contraindicate the discontinuance of any of the materials, which include dental amalgam and nickel- and chromium-containing metals. The dentist forms a vital link in the team approach to the differential diagnosis of allergenic biomaterials that elicit symptoms in a patient, not only intraorally, but also on unrelated parts of the body. (Quintessence Int 1996:27:513-520.)

Clinical relevance

Although the dentist should be aware of the allergenic materials used in practice, which include acrylic resin, amalgam, impression materials, eugenol products, and metal products, particularly nickel, currently neither substantial data nor clinical experience unequivocally contraindicates the discontinuance of any of the materials.

Introduction

Allergic hypersensitivity related to dentistry is acquired by exposure to specific dental material allergens and the altered capacity of the patient to react when re-exposed to the allergen. Allergic reactions associated with dental materials are generally delayed hypersensitive reactions that are usually not associated with circulating antibodies, because the causative agents attain their allergenic properties by combining with the mucosal tissues of the patient. The delayed hypersensitive reaction is not manifested clinically until several hours after exposure.

A contact allergy in dentistry is the type of reaction in which a lesion of the skin or mucosa occurs at a localized site after repeated contact with the allergenic material. The ability to cause contact sensitivity appears to be related to the ability of the simple chemical allergen to bind to proteins, especially those of the epidermis and, in dentistry, specifically the oral mucosa.

Contact dermatitis

Clinical features

As in all forms of cell-mediated immunity, in contact dermatitis there is a minimum latent period of at least 5 days between the first contact with the allergen and the ability to react at a distant site to further contact with a nonirritant concentration of the allergen. Reactions take between 24 and 48 hours to develop and, if severe, may last for 7 to 10 days.

Contact dermatitis is manifested by an itching or burning sensation at the site of contact, followed a short while later by the appearance of erythema and then vesicles. Once the vesicles have ruptured, the erosion may become more extensive, and secondary infection may develop.
This article will review allergic hypersensitivity to various modern dental materials.

Allergenic dental materials

Acrylic resin

Acrylic resin has been reported to occasionally induce an allergic hypersensitivity when used as a denture base, restorative material, or provisional fixed partial denture resin (Fig 1). Normally, the patient is exposed to the free monomer in acrylic resin, which may cause a toxic reaction. Hypersensitivity in denture wearers should not be confused, however, with physical irritation of the oral mucosa caused by ill-fitting dentures. Acrylic resin hypersensitivity may develop shortly after insertion of the denture or may not manifest for an extended period of time, even many months\(^1\) (Figs 2a and 2b). Clinical reactions may occur at secondary sites (Figs 3a and 3b).

Resin composite

Lind\(^5\) reported that resin composite materials could be an etiologic factor in the development of lichenoid reactions in the oral mucosa. The pathogenic mechanism may be related to contact allergy to formaldehyde formed in resin composite restorations. Formaldehyde causes more than one third of all allergic reactions caused by dental materials.\(^5\) A report by Øysæd et al\(^6\) indicated that formation of formaldehyde was found in light-, ultraviolet light-, and chemically activated resin composites.

Impression materials

Polyether impression materials have been reported to cause allergic problems in the past, but have since changed their compositions. Care should be taken to mix the material thoroughly and to avoid contact of the aromatic sulfuric ester catalyst paste with the skin or mucosa because it may elicit adverse tissue reactions.\(^7\)

Eugenol-containing products

Oil of cloves, or eugenol in its unrefined form, is mixed with zinc oxide to form zinc oxide-eugenol (ZOE), which exhibits a combination of physical and therapeutic properties making it useful as a provisional restorative material, base material, and root canal filling material. Zinc oxide-eugenol impression pastes and ZOE periodontal packs are also available. Eugenol is highly soluble and is continuously released from ZOE, which can lead to short-term saturation of the oral environment with eugenol in a concentration...
sufficient to cause cytotoxicity. This is why eugenol periodontal packs, which are in contact with open mucosal wounds, are no longer popular.

