Review and relevance of the allergic potential of methyl methacrylate - A case report.

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Abstract
Purpose: The purpose of this article is to provide perspective regarding allergy to acrylates in dental personnel.
Materials and methodology: All data were collected from Pubmed, and Google Scholar.
Results- Based on the data collected it was found that methyl methacrylate has high allergic potential.
Conclusion: Methyl methacrylate causes type IV delayed hypersensitivity reaction and its use have been increased worldwide including dentistry, paint industry, artificial nails and variety of sealant. Allergy to methacrylate in dentistry is a prime concern. Use of barrier protection and protective measures should be employed by dental staff which might be challenging at times.
Keywords: Allergic contact dermatitis, Contact Dermatitis, Delayed hypersensitivity, Methyl Methacrylate**.**

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Introduction

Allergens when repeatedly comes in contact with skin causes allergy. Allergic responses fall mostly into two groups: immediate and delayed. In recent years there is increased incidence of allergy has been reported and development of contact dermatitis (CD) occurs due to direct contact of allergens. It is of two distinct variants: irritant contact dermatitis (ICD) and allergic contact dermatitis (ACD). Acrylates and methacrylate (MA) are often used in dentistry, including in composite resins, glass ionomers, dentin bonding agents and dental prostheses. Discovery of acrylic acid dates back to 1843 and that of Methacrylic acid in 1865. In 1880, acrylic compound which are light polmerised were introduced. Polymethylmethacrylate (PMMA) is a polymer of acrylic acid that was initially described by Redtebacher in 1843.[1] PMMA which is a synthetic polymer industrially produced from the polymerization of methyl methacrylate (MMA) was discovered in early 1930, it is a transparent resin having high industrial demand.[2] It is estimated that annual requirement is growing at a rate of 8%-9% per year with approximately $8 billion market by 2025. [3] Many products, including paint, insulators, plastic outdoor sign, adhesives, compact disk like artificial nails, anaerobic sealants, printing inks, cosmetics, and instant glues, and are made using polymethylmethacrylate and other acrylate polymers. Medical use includes contact and intraocular lenses, bone cement, and hearing aids.[4] PMMA is one of the most popular and favored material for dental application because of its unique property like low density, low cost, aesthetic, easy manipulation and desirable physical and mechanical properties. It is used as occlusal splints, printed or milled casts, making artificial teeth, dies for treatment planning

and embedding tooth specimens for research. It is also used by orthodontist for fabrication of retainers and prosthodontist for dentures repair, relining dentures, provisional crowns, and obturators. [5]

While MMA has many uses, it has many side-effects also. One of the worst side effects of utilising monomer MMA is allergic contact dermatitis (ACD), which develops when it comes into contact with the skin.[6] ACD, which manifests as desquamation and pigmented macules, is an inflammatory condition in the skin brought on by contact with an allergen that both directly and indirectly harmed the skin. MMA is also known to irritate the respiratory system and sensitise the skin.[7] The metabolism and reactive chemistry of MMA strongly influence its toxicity, notably its ability to irritate and develop sensitization. Apart from acrylates there are many allergens that can cause ACD. Thus, proper history taking and related sensitization are important to avoid misleading conclusion. This emphasises the necessity to concentrate more intently and thoroughly on such events. This article intends to highlight MMA allergies that result from coming in contact with it and also to report a case of MMA allergy in a dental student.

Review of allergic potentiality

Dentist, dental staff and laboratory personnels are exposed to large no of allergic potential materials like acrylates, methacrylates, urethane acrylates and epoxy acrylates. These materials are mainly used in dentistry for fabrication of prosthesis, as dentin bonding agent, as restorative and luting cement. MMA monomer is recognised as the major allergen causing dermatitis in dental personnel by. In 1990s, there were rapid increase in the cases sensitization to monomer in dentistry. The first case of allergy to acrylates was reported in 1941.[8] Aalto-Korte *et al.*, reported in his study 2-hydroxyethyl methacrylate (HEMA) and MMA as the two most common allergic material among dental personnel. In this profession typical clinical features of allergy to MMA includes hand eczema and pulpitis of the fingertips that too especially of the first three fingers, although few cases of wide-spread dermatitis have also been reported.[9] According to Mikov et al, prevalence of contact dermatitis to MMA is 1%.[10] Apart from professionals, general population is also affected by allergy to acrylates in many forms. Canizes published first report of allergy to artificial nails in 1956. Artificial nails of all type contain acrylate which can be cause of allergy to user.[9]

