Dentistry Occupational Hazards - A Review

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Abstract
Dental professionals and their patients are constantly exposed to a number of specific occupational hazards. In many cases, this exposure results in diseases, which are regarded as occupational illnesses. Relying on relevant literature, this paper discusses the occupational hazards present in the dental environment. These range from toxicity from chemicals routinely used in dentistry and threat of cross-infection in the dental clinic to musculoskeletal diseases consequential to sub-optimal working posture. Such hazards cause the appearance of various ailments that are specific to the profession and that develop and intensify over years. Being unaware of the potential hazards in the work environment makes dental personnel more vulnerable to injury and illness. Awareness of these occupational hazards and implementation of preventive strategies can provide a safe dental environment for all concerned.

Keywords:
occupational hazards, dental surgeons, mercury poisoning, allergic reactions, dental restorative materials, latex sensitivity

Introduction
Occupational hazard refers to a risk or danger as a consequence of the nature or working conditions of a particular job. Dental professionals are susceptible to a number of occupational hazards. These hazards cause the appearance of various ailments that are specific to the profession and that develop and intensify over years. In many cases, they result in diseases and disease complexes, some of which are regarded as occupational illnesses. Dental occupational hazards range from toxicity from chemicals routinely used in dentistry and threat of cross-infection in the dental clinic to musculoskeletal diseases consequential to sub-optimal working posture. Being unaware of the potential hazards in the work environment makes dental personnel more vulnerable to injury and illness. Awareness of these occupational hazards and implementation of preventive strategies can provide a safe dental environment for all concerned.

The most dramatic dental occupational hazard is close contact with patients’ saliva and blood, which exposes the dentist, hygienists, and assistants to contagious illnesses. Another prevalent dental occupational hazard is working on patients with a strained posture, which destabilizes the osteoarticular system and causes overburdening of the spine. The overburdening also affects certain groups of muscles and joints. This brings about diseases of the musculoskeletal system and of the peripheral nervous system. Moreover, the functioning of the respiratory, cardiovascular, and alimentary systems is disrupted.

The noise of the suction, saliva ejectors, turbines, engines, amalgamators, and compressors causes impaired hearing. A limited surgical area with artificial lighting may result in eyestrain, conjunctivitis, blurred vision, or nearsightedness. Many clinical situations may be a source of stress for the dental
practitioner. Some dental restorative materials can be potentially harmful to dental personnel and patients and can cause allergic contact dermatitis, asthma, and conjunctiva symptoms. Previously, allergic contact dermatitis was generally addressed as a reaction to oral hygiene products (e.g., mouthwash, dental floss, and toothpaste), metals, disinfectants, and glutaraldehyde. The use of latex gloves to provide a physical barrier has resulted in a decrease in allergic reactions caused by traditional allergens in dental personnel (allergic reactions to oral hygiene products and metals are, however, still prevalent in patients). Despite the physical latex barrier, an escalation of allergic reactions to the latex protein itself has been noted in both dental personnel and patients.

The term “allergy” (from the Greek allos meaning changed or altered state, and ergon meaning reaction or reactivity) was used for the first time by the Viennese pediatrician Baron Clemens Von Pirquet in 1906. Von Pirquet used the term to describe an altered reaction he had observed in patients, which he described as the influence of an external factor, called an allergen (e.g., pollen, stings, drugs, or food), on the immune system. An allergic reaction, also known as a hypersensitivity reaction, is therefore a reaction caused by the immune system in response to a foreign substance (or allergen). Restorative products like acrylics, resins, and polymer materials used in dental practices can potentially cause an allergic reaction. Allergies may develop from a mild sensitivity that increases over time or they may affect a person suddenly. Hypersensitivity to allergens can also be referred to as immune-mediated injury.

**Biological Health Hazards**

Dentists constitute a group of professionals who are likely to become exposed to biological health hazards. These hazards are infectious agents of human origin and include prions, viruses, bacteria, and fungi. A dentist can become infected either directly or indirectly. In direct infection, microorganisms pass into the dentist through a cut on the skin of his/her hand while performing a medical examination, or as a result of an accidental bite by the patient during a dental procedure, or through a needle wound during an anesthetic procedure. An indirect infection occurs when an infectious agent is transmitted into the dentist through a so-called carrier. The following are the main sources of indirect infection: aerosolized saliva, gingival fluid, natural organic dust particles (dental caries tissue) mixed with air and water, and organisms released from the surfaces of used dental instruments and devices.