Five of the periodontal dressing materials listed in *Accepted Dental Therapeutics* contain colophony (resin), and four of them contain eugenol. The only one that is eugenol free (Coe-pak, Coe Laboratories) contains, among other things, balsam of Peru. In this context the cross reactivity between many allergenic substances, such as between eugenol and balsam of Peru, should be borne in mind. Thus, when the causative agent in an allergic reaction to periodontal dressing materials has not been positively identified, a choice among the materials, whether they are eugenol-free or not, is impossible.
The inflammatory response caused in mucosal tissue by eugenol should not, however, be confused with allergic hypersensitivity. From a biologic point of view, ZOE is in fact considered the least damaging restorative material and possesses sedative or anodyne properties, which are very useful in dentistry.\textsuperscript{10,11} Despite the advantageous properties of eugenol, however, sensitivity, manifested as positive inflammatory responses to eugenol in certain root canal sealers has been described.\textsuperscript{12}

Metals

Amalgam

Although rare, allergy to mercury\textsuperscript{13} as well as copper in amalgam\textsuperscript{14} has been described. In addition, the release of mercury from amalgam restorations has been the cause of skin and mucosal disorders\textsuperscript{13} (Fig 4). There is also growing evidence that amalgam restorations may be etiologic factors in some of the mucosal changes classified as oral lichen planus.\textsuperscript{15} Some of these disorders may be considered a mucosal pattern of response to several distinct pathogenic factors. Allergy to amalgam compounds may be one such pathogenic mechanism.\textsuperscript{15} In many cases, electrogalvanism may enhance the allergic reaction as a transmitter of reactive ions, justifying the term \textit{electrogalvanic white lesion}, used by Bánóczy et al.\textsuperscript{16}

Because erosive forms of oral lichen planus are known to be susceptible to cancer development, patients should be given effective causal treatment.\textsuperscript{15}

Vernon et al\textsuperscript{16} reviewed 41 published cases of allergy to dental amalgam, which included 30 female and 11 male patients. Twenty of the 41 patients recovered on removal of their amalgam restorations. The most frequent symptoms were of the remote cutaneous type (38 of 41 cases), while local symptoms, particularly gingivitis and stomatitis, occurred in 17 cases. The authors suggested that the figures probably underestimate the true prevalence of the condition because of underreporting of cases. Mercury was found to be the most common sensitizing agent, but other metals, particularly copper, zinc, and silver, could also be implicated.\textsuperscript{17}

Gold

Gold is generally regarded as an inert and safe material,\textsuperscript{3} but the belief that gold is nonsensitizing is not substantiated by reported data. Comaish\textsuperscript{18} reported allergic dermatitis to a gold wedding ring. Elgart and Higdon\textsuperscript{19} described stomatitis caused by a gold dental restoration and concomitant dermatitis at sites in contact with gold jewelry worn by the patient. The number of confirmed cases of gold sensitivity is extremely low\textsuperscript{3} (Fig 5).

Nickel

In general, nickel, ranked third among the five most common causes of allergic contact dermatitis\textsuperscript{20} and first in most industrialized countries, is the most common contact allergen in dentistry affecting females in Europe and the United States.\textsuperscript{21} Nickel hypersen-
Nickel dermatitis of the earlobe is common in nickel-sensitive individuals who wear nickel-containing jewelry. Swelling and erythema of the earlobe are evident after removal of the earring.

Nickel dermatitis is found more frequently among women than men. About 10% of females are sensitive to nickel, and the majority become sensitized through jewelry, although one report indicates that up to 20% of females are sensitive to nickel. Nickel dermatitis of the earlobe is common in nickel-sensitive females (Figs 6a and 6b). Only 1% to 2% of males are found to be nickel sensitive, indicating a striking sex difference. The signs and symptoms of nickel sensitivity often are manifested when nickel-containing gold jewelry, such as watches (Fig 7) and bracelets, is worn. With the increased popularity of metal-framed eyewear, a new source of prolonged contact with nickel has arisen.

Nickel accounts for between 64% and 78% of the composition of some nickel-based base metal alloys. Nickel has been found to produce more contact dermatitis than all other metals combined, and even partial denture frameworks containing as little as 1.5% nickel have been reported to cause contact dermatitis, indicating that the allergic response is virtually dose independent in a sensitized individual. Reactions to nickel at extraoral sites at areas of contact with chromium-plated jewelry, as well as at areas totally unrelated to direct exposure to metal have also been reported.

