ISSN: 0975-833X

Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 12, Issue, 05, pp.11428-11430, May, 2020

DOI: https://doi.org/10.24941/ijcr.38621.05.2020

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

RESEARCH ARTICLE

TOXICITY AND ALLERGIES DUE TO THE USE OF ACRYLIC RESINS IN THE PRACTICE OF DENTISTRY: IS THERE A RISK?

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ARTICLE INFO

Article History:
Received 18th February, 2020
Received in revised form
04th March, 2020
Accepted 28th April, 2020
Published online 30th May, 2020

Key Words:
Acrylic polymer, Toxicity, Allergic Contact Dermatitis, Methyl Methacrylate, PMMA, Residual monomer, Skin sensitization.

ABSTRACT

Acrylic, Poly Methyl Methacrylate (PMMA) based polymers are found in many industrial, professional and consumer products and are of low toxicity, but do contain very low levels of residual monomers and process chemicals that can leach out during handling and use. Methyl Methacrylate, the principle monomer is of low toxicity, but is a recognized weak skin sensitizer. When exposed to MMA in the dental clinic, dentists and other dental staff appear to occasionally suffer hypersensitivity, asthmatic reactions, local neurological symptoms, irritant and local dermatological reactions. The integrity of latex gloves may also be compromised after exposure to MMA during dental procedures. Dental staff should avoid direct contact with MMA and room ventilation should be optimized. The purpose of this article is to outline the cytotoxic consequences of acrylic resins and clinical recommendations for their use.

Citation: ***Benazouz, I., Boujoual, I. and Andoh, A.*** **2020.** "Toxicity and allergies due to the use of acrylic resins in the practice of dentistry: is there a risk?", *International Journal of Current Research*, 12, (5), 11428-11430.

INTRODUCTION

Due to the growing number of substances and materials used in dentistry, the frequency of allergies keeps raising. The professionals of dentistry represent a high risk population since they are in constant contact with a diversity of allergens. Among these, we can cite the latex of the gloves, metals used in prosthodontics, and materials used for impressions, prosthesis, and mostly acrylic resins. Common uses of the seresins include the fabrication of denture bases, orthodontic removable appliances, temporary crowns, and denture relining (Urban *et al*., 2009; Haroon *et al*., 2015). The main aim of this work is the determine the different allergens contained in resins, the clinical forms of allergic reactions encountered, the etiologic diagnosis and the preventive measures to take against these allergies in dentistry.

Etiology & epidemiology: The polymerization reaction in denture base resins is an addition reaction that involves the activation of the initiator. It is usually through heat polymerization (heat-curing), auto-polymerization (self-curing), and light polymerization (Goldibi *et al*., 2009). The polymerization reaction (the curing process) results in the conversion of MMA into poly-MMA during which the monomer molecules are converted into polymers. During this process, not all the monomer molecules are converted and thus, some unreacted residual monomers remain unpolymerized. During manipulation of acrylic resins, the unreacted monomer (MMA) may cause direct effects on the skin of dental technicians and students in the laboratories. The table-1 outlines the main constituents of powder and liquid of denture base polymers (Haroon *et al*., 2015). MMA is a low molecular weight (100.12 g/mol) organic chemical that is readily absorbed through the skin giving it ready access into the viable layers of the epidermis (Pemberton *et al*., 2014). MMA, like other acrylic and methacrylic esters, is a Michael acceptor electrophile and as such is capable of reaction with tissue nucleophiles via Michael addition on the electrophilic Cβ of the α,β-unsaturated (Pemberton *et al*., 2014). MMA is likely therefore, to form covalent adducts with carrier proteins, that can subsequently be recognized as antigenic hapten-protein complexes (Natsch *et al*., 2008; Roberts *et al*., 2008 April; Roberts *et al*., 2008 May; OECD, 2012; Pemberton *et al*., 2014). In a retrospective study, Kaneva *et al*. Reported 630 case of contact dermatitis among dentistry professionals: 70,6 % was form the allergic type, 161 dermatosis were related to méthacrylate (acrylic resins setting chemically). It is well understood that heat-cured acrylic resins have shown to produce less cytotoxic effects, while the greatest deleterious effects have been shown to be produced by self-cured acrylics.

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(Ata So *et al*., 2009; Chaves *et al*., 2012; Haroon *et al*., 2015) Aalto-Korte *et al*. analysed the allergic contact dermatitis to acrylates and methacrylates in dental personnel listed by the FIOH (Finnish Institute of Occupational Health) between 1994 and 2006. They stated that the most frequent allergens are the 2-HEMA among the dentists and the dental assistant and the MMA and l'EGDMA among the laboratory technicians (Aalto-Korte *et al*., 2007). Wallenhammar and al. declared that the prevalence of allergies dues to acrylates or méthacrylates isinferiorto 1 % among the Swedish dentists (questionnaire sent to3 500 dentists and completed with skin allergy tests). (Wallenhammar *et al*., 2000; Crepy, 2018). Herati-zadeh and al. analyzed, in a retrospective study, the results of the tests among the German dental professionals: 226 technicians presented a contact dermatitis between 2001 and 2015. The acrylates and methacrylates the most frequent positive allergens, affecting almost 30% of the laboratory technicians who had a contact dermatitis (Heratizadeh *et al*., 2018).