The following are the main entry points of infection for a dentist: the epidermis of hands, oral epithelium, nasal epithelium, epithelium of the upper airways, epithelium of the bronchial tubes, epithelium of the alveoli, and conjunctival epithelium. In dental procedures such as the drilling of tooth tissues (cariotic defects, denture abutments), filling cavities, and removal of dental cement, dentists use burs with a slow-speed, turbine, or ultrasound handpiece that stir up the bacterial flora in the oral cavity (1, 2). In this way, dental procedures cause major disruption in the microbiological environment of a dentist’s operatory. Legnani et al. assessed the aerosol contamination resulting from dental procedures (3). Air contamination was measured by means of the Surface Air System method and the “plate” method (Air Microbial Index). This assessment demonstrated that during working hours the average air bacterial load increased over three times, and the air load levels were 1.5 times (aerobic bacteria) and 2 times (anaerobes) greater as compared to the initial load.

**Latex Hypersensitivity**

Gloves and a mask form an integral part of a dentist’s protective equipment. Latex gloves dusted with cornstarch powder are most often used. The gloves and the mask form an efficient barrier against most pathogens and as recently proven, they also constitute a very good barrier against viruses, provided the gloves and the mask are intact (4). However, they may also be a source of allergies—primarily in those persons who use rubber products on a regular basis. In this respect, dentists are at particularly high risk.

Since the beginning of the 1980s, the number of
cases of immediate allergies to latex has increased dramatically (5). The most important risk factor of immediate allergies is repeated exposure to latex products (5, 6, 7). Atopy is another essential factor contributing to the increased number of allergic cases. It is estimated that 2.8%–17% of the employees in health service are allergic to latex. Approximately 8.8% of dentists were found to be allergic to latex. The increased use of rubber gloves to prevent infections caused by immunodeficiency viruses (HIV) and hepatitis viruses is closely related to the number of persons with allergies to latex. Palczynski and Walusiak include among other hypothetical causes for the appearance and increased number of cases of immediate allergies to latex the following: improved diagnosing and reporting of latex allergies; increased occurrence of allergic diseases in the general population; appearance of low quality rubber gloves with high allergenic potential; changed locations of rubber tree plantations; changed storage conditions of latex products, including extended time of storage; changes in the production process; damage to the skin barrier, including allergic and contact irritation dermatitis; creams used in allergic and contact irritation dermatitis (Fig. 1) and dyshidrotic dermatitis (Fig. 2) that make the penetration of allergens easier; increased content of latex aerosol in hospitals; increased exposure to cross-allergens (such as exotic fruit); and increased use of ethylene oxide for speeding up the growth of rubber trees and for sterile packaging of latex products (8).

Fig. 1. Contact irritation dermatitis.

Fig. 2. Dyshidrotic dermatitis.

The clinical symptoms of latex allergies include: contact urticaria (Figs. 3, 4), conjunctivitis accompanied by lacrimation and swelling of the eyelids, mucous rhinitis, bronchial asthma, and anaphylactic shock (7, 9). Cornstarch or the so-called absorbable dusting powder also plays an important

Fig. 3. Contact urticaria of the tongue in a patient with latex allergy.
role in latex allergies in the reaction of the airways. This powder is not biologically neutral, as was previously thought. It is allergenic and participates in immediate allergic reactions. The powder does not include detectable proteins but, as some studies demonstrated, the health service employees who had an anaphylactic reaction to the dusting powder had positive skin tests (6, 10). Starch particles combined with latex protein allergens become airborne and consequently, they are inhaled or absorbed through the skin (5, 11). The intensity of the aerosol effect grows with the increased use of rubber gloves (9).

The most frequent allergy reported in dental practices is sensitivity to latex (12, 13). Powdered latex gloves were mentioned to cause allergic reaction (Fig. 5), although dentists with an allergic profile reported that all latex gloves cause irritation. The powder in latex gloves itself is not the allergen (14).

It only provides binding sites for latex protein and aids in carrying the protein into the skin (15, 16). It has also been reported that airborne powder particles can cause asthmatic allergic reactions and even anaphylaxis (17). Dental personnel should also note that latex is present in other personnel protective equipment, e.g., masks, eyewear, and clinical gowns. These items have been linked to adverse skin and mucous membrane reactions.

There are three basic categories of adverse conditions associated with latex gloves: irritant, allergic, and immediate or type I hypersensitivity allergy. The first two types (irritant and allergic contact dermatitis) are painful and temporarily debilitating, but without potential for serious reactions. The third type (immediate or type I hypersensitivity) is the least common but the worst type of reaction, sometimes leading to anaphylaxis (18). Sufferers from latex allergy should instead use vinyl or nitrile gloves, while those with severe latex allergies should attempt to work in a latex-free environment.