Clinical reactions to nickel include edema of the eyelids, swollen and fissured lips, and chronic eczema of the cheeks and palms. Nickel dermatitis can spread symmetrically to secondary sites such as the arm, eyelids, sides of the neck, and face. How nickel dermatitis spreads to distant areas is not known. However, such spreads to secondary sites may be caused by contaminated, perspiring fingers of the patient during the initial eruptive stage.

In orthodontics, allergic reactions to nickel in cervical headgear, as well as allergic reactions to orthodontic wires and nickel-titanium orthodontic wires, have been reported. However, a recent study did not find that nickel-sensitive persons are at greater risk of developing discomfort in the oral cavity when wearing an intraoral orthodontic appliance.

Despite the reported allergenicity of nickel, few cases of adverse reactions to nickel-containing dental prostheses have been reported. The evidence that nickel absorption introrally exacerbates existing dermatitis is also minimal. Furthermore, there is little...
evidence available to implicate nickel as playing any part in the rejection of nickel-containing prostheses, dental or orthopedic, and it must be concluded that nickel materials are generally safe to use in dentistry.

Chromate

Chromium differs from nickel in that it is not antigenic in metal form, but usually only in the hexavalent salt form as chromate. Minute quantities of chromium salts can, however, sensitize. Chromium compounds, on the other hand, can induce contact dermatitis and even cause severe corrosive irritation of the skin. Exposure normally occurs due to industrial exposure or through handling or use of detergents, bleaches, shaving creams, lotions, matches, and chromated catgut. However, it has been found that neither chromium-containing alloys nor chromium-plated objects, such as jewelry, produce allergic contact dermatitis in chromium-sensitive individuals. Although allergic reactions resulting from contact with chromium-type alloys do occur, such allergies are usually due to some other metal in the alloy, normally nickel.

Although base metal alloys contain between 11% and 35% chromium, chromium allergy is rarely seen. It is a less common problem than is nickel allergy. The chances of an adverse reaction to chromium found in dental materials, therefore, appears to be remote, but clinicians should nevertheless always be on the alert.

Platinum

Documented cases of platinum hypersensitivity are even more rare than is chromium allergy. Platinosis is not caused by metallic platinum but by contact with complex platinum salts and mainly affects platinum refiners. Manifestations include pruritis, erythema, eczema, and urticaria, usually limited to the exposed parts of the body.

Cobalt

Cobalt-chromium alloys, forming the framework of metal partial dentures, and base metal alloys contain about 60% to 65% cobalt. They are regarded as biocompatible because of the absence of nickel and beryllium in their composition. Cobalt is nevertheless listed as a sensitizing metal. Allergic reactions to cobalt used in dentistry are very rare, however. In patients with no known allergy, preventive screening is unnecessary.

Restorations

Recently, Suzuki used the x-ray fluorescence spectroscopy to detect the allergenic metals in introral metal restorations and personal and household items of metal-allergic patients. Of the 275 subjects who had positive reactions to M-9 series patch tests, the 10 most common elements detected for restorations were silver, copper, zinc, gold, palladium, tin, mercury, indium, nickel, and chromium. Allergens were detected in 161 patients, and the five elements with higher allergenicity were mercury, nickel, tin, chromium, and cobalt. In personal and household items, the top five elements with higher allergenicity were copper, nickel, chromium, zinc, and molybdenum.

Suzuki concluded that metal allergy should be taken into consideration whenever dental treatments with alloys are planned. For patients with metal allergies, as well as for those without, it is prudent to avoid the use of mercury, nickel, and other elements with a high sensitization rate. Even precious metals, such as gold or platinum, may cause allergies, especially for individuals with a history of direct contact with intradermal tissues. It is recommended that similar types of alloys be used in a single oral environment, where possible, to prevent corrosion and dissolution by intraoral electric current.

Axell et al reported on 139 published cases of allergy to dental restorations. The most frequent symptoms were local gingivitis and stomatitis (99 of 139) while general and remote symptoms occurred in 33 patients. Ninety-two female and 47 male patients were involved. In another review, the same authors reported that allergic reactions to nickel, cobalt, and chromium in dental prostheses and restorations may appear either locally as stomatitis or distantly in the form of general or local contact dermatitis.

