



Irritants and Allergens in Dental Materials - A Review

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Authors' contributions

This work was carried out in collaboration among all authors. Author RSG designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors NPM and AR managed the analyses of the study. Author AR managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

This review aims to develop a systematic approach for the selection of suitable and safer dental materials available in the market thereby giving an insight to predict their risk of inducing allergic reactions. The review was conducted by referring to various relevant articles and retrospective studies. It was noted that the most common allergic reactions in dental staff are allergies to latex, acrylates and formaldehyde. The other dental materials that caused irritation included impression materials, metals, resins, rubber products, amalgam restorations. The study comprehended that dental personnel have high risk of allergy from latex gloves, bio aerosols inhaled during the dental practice, contact dermatitis and from the usage of various other potentially harmful dental materials. On the other hand, the patients have high risk of irritation from commonly used dental materials like metals (gold, mercury, chromium, palladium etc), root canal sealants, obturation materials, formaldehyde, amalgam restorations, resin, acrylates, impression materials, latex and local anesthesia. Patients begin to develop symptoms of stomatitis, burning, tingling, cheilitis, oral lichenoid lesions, lip and facial swelling. The oral cavity is exposed to various sensitizing substances that cause allergic reactions. Hence it is necessary to provide comprehensive dental treatment without compromising the health of the patient.

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1. INTRODUCTION

Dentistry is considered as a high-risk profession. The clinical environment is polluted by many factors that include high risk aerosol, spills, splatters, handling sharps and chemicals that are volatile and may act as an irritant or even as an allergen. The risk is equal to the patients and the dentist. The incidence of adverse reactions to dental treatment and various dental products is difficult to estimate but reported to be low considering the number of dental treatments undertaken in most of the countries. This review aims to develop a systematic approach for the selection and monitoring of dental materials available in the market thereby giving an insight to predict their risk of inducing allergic reactions or acting as an irritant.

Patients undergoing various dental treatments can be exposed to various range of potential allergens but adverse events seem infrequent. Patients with symptoms of stomatitis, burning, tingling, cheilitis, oral lichenoid lesions, lip and facial swelling may relate their problems with dental treatment or against the use of dental products.

Dentists and their staff use many potential allergens and irritants during the course of their work. These materials include antiseptics, metals, impression materials, local anesthetics, ultraviolet radiation, cements, latex gloves, rubber dams, acrylics, adhesives, mouthwashes and many other dental hygiene materials. Most of these materials can be allergens, irritants or sometimes both. It is not that uncommon for a patient to give a history of having a reaction after dental treatment, within minutes, hours or weeks. Dentists use many metals in amalgam restorations, most preferably mercury, which may give an oral lichenoid eruption, and use gold and platinum group metals for inlays, crowns or bridges, which may give allergic reactions. Dentists use acrylate resins extensively for dentures, and even traces of these plastics can sometimes give rise to many allergic symptoms, although most cases of apparent reactions to dentures are not 'allergic' in origin. The presentation of most of the oral complaints can include stomatitis, lichenoid changes, burning in the mouth, cheilitis and lip swelling, facial swelling, general symptoms and anaphylaxis.

Apart from these irritants, due to the limited space and ventilation in the various dental

clinics, the dentists are prone to various serious health conditions. The bio aerosols mainly composed of microbes, viruses, fungi, allergens, or other toxic substances are inhaled by the dentists thereby causing various nosocomial infections.

Dental Technicians are exposed to multiple occupational hazards which can bring about adverse health issues [1]. These potential risk hazards include chemical, physical, psychological, ergonomic, and other job-related factors [2]. The health effects include: potential adverse respiratory effects from inhalation of dusts from grinding and polishing of metal alloys, resins, ceramics, plaster, and the abrasives used for polishing or acrylates [3]; dermatitis from contact with acrylates and metals [4,5]; neurotoxicity or disturbance of olfaction by methyl methacrylate (MMA) monomer [6]; genotoxic damage in lymphocytes possibly related to occupational exposure to chromium [7], cobalt, and nickel and health complaints caused by noises [8], vibration of handpieces and long working hours [9].