Hypersensitivity

The primary cause of CD is skin contact with allergens and/or irritants, which can result in either allergic or non-allergic (toxic or irritant) CD. First and foremost, etiologic factors of contact dermatitis for dental professionals are responses to latex-containing gloves, which are followed by other dental products, detergents, lubricants, solvents, and chemicals. Among the several laboratory techniques used to polymerize denture base acrylic resins, heat-polymerised acrylic resins have proven to generate fewer cytotoxic effects, whereas the most harmful effects are shown by self-polymerised acrylic resin. It must be emphasised that even though the effect of self-polymerised resin is more than the heat polymerised, the symptoms like burning sensation and pain may also be caused by various other factors like poorly fitting dentures and poor oral hygiene. [5] The oral symptoms include subjective sensations like mucous membrane inflammation, vesiculations, burning or soreness in the mouth, loss of taste, numbness, erosions, lichenoid reaction confined to the area in contact with dental materials. Methyl methacrylate (MMA) and ethylene glycol

dimethacrylate (EGDMA) are the agents that are mostly exposed by the dental technicians.

Exposure and portal of entry

Orthodontists, dentists, dental assistants and specially prosthodontist are highly susceptible to allergic sensitization to acrylics.[11] Several studies and case reports have been documented occupational contact dermatitis caused by the epoxy acrylates, MMA, 2-HEMA, Triethylene glycol dimethacrylate (TEGDMA), Di-ethylene glycol dimethacrylate (DEGDMA) and EGDMA as well as Bisphenol-A glycidyl methacrylate (Bis-GMA), Bisphenol-A ethoxylated dimethacrylate (Bis-EMA) and Bis-MA.[12] Vaporization of the MMA monomer followed by inhalation during the manipulation of acrylic resins may have negative consequences, which might irritate lung tissues and have an impact on the central nervous system (CNS) also.[13] Common respiratory hypersensitivity symptoms cause by acrylates e.g. wheezing, asthma or rhinoconjunctivitis.[7] A study that comprised introducing rats to MMA vapours revealed that histological symptoms including oedema, emphysema, and even lung collapse were definitely evident.[14] It is best to avoid dentures produced from acrylic resins that self-cure, and immersing freshly created dentures in water is advisable. The presence of residual monomer is unavoidable in denture base acrylic resins and may give rise to trouble for both dentist and patients, independent of the curing circumstances. The hands are the major body place where contact dermatitis occurs most frequently. The dorsal hands, fingers, and wrists of ACD of the hand often have well defined plaques and vesicles.

Allergy test

The diagnosis is suspected on the basis of the case history or the clinical picture presented by the patient. Patch testing is considered to be a gold standard in confirming the diagnosis of allergy to acrylates. It elicits a type IV (delayed-type hypersensitivity) allergic response. Standard allergens are selected based on the exposure history and clinical suspicion of patient. Standardised trays for patch testing are available. FDA has authorised the thin-layer rapid use epicutaneous (T.R.U.E.) test as the only patch test tray till date. To elicit an eczematous reaction, a causative allergen is administered to the suspect's back in an undamaged skin under occlusion for two days and assessment of the results was performed after 48 (first reading) and 72 hours (second reading).

A nonlinear, descriptive grading scale introduced by International Contact Dermatitis Research Group in 1970 is most widely used.

The grading scale as follows:

- Negative reaction (-);
- Uncertain reaction (?);
- Weak positive reaction (+);
- Strong positive reaction (++)
- Extreme positive reaction (+++).

For composite resins, the patch test concentration should preferably not go over 1% and for acrylic monomers, it shouldn't go over 2% in petrolatum. Determining the source of the allergic reaction could be challenging due to the delay in responding. Hence, without comprehensive examination and raised suspicion, it can be difficult to show that dermatitis is connected to the workplace. [15]

Clinical report

A 29-year female in her first year of Postgraduation reported with a chief complaint of rashes on tips of the thumb and fingers while doing her routine professional work during her posting in the department of Prosthodontics, crown and bridge. The rashes developed with itching and burning sensation during fabrication of acrylic prosthesis with self-cure resin. The temperature of the affected area was found to be raised and she

did not have any respiratory problem. Later, she developed desquamation & pigmented macule and clearly marked borders over the skin of the affected area (Fig. 1).