Allergy testing

Allergy testing of dental materials consists of epicutaneous patch testing, in which readings of skin reactions are made on removal of patches after 48, 72, or 96 hours. The presence of erythema, combined with edematous infiltration with or without papules or vesicles, is used as the criterion for a positive result. There is no need to perform an epimucous test to detect contact allergy in the oral mucosa, because the epicutaneous test gives the applicable information.

Axell et al designed a list for patch test screening of dental materials in cooperation with The Nordic
Institute of Dental Materials (NIOM). This patch test series (dental screening) consists of 21 chemicals. The substances used in the list were chosen from reports in the literature on contact allergic reactions to dental materials. The dental screening test series was devised for use mainly in the investigation of patients with stomatitis, to rule out a possible allergic reaction to a component in the dental materials used. In the dental screening test series, the main group of compounds is the methacrylate monomers, which are fundamental in dental resin materials, such as resin composite restorations, pit and fissure sealants, resin bonding materials, resin veneering materials, and denture base materials. Triethylene glycol dimethacrylate (TEGDMA); urethane dimethacrylate (UDMA); ethylene glycol dimethacrylate (EGDMA); bisphenol A-glycidyl methacrylate (bis-GMA) as well as accelerators (N,N-dimethyl-p-toluidine and 2-hydroxy-4-methoxybenzophenone); aromatic sulfuric esters (methyl dichlorobenzene sulfonate); eugenol; colophony; nickel sulfate; copper sulfate; and formaldehyde, among others, are included in the test series.

More recently, Axell et al.18 described a new method for intraoral patch testing in which maxillary acrylic resin plates carrying test pieces containing 66% nickel were applied for 48 hours. Readings were performed 24 hours after removal. Although few, if any, clinical signs were elicited in three test subjects, two of whom were contact sensitive to nickel, biopsy specimens from the mucosal contact sites revealed lichenoid reactions. Biopsy specimens from control sites showed no or slight nonspecific inflammatory reactions.25 The use of biopsy testing for allergy may raise ethical problems, however.

Although not allergy testing per se, the Fleigl test, a simple, inexpensive, and reliable test, has also been used3 to determine which metal objects produce contact dermatitis in nickel-sensitive individuals. Placement of two or three drops of a 1% alcoholic solution of dimethylglyoxime and a few drops of ammonia water on a metallic object, on skin, or in a solution, produces a strawberry-red insoluble salt in the presence of available nickel. Most nickel-containing alloys, except stainless steel, yield a positive test.

Recomendations
Extensive reports in the literature indicate that certain materials in dentistry cause allergic hypersensitivity in patients; nevertheless, currently, neither substantial data nor clinical experience unequivocally contra-indicates the discontinuance of any of the materials, including mercury-, nickel-, chromium-, or eugenol-containing dental materials.29 Nevertheless, it is advisable to ask patients questions concerning past hypersensitivity to dental materials or following dental procedures. As part of the medical history, each patient should also be specifically asked whether a rash or eczema had ever developed following the wearing of earrings or jewelry.

In most patients, there is no indication for patch testing. Routine use of such a test for all patients should be avoided, because the test procedure may in some cases provoke sensitization of the patient.35 The main indication for an epicutaneous test is the presence of local symptoms in the mouth close to a dental restoration or prosthetic or orthodontic appliance.

When skin symptoms are present, the patient should be referred to a dermatologist for consultation. The epicutaneous test should be undertaken by a dermatologist.36 Once a positive test has been confirmed by the dermatologist, the offending material should be withdrawn. Rapid remission of the symptoms will confirm the positive allergy test, and the patient should be made aware of his or her allergic status and be advised to report it to future dental practitioners. A repeat test may be necessary for true confirmation of allergy, but because of ethical considerations, may not be clinically possible.

The dentist forms an important link in the differential diagnosis of allergy. All possible allergenic dental materials should be considered when allergic patients with symptoms, whether intraoral or on unrelated parts of the body, are tested.

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References

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