Several studies have examined the effects of occupational exposures on respiratory health among dental technicians. It was reported that there were significant differences in lung function and prevalence of respiratory symptoms between dental technicians and controls [10], and there was an increased risk of pneumoconiosis among dental technicians and a positive interaction between occupational exposure and cigarette smoking [11].

Dental personnel are exposed to a high number of sensitizing chemicals such as acrylics, metals, fragrances, antimicrobials. They have a high frequency of occupational skin problems and may complain of hand dermatitis or itching, facial eruptions and other respiratory symptoms. Allergies related to dentistry generally constitute delayed hypersensitivity reactions to specific dental materials. Extensive reports in literature state that certain types of materials cause allergies in patients, who exhibit mucosal and skin symptoms.

1.1 Review

The review study was conducted by referring to various relevant articles and retrospective studies. These include allergies to impression

materials, sodium hypochlorite, methyl methacrylate, zinc oxide eugenol, composites, mercury, local anesthesia etc.

After reviewing the literature, it was noted that the most common allergic reactions in dental staff are allergies to latex, acrylates and formaldehyde. Moreover, in patient's incidence of oral lichenoid reactions due to amalgam restorations occur more often than other dental materials.

2. DISCUSSION

2.1 Potential Irritants

General materials that might be irritant to staff or patients include antiseptics used for cleaning and disinfecting, and hygiene products, such as mouthwash, toothpaste, hand wash and lip products. Other possible irritants include etching gels, astringents and acids.

Impression materials, usually made of silicone/polyether, can occasionally be suspected of causing an allergic reaction such as swelling, itching and redness. There is only a single allergic case reported in which a patient developed hypersensitivity reaction due to polysulfide material in the form of redness, itching and edema following secondary impression for upper and lower complete dentures and on treatment with topical corticosteroids (Betamethasone valerate ointment 0.1%) helped her to recover from the allergy [12].

The other main irritants used by dentists are metals, rubber products, acrylates and resins. Metals are used mainly for amalgam restorations, inlays, crowns, bridges, posts, cores and braces. The metals employed in amalgam restoration include mercury, tin, silver and copper. The first step in recognizing allergy associated with mercury in amalgam restorations is a detailed history of the complaint and its clinical course. In 1976, the Council on Dental materials and devices advised using conventional amalgam condensers instead of the ultrasonic amalgam condensers [13]. Air conditioners, proper ventilation of the operating rooms and proper handling of the amalgam scraps under sulphide solution can avoid mercury vapor production [14]. Another most common manifestation of allergy to mercury is burning mouth syndrome (BMS) [15]. These can

also develop in patients who are denture wearers; a few of them may have iron or folate deficiency, or an infection with *Candida albicans*. Rubber is usually encountered in the form of certain latex gloves worn by dentists or used as rubber dams. The principal factor for skin irritations among the dental personnel is the habit of glove wearing and the intensity of the difficulties increase with respect to the duration of wearing the gloves. The swelling of the face is due to various latex allergies. Resins, mainly acrylates, are employed in composites for filling teeth, as bonding agents and in the manufacture of dentures [16]. Acrylates are preferably used for dentures, composite restorations and bonding materials. Most commonly used compounds include methyl methacrylate (MMA), cyanoacrylate (CA), triethylene glycol dimethacrylate (TGDM) and polymethyl methacrylate. CyanoAcrylates retain their adhesive qualities even in the presence of moisture and also have the added benefits of being bacteriostatic and hemostatic [17]. Methyl Methacrylate is a monomer of acrylic resin that has a potential toxicity in dental use for both the dentist and the patient. Patients exposed to MMA may develop local mucosal irritation while the dentist and the dental technicians occasionally suffer from hypersensitivity, irritation, asthmatic reactions, local neurological symptoms and other dermatological reactions.

Patients may also tend to complain of sore mouth (stomatitis) or mouth ulceration, soreness in the mouth from oral lichenoid lesions, burning or tingling in the mouth, an eruption on the lips (cheilitis) or lip swelling, facial eruption or more systemic and extreme problems such as anaphylaxis.