There was no significant medical history. On consultation and during detailing the past history, the dermatologist observed no such history of allergy during her under graduation. She was prescribed anti histamines, antibiotics and topical steroid ointments in order to prevent infection and control inflammation. Instruction was given to discontinue laboratory work for 3 weeks and continuing with the rest of the activities. Following the dermatologist's recommended treatment plan, improvements were gradually observed. On the fifth day, the irritation and itching in the affected regions began to subside slightly. By day ten, edema, inflammation, and pigmentation had decreased. After receiving medications for a further 21 days, all lesions were completely gone (Fig. 2). Follow-up was continued for three months. She was advised to avoid contact to monomer. The treatment regime includes application of topical ointments and oral antibiotics (Table No. 1).

Discussion

Various dental materials can elicit allergic response, among them are latex gloves, metals (Nickel, Bereliyum, etc.) formaldehyde, eugenol, acrylic resin. Methacrylates among other acrylates are frequently used in dentistry for e.g fillings, in dental plates and dentures, coating of teeth and in prosthetics. To elicit a reaction to skin and the oral mucosa like stomatitis, burning mouth syndrome in sensitized individuals, sufficient amount of residual acrylic monomer in the self-cured portion of denture must be present.[10] Allergic reaction in the form of contact dermatitis commonly occur in dental personnel while the dental patient usually experiences delayed type (general or dermal) of reactions.[16,17] During manipulation of acrylic resin, monomer used can cause dermal reactions to the dental technicians and students working in the laboratories These affects are mostly occupational and depends on the duration of exposure to the allergens.[13] In Germany a study done on fifty five dental technicians with occupational skin disease and methylmethacrylate was identified as an allergen in 16% of the cases.[10] A dental professionals must have through knowledge about the materials they handle. National Institute for Occupational Safety and Health (NIOSH) has developed an approach involving Hierarchy of Controls (Fig. 3) for hazardious workplace conditions.[18]

This hierarchy has five levels of actions to reduce/remove hazards as follows: Elimination, Substitution, Engineering controls, administrative controls and personal protective equipment (PPE). Using this hierarchy one can lower worker exposures and reduce their risk of any kind of illness or injury.[18] Moreover, to reduce skin contact with toxic/allergic substances, no-touch procedures should be developed. Also, wearing double gloves or nitrile rubber gloves are other measures of increasing the protection. Furthermore, it has been suggested that neoprene gloves can offer the most protection but may present dexterity difficulties.[3]

Conclusion

Acrylates and methacrylates are materials that are widely used nowadays. They have a wide variety of uses, including dentistry, the printing sector, artificial nails, and a variety of adhesives such anaerobic sealants and quick glues. It is especially important to achieve skin protection in exposed workplaces, as well as to execute measures appropriately and enough, which might be challenging at times. Dental staff should be

more conscious of the materials they use and implement proactive workplace measures to decrease the risk of methacrylate exposure because methacrylates are pervasive in modern dental practise and cannot be eradicated.