Clinical manifestations: The cutaneous lesions appears like important pulpitis of the fingers often chronic and mostly touch the index or the thumb fingers (Gargouri and al. 2002, Kissi *et al*., 2010). The second type is keratotic dermatitis, fissured, painful, often associated to a reduction of tactile sensibility. Myelinated nerve functions have shown to be affected if MMA is absorbed directly via the skin and may lead to neuropathy (Böhling *et al*., 1977; Haroon *et al*., 2015)

The allergic stomatitis to methacrylate is characterized by:

A diffuse erythema, an oedemic aspect and sometimes-small erosions or localized vesicles on the face, eyelids and the neck. (Via a hand-carried or aero-carried way)(Crepy, 2018). A study, which involved exposing rats to MMA vapors, showed that there were histological manifestations clearly present such as edema, emphysema, and even collapse of the lungs (Sokmen *et al*., 1988; Haroon *et al*., 2015). Another more recent study has shown that acrylic monomers (acrylates) and methacrylates can be respiratory sensitizers (Walters *et al*., 2017). Therefore, it must be stressed that the dental technicians who manipulate acrylic resin must work in an environment, which is thoroughly ventilated so that harmful effects including dyspnea, cough, and triggering of asthma could be minimized and ideally avoided (Aalto-Korte *et al*., 2007; Haroon *et al*., 2015)

Etiologic Diagnosis & preventives measures: The skin allergy test (patch test) are the method of reference for identifying the contact allergic dermatitis, in condition that they are not irritant (Crepy, 2018; Rai *et al*., 2014).

Collective protection: Collective protection is essential and must be considered before any individual protective measure. The main measures are: (Crepy, 2018)

- Packaging of the product containing the acrylates and the methacrylates this avoid the direct contact with the skin during the opening or closing of the cover.
- The regular cleaning of the local of work to reduce every possibility of contamination through the surfaces.
- The general ventilation of the locals.

Individual protection: The wearing of personal protective equipment may be necessary in addition to the collective protection measures: gloves, protective clothing, suitable respiratory protection, visor or safety glasses.

Table 1. Composition of acrylic denture base materials (Haroon *et al.*, 2015)

Component	Constituents
Powder	
Polymer	Polymethylmethacrylate beads
Initiator	A peroxide such as a benzoyl peroxide
Pigments	Salts of cadmium or iron or organic dyes
Liquid	
Monomer	Methylmethacrylate
Cross-linking agent	Ethylene glycol dimethacrylate
Inhibitor	Hydroquinone
Activator	N N'-dimethyl-p-toluidine

Studies published on this subject recommend the following measures (Mäkelä *et al*., 2005). Wear a double glove of medical gloves (PVC or latex) during short activities in contact with acrylates and methacrylates (duration <15 minutes, if the duration is longer (between 15 and 30 minutes), wear nitrile gloves (Minamoto, 2014) Preferably on another pair of gloves. The wearing polyethylene gloves under other gloves improves considerably protection in case of prolonged contact with acrylates. In case of double glove, it is advisable to choose a larger inner glove cut; the two gloves must be changed after each use, or in case of accidental contact with a product - avoid the use of preparations containing acetone as a solvent for adhesives because this substance facilitates the penetration of acrylates (Crepy, 2018)

- Wash your hands with lukewarm water, avoiding hot water, which worsens skin irritation; rinse hands well and dry. (Agner 2002)
- Do not wear rings at the workplace. (Irritants can be trapped under the ring and thus promote dermatitis irritation contact). (Agner 2002)
- Apply emollients to clean hands after work, rich in lipids and fragrance-free, with preservatives with the lowest sensitizing potential by emphasizing the interdigital spaces, the pulp of the fingers and the back of the hands (Crepy, 2018)

Conclusion

Allergic accidents in oral surgery are not uncommon. Several risk situations are present in dentistry bringing allergens into contact with the mucous membranes but also the skin. Unfortunately, this incidence is underestimated in oral surgery. The mechanisms involved in these allergies are complex and have not been fully elucidated. Irritant manifestations must be treated actively and must be avoided as much as possible by the rigorous application of collective and individual preventive measures.

Competing interests: The authors declare no competing interest.

Authors' contributions: Ichraq benazouz and Imane boujoual provided the electronic search and realized the synthesis and the writing. A.A gave his corrections and appreciations. All authors read and approved the final manuscript.

Abbreviations

PMMA: Poly Methyl Methacrylate
MMA: Methyl Methacrylate
2-HEMA: 2-Hydroxyethyl Methacrylate
EGDMA**:** Ethylene glycol dimethacrylate

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