2.2 Irritant Reactions Due to Metals

Patients with reactions associated with delayed type hypersensitivity to mercury and various other metals develop oral lichenoid lesions complain mostly of soreness or discomfort in the mouth, or may have oral ulceration. These are mostly seen in patients undergoing orthodontic treatment which consists of the use of stainless-steel wires that are mainly made of nickel and chromium. Patients who tend to develop such conditions are allergic to metals such as mercury, gold, copper, tin, silver, palladium, chromium etc. For such patients who consider it to be an irritant, removal of amalgam can be a significant solution.

Table 1. Showing list of irritants and allergen in dental materials

Sl. no	Compound	Product	Mode of action
1	Nickel	Wires, crowns	Allergen
2	Antiseptic And Hygiene Products	Mouthwash, toothpaste, handwash, lip products	Irritant
3	Impression Materials	Poly ether, polysulphide materials	Allergen
4	Metals: Mercury, Tin, Silver, Copper	Amalgam restorations, inlay, crowns, bridges, cores and braces.	Allergen
5	Rubber	Latex gloves, rubber dams	Irritant
6	Acrylates: Methyl Methacrylate, Cyanoacrylate, Triethylene Glycol, Dimethacrylate, Poly Methyl Methacrylate	Dentures, composite restorations and bonding materials.	Allergen
7	Stainless Steel: Nickel, Chromium	Orthodontic wires	Irritant
8	Eugenol	Root Canal Sealants, Obturation materials like Gutta Percha, Zinc Oxide Eugenol	Irritant
9	Formaldehyde	Disinfectants for Root Canal Treatment	Allergen
10	Local Anesthesia	Local anesthetic drugs	Allergen

2.3 Irritations Due to Root Canal Sealers and Obturating Materials

Eugenol acts as a contact irritant and induces type IV hypersensitivity reactions and produces generalized anaphylactic symptoms [18]. Munaco et al., (1978) and Pascon & Spangberg (1990) reported that Gutta-percha is biocompatible; however, the high content of zinc oxide in them can contribute to its toxicity. Hence, recently a resin-based filling material (Resilon, Penton Clinical Technologies, Wallingford, CT, USA) has been introduced as an alternative to gutta-percha which is composed mainly of polyester, difunctional methacrylate resin, bioactive glass and a resin sealer. Studies have shown that resilon is biocompatible and can be used as a good alternative for patients allergic to zinc oxide-eugenol based dental materials [19]. A case was reported of an allergy to sodium hypochlorite. On irrigating the canals with the same, the patient developed burning sensation and difficulty in breathing and was administered with corticosteroids, antibiotics, antihistamines and analgesics for symptomatic relief. After 15 days, a positive skin scratch test was seen which confirmed that the allergy was due to 1% sodium hypochlorite [20].

2.4 Irritation Due to the Materials Used in Endodontic Formaldehyde

Formaldehyde is a common cause for allergic contact dermatitis [21]. The patients allergic to

formaldehyde are usually women who tend to develop eczema on the hands or face [22,23]. The characteristic features of formaldehyde allergy include anaphylactic reaction [24] or shock [25] and generalized urticaria [25,26]. The most useful and diagnostic tool to determine formaldehyde allergy is the assessment of specific IgE antibodies in formaldehyde [27].

2.5 Reactions towards Local Anesthetics

Local anesthetics are used extensively in dentistry and are normally tolerated well. There are a wide range of reactions from simple vasovagal episodes to tachycardia (due to intravascular administration of epinephrine). The allergic reactions are caused by the co-incidental exposure to other antigens such as preservatives (methyl-p-hydroxybenzoate), antioxidants (bisulphate), antiseptics (chlorhexidine) and other antigens like latex, as well as other local anesthetic drugs [28].

2.6 Immediate Type of Reactions and Anaphylaxis Due to Various Dental Products

The most common cause of systemic symptoms such as wheezing or, at the extreme, anaphylaxis, and due to contact with a dentally related material, is immediate allergy towards latex. Atopic are at an even higher risk of developing latex allergy. Immediate type of latex allergy, and also delayed type hypersensitivity to

rubber additives, may manifest symptoms such as swelling of the face or mouth following the dental treatment due to contact of the dentist's latex rubber glove with the patient's skin or mucosa [29].