**Dental Restorative Materials and Allergic Reactions**

In this review, common dental restorative allergens as well as their allergic reactions are discussed. The information provided can be used as a guideline to assist the dentist in providing a controlled allergen environment for personnel as well as patients. Scot et al. mentioned several manifestations of allergic reactions that have oral and facial involvement (19). These include angio-edema of the lips and tongue, urticaria of the face, and erythema multiforme of the skin, lips, and oral mucous membrane (Figs. 6–9). Allergic contact dermatitis may not only appear on the hands, but also on the eyelids, as reported by Guin and Fowler (20, 21). Contact allergy involving the oral mucous membrane, according to Scot et al., is a poorly understood clinical entity that is infrequently described (19). Contact allergy is also often mistaken for chronic trauma caused by fractured teeth, fractured restorations, ill-fitting prostheses, or parafunctional oral habits. Such lesions have a similar clinical appearance (Fig. 10).
Fig. 6. Local reaction in buccal mucosa adjacent to an amalgam filling.

Fig. 7. Perioral dermatitis following insertion of gold inlays.

Fig. 8. Ulcers on the tongue corresponding to the location of soldered parts of an orthodontic retainer.

Fig. 9. Lichen planus–like lesion adjacent to a dental restoration.

Fig. 10. Allergic contact reaction due to nickel in a dental brace.
Contact allergy appears as a hypersensitivity reaction (type I or IV) when a small molecular weight protein penetrates the mucous membrane. That protein then combines with the mucosal proteins to form an allergen that can potentially trigger the immune system. Usually the reactions appear to be non-specific, both clinically and histologically. It is therefore of great importance that the diagnosis of intra-oral contact allergy is based on the temporal relationship between the onset of the symptoms and the exposure to a possible allergen. Dental personnel should therefore be aware of the possible allergens that they, as well as their patients, are exposed to, so that they can make informed decisions once faced with contact allergic symptoms. Previous allergic reactions in patients and personnel should always be noted (because type IV hypersensitivity may be triggered as a result of a previous exposure to an allergen).

**Acrylate and Its Compounds**

Dental polymer materials based on methacrylate, its polymer, and polyelectrolytes, seem to be a major cause of contact dermatitis in dental personnel (22, 23). Dentistry uses a variety of polymer materials. The setting of restorative materials and adhesives is initiated chemically by mixing two components or by exposure to intense visible light. In both cases, polymerization is incomplete and unreacted monomers (also known as free monomers) are released (24). These free monomers may cause a wide range of adverse health effects such as irritation to skin, eyes, or mucous membranes, allergic dermatitis, asthma, and paraesthesiae in the fingers. Additionally, disturbances of the central nervous system such as headache, pain in the extremities, nausea, loss of appetite, fatigue, sleep disturbances, irritability, loss of memory, and changes in blood parameters may also be noted.

**Acrylate Patch Testing**

If acrylate sensitivity is suspected, a pathologist may perform specific acrylate patch testing. However, this test may not give an immediate result, according to Fowler (21). He reported the case of a dental technician with eyelid and hand dermatitis. There was evidence of a delayed positive test result when a patch test with a sample of an acrylic material from a nail salon showed a positive reaction only after one month. Repeat testing with ethyl acrylate and methyl methacrylate became positive only after five weeks. Kanerva and Estlander also warned that strong concentrations of patch test substances may cause a severe allergic reaction and the patch test sites may remain vitiliginous for a period of time. Dental personnel should therefore be aware that patch testing may have a delayed response and even cause severe discomfort in some people (25).

**Sources of Allergic Reactions**

Commercially available dentin primers and dentin bonding agents and cements that contain 2–HEMA (hydroxyethyl methacrylate) are widely used in dental practices (26, 27). Hamid et al. studied the components released from dental cements using tooth and mold samples (28). Analyses of diffusion of HEMA through the dentin showed a relatively sustained movement into the pulp space during the first day, with exponential decline thereafter. The authors concluded that the release of this material may be relevant to the risk of adverse pulp responses in patients and to the risk of allergy in patients and dental personnel. Sensitivity to monomers that do not react while material is prepared can affect dental personnel as well as patients in the immediate vicinity. Patients are, however, also at risk when they come in contact with leachables from their fillings. This may occur at any time after the dental procedure. Lygre et al. separated and identified leachables from three different polymer–based dental filling materials by using a combined method of gas chromatography and mass spectrometry (29). The following organic leachables were identified and quantified: DL-camphorquinone, 4’-dimethylaminobenzoic acid ethyl ester (DMABEE), drometrizol, 1,7,7-trimethylbicyclo [2,2,1]/heptane, 2, 2-dimethoxy /1,2/ diphenyl ether, (DMPB), ethylene glycol dimethacrylate (EGDMA), and triethylene glycol dimethacrylate (TEGDMA). All of these
materials may potentially cause allergic reaction. There are numerous other reports of allergy associated with acrylate and its compounds. Bauer and Wollina reported denture-induced local and systemic reactions to acrylate (30). Kanerva reported fingertip paraesthesia and occupational allergic contact dermatitis caused by acrylics in a dental nurse (31). Another report noted allergic contact dermatitis from eugenol used as a restorative dental material with polymethylmethacrylate (32).