References

1. Staehle HJ, Sekundo C. The Origins of Acrylates and Adhesive Technologies in Dentistry. J Adhes Dent. 2021 Oct 1;23(5):397-406.
2. Umar Ali, Khairil Juhanni Bt. Abd Karim & Nor Aziah Buang (2015) A Review of the Properties and Applications of Poly (Methyl Methacrylate) (PMMA), Polymer Reviews, 55:4, 678-705
3. Bishop, Susan & Roberts, Howard. (2020). Methacrylate perspective in current dental practice. Journal of Esthetic and Restorative Dentistry. 32. 10.1111/jerd.12633.
4. Sasseville D. Acrylates in contact dermatitis. Dermatitis. 2012 Jan-Feb;23(1):6-16.
5. Zafar MS. Prosthodontic Applications of Polymethyl Methacrylate (PMMA): An Update. Polymers (Basel). 2020 Oct 8;12(10):2299.
6. Wiltshire WA, Ferreira MR, Ligthelm AJ. Allergies to dental materials. Quintessence Int. 1996 Aug;27(8):513-20.
7. Mark A. Pemberton & Ian Kimber (2022) Methyl methacrylate and respiratory sensitisation: a comprehensive review, Critical Reviews in Toxicology, 52:2, 139-66
8. S. Gardeen, S. Hylwa, A Review of Acrylates: Super glue, nail adhesives, and diabetic pump adhesives increasing sensitization risk in women and children, International Journal of Women's Dermatology (2020).
9. Kucharczyk M, Słowik-Rylska M, Cyran-Stemplewska S, Gieroń M, Nowak-Starz G, Kręcisz B. Acrylates as a significant cause of allergic contact dermatitis: new sources of exposure. Postepy Dermatol Alergol. 2021 Aug;38(4):555-60.
10. Mikov I, Turkalj I, Jovanović M. Occupational contact allergic dermatitis in dentistry. Vojnosanit Pregl. 2011 Jun;68(6):523-25.
11. Kashinath, Naveen B H. K R and Mythri H. Nausheen. Rare but reality of methyl methacrylate in dentistry- a case study. Int J Pharm Pharm Sci. 2014;6(6). 39-40
12. Lugović-Mihić L, Ferček I, Duvančić T, Bulat V, Ježovita J, Novak-Bilić G, Šitum M. OCCUPATIONAL CONTACT DERMATITIS AMONGST DENTISTS AND DENTAL TECHNICIANS. Acta Clin Croat. 2016 Jun;55(2):293-300.
13. Rashid H, Sheikh Z, Vohra F. Allergic effects of the residual monomer used in denture base acrylic resins. Eur J Dent 2015;9:614-9.
14. Leggat PA, Kedjarune U. Toxicity of methyl methacrylate in dentistry. Int Dent J. 2003 Jun;53(3):126-31.
15. Lampel, H.P., Powell, H.B. Occupational and Hand Dermatitis: a Practical Approach. Clinic Rev Allerg Immunol **56**, 60–71 (2019).
16. Das S, Agarwal S, Pandey S, Madan R. A suspected case of allergic contact dermatitis due to Methyl methacrylate; Chronicles of Dental Research 2022 June;11(1).
17. Hochman N, Zalkind M. Hypersensitivity to methyl methacrylate: mode of treatment. J Prosthet Dent. 1997 Jan;77(1):93-6.
18. Centers for Disease Control and Prevention. National Institute for Occupational Safety and Health (NIOSH) “Hierarchy of Controls” Website.

https://www.cdc.gov/niosh/topics/hierarchy/default.html. Accessed April 11, 2020.

TABLES

Treatment Regime

1. Tab Amoxiclav 625 (amoxicillin 500, clavulanic acid 125mg)	Twice daily for 5 days
2. Tab hydroxyzine hydrochloride (hydrochloride salt) 10 mg	Once a day for 15 days.
3. Topical application of Topinate cream (Clobetasol propionate 0.05%)	Four times a day till the lesions subsides.
4. Moisturising cream	For every three hours

Table No. 1: Treatment regime

FIGURES

Figure No. 1

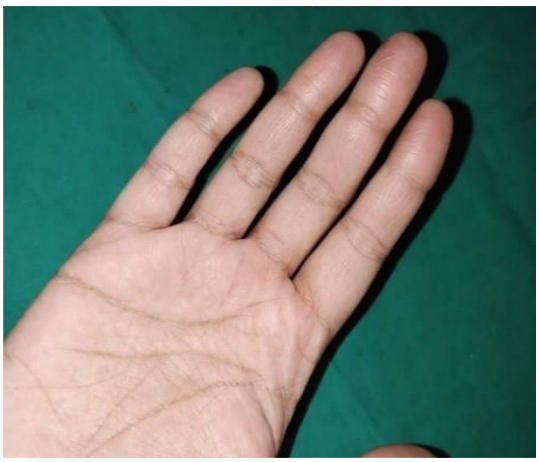

Figure No. 2

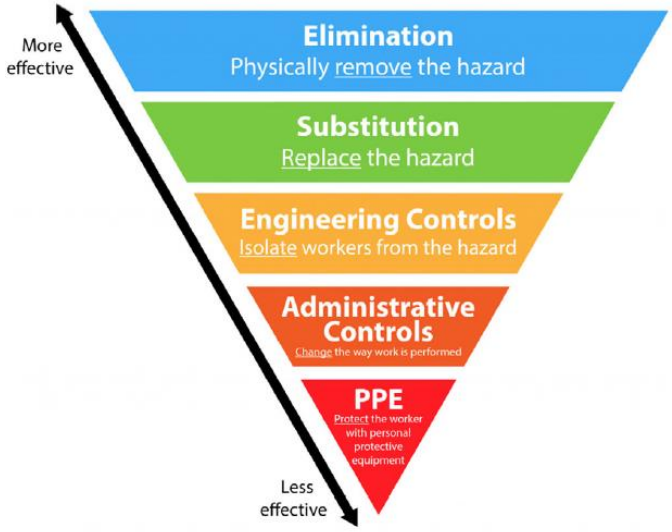

Figure No. 3