Formaldehyde, used as a disinfectant for the root canal treatment, has been recorded to cause anaphylaxis within minutes of exposure. Contact allergy to acrylates is a particular problem with dentists and dental technicians, typically presenting with dermatitis on the fingertips (sometimes with facial or eyelid involvement).

3. CONCLUSION

The study comprehended that the dental personnel have higher risk of allergy from latex gloves, bio aerosols inhaled during the dental practice, contact dermatitis and from the usage of various other potentially harmful dental materials. On the other hand, the patients have high risk of irritation from the commonly used dental materials like metals (gold, mercury, nickel, chromium, palladium etc), root canal sealants, obturating materials, formaldehyde, amalgam restorations, resin, acrylates, impression materials, latex and local anesthetics. The oral cavity is constantly exposed to various sensitizing substances that cause allergic reactions and contributes to rise in healthcare expenditures annually. Hence it is necessary to provide comprehensive dental treatment without compromising the health of the patient.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Hensten-Pettersen A, Jacobsen N. The role of biomaterials as occupational hazards in dentistry. *Int Dent J.* 1990;40: 159–66.
2. Hensten-Pettersen A, Jacobsen N. Toxic effects of dental materials. *Int Dent J.* 1991;41:265–73.
3. Jacobsen N, Pettersen AH. Self-reported occupation-related health complaints among dental laboratory technicians. *Quintessence Int.* 1993;24:409–15.
4. Jacobsen N, Derand T, Hensten-Pettersen A. Profile of work-related health complaints among Swedish dental laboratory technicians. *Community Dent Oral Epidemiol.* 1996;24:138–44.
5. Savonius B, Keskinen H, Tuppurainen M, Kanerva L. Occupational respiratory disease caused by acrylates. *Clinical & Experimental Allergy.* 1993;23:416–24.
6. Lee JY, Yoo JM, Cho BK, Kim HO. Contact dermatitis in Korean dental technicians. *Contact Dermatitis.* 2001;45: 13–6.
Available:<https://doi.org/10.1034/j.1600-0536.2001.045001013.x>
7. Nayebzadeh A, Dufresne A. Evaluation of exposure to methyl methacrylate among dental laboratory technicians. *Am Ind Hyg Assoc J.* 1999;60:625–8.
Available:<https://doi.org/10.1080/00028899908984482>
8. Nayebzadeh A, Stangel I, Dufresne A. Risk of respiratory exposure of dental personnel to amalgam alternatives. *Sci Total Environ.* 2000;247:33–9.
Available:[https://doi.org/10.1016/s0048-9697\(99\)00463-5](https://doi.org/10.1016/s0048-9697(99)00463-5)
9. Arrighi HM, Hertz-Picciotto I. The evolving concept of the healthy worker survivor effect. *Epidemiology.* 1994;5:189–96.
Available:<https://doi.org/10.1097/00001648-199403000-00009>
10. Choudat D. Occupational lung diseases among dental technicians. *Tuber Lung Dis.* 1994;75:99–104.
Available:[https://doi.org/10.1016/0962-8479\(94\)90037-X](https://doi.org/10.1016/0962-8479(94)90037-X)
11. Choudat D, Triem S, Weill B, Vicrey C, Ameille J, Brochard P, et al. Respiratory symptoms, lung function, and