Asthma Due to Acrylate Compounds

Asthma due to dental materials is another important occupational hazard. Piirilä reported occupational asthma, conjunctival symptoms, and allergic contact dermatitis among dental technicians exposed to acrylate compounds (33). Nayebozadeh and Dufresne conducted a study on occupational asthma among dental technicians by determining the time-weighted average and peak concentrations of methacrylate vapor and the time-weighted average concentration of acrylic dust (34). They suggested that the use of a local exhaust ventilation system significantly reduced the peak concentration of methyl methacrylate vapor in the breathing zone of dental technicians. However, local exhaust ventilation was not efficient in reducing the concentration of airborne acrylic dusts.

Cross-sensitivity

Carmichael et al. reported the case study of a patient who presented with recurrent facial dermatitis associated with dental work in response to epoxy acrylate BIS-GMA (bisphenol-A0 glycidilidimethacrylate) (35). Epoxy acrylate resins have been used in dental fillings since 1962. BIS-GMA is a monomer produced by the reaction of methyl methacrylate and diglycidylether (epoxy resin). BIS-GMA is then cured by the peroxide/amine method or visible light to produce the final non-allergenic polymer in the mouth. BIS-GMA itself rarely causes allergic reactions. Epoxy sensitivity, however, is well recognized. Carmichael et al. therefore suggested that given the structural homology of BIS-GMA and epoxy, the associated sensitivity represents cross-sensitivity to the epoxy moiety within the BIS-GMA (35).

Sensitivity to Dentures

Another commonly utilized dental material is resin in dentures. Barclay et al. noted that hypersensitivity reactions to the commonly used denture base resins are infrequently reported. When they have been reported, most acrylic hypersensitivity reactions have been described as local contact reactions, with few reports identifying any significant systemic symptoms (Fig. 11). They reported a case in which the patient experienced extensive systemic symptoms that were strongly linked to denture wear. However, the authors hypothesized that the reactions experienced by this patient to some denture resins were the result of the incorporated coloring agents, because the patient responded positively to a patch test of pure dye samples (36).

Protection Against Acrylate Compounds

Unfortunately, gloves do not protect the hands against the free monomers, which easily penetrate the gloves. Dental personnel may also inhale these free monomers, because facemasks do not provide enough protection and eyes are exposed to the monomer vapor. Because the gloves are permeable to monomers, Andersson et al. tested the ability of six different types of gloves to prevent the penetration of

Fig. 11. Acrylic hypersensitivity reactions causing dentures sores.
2-hydroxyethyl methacrylate (2-HEMA) and triethylene glycol dymethacrylate (TREGDMA) present in Scotchbond1, a commonly used dental adhesive (37). The types of gloves were: one vinyl glove, two kinds of latex gloves, two kinds of nitrile gloves, and one 4H glove. Their results indicated that the 4H glove gave the best protection by far, followed by one of the nitrile gloves. The two kinds of latex gloves and the vinyl glove gave very poor protection against the adhesive. It is therefore suggested that when acrylate allergy is suspected, nitrile or 4H gloves should be used.

**Mercury as a Potential Hazard for the Dental Practitioner**

Mercury has been used for centuries for medical, chemical, metallurgical, and electrical applications. It is an element of mystery: in its metallic form, mercury is an enticing silvery liquid that can be as fascinating as it is dangerous. Its use in dental amalgam has a potential for continuous occupational exposure of dental practitioners to mercury vapor. It is imperative that the dental practitioner understands the hazards associated with the use of mercury and controls exposures to prevent the development of any untoward effects (Fig.12). If mercury sensitivity is suspected, specific patch testing can be done. Dental personnel should also be aware that patch testing may have a delayed response and even cause severe discomfort in some people (Fig. 13).

**Musculoskeletal Disorders and Diseases of the Peripheral Nervous System**

Musculoskeletal pain, particularly back pain, has been found to be a major health problem for dental practitioners (38). At work, the dentist assumes a strained posture (both while standing and sitting close to a patient who remains in a sitting or lying position), which causes an overstress of the spine and limbs. This strained posture is held for 37.7% of the time at work (39). The overstretch negatively affects the musculoskeletal system and the peripheral nervous system; above all, it affects the peripheral nerves of the upper limbs and the nerve roots of the neck.

Back pain syndromes diagnosed in dental workers originate from spinal degeneration in its different phases. Neck disc pathology results in cervical nerve pain or cervico-acromial pain, which are particularly common among dental practitioners (39, 40). The posture of the dentist at work, with the neck bent and twisted, one arm abducted, and repetitive and precise movements of the hand, are, according to Milerad and Ekenvall, a frequent cause of the neck syndrome and of pain within the shoulder and upper extremities (41). Lumbar and lumbosacral discopathy arouses pain in the hips and low back that radiates to the lower extremities, more often on the right side than on the left. This can be explained by a greater stress on the right side of the body when a right-
handed dentist works on a sitting patient. The dentist makes constant repetitive movements that stress the wrist and elbow joints. Mechanical vibrations are also of consequence (42).

In some dentists, a defect of the median nerve and the cubital nerve develops. An early syndrome of a defective median nerve shows in *acroparesthesiae*. One consequence of the defective median nerve in the carpal canal is the so-called carpal tunnel syndrome. Its early phase is dominated by paroxysmal *paraesthesiae* of the thumb and index finger, which occurs almost without exception at night and which is accompanied by sensomotor disorders of the thumb and index finger as well as by the atrophy of the thenar (39). The necessity of keeping the upper limbs extended upwards in a bent and abducted position, without the possibility of resting the hands on the elbows, is conducive to a defect of the elbow nerve. While bending the forearm, the medial head of the triceps muscle goes into the sulcus of the elbow nerve, which facilitates pressure on the nerve.

Pains of the epicondylus, appearing at first during strain and specific movements, gradually intensifying and radiating along the forearm, point to an inflammation of the epicondylus of the humeral bone (39). Motions carried out during extractions stress not only the elbow joint and the wrist joint but may result in chronic tendon sheath inflammation. The long-term effect of all of those adverse circumstances occurring in the work of the dentist may lead to medical conditions described as cumulative trauma disorders (43).

### Eye Protection in Dental Laboratories

Many dental laboratory procedures increase the chances of serious eye injury. These injuries include traumatic injuries due to projectiles, those from exposure to harsh chemicals or heat, and infections from contact with patient body fluids. To help assure a safer working environment, awareness of the need for eye protection must be established and maintained by all laboratory personnel (Fig.14). Laboratories today must comply with safety mandates in the most effective and efficient manner.

![Ear loop mask with eye shield.](image)

**Conclusion**

With respect to hazards in dentistry, more people are becoming aware of occupational hazards and paying more attention to the prevention of such hazards. Dental products such as acrylics, resins, and polymer materials used in restorative dentistry represent a major advance in dentistry. Although these products may act as allergens in a portion of the population, one should keep in mind that every technology, no matter how beneficial, can exert a negative impact on some members of the population. The reality of public health will always involve balancing maximum benefit and minimum harm to the public health and well-being. Because allergy is a reality that dentists have to deal with, the following guidelines are proposed:

- Dental personnel should be familiar with the major signs and symptoms of allergic reactions, including anaphylaxis should an allergic emergency arise during a consultation. The previous allergic status of patients and personnel should be noted.
- Dental personnel should always keep records of dental materials used. If allergic reaction occurs, backtracking is necessary to identify the specific allergen.
Contact allergy should not be mistaken for chronic trauma.

Local exhaust ventilation systems can significantly reduce the peak concentration of acrylate vapor in the breathing zone of dental technicians. However, the local exhaust ventilation is not efficient in reducing the concentration of airborne acrylic dusts.

Nitrile, vinyl, or 4H gloves should be used by the dental practitioner if acrylate or latex sensitivity is suspected.

If sensitivity is suspected, the patient should be informed about possible clinical tests to determine the origin of allergy, e.g., acrylate patch testing. Delayed sensitivity may be prevalent in certain cases.

Cross-sensitivity towards coloring agents used in dentures should be considered.

A latex-free environment should be created for personnel and patients with latex sensitivity.

Further research is now needed to more carefully elucidate the impact of hazards on dentists, and also to identify specific risk factors and effective measures for reducing dental occupational hazards.

References