- pneumoconiosis among self employed dental technicians. *Br J Ind Med.* 1993;50: 443–9.
Available: <https://doi.org/10.1136/oem.50.5.443>
12. Mobeeriek AA, Eshiekh HA. Adverse effect of polysulphide impression material: Case report. *The Saudi Dental Journal.* 1998;10: 86–8.
 13. Bains VK, Loomba K, Loomba A, Bains R. Mercury sensitisation: review, relevance and a clinical report. *Br Dent J.* 2008; 205:373–8.
Available: <https://doi.org/10.1038/sj.bdj.2008.843>
 14. Recommendations in Mercury Hygiene. *The Journal of the American Dental Association.* 1976;92:1217.
Available: <https://doi.org/10.14219/jada.archive.1976.0166>
 15. Pigatto PD, Guzzi G, Persichini P, Barbadillo S. Recovery from mercury-induced burning mouth syndrome due to mercury allergy. *Dermatitis.* 2004;15:75–7.
Available: <https://doi.org/10.2310/6620.2004.03021>
 16. Henriks-Eckerman M-L, Suuronen K, Jolanki R, Alanko K. Methacrylates in dental restorative materials. *Contact Dermatitis.* 2004;50:233–7.
Available: <https://doi.org/10.1111/j.0105-1873.2004.00336.x>
 17. Bhaskar SN, Frisch J. Use of Cyanoacrylate Adhesives in Dentistry. *The Journal of the American Dental Association.* 1968;77:831–7.
Available: <https://doi.org/10.14219/jada.archive.1968.0310>
 18. Seiss M, Marquardt W, Hickel R, Reichl F-X. Excretion of dental resin monomers and metabolic intermediates via urine in guinea pigs. *Dental Materials.* 2009;25:481–5.
Available: <https://doi.org/10.1016/j.dental.2008.08.013>
 19. Silvestre JF, Albares MP, Blanes M, Pascual JC, Pastor N. Allergic contact gingivitis due to eugenol present in a restorative dental material. *Contact Dermatitis.* 2005;52:341–341.
Available: <https://doi.org/10.1111/j.0105-1873.2005.0612c.x>
 20. Çalişkan MK, Türkün M, Alper S. Allergy to sodium hypochlorite during root canal therapy: a case report. *International Endodontic Journal.* 1994;27:163–7.
Available: <https://doi.org/10.1111/j.1365-2591.1994.tb00247.x>
 21. Latorre N, Silvestre JF, Monteagudo AF. Allergic Contact Dermatitis Caused by Formaldehyde and Formaldehyde Releasers. *Actas Dermo-Sifiliográficas (English Edition).* 2011;102:86–97.
Available: [https://doi.org/10.1016/s1578-2190\(11\)70765-x](https://doi.org/10.1016/s1578-2190(11)70765-x)
 22. Cronin E. Formaldehyde is a significant allergen in women with hand eczema. *Contact Dermatitis.* 1991;25:276–82.
Available: <https://doi.org/10.1111/j.1600-0536.1991.tb01874.x>
 23. Agner T, Flyvholm M-A, Menné T. Formaldehyde Allergy: A Follow-up Study. *Dermatitis.* 1999;10:12–7.
Available: <https://doi.org/10.1097/01206501-199903000-00004>
 24. Haikel Y, Braun J, Zana H, Boukari A, Deblay F, Pauli G. Anaphylactic Shock during Endodontic Treatment due to Allergy to Formaldehyde in a Root Canal Sealant. *Journal of Endodontics.* 2000;26: 529–31.
Available: <https://doi.org/10.1097/00004770-200009000-00011>
 25. Braun JJ, Zana H, Purohit A, Valfrey J, Scherer P, Haikel Y, et al. Anaphylactic reactions to formaldehyde in root canal sealant after endodontic treatment: Four cases of anaphylactic shock and three of generalized urticaria. *Allergy.* 2003;58: 1210–5.
Available: <https://doi.org/10.1034/j.1398-9995.2003.00295.x>
 26. Sayed F el, el Sayed F, Seite-Bellezza D, Sans B, Bayle-Lebey P, Marguery MC, et al. Contact urticaria from formaldehyde in a root-canal dental paste. *Contact Dermatitis.* 1995;33:353–353.
Available: <https://doi.org/10.1111/j.1600-0536.1995.tb02056.x>
 27. Groot AC de, de Groot AC, Flyvholm M-A, Lensen G, Menné T, Coenraads P-J. Formaldehyde-releasers: Relationship to formaldehyde contact allergy. Contact allergy to formaldehyde and inventory of formaldehyde-releasers. *Contact Dermatitis.* 2009;61:63–85.
Available: <https://doi.org/10.1111/j.1600-0536.2009.01582.x>

28. Wray D. The role of allergy in oral mucosal diseases. QJM. 2000;93:507–11. Available:<https://doi.org/10.1093/qjmed/93.8.507>
29. Shah M, Lewis FM, Gawkrödger DJ. Delayed and immediate orofacial reactions following contact with rubber gloves during dental treatment. British Dental Journal. 1996;181:137–9. Available:<https://doi.org/10.1038/sj.bdj.4809189>

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